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GEOLOGICAL CORRELATION

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REPORT OF THE INTERNATIONAL GEOLOGICAL CORRELATION PROGRAMME (IGCP)

CONTENTS

Report of the twentieth session of the IGCP Board

Introduction, list of participants

The twentieth session of the IGCP Board was convened at UNESCO Headquarters in Paris, France, from 3 to 7 February 1991. It was attended by:

Board members

S. Alidou (Benin)
B.A. Baldis (Argentina), Vice-Chairman
A.G. Bellizzia (Venezuela)
K. Birkenmajer (Poland)
G.M. Brown (United Kingdom)
A. Dudek (Czechoslovakia)
S. Karamata (Yugoslavia)
L.K. Kauranne (Finland)
A.H. Kazmi (Pakistan)
A.J. Naldrett (Canada), Chairman
I.O. Nyambok (Kenya)
I.D. Ryabchikov (USSR)
B.J. Skinner (United States)
R.P. Suggate (New Zealand), Vice-Chairman and Rapporteur

Ex officio members

A. Badran, Assistant Director-General for Science, representative of the Director-General of UNESCO
R. Brett, Secretary-General of IUGS

IGCP Scientific Committee representative

R.A. Price (Canada), Chairman

IUGS

J.M. Aaron, ***Episodes***
J.W. Cowie, International Commission on Stratigraphy
J. Remane, International Commission on Stratigraphy

UNESCO, Division of Earth Sciences

E. Dudich, IGCP Secretary, Acting Director of the Division p.i.
E.K.M. Bloem, Assistant IGCP Secretary
S. Cochrane-Tyurin
L. D'Andigné de Asis
D. Jean

L.O. Kovács
S. Laryea
R. Missotten
B. Rouhban
K. Tokumaru

Observers from UNESCO

N. Ishwaran, Division of Ecology
S. Monsalve, Permanent Delegation of Chile
D. Rachid, Permanent Delegation of Algeria
N. Törnudd, UNESCO Press

Observers from other organizations

P. Bouysse, Commission on the Geological Map of the World
M. Millward, International Council of Scientific Unions
Z. Xun, Ministry of Geology and Mineral Resources, People's Republic of China

Observers from IGCP projects and National Committees

M.P. Aubry, Leader, IGCP Project 308
L. Cabrera, Co-Leader of IGCP Project 324
J. Barruol, French IGCP National Committee
N.P. de Bellizzia, Venezuelan IGCP National Committee
D.G. Benson, Canadian IGCP National Committee
T. Huiliang, IGCP National Committee of China
W. Orr, U.S.A. IGCP National Committee
A. Pärtan, Austrian IGCP National Committee
S. Reguant, Spanish IGCP National Committee
A. Tollmann, Austrian IGCP National Committee
Ch. Vassoughzade, Iranian IGCP National Committee

Observers of IOC-UN (OALOS) Programme on Ocean Sciences in relation to Non-Living Resources (OSNLR)

L. Awosika, Nigerian Institute of Oceanographic Research (Nigeria)
P.J. Cook, Vice-Chairman, Director, British Geological Survey, U.K.
R. Gruszka, United Nations
K. Kitazawa, Technical Secretary, IOC
C. Latouche, Consultant, University Bordeaux I (France)
L. Martins, University of Porto Alegre (Brazil)
A. Stefanon, University of Naples (Italy)

Opening address by the representative of the Director-General of UNESCO

Dr Brett explained that Dr Badran, who was unable to attend the session on behalf of the Director-General, had asked him to present his address. The key points in Dr Badran's address related to the financial situation. Although IGCP was highly regarded, as had been emphasized at the 1991 twenty-sixth session of the General Conference of UNESCO, it had to be included in the overall 21 per cent cut in 1992-1993 expenditure. Accordingly, the Board would need to make the necessary adjustments. Further, Dr Badran noted the growing dependence of IGCP on the voluntary contribution from the U.S.A. and United Kingdom, a situation which was regarded generally as unsatisfactory. He also noted, with regret, the coming retirement from UNESCO of the IGCP Secretary, Dr Dudich, and assured the Board that a suitable successor would be appointed.

Address by Dr R. Brett, Secretary-General of IUGS

IUGS maintained its support of IGCP and welcomed the participation of IGCP projects at the International Geological Congress at Kyoto. IUGS was most concerned about the 21 per cent cut in UNESCO support, with its consequence that the U.S.A./United Kingdom contributions had reached 45 per cent of the total IGCP funding. Following discussion with Dr Badran, there was a slight hope of a small contribution from the UNESCO Director-General's reserve. The Board might consider cutting administrative expenses, particularly those of the Scientific Committee (17 members) and of the Board (15 members), rather than taking money from the projects. IUGS was confident that UNESCO regarded IGCP highly, although there was a tendency to favour environmental, co-operative and similar programmes.

Address by the Acting Director of the Earth Sciences Division

Dr Dudich explained that because the position of the Director of the Earth Sciences Division was vacant, and Dr M. Hashizume, the Acting Director was on leave, he was presenting a report on the 1991 activities of the Division as the present Acting Director. He conveyed greetings from the former Director, Dr V. Sibrava, who is now back in Prague, Czechoslovakia. His successor, Dr F.W. Eder of Göttingen, Germany, was expected to take up his post in April 1992.

Geology for sustainable development

A *field workshop* on the Mozambique Belt was held in Tanzania, to review the state-of-knowledge and to prepare an integrated research proposal on this major Proterozoic belt in Eastern Africa.

Two workshops and several field campaigns were organized in the framework of the CASIMIR project concerning Lakes Tanganikar, Malawi and Baikal. The project strengthens West-East European and European-African co-operation. An effort is made to set up an information network on earth sciences projects related to major rift lakes.

Discussions are being held to explore possibilities of organizing *transect studies in southern Africa* in co-operation with the International Lithosphere Programme (ILP). These transects would allow the continuation of similar work undertaken by UNESCO in Latin America.

In co-operation with ILP and World Data Centers, *two pilot projects* are being undertaken concerning the use in African research institutes of geological (mainly geophysical) data in CD ROM, namely in Malawi and Zambia.

Data handling

UNESCO is developing with CIFEG, U.S.G.S., B.R.G.M. and M.R.A.C. (Musée royal de l'Afrique central, Belgium) a geodata exchange network called ***PANGIS*** (*Pan-African Geographical Information Systems*) in which 15 African countries participate. At the moment, the network includes bibliographic data only. However, factual data handling in the fields of hydrogeology, geochemistry, mineral resources and field geological data will be introduced by the end of 1992.

A workshop on the use of microcomputers for field geology data handling was organized in Spain for African geologists, in co-operation with IUGS.

IUGS/UNESCO Mineral Deposit Modeling Programme (DMP)

A special volume on *DMP sessions held during the IAGOD meeting* in Canada (March 1990) is in preparation. A DMP workshop focusing on tin and associated mineralizations will be held in Malaysia this year.

UNESCO/IUGS Geological Applications of Remote Sensing Programme (GARS)

The remote sensing activities of UNESCO have especially been strengthened in view of the International Space Year celebrations in 1992. (UNESCO will present its activities at two important congresses, namely 'Space in the Service of the Changing Earth' (Munich, 30 March-4 April 1992) and 'World Space Congress' (Washington D.C., 28 August-5 September 1992.)

The GARS programme focuses on *research on the use of multisensor data* for the study of natural hazards of geological origin such as landslide, and in the framework of the UNESCO/ITC (Netherlands) and UNESCO/MRAC *training and transfer of knowledge programmes* to Latin America and Africa. Space agencies give special support to the latter programmes by providing expert assistance and advanced access to data, e.g. ERS-1 or JES-1, microwave data sets.

Environment programmes are especially highlighted in view of UNESCO's participation in UNCED (United Nations Conference on Environment and Development, Rio de Janeiro, June 1992). In December 1991, *a refresher workshop on environmental geology for Eastern/Western European geologists* was held, in co-operation with IUGS and the Geological Survey of Prague.

Discussions will be held early 1992 concerning possibilities of co-operation with IUGS on a programme 'Earth Processes and Global Change'. Co-operation in this field is a priority, however, due to ever growing budgetary constraints, it would be difficult to identify the necessary funding sources.

Geological maps

Thanks to the active co-operation of the Commission for the Geological Map of the World, it has been possible to publish in 1991 the *Geological Map of South and East Asia* at the 1/5M and the *Geological Map of the World* at the 25/M. Both of them have been entirely computerized. The first sheet of the new edition of the *Map of Mineralizations of Africa* is in press and is being expected in the very near future, while work continues on the *Tectonic Map of Africa and on the Mineral Map of the World.*

Training courses

UNESCO continues to participate in the organization of activities aimed at increasing the number of scientists in developing countries through training courses and workshops in the various fields of the earth sciences.

Among others, in 1991, one can mention the following courses: Quarternary Geology, in Brussels, Belgium; Mineral prospection in Delft, Netherlands; and in Paris, France; Geochemistry, in Prague, Czechoslovakia; Metallogeny, in Quito, Ecuador; Mineralogy, in Madrid, Spain; Geothermics, in Pisa, Italy; and Kyushu, Japan; Seismic risk assessment, in Potsdam, Germany; Geophysics, in Hyderabad, India; Structural geology, in Dehra Dun, India; Geochemistry, in Sao Paulo, Brazil; Micro-palaeontology, in Buenos Aires, Argentina.

Natural disaster reduction

The UNESCO activities related to natural hazards in the Division of Earth Sciences continue to promote the scientific understanding of geological hazards such as earthquakes, volcanic eruptions and landslides, and the engineering and other measures for the mitigation of risks arising from these hazards.

The activities are being aligned to the fullest possible extent with the goals of the *International Decade for Natural Disaster Reduction (IDNDR)* which began in January 1990.

Regional and national seismological networks in the Balkans, Viet Nam, Mongolia and the Arab countries have been or are being improved.

The establishment of an *Institute of Earthquake Engineering and Seismology* in Iran is being executed by UNESCO.

The *Programme for Assessment and Mitigation of Earthquake Risk in the Arab Region* is being resumed after the Gulf crisis.

A project on *Training Materials for Disaster Reduction,* co-funded by Netherlands and Denmark is implemented by UNESCO.

Whereas the resources under the regular programme are scarce, six extra-budgetary projects related to natural hazards are ongoing, and two more are expected in 1992.

This confirms the increasing potential of this programme in mobilizing extra-budgetary resources.

We are pleased to note that Professor U.G. Cordani is a member of the *Scientific and Technical Committee for IDNDR.*

Report by the IGCP Secretary, Dr E. Dudich, on 1991

1. Thanks to the outgoing members of the Scientific Committee

The third and last two-year term of the following members of the IGCP Scientific Committee expired with 1991:

Professor H. A. F. Chaves, Chairman - Stratigraphy
Professor D.J. Groves, former Vice-Chairman - Mineral Deposits
Dr F.H.A. Hehuwat - Structural Geology and Tectonics
Professor E.F. Stumpfl - Petrology and Geochemistry.

I express herewith the sincere appreciation and hearty acknowledgement of the IGCP community for their six-year active contribution, hoping that they will maintain their interest for, and support to, IGCP.

2. New members of the Scientific Committee

For four vacancies, 64 nominations have been received from 24 countries. From some countries, several candidates were advanced for the same slot. This time, there were also two ladies among the nominees.

The four new members appointed jointly by the Director-General of UNESCO, Professor F. Mayor, and the President of IUGS, Professor U.G. Cordani, are:

Professor R.G. Coleman (U.S.A.), Structural Geology
Professor G. Gaál (Hungary), Mineral Deposits
Dr M. Iturralde-Vinent (Cuba), Stratigraphy
Dr M. Ramakrishnan (India), Petrography.

We congratulate and welcome them, expecting their active contribution to the progress and enrichment - both intellectual and material - of IGCP.

3. Outgoing members of the IGCP Board in 1992

I am pleased to inform you that there is no outgoing member of the Scientific Committee in 1992. On the contrary, seven members of the Board will complete their six-year service this year:

Dr S. Alidou (Benin)
Professor B.A. Baldis (Argentina), Vice-Chairman
Professor K. Birkenmajer (Poland)
Dr A. Dudek (Czech and Slovak Federal Republic)
Professor A.J. Naldrett (Canada), Chairman
Dr I.D. Ryabchikov (USSR)
Dr R.P. Suggate (New Zealand), Vice-Chairman and Rapporteur

4. IGCP projects terminated in 1990 Altogether *12* projects: (recapitulation)

No.	
165	Regional stratigraphic correlation of the Caribbean region; J.L. Yparraguirre (Cuba), 1983-1989, O.E.T. in 1990
211	Late Palaeozoic of South America; A.J. Amos, S. Archangelsky (Argentina), 1984-1989, O.E.T. in 1990
215	Proterozoic fold belts; R. Caby (France), 1984-1989, O.E.T. in 1990
217	Proterozoic geochemistry; K.C. Condie (U.S.A.), 1984-1990
219	Comparative lacustrine sedimentology through space and time; K. Kelts (U.S.A.-Switzerland), 1984-1990
224	Pre-Jurassic evolution of Eastern Asia; K. Ichikawa (Japan), 1985-1990
227	Magmatism and evolution of extensional regions of the African plate; A.B. Kampunzu, R.T. Lubala (Zaire), 1985-1989, O.E.T. in 1990
235	Metamorphism and geodynamics; L.L.Perchuk (USSR), M. Brown (United Kingdom), 1985-1989, O.E.T. in 1990
239	Exploitation of IGBADAT (Igneous rocks data base); J. Frizado (U.S.A.), 1985-1990
242	Cretaceous of Latin America; W. Volkheimer, J.A. Salfity (Argentina), 1986-1990
250	Regional crustal stability and geological hazards; Chen Qingxuan (China), 1986-1989, O.E.T. in 1990
285	Metamorphism in Eastern Asia; Chen Yugi, Dong Shenbao (China), provisionally in 1990

The final reports of the following terminated projects have been received: 211, 215, 217, 219, 224, 235, 242, 250.

The final, summarizing book published by Project 227 is suggested to be accepted as the final report of the project.

Reminders requesting submission of a final report have been sent to the leaders of the following Projects: 165, 239.

No final report is requested from Project 285.

5. Project proposals received in 1990 (recapitulation)

(1) Out of the record number of *27* proposals received, *ten* were accepted in 1991. The Board aimed at zero growth in order to avoid excessive dispersion of the available modest funds.

No.

301 Correlation of Palaeogene formations of South America; N. Malumiàn (Argentina), S. Benitez (Ecuador), 1991-1995

314 Alkaline and carbonatitic magmatism of the Earth and related ore deposits; L. Kogarko (USSR), J. Keller (Germany), 1991-1995

315 Correlation of rapakivi granites and related rocks on a global scale; I. Haapala (Finland), 1991-1995

317 Correlation of continental ancient weathering surfaces; M. Thiry, J.M. Schmitt (France), 1991-1995

318 Genesis and correlation of marine polymetallic oxides; J.R. Hein, B.R. Bolton (U.S.A.), 1991-1995

320 Neoproterozoic events and resources; N. Christie-Blick (U.S.A.), M. Fedonkin, M. Semikhatov (USSR), 1991-1995

321 Gondwana dispersion and Asian accretion in the Eastern Tethys and Western Circum-Pacific region; Ren Jishun (China), J. Charvet (France), Shigeki Hada (Japan), 1991-1995

324 Global limnogeology (GLOPALS); L. Cabrera, P. Anadon (Spain), 1991-1995

325 Palaeogeography and authigenic minerals; J. Lucas, L. Prévôt (France), 1991-1995

328 Palaeozoic microvertebrates; S. Turner, G.C. Young (Australia), A. Blieck (France), T. Marss (Estonia), N.Z. Wang, S.T. Wang (China), 1991-1995

(2) *Seventeen* projects were rejected in 1991, *nine* of them having been recommended for resubmission.*

No.

292 Global continental palaeohydrology; K.J. Gregory (United Kingdom), L. Starkel (Poland)

305 Influence of weathering on the physico-mechanical behaviour of rocks; B. Christaras (Greece), N. Herz (U.S.A.)

306 Stratigraphic correlation in Indochina; Tong-Dzuy Than, Dang Vu Khuc (Viet Nam), Ph. Janvier, H. Fontaine (France)

307 Seismotectonics and geodynamics of the Arabian plate; S. Alsinawi (Iraq)

312 Comparative studies of gold deposits; Liu Bingguang, Wang Xiuzhang, Zhou Chuanxin (China)

313* Quaternary period of closed basins; Kh. Aliyulla (USSR)

316* Boreal Triassic correlation; A. Yu. Egorov (USSR), A. Mørk (Norway)

319* Global palaeogeography of the late Precambrian and early Palaeozoic; V. Khain, K. Seslavinsky (USSR)

322* Jurassic events in South America; A.C. Riccardi (Argentina)

323* Middle Miocene-Pliocene magneto-stratigraphic correlations; D.P. Elston (U.S.A.), M. Lantos (Hungary)

326* Oligocene-early Miocene of the world; V. Yu. Reshetov, M.A. Akhmetiev (USSR)

327* Environmental geochemical monitoring; R. Salmihen, J. Kukkonen (Finland)

329* Neogene of the Paratethys; N. Krstić (Yugoslavia)

330 Emplacement and evolution of greenstones; N. Opiyo-Aketch (Kenya)

331 Physics and technology of minerals; A.S. Marfunin (USSR)

332 Seismic zoning; L.S. Srivastava (India)

333 Building linkages between petrological data bases; J. Frizado (U.S.A.), N.M. Rock (Australia), F. Bea (Spain)

Reminders have been sent to the proposers of the proposals recommended for resubmission, with the exception of PP 313, which has been decided to become part of Project 324 Global limnogeology.

6. Ongoing projects in 1991 (59 projects)

Fifty six active projects and three projects O.E.T. (Nos. 226, 233 and 237).

Distribution of projects according to the year of termination:

1991: 216, 226, 233, 237, 245, 246, 247, 249, 252, 254, 255, 257, 260, 261, 262, 264 (sixteen)

1992: 256, 259, 269. 270, 271, 272, 273, 274, 276, 277, 279, 280 (twelve)

1993: 267, 275, 281, 282, 283, 287, 291, 293, 294, 296, 297, 303 (twelve)

1994: 234, 253, 286, 288, 290, 299, 302, 304, 308 (nine)

1995: 301, 314, 315, 317, 318, 320, 321, 324, 325, 328 (ten)

7. Projects due to terminate in 1991 (16 projects)

No.

216 Global biological events in Earth history; O.H. Walliser (Germany), 1984-1991

226 Correlation of manganese sedimentation to palaeoenvironments; B. Bolton (Australia - U.S.A.), S. Roy (India), 1986-1990, O.E.T. in 1991

233 Terranes in the Circum-Pacific orogens; J.D. Keppie (Canada), R.D. Dallmeyer (U.S.A.), 1985-1990, O.E.T. in 1991

237 Floras of the Gondwanic continents; O. Rösler (Brazil), 1986-1990, O.E.T. in 1991

245 Non-marine Cretaceous correlation; N.J. Mateer (U.S.A.), Chen Pei-ji (China), 1986-1991

246 Pacific Neogene events in time and space; R. Tsuchi (Japan), 1985-1991

247 Precambrian ore deposits related to tectonic-styles; G. Gaál (Hungary) et al., 1986-1991

249 Andean magmatism and its tectonic settings; M.A. Parada (Chile), C. Rapela (Argentina), 1986-1991

252 The past and future evolution of deserts; N. Petit-Maire (France), 1987-1991

254 Metalliferous black shales; J. Pašava (Czechoslovakia), 1987-1991

255 Kibaran metallogeny; W. Pohl (Germany), A. Ntungicimpaye (Burundi), D.P.M. Hadoto (Uganda), 1987-1991

257 Precambrian dyke swarms; H.C. Halls (Canada), 1987-1991

260 Earth glacial record; M. Deynoux (France), 1987-1991

261 Stromatolites; S. Awramik (U.S.A.), 1987-1991

262 Tethyan Cretaceous correlation; G. Császár (Hungary), H. Kollmann (Austria), 1987-1991

264 Remote sensing spectral properties; M.H. Podwysocki, (U.S.A.), 1987-1991

8. Extension requests by projects

Active extension is requested by the following projects:

for 1992:	246, 254
for 1992-1993:	262
for 1993:	274
for 1994:	283
for 1995-1998:	253

Active extension will be requested in 1992 for 1993 by Projects 276 and 280.

O.E.T. status is requested for 1992 by Project 247.

9. The IGCP Secretary's missions in 1991

(1) **New Delhi (India)**, 3-10 March 1991

Aim: To attend the third IGCP Regional Meeting for Southwest Asia, organized by the Indian IGCP National Committee/Geological Survey of India and ROSTSCA. This meeting has been postponed from 1990, due to political troubles in the country.

(2) **Strasbourg (France)**, 24-28 March 1991

Aim: To attend the VIth Conference of EUG (European Union of Geosciences), and in its framework the Symposium of IGCP Project 287 'Tethyan Bauxites'.

(3) **Manila (Philippines), Bangkok (Thailand), Hanoi (Viet Nam)**, 3-17 November 1991

Aim: To attend the second IGCP Regional Meeting for Southeast Asia and the Pacific in Quezon City (Manila), to have consultations with ESCAP's Mineral Resources Division in Bangkok, and to attend the second conference on the Geology of Indochina in Hanoi.

(4) **Fontainebleau (France)**, 25 and 27 November 1991

Aim: To attend the inaugural meeting of IGCP Project 317 'Palaeoweathering records and palaeosurfaces'.

10. Regional IGCP meetings held in 1991

(1) **Third IGCP Regional Meeting for Southwest Asia, New Delhi (India)**, 3-8 March 1991

The meeting, postponed from 1990, was organized jointly by ROSTSCA, the Indian IGCP National Committee (Geological Survey of India), and the Wadia Institute of Himalayan Geology (Professor A.K. Sinha, former member of the IGCP Scientific Committee, present Co-Leader of Project 276). It was attended by delegates from six countries of the region: Iran, Afghanistan, Pakistan, Nepal, India and Sri Lanka. National activities and those of 16 IGCP projects operating in the region were discussed. It was considered that ROSTSCA should act as the focal point of IGCP activities in the region. Several ways of reinforcing regional co-operation were put forward and discussed, including the publication of a Newsletter in Delhi. No project proposals were tabled,

but it was hoped that such would come from the region as an outcome of the meeting.

A field trip went to Mussoorie in the Lesser Himalayas, via Dehra Dun, where the Wadia Institute of Himalayan Geology was visited.

The next, Fourth Regional IGCP Meeting for Southwest Asia was offered to be hosted by Iran in 1993.

(2) **Seventh Regional Meeting of the IGCP for Latin America, Viña del Mar (Chile),** 8-9 August 1991

An IGCP meeting has been convened in conjunction with the VIth Chilean Geological Congress. (IGCP supported it financially with US $4,000 from the IUGS voluntary contribution.) Two members of the IGCP Boards, Professor B.A. Baldis and Dr A. Bellizzia were present. Unfortunately, only three countries were represented: Argentina, Chile and Venezuela. Several new project proposals were tabled.

IGCP Round Table Meeting at the 7th Congress of the Association of European Geological Societies (AEGS), Paris (UNESCO), 10-12 September 1991

The round table was held on 12 September in the afternoon. Some 15 persons attended, from France, Hungary, Spain, United Kingdom and U.S.A. None of them was actively involved in IGCP. Accordingly, the meeting was a briefing and free exchange of ideas on IGCP rather than an IGCP meeting proper.

In the future, this type of meeting would need careful preparation involving several IGCP National Committees and Project Leaders.

Fourth Subregional Consultative Meeting of the IGCP National Committee Representatives of the Northeast Mediterranean Countries

This meeting was planned to take place in Autumn 1991 in Czechoslovakia or Hungary. However, due to the ongoing reorganization of the geological institutions in these countries, none of the two IGCP National Committees was able to undertake the organization of such a meeting in 1991. Instead, the Austrian IGCP National Committee has kindly offered to host the meeting in Vienna, from 27 to 29 April 1992.

(3) **Second (Third) Regional IGCP Meeting for Southeast Asia and the Pacific, Quezon City (Manila), Philippines,** 5-8 November 1991

Organized by ROSTSEA and the Philippine Institute of Volcanology and Seismology, the meeting was attended by delegates from eight countries of the region: Australia, China, Japan, Malaysia, New Zealand, Philippines, Republic of Korea and Viet Nam. Three project proposals were discussed. They will be submitted in 1992. The relaunching of the Southeast Asian Geosciences Newsletter was recommended. Problems of training courses to be held in the region were also discussed. A field trip went to the area devastated by pyroclastic mud flows (lahars) resulting from the mid-June 1991 explosive eruption of Mount Pinatubo volcano.

11. Participation of IGCP in major international meetings

(1) 24-28 March 1991
VIth EUG, Strasbourg, France
Projects 277, 280, 287, 294

(2) 25-30 June 1991
8th International Gondwana Symposium
Hobart, Tasmania, Australia
Projects 267, 272, 288

(3) 2-9 August 1991
XIIIth Congress of INQUA
Projects 252, 253, 274

(4) 6-14 August 1991
International Symposium on Granites and Geo-Dynamics
Moscow, USSR
Project 282

(5) 28-30 August 1991
Event Markers in Earth History
Calgary, Alberta, Canada
Projects 216, 293, 303

(6) 22-27 September 1991
International Congress on Carboniferous-Permian Stratigraphy and Geology
Buenos Aires, Argentina
Projects 270, 272

(7) 6-10 October 1991
5th International Congress on Pacific Neogene Stratigraphy
Shizuoka, Japan
Project 246

(8) 5-8 November 1991
VIIth GEOSEA
Bangkok, Thailand
Project 282

(9) 11-28 November 1991
5th International Conference on Circum-Pacific Terranes
Santiago de Chile
Projects 233, 267, 279, 288

12. Links of IGCP with major science programmes and institutions

Previously established co-operation was running smoothly. Ties were strengthened with INQUA.

13. Publications

Geological Correlation No. 18 (1990). The English and French versions have been published and dispatched according to the updated computerized address list.

Geological Correlation No. 19 (1991) was submitted by the IGCP Secretary for technical editing in June 1991. The French translation of the English-language manuscript is under way. (Delayed by the extra work-load imposed by the twenty-sixth session of the General Conference of UNESCO.)

N.B. Only a minority of the Project Leaders have produced text drafted specifically for publication in Geological Correlation.

A contract has been signed between UNESCO and the American Geological Institute (AGI) to produce Vol. IV (1985-1989) of the Catalogue of IGCP Publications. The publication list compiled on the basis of the data supplied by the Project Leaders has been sent to AGI which had to produce the revised and completed text by 31 December 1991.

The Report by the Board of the International Geological Correlation Programme on its Activities (1990-1991), document 26 C/85, was submitted on 15 September 1991. The original English text has been translated into the other five conference languages of UNESCO (Arabic, Chinese, French, Russian and Spanish) and printed. It was presented to Special Commission III of the twenty-sixth session of the General Conference of UNESCO by the Chairman of the IGCP Board, Professor A.J. Naldrett, on 28 October 1991.

Episodes, the journal of IUGS, continued publishing information on IGCP.

Vol. 14 No. 1 (March 1991)

pp. 73-74 15th Colloquium on African Geology (Nancy, France), 10-13 September 1990
Projects 210, 227, 252, 255, 282, 288

pp. 75-76 Metamorphic styles in young and ancient orogenic belts (Calgary, Canada), 6-23 August 1990
Projects 235, 304

pp. 77-78 New IGCP projects accepted and starting in 1991

pp. 80-81 IGCP Project 299: Geology, Climate, Hydrology and Karst Formation

Vol. 14 No. 2 (June 1991)

pp. 145-146 Reconstructing the Tethyan High Sea (IGCP Project 262, Cracow, Poland, 28 May-2 June 1991)

pp. 153-154 Correlating the Tethyan Cretaceous - Activities and achievements of IGCP Project 262

Nature and Resources, a scientific journal of UNESCO, has been renewed. *Vol. 27 No. 2 (1991)* was devoted to Natural Disasters. There are plans to produce an issue in 1993 on geology. Suggestions would be most welcome.

14. Annual reports received from IGCP National Committees

With the establishment of an IGCP National Committee in Portugal, as a result of the IGCP Secretary's mission to that country in January 1990, the number of formally existing IGCP National Committees has increased to *92*.

The number of additional contact addresses appearing in Geological Correlation has been reduced *from 37 to 22*, eliminating those which have not responded to the letters sent to them by the IGCP Secretariat for several years.

A *circular letter* was sent to all National Committees in October 1991, requesting submission of a Summary Annual Report (the Comprehensive Annual Report remaining optional).

As of 3 February 1992, the following *47* countries have reported: Albania, Argentina, Australia, Austria, Bangladesh, Belarus, Belgium, Benin, Brazil, Bulgaria, Canada, Chile, China, Costa Rica, Cuba, Cyprus, Czechoslovakia, Denmark, Finland, France, Germany, Greece, Hungary, India, Iran, Iraq, Italy, Japan, Republic of Korea, Morocco, New Zealand, Peru, Poland, Republic of South Africa,

Romania, Spain, Sweden, Switzerland, Thailand, Turkey, Ukraine, United Kingdom, U.S.A., USSR, Venezuela, Viet Nam and Yugoslavia.

15. Finances

(1) *The direct financing of IGCP projects in 1991* shows a slight increase of US $16,000 (5.2 per cent), due entirely to an increase of the IUGS voluntary contribution (the Royal Society of the United Kingdom and the US National Academy of Science).

Year	UNESCO	IUGS	Total	No. of projects			Average
				Overall	Funded	OET+nil	
	(all sums in US $1,000 units)						
1987	177.5	83.0	260.5	51	44	6+1	5.92
1988	173.5	104.0	277.5	53*	50	3	5.55
1989	143.1	109.9	253.0	55	50	2+3	5.06
1990	185.0	121.0	306.0	61	54	6+1	5.67
1991	185.0	137.0	322.0	59	55	3+1	5.85

* Including a symposium organized by the subprogramme 'Quaternary Geosciences and Human Survival'

In 1991, the distribution of funding was as follows:

Category	Range	No. of Projects
	(US $)	
High funding	(7,600-8,900)	7
Medium funding	4,700-6,600	45
Low funding	4,000	3
Nil funding	(3 O.E.T.+1 nil)	4
		Total 59

There were less 'high' and 'low' funded projects than in 1990 (13 and 9 respectively in 1990). This rendered it possible to increase their allocations.

The average funding was increased by US $180 (3.2 per cent). This reflects that the firm intention of the Board to stick to (approximately) zero growth in the overall number of funded projects (declining most of the requests for active extension and accepting only a limited number of proposals) was justified and successful.

As Professor Nadrett has repeatedly stressed (recently in the IGCP Chairman's address to Special Commission III of the twenty-sixth session of the General Conference of UNESCO) there is a potentially dangerous shift in the ratio of UNESCO and IUGS-channeled US+UK funding over the past years, both in absolute figures and in percentage:

Year	UNESCO	IUGS (US $1,000)
		%
1987	68.1	31.9
1988	62.5	37.5
1989	56.6	43.4
1990	60.4	39.6
1991	57.5	42.5

It should be pointed out, however, that this concerns only the direct funding of projects. The overall expenditure of IGCP from UNESCO's regular budget during the 1990-1991 financial biennium was *US $593,066*. Out of this amount, US $370,000 was granted directly to the projects (62.4 per cent), US $223,066 (37.6 per cent) has been used for other purposes. (This sum does *not* include the staff expenses.)

The streamlined contractual arrangement introduced in 1990 (one single global contract between UNESCO and IUGS instead of separate contracts for each project) was repeated and it functioned impeccably.

(2) *Overview of the funds decentralized to UNESCO's Regional Offices for Science and Technology (ROSTs) for regional IGCP meetings*

Year	Venue ROST in charge	Funds US $
1987	Latin America, ROSTLAC (Montevideo) (Tucumán, Argentina)	10,000
1988	Latin America, ROSTLAC (Montevideo) (Belém, Brazil)	10,000
	North-East Asia, Beijing Office	10,000
1989	Africa, ROSTA (Nairobi) (Nairobi, Kenya)	10,000
1991	South-West Asia, ROSTSCA (New Delhi) (New Delhi, India)	12,000
	South-East Asia and the Pacific, ROSTSEA (Jakarta)	14,000
	Latin America (direct) (Santiago de Chile)	4,000 IUGS funds
	Total	70,000

It has to be pointed out again that the south east and north east European subregional meetings have received *no financial support* from IGCP funds.

16. IGCP project proposals received by 15 December 1991

No.

306 RS Stratigraphic Correlation in South-East Asia; Tong-Dzuy Thanh, Dang Vu Khuc (Viet Nam), Ph. Janvier (France)

307 RS Geodynamics of the Arabian Lithosphere; S. Alsinawi (Iraq), Z. El-Isa (Jordan)

310 RS Correlation of Oil Shales; G. Panov (Bulgaria)

311 RS Phanerozoic River Deltas; V. Babadagly (Ukraine)

319 RS Palaeogeography of Late Precambrian and Early Cambrian; V. Khain, K. Seslavihsky (USSR)

322 RS Jurassic Events in South America; A.C. Riccardi (Argentina)

326 RS Oligocene-Miocene Transition in the North Hemisphere; V. Yu. Reshetov, M.A. Akhmetiev (USSR)

329 RS Neogene of the Paratethys; N. Krstić (Yugoslavia)

No.

334 New Mid-Atlantic Correlation in the last 150 ka; N. Petit-Maire (France), J. Meco (Spain)

335 New Recovery from Mass Extinctions; W.D. Almon (United States)

336 New Intraplate Magmatism and Metallogeny; M.L. Zientek (United States)

337 New Palinspastic Reconstruction of the Central Paratethys; A. Nagymarosy (Hungary)

338 New Precambrian Rocks in Afghanistan Territory; S.M. Nek (Afghanistan)

339 New Geomagnetic Equator; Nguyen Thi Kim Thoa (Viet Nam)

340 New Fossil Vertebrates and the Geological Time-Scale; S.G. Lucas (United States)

341 New Southern Hemisphere Palaeo- and Neo-Climates; W. Volkheimer, R. Compagnucci (Argentina)

342 New Age and Isotopes of South American Ores; M. Zentilli (Canada)

343 New Stratigraphic Analysis of Tethyan Basins; J. Dercourt (France), F. Cecca (Italy)

344 New Biosedimentology and Correlation of Microbial Buildups; C. Monty (France)

345 New Andean Lithospheric Evolution; M.C. Gardeweg (Chile), R. Pankhurst (United Kingdom), C. Rapela (Argentina)

Altogether 20 project proposals (eight resubmitted and 12 new ones).

17. IGCP meetings of regional character proposed for 1992

Eighth IGCP Regional Meeting for Latin America and the Caribbean Region

Its date and venue are still under discussion. ROSTLAC (F. Repetto) proposed to organize it in Guatemala City, in conjunction with the 8th Geological Congress of Central America, 9-13 November 1992. This would be the first meeting of this type in Central America.

The fourth Consultative Meeting of the IGCP National Committee Representatives of the North-East Mediterranean and Neighbouring Countries, Vienna, Austria, 27-29 April 1992.

18. The CANARID failure

In 1990, the Canarian Government authorities proposed to UNESCO and IUGS to discuss a draft

agreement of establishing a permanent research, documentation and field training centre on the geology and hydrogeology of arid areas.

The IGCP Secretary and Dr N. Petit-Maire, Leader of IGCP Project 252 and Vice-President of IUGS, went on mission to the Canary Islands in November 1990 to discuss this issue. Subsequently the IGCP Secretary drafted several successive versions of the Agreement, in consultation with the Legal Affairs Division of UNESCO. In March 1991, IUGS announced its withdrawal from the planned trilateral agreement. In the meantime, elections were held on the Canary Islands, and a new government has been formed. Upon request of UNESCO's Bureau of External Relations, the Permanent Delegation of Spain at UNESCO was also contacted, in order to obtain the approval of the Spanish Ministry of Foreign Affairs. As a consequence, the Agreement could not be forwarded to the twenty-sixth session of the General Conference of UNESCO for approval. It is doubtful whether the issue is worth being pursued.

19. Final words of the IGCP Secretary

In a memo dated 19 September 1991, addressed to Mr A. Badran, Assistant Director-General for Science of UNESCO, I announced that I do not wish to extend my contract with UNESCO beyond the end of my third two-year term, i.e. *30 September 1992,* and I will return to my home country, Hungary.

I feel that it has been an extraordinary privilege to serve the Earth Science community of the world as the Secretary of IGCP for six years.

I have tried hard to do my best.

It is not up to me to assess the outcome, to draw a balance of the achievements and shortcomings. However, I am convinced that IGCP is now more dynamic than ever, and I am sure that my distinguished successor will find its administration and management in a fairly good shape.

I sincerely hope that he (or she) will be able to counterbalance the present budgetary constraints and achieve a further upswing of IGCP activities.

Anticipating the final words of my 'swan song' to be presented at the IGCP Symposium of the 29th International Geological Congress, I would like to express my sincere gratitude to all colleagues who have contributed to the success of IGCP, rendering my work in the Division of Earth Sciences of UNESCO both profitable and enjoyable.

Report by the Chairman of the Scientific Committee

Dr Price presented his report. This included:

(a) Recommendations:

1991 projects: 11 terminations
2 O.E.T.
1 No funding
11 Low funding
27 Medium funding (2 A.E.)
7 High funding (1 A.E.)

Proposals: 2 Rejection
6 Resubmission
1 Integration
3 Low funding
8 Medium funding

The recommendations would result in an increase of one in the number of projects to be funded.

(b) Suggestions for meetings in 1993 and 1994 in the context of diminished funding:

'The Scientific Committee, recognizing that proper scientific peer review and geographic representation is essential for maintaining the scientific quality and credibility of IGCP, and that under the current financial crisis any money spent on meetings of the Scientific Committee and the Board must result in further cuts of IGCP projects or of the level of support to IGCP projects, recommends to the Board that the Statutes of IGCP be modifed to provide:

(1) that for 1993, as an emergency measure, the Scientific Committee conduct part of its scientific review and assessment by mail, telephone and fax (using a procedure and schedule that was developed during the Scientific Committee and that involves co-ordination by four working group leaders) and the remainder of its review and assessment in a joint, four-day meeting of the Scientific Committee and the Board. This meeting is to involve the four working group Leaders, Rapporteur and Chairman of the Scientific Committee and three representatives of the Board; the costs of this participation to be covered by the $17,500 requested from the Director-

General's reserve. Other members of the Board and Scientific Committee may attend if their travel costs are covered from other sources);

(2) that for 1994 and subsequent years the Scientific Committee be merged with the Board to form a single Management Committee of about 18 members that includes the present range of discipline expertise and geographic representation of the Scientific Committee, to ensure the scientific quality and credibility of IGCP'.

(c) The Scientific Committee recommended particular IGCP topics that were worth bringing to the attention of the media:

(1) oldest rocks on earth
(2) the growth and destruction of supercontinents
(3) new sources of precious metals
(4) contribution to global change.

***Note:** A UNESCO press representative later discussed these and other topics with the appropriate Board members.

(d) The Scientific Committee considered that extra-budgetary funding could be sought.

Discussion of the report focused on the need for cutting costs.

Comments of Board members on 1991 activities

Several members of the Board noted that IGCP projects featured at more international meetings than had been previously noted. Others indicated that changes were common to the way in which national scientific funds were allocated, making it more difficult for direct funding of IGCP projects. **Mrs Pärtan** (Austria, observer) noted, however, increase of support to IGCP projects in Austria.

Dr Skinner noted that ICSU had provided 16 position papers, six in part geological, for the UNCED Conference in Brazil in 1992. ICSU regarded IGCP as both important and as a good international programme.

Dr Brett noted that the proposal for a UNESCO programme 'Earth Processes and Global Change' had not succeeded because of lack of funding, although modest funds were available for a workshop on the subject.

Dr Brett also noted that the backing of ***Episodes*** from the United States Geological Survey was to be terminated for financial reasons and IUGS was currently looking for a new permanent home.

Discussion of how to deal with financial problems

The **Chairman** asked for general discussion on this topic. He said that he would nominate a working group to examine the question in detail and report back. He suggested that there was general agreement that it was undesirable to make cuts solely to the projects.

Dr Price noted that the short-term (1993) problem needed to be separated from consideration of any future changes.

Dr Baldis: Because IGCP is a highly regarded programme, the Board should not think in terms of economy, which could damage the programme. The Scientific Committee and Board should continue.

Professor Skinner noted that the debate was long-standing and urgency was forced on us now by the UNESCO funding crisis. The Board could only give advice to UNESCO and IUGS.

Dr Suggate suggested that any proposals should be for permanent changes, should be simple, and should maintain both Scientific Committee and Board functions. Savings could come from less frequent reviewing.

Professsor Malcolm Brown considered that cuts should not fall on only the projects or only the Scientific Committee and Board. New project proposals could be judged more critically.

Dr Kauranne supported Dr. Suggate's suggestion and considered that both Scientific Committee and Board meetings could be completed within one week.

Dr Karamata noted that the Statutes may need to be changed. Perhaps the number of Board members from Europe could be reduced.

Professor Price emphasized the need for annual meetings of the Scientific Committee, particularly for the assessments of new proposals. Board reviews of annual reports might be reduced. The Scientific Committee has strong regional representation which should be a factor in reviewing the activities of the Scientific Committee and Board.

Dr Nyambok regarded the Scientific Committee and Board as complementary, but

members could be reduced on both. All projects might not need to be reviewed every year. Meetings could be shorter, but should be held annually.

Dr Dudek emphasized the need for annual assessment of new proposals. Projects that do not seem to be going well should be cut. Now was the opportunity to reduce numbers especially of the Board.

Professor Malcolm Brown supported Dr Price in identifying the Scientific Committee as the key to IGCP reviewing. He thought that initial addresses to the Board (and Scientific Committee) might be omitted as they did not lead to discussion. Reviews of National Committee reports could be done by non-attending Board members.

Professor Skinner suggested that Board members might act as primary reviewers for the Scientific Committee.

The **Chairman** nominated Professor Price, Professor Skinner (Chairman), Dr Kazmi and Dr Karamata to report on Wednesday on both short- and long-term advice for UNESCO and IUGS. Cuts to funds allocated to projects should be less than 10 per cent. Suggestions from Board members should be given to the working group.

The **Secretary** noted that the previous day's meeting between himself (as Acting Director of the Earth Sciences Division) and Dr Badran gave some hope for relief from this year's problems.

Dr Brett said that IUGS regarded the present situation as an opportunity for change, and that the changes to any regulations could be effected quickly.

Working group recommendations

These were presented by **Dr Skinner**, who indicated that except on the question of European representation on the Board, they were unanimously agreed.

1994 and subsequently

(i) Board of seven members, drawn (as far as possible) from geologically coherent regions:

Europe (including Russia), South-East Asia, Australia and South-West Pacific, North-East Asia, South and Central Asia, Africa, North America (including Mexico), South and Central America and the Caribbean.

Professor Skinner emphasized that these deliberately avoided cultural, linguistic or similar groupings. He noted that six of the regions were represented among the eight members of the Board who will continue to 1994. A minority opinion was that the Europe/Russia region should have two members.

(ii) Scientific Committee of 13 members:

Three for each working group (Petrology, etc.) Chairman

(iii) Meeting schedule for 1994 and beyond:

	Scientific Committee	Board
Sunday afternoon	x	
Monday	x	
Tuesday	x	
Wednesday	x	x
Thursday	x	x
Friday		x
Saturday		x

The general presentations from UNESCO, IUGS etc. would be given on Wednesday, avoiding the present duplication.

(iv) 1993 special problem

This arises because the present 32 members of the Scientific Committee and Board are in Paris for a week in 1992, taking a large part of the money available for both 1992 and 1993 meetings in the biennium. Accordingly specially great reductions are desirable for 1993.

Scientific Committee: Chairman, Working Group Leader

Board: Chairman, Vice-Chairman, one other to redress any regional imbalance among the Scientific Committee and Board

The reduction of the Scientific Committee is made possible by using an external review system (mail, fax, etc.) among the whole committee.

*Note: In view of the fact that two Vice-Chairmen were later elected for 1993-1994, the members attending in 1993 will be the Chairman and the two Vice-Chairmen.

(v) External review system

Professor Skinner indicated that the system was already being developed by the Chairman of the Scientific Committee. Deadlines would have to be carefully set and precisely kept.

(vi) After 1994

The Board, at its meeting in 1994, would need to decide whether the special case for 1993 should become the general case for alternate years. It was emphasized that it was essential to the success of the external review system that the whole Scientific Committee should meet at least every second year in order to gain mutual appreciation of the way in which the system was being operated by the diverse individuals.

The **Chairman** indicated that discussion should focus on the four principal aspects:

(a) 1994 and beyond. After general discussion, the Board agreed to the working group's proposal.

(b) 1993. The Board agreed to the working group's proposal.

(c) Selection of Chairman and Vice-Chairman for 1993. The Board agreed to the Chairman's proposal that nominations should be given to the Secretary and an election held, if necessary.

(d) Europe/Russia representation. Dr Karamata considered that the huge extent of the region, together with the scale of IGCP activity within it, warranted two members. In general discussion it was emphasized that IGCP organization needed to be considered from a global point of view, and greater representation from regions where activity was less could be regarded as desirable. After it was reiterated that the Board's suggestions were only advisory to UNESCO and IUGS, where the decision lay, discussion lapsed.

The **Chairman** indicated that the recommendation of the Board should be adequate to avoid major cuts to projects. Nevertheless, the final result would depend on whether the additional money requested from the Director-General's reserve becomes available.

It was calculated that for 1993 there would be a reduction of 76 per cent in the cost of the Scientific Committee and Board meetings. For 1994 the reduction would be 44 per cent. Combined, the reduction would be about 60 per cent.

Review of annual reports of IGCP National Committees

From a total of 92 National Committees, 47 reports were received. Individual Board members appraised groups of reports, which varied greatly in scope and detail. No significant changes in the extent of IGCP activity in individual countries were noted. Political changes are certain to lead to changes in National Committees. No special matters were brought to the attention of the Board.

Review of regional IGCP meetings

The **Secretary** reported:

(1) Third Regional Meeting of the IGCP for Southwest Asia, New Delhi, 5-6 March 1991

Six countries were represented each giving a report covering national IGCP activities. A regional newsletter was advocated but no funding is presently available. No new project proposals were brought forward.

(2) Third Regional Meeting of the IGCP for Southeastern Asia, Manila, 5-8 November 1991

Eight countries were represented. A revival of the South-East Asia Geosciences Newsletter was recommended, and the Australian representative indicated that Australia could take it over from the UNESCO Regional Office. Several project proposals were developed, two of which were submitted at the end of 1991.

Dr Baldis reported:

(3) Seventh Regional Meeting of the IGCP for Latin America and the Caribbean Region, Viña del Mar, 8-9 August 1991. Owing to some difficulties relating to financial support, only three countries were officially represented. One project proposal was developed.

Discussion of the recommendations of the Scientific Committee on the project annual reports and project proposals

The Chairman indicated that it was essential to examine all projects and proposals very carefully, in order to cope with the reduction in the UNESCO budget. With the drastic proposals concerning the Scientific Committee and Board meetings in 1993, and with the hoped-for partial recuperation of funds from the Director-General, a cut to a maximum of 52 (from 55) funded projects was necessary if the level of individual project funding was to be maintained. He regarded this as essential. (A further cut to 48 would be necessary if the requested money was not provided.) Requests for active extension (funded) would almost certainly be rejected.

After the discussion one by one of the project reports and the project proposals, the decisions of the Board resulted in the following status of IGCP projects for 1992.

The following projects are ongoing:

No.	
234	Precambrian Volcano-Sedimentary Complexes in West Africa
253	Termination of the Pleistocene
256	Ophiolite Genesis and Evolution of Oceanic Lithosphere
259	International Geochemical Mapping
269	A Global Data Base in Sedimentary Petrology
270	Early Palaeozoic Events in Latin America
271	South American Palaeozoic Conodontology
272	Late Palaeozoic and Early Mesozoic Circum-Pacific Events
273	Archean Cratonic Rocks of Kasaï
274	Coastal Evolution in the Quaternary
275	Deep Geology of the Baltic Shield
276	Palaeozoic of the Tethys
277	Phanerozoic Oolitic Ironstones
279	Terranes in Latin America
280	The Oldest Rocks on Earth
281	Quaternary Climates of South America
282	Rare Metal Granitoids
283	Evolution of the Palaeoasian Ocean
286	Early Palaeogene Benthos
287	Tethyan Bauxites
288	Gondwanaland Sutures and Fold Belts
290	Anorthosites and Related Rocks
291	Metamorphic Fluids and Mineral Deposits
293	Geochemical Event Markers in the Phanerozoic
294	Very Low Grade Metamorphism
296	Quaternary in the Asia/Pacific Region
297	Geocryology of the Americas
299	Geology, Climate Hydrology and Karst Formation
301	Palaeogene of South America
302	The Structure and Metallogenesis of Central African Late Proterozoic Belts
303	Precambrian/Cambrian Event Stratigraphy
304	Lower Crustal Processes
308	Palaeocene/Eocene Boundary Events
314	Alkaline and Carbonatitic Magmatism
315	Rapakivi Granites and Related Rocks
317	Continental Answer
318	Marine Polymetallic Oxides
320	Neoproterozoic Events and Resources
321	Gondwana Dispersion and Asian Accretion
324	GLOPALS: Global Limnogeology
325	Palaeogeography and Authigenic Minerals
328	Palaeozoic Microvertebrates
	(42)

The following projects are O.E.T.:

No.	
246	Pacific Neogene Events in Time and Space
247	Precambrian Ore Deposits Related to Tectonic Styles
254	Metalliferous Black Shales
261	Stromatolites
262	Tethyan Cretaceous Correlation
	(5)

New and resubmitted proposals accepted:

No.	
306	Stratigraphic Correlation in South-East Asia
319	Global Palaeogeography of the Late Precambrian and Early Palaeozoic
322	Jurassic Events in South America
326	Oligocene-Miocene Transition in the Northern Hemisphere
329	Neogene of the Paratethys
336	Intraplate Magmatism and Metallogeny
339	Geomagnetic Equator
342	Age and Isotopes of South American Ores
343	Stratigraphic Analysis of Peritethyan Basins
	(9)
Total	56

The following table summarizes the allocation of funds:

	Funding				
	High	Medium	Low	Nil	Total
Ongoing projects	3	30	8	1	42
Accepted projects	-	8	1	-	9
Total	3	38	9	1	51

There are 50 funded projects. One is ongoing without funding. Five are on extended terms. The total of 1992 IGCP projects is 56.

Co-operation with other programmes and organizations

(1) **International Commission on Stratigraphy. Dr J. Cowie**, Chairman of ICS, spoke of the Commission's work, particularly related to the definition of boundaries of internationally recognized units. He noted that the number of subcommissions and working groups had been substantially reduced by putting boundary working groups into the subcommissions on the overlying major units. Other subcommissions were concerned with stratigraphic classification and geochronology; committees were concerned with quantitative stratigraphy and with the relation between the continental and oceanographic records.

(2) **UNESCO World Heritage Commission. Dr J. Cowie**, Chairman of the Working Group on Geological Sites, spoke of the work of the group. He acknowledged that the problem of criteria for sites is exceptionally difficult, particularly as the UNESCO World Heritage Commission will finally select about 30. Only in Northern and Western Europe, North America and Australia were there sufficient sites nominated to his working group. A suggestion for an IUGS-sponsored data base of perhaps thousands of sites was being considered at the level of a pilot project.

(3) **Intergovernmental Oceanographic Commission. Dr K. Kitazawa**, Assistant Secretary of IOC, attended the meeting together with **Dr P. Cook**, the Vice-Chairman of the I.O.C.L.R. Committee which is concerned with the ocean's living resources. Dr Cook spoke particularly of work relevant to IGCP projects in the coastal zone where IOC has some regional projects, and the continental margins where there are projects off the coasts of Portugal, Morocco and Peru. In discussion, Dr Cook indicated that projects usually involved 50-100 people, but there was not a large involvement of individuals from developing countries. IOC had a major role in data co-ordination. Its work on non-living resources was closer to IGCP, and knowledge of each other's projects would be beneficial.

IGCP presence at the 29th IGC, Kyoto, 1992

The **Secretary** indicated that IGCP would have a half-day general symposium, and that 16 projects were involved in presentations at IGC.

Professor Skinner suggested that more publicity documents on IGCP should be available than at the 28th IGC, and that the symposium should be brought to the attention of Scientific Committee and Board members and project Leaders.

Other business

(1) 30th IGC 1996 - China's preparations towards holding the Congress. **Professor Zhao Xun** made a comprehensive exposition of the progress being made towards holding the Congress, which they are expecting to do following an invitation that China gave at the 28th IGC. Conference facilities, programme preparation, field excursion planning, involvement of many organizations; all these indicate that a well-organized Congress can be staged. The context is the enormous variety in the geology of China. While the decision by IGC to hold the 30th IGC in Beijing is not yet made, nowhere else can be as well prepared as China.

(2) **Dr Kazmi** proposed that, to improve communication and co-ordination, the Secretariat should ask project Leaders to send copies of newsletters, progress reports, etc. to the relevant Board member(s) in the regions that individual members were now apparently to represent. A list of Board members could be sent to each project Leader. The **Secretary** indicated that this could be useful.

(3) **Dr Kazmi** suggested that regional meetings should be attended by Board members. The **Secretary** noted that they used to be, and that an attempt could be made to reinstate the practice.

(4) **Election of offices for 1993-1994**

The following were elected by acclamation:

Chairman:	Professor Malcolm Brown
Vice-Chairmen:	Dr Kazmi
	Dr Nyambok

(5) *Episodes*

Dr Kazmi asked whether continuation after the withdrawal of USGS support was likely.

Professor Malcolm Brown indicated that some very preliminary discussion with Dr Cook, Director of the British Geological Survey, indicated a small hope that the journal might be produced in the United Kingdom.

(6) **Dr Nyambok** continues to be concerned that the philosophy behind IGCP was not well understood in much of Africa. Had AGID been contacted to assist?

The **Secretary** replied that AGID had not been reached last year; he would try again.

(7) **Levels of funding of projects in 1992**

The **Secretary** reported that after deliberation with Dr Brett, Secretary-General of IUGS, it is anticipated that the 1991 levels of project funding are being maintained in 1992.

Dates of the next sessions of the Scientific Committee and the Board

Following the previous decision a joint meeting of only the principal members of the Scientific Committee and the Board will be held in 1993. The dates are 1-5 February 1993.

Adoption of the minutes

After minor corrections, the minutes were adopted.

Closing of the session

In closing the 20th Session of the IGCP Board, the Chairman spoke as follows:

Chairman's concluding remarks

Ladies and Gentlemen, it is with sadness that I realize that this will be my last report to you as your Chairman. I have enjoyed my six years on the Board and two years before that as observer for Canada very much indeed. Not the least because of the kindness and friendliness that is always given to us by the staff of the Secretariat. This year is no exception, and I would like to thank this year's staff very much for all their hard work on behalf of all of us.

It is with enormous regret that we note that Endre Dudich will be leaving IGCP. His six years at UNESCO have coincided exactly with the term of seven of us. We have seen IGCP grow to a record level of funding and number of projects in 1991 under his capable leadership. New proposals have never been more numerous than they were last year, rarely as numerous as this year. The science, and the enthusiasm with which it is undertaken within IGCP has never been stronger than under his leadership. IGCP is going to miss him, particularly at this time when the foundations of our financial support are being shaken so severely.

Turning to finances, despite warnings in each of my three preceding 'Concluding Remarks' about the reduction in UNESCO funding leaving us enormously exposed to financial decisions in the United States and United Kingdom, we are now rapidly heading to the point where IGCP must be viewed as a United States-United Kingdom programme with assistance from UNESCO. If the United States and United Kingdom funding were withdrawn, the programme would now be unworkable.

It has been with great difficulty and some cost that we have struggled this week to make recommendations to cope with the 21 per cent reduction in UNESCO funding that was imposed on us only a few weeks after the delegates at the 1991 General Conference had approved the Director-General's budget for the 1993-1994 biennium. In our recommendations, we have given priority to preserving IGCP's scientific integrity, and I believe that this has been achieved in that there will be no diminution in funding per project this year. Part of the cost has been the elimination of six ongoing and two new proposals that had been approved by the Scientific Committee. We have achieved most of our saving through recommending cuts in administrative expenses. However, also to preserve scientific integrity, we felt it necessary that minimal cuts be made to the Scientific Committee, reducing them from 17 to 13. This has had the result that we suggest that the Board be cut from 15 to seven, and has brought with it the sad situation that we are recommending that the traditional European membership of six shrink to one or perhaps two; along with this we recognize that the Europe as defined by us extends from Iceland to the Bering Straits. It is no wonder that our European colleagues

are disturbed - and yet when Cape Town to Damascus is represented by one person, as is Fiji to Bangkok, others feel that European representation should be reduced accordingly.

Once we are over the present difficult biennium (1992-1993) which has been brought about by the imposition of cuts after many expenditures for 1992 had already been incurred, we are still far from out of the woods. Our recommendations for the new Scientific Committee will still incur 20 person weeks in per diem, plus air fares per year, amounting to 40 over the biennium, when we only have funding (without cutting into project funds) for 32 person weeks and air fares per biennium. Unless we receive addbacks amounting to eight person weeks plus fares, the full Scientific Committee and Board will only be able to meet every two years, with a skeleton group (about eight people) meeting on alternate years. This will bring about a major deterioration in the quality of review, in the consistency of advice and in cohesiveness of the whole of IGCP.

Mr Chairman and Vice-Chairmen elect, continuing members of the Board, I believe that my analysis is correct - I believe that we have struggled with the cuts this year, we have teetered on the brink of division but have drawn back and remain a cohesive group, working together for the good of the programme, but I believe that we have gone as far as we can in saving money through simplifying administration, and that without additional funding of $25,000 on a regular basis per biennium in 1994 and beyond, IGCP faces a serious decrease in the quality of its programme. I wish you the very best in grappling with these problems in the future.

The nineteenth session of the IGCP Scientific Committee

The nineteenth session of the IGCP Scientific Committee was held from 27 to 31 January 1992 at UNESCO Headquarters, Paris, France. It was attended by:

Members of the Scientific Committee

A.-M. Abed
R.G. Coleman
J.J. Collin
D.L. Dineley, Vice-Chairman and Rapporteur
G. Gaál
M. Iturralde-Vinent
I. Kushiro, Vice-Chairman
R. Meissner
S. Mora-Castro
C. Mpodozis
R. Paepe
I. Premoli-Silva
R.A. Price, Chairman
M. Ramakrishnan
A.Yu. Rozanov
V.T. Vuchev

Absent

C. Schlüchter

IGCP Board representative

S. Karamata

IUGS

U.G. Cordani, President
R. Brett, Secretary-General

UNESCO

A. Badran, Assistant Director-General for Science, representative of the Director-General of UNESCO, Division of Earth Sciences
E. Dudich, IGCP Secretary
E. Bloem
S. Cochrane-Tyurin
L. D'Andigné de Asis
D. Jean
L.O. Kovács

S. Laryea
R. Missotten
B. Rouhban
Ch. Zhao

Observers

J.M. Aaron, ***Episodes*** (IUGS)
W. Orr, U.S. IGCP National Committee
M.P. Aubry, Leader, IGCP Project 308
Ch. Vassoughzade, Iranian IGCP National Committee

Address by Dr A. Badran, Assistant Director-General for Science, representative of the Director-General of UNESCO

Welcoming you at UNESCO Headquarters, I would like to point out that this session of the IGCP Scientific Committee takes place at a crucial moment: between the twenty-sixth session of the General Conference of UNESCO held in October-November 1991, and the United Nations Conference on Environment and Development (UNCED) which will take place in Rio de Janeiro, Brazil, in June 1992. Both of these are of great importance to UNESCO's science programmes, including IGCP.

IGCP celebrates its twentieth anniversary this year. On this occasion, I have the pleasure of conveying you the congratulations of UNESCO, which has always been very much pleased with the excellent progress and great impact of this programme.

At the twenty-sixth session of the General Conference of UNESCO in October-November 1991 IGCP was very much appreciated as providing an important forum for participation of Member States in studies of earth sciences. This was expressed by delegates of 32 Member States. There were voices calling for new IGCP projects, namely in Africa (Angola, Nigeria) and in southeastern Asia (Thailand). Two countries (People's Republic of China, Côte d'Ivoire) expressed their concern on decentralization of IGCP.

The Chairman of the IGCP Board, Professor A.J. Naldrett, seconded by the delegates of France and Botswana, expressed concern that the financing of IGCP is very much influenced by the policies of the United States and the United Kingdom, and appealed for stable funding from UNESCO. I am afraid this can materialize only when UNESCO regains universality.

For the time being, the financial situation of UNESCO remains critical. We have been forced by the circumstances to introduce a 21 per cent cut in the overall budget of the Science Sector of the 1992-1993 biennium as a budgetary rearrangement. To our regret, this affects also IGCP. It will be one of the important tasks of the present meetings of the Scientific Committee and Board to work out and adopt a - hopefully only temporary - solution which would reduce to the possible minimum the negative effect of this reduction on the direct financing of IGCP projects.

Another negative effect of our financial constraints is that UNESCO was unable to afford the extra sum of US $50,000 foreseen to support participation of young geologists from developing countries in the 29th International Geological Congress, US $9,000 decentralized to ROSTSEA remains available for the GEOHOST programme of the 29th International Geological Congress.

This year will bring about a major change in the IGCP Secretariat. As you may already know, Mr E. Dudich has decided to retire from UNESCO at the end of September 1992, after six years of service, returning to his home country, Hungary. His services have been very much appreciated. I can assure you that we will take care in replacing him in due time by another competent earth scientist, in full consultation with IUGS.

Address by Professor U.G. Cordani, President of IUGS

On behalf of IUGS, I would like to extend a hearty welcome to the four new members of the IGCP Scientific Committee, to Professor R.G. Coleman, Professor G. Gaál, Dr M. Iturralde-Vinent, and Dr M. Ramakrishnan. I wish them every success in their active contribution to maintaining the high scientific level of IGCP.

This year the 29th International Geological Congress, which will be held in Kyoto, Japan, provides us with an excellent opportunity to enhance the visibility of IGCP in the geoscientific community of the world, and to celebrate its twentieth anniversary - a considerable achievement for an international scientific programme. The journal of IUGS, ***Episodes***, has dedicated a full issue to the geology of and in Japan, supplying a good overview for non-Japanese geologists.

The financial problems which IGCP has to face due to the budgetary rearrangements for the 1992-1993 biennium of UNESCO have been discussed at the meeting of the IUGS Executive Committee held in Marseilles last week. IUGS insists very much on finding a solution which would ensure at least the 1991 level of funding of IGCP projects. Both the Scientific Committee and the Board are invited to contribute to the elaboration of such a solution, and IUGS is willing to agree to an eventual modification of the Statutes of the IGCP Board, if necessary. In this context, the support promised by Dr A. Badran, Assistant Director-General of UNESCO for Science, is very much appreciated and gratefully acknowledged.

IUGS has always praised IGCP. At the Executive Committee meeting in Marseilles the interdisciplinary character of IGCP was particularly stressed, in view of its past, present and future contribution to other international scientific

programmes and problems, such as Global Change, IDNDR, and environmental planning.

Last year an international high-level seminar was held in São Paulo, Brazil, on 'New Trends in Geology'. Its proceedings have been published in 'Ciência e Cultura', Vol. 43, No. 2, March-April 1991 (in English). The ideas presented by distinguished geoscientists should be taken into consideration for the future of IGCP.

Last but not least, I would like to express the gratitude and appreciation of IUGS to Dr E. Dudich, who has served as the IGCP Secretary for six years, and will return to his home country, Hungary, at the end of September 1992. He has contributed most efficiently indeed to the progress of IGCP, streamlining and modernizing its management. We have been informed that UNESCO has already taken the necessary steps to replace him by another highly competent earth scientist, with an appropriate overlapping in time, in order to ensure a smooth transition.

Address by the Acting Director of the Earth Sciences Division of UNESCO

Dr Dudich explained that because the position of the Director of the Earth Sciences Division was vacant, and Dr M. Hazhizume, the Acting Director, was on leave, he was presenting a report on the 1991 activities of the Division as the present Acting Director.

This is reproduced in the Board's report. Dr Dudich conveyed greetings from the former Director, Dr V. Sibrava, who is now back in Prague, Czechoslovakia. His successor, Dr F.W. Eder of Göttingen, Germany, was expected to take up his post in April 1992.

Introduction of new members

Professor R.G. Coleman (United States), Structural geology

Professor G. Gaál (Hungary), Ore deposits

Professor M. Iturralde-Vinent (Cuba), Tertiary stratigraphy

Dr M. Ramakrishnan (India), Petrology-geochemistry.

Election of the Chairman

Dr Dudich explained the procedure that had been followed for the election by postal ballot. The meeting confirmed Professor R. Price's election with acclaim.

Organization of the Committee's work and adoption of the agenda

The Committee adopted its usual arrangement of separate working groups for:

I. Stratigraphy and palaeontology (Leader: Dr I. Premoli-Silva)

II. Quaternary, hydro- and engineering geology (Leader: Dr S. Mora-Castro)

III. Petrology, geochemistry and ore deposits (Leader: Professor I. Kushiro)

IV. Structural geology, tectonics and geophysics (Leader: Professor R. Meissner)

The agenda was approved.

Report of the IGCP Secretary, Dr E. Dudich

Dr Dudich's report is included in the Board's report.

The Committee confirmed its belief that the peer review function of the Scientific Committee is essential for the scientific quality and credibility of IGCP. It was suggested that the immediate crisis for 1993 might be resolved by a shorter meeting of a reduced joint Scientific Committee and the Board but other arrangements were required for future years. The working groups were invited to discuss these matters and report back.

Assessment of project reports and project proposals

The assessments of 59 projects and 20 project proposals were prepared by the four working groups, discussed in plenary session, and finalized for submission to the Board.

Recommendations of the working groups for 1993 and 1994

The **working group leaders** reported on their views and suggestions for the Scientific Committee's meetings in 1993 and 1994. They agreed as below:

The Scientific Committee, recognizing that proper scientific peer review and geographic

representation is essential for maintaining the scientific quality and credibility of IGCP, and that under the current financial crisis any money spent on meetings of the Scientific Committee and the Board must result in further cuts of IGCP projects or of the level of support to IGCP projects, recommends to the Board that the Statutes of IGCP be modified to provide:

(1) that for 1993, as an emergency measure, the Scientific Committee conduct part of its scientific review and assessment by mail, telephone and fax (using a procedure and schedule that was developed during the Scientific Committee and that involves co-ordination by four working group leaders, Rapporteur and Chairman of the Scientific Committee and three representatives of the Board; the costs of this participation to be covered by the $17,500 requested from the Director-General's reserve. Other members of the Board and Scientific Committee may attend if their travel costs come from other sources);

(2) that for 1994 and subsequent years the Scientific Committee be merged with the Board to form a single management committee of about 18 members that includes the present range of discipline expertise and geographic representation of the Scientific Committee, to ensure the scientific quality and credibility of IGCP.

29th IGC, Kyoto, Japan

Dr Kushiro noted that preparations for the meeting were well in hand and that some five Committee members hoped to attend. Five thousand three hundred abstracts had been received. Each symposium convenor will receive US $1,000 support for his symposium. There will be 17 IGCP projects holding symposia, including one on IGCP itself. The GEOHOST programme has received about US $200,000 from the Japan Fund and US $9,000 from UNESCO.

Public relations

Professor Meissner distributed his discussion paper on IGCP topics worth bringing to the attention of the media. These and a fifth item will be indicated to the Board by the **Chairman**, with the request that they be used by the UNESCO Press Office and by members to raise the profile of IGCP in the scientific and popular press whenever possible.

Dr Mora-Castro suggested that Committee members be invited to contribute short presentations on their own research in future years, after the Scientific Committee had completed its business. The suggestion was readily accepted.

Financial support from OPEC

The **Rapporteur** moved a motion to request that the Board approach through the appropriate channels OPEC for substantial financial aid. IGCP is truly international in character and serves the earth sciences from which benefits accrue in all parts of the world.

The motion was *carried.*

The **Secretary** in response to questions stated that details of the programme's achievements and finances may be gathered from the five-yearly reports for a supporting document.

Dr Coleman asked if private patrons or affiliates may be enlisted by IGCP.

Dr Kushiro suggested that IGCP make known its financial needs at the 29th IGC and hold a discussion on steps to relieve them. Japanese industry might be persuaded to assist.

The **Secretary** confirmed that UNESCO encourages extra-budgetary funding.

The **Chairman** repeated his readiness to speak about these points at the coming meeting of the Board.

The Committee confirmed the minutes of the meeting and the appended documents, in particular the project assessments and the project proposal assessments.

Concluding remarks by the Chairman

The **Chairman** expressed his pleasure at the good form of the assessments that he would present to the Board. He thanked the Committee for its work and to the applause of the Committee he warmly thanked the Secretary for his splendid services throughout his time with IGCP.

Dr Dudich replied with thanks and good wishes.

List of IGCP projects (status as of February 1992)

No.	Title, Project Leader(s), Duration
234	Precambrian Volcano-Sedimentary Complexes in West Africa **I. Yacé (Côte d'Ivoire), M.A. Rahaman (Nigeria)** 1989-1994
246	Pacific Neogene Events in Time and Space **R. Tsuchi (Japan)** 1985-1991, O.E.T. in 1992
247	Precambrian Ore Deposits related to Tectonic Styles **G. Gaál (Hungary), V. Kazansky (Russia), S.C. Sarkar (India), Zhang Yixia (People's Republic of China)** 1986-1991, O.E.T. in 1992
253	Termination of the Pleistocene **J. Lundqvist (Sweden)** 1989-1994
254	Metalliferous Black Shales **J. Pašava (Czechoslovakia)** 1987-1991, O.E.T. in 1992
256	Ophiolite Genesis and the Evolution of Oceanic Lithosphere **N. Bogdanov (Russia), L. Beccaluva (Italy)** 1988-1992
259	International Geochemical Mapping **A.G. Darnley (Canada)** 1988-1992
261	Stromatolites **S.M. Awramik (United States)** 1987-1991, O.E.T. in 1992
262	Tethyan Cretaceous Correlation **G. Császár (Hungary), H. Kollmann (Austria)** 1987-1991, O.E.T. in 1992
269	A Global Data Base in Sedimentary Petrology **N. Nishiwaki-Nakajima (Japan)** 1988-1992
270	Early Palaeozoic Events in Latin America for the Gondwana Genesis **F.G. Aceñolaza, O.L. Bordonaro (Argentina)** 1988-1992
271	South American Palaeozoic Conodontology **M.A. Hünicken (Argentina), M. Suarez Riglos (Bolivia)** 1988-1992
272	Late Palaeozoic and Early Mesozoic Circum-Pacific Events **J.M. Dickins (Australia), Yang Zunyi (People's Republic of China)** 1988-1992
273	The Archean Rocks of the Kasai Craton **B.T. Rumvegeri, D. Kapenda (Zaire)** 1988-1992
274	Coastal Evolution in the Quaternary **O. van de Plassche (Netherlands)** 1988-1992
275	Deep Geology of the Baltic Shield **R. Gorbatschev (Sweden), F.P. Mitrofanov (Russia)** 1989-1993
276	Palaeozoic in the Tethys **D. Papanikolaou (Greece), P. Sassi (Italy), A.K. Sinha (India)** from 1991 1988-1992
277	Phanerozoic Oolitic Ironstones **J. Petránek (Czechoslovakia)** 1988-1992
279	Terranes in Latin America **F. Hervé (Chile)** 1988-1993
280	The Oldest Rocks on Earth **A. Kröner (Federal Republic of Germany), S. Moorbath (United Kingdom), B.M. Jahn (France)** 1988-1992
281	Quaternary Climates of South America **J. Argollo Bautista (Bolivia)** 1989-1993
282	Rare Metal Granitoids **Zhu Jinchu (People's Republic of China), P.J. Pollard (Australia)** 1989-1993

No.	Title, Project Leader(s), Duration
283	Geodynamic Evolution and Main Sutures of the Palaeo-Asian Ocean **Xiao Xuchang (People's Republic of China), N.L. Dobretsov (Russia), R.G. Coleman (United States)** 1989-1993
286	Early Palaeogene Benthos **L. Hottinger (Switzerland), E. Caus (Spain)** 1990-1994
287	Tethyan Bauxites **A. Dangić (Yugoslavia), A. Mindszenty (Hungary), L. Simone (Italy)** 1989-1993
288	Gondwanaland Sutures and Fold Belts **R. Unrug (United States), G.R. Sadowski (Brazil)** 1990-1994
290	Anorthosites and Related Rocks **M. Higgins (Canada), J.-C. Duchesne (Belgium)** 1990-1994
291	Metamorphic Fluids and Mineral Deposits **W. Frank, W. Prochaska (Austria)** 1989-1993
293	Geochemical Event Markers in the Phanerozoic **H.H.J. Geldsetzer (Canada), Xu Dao-Yi (China)** 1990-1993
294	Very Low Grade Metamorphism **R.E. Bevins, D. Robinson (United Kingdom)** 1989-1993
296	Quaternary in the Asia/Pacific Region **J.L. Rau (Thailand), V. Šibrava (Czechoslovakia)** 1989-1993
297	Geocryology of the Americas **A.E. Corte (Argentina)** 1989-1993
299	Geology, Climate, Hydrology and Karst Formation **Yuan Daoxian (People's Republic of China), H. Hotzl (Germany), J.W. Hess (United States)** 1990-1994
301	Correlation of Palaeogene Formations of South America **N. Malumián (Argentina), S. Benítez (Ecuador)** 1991-1995
302	The Structure and Metallogenesis of Central African Late Proterozoic Belts **M. Wendorff (Botswana), W.M. Katekesha (Zaire)** 1990-1994
303	Late Precambrian-Early Cambrian Event Stratigraphy **M.D. Brasier (United Kingdom)** 1990-1993
304	Lower Crustal Processes **B.J. Hensen (Australia), L.Ya. Aranovich (Russia),** 1990-1994
306	Stratigraphic Correlation in South-East Asia **Tong-Dzuy Thanh, Dang Vu Khuc (Viet Nam), Ph. Janvier (France)** 1992-1995
308	Palaeocene/Eocene Boundary Events **M.-P. Aubry (France)** 1990-1994
314	Alkaline and Carbonatitic Magmatism **L. Kogarko (Russia), J. Keller (Federal Republic of Germany), K. Bell (Canada)** 1991-1995
315	Rapakivi Granites and Related Rocks **I. Haapala (Finland), R.F. Emslie (Canada)** 1991-1995
317	Palaeoweathering Records and Ancient Continental Surfaces **M. Thiry, J.M. Schmitt (France)** 1991-1995
318	Genesis and Correlation of Marine Polymetallic Oxides **J.R. Hein, B.R. Bolton (United States)** 1991-1995
319	Global Palaeogeography of the Late Precambrian and Early Palaeozoic **K. Seslavinsky (Russia), I. Murdmaa (Estonia), T.P. Crimes (United Kingdom)** 1992-1996
320	Neoproterozoic Events and Resources **N. Christie-Blick (United States), M.A. Fedonkin, M.A. Semikhatov (Russia)** 1991-1995
321	Gondwana Dispersion and Asian Accretion in the Eastern Tethys and Western Circum-Pacific Region **Ren Jishun (People's Republic of China), J. Charvet (France), Shigeki Hada (Japan), I. Metcalfe (Australia)** 1991-1995
322	Jurassic Events in South America **A.C. Riccardi (Argentina)** 1992-1996
324	GLOPALS: Global Limnogeology **L. Cabrera, P. Anadón (Spain)** 1991-1995
325	Palaeogeography and Authigenic Minerals **J. Lucas, L. Prévôt (France)** 1991-1995

No.	Title, Project Leader(s), Duration
326	Oligocene-Miocene Transition in the Northern Hemisphere **V. Yu. Reshetov, M.A. Akhmetiev (Russia)** 1992-1996
328	Palaeozoic Microvertebrate Biochronology and Global Marine/Non-Marine Correlation **S. Turner, G.C. Young (Australia)** 1991-1995
329	Neogene of the Paratethys **N. Krstic (Serbia, Yugoslavia)** 1992-1996
336	Intraplate Magmatism and Metallogeny **M.L. Zientek (United States)** 1992-1996
339	Geomagnetic Equator **Nguyen Thi Kim Thoa (Viet Nam)** 1992-1995
342	Age and Isotopes of South American Ores **M. Zentilli (Canada)** 1992-1996
343	Stratigraphic Analysis of Peritethyan Basins **J. Dercourt (France), F. Cecca (Italy)** 1992-1996

Funded projects	50		
Nil funding	1	Total	56 projects
O.E.T.	5		

Nos. 216, 226, 233, 234, 237, 245, 246, 247, 249, 252, 253, 254, 255, 256, 257, 259, 260, 261, 262, 264, 267, 269, 270, 271, 272, 273, 274, 275, 276, 277, 279, 280, 281, 282, 283, 286, 287, 288, 290, 291, 293, 294, 296, 297, 299, 301, 302, 303, 304, 308, 314, 315, 317, 318, 320, 321, 324, 325, 328 (59 projects)

No. 216 - GLOBAL BIOLOGICAL EVENTS IN EARTH HISTORY (1984-1991)

O.H. Walliser, Institut für Geologie and Paläontologie, Goldschmidt-Str.3, D-34 Göttingen, Federal Republic of Germany.

Description: The project arose from a programme of the International Palaeontological Association (IPA). It is concerned with worldwide traceable exceptional changes ('events') within the biosphere. It aims at a better understanding of the interdependences of processes and extraordinary events in the biosphere, geosphere and atmosphere.

The principal objectives are: (1) study of those abiotic (geological) processes and events which provoke global biological events (geological level); (2) reconstruction of the overall effect of global geological events on the biosphere (evological level); (3) evaluation of the impact of global events on evolution and evolutionary mechanisms (evolutionary level); (4) refining of the stratigraphical scales and correlation methods by an integrated stratigraphic approach, aiming at a holostratigraphy with the highest time resolution (chronological level).

Achievements in 1991

Meetings

(1) Joint meeting of IGCP Projects 216, 293 and 303 on 'Event Markers in Earth History', Calgary, Canada, 28-30 August 1991.

(2) Vth and Final International Conference of Project 216: 'Phanerozoic Global Events and Event Stratigraphy', Göttingen, Germany, 16-19 February 1992.

The conference, in which 113 scientists from 29 countries participated, aimed at the discussion of the main achievements, which will be published in a volume with the title of the conference.

The main achievements of the project are:

(1) In contrast to the time when the project started its activity, now the existence of global bio-events is generally accepted.

(2) The extremely spectacular speculations about causes and patterns of global bio-events, which arose after the creation of the very innovative and fascinating Alvarez Hypothesis, are replaced by a much more critical approach now.

(3) The basis for item (b) is the rapidly growing accumulation of new data, received by extremely detailed investigations of critical levels in all regions of the world and on interdisciplinary co-operation including, e.g. geochemistry, oceanography, sedimentology, etc., besides all conventional and modern methods of palaeontology and stratigraphy.

(4) The new approach shows that each of the many discovered Phanerozoic global bio-events has its own individuality caused by the complexity of causes and processes. In most cases the causes are geological ones, such as sea-level changes or/and changes in climate and oceanographic parameters, plate movements, etc. The impact of an extraterrestrial body is an important but exceptional cause for global bio-events.

(5) Global bio-events play an important role in evolution. But also vice versa, the evolutionary level of a group of organisms, i.e. its diversity and specialization, plays a decisive role in the rate of extinctions.

(6) For the Phanerozoic, a detailed global event-stratigraphy has been established for the first time.

(7) The necessary refining of all stratigraphical methods results in much higher resolutions than ever before. The holostratigraphic method, i.e. the combination of all available stratigraphies, leads to an extremely high time resolution, even in the order of x 10^4 years.

(8) The concept of global events now has also gained entry to the considerations of the International Commission on Stratigraphy.

(9) From IGCP Project 216 several new IGCP projects or other scientific programmes arose. After having investigated the global bio-events itself as well as the causes and processes which lead to these events, a new project about 'Recovery of ecosystems after extinction events' is in preparation (Dr Warren D. Allmon, Tampa, U.S.A.). Thus, a continuation of the investigations on global events and their aftermath is guaranteed.

Publications

Altogether 137 scientific papers were published in 1991 under the aegis of the project.

Forty-four countries contributed to the project.

The Board once again commended highly the Project Leader and the participants for the absolutely remarkable achievements of this project. The Board recognized that the project has stimulated a new direction in stratigraphy, improving resolution and correlation throughout the whole Phanerozoic and making use of almost all fossil groups (even the most neglected of them), and clarifying the relationship between fossils and environmental parameters. In addition, the large number of countries effectively involved in the project also ranks it among the best of IGCP's products.

The project is successfully terminated.

No. 226 - CORRELATION OF MANGANESE SEDIMENTATION TO PALAEOENVIRONMENTS (1986-1990, O.E.T. in 1991)

B.R. Bolton, BHP-UTAH International Inc., 200 Fairbrook Drive, Suite 101, Herndon, Virginia, 22070-5200, U.S.A.

Supriya Roy, Department of Geological Sciences, Jadavpur University, 99/5/10 Ballygunge Place, Calcutta, 700 019 India.

Description: The aim of this multidisciplinary project is to determine the palaeoenvironmental setting of manganese sedimentation during Proterozoic and Mesozoic to Cenozoic times using genetic models established for various types of sedimentary manganese deposits. To this end, correlations will be made to contemporary tectonic, physical, chemical, biological, hydrospheric and atmospheric domains, and comparisons made with deposits from around the world, thus contributing to the understanding of the evolution of these deposits and to the development of conceptual models for manganese exploration.

Submission of a final report had been requested. However, no report has been received from the project co-leaders. Thus no evaluation was possible. The Board reiterated its request for a final report.

No. 233 - TERRANES IN THE CIRCUM-ATLANTIC PALAEOZOIC OROGENS (1985-1990, O.E.T. in 1991)

J.D. Keppie, Department of Mines and Energy, P.O. Box 1087, Halifax, Nova Scotia, Canada B3J 2X1.

R.D. Dallmeyer, Department of Geology, University of Georgia, Athens, Geogia 30602, U.S.A.

Description: The objectives of the project are to:

(1) identify and define the terranes and terrane boundaries;

(2) constrain the times of terrane amalgamation;

(3) determine the nature, extent and age of pre-, syn and post-accretionary movements;

(4) interpret the tectonic elements and metallogenesis within each terrane and the overstepping sequences; and

(5) outline the consequences for mineral and energy exploration in Circum-Atlantic

Palaeozoic Orogens from West Africa and northern South America, through Central and Eastern North America, Europe, Scandinavia and Greenland to the Urals, with extension into adjacent areas covered by younger deposits both onshore and offshore.

Submission of a final report had been requested. Having received no report, the Board was not in the position to make a final assessment. Submission of a final report was again requested.

No. 234 - PRECAMBRIAN VOLCANO-SEDIMENTARY COMPLEXES IN WEST AFRICA AND THEIR RELATIONSHIP WITH THOSE OCCURRING ELSEWHERE IN THE WORLD (1989-1994)

I. Yacé, 04 B.B. 337 Abidjan, Côte d'Ivoire.

M.A. Rahaman, University of Ife, Department of Geology, Ile Ife, Nigeria.

Description: A successor to Project 108/144, this project aims:

to study the specific differences in Precambrian volcano-sedimentary complexes at rock and lithostratigraphic levels;

to point out the geodynamic signification of the Birrimian inside and Eburnean cycle;

to integrate the volcano-sedimentary formations in the context of successive remobilization during the Precambrian orogeneses in Western Africa, in comparison with similar formations in South America.

Special emphasis will be laid on:

the petrographic and geochemical features of metasediments and metavolanics, the sedimentation environments, the intraplate eruptions, and the eventual evidence of mantle origin;

radiometric ages of siliceous and mafic rocks;

the structural setting, autochthonous or allochthonous, in convergence with isoclinal folds, overthrust or shear zones, inside the West African craton or on mobile margins.

Achievements in 1991

The second meeting of the project took place in Cotonou (Benin) from 3 to 5 January 1992 (it had been postponed from December 1991). It was attended by 45 geologists from six African, European and American countries. Eight papers were presented and discussed.

The following scientific points were made:

(1) For the first time, the Upper Proterozoic volcano-sedimentary complexes of Benin were characterized in much detail. They are located essentially in the internal and external zones of the pan-African Dahomeyides chain. In the external zone, they are intercalated in the formations of the Buem structural unit. Their volcanic components have been interpreted as produced by a transitional-type magmatism (between the tholeiitic and calc-alkaline ones) in a marginal basin, developed at the boundary between the oceanic and the continental crust. In the internal zone, the volcano-sedimentary complex of similar composition directly overlies the crystalline basement. The entire volcano-sedimentary complex of Benin has undergone anchi- to epi-zonal metamorphism, with the exception of the Lanta Series. The sedimentary components of the internal zone are molasse deposits resulting from the destruction of the pan-African Dahomeyides chain. The ages of the acidic volcanites range from 550 to 483 Ma (Upper Proterozoic-Cambro-Ordovician). This is in harmony with the ages obtained for the granitic intrusions, which, consequently, may well belong to the same magmatic phases.

The overall study of the Volta basins has revealed that the Buem metavolcanites and breccias of Benin are, in fact, the northernmost outcrops of the volcanic rocks of the Buem structural unit, and they can be correlated with those of the Atacora structural unit.

The sedimentary rocks of the internal zone used to be considered as molasse deposits. The Lanta Series is of Ordovician age. The volcano-sedimentary complexes of the internal zone are poorly mineralized. In the South, only the central part of the Daho-Mahou basin displays some traces of lead-zinc-copper mineralization (Aklampa sector). The W and Zn indexes have been determined in the southern part of this basin. Prospecting for copper beneath the Lanta sedimentary series has brought no significant result.

(2) In South-East Ghana, the Nsawam area comprises gneiss and migmatite complex, crossed by dykes and stocks of microgranite and diorite. The old denomination of 'Cape Coast Granitoid Complex' is no more

adequate. In fact, we have to deal with a very complex evolution of a petrogenetic series: original gneisses at migmatites, pre-existing mafic and ultramafic igneous rocks, amphibole-bearing residual melanosomes. The K-Ar ages are between 1800 and 2100 Ma for the gneisses and migmatites (Eburnian II, while the mafic and ultramafic rocks are Eburnian I).

(3) A fruitful discussion was carried out about the petrologic nomenclature concerning the Birrimian, as it is used in Ghana, in comparison with Côte d'Ivoire. In view of the existing contradictions, a thorough revision of the pertinent literature has been recommended, based on field observations in the countries concerned.

(4) From the structural point of view, the investigations on the acidic rocks of the Dahomeyides along the Eastern bank of Prampram (Accra) have revealed the existence of at least four deformations. D1 is obliterated by the accompanying metamorphism. D2, D3 and D4 are superimposed on the metamorphic structure. D2 and D3 are coaxial, but D3 is as a rule more open. D2 often displays double dip. D4 has produced domes and depressions (very probably due to an igneous intrusion). D1, D2 and D3 are apparently prior to the pan-African phase, while D4 is probably bound to the pan-African tectonism proper.

(5) As far as Côte d'Ivoire is concerned, new working hypotheses were presented concerning the Precambrian basement: e.g. the hypothetic existence of two cycles (Burkinian and Eburnian) in the Lower Proterozoic, supported by overthrusts in the South-West, North-East and Central-East of the country. This would mean a return to the distinction between a sedimentary Lower Birrimian and a volcanic Upper Birrimian.

(6) The Kokumbo-Zaakro gold fields were described (SW of Toumodi in Central Côte d'Ivoire). They are part of a succession of hills oriented NNE-SSW, located in a volcano-sedimentary trough of the same strike, 300 km long and 10 km wide. In this trough, there are mafic breccias and tuffs, some massive mafic lavas, cinerites and ignimbrites associated with massive rhyolites and dacites, sandstones and conglomerates, all having been meta-morphosed (green-schist facies). The gold mineralization has three forms: veins, residual gold and alluvial gold, in four fields: Auadia (6-72 g/t gold) Central Kokumbo (3-10 g/t) Kpolessou (2-40 g/t) and Zaakro (20-25 g/t).

(7) In Togo, the following units have been described: the ridge, the internal and external zones of the Dahomeyides, and the basement. The composite basement is overlain by super-groups consisting of 2-3 groups comprising 2-3 formations. The complex comprises the units of Volta Basin, of Buem and of Atacora, the internal units and the Birrimian basement. Each structural unit is characterized by a varying number of supergroups (SG1 to SG3) and of deformations (from D0 to D5). The volcanic zone (the suture) has to be added. Mineralization is distributed as follows:

iron in the Buem and Atacora units;

carbonates in the Basin, Buem, Atacora and internal units;

phosphates in the Basin, Buem and Atacora units;

manganese in the Basin;

gold in the Atacora and the internal units;

diamond in the Atacora unit;

copper in the internal units.

(8) The siderite of Opoblé (in Pagala area of Togo) is a good example of pan-African mineralization in the Atacora structural unit. It has been described as an iron cap due to superficial oxidation. The ore contains 80 per cent of siderite (with 2 per cent MnO and 2.4 per cent ZnO), and Zn-bearing carbonates. The textural features speak in favour of epigenetic alteration by iron-bearing carbonates of a siliceous rock. There is much evidence of a hydrothermal impact: beside the Zn, Mn and Ba anomalies, the siderite is particularly rich in heavy rare earth elements. The differentiation has gone too far for a simple sedimentary process. In addition, a siderite-muscovite with baryte-pyrite-vein quartz mineral assemblage has been described from the carbonate rock, obviously produced by hydrothermal fluids.

Before the field trip, four resolutions were approved, concerning UNESCO-IUGS, the Benin Government, the West African governments and the geological surveys. It was decided that a subgroup of sedimentologists would be in charge of carrying out

an in-depth study of the sedimentation in the Precambrian volcano-sedimentary troughs, from 1992 onwards. It will be directed by the delegation of Benin.

The field trip was to the Dassa-Zoumé area, in the South-Central part of Benin. The participants observed and described the main facies of the DahoMahou volcano-sedimentary series, namely:

(1) sandstones, microconglomerates and conglomerates of Aliboukoto;

(2) metabasaltes and metabasalt breccias, rhyodacite breccias and tuffs of Aliboukoto;

(3) sandstones cut by a porphyry dyke and porphyroid granite, of Son'ta;

(4) polygenetic conglomerates by porphyry dyke, of Son'ta;

(5) fine-grained sediments (siltstones or tuffites), mafic volcanic breccias with huge lava blocks and pillow-lava flows, of Son'ta.

Activities planned

The third General Assembly of the project will take place at the Ife University, Nigeria, in 1992.

Workshops will be held in Accra, Ghana in November 1992, in the framework of the Conference of the Geological Society of Africa (GSAF) in Nigeria in conjunction with the Biannual Meeting of the West African Scientific Association (WASA) and in Dakar, Senegal, during a colloquium on the Lower Proterozoic.

No. 237 - FLORAS OF THE GONDWANIC CONTINENTS (1986-1990, O.E.T. in 1991)

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Description: The primary objective is to produce a general, up-to-date summary of the Upper Silurian to Lower Tertiary floras of the Gondwanic continents. Individual and group research studies intend to fill some important gaps. The final version of the summary will include some relevant taxonomic, biostratigraphic and palaeophytogeographic problems treated on an international scale.

Final report

Members of 47 institutions, from 15 countries (Argentina, Australia, Bolivia, Brazil, Chile, China, Colombia, Cuba, France, India, Israel, Poland, United Kingdom, U.S.A. and Venezuela) contributed to the project.

Close collaboration with IGCP Projects 193, 211 and 242 was successful. Collaboration was initiated also with IGCP Project 272 and to a lesser extent, with Projects 216, 219, 261 and 270.

An important achievement has been the remarkable participation of botanists working with geoscientists in multidisciplinary teams.

Altogether 15 meetings, including one for the preparation of the project (Ohio, U.S.A., 1985) and one field trip (Paraná Basin, Brazil, 1987) were held in seven countries:

Columbus, OH, U.S.A., August 1985
Medellín, Colombia, July 1986
Calcutta, India, March 1987
Buenos Aires, Argentina, April 1987
Rio de Janeiro, Brazil, July 1987
S. Cruz de La Sierra, Bolivia, July 1987
São Paulo, Brazil, December 1987
Paraná Basin, Brazil (field meeting), December 1987
São Paulo, Brazil, July 1988
Lucknow, India, February 1990
London, U.K., February 1990
Cordoba, Spain, April 1990
Havana, Cuba, June 1990
São Paulo, Brazil, December 1990
Buenos Aires, Argentina, September 1990.

Scientific interchange and divulgation of the objectives, activities and results of the project was provided not only by mail and by the meetings mentioned above, but also by a series of lectures and talks, e.g. those by Professor W.G. Chaloner (University of London, U.K.) in São Paulo, Brazil, December 1987; one by Dr R.L. Leary (Illinois State Museum) in São Paulo, Brazil, November 1991; one by Srivastava Biraba Sahni, Inst. Palaeobotany, India) in São Paulo, Brazil, November 1991; and six by Professor Oscar Rösler (USP, Brazil):

in Medallín, Colombia, July 1986
in Buenos Aires, Argentina, April 1987
in Lucknow, India, February 1990
in the N.H.M. London, U.K., in February 1990
in Cordoba, Spain, April 1990
in Havana, Cuba, June 1990
in São Paulo, Brazil, June 1991.

The project participated in several major international meetings, e.g. 6th (Ohio, U.S.A.) and 7th (São Paulo, Brazil) international Gondwana symposium; 4th Latin American Congress of Botany

(Medellín, Colombia, 1986) 12th International Conference on Carboniferous and Permian (Buenos Aires, Argentina, 1991) and in several other national and regional meetings.

The project organized and sponsored the Technical Sessions on Gondwana Biota and Biostratigraphy of the 7th International Gondwana Symposium. All selected contributions have been published in the symposium proceedings. The last meeting of palaeobotanists and palynologists, held in São Paulo, Brazil, in December 1990 was sponsored by IGCP Project 237 and by the Instituto de Geociências, USP. The proceedings of this meeting are still in press.

The project encouraged research in some regions where fossil plants were less well known in spite of their occurrence and importance: Antarctica, Bolivia, Venezuela, Madagascar, Northeastern Brazil, etc.

Several subprojects involving the collaboration of two or three countries were generated as parts of the project. They now follow their own planned activities, e.g. the study of:

(1) Carboniferous floras from Brazil and Bolivia.

(2) Carboniferous and Permian floras of Venezuela, Brazil, Spain and Cathaysian regions.

(3) Carboniferous and Permian floras of Argentina and Brazil.

(4) *Glossopteris* floras from Brazil and India; Mesozoic and Tertiary floras of the Antarctic Peninsula, with the participation of several countries, etc.

Devonian floras in Gondwanic continents (particularly in South America) unstudied or unknown before the project have been discovered or are now better known thanks to the project activities. The knowledge of the Carboniferous, Permian and Triassic floras of almost all Gondwanic continents were intensively studied by members of the project. Jurassic and Cretaceous of the Antarctic Peninsula and of South America have been paid special attention by IGCP Project 237 in collaboration with other projects, including IGCP Project 242.

The Lower Tertiary floras from India, Brazil, Antarctic Peninsula represent another set of topics the study of which has been activated by IGCP Project 237.

More than 100 papers have already been published. Several will be issued in 1992. The summary of the scientific achievements is part of special papers still in preparation to be concluded by the end of 1992.

The Board declared the project terminated.

No. 245 - NON-MARINE CRETACEOUS CORRELATIONS (1986-1991)

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Chen Pei-ji, Nanjing Institute of Geology and Palaeontology, Academia Sinica, Chi-Ming-Ssu, Nanjing 210008, People's Republic of China.

Description: The objectives of this project were to attempt intrabasinal studies, interbasinal and intercontinental correlations of terrestrial Cretaceous strata in the principal sedimentary basins in the world. The basis for the correlations was a thorough assessment of the floral and faunal biostratigraphy, palaeoecology, event stratigraphy, and radiometric dates and magnetostratigraphy. Correlation with well-defined marine sequences has been attempted in several regions to provide additional age resolution. An additional goal of the project was to provide additional continental data to complement the marine record, thus providing a more comprehensive picture of the Cretaceous Period.

Between 1986-1991 numerous meetings and many publications have resulted directly from the impetus of this project. It has involved almost 500 participants in 36 countries. The project has held 13 regional and international meetings (India [4], France [1], China [2], USSR [3], Germany [2], Israel [1], Romania [1] and Japan [1]; Australia, Thailand and the U.S.A. [4] have hosted project meetings in association with other symposia. Nine newsletters containing a bibliography of non-marine Cretaceous papers were circulated to all participants. The attainment of the project goals has not been possible for all regions of the world, and even in the regions active within the project (principally China, India, USSR and Australia), much work remains. The economic resources in non-marine Cretaceous rocks is of great importance in many parts of the world, and this project has initiated a more systematic awareness of the correlation possibilities on non-marine strata.

Achievements in 1991

Meetings held

(1) A joint meeting with a symposium on 'Origin, Sedimentation and Tectonics of the Mesozoic to Early Cenozoic Sedimentary Basins at the Eastern Margin of the Asian Continent', held in Fukuoka, Japan from 25 August to 2 September 1991. The meeting was successful in bringing together tectonic geologists, biostratigraphers and sedimentologists to focus on the Late Mesozoic development of Eastern Asia (India to the Russian Far East). Papers from this meeting will be submitted to *Cretaceous Research.*

(2) The African regional working group will hold a meeting in Garoua, Cameroon, early in 1992. The aim of this meeting is to discuss and build upon a review of the non-marine Cretaceous of the African continent and the Middle East (Mateer et al., in press).

Selected publications

- Buffetaut, E. & Riegel, W. (Eds), 1991. Non-marine Cretaceous Correlations [Special issue containing six papers]. *Cretaceous Research, 12* (2), 93-208.

- Dettmann, M.E. & (13 co-authors), 1992. Australian Cretaceous terrestrial faunas and floras: biostratigraphic and biogeographic implications. *Cretaceous Research, 13* (in press).

- Krassilov, V.A. (Ed.), 1990. *Continental Cretaceous of the USSR* (USSR Academy of Sciences, Vladivostok). 225 pp.

- Mateer, N.J. & Chen, P.J. (Eds), 1992. *Aspects of Non-Marine Cretaceous Geology* (China Ocean Press, Beijing).

- Mateer, N.J. & (14 co-authors), 1992. Correlation of non-marine Cretaceous strata of Africa and the Middle East. *Cretaceous Research, 13* (in press).

- Matsukawa, M. (Ed.), 1991. IGCP Project 245 *Field trip guidebook: Lower Cretaceous non-marine and marine deposits in Tetori and Sanchu, Honshu* (Fukuoka). 116 pp.

- Sahni, A. & Jolly, A. (Eds.), 1991. *Cretaceous event stratigraphy and the correlation of the Indian non-marine strata* (Chandigarh). 125 pp.

The 36 participating countries were: Argentina, Australia, Brazil, Cameroon, Canada, China, Czechoslovakia, Denmark, Egypt, France, Germany, Hungary, India, Israel, Italy, Japan, Jordan, Mongolia, Netherlands, New Zealand, Nigeria, Norway, Poland, Romania, Somalia, South Africa, South Korea, Spain, Sweden, Tanzania, Thailand, United Kingdom, United States, Uruguay, USSR and Yemen.

Activities planned

Although the project terminated in 1991, a special session of non-marine Cretaceous Stratigraphy has been planned at the Society of Economic Palaeontologists and Mineralogists (SEPM) meeting in Colorado, in August 1992.

A significant product of the Fukuoka meeting was the intent to submit a proposal for a successor project. The high level of activity in this region shown during the life of IGCP Project 245, indicates much promise. A working title chosen was 'Environmental and Biological Change in E. & S. Asia during the Cretaceous'. The work of this proposed project would encompass a thorough and systematic documentation of environmental and biological changes throughout the region. Finally, a synthesis of the documentation would be attempted, drawing conclusions from interrelationships between various physical and biological changes in the Cretaceous. The region would include: Thailand, Cambodia, Viet Nam, Laos, People's Republic of China, Japan, Korea and the Russian Far East.

The Board commended the activity of the project which brought together a large number of participants (500) from 36 countries in several synthesis papers dealing with regional stratigraphy from various continents and geological regions. The project is terminated.

No. 246 - PACIFIC NEOGENE EVENTS IN TIME AND SPACE (1985-1991, O.E.T. in 1992)

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Description: The project aims to evaluate the major events of the Neogene of the Pacific Basin, especially those relating to palaeoclimatology, palaeobiogeography, palaeooceanography, tectonism and eustasy. It will analyse the precise temporal and spatial extension of major Pacific Neogene events, consider their nature, interrelationships, causes and consequences, in comparison with those recognized in other well-studied regions. The studies will be mainly biohistorical. However, intercontinental correlations will be achieved through interdisciplinary approaches combining micropalaeontological, radiometric, seismic and other evidence.

Achievements in 1991

Meeting

Recent progress was reviewed in October 1991 at an international conference entitled 'Pacific Neogene: Environment, Evolution and Events', which was held at Shizuoka, Japan. The meeting was hosted by IGCP Project 246 National Working Group of Japan and attended by 140 participants from 20 countries.

Highlights of the conference were:

(1) Synchronism, aspects and a real distribution of Mid-Neogene climatic optimum around 16 Ma.

(2) Process of the opening of the Sea of Japan since 17 Ma.

(3) Cryospheric climatic changes derived from the evolution of the Antarctic ice sheet.

(4) Accelerated biotic evolutions recognized in endemic mollusca since 3 Ma seem to be characteristic events in the middle latitude areas.

(5) A high resolution chronology in Pliocene-Pleistonce time based on isotopic events. The process of the closing of the Indonesian and Central American seaways and its influence was also stimulatively discussed. Drafts of a time-space chart and a palaeogeographic map of the Pacific at 16-17 Ma were discussed at the poster session.

Publications

(1) Abstract Volume for the 5th International Congress on Pacific Neogene Stratigraphy and IGCP Project 246 'Pacific Neogene: Environments, Evolution and Events', 6-10 October 1991, V-CPNS-IGCP 246, Shizuoka, Japan, 136 pp.

(2) Guidebook for Field Trip 1 'Neogene Evolution of the Japan Sea Side', V-CPNS-IGCP 246, Shizuoka, Japan, 83 pp.

(3) Guidebook for Field Trip 2 'Mid-Neogene Palaeoenvironment of Central Japan, V-CPNS-IGCP 246, Shizuoka, Japan, 28 pp.

(4) Guidebook for Mid-Congress Tour 'Mt Fuji and its environs', V-CPNS-IGCP 246, Shizuoka, Japan, 14 pp.

Twenty-five countries participated in the project this year (* indicates countries active this year): Australia, Canada, Chile*, People's Republic of China*, Colombia*, Costa Rica*, Ecuador*, Fiji, India*, Indonesia*, Iran, Japan*, Korea*, Malaysia, Mexico*, New Zealand*, Papua New Guinea, Peru*, Philippines*, Singapore, Thailand*, United Kingdom*, United States*, USSR* and Viet Nam*.

Activities planned

The following scientific goals have been set:

the production of a time-space chart showing major Pacific Neogene events within a biochronologic framework;

the preparation of some palaeobiogeographic maps of the Pacific region related to major Pacific Neogene events;

the publication of the final report of the project as a special volume from the University of Tokyo Press, Japan, entitled 'Pacific Neogene: Environment, Evolution and Events'.

Meetings foreseen

(1) August 1992: International symposium hosted by IGCP Project 246 at IGC in Kyoto, entitled 'Pacific and Global Neogene Events', will discuss future problems on Neogene event studies in a pan-Pacific and global context. Arrangements for the proposal of the successor project(s) will also be made.

(2) October 1992: International symposium for IGCP Project 246 'Neogene Events in the Indian Ocean and SW Pacific' will be held at Yogyakarta, Indonesia with a field trip.

(3) 16-18 November 1992: International symposium for IGCP Project 246 'Neogene Events in Tropical South America' will be held at Quito, Ecuador on the process of the closing of the Central American seaway and its palaeobiogeographic effects.

Publications planned

Proceedings of the 5th International Congress on Pacific Neogene Stratigraphy and IGCP Project 246, combined with the final report of IGCP Project 246, are in preparation and will be published by the University of Tokyo Press. A time-space chart and palaeogeographic maps will be included.

A proposal for a successor project will be finalized at the meeting in Kyoto.

Despite the Board's refusal of an active extension beyond 1991, a full year of activity has been planned for 1992. The Board recommended that the project be encouraged to hold a single 'final' meeting in 1992 to fulfil the aim of producing a final report. For this, On Extended Term status has been granted for 1992.

No. 247 - PRECAMBRIAN ORE DEPOSITS RELATED TO TECTONIC STYLES (1986-1991, O.E.T. in 1992)

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V. Kazansky, Institute of Ore Deposits, Petrography, Mineralogy and Geochemistry, Academy of Sciences of Russia, 35 Staromonetny per., Moscow 109017, Russia.

S.C. Sarkar, Department of Geological Sciences, Jadavpur University, 700032 Calcutta, India.

Zhang Yixia, Geology Department, Changchun College of Technology, Changchun, People's Republic of China.

Description: The project focuses on unsolved problems of Precambrian tectonics and metallogeny, namely: contrasts in mineral deposits between Precambrian greenstone belts of different tectonic style and age; tectonic controls of mineralization in Proterozoic mobile belts with particular emphasis on continental margins; tectonic reactivation processes in the Precambrian and related mineral deposits.

Activity report 1986-1991

Introduction

The proposal to start IGCP Project 247 was approved at the first Final Meeting of IGCP Project 91 'Metallogeny of the Precambrian' in Changchun, China, in October 1985. To preserve established international co-operation and to focus on the poorly investigated problems of Precambrian tectonics and metallogeny, five subprojects were defined: (1) contrasts in mineral deposits between Precambrian greenstone belts of different tectonic style and age; (2) Late Archaean magmatism and tectonism as source of ore components in Early Proterozoic sedimentary basins; (3) evolution of Proterozoic structures and associated metallogeny basins; (4) tectonic controls of mineralization in Proterozoic mobile belts; and (5) reactivation processes and related mineral deposits.

In February 1986, the IGCP Board accepted the project, which was due to last four years (1986-1990). It recommended avoiding the dangers of an excessively broad approach and eliminating the lack of balance between the subprojects. The lifetime of the project was later extended by one year, for 1991.

Detailed plans and structure of IGCP Project 247 were discussed at the first working group meeting at the 7th IAGOD Symposium in August 1986 in Lulea, Sweden. The meeting was attended by 24 participants from 15 countries. It was agreed to focus activity on clearly defined topics, to have a sufficient number of research organizations involved in future activities and to assure the representative participation of scientists from developing countries. The number of subprojects was reduced to three, namely:

> Contrasts in mineral deposits between Precambrian greenstone belts of different tectonic style and age, Leader D. Groves (Australia).
>
> Tectonic controls of mineralization in Proterozoic mobile belts with particular emphasis on continental margins, Leader: G. Gaál (Finland).
>
> Tectonic reactivation processes in the Precambrian and related mineral deposits, Leader: V. Kazansky (USSR).

Geologists from 31 countries were involved in the project: Australia, Benin, Botswana, Brazil, Burkina Faso, Burundi, Canada, China, Czechoslovakia, Finland, France, Germany, Hungary, India, Iran, Italy, Netherlands, Nigeria, Norway, Poland, Romania, Sweden, Switzerland, Tanzania, United Kingdom, U.S.A., USSR, Venezuela, Zaire, Zambia and Zimbabwe. During 1986-1991 international scientific meetings and field conferences were organized in Australia, Canada, China, Finland, Hungary, India, Tanzania, U.S.A., USSR and a considerable number of publications were produced.

Scientific meetings and field conferences

- At the 7th IAGOD symposium in Lulea, Sweden, 18-22 August 1986 the first working group meeting was organized for preparation of the scientific programme and organization of the project.

- International conference 'Precambrian metallogeny related to tectonics and computerized mineral resource assessment methods applied to metallogenic provinces' with pre- and post-conference excursion and working group meeting was jointly organized by IGCP Project 247 and

COGEODATA in Arusha, Tanzania, 7-9 December 1987.

- International symposium 'Tectonic setting of Proterozoic volcanism and associated ore deposits' in Turku, Finland, 15-21 August 1988, with field trips in Finland and Sweden in co-operation with IGCP Project 217.

- International conference 'Metallogeny related to the tectonics of Proterozoic mobile belts and computerized mineral resource assessment methods applied to metallogenic provinces' in Calcutta, India, 8-10 December 1988, with pre- and post-conference field trips, organized jointly with COGEODATA, working group meeting.

- International symposium 'Gold deposits geology' in Changchun, China, 17-20 May 1989.

- Special session of IGCP Project 247 on 'Precambrian metallogeny related to plate tectonics' at the 28th International Geological Congress in Washington D.C., U.S.A., 9-19 July 1989, working group meeting.

- International symposium 'Precambrian Granitoids-Petrogenesis, Geochemistry and Metallogeny' in Helsinki, Finland, 14-17 August 1989 with pre- and post-symposium field trips, organized jointly with IGCP Project 217, working group meeting.

- International field conference on the Nordkalott Gold Province in Sweden, Norway and Finland, 7-11 August 1989.

- International symposium on 'New ore types in Northern Fennoscandia' in Lulea, Sweden, 26-28 September 1989.

- Special symposium 'Precambrian ore deposits and tectonics' at the 8th IAGOD Symposium in Ottawa, Canada, 12-18 August 1990, working group meeting.

- International field conference 'Greenstone, ophiolite and intracratonal volcanic belts in the Baikal area' in Ulan-Ude and Irkutsk, USSR, 21-31 August 1990.

- The third Archean symposium at Perth, Australia, 7-21 September 1990 was co-sponsored by IGCP Project 247.

- An international conference 'Precambrian mineral deposits, tectonics and geophysics' was planned for October 1991 in Changchun, China. Unfortunately the conference was cancelled at the end of September due to financial difficulties.

Scientific achievements

The recent rapid progress in Precambrian geology has provided new data on relationships between tectonic setting and origin of Archean and Proterozoic mineral deposits. IGCP Project 247 undertook to compile the up-to-date knowledge on examples from the Aldan, Arabian, Baltic, Brazilian, East- and Western African, Indian, Sino-Korean and Western Australian shields and platforms, marginal zones of the Siberian Platform, Lufilian Arc and some other Precambrian metallogenic provinces. The studies embraced reinterpretation of tectonics and metallogeny of classical Precambrian regions, as well as characteristics of previously poorly studied areas. The main targets were to relate origin and distribution of ore deposits to crustal evolution, to compare mineralized structures of different age and style and to interpret them in terms of plate tectonics.

Subproject 1 - Contrasts in mineral deposits between Precambrian greenstone belts of different tectonic style and age

It was demonstrated that many Archean greenstone belts do not fit into the widely known Barberton model and that supracrustal tectono-stratigraphic or lithological-structural associations of some belts reflect tectonic settings similar to those of modern island arcs, marine extensional and orogenic pull-apart basins.

The tectonic history of the Norseman-Wiluna Belt in Western Australia was divided in several phases comparable to that of modern obliquely convergent continental margins (Barley and Groves, 1990):

(1) Volcanism and sedimentation (2.7 Ga) in two different environments of subduction-related volcanic arc and submarine extensional basin with komatiite-associated Ni-Cu sulfide deposits.

(2a) Deformation (2.66-2.63 Ga), crustal shortening and assembly of domains into their present configuration.

(2b) Synkinematic emplacement of arc-related I-type granitoids, porphyries and lamprophyres.

(2c) Gold mineralization. Although occurring in most tectono-stratigraphic associations gold mineralization is structurally controlled and is an integral part of the tectonic event that resulted in the stabilization of the Yilgarn craton.

Similar but more complex variations in greenstone sequence development characterize the Archean metallogeny of the Superior Province in the Canadian Shield (Thrurston and Chivers, 1990). Four lithostratigraphic units are distinguished within the province. Recently recognized carbonite-evaporite bearing platformal sequences (2.75 Ga) contain banded iron formations, pebble conglomerates and bedded barites. Overlying mafic oceanic-plain sequences (2.7 Ga) embrace komatiite-related Ni-Cu sulfide deposits and PGE deposits associated with mafic-ultramafic layered intrusions. The following mafic to felsic volcanic sequences most closely resemble the continental margin associations. They vary in age from 2775 to 2700 Ma and contain important volcanogenic Cu-Zn-Pb massive sulfide deposits and scarce Cu-Mo porphyry-type deposits. Finally, the 2685 Ma old 'Timiskaming type' sequences are best compared with modern pull-apart basins. They are composed of fluviatile conglomerates, immature arenites and wackes, subarial alkaline to calc-alkaline volcanics and related sub-volcanic intrusions. They control the distribution of Iode and quartz-vein gold deposits. Although the basement and supracrustal rocks of the Superior Province span more than 500 m.y. of Archean time, most mineral deposits formed in an interval of 100 m.y. or less corresponding to a period of accretion of oceanic and pre-existing fragments of continental crust 2.7 Ga, ago (Poulsen et al., in press).

Investigations of Archean cratons of Tanzania, Uganda and Kenya confirmed the above-mentioned geotectonic and metallogenic concepts (Gabert, 1990; Kuehn et al., 1990). The 2700-2500 Ma-old granitoids and greenstone-belt volcanites are considered as products of continental accretion. The granulite facies metamorphism was dated as 2.9 Ga, and the age of superimposed 'wet' metamorphism as 2.5 Ga. This late metamorphism and tectonic events at 2550 Ma coincided with a period of intense migmatization and granitization and were responsible for remobilization of syngenetic gold mineralization in banded iron formations. This widespread remobilization caused development of gold-sulfide-bearing quartz veinlets in the hosting greenstone-belt rocks, as well as formation of the majority of epigenetic hydrothermal auriferous quartz veins and reefs. Subsequently, epigenetic-metasomatic gold mineralization was generated.

Nevertheless, two types of tectonic models have been applied for the same Archean granite-greenstone terrains: those that explain their development by plate tectonic models and those that suggest formation of greenstone belts by rifting of primitive sialic crust followed by calc-alkaline volcanites and granitoids derived largely by melting of continental crust. According to Padgham (in press) the Archean tectonics and metallogeny of the Slave Province in the Canadian Shield are explained by a rift-related model. Terrain boundaries as possible accretionary zones have not been identified in the Slave Province and metallogenic zonation does not fit patterns of sutures or accreted terranes. Thus, the Slave Province has a number of features that distinguish it from most Archean cratons. These include ancient granitoid basement, early shelf arenites, extensive felsic-intermediate volcanic belts with volcanogenic massive sulfide Pb-Ag deposits and widespread turbidite sediments containing numerous quartz-vein and BIF-hosted gold deposits.

In the Eastern part off the Baltic Shield three segments of Archean continental crust with varying tectonic and metallogenic characteristics have been recognized (Turchenko, in press). The Kola Peninsula Segment consists of Early Archean granite-gneiss terrains with BIF, Ni-Cu sulfide and REE deposits, highly deformed and metamorphosed basins with kyanite deposits and Late Archean gabbro-anorthosite intrusions hosting Fe-Ti-V deposits. In the Karelian Segment the greenstone 2.9-2.6 Ga old belts were formed in tectonic environment resembling rifts and island arcs and contain Ni-Cu sulfide and massive pyrite deposits. The Belomorian Segment represents granulite-gneiss and granite-greenstone terrains reworked tectonically and metamorphically in Late Archean and Early Proterozoic times with simultaneous formation of numerous muscovite pegmatites.

Subproject 2 - Tectonic controls of mineralization in Proterozoic mobile belts with particular emphasis on continental margins

The boundary between Archean and Early Proterozoic was marked by drastic changes in tectonic style, ore-forming processes and structural control of mineral deposits. Early Proterozoic greenstone belts (2.2-2.0 Ga) are characterized by within-plate tholeiitic and sometimes komatiitic volcanism, massive sulfide and hydrothermal Au mineralization. Unique ore accumulations originated in banded iron formations. Active and passive continental margins became major sites of ore deposition in the Early Proterozoic. They controlled a great variety of ore deposits - to begin with base metal massive sulfide and Cr, Ni, Cu-Ni, PGE ores in association with ophiolites and synorogenic mafic-ultramafic intrusions and to end with late S-or I-type granites containing Sn, W, U and Mo mineralization. The most diversified mineralized structures were formed in the Upper Proterozoic such as completely reworked Archean rocks with rare-metal pegmatites and Fe-Ti bearing anorthosites, ensialic thrust belts with stratabound

base metal and U deposits and intracontinental rift system with native and sulfide Cu mineralization.

The Ladoga-Bothnian Bay Belt in the Fennoscandian Shield provides a convincing example of a plate tectonic metallogenic model for the Early Proterozoic (Gaál, 1986). Later studies revealed two major stages in Early Proterozoic crustal and metallogenic evolution of the Shield: the Karelian continental development (2.5-2.1 Ga) and the Svecofennian orogeny (2.0-1.75 Ga). The Karelian stage was dominated by deposition of terrestrial sediments and tholeiitic volcanism on Archean crust, generation of rift zones intruded by layered mafic-ultramafic complexes hosting Cr, Ni-Cu, Fe-Ti-V, and PGE ores and existence of an ocean at the South-West flank of the Ladoga-Bothnian Bay Belt. Oceanic crust is preserved in a 1.96 Ga old ophiolite complex. The Cu, Zn and Ni deposits associated with ophiolites derived from hydrothermal leaching of oceanic crust and experienced several phases of metamorphism and tectonic deformations. During the Svecofennian stage the divergent continental margin was transformed into an active margin. Subduction of oceanic crust produced oceanic and continental island arcs containing massive sulfide Cu-Zn-Pb-Ag-Au deposits. By the end of the Svecofennian orogeny island arcs were accreted to the Archean crust and 1.89-1.75 Ga old granitoids generated minor Cu-Mo-Au, Sn and REE deposits. In the frames of this model the origin of Ni-bearing tholeiitic to komatiitic magmas is explained by partial melting of the subduction-related mantle wedge, and the genesis of granitoids by magmatic underplating phenomena (Gaál, 1990).

Various plate tectonic elements with typical metallogeny have been recognized in the Aravalli-Delhi orogenic complex in North-Western India (Deb and Sarkar, 1990). The complex hosts a large number of economically important base metal sulfide deposits related to various tectonic settings:

(1) rifted Archean basement with SEDEX-type Zn-Pb deposits in isolated enclaves and layered PGE, Cr, Ni-Cu-bearing intrusions;

(2) accreted island arcs with Ni-Cu mineralization;

(3) rifted continental island arcs with massive Zn-Cu-Pb sulfide deposits and banded iron formations;

(4) marginal basins with Cyprus-type massive sulfide Cu-Zn-Co deposits and syn-, late- and post-orogenic granitoids with porphyry-type Co-Mo-Au and Sn, U and W mineralization.

The Krivoy Rog Basin on the Ukrainian Shield, the Transbaikalian fold belt in Southern Siberia, the boundary between the North and South Liaoning blocks on the Sino-Korean Shield and the Singhbhum Belt on the Indian Shield were referred to be associated with Early Proterozoic continental margins (Gaál and Kazansky, 1988). The interpretation of marginal structures of the Siberian platform was supported by recent studies of Baikal-Muya ophiolite belt where metavolcanic rocks (including komatiites and komatiitic basalts), sheeted dyke complex and upper cumulate gabbros and lower metaperidotites have been discovered (Dobretsov et al., in press). These 1.9 Ga ophiolites differ from the Early Archean (3.2-2.9 Ga) mafic-ultramafic rocks of the Olondo greenstone belt in the Aldan Shield, as well as younger (0.60-0.52 Ga) ophiolites in the Sayan Fold Belt. These data testify to a general change in Precambrian metallogeny at the boundary of 1.9-1.8 Ga. Drilling of the Krivoy Rog superdeep borehole provided more controversial information (Kazansky, in press). The drilling stimulated the geological and geophysical studies of adjacent territories. As a result two geodynamic models were proposed for the central part of the Ukrainian Shield: (1) a plate tectonic model involving westward subduction of oceanic crust, and (2) a model implying a rise of an asthenolite during Early Proterozoic time West of the Krivoy Rog Basin.

Quite different marginal structures stretch along the Southern and South-Eastern boundaries of the Canadian Shield. Late Archean orogen resulted in the formation of a supercontinent that include the Superior and the Wyoming cratons and was followed by deposition of the Huronian Supergroup in a broad East-West trough controlled by Murray and Onapping fault systems (Roscoe and Card, in press). Early Proterozoic metallogenic processes were controlled here by a distribution of mineral deposits in the Archean basement, variations in Huronian sedimentation and deformation, emplacement of layered intrusions and transition from anoxic to oxygenic conditions. Much of the mineralization in the Early Proterozoic rocks derived from the Archean basement by weathering (uranium palaeoplacers of the Elliot Lake area) and hydrothermal remobilization (silver-arsenite veins in the Upper Huronian). Even the Ni-Cu-PGE-ors of the Sudbury structure initiated by an ancient meteorite impact may, in part at least, have been derived from older crustal sources. In the Late Proterozoic Grenville Province, on the contrary, Archean supercrustal sequences were subjected to intense tectono-metamorphic reworking reaching PT conditions of the granulite facies (Sangster et al., in press). As a result base metal massive sulfide and gold

mineralization typical for greenstone belts were dispersed.

A new model of the Late Proterozoic Lufilian arc in Central Africa was developed on an example of the Dome Area (Cosi et al., in press). The investigation followed the discovery of previously unknown U deposits. The characteristic dome shapes of the area were explained by intersection of flat topography with a multiply folded edifice of thin fold-thrust nappes. According to this model the nappe-pile presently exposed was exhumed from the deepest Lufulian metamorphic environment, as demonstrated by high-pressure assemblages, while U deposits show clear structural control. Uraninite mineralization is confined to shear zones between the Lower Roan Group and Basement Complex. Uranium was transported from the source rocks in the basement or unknown volcanic sequences and fixed in a disseminated form in reducing traps. Hot metamorphic Cl - or CO_2 - rich fluids leached uranium from pre-existing deposits and redeposited commercial ores by ionic exchange at new sites.

Models for the Late Proterozoic (1.1-1.0 Ga) Midcontinent Rift system of North America has been refined on the basis of deep seismic reflection profiling and high-precision U-Pb zircon dating (Nicholson et al., in press). The studies revealed enormous volumes of rift-related basalt flows and mafic intrusions with a very short interval of their emplacement (3-5 m.y.). New data explain specific features of Cu-Ni-PGE (platinum group elements) mineralization in the Duluth Complex, native copper deposits in basalts and Cu-Mo-bearing pipes by evolution of an anomalously hot mantle plume and by late-stage compression event that enhanced leaching and fluid migration of ore components.

Subproject 3 - Tectonic reactivation processes in the Precambrian and related mineral deposits

In many shields previously consolidated continental crust underwent in Proterozoic times intense superimposed tectonic deformation accompanied by subaerial volcanic activity and sedimentation. Ultramafic, alkaline and felsic intrusions, progressive and regressive metamorphism and diverse endogenous ore formation are associated with these processes. To define and to investigate these phenomena in more details the terms 'protoactivation processes' and 'protoactivation regions' were introduced (Kazansky, 1988). In tectonic and metallogenic contexts the protoactivization regions may be compared with regions of tectono-magmatic activation arising in the Phanerozoic. According to the plate tectonic concept they may be partly correlated with intracontinental rift zones and hot-spot related phenomena.

Depending on the dominant ore-forming processes the protoactivated regions of the Aldan, Anabar, Baltic and Ukrainian Shields were divided into four types: tectono-plutonic, tectono-volcanic, tectono-metamorphic and tectono-metasomatic types. Layered mafic-ultramafic intrusions with magmatic Cr, Ti, V, Ni, Cu, Pt deposits, rare-metal carbonatites and ultramafic-alkaline ring complexes, rapakivi granites with hydrothermal Sn deposits are characteristic for the first type (the Moncha, Chinei, Korosten, Oktyabrsk, Viborg plutons). The second type includes the Akitkan and Ulkan volcanic belts and associated hydrothermal deposits of rare and base metals, the third type - polymetamorphic belts with muscovite and rare-metal pegmatites (the Anabar Shield, the Belomorian Belt), the fourth type - ore-bearing alkaline metasomatites confined to regional faults (the Kirovograd Block in the Ukrainian Shield).

There are different interpretations of the geotectonic nature of mafic-ultramafic, ultramafic-alkaline complexes and rapakivi granites. The association of these plutons with superimposed protoactivation processes is more precisely established if they have been intruded into epicratonic sedimentary basins, as, for example, in the Western part of the Aldan Shield, where 2.0-1.9 Ga old layered gabbroanorthosites and rapakivi granites intruded the rocks of the Early Proterozoic Udokan Group. Specific features of volcanic processes within protoactivated regions were established in the Akitkan volcanic belt in Eastern Siberia (Bukharov, 1987). In contrast to the adjacent Baikal-Muya ophiolites the Akitkan Belt formed on consolidated Late Archean-Early Proterozoic (~ 2.2 Ga) ensialic crust in subaerial environment indicated by intercalation of red coloured sandstones, siltstones and conglomerates with volcanites. Sedimentary rocks are confined mainly to basal horizons of six volcanic complexes which were generated 1800-1650 Ma ago. Andesites, trachyandesites along with trachytes and comagmatic diorites, granodiorites, syenite-porphyries are characteristic for the lower complexes, while rhyolites, felsic tuffs and ignimbrites accompanied by subvolcanic bodies of granites, granosyenites, quartz monzonites predominate in the upper ones. Various volcanotectonic structures were discovered within the belt including deeply eroded vents and subsidence calderas. It should be emphasized that subvolcanic felsic bodies correspond to rapakivi granites in petrochemical terms. The sedimentary and magmatic rocks are mostly unmetamorphosed. Commercial deposits are not yet known within the Akitkan Belt, but rare-metal alkaline metasomatites and hydrothermal Au, Sn, Bi, Pb, Zn mineralization, associated with local volcano-tectonic structures, was discovered in many places.

Superimposed metamorphic and metasomatic processes within protoactivated regions were controlled by deep faults in the crystalline basement marked by injection migmatites, hypabyssal and abyssal intrusive bodies characterized by cataclastics and amphibolite-facies blastomylonites. The faults penetrated the upper mantle controlling the introduction of syntectonic reducing fluid system and leading to superimposed vertical structural, metamorphic, metasomatic and metallogenic zonation. Ductile deformation, partial melting and mobilization of ore components are characteristic for the deepest levels whereas brittle deformation, regressive metamorphism and redeposition of leached components are dominant in the upper part. Unusual mineral deposits were discovered in association with these faults: microdiamonds in felsic metamorphic rocks and ore-bearing alkaline metasomatites (Letnikov and Kazansky, 1991).

In most cases, abyssal depths are regarded as unfavourable for hydrothermal ore mineralization. Geological, structural and petrological studies of uraniferous albitites in the Kirovograd Block of the Ukrainian Shield and Ta-Nb bearing metasomatites in the Charo-Udokan region of the Aldan Shield refuted this concept and resulted in a new model of abyssal granitoid plutons and associated ore-bearing faults (Kazansky, 1988; Prokhorov et al., 1990). According to this model plutons were formed by a combination of 'ground preparation' and melting of metamorphic rocks and experienced multiphase compressional deformations during crystallization and cooling. Compressional deformations were interrupted by emplacement of aplites and pegmatites. Hydrothermal processes were associated with regressive dislocation metamorphism of greenschist-facies grade and mass decompaction of granitoids, migmatites, blastomylonites and blastoclataclasites. It is supposed that development of decompaction zones controlling uraniferous albitites was influenced by overpressure of hydrothermal solutions.

The static concept of continental crust excludes the formation of mineralized cataclastic and fissure zones at the distance of 6-7 km below the present surface. However, investigations of core samples from the Kola borehole revealed them at depth of 6-11 km (Kazansky, 1991, in press). Some of them manifest metamorphism of greenschist and prehnite-pumpellyte facies and contain Pb, Cu, Zn, Au mineralization. Geological reconstructions testify for the formation of retrograde zones and hydrothermal mineralization at even greater depth - not less than 15-17 km.

No linear relationships between temperature and depth have been established for either the Proterozoic or for the vertical component of recent stress. These data are in good agreement with modern dynamic models of the continental crust and help to understand the development of various types of hydrothermal mineralization at abyssal depths.

References

- Barley M.E. and Groves D.I. 1990: Deciphering the tectonic evolution of Archaean greenstone belts: the importance of contrasting histories to the distribution of mineralization in the Yilgarn Craton, Western Australia. *Precambrian Res.* 46, 3-20.

- Bukharov A.A. 1987: Protoactivized regions of ancient platforms, Nauka, Novosibirsk (in press).

- Cosi M., De Bonis A., Gosso G., Hunziker J., Martinotti G., Moratto S., Robert J.P. and Ruhlman F.: Late Proterozoic thrust tectonics, high-pressure metamorphism and uranium mineralization in the Domes Area, Lufilian arc, North-Western Zambia. *Precambrian Res.* (in press).

- Deb M. and Sarkar S.C. 1990: Proterozoic tectonic evolution metallogenesis in the Aravalli-Delhi orogenic complex, North-Western India. *Precambrian Res.* 46, 115-138.

- Dobretsov N.L., Konnikov E.G. and Dobretsov N.N.: Precambrian ophiolite belts of Southern Siberia, USSR, and their metallogeny. *Precambrian Res.* (in press).

- Gaál G. 1986: 2200 million years of crustal evolution: the Baltic Shield. *Bull. Geol. Soc. Finland*, 58, 149-168.

- Gaál G. and Kazansky V.I. 1988: Early Proterozoic continental margins as major sites of ore deposition. Proc. of the seventh IAGOD symposium. E.-Schweizbartsche Verlags-buchhandlung, Stuttgart, 93-102.

- Gaál G. 1990: Tectonic styles of Early Proterozoic ore deposition in the Fennoscandian Shield. *Precambrian Res.* 46, 83-114.

- Gabert G. 1990: Lithostratigraphic and tectonic setting of gold mineralization in the Archean cratons of Tanzania and Uganda, East Africa. *Precambrian Res.* 46, 59-70.

- Kazansky V.I. 1988: Evolution of Precambrian ore-bearing structures, Nedra, Moscow, (in Russian).

- Kazansky V.I.: Deep structure and metallogeny of Early Proterozoic mobile belts in the light of the superdeep drilling in the USSR. *Precambrian Res.* (in press).

- Kuehn S., Ogola J. and Sango P. 1990: Regional setting and nature of gold mineralization in Tanzania and South-West Kenya. *Precambrian Res.* 71-82.

- Letnikov F.A. and Kazansky V.I. 1991: On the problem of vertical zonality and ore mineralization of Precambrian deep faults. *Geology of ore deposits*, No. 2.

Nicholson, S.W., Cannon, W.F. and Schulz, K.J.: Metallurgy of the Midcontinent Rift System. *Precambrian Res.* (in press).

- Padgham W.A.: Mineral deposits in the Archean Slave structural province; lithological and tectonic setting. *Precambrian Res.* (in press).

- Poulsen K.H., Card K.D. and Franklin J.M.: Archean tectonic and metallogenic evolution of the Superior Province of the Canadian Shield. *Precambrian Res.* (in press).

- Roscoe S.M. and Card K.D.: Early Proterozoic tectonics and metallogeny of the Lake Huron region of the Canadian Shield. *Precambrian Res.* (in press).

- Sangster A.L., Gauthier M. and Gower C.F.: Metallogeny of structural zones, Grenville Province, North-Eastern North America. *Precambrian Res.* (in press).

- Thurston P.C. and Chivers K.M. 1990: Secular variation in greenstone sequence development emphasizing Superior Province, Canada. *Precambrian Res.* 46, 21-58.

- Turchenko S.I.: Precambrian metallogeny related to tectonics in the Eastern part of the Baltic Shield, *Precambrian Res.* (in press).

No. 249 - ANDEAN MAGMATISM AND ITS TECTONIC SETTING (1986-1991)

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Description: The project aims at a detailed investigation of Andean igneous formations in order to characterize the main magmatic events and their geodynamic significance, through multidisciplinary research.

The main topics are: (1) Correlation of plutonic and volcanic events within the different segments of the Andean Cordillera. (2) Precise geochemical characterization of the Andean igneous rocks in relation to specific tectonic setting, age, nature of the magma source, and magmatic evolutionary history. (3) Magmatic, metamorphic and tectonic interactions analysed within the framework of plate convergence in order to understand source migration, segmentation, vertical and horizontal accretion, uplift, allochthonous terranes and the relationships between the mechanism of plutonic emplacement and deformation phases. (4) Andean metallogeny and volcanic hazard evaluation in regions of recent volcanism.

Achievements in 1989

The following review accounts for the new results presented at the symposium on 'Andean Magmatism and its Tectonic Setting' held in Viña del Mar, Chile, 8-9 August 1991. Twenty-eight papers were presented by authors from Argentina, Chile, Spain, United Kingdom and United States.

Mesozoic magmatism

Mesozoic igneous rocks of wide apart sectors of the Andes were studied rom geochemical, geochronological and tectonic points of view. The tectono-magmatic evolution of Northern Chile (25°30 -27°S) during the Permian-Cretaceous is a consequence of subduction which gave rise to increasingly significant crustal accretion from a mantle input that decreases with age. Mechanism of roll-back of the subducting plate and formation of ensialic back-arc basins have been suggested for the Mesozoic plutonic development.

Jurassic volcanism of the Andes of Central Chile-Argentina developed in two North-South striking belts: the coastal and high Andes ones. Geochemical studies carried out in Middle-Upper Jurassic coastal volcanics (basalts, andesites, rhyolites) indicate variations from shoshonitic affinities (Ajial Formation) to calc-alkaline (Horqueta Formation). The shoshonitic rocks are considered as related to an extensional intra-arc basin, whereas the calc-alkaline rocks are thought to represent a volcanic arc associated with an Upper Jurassic uplift in the present Coastal Range. The High Andes counterpart of Horqueta Formation is mainly andesitic and related to volcanic arc extensional processes. The tectonic significance of the two Jurassic volcanic belts still remains poorly understood.

Studies carried out in the North Patagonian Massif allowed to characterize the geochronology and geochemistry of the Central Patagonia Batholith,

which represents a Triassic-Lower Jurassic Magmatism. Despite the present intraplate position of the batholith, its components display a volcanic arc geochemical signature.

New U-Pb zircon ages have been determined on rocks of the Sarmiento Ophiolite Complex in Magallanes, Chile. They confirm that the ophiolite form part of the igneous floor of the Early Cretaceous Rocas Verdes back-arc basin in the southernmost Andes.

Metamorphic and structural characteristics of the Casma volcanic group (Albian-Cenomanian) in the Coastal Range of Peru are compatible with an ocean floor metamorphism, and comparable with the Rocas Verdes unit mentioned above. Tectonic extension and progressive break-up of the continental crust towards the South gave rise to a progressive 'ophiolitization' of the volcanic sequence of the Casma group.

Cenozoic magmatism

Several contributions on the Miocene-Recent volcanic rocks from the Southern Central Volcanic Zone (CVZ) and Northern Southern Volcanic Zone (SVZ) have provided geochemical characteristics that could result from: (1) derivation from ancient subcontinental mantle lithosphere; (2) crustal contamination of mantle-derived magmas during their stay in the crust (particularly at the base of the crust); and (3) source contamination due to incorporation of crustal rocks carried down into the subduction zone as tectonically eroded fragments.

The Cenozoic magmatic evolution of the Northern SVZ has been studied as a function of the variation of the subduction zone geometry, as well as the nature of the continental crust. No differences in isotopic characteristics have been detected in Cenozoic volcanic rocks across the boundary between the flat-slab segment and the SVZ. An increase in 87Sr/86Sr initial ratios and a decrease in εNd with time has been observed, suggesting a progressive increase of crustal participation. The role of crustal components in Miocene to Recent volcanic rocks has been evaluated. Upper crustal components are more important in the flat-slab Main Cordillera volcanic rocks, whereas the lower crust signature has been identified in flat-slab Miocene to Pliocene back-arc volcanic rocks.

South of 40°S the Miocene arc and back-arc igneous rocks show compositional variations from basic granitoids in the arc to felsic granitoids and ignimbrites in the back-arc position. However, all of them have primitive isotopic (Sr and Nd) signatures. Miocene volcanics of the Extra-Andean domain have been interpreted to be derived from melting of subducted oceanic crust either associated with a flat-slab geometry (Pocho volcanic rocks, 30°S) or collision of a segment of the Chile Rise (Cerro Pampa dacite, 48°S).

Palaeozoic pre-Andean events

Geochronological, geochemical and structural studies in the Sierras Pampeanas, the Famatina system and on the Eastern side of the Argentine Puna, have provided further information on magmatic evolution and tectonic setting during Early Palaeozoic times. Rb-Sr whole rocks isochrons in granitoids from Sierra de Quilmes, Sierra Norte de Córdoba and Sierra de San Luis indicate that the 490-510 Ma was an extensive event in the Sierras Pampeanas. During that period the granitoids emplaced to the West of the Sierras Pampeanas show low initial 87Sr/86Sr (0.7043) ratios, while the same ratio in the rhyolitic sequences of the easternmost sector (Sierra Norte de Córdoba) and the syn-kinematic granitoids of the southeastern sector (Sierra de Luis) are high (87Sr/86Sr>0.710).

Very high initial 87Sr/86Sr ratios (>0.713) were reported for the Achala Batholith, suggesting that a regional anatexis took place in the whole Pampean system during the Late Devonian-Early Carboniferous. Granites of that period are typically two-mica peraluminous porphyritic monzogranites and, subordinately, muscovitic leucoranites. An extensive suite of mylonitic and cataclastic rocks recognized in the Famatina system indicates that a regional thrusting event occurred between 440 and 380 Ma.

Meetings held

Besides the symposium in Viña del Mar, summarized above, a symposium on 'Andean Magmatism and its Tectonic Setting', was held in Manizales (Colombia), 3-5 July 1991, with an attendance of over 190 participants from Argentina, Bolivia, Bulgaria, Chile, Colombia, Costa Rica, Ecuador, France, Germany, Italy, Japan, Peru, Poland, United Kingdom and United States. Scientific highlights included topics such as tectonic and geodynamic framework, metallogenesis and mineral deposits, geochemistry, volcanic events, magma evolution and sources, and volcanic-related environmental issues. Twenty-four papers were presented.

J.F. Toussaint (Colombia) presented results, mostly based upon Rb/Sr and K/Ar dating, of a co-operative work between the National University of Colombia (Medellín), INGEOMINAS, Universidade de São Paulo (Brazil) and INGEIS (Argentina) which was focused on geochronology of the northwestern

most part of South America. Toussaint made precisions about several magmatic events and gave insight into the geodynamic evolution of northwestern South America. In the same context, J.F. Toussaint and J.J. Restrepo (Colombia) discussed magmatism within the framework of Colombian geotectonic evolution.

The Colombian Santa Cecilia-La Equis volcano-plutonic complex was presented by G. Salazar (Colombia), M. James (U.S.A.) and M. Tistl (Germany) as an expression of an early Tertiary, mature island arc that had been formed by westwards subduction of oceanic crust and was accreted to the Colombian Western Cordillera. Island arc models were also invoked by G. Alvarado (Costa Rica) to explain the evolution of the Neogene and Quarternary sub-alkaline plutonic and volcanic rocks of Costa Rica.

M. Brown (U.S.A.) showed in a mantle reference frame that the tectonic and magmatic evolution of Northern Chile during the Permian-Cretaceous time was probably a consequence of the interaction between the subducting Pacific Ocean plates and the South American plate. Variations in subduction style were accompanied in turn by differences in type and occurrence of four different age plutonic complexes. A. Busteros and H. Lema (Argentina) presented new petrologic and geochemical data on the 'Neopalaeozoic-Eomesozoic' magmatic rocks from the Chubut Province, Argentina, which appear to indicate that the epizonal plutonic suite has characteristics attributable to deep-seated origin, I-type granitoids generated in a convergent margin associated to subduction tectonics.

New REE and trace element data for the Southern (Toquepala section) part of the Jurassic to Cretaceous Peruvian Coastal Batholith were discussed by R.A. Oliver and N. Vatin-Perignon (France). They also pointed out subduction characteristics in the Northern part of the Peruvian Central Volcanic Zone on the basis of geochemical data and quantification of crustal contamination of the Nevado Solimana volcano (South Peru). Besides, they presented results of research conducted on type and products of the 18 February 1600 AD eruption of Huaynaputina volcano, Province of Moquegua, Central Andes of Southern Peru.

Geochemical results of a co-operative research between Caldas University (Colombia) and the Complutense University (Spain) focused on ancient pyroclastics from the Nevado del Ruiz volcano were presented by J.L. Naranjo. REE, major and minor element data indicate that pyroclastics can be subdivided into two major groups, medium-K and high-K andesites-dacites and this is explained in terms of magmatic evolution. Additional geochemical data leading to similar conclusions were given by S.J. Schaefer (U.S.A.) who showed that the most significant eruptive products of this volcano fall into two distinct magma series, low-K and high-K series, respectively, and that products from both series overlap in time and space which indicates either two separate magma sources or two different evolution trends. Emplacement mechanisms for pyroclastics were also discussed by J.L. Naranjo. On the other hand, D.L. López described the Nevado del Ruiz volcano from the point of view of recent hydrothermal processes related to magmatic activity.

Two magma series (shoshonitic and high-K calc-alkaline) are postulated by L. Pozzo-Iñiquez and A. Saavedra-Muñoz (Bolivia) as source for volcanic materials of the Guadalupe ignimbrite plateaux, Potosí Department. M.L. Calvache (Colombia) and S.J. Williams (U.S.A.) characterized the more recent eruptions of the Galeras volcano (Colombia) and proposed an evolution style for this volcano. H. Cepeda (Colombia) postulated magma mixing in a zoned magma chamber as the mechanism that triggered the last eruption of the Puracé volcano, and G.E. Toro (Colombia) presented results of characterization and dating studies of the San Diego volcano, the northernmost one in the Colombian Central Cordillera.

H.E. Bastias (Chile) described the recently discovered Olivares Volcanic System, correlated it with the Chilean Oligocene-Miocene Norte Chico Volcanic Belt and established its tectonic framework. The Aranzazu (Colombia) volcaniclastic sequence was taken by E. Hernández and M. Valencia as an example of explosive volcanism resulting from compressive stresses along the Colombian Central Cordillera.

Lessons were also learned from research carried out in tectonic frameworks similar to that dominating along Western South America. For example, M. Fernández-Arce (Costa Rica) described the geology and dynamic processes occurring at the Poas volcano site and R. Hirobe (Japan) presented the general characteristics of the Izu-Oshima volcano, its type of magmatic activity, evolution stages and relationship to tectonic stresses.

In addition, some papers about metallogenesis, magmatogenesis and mineral deposits were also presented. W.A. Avila-Salinas (Bolivia) showed the main geochemical features and tectonic settings of the Bolivian tin-bearing granites, particularly in terms of discriminant diagrams (S-type versus A-type), and also discussed the volcanic, petrologic and metallogenic features of the Tatasi (Potosí, Bolivia) caldera, the origin of volcanics (mainly high-K

dacites), and the types of silver-tin xenothermal deposits associated with this caldera. G. Ujueta (Colombia) defined a series of NE-SW trending major lineaments along the Colombian Eastern Cordillera, related them to the igneous volcanic and intrusive rocks present along this chain, and interpreted them as indications of basement faults along which mineralizing fluids ascended and deposited several mineral deposits, including emeralds. Z. Krzowski (Poland) reviewed the Mexican iron deposits on the basis of associated magmatic processes, and A. Rivera-Gaviria (Colombia) sketched the volcano-tectonic framework of epithermal precious-metal deposits and also discussed some aspects of Colombian mineral deposits in relation to tectonic setting and metallogenesis.

The pre-symposium excursion, held over a four-day period, examined the geology of the Colombian Western Cordillera, its geodynamic evolution, several of its magmatic events, and its relationship with the rest of the Andes. The post-symposium excursion visited the 'Los Nevados' National Park located along the Colombian Central Cordillera. The main aim was to examine the general geology, tectonic framework and magmatic events of several volcanoes located at that site, particularly the Nevado del Ruiz, Tolima, Cisne, Santa Isabel, Morro Negro, Quindío y Páramo de Santa Rosa volcanoes.

Proceedings (in Spanish with English abstracts) of this symposium were edited in two volumes that can be obtained, at a modest price of US $10 per volume, from: Libreria Universidad de Caldas, Apartado Aéreo 275, Manizales, Colombia.

Publications

- Special volume of the Revista de la Asociación Geológica Argentina (Ed. Coira, B.), *44*, (1-4), 447 pp. (1989) (published in 1991). This volume contains 40 papers on the general topic of the project.

- A special volume that includes 18 full papers presented at the international symposium held in Manizales, Colombia, was published by the Universidad de Caldas ('Simposio sobre Magmatismo Andino y su Marco Tectónico', Memorias, Tomo I, Manizales, Colombia, 1991, 350 pp.).

- Twenty-eight extended abstracts (including maps and figures) presented at the final symposium organized in Viña del Mar, Chile, were published by the 6th Chilean Geological Congress (Actas, Volumen 1, 1991, 931 pp.).

- Special paper of the Geological Society of America No. 265 'Andean Magmatism and its Tectonic Setting' (1991, in press).

More papers than those reported here have been published as contributions to the project in 1989-1991 in different journals.

The Board considered that IGCP Project 249 has been highly successful (as was its predecessor IGCP Project 120) in encouraging a wide range of multidisciplinary activities involving a large group of scientists from South America, North America and Europe. Almost all the goals of the project were achieved according to schedule. Many papers, memoirs and special publications will record the activities developed within the umbrella of IGCP Project 249 which remains an excellent example of international co-operation.

The project is terminated.

No. 252 - PAST AND FUTURE EVOLUTION OF DESERTS (1987-1991)

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Description: The project, started in 1987, intends to study and compare the recent (past 150,000 years) changes in the environment of present-day deserts and their implications to past and future changes.

Deserts and their margins have experienced considerable and rapid changes during the Pleistocene and the Holocene. The teams working on these topics use interdisciplinary methods, in order to reconstruct rapid environmental and climatic changes, e.g. alternation of dry and wet periods.

This project will be an important contribution to the 'Quarternary Geosciences and Human Survival' subprogramme and to Global Change.

Achievements in 1991

General scientific achievements

In 1991, the project began to produce synthetic results and it extended correlations to the Southern hemisphere.

The thorough investigations on tropical Sahara palaeoenvironmental changes, East to West (in particular those of the German members in Eastern

Sahara and those led by L.G.Q. of CNRS at Marseilles in Northern Mali 17° - 24 N/O - 6° W), a synthesis on Saudi Arabia in the last 30 ka, the new research on the Thar desert (India) and on Chinese arid areas - allowed to conclude to recent Quarternary geological scale wide changes in both the African and Asian monsoonal activity and range, related with Global Changes.

A relationship was established between the palaeohydrological changes (presence of swamps and shallow lakes) and palaeobiological ones (biogenic CH_4 production) in the last 130 ka, in the tropics and subtropics, and the variations of atmospheric methane ratio, as provided by the vostok core.

The question was raised of the value of such established relationships of cold/warm global scenarios with extant deserts extension for the anticipation of our natural (cold) future or our much more probable man-made (warm) greenhouse-forced future.

At a short time-scale, a comparison of African rivers discharge, of climatic data in arid China and of sunspots records in the last 1,500 years, has been tentatively made by scientists from the Institute of Atmospheric Physics in China, in collaboration with French and Belgian members. Preliminary results were presented at the INQUA Congress and the investigations will continue next year, other Chinese scientists being invited to Western Europe to work in the corresponding laboratories of members of the project.

Those results prove tight correlation of regional climatic changes - as recorded by geological archives - with Global Change, despite their wide geographic differences. They show that *geology* should match and *be compared* with the results of models since, when trying to anticipate our future in a realistic manner, one *should* take past events in consideration, especially when the *speed* and *range* of events such as deglaciation and sea level rise are considered. Such data are provided by geology.

The Board appreciated the good record of the project and the efforts of its organizers. A final report is awaited in the expectation that it will summarize achievements and list outstanding questions for future work.

The project is terminated.

No. 253 - TERMINATION OF THE PLEISTOCENE (1989-1994)

Jan Lundqvist, Department of Quaternary Research, Odengatan 63, S-113 22 Stockholm, Sweden.

Description: The project aims to study relationships between the climatic, hydrological and environmental changes characterizing the transition from the last glacial to the present interglacial. The time period covered is 18,000-8,000 BP, but the work will be focused especially on the time span 13,000-10,000 BP. The following problems will be studied in the global, terrestrial, geological record:

(1) Decay of the continental ice sheets. Emphasis is put on identification of some problematic ice sheets, and on modelling of the better-known sheets.

(2) Desertification and changes in monsoonal circulation. Some information in this respect will be obtained from studies of lake sediments and biotic changes in low latitudes. Information will be needed, however, mainly from the recently established INQUA Commission on Global Continental Palaeohydrology.

(3) Relations between the Northern and Southern hemisphere climatic changes. The studies are focused on the fluctuations of local glaciers and small ice caps, and on environmental changes recorded in lake and river deposits as well as in continental biostratigraphy.

(4) Interaction between ocean and land. Studies are focused on the Younger Dryas problem, that is, the changes in ocean circulation, their impact on climate and the possible effects of the drainage of large ice-dammed lakes.

Organization: The project is led by a steering committee consisting of J. Lundqvist (Chairman), M. Saarnisto (Secretary), D. Bowen, J. Rabassa and A. Raukas. The work will be performed within the following working groups (this implies a slight revision of the original organization decided at the inaugural meeting):

WG 1 Problematic Ice Sheets

WG 2 Glacial Modelling

WG 3 Fluctuations of Local Glaciers

WG 4 North Atlantic Seaboard Programme

WG 5 Depositional Changes in Non-glaciated Regions

WG 6 Environmental History and Drainage of Large Ice-dammed Lakes

WG 7 Global Younger Dryas

WG 8 Changes in Permafrost Conditions

WG 9 Environmental Changes.

Within some of these working groups, subgroups for different purposes have been established. In order to provide the working groups with information, organize work in certain areas, initiate new work in those areas, and to establish necessary contacts. Regional groups have been established:

A. Peribaltic Group

B. Nordic Group

C. IGCP 253 Group of USSR

D. European Atlantic Seaboard Group

E. East Balkan Group

F. Alpine Deglaciation and Climatic Changes

G. Commission on the Quaternary of South America

H. A group 'Glacial Deposits and Environment in Monsoon Asia' is being established as a working group within the INQUA Commission on 'Formation and Properties of Glacial Deposits', and will also be active within IGCP.

Achievements in 1991

Besides local meetings of small groups, e.g. the Peribaltic Group, the following should be mentioned:

North Atlantic Seaboard Programme, Egham, Surrey, United Kingdom, 15-17 April. Identification of problems to be studied, and structuring the work.

Billingen Area, Sweden, 2-3 May. The drainage area of the Baltic Ice Lake, with catastrophically transported sediments was identified - a problem that has been discussed but remained unsolved since the early part of the century when the Baltic Ice Lake was first recognized.

East Karelia Field Conference, Finnish and Soviet Karelia, 26 June-4 July. Identification of the Younger Dryas ice-marginal line in Soviet Karelia - for the first time since the Second World War accessible for foreign scientists. Well-developed marginal formations were studied, but some problems of correlation with the Finnish Salpausselkä moraines still remain to be solved.

XIII INQUA Congress, Beijing, China, 7 August. A meeting with discussion about current problems was held.

Some other meetings have not been organized by the project itself, but have had a strong connection with our activities. The project was represented there, and results will be incorporated in our reports. Such a meeting was: 'Physical and Biological Responses to the Younger Dryas Climatic Oscillation in the Circum-Pacific Region', Seattle, Washington, 2-3 May.

Scientific results in 1991

Identification of the traces of the Baltic Ice Lake Drainage and of the Younger Dryas moraines in Soviet Karelia.

In the Balkan area, research was done on palaeogeography, palaeoecology, sedimentology, etc., related to the Pleistocene/Holocene transition along transects through Bulgaria and Greece. A preliminary dendrochronological time-scale has been elaborated.

A report about Younger Dryas conditions in East Greenland, resulting from field work within the PONAM project, is printed as LUNDQUA report 33.

Thirty-one countries participated in the project (* indicates the countries active in 1991): Argentina*, Austria, Belgium*, Bulgaria*, Canada*, China*, Costa Rica, Czechoslovakia*, Denmark*, Estonia, Finland*, France*, Germany*; Greece*, Iceland*, India, Islamic Republic of Iran, Ireland*, Italy, Japan, Netherlands, New Zealand, Norway*, Poland*, Qatar, Spain*, Sweden*, Switzerland*, United Kingdom*, United States and the USSR.

Publications

- Baltačkov, G. and Cherkerzova, E., 1990: Late glacial palaeoenvironment and some geomorphic phenomena in the southern part of Rila Mountains (Rhodope Massif, Southern Bulgaria). *Geographica Rhodopica*.

- Bergsten, H., 1991: Late Weichselian-Holocene stratigraphy and environmental conditions in the Göteborg area, south-western Sweden. Chalmers Tekn. Högsk./Göteb. Univ. A70.

- Rainio, H. and Saarnisto, M. (eds.), 1991: Eastern Fennoscandian Younger Dryas End Moraines. Field conference, North Karelia, Finland, and Karelian

ASSR. 26 June-4 July 1991. Excursion guide. Geol. Survey of Finland, Guide 32, Espoo-Helsinki.

- Shopov, I., 1990: Investigation of the old variations of the climate and solar activity by a new method - LLMZA of cave flowstones from Bulgaria. Proc. 10 Inter. Congr. of Spelaeology, 13-20 August 1989, in Hungary. Hung. Acad. of Science, Budapest.

- Shopov, I., Dermendziev, V., Boyukliev, G., Georgiev, L. and Stoychev, T., 1990: Investigations on the variations of the solar activity during the Holocene by means of LLMZA of cave flowstones. Proc. Intern. Symp. of Mount Karst, Tbilisi. Georgian Acad. of Science.

- Stefanova, I. and Bozilova, E., 1990: Spore-pollen analysis and sedimentation of the glacial lake Bezbog (Pirin Mountain, Bulgaria). *Geographica Rhodopica.*

Activities planned

The following meetings are planned through 1992:

January: Meeting of North Atlantic Seabord Group in Iceland.

May: Meeting of the Peribaltic Group in Poland-Germany.

May: Great Lakes meeting in Ontario.

June: Meeting of Permafrost Group in Estonia.

September: Joint meeting with NORDQUA around Kattegat.

September: Meeting of North Atlantic Seabord Group during the palynological conference in Aix-en-Provence, France.

September: Joint meeting with INQUA Commission on Palaeohydrology in Poland.

September: Meeting of Working Group on Environmental Changes in Moscow, Russia.

October: Meeting of Ice-dammed Lakes Group in Ohio.

The scientific work will consist of compilation of data, completed with new research within the topics of the nine working groups. In connection with the work on the transects mentioned above refinement of dating methods will also take place. Efforts are made to increase the activity in developing countries, although lack of competence in many areas creates difficulties.

Plans for the final report, to be published in *Quaternary Science Reviews* (alt. Quaternary International) in early 1995, have been made. The report shall contain: (1) a summary of the entire project; (2) summaries corresponding to the topics of the nine working groups; and (3) individual papers to an extent determined by the space available.

No. 254 - METALLIFEROUS BLACK SHALES (1987-1991, O.E.T. in 1992)

J. Pašava, Geological Survey, Malostranské nám. 19, 11821 Praha 1, Czechoslovakia.

Description: The economic importance of mineralized black shales has been increasing considerably during the past years. Ore deposits of economic importance and promising metal accumulations associated with black shale formations have been found in many areas of the world. They represent important sources of precious and base metals, U, Mo, Ni, Mn, Hg, Sb, W, and others.

The ultimate aim of the project is to establish the general characteristics of black shale formations and to describe the ore-forming processes that have led to the formation of economically important ore deposits. The establishment of appropriate criteria for prospecting is also being planned.

Achievements in 1991

More than 360 scientists from 26 countries participate in the activities of the project. National working groups have been formed in 20 countries.

Four major very well attended international meetings and a number of workshops on a national level took place.

(1) International symposium 'Biogeochemistry and Sedimentology of Precambrian and Phanerozoic Black Shales, Sedimentary Rocks and Related Ore Deposits', in Dallas, Texas, United States, 27 October 1990. There were 14 talks given by scientists from four countries and attended by 70 people during one full-day meeting. Selected papers are to be published in *Precambrian Research.*

(2) International workshop of a 'training course' character on the 'Metallogeny of Black Shales' with special emphasis on precious metal deposits, in Rabat, Morocco, 7-13 November 1990. The main goal was to enable geologists, especially those from developing countries, to

learn about recent results on the metallogeny of black shales. Thirteen scientific papers and one keynote lecture were attended by more than 60 participants from eight countries. The field trip visiting classical oil shale and precious metal deposits hosted by black shales followed. The Abstracts as well as a Field Guide were distributed during the meeting.

(3) International symposium 'Black Shale Basins and Related Mineral Deposits', in Novosibirsk, former USSR, 5-9 August 1991. More than 120 presentations given by scientists from eight countries were attended by 150 participants. A Book of Abstracts was distributed at the meeting. Selected papers are to be published in a special volume. Two field trips were arranged to cover some of the important mineral deposits of Siberia.

(4) International symposium 'Metals and Organic Matter, Bioaccumulation, Biodegradation', in Nancy, France, 30 August-3 September 1991 in the framework of the 25 years SGA Anniversary Meeting. Approximately 100 scientists from 15 countries attended 18 lectures. The extended Abstracts were included in a hardback 841-page book.

National meetings were held in 14 countries: Argentina, Bulgaria, China, Czechoslovakia, Finland, France, Germany, Hungary, Morocco, Poland, United Kingdom, United States, USSR and Venezuela.

The 26 countries involved in the project are: Argentina, Australia, Austria, Bulgaria, Canada, China, Cuba, Czechoslovakia, Denmark, Finland, France, Germany, Hungary, India, Japan, Jordan, Morocco, Pakistan, Poland, Rwanda, Sweden, Tunisia, United Kingdom, United States, former USSR and Venezuela.

Scientific achievements (summary)

Important scientific results were reached in the field of metallogeny of black shales. The principles giving information on ore deposits which are genetically or paragenetically associated with black shale formations including a general review of processes leading to the origin of ore deposition in these rocks were summarized.

During sedimentation black shales become a reservoir of trace elements and sulphur. The accumulated metals, however, attain economically significant concentrations only under very specific conditions. The economically important deposits were formed only during the subsequent diagenetic, hydrothermal, metamorphic or infiltration remobilization processes under favourable structural conditions. Most of the deposits hosted by black shales are polygenetic.

A new uncommon and very promising ore deposit type - Mo-Ni-PGE-Au-rich black shales was first described from South China. In 1990, a similar deposit was reported from Canada with indications of others from Czechoslovakia, United States and Finland. In 1991, it was newly discovered in the Kazakhstan ophiolite belt, the former USSR. It is favourable to notify that this ore type is becoming an important new global resource especially for precious metals.

Important progress was made by Bulgarian scientists on the genesis of Au-Ag mineralization hosted by Early Palaeozoic black shales in north-west Bulgaria.

In Morocco, activities on black shales led to the discovery of economically important reserves of Ag ores hosted in Precambrian black shales of the Igoudrane area, north-east of the exploited Imiter silver deposit, which represent the most important high-grade silver accumulation in Africa.

Cu ores of the Kupferschiefer type represent one of the most important copper source in the world. New data supporting a late diagenetic/epigenetic model of origin were reached by Polish, Canadian, German and United States scientists.

New important data were presented by the United Kingdom and Chinese scientists on prospecting criteria raised from the studies of bitumens. It was proved possible to date the interaction of bitumens and metals, thus providing a new field of possibilities to study the genesis of metal concentrations in black shale formations.

In the field of base metals an important progress was made by the Australian participants. It was proposed that coeval granitoid batholits, in the Mt. Isa inlier and McArthur Basin, may have generated sufficient heat from radioactive decay to drive ore-forming fluids convention cells in overlying shaly sediments. These may have formed the giant synsedimentary Mt. Isa and HYC Pb-Zn deposits.

According to this model, large deposits will only form in water-saturated sediments that overlie high heat producing granites, and the size of the deposits is likely to be related to the volume of the granite.

In Poland, an extended research programme of the leaching process of U, V, Mo, Zn, Pb from

Ordovician metal-rich black shales was carried out applying the selected strains of sulphuric bacteria. Range of conditions, under which the process was most effective was determined. The results are very important for the future exploitation of lower grade ore types.

IGCP Project 254 Newsletters Vol. 3 was published summarizing scientific activities of the project in the period from October 1989 to November 1990. Collecting of forms with data on description of black shale formations as well as mineral deposits hosted by black shales for a computer data base continued.

More than 200 scientific papers (monographs, articles, abstracts) resulted from the project activities of which the most important ones are listed in the 1991 IGCP Project 254 annual report.

The exchange of information through bulletins and newsletters with IGCP Project 255 continued. New links were established with IGCP Project 318. Close co-operation was going on with IAGOD and WG 2 of the Global Sedimentary Geology Program (SEPM).

A special international workshop of a 'training course' character on the 'Metallogeny of Black Shales' was successfully held in Rabat, Morocco, in co-operation with the Royal Geological Society.

Activities planned

Termination of special laboratory investigations (fluid inclusion and isotope studies, geochronological dating, etc.).

Compilation of genetic models especially for a Ni-Mo-PGE-Au, Au-Ag, Cu and accompanied elements of the Kupferschiefer type and base metal deposits.

Termination of work on the computer data base.

Editing of Newsletter No. 4.

Presentation and publication of the final scientific results at the 29th IGC in Kyoto, Japan.

One major international meeting is planned for 1992.

International symposium II-16-10 'Metallogeny of Anoxic Environment' in Kyoto, Japan, 24 August-3 September 1992, in the framework of the 29th IGC.

In addition, several workshops will be held.

The IGCP Board stated that the project has successfully addressed a number of questions in the interdisciplinary area between organic geochemistry, metallogeny and regional geological evolution. However, it regretfully declined the requested active extension for 1992-1993, and requested the submission of a final report.

No. 255 - KIBARAN METALLOGENY (1987-1991)

W. Pohl, Technical University, P.O. Box 3329, D-3300 Braunschweig, Germany.

J. Klerkx, Royal Museum for Central Africa, B-1980 Tervuren, Belgium.

D.P.M. Hadoto, Geological Survey, P.O. Box 9, Entebbe, Uganda.

A. Ntungicimpaye, Direction Générale des Mines et de la Géologie, BP 837, Bujumbura, Burundi.

Description: Kibaran (mid-Proterozoic, about 1400-900 Ma) orogenic belts in central and southern Africa carry significant mineralization, most prominently tin and tungsten associated with post-orogenic granites. Ores of both metals have been exploited from quartz veins and pegmatites for many years. More recently, economically promising occurrences of gold, nickel, platinoids and industrial minerals have been discovered. This has spurred much prospecting and scientific work, which was, however, often isolated because of political and language barriers.

In view of this situation the project was conceived to co-ordinate and to correlate ongoing single projects, to associate more overseas laboratories with field work in the region, and to assist African geologists to participate in active research. Last, but not least, it was to serve individuals and small groups working somewhat isolated in the region by distributing information and ideas hitherto not available to them.

As a result, 22 countries participated in the project: Australia, Austria, Belgium, Brazil, Burundi, Canada, Congo, France, Germany, India, Italy, Malawi, Netherlands, Nigeria, Rwanda, Republic of South Africa, Tanzania, Uganda, United Kingdom, United States, Zaire and Zambia.

The basic scientific approach was to study the origin of Kibaran mineral deposits within and together with their geological environment in the widest sense, encompassing sedimentology, stratigraphy, synsedimentary volcanic rocks, the

deformational and metamorphic evolution, the intrusive magmatic rocks, and the geodynamic setting of the Kibaran Belt *sensu stricto*. For a wider perspective, comparative studies of Kibaran belts in the whole of Africa and synchroneous belts in other continents were solicited. At a more practical level, it was hoped that the project would provide results which could be used to develop more specific prospecting guides for Kibaran mineralization, that it would identify additional geological controls to help mine planning, and that it would assist to find new deposit types or new mineral resources.

Contacts and collaboration existed with the following IGCP Projects: 254, 273, 282, 288 and 291.

Achievements in 1991

The final plenary meeting of IGCP Project 255 was organized by Dr Audace Ntungicimpaye and co-workers from the Geological Survey and Mines Department at Bujumbura, Burundi, from 11 to 13 September, jointly with a meeting of IGCP Project 273. It was attended by about 50 participants from 11 countries. From the 40 abstracts submitted, 30 were chosen as oral communications representing recent work in various parts of Africa. In order to interest geologists working in exploration, mining, or with governments, the main theme of the meeting was 'Gold and Platinoids in Central Africa'.

The meeting was preceded by a field trip which allowed about 30 participants to study major geological features of Burundi and its most important mineralizations and mineral prospects. Among the latter were: layered mafic intrusions with lateritic nickel, vanadiferous magnetite, and potential PGE-mineralization, granite-related tin, phosphate-bearing carbonatite, and several gold mineralizations.

Scientific achievements presented at Bujumbura concern both the geology and mineralization of the Kibaran Belt *sensu stricto* as well as its wider geological environment. For example, detailed geochemical data and radiometric ages were presented for gold mineralization in north-west Burundi (J. Brinckmann). Geochemical soil sampling methods for gold adjusted for mountainous terranes in tropical areas were described (I. Salpeteur). Preliminary PGE-determinations on rocks from layered mafic intrusions in Burundi (A. Deblond) are important indications for future exploration campaigns. The Ni-Cu-Co sulphide mineralizations associated with these intrusions formed by fractional crystallization and unmixing (J.R. Ikingura). The structures controlling these post-orogenic layered mafic intrusions in Burundi were shown to have been formed as extensional faults with later inversion to thrusts (L. Tack). A unifying geological and metallogenetic model of the Kibaran Belt was presented by W. Pohl. Several important papers concerned the setting of gold mineralization in the Kibaran foreland or basement, both of Proterozoic and Archean age (G. Borg, C. Chartry and G. Ntirandekura, J. Lavreau) and in Kibaran belts elsewhere in Africa (R. Thomas). The Kibaran evolution was shown to be intimately associated with early phases of the Mozambique Belt in eastern Africa (P. Pinna et al.).

Activities planned

The project terminated in 1991. In order to present the last years' work to the roughly 200 participants and affiliates of the project, a final edition of IGCP Project 255 Newsletter/Bulletin (4/1992) will be printed and distributed. For a wider audience, a thematic issue of Elsevier's journal *Ore Geology Reviews* on 'Kibaran evolution and metallogeny' is in preparation, to summarize the project's work.

The Board commended the very successful efforts of Dr Pohl, declared the project terminated, and requested the submission of a final report.

No. 256 - OPHIOLITE GENESIS AND THE EVOLUTION OF OCEANIC LITHOSPHERE (1988-1992)

N. Bogdanov, Institute of Lithosphere, Staromonetny per. 22, Moscow 109180, Russia.

L. Beccaluva, Istituto di Mineralogia, Università di Ferrara, Corso Ercole I D'Este, 32, 441000 Ferrare, Italy.

Description: A successor project to IGCP Project 195; this project intends to refine the role of ophiolites in different oceanic settings, especially in arc and back-arc basins. It will review the 'typology' of ophiolites as regards their distinctive petrological character and genesis, and will work to develop genetic models of oceanic accretion in marginal basins and other oceanic settings. Close co-operation is being maintained with the Ocean Drilling Programme and the Lithosphere project. The Bulletin *Ofioliti* is the official organ of the project.

Achievements in 1991

The members of the working group of the project met in Granada, Spain, from 12 to 17 September at a conference which was attended by 30 scientists from eight countries. The programme of the conference consisted of a scientific session (two days) and field trips (four days).

Thirteen papers were presented at the scientific session devoted to different aspects of ophiolites. They dealt with the composition and geological setting of ophiolites in various fold belts, and the problems of the general evolution of the oceanic crust in the course of geological time.

The objective of the field trips was to observe the Ronda and Ojén ultramafic massifs and the Betic ophiolite association of the Nevado Filabride complex.

The Ronda ultramafic massif is exposed in the Alpujarride complex in the internal zones of the Alpine Betic chain over 300 km². This massif like other ultramafic massifs in the western Betic Cordillera, has been interpreted as being a portion of the upper mantle emplaced at high temperature (900°) in the continental crust as a part of a major thrust sheet.

The ultramafic rocks are mainly therzolites and harzburgites with minor amounts of dunites, pyroxenites and gabbro layers.

Scientists from the following countries actively participated in the project activities in 1991: Albania, France, Greece, Italy, Morocco, Oman, Spain, Turkey, United Kingdom, United States and USSR. Other countries participating in the project: Canada, China, Colombia, Germany, India, Japan, Netherlands, Norway, Switzerland, Ukraine and Yugoslavia.

Publications

The abstracts of papers and guides for the field trips have been published. The main publication of the project in 1991 is a special issue of *Ofioliti* devoted to the structure of the oceanic crust and ophiolites.

Activities planned

The final meeting of the project with a field trip is planned to be held in Albania, Tirana, at the invitation of Albanian colleagues (4-10 October 1992). A two-day scientific session will be followed by a four-day field trip on Albanian ophiolites.

The field trip will provide participants with the opportunity to visit two adjacent well-exposed and complete ophiolite belts with distinctive petrological features.

The Board noted improved reporting and substantial efforts and results. Publications should be placed in international journals as well as specialized journals. Special efforts should be made to distribute new information on Albanian ophiolites. A summary should be written for *Episodes* or *Geotimes*.

No. 257 - PRECAMBRIAN DYKE SWARMS (1987-1991)

H.C. Halls, Department of Geology, University of Toronto, Erindale Campus, Mississauga, Ontario, L5L 1C6 Canada.

Description: Large numbers of mafic dyke swarms are found cutting Precambrian shields on every continent and were injected at intervals throughout the Proterozoic. An understanding of these swarms in terms of mantle and tectonic processes requires co-ordinated and co-operative studies on a global scale.

The scientific objectives of the project include:

(1) The correlation of Precambrian swarms on a global-wide basis through measurement of radiometric age, palaeomagnetism and geochemical composition. Ultimately a test will be possible of whether or not times of major dyke intrusion are globally synchronous.

(2) The correlation of dyke swarms with coeval volcanics. In many cases dyke swarms may represent the only surviving igneous products of major rifting episodes.

(3) The definition of dyke swarm geometry in three dimensions (i.e. the recognition of dykes emplaced in the deep crust and their comparison with those from upper crustal levels).

(4) An improved understanding of the mechanics of dyke swarm emplacement. In particular the relative importance of lateral versus vertical magma transport, especially in giant radiating dyke swarms where feeder chambers may lie in the focal region.

(5) An understanding of Precambrian swarms in terms of crustal tectonics and mantle processes.

(6) The use of Precambrian swarms in structural and stratigraphic studies.

Achievements in 1991

The general scientific achievements of the project this year may be summarized with reference to three scientific meetings, held in Finland, Canada and Brazil, which collectively represent the greatest annual activity for the project since its inception.

(1) Field conference in Finland (10-15 June 1991). Symposium attendance: 25. Number of field trip participants (minimum 10, maximum 15). Number of countries: five (Australia, Canada, Estonia, Sweden and Finland).

(2) Special Session 'Giant Radiating Dyke Swarms and Mantle Plumes'. Geological Association of Canada Annual Meeting, Toronto, Canada, 29 May 1991. Attendance: ≥ 100. Number of countries: five (Finland, United Kingdom, Australia, Canada and United States).

(3) International Conference and Field Trips on Mafic Dyke Swarms, São Paulo, Brazil, 25 September-11 October 1991. Meeting attendance: 65. Number of Salvador-Olivença field trip participants: ten. Number of Uruguay field trip participants: 15. Number of countries: ten (Brazil, Uruguay, United Kingdom, Italy, France, Canada, Portugal, Finland, Ukraine and India).

1. Field conference in Finland

A five-day field trip and conference (10-15 June 1991) examined mafic dyke swarms associated with rapakivi granites in Finland. The field conference, organized by Ilkka Laitakari of the Geological Survey of Finland (IGCP Project 257. Technical Report No. 4) took participants to the Håme dykes which radiate from the Vyborg Rapakivi pluton and to dykes associated with the Åland pluton in the Åland archipelago in the Gulf of Bothnia between Sweden and Finland.

The main geological observations of the Finland excursion are that mafic and felsic magmas are closely associated in time and sometimes simultaneously leading to magma mixing. Both of the igneous complexes are similar. The rapakivi granites yield U-Pb Zircon ages that cluster closely around 1575 Ma (Åland) and 1640 Ma (Vyborg). The associated dyke swarms do not cut the granites, and in the Åland complex, dyke pyroxenes become increasingly altered to amphibole closer to the granite and in one case granite porphyries are observed to cut a dyke. In the Vyborg complex U-Pb dating suggests that mafic dykes are of two ages, 1646 and 1667 Ma and hence are mainly older than the granites. In both complexes both mafic and felsic magmas are present, and composite dykes and hybrid relations showing magma co-mingling are found. It seems that while the more common, mafic dyke swarms are older, a younger mafic magma showing more felspar phenocrysts and felsic xenoliths is co-magmatic with the older parts of the rapakivi granite complex. In the Åland complex excellent exposures demonstrate how basaltic magma has caused melting of adjacent country rock to produce a quartz-porphyry-like rock. In the Vyborg complex, an associated gravity low is superimposed on a broad high which may reflect the expression of deeper denser rocks underlying the granite.

The current interpretation of the observed relations is that mafic magma was ponded at the base of the crust where it started to melt the overlying rocks during its ascent. Some of this magma was injected towards the surface as dykes centred on the rising pluton. The pluton then continued to rise, by this time largely granitic in composition, and was subsequently emplaced at the same crustal level as the preceding dykes. Some mafic magma, perhaps continued to be supplied to the base of the rising pluton and was available to mix with the rapakivi magma but also solidified at depth below the pluton. The rapakivi-basaltic dyke association may be important as a smaller scale version of mantle plumes that are thought to produce the giant radiating dyke swarms that are so characteristic of the Canadian Shield. In the latter case however the time between the ponding of mafic magma within the mantle and its release through dyke injection was possibly too short to produce melting of the lower crust.

2. Special session at the GAC meeting in Toronto

A one-day special session 'Giant radiating dyke swarms and mantle plumes' was held at the Geological Association of Canada annual meeting in Toronto (29 May 1991) and was organized by Henry Halls to further explore the relationship between plumes and radiating dyke swarms. The session was extremely well attended (more than 100 people).

Highlights included film demonstrations by Ian Campbell (Australia) of a rising plume and lateral propagation of a dyke at the level of neutral buoyancy. Richard Ernst (Canada) showed from the anisotropy of magnetic susceptibility that the flow trajectories in the giant Mackenzie swarm are vertical out to about 500 km from the focal region but flatten to subhorizontal trajectories thereafter. The interpretation of this observation is that the main source for the magma was near the focus and that magma in the more distal regions flowed hundreds of kilometres laterally from the source. Phinney (United States) showed that this relatively simple picture does not hold for the 2.45 Ga Matachewan dyke swarm because major and trace element abundances from dykes along six traverses across the swarm show no clear correlation. Phinney proposed that magma assimilated a variety of lower crustal material and then underwent replenishment and fractional crystallization in magma chambers 10-15 km deep before final intrusion as dykes. Several melt types

distributed over a broad area are consistent with a rising plume 1,000 km or more in diameter. The maximum distance of samples from the focal region is however only about 400 km so that the area of study may still remain within the vertical magma flow regime if a comparison with the Mackenzie event is valid. Other important contributions to the special session included: (1) the demonstration from U-Pb dating by Buchan (Canada) that the Fort Frances and Marathon dyke swarms are virtually identical in age and thus together form a radiating swarm centred immediately south of Lake Superior; (2) a positive correlation of amphibole aluminium content in Matachewan dykes was found by Palmer (Canada) with previous palaeo-pressure estimates on country rocks; and (3) palaeomagnetic data from the Matachewan dykes reflect differential crustal uplift and vertical-axis rotation of the Superior Province over an area of 250,000 km², related to foreland deformation during the 1.9 Ga Hudsonian collisional event (Halls, Canada).

3. International meeting in Brazil and Uruguay

The 1991 international meeting was held in São Paulo, Brazil, in conjunction with the 3rd Brazilian Geochemical Congress, 29 September-2 October 1991. The meeting was organized by co-convenors Wilson Teixeira (Univ. São Paulo) and Elson Oliveira (Univ. Estadualde Campinas). Most of the talks concentrated on the description of Brazilian swarms, some of which were featured in two field trips which took place both before and after the main meeting. The most notable one was in the Salvador region, where hundreds of dykes (900-1000 Ma old) of the Salvador-Olivenca swarm are magnificently exposed along the coastline and where participants enjoyed excellent discussions about dyke structure and magma flow trajectories under the direction of the field trip Leader Luis Gomes (Univ. Salvador). The dykes, intruded into granulite-grade basement have a broad radial pattern centred offshore to the east. Dykes bifurcate to the west and have primary features that suggest magma also flowed towards the west. The swarm is the best example in Brazil of a large radiating swarm whose focus and main source area may have been in Gabon, Africa. The second field trip which took participants on a 1,500 km journey from São Paulo to Uruguay via the Parana Basalts and associated dyke swarms, was organized by Ernesto, Marques and Teixeira (Brazil) and by Bossi, Campal and Chulepin (Uruguay). A highlight of the trip was the Florida swarm of Uruguay (ca. 1.8 Ga) which covers most of the Uruguayan Shield (Bossi, Campal, Uruguay). This swarm is an excellent example of one that is commercially used for monument and building stone. Excellent exposures in quarries were visited and showed the massive interior exhibited by many of the dykes. In both the Salvador and Florida swarms a high Ti and low Ti dyke suite is present, but the age relations between the two compositional types is unknown.

Other highlights of the Brazilian meeting included: (1) slides of dykes from the Kola Peninsula by Shatalov (USSR) showing spectacular and extensive exposures of undeformed dykes and host rocks along the Arctic coast; (2) a demonstration from AMS measurements that magma flow was generally lateral in the Ponta Grossa dyke swarm (Ernesto, Brazil); (3) the first indication that a NNW-trending swarm about 400 km long occurs in Angola (Silva, Portugal); and (4) the correlation of Mesozoic dyke swarms in Africa on the basis of geochemistry with counterparts in North America (Bertrand, France) and South America (Bellieni, Italy).

Publications

Publications with an IGCP Project 257 number total 54. The number published or in press for 1991-1992 is twenty.

The most important publications for 1991-1992 are:

- Bates, M.P. and Halls, H.C. 1991. Broad-scale Proterozoic deformation of the Central Superior Province revealed by palaeomagnetism of the 2.45 Ga Matachewen dyke swarm. In press, *Canadian Journal of Earth Sciences.*

- Hargraves, R.B., Johnson, D. and Chang, C.Y. 1992. Distribution anisotropy: the cause of AMS in igneous rocks. In press to *Geophysical Research Letters.*

- Heaman, L., LeCheminant, A. and Rainbird, R. 1992. Nature and timing of Franklin igneous events. In press to *EPSL.*

- Solyom, Z., Lindqvist, J.E. and Johansson, I. 1991. The geochemistry, genesis and geotectonic setting of Proterozoic mafic dyke swarms in southern and central Sweden. In press to *GFF.*

- Vuollo, J., Piirainen, T. and Huhma, H. 1992. The early Proterozoic tholeiitic diabase dykes in the Koli-Kaltimo area, northern Karelia. In press, *Geological Survey of Finland.*

- West, G.F. and Ernst, R.E. 1991. Evidence from aeromagnetics on the configuration of Matachewan dykes and the tectonic evolution of the Kapuskasing Structural Zone, Ontario, Canada. In press, *Canadian Journal of Earth Sciences.*

Twenty-five countries were involved in IGCP Project 257 (* indicates the countries active this year): Australia*, Brazil*, Canada*, China, Denmark, Finland*, France*, Iceland, India*, Israel, Italy*, Republic of South Korea, Netherlands, Nigeria, Norway*, Portugal*, Russia, South Africa, Sweden*, Ukraine*, United Kingdom*, Uruguay*, United States*, Zaire and Zimbabwe.

Activities planned

Although IGCP Project 257 terminated in 1991, one further activity is planned. A symposium (No. II-8-9) on: 'Mafic dyke swarms: Distribution, morphology, origin and geological significance', organized by N.M.S. Rock (Australia) and H.C. Halls (Canada) will be held at the 29th International Geological Congress in Kyoto, Japan.

The Board commended the project and the leader for its success, declared the project terminated and requested the submission of a final report.

No. 259 - INTERNATIONAL GEOCHEMICAL MAPPING (1988-1992)

A.G. Darnley, Geological Survey of Canada, 601 Booth Street, Ottawa, Ontario, K1A 0E8, Canada.

Description: The objective is to assess, demonstrate and recommend methods suitable for global surficial geochemical mapping. At the present time there is no part of the world where there are maps showing the distribution of all the elements; systematic baseline data are available for only a few elements over less than 20 per cent of the world's land surface. These missing data could be critical to the solution of many types of problem, ranging from land use, agriculture and human health, to mineral exploration.

Achievements in 1991

Meetings

Uppsala general meeting

The principal 1991 meeting took place in Uppsala, Sweden, 14-20 September. In order to obtain input from environmental scientists it was arranged in conjunction with the 2nd International Symposium on Environmental Geochemistry organized by the Geological Survey of Sweden and the Swedish University of Agricultural Sciences. The International Association of Geochemistry and Cosmochemistry and the Society for Environmental Geochemistry and Health were sponsors. The Steering Committee met on 14 September; a one-day workshop on 'Environmental Geochemistry and the International Geochemical Mapping Project' organized by Alf Bjorklund, was held on 15 September. There were 64 registrants, including the leaders of all technical committees, plus regional representatives from the European Community, Fennoscandia, USSR, China, Africa and North America, including the Caribbean. Twenty scientific papers and posters relating to IGCP Project 259 were presented in the mapping workshop and during the symposium.

Other international meetings during 1991

Eight papers (and an information poster) were presented at the 15th International Geochemical Exploration Symposium, Reno, Nevada, United States, 29 April-1 May.

Three papers were given at the Exploration and the Environment Symposium, Edinburgh, Scotland, 2-4 September.

Information about IGCP Project 259 was provided at the 8th International Conference on Heavy Metals in the Environment, held in Edinburgh, 16-20 September; also at the Conference on Geology, Mineral and Energy Resources of South-East Asia, Bangkok, Thailand, 5-8 November.

Meetings of the West European Group (WEGS) took place in Heerlen, Netherlands, in May and at Uppsala in September.

National meetings during 1991

A meeting of the Canadian group was held in Ottawa on 24 January 1991 and a meeting of the Australasian group took place in Sydney on 22 February 1991.

One of the major events of the year was a meeting of geochemists which took place in Moscow, 3-4 December 1991. It was attended by 200 geochemists from 53 institutions and regional organizations in Russia, Byelorussia, Ukraine, Kazakhstan, Turkmenia and Lithuania and members of the IGCP Project 259 Steering Committee. It discussed plans for two new programmes, the 'Geochemical Map of Russia and the Geoecology (environmental geology) of Russia' in the context of IGCP Project 259 recommendations. The motivating force for both these programmes is the 'intensive deterioration of the environment in recent years'.

Scientific progress

Applied geochemistry and, therefore, plans for geochemical mapping, are being driven increasingly by environmental considerations.

From papers and discussion it has become clear that the preferred sampling media for IGCP Project 259 are stream sediment and soils, plus water samples as and when the analytical problems relating to satisfactory below-background detection limits can be achieved. Overbank samples seem to be less favoured in 1991 than in 1990. Evidence presented by John Ridgway et al. in Uppsala indicated that they require, in general, detailed site investigations which are impracticable for regional reconnaissance purposes.

With emphasis on the need for baseline data for environmental purposes, soils provide the almost universal surface sampling media of general environmental significance. Stream sediments are comple-mentary to soils in providing enhanced sensitivity for some elements of economic importance, but this sample medium is of lesser interest to most scientists concerned with non-geological environmental issues. Lake sediments substitute for stream sediments in wet shield areas with poorly developed drainage.

With increasing attention being given to soil sampling as a reconnaissance medium, more serious consideration is being given to the use of airborne gamma ray spectrometry (AGRS) as a means of providing an interregional and intercontinental reference datum along continuous profiles. AGRS is the most automated and standardized of any soil surveying technique, measuring the radioelement content of the upper 0.5m (approximately 66 per cent of the response is from within plough-depth (20 cm)). In addition to providing a reference-level for natural radioelement concentrations, each flight-line also identifies and measures fall-out.

Concerning wide-spaced sampling. This concept is important because it provides the only practical way to obtain an overview of global geochemistry within a decade. It offers speed and economy. However, wide-spaced sampling must first be accepted as being useful. In Reno, Edinburgh and Uppsala this aspect of the IGM project continued to cause the greatest hesitation amongst those whose working experience has been focused on detailed investigations. Regional overviews contribute to the understanding of large-scale processes and the identification of areas deserving more detailed attention.

Evidence presented in recent meetings indicates that major geochemical features can be delineated by:

1 sample per 1,600 km² (soil sampling, China; Xie et al., in press);

1 per 625 km² (lake sediment surveys, Labrador/Quebec; Garrett et al.);

1 per 400 km² (lake sediment surveys, Newfoundland; Davenport et al.);

1 per 300 km² (till sampling, Finland; Koljonen et al.).

It may be noted that in the 1970s several publications illustrated the resolution provided by airborne radiometric surveys at different line spacings. In the absence of other information, useful results were demonstrated for regional reconnaissance purposes at up to 30 km spacing. Further demonstrations are needed to evaluate the effect of lowered sampling density by experimenting with existing detailed data sets.

There is no reason to doubt that coarser geochemical patterns exist than those already delineated in the few regions where extensive coverage is available. For example, 1,000 km spacing would distinguish between continents and ocean floor, but this would not be significant information. Coarse patterns could be outlined with much lower sample densities or line spacings than those advocated to date. The Global Mapping Committee has recently suggested one composite drainage sample per 160,000 km or one composite/40,000 km² for soils. The value of this approach has aroused scepticism amongst many earth scientists and so the subject remains under discussion and awaiting more evidence. What are the dimensions of the largest geochemical features that are of practical interest for geological, mineral exploration or environmental purposes (e.g. fragments of accreted terrane; metallogenic province identification; baseline levels in major drainage basins)? Until evidence is gathered its significance cannot be demonstrated. Conversely, there is virtually no limit to the detail that could be advantageous over restricted areas for special purposes. However, time-consuming and costly detailed investigations logically follow after gross features have been outlined, when there can be some confidence that such investigations are justified.

The geochemical mapping programme is designed to be multi-purpose, to relate to mineral resource evaluation and exploration, soil geochemistry (from an agricultural perspective), as well as environmental pollution. Although geochemical mapping first began in the USSR (in 1934), Russia currently lacks a comprehensive data base and much past work was uncoordinated, unsystematic and lacking in quality control. A new start is being made under scientific Leaders Dr E.K. Burenkov and Dr E.I. Filatov, and executors-in-charge Dr A.A. Golovin and Dr I.N. Reznilov. Work

will be supervised by IMGRE. The programmes were approved by the Russian State Committee for Geology in April 1991.

The mapping will require the determination of 40 to 60 chemical elements, radionuclides, and many toxic organic compounds. Some use of remote sensing techniques, including infra-red, gamma spectrometric, gas geochemical, aerosol, ultraviolet, laser spectrometric, etc., is planned.

Important publications

Nine papers presented at the International Geochemical Mapping Sessions of the 29th International Geological Congress, 1989, plus a later contribution, have been published in: Transactions Institution of Mining and Metallurgy, London (Sect. B: Appl. earth sci.), 1991, Vol. 100, pp. B47-B147. Editor: John Ridgway, British Geological Survey, Keyworth. Introduction: A.G. Darnley.

- Canada's National Geochemical Reconnaissance Program: P.W.B. Friske and E.H.W. Hornbrook (Canada).

- A decade of regional geochemistry in China - the National Reconnaissance project: Xie Xuejing and Ren Tianxiang (China).

- Potassium, uranium and thorium geochemical maps of the conterminous United States: J.S. Duval (United States).

- Geochemical mapping of carbonate terrains: S. Pirc, T. Lenarcic, E. Prohic and R. Svrkota (Yugoslavia) and J.M. McNeal (United States).

- Recent Regional Geochemical Studies in Jamaica: R.G. Garrett (Canada) and A.J.S. Geddes (Jamaica).

- Orientation studies and a preliminary dispersion model of Jamaica for multi-purpose geochemical mapping of the Caribbean region: P.R. Simpson, G.C. Lalor, J.A. Plant and C. Thompson (United Kingdom); J. Hurdley and H. Robotham (Jamaica).

- The definition of large-scale zones of hydrothermal alteration by geochemical mapping using organic lake sediment: P.H. Davenport and W.L. Nolan (Canada).

- Variations in regional geochemical patterns - the effects of site selection and data processing algorithms: J. Ridgway, J.D. Appleton, R.C. Jones and K. Greally (United Kingdom).

- An assessment of biogeochemical mapping at low sample density: C.E. Dunn (Canada).

- Regional distribution of As, Sb and Bi in the Grampian Highlands of Scotland and English Lake District: implications for gold metallogeny: J.A. Plant, D.C. Cooper, P.M. Green, A.J. Reedman and P.R. Simpson (United Kingdom).

The International Atomic Energy Agency has published another 'how to' report, in support of the objectives of IGCP Project 259: IAEA, 1991. *Airborne gamma-ray spectrometer surveying.* Technical Report Series No. 323, IAEA Vienna, 97 pp. It was prepared by R.L. Grasty, H. Mellander, M. Parker and A.Y. Smith on behalf of the Radiometric Methods Committee.

Other papers and numerous abstracts relevant to International Geochemical Mapping have been published in 1991. A full bibliography is in preparation.

List of countries involved in the project (* indicates the countries active this year): Algeria, Angola*, Argentina, Australia*, Austria*, Belgium*, Botswana, Brazil*, Bulgaria, Burkina Faso, Canada*, Chile, China*, Colombia, Congo, Costa Rica, Cyprus, Czechoslovakia*, Denmark*, Republic of Dominica, Ecuador, Egypt, Ethiopia, Finland*, France*, Gabon, Germany*, Ghana*, Greece*, Greenland*, Guinea-Bissau*, Guyana, Hungary*, India, Islamic Republic of Iran*, Iraq, Ireland*, Israel*, Côte d'Ivoire, Jamaica*, Japan*, Kenya*, Korea, Libyan Arab Jamahiriya, Malaysia, Mali, Mexico, Morocco, Mozambique*, Netherlands*, New Zealand, Nicaragua, Nigeria, Norway*, Pakistan, Philippines, Poland*, Portugal*, Romania*, Sierra Leone, Somalia, South Africa*, Spain*, Sri Lanka, Sweden*, Switzerland, Syrian Arab Republic, Tanzania, Thailand*, Togo, Turkey*, Uganda, United Kingdom*, United States*, USSR*, Venezuela, Viet Nam, Yugoslavia, Zambia and Zimbabwe*.

Activities planned

It was anticipated that the 1992 International Geological Congress in Kyoto, Japan, would provide a venue for a meeting, but inquiries have indicated that few project members expect to be able to attend, so no formal programme has been arranged. However, a meeting room is available at 6 p.m. on 28 August and poster space has been arranged.

European meeting, 21-24 April 1992

British Geological Survey headquarters at Keyworth, Nottingham, United Kingdom, will be the location for a project meeting on the theme 'Geochemical

Mapping and Geochemical Provinces: regional anomalies and mineral deposits' in conjunction with a conference on 'Mineral deposit modelling in relation to crustal reservoirs of the ore-forming elements' supported by the IUGS-UNESCO Deposit Modelling Programme, and a Mineral Industries Forum organized by BGS.

North American meeting, 7-10 May 1992

IGCP Project 259 was launched at the first Goldschmidt Conference in 1988. A full day will be devoted to International Geochemical Mapping at the 1992 Conference in Reston, Virginia, at the Hyatt Regency Hotel, close to the headquarters of USGS. Papers will be given in four sessions, entitled: Progress with National Mapping Programs; Applications; Data Levelling and Media Comparions; 'New' methodologies and media.

There will be a Steering Committee meeting in mid-October 1992 in Copenhagen to review, revise and finalize the recommendations prior to publication in 1993.

Southern and East Africa

Plans are being made in conjunction with the Geological Survey of Zimbabwe to hold a four-day workshop on 'Systematic Geochemical Mapping in Southern Africa' in Harare, during January 1993. This will be designed to cover the 'why, where and how' of regional geochemical and radiometric surveys. Those interested in attending should contact Dr J.L. Orpen, Director of GSZ in Harare.

1993 General meeting

This will be held in Beijing, China, in September 1993. IGCP Project 259 will then be five years old and it will be time to launch its successor. This meeting will be an occasion to review and summarize the progress that has been made since 1988, and plan the way ahead.

The Board commended the high degree of activity exhibited by the project participants. The project provides a highly visible and active forum for worldwide co-ordination of geochemical surveys. It has successfully demonstrated that geochemical mapping of the world is a feasible enterprise which will have a significant impact on geological knowledge of the continents, and on monitoring our environment. The Board, however, strongly recommends that the final products of the geochemical mapping be specified in terms of elements and format.

No. 260 - EARTH GLACIAL RECORD (1987-1991)

M. Deynoux, Institut de Géologie, 1, rue Blessig, 67084 Strasbourg Cedex, France.

Description: The project is a continuation of two previous IGCP Projects: No. 24 'Quaternary Glaciations in the Northern Hemisphere' and No. 38 'Pre-Pleistocene Tillites'. Palaeomagnetic research initiated late during the life of IGCP Project 179 'Stratigraphic Methods Applied to the Proterozoic Record' is also continuing under this project.

There will be links between it and the Global Sedimentary Geology Project, and ILP programmes. The main aims are: (1) Glaciation versus tectonism will be investigated in specific geographic areas, e.g. Brazil and West Africa (Late Proterozoic glaciation and pan-African orogeny). South-east Alaska (Tertiary-Quaternary glaciation at a convergent plate margin. (2) Existing Proterozoic and Palaeozoic palaeomagnetic data will be synthesized and combined with new data from China, Mauritania, United States and the USSR. (3) Existing data will be synthesized and new research will be initiated in specific areas, e.g. sequence stratigraphic studies (tectonic versus eustatic controls on sea level), Lower Permian black shale-diamictite associations (significance of eustatic, palaeoclimatic and productivity changes).

Achievements in 1991

Meetings held

- 7-17 January 1991, Bamako, Mali (West Africa), IGCP Project 260 annual meeting and field trip. Twenty-nine geologists from nine countries (Belgium, Canada, France, Mali, Mauritania, Morocco, United States and the USSR).

- 27-28 May 1991, Toronto (Canada), Symposium on 'The Sedimentary Record of Glaciers and Ice Sheets' under the aegis of IGCP Project 260, in conjunction with the Geological Association of Canada annual meeting. About 30 people, from Canada, United States, United Kingdom and Brazil.

- 24-28 June 1991, Hobart (Tasmania), special IGCP Project 260 session on 'Glacial Palaeoenvironments' in conjunction with Gondwana 8 Symposium. About 15 members of IGCP Project 260 from Australia, France, New Zealand, South Africa, United Kingdom and the United States attended the session and a post-session informal business meeting.

- 22-27 September 1991, Buenos Aires (Argentina), Symposium on 'Glacial Events Through Gondwana' under the aegis of IGCP Project 260, in conjunction with the 12th International Congress on Carboniferous and Permian Stratigraphy. About 35 people from Argentina, Austria, Bolivia, Brazil, Canada, South Africa and the United States participated in the meeting.

The 1991 annual meeting of IGCP Project 260 in Mali was organized by the 'Direction Nationale de la Géologie et des Mines' (DNGM) of Mali and the University of Strasbourg. It was sponsored by UNESCO, IUGS and the French 'Centre National de la Recherche Scientifique' (CNRS).

Most of the presentations dealt with tectonic versus climatic control of sedimentation during glacial periods. N.M. Chumakov questioned the age of the middle Siberian glacial horizon leading to the assumption of an earliest Late Proterozoic glaciation in North Eurasia. M. Deynoux tried to demonstrate that Proterozoic, Palaeozoic and Pleistocene glaciations resulted in a combination of various events, and in each case a different event was predominant. N. Hamoumi described various facies and structures which characterize the Late Ordovician glaciation in Brittany and Morocco and gave a view of their structural setting. R.W. Ojakangas discussed the continental extension of Early Proterozoic glacigenic deposits on the Fennoscandian shield and the origin of the rapid climatic change which is figured by a very thick metaregolith overlying the glacial deposits. R.D. Powell gave a very descriptive and well-illustrated model of glacial sedimentation at grounding lines and over morainal banks along tidewater termini of temperate glaciers. J.N. Proust showed how principles of sequence stratigraphy can be applied to a glacially influenced basin, which was also an introduction to the field trip of the meeting. P.E. Schenk proposed correlations between north-west Africa and North America, leading to the assumption that Upper Proterozoic rocks of West Africa, especially the Late Proterozoic glacials, are the source for the Lower Palaeozoic Meguma Supergroup of Nova Scotia.

Other events related to IGCP Project 260

1. **Geological Association of Canada Annual Meeting, Toronto, May 1991**

N. Eyles, Leader of Subgroup 1, organized, in conjunction with the Canadian annual meeting, a one and a half day symposium on 'The Sedimentary Record of Glaciers and Ice Sheets' and a field trip to the Lower Proterozoic Gowganda Formation in northern Ontario and Quaternary sections in southern Ontario. Several members of IGCP Project 260 attended this meeting during which 18 papers and nine posters were presented.

2. **8th International Symposium on Gondwana, Hobart, Tasmania, June 1991**

IGCP Project 260 Australian Working Group and members of Subgroup 3 (black shales section), attended Session T7 'Glacial Palaeoenvironments' convened by J.N.J. Visser (South Africa) and chaired by J.F. Lindsay (Australia). Several papers concerning the broad regional setting of the Gondwanan glaciations were presented. Some were concerned by more detailed aspects of glaciations in Tasmania, north-western Australia and Antarctica.

In the evening following the session John Lindsay convened an informal business meeting. This meeting was also well attended with representatives from major Gondwana areas. The main points discussed were: (1) final publication of the project; (2) relationships with the Pangea project; (3) organization of a South African symposium and field trip on the Dwyka Formation to be held in July 1992 (Johan Visser); (4) informal field trip in conjunction with the Australian Geological Convention to see the Permian glacials at Bacchus Marsh in January 1992 (Phil O'Brien); (5) up-to-date information concerning the Permo-Carboniferous meeting in Argentina (Oscar Lopez Gamundi); (6) the need for glacial facies models (facies chart); and (7) the origin of some Jurassic diamictites in Antarctica (Ken Woolfe and Jane Francis).

3. **12th International Congress of Carboniferous and Permian Stratigraphy and Geology, Buenos Aires, Argentina, September 1991**

O. Lopez Gamundi (Argentina, Convenor), J.M. Dickins (Australia) and J.N.J. Visser (South Africa) organized under the aegis of IGCP Project 260 a Symposium on 'Glacial Events Through Gondwana' in conjunction with this congress. Nine out of the 11 abstracts submitted were presented in the symposium. Main topics were: age of earliest glacial episode (Early Carboniferous in Bolivia, E. Diaz et al.); glacial facies in the Parana Basin (A.F. Franca et al., R.R. Andreis et al.); and the never-settled argument about cyclicity in the United States and Europe and its relation with Gondwanan glaciation (R.L. Langenheim, G.S. Soreghan). The scarcity of good biostratigraphic markers was viewed as a major obstacle to global correlation, although regional correlation can be attained in some areas (O. Lopez Gamundi and I. Espejo). Glacioeustatic fluctuations in Gondwanan basins were marginally discussed (F. Bercowski et al.).

The general feeling is that the study of Gondwanan glaciation is ripe enough to start global syntheses based on regional studies already carried out or in progress (proposal by J.N.J. Visser).

National working group reports

1. **Australia** (from J.F. Lindsay)

The Australian working group met in February at the Australian Geological Convention in Hobart. Members suggested a number of possible field excursions to examine glacial sequences in Australia and discussed the organization of Gondwana 8 in Hobart. Members agreed to provide summaries of their present programmes. However, few have returned their summary of relevant activities and interest to the national correspondent.

J.F. Lindsay convened an IGCP Project 260 symposium and business meeting during Gondwana 8 in Hobart.

N. Alley and R. Bourmann have completed a study of the Permian glacial outcrops in South Australia.

The Bureau of Mineral Resources conducted field work on Permian glacial sediments (Grant Group) as part of the Canning Basin Project.

2. **USSR** (from N.M. Chumakov)

A number of glaciomarine or glacioterrestrial formations have been studied in the Riphean sections of Middle Siberia. Almost identical stratigraphic position of these formations allow to correlate them in a regional stratigraphic marker horizon named Middle Siberian glaciohorizon. The stromatolites and microphitolites which are above and below the Middle Siberian glaciohorizon are regarded as Middle Riphean (between 1000 and 1350 Ma). These conclusions are in agreement with geological and geochronometric constraints. Another less popular opinion assumes a Late Riphean age for this glacial horizon (800 Ma). The first assumption suggests that the Middle Riphean glaciohorizon is the first indication of the earliest Late Precambrian glaciation. The second assumption regards the glaciohorizon as the first indication of the Late Riphean glaciation in North Eurasia.

Besides age, two other problems related to the Middle Siberian glaciohorizon are actively studied: the hierarchy of glacial episodes and the paradox of Late Precambrian glaciations in low latitudes.

Subgroup 3 report (carbonate section, I.J. Fairchild)

Much progress has been made in interpreting the meaning of the carbonates associated with glacial rocks in Neoproterozoic sections. It has been found that two distinct group of carbonates occur. One group occur immediately below and above glacial formations and include the same range of facies as 'normal' Neoproterozoic carbonates, that is those distant from glacial formations: they have evidence for warm, actively evaporating climates in several instances. The second group of carbonates includes those inside glacial formations and consists largely of detrital carbonate reworked from underlying platform sequences. It is apparent however that the presence of large volumes of detrital carbonate locally allowed carbonate to reprecipitate in glacial conditions. One form of reprecipitation is a recrystallization of glacially transported rock flour, another (recognized from Spitsbergen) is reprecipitation induced by evaporation and/or photosynthesis in glacial lakes in arid environments. In contrast, West African continental tillites are more leached, probably reflecting a more humid palaeoclimate, although local reprecipitation related to subglacial processes has occurred. A review paper on the overall significance of the association is in press and several papers giving new data on individual occurrences in Africa and Asia have been offered for the IGCP Project 260 volume. The Proterozoic work has also stimulated a study of modern processes and Pleistocene and Holocene situations where glacial transport of carbonate has occurred. This work in progress will eventually feed back more quantitative information of use in interpreting the Neoproterozoic sequences and will also highlight the extent to which modern analogues exist for these sequences. There remains a large potential for studying the significance of the carbonates associated with Neoproterozoic glacial units in many geographic areas. The potential yield of environmental and palaeogeographic data is large and should make a significant contribution to the debate about the synchroneity and latitudinal distribution of the Neoproterozoic glaciations.

Publications

List of publications No. 4 (November 1991), covering the years 1987-1991, contains 62 titles. The following papers were published in 1991:

- Aitken, J.D. (1991). Two Late Proterozoic glaciations, Mackenzie Mountains, Southwestern Canada. *Geology*, 19, 445-448.

- Boyce, J.I., Eyles, N. (1991). Drumlins carved by deforming till streams below the Laurentide ice sheet. *Geology*, 19, 787-790.

- Chumakov, N.M. (1991). Middle Siberian glacial horizon: traces of earliest Late Precambrian glaciation? Annual meeting of IGCP Project 260 Earth Glacial Record, Bamako, Mali, 7-17 January 1991, Abstract and field guide volume, 9.

- Chumakov, N.M., Krasilnikov, S.S. (1991). Lithological features of Riphean tilloids in the Ura uplift (Lena River). *Lithology and Mineral Resources*, 3, 58-78 (in Russian).

- Clark, P.U. (1991). Striated clast pavements: products of deforming subglacial sediment? *Geology*, 19, 530-533.

- Crowley, T.J., Baum, S.K. (1991). Estimating Carboniferous sea-level fluctuations from Gondwanan ice extent. *Geology*, 19, 975-977.

- Deynoux, M., Convenor (1991). Annual meeting of IGCP Project 260 Earth Glacial Record, Bamako, Mali, 7-17 January 1991, Abstract and field guide volume, 96 pp.

- Deynoux, M. (1991). Glaciation et dynamique globale. Annual meeting of IGCP Project 260 Earth Glacial Record, Bamako, Mali, 7-17 January 1991, Abstract and field guide volume, 10-11.

- Deynoux, M., Proust, J.N. (1991). Les formations glaciaires du Proterozoic terminal au Mali occidental. Annual meeting of IGCP Project 260 Earth Glacial Record, Bamako, Mali, 7-17 January 1991, Abstract and field guide volume, 10-11.

- Diawara, C.S., Keita, N.D. (1991). L'or au Mali. Annual meeting of IGCP Project 260 Earth Glacial Record, Bamako, Mali, 7-17 January 1991, Abstract and field guide volume, 25-27.

- Domack, E.W., Domack, C.R. (1991). Cenozoic glaciation: the marine record established by ocean drilling. A supplement to undergraduate curricula.

- Domack, E.W. et al. (1991). United States Antarctic Program: R/V Polar Duke Cruise 90-7 Report, 45 pp.

- Evans, D.J.A. (1991). A gravel/diamicton lag on the south Albertan prairies, Canada: evidence of bed armoring in early deglacial sheet-flood/spillway courses. *Geol. Soc. Amer. Bull.*, 103, 975-982.

- Frakes, L.A., Francis, J.E., Syktus, J.I. (1991). The termination of Phanerozoic cool modes. Annual meeting of IGCP Project 260 Earth Glacial Record, Bamako, Mali, 7-17 January 1991, Abstract and field guide volume, 12.

- Govare, E., Gangloff, P. (1991). Les dépôts lacustres d'obturation de Saint-Placide, Charlevoix, Quebec. *Géogr. Phys. Quater.*, 45, 141-154.

- Hambrey, M.J., Fairchild, L.J., Glover, B.W., Stewart, A.D., Treagus, J.E., Winchester, J.A. (1991). The Late Precambrian geology of the Scottish Highlands and Islands. The Geologists' Association London, Guide Book, 130 pp.

- Hamoumi, N. (1991). L'Ordovicien supérieur du massif armoricain (formation du Cosquer, presqu'île de Crozon): une période d'interactions climatique (glaciation saharienne) et tectonique (distension). Annual meeting of IGCP Project 260 Earth Glacial Record, Bamako, Mali, 7-17 January 1991, Abstract and field guide volume, 13.

- Hamoumi, N. (1991). Contrôle climatique (glaciation) et tectonique du bassin hirnancien marocain. Annual meeting of IGCP Project 260 Earth Glacial Record, Bamako, Mali, 7-17 January 1991, Abstract and field guide volume, 14.

- Iverson, N.R. (1991). Morphology of glacial striae: implications for abrasion of glacier beds and fault surfaces. *Geol. Soc. Amer. Bull.*, 103, 1308-1316.

- Johnson, R.G. (1991). Major Northern Hemisphere deglaciation caused by a moisture deficit 140 ka. *Geology*, 19, 686-689.

- King, L.H., Rokkoengen, K., Fader, G.B.J., Gunleiksrud, T. (1991). Till-tongue stratigraphy. *Geol. Soc. Amer. Bull.*, 103, 637-659.

- Lowell, T.V. (1991). Late Wisconsin iceberg-calving rate and ice-sheet mass balance reconstructed from palaeo-sea levels, Mount Desert Island, Maine. *Geology*, 19, 155-158.

- Mazzullo, J., Ritter, C. (1991). Influence of sediment source on the shapes and surface textures of glacial quartz sand grains. *Geology*, 19, 384-388.

- Nesje, A., Kvamme, S.P. (1991). Holocene glacier and climate variations in Western Norway: evidence for Early Holocene glacier demise and multiple neoglacial events. *Geology*, 19, 610-612.

- Ojakangas, R.W. (1991). Regolith on Early Proterozoic glacigenic deposits: climatic change due to plate motion or non-tectonic causes? Annual meeting of IGCP Project 260 Earth Glacial Record, Bamako, Mali, 7-17 January 1991, Abstract and field guide volume, 15.

- Powell, R.D., Lawson, D.E., Cowan, E.A., Hunter, L.E. (1991). Observed processes at grounding-lines

and morainal banks of tidewater termini of temperate glaciers. Annual meeting of IGCP Project 260 Earth Glacial Record, Bamako, Mali, 7-17 January 1991, Abstract and field guide volume, 16.

- Proust, J.N. (1991). Modelisation géologique du bassin épicratonique de Wassangara (Mali occidental) sous contrôle glaciaire direct. Annual meeting of IGCP Project 260 Earth Glacial Record, Bamako, Mali, 7-17 January 1991, Abstract and field guide volume, 17-18.

- Ridge, J.C., Franzi, D.A., Muller, E.H. (1991). Late Wisconsinian, pre-Valley Heads glaciation in western Mohawk Valley, Central New York, and its regional implications. *Geol. Soc. Amer. Bull.*, 103, 1032-1048.

- Schenk, P.E. (1991). Upper Proterozoic rocks of West Africa as source for the lower Palaeozoic Meguma Supergroup of southern Nova Scotia, Canada. Annual meeting of IGCP Project 260 Earth Glacial Record, Bamako, Mali, 7-17 January 1991, Abstract and field guide volume, 19.

- Shipunov, S.V., Chumakov, N.M. (1991). Palaeomagnetism of Late Proterozoic deposits of Kola Peninsula. *Geotectonics*, 5, 38-50 (in Russian).

- Socci, A.D. (1991). Controls and feedbacks to climate (glaciation and deglaciation): an evaluation of earth systems in the context of the stratigraphic record. Annual meeting of IGCP Project 260 Earth Glacial Record, Bamako, Mali, 7-17 January 1991, Abstract and field guide volume, 20.

- Socci, A.D. (1991). Climate, time and tectonostratigraphy: a synthesis of Late Proterozoic circum-Atlantic basins and worldwide analogues. Annual meeting of IGCP Project 260 Earth Glacial Record, Bamako, Mali, 7-17 January 1991, Abstract and field guide volume, 21.

Thirty-two countries are involved in the project (* indicates the countries active this year): Algeria, Argentina*, Australia*, Belgium*, Brazil*, Canada*, Chile, People's Republic of China, Denmark, Finland, France*, Germany, India, Ireland, Japan, Mali*, Mauritania*, Morocco*, Netherlands, New Zealand*, Norway, Poland, Senegal, South Africa*, Spain, Sweden, Switzerland, Togo, United Kingdom*, United States*, USSR* and Yugoslavia.

Activities planned

The final volume containing products of IGCP Project 260 is to be published by Cambridge University Press (the memorandum of agreement has been signed). The book organization is as follows: *Title*: Earth's Glacial Record. *Subtitles*: Part 1: Facies models and geodynamic evolution (about 20 papers); Part 2: Rock type association (about ten papers). *Co-editors*: Preface and general supervision: M. Deynoux (Strasbourg, France), J.M.G. Miller (Nashville, United States). Part 1: N. Eyles (Toronto, Canada), G.M. Young (London, Canada); Part 2: (black shales): E.W. Domack (New York, United States), (carbonates): I.J. Fairchild (Birmingham, United Kingdom). *Deadline for submission of manuscript*: 31 December 1991. *Intended completion date*: 30 June 1992.

The project is terminated. The Board highly commended the project and its personnel.

No. 261 - STROMATOLITES (1987-1991, O.E.T. in 1992)

S.M. Awramik, Department of Geological Sciences, University of California, Santa Barbara, CA 93106, United States.

Description: The aim of the project is to create an in-depth understanding of stromatolites from the interaction of sedimentological, microbiological, geochemical, biostratigraphical and environmental perspectives and integrate these approaches through time and space. Specific goals include: (1) to co-ordinate and encourage research on stromatolites; (2) to assess the potential of stromatolites for biostratigraphic correlation on regional, interregional and global scales; (3) to understand the significance of stromatolites as records of the evolution of life and the development of the earth's surface environment; (4) to develop an international consensus on techniques for the study and description of stromatolites; (5) to encourage sedimentologists to broaden the base of stromatolite interpretation through the application of techniques of facies analysis and process studies; (6) to determine the relative roles of cyanobacteria, other bacteria and eukaryotes in the construction of stromatolites in time and space; (7) to attempt to differentiate between those attributes of stromatolites that are under biological control/influence with those attributes that are controlled/influenced by the environment; (8) to rationalize stromatolite nomenclature and taxonomy; (9) to determine patterns on the distribution of stromatolites in time and space; (10) to analyse any patterns that emerge; (11) to study the diagenetic alteration of stromatolite microstructure and the possible retention of primary geochemical (e.g. isotopic) signatures that could be of stratigraphic usefulness in pre-Phanerozoic and Phanerozoic successions; (12) to study the organic geochemistry of present-day microbial communities and to attempt to

apply this to an understanding of the organic geochemistry of ancient stromatolites; and (13) to facilitate the exchange of knowledge and ideas on stromatolites between experienced and inexperienced researchers in the international community.

IGCP Project 261 is probably one of the most multidisciplinary IGCP projects drawing upon numerous specialties within the geological and biological sciences. This also underscores the incredibly complex nature of stromatolites and contributes to the high degree of difficulty in understanding the distribution in time and space.

Achievements in 1991

Meetings held

International meeting on the contribution of non-marine stromatolites to the overall understanding of stromatolites, Capri, Italy, 7-12 April 1992.

Presented papers will be published in the *Bulletin of Italian Palaeontology*.

A major accomplishment of the project has been to capitalize on the strong integrative approach to the study of stromatolites. Under its umbrella, IGCP Project 261 has brought together palaeontologists, biostratigraphers, sedimentologists, field geologists, geochemists, microbiologists and microbial ecologists. This has given us a new view of stromatolites as microbiologically complex and sedimentologically sensitive constructions.

The project pursued a broad approach but also focused on several key areas: (1) taxonomy and biostratigraphy; (2) microbiology; (3) sedimentology; and (4) non-marine stromatolites.

Publications

- Ginsburg, R.N., 1991. Controversies about stromatolites: Vices and virtues. Controversies in Modern Geology. Chap. 3, pp. 26-36.

- Schopf, J.W. and Klein, C. (eds.), in press. The Proterozoic Biosphere. A Multidisciplinary Study. New York: Cambridge University Press.

- Valdiya, K.S. and Tewari, V.C. (eds.), 1989. Stromatolites and Stromatolitic Deposits. *Himalayan Geology*, 13.

- Hofmann, H.J., Sage, R.P. and Berdusco, E.N., 1991. Archean stromatolites in Michipicoten Group siderite ore at Wawa, Ontario. *Economic Geology*, 88:1023-1030.

- Jahn, B., Bertrand-Sarfati, J., Morin, N. and Mace, J., 1990. Direct dating of stromatolitic carbonates from the Schmidtsdrif Formation (Transvaal Dolomite), South Africa, with implications on the age of the Ventersdorp Supergroup. *Geology*, 18:1211-1214.

- Kempe, S., Kazmierczak, J., Landmann, G., Konuk, T., Reimer, A. and Lipp, A., 1991. Largest known microbialites discovered in Lake Van, Turkey. *Nature*, 349:605-608.

- Knoll, A.H. (ed.), 1990. Proterozoic Evolution and Environments: a special volume dedicated to Preston Cloud. *American Journal of Science*, 290-A.

- Monty, C.L.V. and Bertrand-Sarfati, J., in press. Phanerozoic Stromatolites II. Springer Verlag, Berlin.

- Riding, R., Braga, J.C. and Martin, J.M., 1991. Oolite stromatolites and thrombolites, Miocene, Spain: analogues of recent giant Bahamian examples. *Sedimentary Geology*, 71:121-127.

During 1991, over 200 scientists from the following countries participated in the project: Argentina, Australia, Belgium, Botswana, Brazil, Canada, Czechoslovakia, Ecuador, Finland, France, Germany, Greece, Hungary, India, Indonesia, Iraq, Israel, Republic of Korea, Kuwait, Malagasy, Mauritania, Nepal, Norway, Philippines, People's Republic of China, Poland, Saudi Arabia, Spain, Sweden, Switzerland, Thailand, United Kingdom, United States, USSR, Zaire and Zambia.

Activities planned

1991 was the last year of the project and it has been granted an on-extended term status. Many of the specific goals of the project are nearing completion; however, much remains to be done.

Specific goals

(1) It is anticipated that the Code for the Nomenclature of Stromatolites will be ready to submit for publication later this year.

(2) The final draft of the Handbook for the Description of Stromatolites will be presented at the 1992 Plenary Meeting of the Project in Tianjin, 6-8 October.

(3) Taxonomic range charts for stromatolites in the major sedimentary basins of the Proterozoic will continue to be prepared.

Meetings and field trips

The programme for 1992 will have as its focus the Plenary Meeting for IGCP Project 261 in Tianjin, People's Republic of China, 6-8 October 1992, with field trips to follow the meeting.

Some specific projects are:

(1) Handbook for the Description of Stromatolites. *Goal*: A clear and concise reference for the non-taxonomic description of stromatolites. This handbook will contain details on the features of stromatolites that are important for their careful description and is designed with the field geologist in mind. Rigorous methods of study and morphological description are stressed, not nomenclature and taxonomy. A fourth, penultimate draft is being completed and will be circulated to contributors in mid-1992.

(2) Treatise of Most Common Stromatolites. *Goal*: The preparation of a treatise on stromatolites that includes protologues with rigorous diagnoses (descriptions) of the major stromatolite taxa known. The treatise, however, hinges on results of three other projects: Nomenclature, Taxonomy and the Stromatolite Handbook.

(3) Stratigraphic Range Charts for Stromatolites. *Goal*: Charts showing the stratigraphic ranges of stromatolites for the world's major sedimentary basins and or by country.

(4) Nomenclature. *Goal*: A code for the nomenclature of stromatolites to provide rules for the naming of stromatolites and ensure stability of the names of stromatolites. The code follows the format of the International Code of Botanical Nomenclature and makes use of several of the recommendations of a proposed code for the nomenclature of trace fossils; however, the stromatolite code is designed to fulfil the peculiar requirements and needs of stromatolites. The final draft of the code is being prepared.

(5) Taxonomy. *Goal*: To present clear, precise and rigorous descriptions of stromatolites. This is the most intractable goal. There are several different philosophies regarding criteria and the weighting of these criteria in the formal descriptions of stromatolites. The project has begun the preparation of a document for publication that presents the different approaches to stromatolite taxonomy and will present guidelines for some minimum standards.

(6) Sedimentology. *Goal*: To understand the sedimentological framework of stromatolites. Studies on relationships between microbes of modern and ancient stromatolites have seen important results. Grainsize and fabric analyses of stromatolites provide clues to microbiology, palaeoecology, and may prove to be a unique attribute of certain stromatolites.

(7) Geochemistry. *Goal*: To understand geochemical (including isotopic) signatures in stromatolites. The stable isotopic geochemistry of stromatolites is now becoming an almost regular analysis in a number of stromatolite studies, in particular those stromatolites from non-marine environments.

Important publications

- Awramik, S.M., in press. The earliest records of photosynthesis. *Photosynthesis Research.*

- Fairchild, I.J., Marshall, J.D. and Bertrand-Sarfati, J., 1990. Stratigraphic shifts in carbon isotopes from Proterozoic stromatolitic carbonates (Mauritania); influences of primary mineralogy and diagenesis. *American Journal of Science.* 290-A: 46-79.

The Board considered that IGCP Project 261 has achieved important results despite the difficulties from various sources it had to face and solve in five years' life. The Board, however, thought that all scientific achievements have to be made available in official publications. In order to have that accomplished, it agreed with the Project Leader that O.E.T. status should be granted for 1992.

No. 262 - TETHYAN CRETACEOUS CORRELATION (1987-1991, O.E.T. in 1992)

G. Császár, Hungarian Geological Survey (MAFI), Népstadion út 14, Pf. 106, H-1442 Budapest, Hungary.

H. Kollmann, Naturhistorisches Museum, Burgring 7, Postfach 417, A.1014 Vienna, Austria.

Description: The main objective is to produce stratigraphic correlation between the different facies of the Tethyan Cretaceous, to establish their distribution in time and space, as well as their relation to tectonic events. The project will also study the connection between individual facies types and sedimentary mineral resources. The range of fossil

types considered should include all relevant groups of macro-, micro- and nannofossils. Key section descriptions, facies pattern models, palaeogeographic maps and stratigraphic correlation charts should result.

Achievements in 1991

Meetings held

- 19-20 April, Basel. Benthic Foraminifera Team; ten experts from four countries.

- 12-18 May, Zadar, Yugoslavia. Shallow Marine Working Group (together with GSCP-CRER).

- 18-29 May, Grenoble. Cenomanian-Turonian boundary events; 101 participants from 18 countries. Excursions: Tunisia, Southern France.

- 27-30 May, Sümeg, Hungary.- Data Base Map Meeting; eight participants from five countries.

- 11-18 October, Tirana, Albania. Tethyan Cretaceous Formations and related mineral resources; 60 participants from eight countries.

A meeting in Romania was cancelled due to the political situation.

Scientific achievements

Benthic Foraminifera Team

The revision of taxa has been accomplished. Range charts of species have been compiled and are currently the subject of discussion.

Algae Team

A distribution chart and a calibration with benthic foraminifera are discussed between teams.

Pelagic Facies Working Group

The redefinition of the Cenomanian-Turonian boundary was the main result of ammonite, planktonic foraminifera and nannofossil teams.

Coral Sponge Team

Coral and chaetetid studies are concentrating on the Lower Cretaceous of the Central Eastern Mediterranean and the Southern Soviet Union.

Bivalve and Gastropod Teams

A biozonation for the Upper Lower Cretaceous and the Upper Cretaceous based on nerineaceans has been presented.

Palynology Team

Sequence stratigraphical systems tracts have been recognized and correlated with results of palynology in selected Lower Cretaceous sequences.

Maps and Key Sections

A pilot version of data base maps has been the subject of discussion. As a result the principles for compilation have been completed. The Caravaca section has been accepted as the key section for the Lower Cretaceous. It is investigated in broad international co-operation.

Important publications

(1) Preliminary Ammonite zonation for the Lower Cretaceous of the Mediterranean region. *Geologie Alpine* 66.

(2) Excursion guide book and abstracts to 'Field Symposium on Tethyan Cretaceous formations and related mineral resources' in Albania. Two volumes.

(3) Tethyan Cretaceous floral and faunal assemblages. Schriftenreihe der Erdwissenschaftlichen Kommissionen der Österreichischen Akademie der Wissenschaften. In press.

(4) Hancock, J.M. Ammonite Scales for the Cretaceous System. *Cretaceous Research*, 12/3.

(5) Abstracts volume. Cenomanian Turonian boundary events. *Geologie Alpine*, Mem. H. S. 17. Grenoble.

The fifth special volume dedicated to Tethys concepts and Tethyan floral and faunal assemblages is in press. The content and structure of the final volume of the project is accepted.

Forty-four countries participated in the project (* indicates the countries active in 1991): Albania*, Algeria, Argentina, Australia, Austria*,

Belgium, Bulgaria, Canada, Cuba, Cyprus, Czechoslovakia, Egypt, France*, Germany, Greece, Hungary*, India, Islamic Republic of Iran, Iraq, Ireland, Israel*, Italy*, Jamaica, Jordan, Libyan Arab Jamahiriya, Mexico, Morocco*, Netherlands*, Pakistan, Poland*, Portugal, Romania*, South Africa, Spain Sweden, Syrian Arab Republic, Switzerland*, Tunisia*, Turkey, United Arab Emirates, United Kingdom*, United States, USSR* and Yugoslavia.

Activities planned

Start producing contributions for the final volume: National key sections; Regional key sections; Correlation of biozones within various facies; Correlation of biozones over facies boundaries; Facies changes and migrations in time and space; Compilation of data base map series; Continuation of revisions of Cretaceous fossils of Coquand's and d'Orbigny's collections.

Meetings

(1) 3-6 February, Vienna. Correlation of data base maps. Discussion of facies contributions.

(2) 22-27 May. General meeting in Athens, Greece.

(3) 8-18 June. Preparatory meeting of Pelagic facies and Flysch facies meeting in Baku.

(4) 2-5 July. Lower Cretaceous Cephalopod Team. Mula, Spain.

(5) 10-14 August. Participation at the 13th Caribbean Geological Conference in Pinar del Rio, Cuba.

(6) End of September. Foraminifera Team meeting, Bucharest, Romania.

(7) 5-12 October. Meeting of working group on Pelagic and Flysch facies in Baku, USSR.

The project has improved the knowledge on biostratigraphy based on most important fossil groups. Some new recognition has already been achieved in the field of palaeobiogeography and facies evolution within the Tethyan realm. Further activities are needed to synthesize these accomplishments towards a correlation over facies boundaries. For this purpose it is necessary to use multiple methods including an evaluation of results by new methods of sequence stratigraphy.

The Board regretfully declined the active extension request for 1992-1993. On extended term status was granted for 1992.

No. 264 - REMOTE SENSING SPECTRAL PROPERTIES (1987-1991)

M.H. Podwysocki, United States Geological Survey, 913 National Center, Reston, Virginia, 22092, United States.

Description: The project aims to measure the spectral properties of minerals, rocks, soils and vegetation, both in the laboratory and in the field, to produce a data base and an international forum for spectral studies, and to define the requirements for geological satellite-based remote sensing.

Achievements in 1991

Meetings held

(1) 2-10 December 1991, Workshop on geological applications of remote sensing, University of Poona, Pune, India

Seventeen instructors from seven countries taught various aspects of remote sensing to the 15 selected young scientists from less developed countries and at least 30 additional participants (graduate students, faculty and various Indian Government personnel). The non-Indian instructors were drawn from the membership of IGCP Project 264. In addition to the class lectures, a one-day field trip to examine various remote sensing aspects of the basalts of the Deccan Plateau took place as well as a full day excursion to the Indian Space Centre in Ahmedabad to view the latest efforts of the Indian space remote sensing programme.

(2) 11-12 December 1991, IGCP Project 264 meeting at the University of Poona, Department of Geology, Pune, India

A total of 85 abstracts were submitted for the meeting. However, because of time constraints, only 44 were accepted; of those, 30 were presented. Presentations were made on applications of spectral properties to remote sensing, as well as updates on the remote sensing satellite programmes of Canada, the European Space Agency, India and Japan. The Spectral Data Base was presented and demonstrated.

Because IGCP Project 264 has reached the end of its life span of five years, part of a session was devoted to determining if a need exists for future work along lines established by this project. The participants concluded that there still is much work to be done in spectral research, particularly with the advent of hyperspectral data sets such as the NASA 224-channel Airborne Visible and Near Infrared Scanner (AVIRI), the NASA six-channel airborne Thermal Infrared Multispectral Scanner (TIMS) and

proposed satellite systems with similar characteristics. The recent launch of European Space Agency and Russian radar satellites and the upcoming launches of radar satellites by Canada and Japan open a new part of the electromagnetic spectrum with its unique textural information to worldwide study. Participants felt that these are areas that will require further research, and particularly, the integration of these types of data sets to provide spectral information not only in the visible and reflective infrared, but also the thermal infrared with the added textural information that can be extracted from microwave systems. These new systems, with their 'spectral' coverage in less well-known parts of the electromagnetic spectrum, should provide considerable new information, particularly when integrated with technology such as Geographic Information Systems (GIS).

It was therefore agreed that a new proposal would be submitted to UNESCO-IUGS, with the scope of the project broadened to put more emphasis on the thermal and microwave parts of the electromagnetic spectrum and the treatment of all these data by new integration and analysis methods. These newly emerging sensor systems should be of broad use to the worldwide community and the new project will have as one of its main theses the dissemination of this new technology to less developed countries. An appendix to the hard copy and digital spectral catalogues will be considered, which could contain additional mineral, soil and vegetation spectra.

General scientific achievements

The spectral catalogue was presented in final review form for publication at the Pune meeting, and has been sent out for review. A copy of the catalogue is included with this report. The digital data base has been updated and software extensively modified in the past year to reflect the latest methodology in extracting information on absorption features from the spectra. It is hoped that the spectral catalogue will be published by IUGS; it will be presented to the IUGS Publication Committee for review in the January-February 1992 time-frame by Dr John Aaron of the US Geological Survey. The digital version of the catalogue also is ready for publication; one avenue for its publication is the Open File Report System of the US Geological Survey.

The membership of IGCP Project 264 includes members from 27 nations; membership has increased over the past year from 110 to approximately 160 scientists, with most of this year's additions originating from Latin America and India.

Publications

- Kruse, Fred A., Jr. and Hauff, Phoebe L., The IGCP-264 spectral properties database; in review, 214 pp.

- Kruse, Fred A., Jr. and Hauff, Phoebe L., The IGCP-264 spectral properties database and software for its display and manipulation; in review, US Geological Survey Open File Report 92-xxx, 5 IBM-PC compatible diskettes.

- Peshwa, V.V. and Kale, V.S., 1991. Geological applications of remote sensing with emphasis on spectral properties (Abstracts); International Geological Correlation Programme Project 264, Fifth Annual Meeting, Poona, India, 2-12 December 1991, Department of Geology, University of Poona, Pune, India, 67 pp.

- Phadke, A.V., Kulkarni, H. and Mulay, J.G., 1991. Field trip guidebook to the Lonavala area, Maharshtra (India), International Geological Correlation Programme Project 264, Fifth Annual Meeting, Poona, India, 2-12 December, Department of Geology, University of Poona, Pune, India, 15 pp.

List of countries involved in the project (* indicates the countries active in 1991): Australia*, Belgium*, Bolivia, Brazil, Canada*, Chile, People's Republic of China*, France, Germany, Hungary, India*, Iraq, Japan*, Korea, Norway, Peru, Poland, Qatar, Saudi Arabia, South Africa, Spain, Switzerland, United Kingdom, United States*, USSR, Venezuela and Viet Nam.

Activities planned

It is planned to publish the data base before the close of IGCP Project 264 in March 1992. The spectral data base of 30 critical minerals identified by an earlier survey of the project has been completed. A nearly equal number of less well characterized minerals as well as a large number of rocks, soils and vegetation also have been included. The spectral properties bibliographic section now spans 15 pages. The completed spectral catalogue (draft copy enclosed) will contain approximately 215 pages. Dr John Aaron, a member of the IUGS Publication Committee, has examined the manuscript and has agreed to present it to the full committee for possible publication by IUGS:

This project has fostered communication on a worldwide basis amongst remote sensing scientists and particularly, has provided a means for

transferring advanced remote sensing technology to less-developed nations.

The Board concluded that the outcome of the project was above average. The publication of the spectral data base for minerals and soils has been electronically typeset and is available. There is definitely a need for future work, especially because of the hyperspectral data sets which will be observed in the infrared and the EM-spectrum by various new satellite systems. A new proposal will be formulated and should arouse interest in the scientific community.

The project is terminated.

No. 267 - PALAEOZOIC TERRANES IN THE CIRCUM-PACIFIC OROGENS (1989-1991)

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Guo Lingzhai, Department of Geology, University of Nanjing, Nanjing, People's Republic of China.

Description: This is a successor project to IGCP Project 27, The Caladonide Orogen, and a counterpart of IGCP Project 233, Terranes in the Circum-Atlantic Palaeozoic Orogens, as well as to IGCP Project 279, Terranes in Latin America.

The project intends to compare the tectonic and palaeomagnetic syntheses of terranes in the Circum-Pacific Orogens. A series of terrane maps (1:5 million scale) and correlation charts will be made. It provides also a basis for publication of strato-tectonic terrane analyses, crustal profiles, tectonic maps and models for the evolution of the orogens. It offers important opportunities for participation of developing countries and has the potential to produce a significant impact on tectonic research in the Circum-Pacific region, as well as worldwide.

Achievements in 1991

Meetings held

(1) Lachlan Fold Belt Conference, Canberra, Australia, in February, on the evolution of the Early Palaeozoic south-eastern margin of Australia, including the problems of mineralization. The Abstracts were published in *Geological Society of Australia Abstracts 29.*

(2) The 8th Gondwana Symposium at the University of Tasmania in Hobart, in June. Sections of concern to IGCP Project 267 were on Late Proterozoic to Early Palaeozoic Tectonics, and a workshop on the 500 Ma trans-Gondwana event. A business meeting of the project was also held.

(3) The 5th Pacific Terranes Conference in Santiago de Chile, in November. It was attended by 60 people from South America and six other countries. Sixteen papers were presented. Two field trips were conducted. The extended abstracts were published in *Comunicaciones* No. 42/1991.

The first meeting provided a forum for the presentation of new ideas on the evolution of the Early Palaeozoic south-eastern margin of Australia. Studies of inclusions in volcanics, petrology and geochemistry of granite and zircon dating suggest that there is a Precambrian metasedimentary slab beneath the Palaeozoics. Granite geochemistry indicates narrow terranes of different protolith compositions. Late Precambrian and Early Palaeozoic rocks in Tasmania and New Zealand were presented as possible representatives of this basement.

The Palaeozoic orogen started as a passive margin in the Cambrian but developed an offshore broad and extensive series of Shoshonitic volcanoes flanked by quartz-rich turbidites in the Ordovician. These volcanics are postulated to result from mantle melting unrelated to subduction. Hot asthenospheric upwelling then provided the heat to produce widespread rifting and Silurian S-type volcanics and granites by melting of the older lower crust. Deeper melting then provides I-type magmas across the belt. The Orogenic situation appears to be transitional between Proterozoic and Phanerozoic styles. Only in the far east of the Lachlan belt do subduction-related magmas appear. New structural studies supported by Palaeontology demonstrated previously unknown thrust geometries over much of the belt, thus thin-skinned tectonics is being applied to the Lachlan Fold Belt for the first time.

Sessions of concern to the project at the 8th Gondwana Symposium were on Late Proterozoic to Early Palaeozoic Tectonics organized by Chris Powell and John Lang. Papers dealt with the Gondwana margin of South America, Antarctica and south-eastern Australia. In a keynote address, Ian Dalziel presented a radical new Gondwana reconstruction that placed North America between Australia and South America. Also of great interest was an evening workshop on the 500 Ma trans-Gondwana event organized by Lyall Harris and chaired by Chris Powell.

The major event of the year was the 5th Pacific Terranes Conference in Santiago in November. Representatives from South America, Mexico, United States, Japan, China, Australia and New Zealand were among the 60 participants. Sixteen papers dealing with Palaeozoic Terranes were read along with others on younger terranes about the Pacific. Several papers focused on the hypothesis that North America was part of Gondwana until the Early Palaeozoic, consequently there was active discussion on the likely adjunct terranes with special contributions from the Atlantic Terranes Project comparing the Appalachians with the Andean Cordillera. This new arrangement places North America against Antarctica and Australia against Alaska. The position of China is left open with some opting for a Tethyan relationship and others preferring a Pacific connection. These new developments lend added weight to one of the original proposals of IGCP Project 267, i.e. the comparison of the Australian and Chinese Palaeozoic belts.

Activities planned

Professor Shi Yangshen agreed to convene a symposium and field excursion on the Palaeozoic of South-Eastern China in November 1992 and this would become the major 1992 meeting for IGCP Project 267.

A Conference on Tectonics and Metallogenesis of the New England Orogen sponsored by the Geological Society of Australia and IGCP Project 267 will be held at the University of New England, Armidale, Australia, in January 1993.

The Board stated that although the project had improved its lack of activity compared to 1990, this resulted mainly from collateral participation in meetings such as the Lachlan Fold Belt Conference, the 8th Gondwana Symposium and the 5th Circum-Pacific Terrane Conference. It has, however, failed to establish a more visible profile by its own. Cancellation of the symposium planned to be held at the 29th IGC and the resignation of Dr Rickard as Co-Leader of the project are considered by the Scientific Committee has major setbacks for the project.

The Board regretfully terminated the project.

No. 269 - A GLOBAL DATA BASE IN SEDIMENTARY PETROLOGY (1988-1992)

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Description: Following discussions with the IUGS Subcommission on Data Bases for Petrology, with IGCP Project 239 (IGBADAT), COGEODATA, IUGS Global Sedimentary Geology Project, AAPG, Committee on Computer Application and SEPM Committee on Computer Application, this project intends to construct a prototype global data base for sedimentary petrology. Included will be discussion of the data structure, design and dissemination of data sheets, collection of source data and input, update and distribution of the data itself. Special attention will be given to application to microcomputers. A feedback on the classification of sedimentary rocks is expected.

Achievements in 1991

Meetings held

(1) Fourth International Meeting (28 April-6 May 1991, Egyptian Petroleum Research Institute, Cairo, Egypt).

(2) Working group meeting on constructing the prototype data base (20-28 November 1991, Rennes, France).

In addition to these meetings the organizing committees of the 4th and 5th International Meetings held several meetings, and the following regional and/or national groups also held several meetings: Australia and New Zealand, China, Egypt, France, India and Japan.

Main scientific progress

The detailed structure of the data base was finally determined after discussing the data sheet format and the editorial process of the explanatory textbook.

The final data sheet and its explanatory textbook has been published and distributed to sedimentologists in the world. It will be used not only to collect and describe data for the prototype data base, but also to attract new participants who will join us to construct the actual data base.

A tentative list of recommended terms was also published by the Chinese group. It will help the Chinese members in entering data on the data sheets.

Publications

(1) Encoding textbook for a global data base in sedimentary petrology SEDBA-IGCP Project 269. Alain Ploquin (ed.), 1991, Doc. Geodiffusion, No. 1, 100 pp., Paris, France.

(2) List of recommended terms for SEDBA. Yang Weidong, Nan Junya and Ye Jianliu (eds.),

1990, Chinese Group of IGCP Project 269, 60 pp., Guiyang, China.

(3) SEDBA: Runtime version of Paradox for SEDBA. Stephan Nion and Alain Ploquin, 1991, two floppy discs.

(4) FOXSEDBA: Runtime version of Foxbase for SEDBA. Yang Weidong, Nan Junya and Ye Jianliu, 1991, three floppy discs.

In addition four issues of Project Newsletters, three circulars of the 4th International Meeting and two circulars of the 5th International Meeting have also been published.

Twenty-six countries participated in the project: Algeria, Australia, Bulgaria, Canada, China, Cuba, Czechoslovakia, Egypt, Finland, France, Germany, Greece, Hungary, India, Islamic Republic of Iran, Iraq, Japan, Norway, Russia, Spain, Switzerland, Taiwan, Turkey, United Kingdom, United States and Yugoslavia.

Activities planned

The first version of prototype data base will be finalized at the working group meeting at Rennes, France, in November 1991, by using data which were sent to the central office before the meeting. It will be sent to all members for examination and will be updated at the next international meeting in April-May 1992.

An international training course on the existing data base will be held in December 1992. The prototype data base and its explanatory textbook will be updated and a textbook for the course will be edited and printed.

Meetings foreseen

(1) The Fourth International Meeting of IGCP Project 269, Rennes Univ., France, 19-26 April 1992.

(2) Business meeting of IGCP Project 269, 29th IGC, Kyoto, Japan, August 1992.

(3) Small meeting on IGCP Project 269 and its successor project, 13th CODATA Conference, Beijing, China, October 1992.

(4) Training Course on Sedimentary Data Base, India (venue not fixed), December 1992 (one week course).

(5) The organizing committee of the training course will meet several times, and the editors will meet for publishing new textbooks, and each regional group will meet several times.

Publications to come

(1) Textbook for Training Course on Sedimentary Data Base. 50 pp.

(2) Revised version of Explanatory Textbook of SEDBA. 100 pp., with floppy discs of DBMS for data entry and retrieval.

(3) Introduction to SEDBA: Data Base in Sedimentary Petrology. 30 pp., with floppy discs of the prototype data base.

(4) The Project Newsletter will be published every two to three months.

No. 270 - EARLY PALAEOZOIC EVENTS IN LATIN AMERICA FOR THE GONDWANA GENESIS (1988-1992)

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Description: This is a successor project to IGCP Project 192 'Cambrian and Ordovician Development in Latin America'. It intends to evaluate sedimentary events in Andean and related basins during the Late Precambrian and Early Palaeozoic. The 'tectono-sedimentary', magmatic and metamorphic events will be correlated. Attention will also be given to defining important stratigraphic coboundaries, to reconstruct palaeogeography, palaeoclimate and palaeo-oceans, and to determining the age and location of mineral resources related to the events under study.

Achievements in 1991

The fourth International Meeting of the project was held in Merida, Venezuela, 1-7 December 1991. Attendance was almost 30 geologists and the countries represented were Argentina, Brazil, Bolivia, Colombia, Venezuela, Spain, Germany and the United States.

A field trip was organized to the Andes of Merida to see the Upper Precambrian and Early Palaeozoic basement composed by Iglesia Group, Cerro Azul and Caparo Formations, and to see the Bocono transcurrent fault.

Regional meetings were held during the 6th Geological Congress in Chile in September, where 20 representatives of the project from Chile, Argentina, Uruguay, Peru, Bolivia and Venezuela participated.

Scientific progress can be summed up as follows:

Zuata Area (Venezuela)

In the underground Carrizal Formation composed of arcilites, limolites and sandstones were recently found acritarch faunas of the Lower Cambrian age. The fossils are *Archaeodiscina umbonata*, *Baltisphaeridium ciliosium*, *Leiosphaeridia* sp., *Stellinum* sp. and *Skiagia* sp. that are comparable with the USSR acritarch and are a guide to the Atdabaniano-Lenniano age.

Perijá Range (Venezuela and Colombia)

The basement of Perijá block is composed by metacuarcitas and green schists of the Perijá formation which is assignable to the Early Palaeozoic (Cambrian-Ordovician) and have a metamorphic Caledonian event. The Devonian of Cachirí Group is overlying by unconformity composed by conglomerates, sandstones and shales without metamorphism and with typical Appalachian faunas.

The Perijá block is interpreted as an allochthonous block which originated in the Early Palaeozoic Caledonian event.

Tunari Cordillera (Bolivia)

New findings of fishes (*Sacabambaspis janvieri*) from the Millu Mayu and Ea. Caliente in Tunari Cordillera were made associated with trilobites faunas (*Homalonotus Brongniartella bistrami*) that are Llanvirnian in age. Those fossils are the oldest fishes in the Early Palaeozoic of South America.

South of Brazil

New traces fossils were found in volcano-molassic deposits of Camarinha Formation, surrounding the Paraná basin, south-east Brazil. The fossils *Gordia arcuata*, *Planolites montanus*, *Skolithos* and impressions of Cnidariaare are representative of marine levels and their most probable age is Vendian to Tommotian.

Analysed Rb/Sr and K/Ar from siltstones and shales of Bambui Group in Mina Gerais area indicated the start of sedimentation about 680 ± 40 m.y. (Vendian) ago and a diagenetic or metamorphic event about 600 ± 15 m.y. ago.

In Paraná State the Cambro-Ordovician Castro Basin comprises volcanic (rhyolites, andesites), pyroclastic (ignimbrites) and sedimentary rocks (alluvial and deltaic) deformed by faulting and block tilting in a transtensional regime that was responsible for the basin formation in the Early Palaeozoic.

The Camaqua and Santa Barbara basins, in Río Grande do Sul, are interpreted as a foredeep mollasse basin developed during the final stage of Brazilian-Pan-African orogeny cycle. The main depositional system comprises alluvial, delta and desert systems with related sedimentary facies, erosional surfaces and flooding surfaces.

East of Paraguay

Silurian Chitinozoans of the shales of Vargas Peña Formation (Itacurubi Group) from eastern Paraguay were found. The microplancton is represented by Chitinozoans like *Ancyrochitina* sp., *Angochitina* sp., *Conochitina* sp., and *Sphaeromorphitae*, the age is Early Silurian (Llandovery, Rhudaniano or Aeroniano). These fossils are comparable with those of Villa María Formation (Paraná Basin) and Pitinga Formation (Amazonas Basin), both in Brazil.

Rio de la Plata Cratón (Uruguay and Argentina)

The tectonic evolution of areas located peripherically to the Río de la Plata Cratón such as Las Breñas Basin and Sierras de Córdoba in Argentina; Piedras de Afilar Formation in the Southern Don Feliciano Belt in Uruguay and Florianopolis and Camaqua areas in Brazil is characterized by similar events.

Puna (Chile and Argentina)

The Early Palaeozoic of the Puna Area in north-western Argentina and south-eastern Chile geotectonically developed during the Famatinian Cycle (Middle Cambrian to Upper Devonian). The Ordovician Puna basin and this segment of the Gondwana continental margin is interpreted in terms of the basin's evolution from back-arc to foreland basin. In this scheme the Guandacolic Phase (Llanvirn-Llandeil) is interpreted as a collision between the Sierra Moreno block (Chile) and Antofalla-Massif (Argentina). The Ocloyic diastrophism (Upper Ordovician-Early Silurian) controlled the accretion of Antofalla-Sierra Moreno Massif to the continental margin of Pampean Craton in an active continental margin of the Gondwana.

North-Western Argentina

In the Puncoviscana Formation outcropping in all northwestern Argentina the Precambrian-Cambrian boundary based on traces fossils has been determined.

Moreover, the radimetric data of Puncoviscana Formation indicate ages that range between Upper Precambrian (580 m.y.) in Tucumán Areas and Lower Cambrian-Middle Cambrian (530-560 m.y.) in Salta areas.

Pampean Ranges (Argentina)

The igneous-metamorphic Upper Precambrian and Lower Palaeozoic units of the Pampean Ranges are assigned to a collisional event that originated an orogenic belt between the Occidentalia continental plate and the Brazil-Africa Craton. This evolved from an intense tecto-thermal event characterized by high temperature and medium pressure conditions associated to a regional penetrative NNW foliation developed through flattened folds resulting from the main Ordovician collisional event.

Famatina Range (Argentina)

The Famatina Terrane originated in an active continental margin of Gondwana during the Upper Precambrian to Early Palaeozoic. The Early Palaeozoic geotectonic evolution is explained as a plate interaction effect. They originated a volcanic island arc related to precollisional subduction process and the generation of granitoids.

Publications

6th International Symposium Ordovician System, Sydney, Australia, 1991

- Aceñolaza, F.G. and Aceñolaza, G.F. The genera Jujuyaspis as a world reference fossil for the Cambrian-Ordovician boundary.

- Baldis, B., Martinez, R., Pereyra, M., Perez, M. and Villegas, R. Ordovician Events in South America Andean Platform.

- Beresi, M. La cuenca Ordovícica de la Precordillera Argentina.

- Peralta, S., Carter, Ch., and Martinez, R. Late Ordovician Gondwana glaciation: Evidence in pebbly mudstone of Don Braulio Formation, Precordillera, San Juan, Argentina.

6th Geological Congress of Chile, 1991

- Beresi, M. Las algas calcáreas: aporte a la formación del sedimento carbonático del Ordovícico inferior de la Precordillera Argentina, pp. 781-783.

- Beresi, M. Caracterización de la Formación San Juan (Ordovícico inferior) de la Precordillera de San Juan, Argentina, pp. 302-304.

- Perez, W., Lencinas, R. and Durand, F. Las milonitas de la Sierra de Paimán, La Rioja, Argentina: Indicadores cinemáticos, edad y significado geotectónico, pp. 1-6.

- Toselli, A., Weber Diefenbach, A., Rossi, J. and Miller, H. Interpretación genética de los granitos del Paleozoico inferior de Cerro Toro y ñuñórco, Sistema de Famatina, Argentina, pp. 248-252.

- Toselli, A., Aceñolaza, F., Durand, F., Rossi de Toselli, J., Indri, D., Cisterna, C., Lisiak, H., Lopez, J., Saal, A. and Esteban, S. El Paleozoico inferior del Sistema de Famatina, Noroeste de Argentina, pp. 867-871.

Revista Ciencias, Universidad Nacional de San Juan, 1991

- Arroqui Langer, A., Bordonaro, O. and Keller, M. Variaciones magnesianas de la Formación Zonda en la Sa. de Villicum, San Juan. Una hipótesis sobre su origen y leyes, Vol. 1, pp. 1-5.

- Banchig, A.L. Estratigrafía y paleontología de una secuencia Cámbrica en la Qda. Ojos de Agua, Sa. del Tontal, San Juan, Argentina, Vol. 1:5-10.

- Bordonaro, O., Aceñolaza, F. and Pereyra, M. Primeras trazas fósiles de la sierra Pie de Palo, San Juan, Argentina, Vol. 1, pp. 11-14.

- Baldis, B., Martinez, R., Pereyra, M., Perez, M. and Villegas, R. Fracturación transversal del continente de Gondwana y sus efectos desde Nord Africa hasta la Argentina central. Vol. 1, 23 pp.

Seventeen countries participated in the project (* indicates the countries active in 1991): Argentina*, Australia*, Bolivia*, Brazil*, Bulgaria, Chile*, Colombia*, Ecuador, Germany*, Greece*, Italy, Mexico*, Spain*, Uruguay, Venezuela*, United Kingdom and United States*.

Activities planned

A special volume of the 3rd International Meeting of IGCP Project 270, held in São Paulo, Brazil, is in press. Another special volume will contain the papers presented at the 4th International Meeting of the project held in Mérida, Venezuela.

The project will contribute to the International Conference on the Early Palaeozoic of Ibero-America,

in Mérida, Spain, May 1992, and to the 5th Colombian Petroleum Congress in Santa Fé de Bogotá, Colombia, in October 1992. The 5th International Meeting of the project, with a field trip to the Yucatan Peninsula, will be held in Mexico in November 1992.

No. 271 - SOUTH AMERICAN PALAEOZOIC CONODONTOLOGY (1988-1992)

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M. Suarez Riglos, Casilla de Correo 1321, Santa Cruz de la Sierra, Bolivia.

Description: This is a successor project to IGCP Project 193 'Siluro-Devonian of Latin America', thematically more specific but temporally more comprehensive. Its aim is a systematic study of conodonts and the correlation of their host rocks in the Cambrian-Permian interval. A correlation with graptolite and trilobite stratigraphy will be made. The Color Alteration Index (CAI) will be applied to problems of geothermometry, metamorphism, structural geology and hydrocarbon potential. It is intended to develop a training component. Correlations outside Latin America will also be attempted.

Achievements in 1991

Meetings held

(1) International (IV) Meeting of IGCP Project 271, Porto Alegre, Brazil, 10-12 November 1991. Field trip, 12-14 November 1991: Porto Alegre-Yaguarão (Brazil), Rio Branco-Melo-Tacuarembó, San Gregorio-Blanquillo and Montevideo (Uruguay). Devonian and Upper Palaeozoic were visited and sampled. Leaders: J. Da Silva and P. Sprechmann. Attendance: 40 participants from Argentina, Bolivia, Brazil, Chile, Uruguay, Canada, Spain, Bulgaria and Australia (among them, 26 attending participants and 14 non-attending ones).

(2) University of Leicester, United Kingdom: Training works of Dr Graciela Sarmiento (IGCP Project 271 member at Córdoba University, Argentina, and Complutense University, Madrid, Spain) on Silurian Conodonts in Dr R.J. Aldridge's laboratory (June 1991).

(3) Training course on conodonts (M. Hünicken) in Universidad Nacional de la Pampa, Argentina (April 1991; six postgraduate students) and field trip to the western region of La Pampa Province to recognize and sample the San Jorge Formation (carbonate Ordovician).

Important publications

- Bagnoli, G. and Stouge, S., 1991. Palaeogeographic distribution of Arenigian (Lower Ordovician) conodonts. Academia Brasileira de Ciências, *ANAIS*, 63(2):171-183, four figs. text, Rio de Janeiro.

- Rao, R., Hünicken, M.A. and Ortega, G., 1991. Conodontes y graptolitos ordovícicos en la Quebrada de Los Colorados (Depto. Tumbaya), Cordillera Oriental, Prov. de Jujuy, Argentina. Academia Brasileira de Ciências, *ANAIS*, 62(2):185-192, two figs. text, two láms, Rio de Janeiro.

- Fordham, B.G., 1990. IGCP Project 271: First Latin American Conodont Symposium (LACON I), *The Australian Geologist*, 77:32-34.

- Barnes, Ch.R., 1990. First Latin American Conodont Symposium. Bolivia and Argentina, 26 August-8 September 1990, *Episodes*, 13(3): 189-190.

- Hünicken, M.A. (ed.), 1990. First Latin American Conodont Symposium (LACON I), August-September 1990. Academia Nacional de Ciencias, Part 1: Guide to Field Trips, Bolivia-Argentina, pp. 9-86 (nine papers); Part 2: Abstracts of Meeting, pp. 87-118 (28 papers), Córdoba.

- Suarez Soruco, R. (ed.), 1989. IGCP Project 193, Meeting in Oaxtepec, Mexico, October 1984. Leader: M.A. Hünicken. Revista Técnica de Yacimientos Petrolíferos Fiscales Bolivianos, Vol. 10, No. 3-4:213-243, Cochabamba, Bolivia.

- Boneta, J.L. El límite Devónico-Carbonífero en el Subandino Sur de Bolivia, 213-217.

- Popp, M.T.B. and Baldis, B.A. Trilobites y comunidades faunísticas del Devónico de la Formación Ponta Grossa, Paraná, Brazil, 219-227.

- Janvier, Ph. and Suarez Riglos, M. Los primeros vertebrados devónicos de Sud América, 229-231.

- Suarez Soruco, R. El Ciclo Cordillerano (Silúrico-Carbonífero inferior) en Bolivia y su relación con países limítrofes.

Nineteen countries participated in the project (* indicates the countries active in 1991): Argentina*,

Australia*, Bolivia*, Brazil*, Bulgaria*, Canada*, Chile*, Colombia, Denmark*, Ecuador, Germany, Hungary, Italy*, Paraguay, Peru, Spain*, United Kingdom*, Uruguay* and Venezuela.

Activities planned

The Second Latin American Conodont Symposium (LACON II) will be held in Córdoba (Argentina), 10-13 November 1992, with several pre- and post-symposium field trips in Bolivia and Argentina. All the necessary information is included in the First Circular of LACON II.

Future goals

- Systematic studies of conodonts and related groups of the Cambrian-Triassic interval in all the world.

- Conodont faunal units; age of bearing formations and correlation with trilobites, graptolites, foraminifers, achritarcs, etc., stratigraphy. Palaeozoic systems boundaries.

- Regional, interregional, continental and intercontinental correlation.

- Application of the Color Alteration Index (CAI) to geothermometry, metamorphism and structural geology and for assessing hydrocarbon potential.

- Human resources training. Regional and international experts exchange and co-operation.

No. 272 - LATE PALAEOZOIC AND EARLY MESOZOIC CIRCUM-PACIFIC EVENTS (1988-1992)

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Description: IGCP Project 272 is a successor to IGCP Project 203 'Permo-Triassic events of East Tethys and their intercontinental correlation'. It aims to correlate, integrate and publish information on faunal-floral, climatic, sedimentary, volcanic-magmatic, tectonic, sea-level, palaeomagnetic, geochemical and metallogenic events especially around the Pacific.

In addition to the events well known to be associated with the Permian-Triassic boundary other important changes are known to be associated with the Carboniferous to Permian (base of Asselian), mid-Permian (two-fold Permian Subdivision), Lower to Middle Triassic, Middle to Upper Triassic and Triassic to Jurassic. The project plans to study and integrate information on these events which have potential for understanding the fundamental development of the earth and its mineral resources. The project also anticipates pin-pointing the time and nature of other important changes during the Upper Palaeozoic and Lower Mesozoic.

Meeting and field visits have now taken place in three of the four sectors of the Pacific. These comprise Australia (New South Wales and Tasmania) and New Zealand, Japan and South America (Argentina and Brazil). The fourth sector will be covered in a meeting next year in North America and further field work and meetings will be held in Asia.

Achievements in 1991

Main scientific achievements

(1) Carboniferous and Permian of South America (Argentinian working group meeting)

It is now possible to determine the Carboniferous-Permian boundary better than previously. The faunal relationships now found are rather unexpected. As previously known the Middle Carboniferous is related to Eastern Australia whereas the Permian of the Andean region and north-east South America is related to the Northern hemisphere and Western Australia.

(2) The Carboniferous-Permian Boundary (Permian congress)

The base of the Permian is now being established at the base of the Asselian stage of the Urals. This boundary corresponds not only to a marked cooling in world climate but to a major world transgression.

(3) Midian-Dzhulfian Boundary (Argentinian meeting)

This boundary has been found by the project to be of major significance. It corresponds to an important faunal change and to major changes in tectonism and magmatism.

(4) Other boundaries on which work has been carried out include Permian-Triassic (Permian congress), Lower to Middle Triassic (Hobart working group meeting) and Triassic-Jurassic (Buenos Aires meeting).

(5) Other events on which progress has been made are:

(i) Glaciation: It now appears that in South America a warm period intervenes between the glaciations of the Middle Carboniferous and the Asselian (lowermost Permian). New evidence now seems to be showing that in at least some of the Gondwana areas there is not a single ice sheet but a number of really separated regions of ice.

(ii) Development of compressive tectonic activity during the Upper Permian and Triassic and associated acidic and intermediate magmatic activity - Hunter-Bowen or Indosinian Orogeny (Hobart, Permian and Argentinian meetings).

(iii) Mineralization associated with the magmatic and tectonic development referred to in (ii) above (Buenos Aires meeting).

Meetings

(1) In association with the 10th Gondwana Symposium, Hobart, 24-28 June 1991, which also included a field visit. Total attendance at the meeting was 150 and more than 15 papers from eight countries were directly concerned with the project.

(2) Associated with Permian Congress, Perm, USSR, 4-10 August 1991 - a joint meeting was held with the Permian Subcommission and the working groups on the Carboniferous-Permian and the Permian Triassic boundaries. Thirty-eight people attended from nine countries. More than 200 papers were given at the Congress, many of which were important for the project.

(3) In association with the 12th International Congress on Carboniferous and Permian Geology and Stratigraphy, 22-27 September, Buenos Aires, Argentina, eight papers were given in the glacial symposium jointly organized by the project, and 15 other papers were of particular interest. Approximately 250 people attended this Congress. The attendance was from various parts of the world.

Important publications

Papers from last year's working group meeting in Sendai, Japan, have now been published in a special publication *Saito Ho-on Kai* No. 3. This comprises papers from the IGCP Project 272 symposium and five other papers presented in other parts of the programme. The volume also contains a report summarizing the scientific and business results of the IGCP meeting together with an account of the significant features of the field visit.

The papers delivered at the Hobart meeting and the Buenos Aires meeting in 1991 will be published as part of the publication for these meetings.

An important publication for the project is Palaeozoic and Early Mesozoic Palaeogeographic Relations; Sierra Nevada, Klamath Mountains and Adjacent Terrains, edited by D.S. Harwood and M.M. Miller, *Geological Society of America Special Publication 255*, 1990. It is planned to incorporate the results from this publication in the work of the project during our meeting in north-western United States in 1992.

Twenty-six countries participated in the project: Argentina, Australia, Austria, Brazil, Canada, Chile, China, France, Germany, Hungary, India, Israel, Italy, Japan, Mexico, Netherlands, New Guinea, New Zealand, Peru, Spain, Switzerland, Thailand, United Kingdom, United States, USSR and Viet Nam.

Activities planned

Meetings foreseen

A symposium will be held at the International Geological Congress, Kyoto, Japan, 24 August-3 September 1992 'Late Palaeozoic and Early Mesozoic Circum-Pacific Events'. Associated with this symposium will be a meeting at Vladivostock and field work in this area after IGC. Prior to this, in conjunction with the North American Palaeontological Convention, Chicago, 28 June-1 July 1992 a meeting and field visit is to be held in the eastern United States to be organized by C.V. Stanley and D.W. Boyd. An integral part of these meetings is participation from the developing countries. We expect Viet Nam, Thailand and India to be especially involved.

Publications planned

Publication continues of the work of the project. We are now organizing a volume which will include papers from the two meetings in 1992 and with the addition of other papers which will incorporate the results of the project.

No. 273 - THE ARCHEAN ROCKS OF THE KASAI CRATON (1988-1992)

B.T. Rumvegeri and D. Kapenda, Université de Lubumbashi, Département de Géologie, BP 1825, Casier 398, Lubumbashi, Zaire.

Description: The project aims at an integrated, complex study of the Kasai Craton involving remote-sensing, petrology, geochemistry, radiometric-dating and geophysics. It is intended to collect data on the Archaean of the Kasai Craton, to analyse its influence in the Early Proterozoic evolution of Central Africa, and to establish correlations with other regions of Africa and the Western hemisphere. All previous studies should be taken into consideration and broad international co-operation should be established.

Achievements in 1991

- The third workshop of IGCP Project 273 in Bujumbura (Burundi) where 23 papers were presented.

- One paper on structural geology and two on geochronology of the Kasai Craton published.

- Collaboration with the Geological Survey (Pretoria, South Africa) in geochronology and with the Tervuren Museum (Belgium) and the Laboratory of Petrology of Marseilles (France) in geochemistry and petrology of Archaean rocks of Kasai.

- The IGCP Project 273 Newsletter 2 will be printed in South Africa.

- First tentative correlation of geological events in Congo Craton, West Africa, Tanzania and Rhodesia-Kaapvaal Cratons.

- Launching of Thesis on Tectonic and Petrology of Archaean rocks in the central part of the Kasai Craton.

- Remote-sensing (gravimetry) survey on Archaean and surrounding Proterozoic belts has been undertaken in Thesis with collaboration of the Centre of Geophysics and Geology, University of Montpellier (France).

- First model of formation of platinum resources in different Archaean Cratons of Africa.

- Collaboration with the project International Tectonic Map of Africa and the BRGM (France).

- Collaboration with IGCP Project 255 with which the third meeting of IGCP Project 273 was co-ordinated (final meeting of IGCP Project 255).

- Scientists of Europe (France, Belgium and Germany) and Africa (South Africa, Tanzania, Kenya, Burundi, Zaire, Uganda, Côte d'Ivoire, Nigeria and Ethiopia) worked together on formations of comparable ages in Africa.

- Using new geochronological and petrological data made on the Kasai Craton, geotectonic settings of different complexes of the craton have been defined: the Sandoa Kapanga complex, the Charnockitic complex and the granite-migmatic complex. Moreover, the greenstone belt of Kasai considered by previous work as Early Proterozoic, is now demonstrated to correspond to an Archaean greenstone belt. Thus, the first model of geodynamic evolution of this craton has been established. Remote-sensing survey undertaken on these formations will permit, at the end of the thesis (Ph.D.), to better understand relations between the Archaean and surrounding Proterozoic belts.

Meetings held

The 3rd Field Conference in Bujumbura (Burundi), 11-15 September 1991, 30 participants from 12 countries.

Important publications

- Rocci, G., Bronner, G. and Deschamps, M. The West African orogenesis and Circum Atlantic correlatives.

- Walraven, F. and Rumvegeri, B.T. Implications of whole-rock Pb-Pb and zircon evaporation dates for the early metamorphic history of the Kasai Craton.

- Tredoux, M. Platine resources in Africa: the reason for looking carefully at the Archaean Craton.

- Borg, G. Regional controls on the distribution of gold occurrences in the Sukumaland greenstone belts in Tanzania.

- Mashala, N.A. Geology and economic significance of the Nyanzian greenstone belts in Tanzania.

- Mathu, E.M. The structures and tectonics of the Archaean and Early Proterozoic rocks of the Kakamega area, Western Kenya.

- Rumvegeri, B.T. The Central African plate at Archaean times.

- IGCP Project 273 Newsletter 2 (in print).

Twenty-one countries participated in the project: Angola, Belgium, Burundi, Cameroon, Central African Republic, Congo, Côte d'Ivoire, Ethiopia, France, Gabon, Germany, Kenya, Madagascar, Mauritania, Nigeria, Republic of South Africa, Swaziland, Tanzania, Uganda, USSR and Zaire.

Activities planned

Research

- Field interpretations.

- Sampling for petrology and geochronology.

- Laboratory analyses.

- Correlation with other Archaean formations in Africa.

- Gravimetry survey and analyses of data obtained.

Meetings

- Business meeting of the project during the 29th IGC in Kyoto, Japan, August 1992.

- Final meeting of the project in Abidjan, Côte d'Ivoire, 1-8 February 1993.

Publications

- IGCP Project 273 Newsletter 2.

- Rumvegeri, B.T., Kabengele, M., Walraven, F. and Lubala, R.T. The Kasai Craton in Central Africa: a review. In: The Archaean of Africa, in collaboration with the Geological Society of South Africa.

- Walraven, F. and Rumvegeri, B.T. Implications of whole-rock Pb-Pb and zircon evaporation date for the early metamorphic history of the Kasai Craton, Southern Zaire.

No. 274 - COASTAL EVOLUTION IN THE QUATERNARY (1988-1992)

O. van de Plassche, Faculty of Earth Sciences, Free University, De Boelelaan 1085, 1081 HV Amsterdam, Netherlands.

Description: The project, inaugurated in September 1988, is concerned with documentation of coastal and shelf evolution of various regional coastal types leading to a better understanding of interactive forces and products responsible for past, present and future changes to coasts of the world. This is to be achieved by (re)evaluation and synthesis of existing data and by promotion of new research related to:

(1) morphological and depositional records of past environmental conditions and the evolution of coastal and shelf areas;

(2) modern coastal/shelf environments;

(3) future changes in controlling variables; and

(4) conceptual and numerical modelling.

Achievements in 1991

In 1991, the membership list increased from almost 500 to over 580 researchers. Names, addresses, and areas and objectives of research have been assembled in an updated Membership Directory (122 pp). Communication among the participants was also maintained and promoted by means of circular letters and an annual report annex newsletter (April 1991, 160 pp.)

Forty-one countries officially participated in the project (* indicates the countries active in 1991): Argentina*, Australia*, Austria*, Bangladesh*, Barbados*, Belgium*, Benin*, Brazil*, Canada*, People's Republic of China/Hong Kong*, Colombia*, Cyprus, Egypt*, Estonia*, Finland*, France*, Germany*, Greece*, India*, Islamic Republic of Iran*, Ireland*, Israel*, Japan*, Korea*, Malaysia*, Netherlands*, New Zealand*, Norway*, Peru*, Poland*, Qatar*, Russia*, Senegal*, Spain*, Suriname*, Thailand*, Turkey*, United Kingdom*, United States*, Viet Nam* and Yugoslavia.

Twenty-eight countries have been informally involved in the project (* indicates the countries active in 1991): Belize, Cameroon*, Côte d'Ivoire*, Denmark*, Ethiopia, Fiji*, Gabon, Indonesia, Italy, Morocco*, Mozambique, Nigeria*, Pakistan, Papua New Guinea, Philippines, Portugal*, Singapore*, South Africa*, Sri Lanka*, Sweden*, Switzerland*, Taiwan-China*, Tanzania*, Togo, Trinidad and Tobago, Tunisia*, Uruguay and Venezuela*.

The project continued to enjoy the generous collaboration of 24 radiocarbon dating laboratories from 18 countries. Together, these laboratories are offering 130 free radiocarbon dates annually to project participants, primarily from lesser developed nations. The 14C-dating pool is centrally administered at the University of Delaware.

Publications

- The 1991 Annual Project Report annex Newsletter (122 pp.; 650 copies distributed).

- Membership Directory (112 pp.; 650 copies distributed).

- Gayes, P.T., Lewis, R.S. and Bokuniewicz, H.J. (eds.), 1991. Late Quaternary sea level and coastal evolution in southern New England. *Journal of*

Coastal Research, Special Issue No. 11 (with 12 contributions).

- Mathur, U.B. (ed.), 1991. Evolution of West coast of India during Quaternary and modern coastal processes. Volume of abstracts and full papers of a workshop held at Goa, India, 3-5 June 1991, 106 pp.

- Pirazzoli, P.A., 1991. World atlas of Holocene sea-level changes. Elsevier Oceanography Series, 58, 300 pp.

- Qin Yunshan and Zhao Songling (eds.), 1991. Quaternary coastline changes in China, IGCP Project 274 China Working Group, China Ocean Press, Beijing (with 15 contributions).

- Yonekura, N. (ed.), 1990. Sea-level changes and tectonics in the middle Pacific. Report of the HIPAC project in 1988 and 1989, 280 pp.

- Numerous other publications in scientific journals (reprints of 77 papers received and submitted to the IGCP Secretariat).

Activities planned

Meetings

(1) International symposium on 'Former ENSO phenomena in western South America: Records of El Niño events', Lima, Peru, 4 -12 March 1992, with four-day field trip; jointly with IGCP Projects 281 and 297.

(2) Presentation and business meeting during the 29th IGC, Kyoto, Japan, 24 August-3 September 1992.

(3) International Research Conference on 'Diversity in Quaternary coastal evolution', Wellington, New Zealand, 7-15 December 1992, with six-day field trip and annual business meeting of the International Working Group.

Publications foreseen

- Donoghue, J.F., Davis, R.A., Fletcher, Ch.H. and Suter, J.R. (eds.). Quaternary coastal evolution. *Sedimentary Geology*, Special issue.

- Ota, Y., Nelson, A.R. and Berryman, K. (eds.). Impacts of neotectonics on Quaternary coastal evolution. *Quaternary International*, Special issue.

- Prost, M.T. and Lointier, M. (eds.). Proceedings of the International Symposium on 'Evolution of the Guianas and Southern Caribbean coastal areas during the Quaternary'.

- Wehmiller, J.F. and Fletcher, Ch.H. (eds.). Quaternary coastal systems of North America. SEPM, Special issue.

- Woodroffe, C. (ed.). Holocene evolution of muddy coastal areas in South-East Asia. *Sedimentary Geology*, Special issue.

Several other special issues and one book are in preparation.

No. 275 - DEEP GEOLOGY OF THE BALTIC SHIELD (1989-1993)

R. Gorbatschev, Department of Mineralogy and Petrology, Institute of Geology, Lund University, Sölvegatan 13, S-223 62 Lund, Sweden.

F.P. Mitrofanov, Geological Institute of the Kola Science Centre, Russian Academy of Sciences, Fersman Street 14, 184200 Apatity, Russia.

Description: The project applies geophysical-geological-geochemical correlation to create consistent crustal and geodynamic models of the Baltic/Fennoscandian Shield and its principal structures. Emphasis is on the application and testing of plate tectonics in the Precambrian. The project created a long-needed forum for work aiming at the entire Shield area. The Shield is also correlated with the adjoining basement of the East European Platform and with other Precambrian cratons like Greenland and Laurentia.

There are strong links between this project and the work of various groups of ILP as, for instance, Europrobe. The work of IGCP Project 257 (Mafic dyke swarms), Project 304 (Lower crustal processes), Project 314 (Alkaline and carbonatite magmatism) and Project 315 (Rapakivi granites) is, as far as the Baltic Shield is concerned, related to the work of IGCP Project 275. The project operates on the basis both of national project working groups/national representatives, and thematic and regional task groups. In 1990, breakthroughs have been made in regard to:

the westward accretion of the Shield particularly during the Grenvillian orogeny and also during the preceding part of the Middle Proterozoic;

the similarity of crust formation and evolution in north-eastern Europe, Greenland and North America in the late Archaean and the Early and Middle Proterozoic with implications regarding the Precambrian siting of these crustal segments;

the definition of crustal-age provinces in the Shield and their tracing south-eastwards into the basement of the East European Platform;

the geophysical-geological study of plate tectonics in the Baltic Shield;

the apparently recurrent alternation of evolved and depleted mantle characteristics correlated with orogenic, compressional and rifting, dispersional crustal regimes. Advances were also made in discriminating between reworked older and juvenile, mantle-derived continental crust.

Achievements in 1991

Meetings held

(1) Annual Meeting 1991 with 'International Symposium on Metamorphism, Deformation and Structure of the Crust', arranged jointly with IGCP Project 304 (Lower Crustal Processes), 26-28 August 1991 in Oulu, Finland, with preceding and following excursions in Lapland and Kainuu in central Finland on 23-25 August and 29 August-1 September 1991; 114 participants plus students from Finland; 24 countries; 84 talks plus posters.

(2) Meeting of the 'Archaean-Proterozoic Boundary' Task Subgroup in Luleå, Sweden, on 9 April 1991; 28 participants from Finland and Sweden; 12 talks.

(3) Seminar on 'Granulite-facies and other High-Grade Terranes in the North Atlantic Area' in Copenhagen, Denmark, on 18-19 April 1991; 22 participants; seven countries; 17 talk presentations.

(4) Meeting of the 'Westward Acccretion of the Baltic Shield' Task Group in Göteborg, Sweden, on 24 May 1991 with excursion on 25-26 May; 28 participants; six countries; 11 talks.

(5) Meeting together with IGCP Project 257 'Precambrian Dyke Swarms' in Espoo, Finland. This was the final meeting of the Nordic Group of IGCP Project 257, of which IGCP Project 275 Co-Leader Gorbatschev was co-ordinator. Symposium with field seminar in southern Finland; 19 participants from six countries; eight formal talks plus posters; 10-15 June 1991.

(6) Field workshop of the 'Trans-Baltic-Sea Correlation' Subgroup of the 'Platform Basement' Task Group in eastern Sweden on 16-20 June 1991; ten participants; four countries.

(7) Joint symposium with IGCP Project 314 (Alkaline and Carbonatite Magmatism) on 19 July-3 August 1991, also comprising a field workshop in the Kola Peninsula, Russia. The symposium was held in Apatity; 15 participants from eight countries.

(8) Field seminar of the 'Archaean Lithosophere' Task Group in the Kola Peninsula, 2-8 September 1991; ten foreign participants from seven countries plus local participants.

(9) Deliberation of the 'Trans-Baltic-Sea Correlation' Subgroup during the Annual Meeting of the Estonian Geological Society in Tallinn (15 September; five participants; three countries).

(10) Field meeting of the 'Sveconorwegian Friends Association' together with the IGCP Project 275 Task Group on 'Westward Accretion of the Baltic Shield' in the Arendal area, Noway, on 4-8 September 1991; 43 participants; seven countries; seven poster presentations.

(11) An important meeting jointly with ILP Europrobe Project was held in Warsaw, Poland, on 26 September-3 October 1991.

IGCP Project 275 and Europrobe will co-operate in a working group on the Archaean and Proterozoic dynamics of Europe. IGCP Project 275 simultaneously also establishes links with 'Europrobe's' Groups on 'Deep Europe', 'Rifts and Basins' and 'The Tornquist Zone'. The meeting attracted 61 non-Polish and about 30 Polish participants. Fourteen European countries were represented.

(12) Numerous IGCP Project 275 participants attended the IGCP Project 315 meeting on Rapakivi magmatism in Helsinki, Finland, on 29-31 July 1991 giving talks and inaugurating that project.

(13) IGCP Project 275 participated in a Soviet national meeting in Moscow on 17 November 1991 intended to implement the 'Europrobe' planning carried out in Warsaw (cf. 11 above).

(14) Several participants of IGCP Project 275 took part in a meeting held on 19-27 September 1991 in Moscow and Zapolyarny, Russia, to discuss the establishment of an 'International

Geolaboratory' based on the Kola Superdeep Drilling. Five talks were given by IGCP Project 275 workers.

The project was representated at the IUGG Congress in Vienna, EUG VI in Strasbourg, EGS, and numerous local, national and regional meetings.

Main scientific achievements

Particularly important results in 1991 have been achieved regarding:

(1) New aspects of Trans-Atlantic correlation. In this field, the Grenvillian orogeny, the Transscandinavian Belt and the Svecofennian-Ketilidian orogen have been considered previously. Similar connection now appears possible also for Early Proterozoic and even Late Archaean collisional belts marked by granulites. This aspect was discussed at the April meeting in Copenhagen. Debate was renewed concerning the Sveconorwegian as a direct continuation or an opposite-shore equivalent of the Grenville Province.

(2) New datings and isotopic studies reconfirm the absence of Early Archaean rocks in the Kola and White Sea areas. However, a sizable domain of 3.4-3.5 Ga old crust exists east of Lake Onega. The existence of hitherto unknown 2.1-1.9 Ga old crust in a source area of Svecofennian sediments has been demonstrated and may modify our understanding of the time and rate of Early Proterozoic crust formation.

(3) Trans-Baltic Sea correlation together with geophysical results (BABEL mostly) has opened new avenues to model Svecofennian plate tectonics all the way from northern Sweden to eastern Poland, in a belt bordering a collage of Archaean crust farther east.

(4) Nd-isotopic and geophysical studies have contributed to a more precise definition and better understanding of the Archaean-Proterozoic boundary in northern Fennoscandia.

(5) New results have been achieved regarding the nature and timing of the earliest Proterozoic (c. 2.4-2.5 Ga) rifting of the Late Archaean crust in the north-eastern part of the Shield.

(6) Previous studies of westward Shield accretion were continued successfully. In addition to a dominant Grenvillian collisional event, distinct 'Gothian' (1.8-1.7 Ga) and 'Kongsbergian' (1.65-1.55 Ga) accretional orogenies appear to have taken place. The existence of a c. 1.4-1-3 Ga 'Hallandian' event comparable to the simultaneous development in Mid-continental North America was supported additionally by new datings which paved the way for genetic studies of this still somewhat enigmatic evolution. New reflection-seismic results from the Skagerrak area may influence the debate on this problem.

(7) A survey of existing information and a definition of priorities regarding the basement of the East European Craton were carried out jointly by IGCP Project 275 and the Europrobe Proposal Group of ILP in preparation for coming geophysical-geological studies across the Tornquist-Teysseire Line boundary between western and eastern Europe, and all the way eastwards towards the Urals Mountains. This is a region critical for the understanding of the Baltic Shield and the North Atlantic area.

Progress is also noted in other fields of the project's activity, like palaeomagnetics, earthquake seismology, multimethod geophysical modelling of the crust, preparation of Moho-depth maps, and activities in connection with the development of the Kola Superdeep Drilling into an object of institutionalized study (cf. the report on meetings).

Important publications

More than 100 papers and short papers (abstracts excluded) on the Baltic Shield and its correlation have been published in the last year by active project participants. Most of them, however, are based wholly or partly on work carried out before the beginning of IGCP Project 275 and it would be presumptuous to list these as project publications. Thus about half of the 32 papers in the GA Canada volume (No. 38) 'Mid-Proterozoic Laurentia-Baltica' (1990) are by project participants. With these limitations, some publications considered important are:

- Issue 5, Ser. A, of the Oulo University Publication 'Res Terrae' featuring 84 abstracts of the 1991 Annual Meeting and the attendant International Symposium (98 pp., P. Tuisku and K. Laajoki, eds. 1991).

- Issues 6 and 7 of 'Res Terrae' with Excursion Guides for Lapland and the Kainuu districts, substantial petrological introductions (same editors, 1991).

- The Abstracts collection of the meeting in Copenhagen 'Granulite-facies and other High-grade Terranes', D. Bridgwater and L. Schiøtte, eds., 1991.

- The Archaean Complex in the Section of the Kola Superdeep Well, eds. Mitrofanov, Yakolev and Lanev, 50 pp., Kola Science Centre, Apatity, 1991.

- Kozlov, Ivanov and Nerovich: The Lapland Granulite Belt: Primary Nature and Development (in Russian). Kola Science Centre, 170 pp.

- New and Traditional Approaches to the Study of Crystalline Shields, M.P. Torokhov, ed., Kola Science Centre, 1991, 46 pp.

- L. Johansson, A. Lindh and C. Möller: Late Svecofennian (Grenville) high pressure granulite-facies metamorphism in south-west Sweden *J. Metam. Geol.*, 9: 283-292 (1991).

- J.A. Zuber and B. Ohlander: Geophysical and geochemical evidence of Proterozoic collision in the western marginal zone of the Baltic Shield. *Geol. Rdsch.*, 79: 1-12 (1990).

- R.G. Park, K.I. Ahäll and M.P. Boland: The Sveconorwegian shear-zone network of south-west Sweden in relation to Mid-Proterozoic plate movements. *Precambrian Research* 49: 245-260.

- P. Hölttä and V. Klein: PT-development of granulite-facies rocks in southern Estonia. Geological Survey of Finland Special Paper 12: 37-47 (1991).

- P.J. Valbracht, H. Helmers and F.F. Beunk: Early Proterozic continental tholeiitesfrom western Bergslagen, central Sweden: I. Petrology, geochemical petrogenesis and geotectonic setting. *Precambrian Research* 52: 187-214 (1991).

- P.J. Valbracht: Early Proterozoic continental tholeiites from western Bergslagen, central Sweden: II. Nd and Sr isotopic variations and implications from Sm-Nd systematics for the Svecofennian subcontinental mantle. *Precambrian Research* 52: 215-230 (1991).

- F.F. Beunk and P.J. Valbracht: Early Proterozoic tholeiites from western Bergslagen, central Sweden: III. Geodynamic inferences. *Precambrian Research* 52: 231-243 (1991).

- L. Matthiasson and A. Lindh: REE-patterns of some Svecofennian migmatite leucosomes. GFF, 113: 1-5 (1991).

- B. Ohlander and H. Schöberg: Character and U-Pb zircon age of the Proterozoic Ale granite, northern Sweden. GFF, 113: 105-112 (1991).

- I. Mansfield: U-Pb age determinations of Småland-Värmland granitoids in Småland, south-eastern Sweden. GFF, 113: 113-120 (1991).

- A. Lindh: Trace-element variation in a suite of Proterozoic granites, south-west Sweden. GFF, 113: 145-158 (1991).

- S.Å. Elming and H. Thunhed: A seismic reflection investigation in the Skellefte district, northern Sweden. GFF, 113: 258-259 (1991).

- J.A. Zuber and B. Ohlander: Gravimetrical and geochemical study of 1.8 Ga old granites in the Strängnäs-Enköping area, south-central Sweden. GFF, 113: 309-318 (1991).

- B.T. Hansen and A. Lindh: U-Pb zircon age of the Gönbjörnarp syenite in Skåne, southern Sweden. GFF, 113: 335-338 (1991).

A map in 1 to 2,500,000 of three-dimensional density and seismic speed in the northern Baltic Shield has been issued by the Geological Institute of the Kola Science Centre.

The 19 countries active this year were: Byelorussia, Canada, Czechoslovakia, Denmark, Estonia, Finland, France, Germany, Ireland (Eire), Latvia, Lithuania, Netherlands, Norway, Poland, Russia, Sweden, Ukraine, United Kingdom and the United States. Belgians did not participate in IGCP Project 275 meetings in 1991.

Activities planned

Scientific goals

The future geophysical-geological work can be divided into two overlapping groups of subprojects:

One of these considers the whole Shield and its global position, while the second calls for regionally restricted studies implying specific field work. In 1992, Trans-Atlantic correlation, continued plate-tectonic interpretation in the light of BABEL results and new datings, and planning of 'WABEL' profiling in the White and Barents Sea areas will be important. The same applies to work on the continuation of the Baltic Shield in the basement of Eastern Europe, where isotopic work on drilling-core materials by Western labs is already in progress and an English-language status review of the crust and the palaeorifts is in preparation. This publication will

give the general reader access to hitherto unavailable data in preparation for new deep-crustal studies. Work on the southern border area of the Shield will receive impetus by interaction with ILP's and ESF's 'Europrobe'.

The outlines of westwards Shield growth have now been established, but follow-up work will continue and new geophysical data acquired by other work will influence the interpretation. Continued Trans-Atlantic correlation will be pursued.

Meetings foreseen

In 1992, the Annual Meeting of IGCP Project 275 will be in Petrozåvodsk, Karelian Republic of the Russian Federation.

Planned for April 1992 is a meeting in Apatity, Kola Peninsula, Russia, on a joint international geophysical enterprise preliminary designated 'WABEL' (White and Barents Sea Echoes from the Lithosphere) and attendant geological-geophysical interpretation of the results.

Already fixed for 21-24 April 1992 is a meeting of the 'Basement of the East European Platform' Task Group of IGCP Project 275 with a symposium on Trans-Baltic-Sea Correlation, discussion of joint IGCP and 'Europrobe' work, and an attendant field trip, all based on Vilnius, Lithuania.

Some of the Task Groups of IGCP Project 275 plan to have special meetings and/or field seminars in 1992.

IGCP Project 275 will be represented at IGC in Japan and other major international events.

Publications planned

Editing of the 'Precambrian Research' Special Volume on the Baltic Shield will be completed and the volume will be printed in 1992.

A joint IGCP Projects 257 and 275 special issue of the Swedish national geological journal GFF appears in March 1992.

Also in GFF, a collection of short papers based on a meeting of the 'Westward accretion' task group will be published.

Deliberations are in progress regarding publication of a volume based on the 1991 annual meeting.

No. 276 - PALAEOZOIC IN THE TETHYS (1988-1992)

D. Papanikolaou, Department of Geology, University of Athens, Panepistimioupoli Zografou, 15784 Athens, Greece.

P. Sassi, Istituto di Mineralogia e petrologia, Università di Padova, Corso Garibaldi 37, I-35137 Padova, Italy.

A.K. Sinha, Wadia Institute of Himalayan Geology, 33 Gen. Mahadeo Singh Road, Dehra Dun, 248001, India (from 1 January 1991).

Description: This is a successor project to IGCP Project 5, 'Correlation of Prevariscan and Variscan Events of the Alpine-Mediterranean Mountain Belts'. The aim is to study the geo-dynamics of Tethyan Palaeozoic formations and their subsequent Mesozoic and Cenozoic evolution. This will be done by tracing Palaeozoic trends beneath the alpidic imprint and establishing pre-Tethyan configurations. The project will also correlate the pre-Alpine basement rocks of the Tethyan realm with those of the Laurasian and Gondwanan margins. It may considerably contribute to the understanding of the genesis and distribution of economic mineral deposits too. Research groups working on palaeomagnetic and palinspastic studies of the Tethyan Belt are active in many countries involved in the project, which covers a wide geographic area from the Mediterranean region up to the Indian subcontinent.

Achievements in 1991

New data and interpretations have been presented at the 4th field meeting, concerning the Palaeozoic of the *Betic Cordillera*. The tectonic contacts separating the Nevado-Filabride, the Alpujarride and the Malaquide complexes have been studied and the alpine deformation is analysed as a major ductile extension in the ENE-WSW direction. The pre-alpine metamorphic events are distinguished from the alpine overprint which is dated at 20-25 Ma.

The compilation of *maps* of 1/2,500,000 scale based on the concept of probable tectonic-stratigraphic terranes has been successfully made for most part of the Mediterranean and also for the Himalayas. The maps for the rest segments of the Tethyan belt are in progress.

The compilation of the *metamorphic* conditions during the pre-alpine events in the Mediterranean is at its final stage and long-term correlations are possible among various segments of the Tethyan belt.

The distinction of pre-alpine *structures* from the alpine overprint has been elaborated over maps at 1/2,500.00 scale. This first draft map is ready for further analysis with distinction of various types of pre-alpine deformation which is now in progress.

A lot of data on the pre-alpine *granitic* rocks of the belt as well as on the *basic and ultrabasic* rocks have been prepared by the thematic groups and some first conclusions on their geodynamic aspects have been obtained.

A re-evaluation of existing *palaeomagnetic* data has started aiming to imply the terrane concept and thus try to distinguish the drift period within the Palaeotethys from the collision stage of each terrane to the active European continental margin.

During the field meeting in Spain *geological correlations* between the units and formations of the Betics and those of the Kabyle massifs in Algeria have been made. In both cases the topmost non-metamorphic units are very similar whereas some differences appear in the distinction of the probable basement rocks and the tectonic interlayering of some mesozoic metamorphic rocks. A major difference is the absence of equivalent rocks in north-west Africa, to the Ronda ultrabasic body of the Betics.

Meetings held

- The 4th Field Meeting, organized by the Spanish working group, 23-28 September 1991. Fifty participants from 14 countries were present.

- A special meeting organized by the Italian working group in memory of Professor Cocozza's 'Geologia del Basamento Italiano'. It was held in Siena, 21-22 March 1991.

The following 19 countries were active during 1991: Albania, Algeria, Austria, Bulgaria, China, Czechoslovakia, France, Germany, Greece, Hungary, India, Italy, Morocco, Romania, Spain, Switzerland, Turkey, USSR and Yugoslavia.

IGCP Project 276 working groups or members exist also in Afghanistan, Cyprus, Islamic Republic of Iran, Iraq, Israel, Libyan Arab Jamahiriya, Pakistan, Syrian Arab Republic and Thailand.

Publications

- The second volume of IGCP Project 276 Newsletter (160 pp., 1991, *Memoires de Geologie*, No. 10, Lausanne) has been distributed.

- The third volume of IGCP Project 276 Newsletter is edited and is expected to be printed by the end of 1991, as a special issue of *Mineralia Slovaca* in Bratislava. It contains 17 contributions of about 160 pages.

- A special volume of IGCP Project 276 was published by the Spanish working group as a special issue of *Acta Geologica Hispanica*. It was distributed at the fourth meeting of the project in Granada.

- A volume of Abstracts and a Guide Book concerning the Betic Cordillera were distributed at the fourth field meeting in Spain.

- A special volume of IGCP Project 276 is edited by Dionyz Stur Institute of Geology, Bratislava, containing about 12 contributions (200-220 pp.) presented at the Vth Slovak Geological Conference (4-6 June 1990). It is expected to be published in the first semester of 1992.

Activities planned

Research

Intensive work of the thematic groups on the basis of the obtained preliminary results and the decided forms for the whole project's area with emphasis on the terrane maps.

Visit to the Palaeozoic outcrops in the Aegean slands of Chios and Lesvos and discussions on the regional correlations and the palaeogeodynamic interpretations during the meeting in Athens within the 6th Congress of the Geological Society of Greece.

Presentation of the first results of the project at its symposium in the framework of the 29th International Geological Congress in Kyoto.

Publication of new results in the Newsletter or in other scientific journals.

Meetings

The fifth field meeting of the project will be organized by the Greek working group in Athens within the 6th Congress of the Geological Society of Greece, 25-31 May 1991.

It will comprise: (i) three days of scientific sessions for presentation of contributions and for discussions of the thematic groups, and (ii) four days of field trip in the Palaeozoic of the Aegean islands of Chios and Lesvos.

Participation from the neighbouring countries of North Africa (Algeria, Egypt, Libyan Arab Jamahiriya, Morocco and the Syrian Arab Republic)

will be encouraged for promoting regional correlations, as well as from Asiatic countries and from East European countries.

The special symposium of the project at the International Geological Congress in Kyoto where the first final results will be presented and discussed.

Publications

- The third volume of IGCP Project 276 Newsletter (special issue of 'Mineralia Slovaca') will be distributed and the fourth volume of IGCP Project 276 will be edited.

- Special issue of 'Dionyz Stur Institute of Geology' will be published and distributed.

- Special issue of IGCP Project 276 Newsletter will be published with the papers presented at the meeting 'Geologia del Basamento Italiano' held to the memory of Professor T. Cocozza in Siena by the Italian working group.

- Special issue of contributions presented at the Athens meeting will be published in the *Bulletin of the Geological Society of Greece*.

No. 277 - PHANEROZOIC OOLITIC IRONSTONES (1988-1992)

J. Petránek, Geological Survey, Malostranské náměsti 19, CS-118 21 Prague 1, Czechoslovakia.

Description: Data on the stratigraphy and sedimentology of Phanerozoic oolitic ironstones for a genetic study will be assembled. A worldwide catalogue of Phanerozoic oolitic ironstones will serve the purpose. Both minor occurrences and major deposits will be registered but information will especially be sought on the less known occurrences. The thus gathered data will be invaluable for the ensuing research, especially in the following research areas:

(1) Chronostratigraphic distribution of Phanerozoic oolitic ironstones in relation to major events, global or regional.

(2) The climatic and facies control of their distribution.

(3) The growth of ooids and the environment of their formation.

(4) The diagenetic transformation of oolitic ironstones.

(5) The source of iron and clay concentrated in ooids.

Achievements in 1991

There are 110 project participants in 34 countries and the research is going on in different fields such as iron behaviour in the weathering process and the residual accumulation (e.g. United States, Russia), mineralogy of oolitic ironstones (e.g. France, Germany, Nigeria), regionally oriented research (e.g. Morocco, United States, United Kingdom, Portugal, Belgium-Zaire), ironstone relation to volcanism (e.g. United States), genetic aspects (Russia, Germany, Czechoslovakia), geochemistry of ironstones (e.g. United States, Argentina), etc.

Joint efforts have been aimed at compilation of a worldwide inventory ('Register') of oolitic ironstones. It will contain mineralogical, geochemical, sedimentological, genetic and other relevant data; upon completion and publication the Register will become an invaluable tool for analyses and interpretations of generations of oolitic ironstones.

Meetings

The annual meeting took place in mid-December in Rabat, Morocco. A symposium and a poster session was organized by the Moroccan working group and attended by about 40 participants from Africa, Europe, North America and Asia. Both the symposium and the poster session were open to advanced students of the Mohamed V University (Rabat) for educational reasons.

Following the Rabat session a six-day field trip to south-eastern Morocco (Anti Atlas region) took place. Because of desert environment the outcrops in the mountainous terrane are unusually fine and have offered rare opportunities for detailed investigation.

A subregional meeting in Černa (Czechoslovakia) was organized jointly by IGCP Project 254 (Metalliferous black shales) and by IGCP Project 277. The meeting comprised a one-day symposium and a field trip (two days).

Major publications

- Hamoumi, N., El Rabous, L., Maazouz, B., Laouar, R. and Makkoudi, D. (1991): Livret-Guide - Guidebook (Ordovician oolitic ironstones of Anti Atlas), 79 pp. (incl. 27 figs.). IGCP Project 277, annual meeting, Mohamed V University, Rabat, Morocco.

- Mudrey, M.G. Jr. (ed.) 1991: Ordovician-Silurian boundary of the Neda Formation, pp. 1-77, Geoscience Wisconsin, 14, University of Wisconsin, Madison, Wisc., United States.

- Young, T.P., Aggett, J.R., Howard, A.S. and Parsons, D. (1991): Jurassic and Ordovician ooidal ironstones, pp. 1-80, published by the British Sedimentological Research Group, Cambridge, United Kingdom.

Activities planned

Research

The study of Phanerozoic oolitic ironstones will be undertaken by individual scientists in their specialized fields, in major countries in co-operation with the national working groups. Correlation of ironstones occurring in specific stratigraphic positions (e.g. in Ordovician of Europe and North Africa, in Silurian of North America) as well as the source of iron or diagenetic transformation of the primary ferruginous sediment are among the priorities.

A major item is the conclusion of the worldwide Register of the Phanerozoic oolitic ironstones and its publishing. The last missing data, especially from some developing countries where the ironstones are little known because of restricted research, should be available in 1992.

Meetings

In addition to informal settings of national working groups there are five international meetings.

(1) Early May 1992, Mérida, Spain: Conference on the Lower Palaeozoic of Ibero-America (in relation to IGCP Projects 249, 270, 271 and 277). One of the five topics is 'Circum-Gondwanan natural resources' and a field trip 'Ordovician oolitic ironstones' will be organized by our project participants M. Robardet and J.C. Garcia-Ramos.

(2) Late May 1992, Wolfville, R.S., Canada: Symposium 'Geochemistry and mineralogy of ironstones' will be a part of the joint annual meeting of the Geol. Ass. of Canada and Mineral. Ass. of Canada. A two-day field trip 'Oolitic ironstones of the Northern Appalachians' will be organized by our project participant G. Yeo.

(3) August/September 1992, Kyoto, Japan: a symposium 'Phanerozoic oolitic ironstones' is planned to take place in the frame of the 29th International Geological Congress.

(4) Early September 1992. Guilin, South China: Symposium 'Devonian and its economical oil and mineral resources' with a field trip. The Devonian of the region is known for its oolitic ironstones. Organizer Hou Hong-fei is member of our project.

(5) The annual meeting 1992 is planned to be held in late September in Russia and Kazakhstan: a one-day symposium in Moscow will be followed by a 12-day field trip to southern Kazakhstan with investigation of Palaeogene oolitic ironstones of fluvial, deltaic, and marine origin.

No. 279 - TERRANES IN LATIN AMERICA (1988-1993)

F. Hervé, Departamento de Geología, Universidad de Chile, Casilla 13518, Correo 21, Santiago de Chile, Chile.

Description: This project emerged from research activities of IGCP Project 202 'Megafaults of South America'. The aim is to identify and characterize allochthonous tectonostratigraphic terranes in Latin America by integrated chronostratigraphic, geophysical and other methods, and to study the nature and dynamics of the sutures involved. Relationship between the accretion and displacement of the terranes along the continental margin and other major events will be established, as will the boundaries of the autochthonous Precambrian crust below the Andean region. Wide international (not only Latin American) participation is expected.

Achievements in 1991

The main activity of the project during 1991 was to organize and participate in the Vth International Conference which took place at Santiago, Chile, 10-14 November (sessions) and 15-28 November (field trips), 1991. This meeting was held in conjunction with IGCP Projects 233, 267 and 288.

The papers dealing with IGCP Project 279 were published as part of the Special Volume, *Comunicaciones* 42.

Three field trips were conducted during the conference:

EXCURSION A (15-22 November). A cross section of the Andes at latitude with 35 participants from 13 different countries.

EXCURSION B (23-29 November). Cross section of the Andes ca. Lat. 23°S. Fifteen participants from eight different countries.

EXCURSION C (16 November). Palaeozoic-Jurassic Plutonic Complex between Santo

Domingo and Algarrobo. Sixty participants from 16 countries.

Complete field guides were published for each excursion and distributed to participants.

During the meeting and the discussions in the field it became clear that the terrane geology of South America cannot be properly treated or understood without due consideration to the geology of other continents. In this respect, the SWEAT hypothesis of Moores (1991) and Dalziel (1991) has as a corollary that Laurentia was placed contiguous to what is now western South America in the Late Proterozoic-Early Palaeozoic. This possibility is already influencing geologic interpretation of Patagonia, the accretionary prism marginal to the Andes for example.

Relations between the Pre-cordillera terrane and the Appalachian Avalon terrane become thus much more explainable in the general framework of the SWEAT hypothesis.

Several cases of accretion of ophiolitic material in Central America, Ecuador and Chile have been analysed and the tectonic environment of their emplacement considered.

The characteristics of several big regional faults or shear zones are being studied and their role as possible terrane boundaries assessed Ar^{40}/Ar^{39} methods are being used to determine more exactly their periods of activity.

Seismic and palaeomagnetic methods are proving their importance in determining the presence of terranes and in characterizing their boundaries.

Metallic mineralization in a terrane boundary scheme is being considered in Chile and Argentina for the first time and some exploration considerations on that base have been advanced.

Meetings held

Administrative meeting at Viña del Mar, August 1991.

Ten participants from six countries (Argentina, Brazil, Chile, Germany, United Kingdom, Venezuela).

Annual meeting of the Working Group as part of the Vth International Terrane Conference, Santiago, 10-28 November 1991.

Twenty-five participants from 11 countries (Argentina, Brazil, Chile, Colombia, Ecuador, France, Germany, Mexico, United Kingdom, United States, Uruguay) on subjects of IGCP Project 279. Ninety participants from 17 countries overall in the meeting.

Important publications

Nineteen Abstracts, Expanded Abstracts and full papers were presented at the Medellin (1989) aborted meeting and at the San Juan (1990) meeting: *Comunicaciones*, v. 41, pp. 41-90, Santiago (1990).

Thirty Abstracts and Expanded Abstracts of the Santiago (1991) meeting: *Comunicaciones*, v. 42, Special Issue, 239 pp., Santiago (1991).

Thirteen countries were active in 1991: Argentina, Brazil, Chile, Colombia, Costa Rica, Ecuador, Germany, France, Mexico, United Kingdom, United States, Uruguay and Venezuela.

Activities planned

Research

Collecting new data and preparation of papers for the final meeting of the project, which will take place in Mexico, 1993.

Meetings

After the original schedule of the project, the final meeting was supposed to take place in one of the countries with less massive participation in it, which would have been incorporated into to the activities during the life of the project.

However, the project leaders proposed to postpone the final meeting to take place in Mexico, November 1993, during the Vth International Terrane Conference. On this occasion, a wider forum for presentation and discussion about terranes will be convened, constituting a better environment for the final meeting than if the group meets by itself. Also, two successive meetings (San Juan, October 1990 and Santiago, November 1991) give a short time for substantial new research work to be presented in 1992, but it should be possible in 1993.

As no major activities are planned for 1992 the Board granted nil funding for this year and active extension for 1993.

No. 280 - THE OLDEST ROCKS ON EARTH (1988-1992)

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Dr S. Moorbath, Department of Earth Sciences, Oxford University, Parks Road, Oxford OX1 3PR, United Kingdom.

Professor B.M. Jahn, Institut de Géologie, Université de Rennes, avenue du Général Leclerc, F 35042 Rennes Cedex, France.

Description: The project promotes detailed geological investigations on all continents of the surviving fragments of the oldest terrestrial crust, using the latest techniques of field work, geochronology, isotope and trace element geochemistry, petrology, structural geology, etc. The aim is to test the many divergent current hypotheses of crustal evolution during the first billion years or so of earth history (e.g. How much continental crust was formed early in earth's history? When did its formation start and why? Did the crust grow continuously or episodically?), and to provide a forum of international discussion for this topic of fundamental importance to a wide spectrum of earth scientists. Ancient rocks and minerals are the *only* clue we have about the nature and origin of the lithosphere, hydrosphere, biosphere and atmosphere, and the interaction between them.

Achievements in 1991

(1) Continuation of Russian-foreign collaboration on Archaean crustal evolution in the Aldan shield of Siberia. A special volume of *Precambrian Research* on 'The Archaean of the USSR' is still in preparation, including new data partly based on international collaborative efforts. Eight manuscripts have so far been accepted for publication.

(2) Further SHRIMP U-Pb zircon dating on rocks of the Acasta gneiss terrane in northern Canada has shown that the 3.96 Ga components are rather limited in extent and occur together with volumetrically more important 3.6 Ga rocks (Williams, Australia; and Bowring, United States).

(3) Reconnaissance SHRIMP U-Pb zircon dating in the Wyoming Province (Mueller and Wooden, United States; Nutman and Compston, Australia) has revealed the presence of 3.96 and 3.73 Ga detrital components in c. 3.3 Ga old metaquartzites.

(4) Continued field work and SHRIMP U-Pb zircon dating on the Sino-Korean craton (Liu and co-workers, China; Nutman and Compston, Australia) has revealed 3.8 Ga tonalitic gneisses associated with more voluminous 3.3 Ga, 2.96 Ga and 2.5 Ga tonalites and granites in the vicinity of Anshan.

(5) Reconnaissance SHRIMP U-Pb zircon dating in the Sao Francisco craton of Brazil (Cordani, Brazil; and Nutman, Australia) has confirmed the existence of gneisses with ages of 3.4 and 3.35 Ga. These rocks will be visited during the field excursion in 1992.

(6) Precise zircon geochronology on Early Archaean greenstone belts in southern Africa and western Australia supports an almost identical evolution and suggests that the Kaapvaal and Pilbara cratons may have been part of the same crustal block 3.45-3.2 Ga ago (results of several teams from Australia, Canada, Germany and South Africa).

(7) Detailed tectonic analyses in several Early Archaean terrains suggests that the 'terrane concept' as now applied in Phanerozoic orogens, may also be applicable to Early Precambrian crustal evolution (Nutman, Canberra; Friend, Oxford; Myers, Perth; Tomkinson, Johannesburg).

As the project progresses, a considerable volume of high-quality geochronological, isotopic and geochemical data is being amassed. To an increasing degree, collection of this data is being integrated with detailed structural and petrological investigations. In this way it is possible to construct more sophisticated schemes for the evolution of Archaean terrains. As a result of this, tectonostratigraphic terrane analysis is, to an increasing degree, applied to unravel the history of Archaean complexes. However, for the earliest (>3.9 Ga) Archaean geological record, giant impacts are considered by some workers to have been a major process in shaping the early lithosphere. In addition, plume tectonics is gaining popularity.

Important publications

- Ashwal, L.D. (ed.) 1991. Two cratons and an orogen - Excursion Guidebook and review articles for a field workshop through selected Archaean terranes of Swaziland, South Africa and Zimbabwe. IGCP Project 280, Dept. of Geology, Univ. Witwatersrand, Johannesburg, 150 pp.

- Cohen, A.S., O'Nions, R.K. and O'Hara, M.J., 1991. Chronology and mechanism of depletion in Lewisian granulites. *Contrib. Mineral. Petrol.*, 106, 142-153.

- Friend, C.R.L. and Nutman, A.P., 1991. Refolded nappes formed during Late Archaean terrane

assembly, Gothaabsfjord, southern West Greenland. *J. Geol. Soc.*, 148, 507-519.

- Harley, S.L. 1991. The crustal evolution of some East Antarctic granulites. In: Geologic evolution of Antarctica (M.R.A. Thomson, A. Crame and J. Thomson, eds.), Cambridge University Press, 7-12.

- Kröner, A., 1991. Tectonic evolution in the Archaean and Proterozoic. *Tectonophysics*, 187, 393-410.

- Kröner, A., Byerly, G.R. and Lowe, D.R., 1991. Chronology of Early Archaean granite-greenstone evolution in the Barberton Mountain Land, South Africa, based on precise dating by single zircon evaporation. *Earth Planet. Sci. Lett.*, 103, 41-54.

- Nutman, A.P. and Collerson, K.D., 1991. Very Early Archaean crustal-accretion complexes preserved in the North Atlantic craton. *Geology*, 19, 791-795.

- Nutman, A.P., Kinny, P.D., Compston, W. and Williams, I.S., 1991. SHRIMP U-Pb zircon geochronology of the Narryer Gneiss Complex, Western Australia. *Precambrian Res.*, 52, 275-300.

- Rapp. R.P., Watson, E.B. and Miller, C.F., 1991. Partial melting of amphibolite/eclogite and the origin of Archaean trondhjemites and tonalites. *Precambrian Res.*, 51, 1-25.

Activities planned

Major research efforts of the project in the last year continue to include the elucidation of field relationships in Early Archaean terrains using modern field techniques, particularly in structural geology; the application of the terrane concept in Archaean studies; the continued search for relicts of continental crust older than ~4 Ga; development of ultra-precise dating techniques for Archaean rocks; investigations on the significance of isotopic heterogeneities in Early Archaean mafic-ultramafic rocks and their relevance for crust-mantle differentiation; geochemical modelling of early crust-mantle differentiation; modelling of the thermal history of the early earth; P-T conditions in, and composition of, Early Archaean lower continental crust.

Specific interlaboratory co-operation is under way on a variety of topics and including scientists from Australia, North America and Europe and colleagues from developing countries such as Brazil, China, India, Nigeria and Viet Nam. Trying to recognize and differentiate between the products of proposed Archaean plate tectonics, plume tectonics and giant impacting should be the major aim for the remaining time of the project, rather than a narrow-minded search for very old rocks.

Meetings

IGCP Project 280 will undertake a two-week field excursion in the State of Bahia, Brazil, in July 1992, preceded by a one-day seminar on Early Archaean evolution. The purpose is to study new developments in Archaean gneiss-granite-greenstone and granulite evolution in the Conquista-Sete Voltas area and the Jequié Complex, Bahia. The project will co-sponsor Symposium A2 (Early history of the earth, birth of continents, oceans and atmosphere) and Symposium 01 (Archaean geology) at the 29th International Geological Congress in Kyoto, Japan.

A final meeting of the project will be an international symposium on early crustal evolution in Montana, United States, with a field trip to Early Archaean assemblages in the Wyoming Province, and is planned for July 1993.

No. 281 - QUATERNARY CLIMATES OF SOUTH AMERICA (1989-1993)

J. Argollo Bautista, Centro de Investigaciones Geológicas, UMSA, Casilla de Correo No. 12198, La Paz, Bolivia.

Description: The aim of the project is to obtain a better understanding of climatic processes such as the consequences of the past climatic changes in soils, vegetation and human distribution. It involves a study of biological, geochemical and hydrological markers in the sedimentary record. The study will be focused on the last great climatic cycle in the Quaternary and possibly on the changes between Pliocene and Pleistocene. The past climatic variations will be a basis for the development of a quantitative climatic model.

Achievements in 1991

General scientific achievements

Geomorphological study of the Amazon basin by using landsat views and aerial photographs.

The Pleistocene sediments chronology was established with different methods: palaeontology, isotopic data (C-14 on carbonate material and organic matter) and sedimentology. Palaeoclimatic interpretations.

Geological, archaeological and historical studies of the Southern Oscillation (e.g. phenomenon El Niño) on the Pacific coast. Teleconnections with the Altiplano and Amazon basins.

Impacts of the climatic variations on the prehistoric human activities (Pacific coast; Altiplano and Amazon basins).

Meetings

- The third meeting of IGCP Project 281, 12 -15 July, Lima, Peru, eight countries participated.

- Simposio Internacional sobre la Ecología de Alta Montaña, 22 October-4 November, Santiago, Chile, 18 countries participated.

- The 5th International Symposium on Inland Saline Lakes, 17-22 May, La Paz, Bolivia, 24 countries participated.

Important publications

- Fifteen publications in the third volume on Quaternary climates of South America.

- Reconstructing the Quaternary record of Western Amazonia with biogeochemical information from Acre Basin sediments. Kronberg, B.I., Benchimol, R.E. and Duenas, H.

- Paleoambientes durante la transición Pleistoceno-Holoceno en los Andes peruanos. Bonavia, D.

- Eventos climaticos en la costa y en la cordillera de los Andes del Peru central. Machare, J., and Velis, Y.

- Reconstrucion palinologica de la vegetacion de Chile Central Sur: Posibles escenarios paleoclimaticos durante el Cuaternario Tardio. Villagran, C.

- Climatic variations in the Argentina Plains during the last 18,000 years. Iriondo, M.

Twelve countries participated in the project: Argentina, Bolivia, Brazil, Canada, Chile, Colombia, Ecuador, France, Mexico, Peru, United States and Venezuela.

Activities planned

Research

- Chronology of the last glacial maximum and intracontinental correlations.

- Study of the last 20,000 years BP (Glacial maximum and interglacial period).

- Palaeoclimatic correlations on a South America scale.

- Pleistocene-Holocene boundary study in South America.

- The problem of the South American climatic optimum.

- Short-term climate variations: the last 2,000 years in South America.

Meetings

- The 4th meeting of IGCP Project 281, Manaus, Brazil, 8-13 November 1992 (8-11 November: Field excursion to Rio Salemoes - Interfluvio Rio negro y Salemoes - Irandura, Rio Preta da Eva; 12-13 November: Scientific session and conclusions).

- International Symposium on Former Phenomena in Western South America, Records of El Niño Events, Lima, 4-7 March 1992.

Publications on the following topics are planned: Palaeoclimatic correlation-Pleistocene-Holocene boundary. Last glacial maximum. The South American climatic optimum.

No. 282 - RARE METAL GRANITOIDS (1989-1993)

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P.J. Pollard, Department of Geology, James Cook University of North Queensland, Townsville Qld 4811, Australia.

Description: This project is investigating the geotectonic, magmatic and postmagmatic evolution of rare-metal mineralization, especially in relation to granites and pegmatites. The project has five major themes which form the focus of investigations: (1) regional and local controls on the generation and emplacement of magmas; (2) petrological, geochemical, mineralogical and isotopic characteristics of rare-metal granitoids; (3) physico-chemical conditions of formation of rare-metal deposits; (4) mineralogy of rare metals; and (5) resource assessment and exploration for rare-metal deposits.

Achievements in 1991

Meetings

(1) The International Symposium on Granites and Geodynamics (Magma generation mechanism, properties of melts, geochemistry and metallogeny) was held in Moscow, 6-14 August 1991.

(2) The twenty-fifth anniversary meeting of the Society for Geology Applied to Mineral Deposits held in Nancy, France, from 30 August to 3 September 1991, provided a forum for special sessions on rare-metal deposits.

(3) The Third Symposium and Workshop on Rare-metal Granitoids was held in Bangkok, Thailand, 5-8 November 1991.

Main scientific achievements

The project held a very successful workshop on rare-metals exploration and resource assessment in Bangkok. The workshop was attended by 35 participants, mostly from East and South-East Asia and included a field trip to south-western Thailand to visit rare-metal deposits, associated granites and mineral dressing plants.

IGCP Project 282 has successfully established links between researchers in Australia, Canada, China, France, Russia and Thailand focused on the nature and evolution of tantalum mineralized granites. These projects are due for completion in 1993.

Important publications

- Cuney, M. and Raimbault, L., 1991. Variscan rare-metal granites and associated mineralizations from the north French Massif Central. 25 Years SGA Anniversary Meeting Field Guide, 75 pp.

- Nakapadungrat, S., Jungyusuk, N., Putthapiban, P., Kosuwan, S. and Chaimanee, N., 1991. Southern Thailand lithophile mineral deposits. Field Guidebook 2, GEOSEA VII, 76 pp.

- Nenakhov, V.M., Kuznetsov, L.V. and Khrestenkov, P.A., 1991. Geological excursions in Turkestan-Alai (southern Tien Shan) guidebook. Proceedings of International Symposium on Granites and Geodynamics Field Session, 25 pp.

- Pagel, M. and Leroy, J.L., 1991. Source, transport and deposition of metals. Proceedings of the 25 Years SGA Anniversary Meeting (Nancy, France), Balkema, Rotterdam, 841 pp.

- Zharikov, V.A. and Knipper, A.L., 1991. International Symposium on Granites and Geodynamics (Magma generation, properties of melts, geochemistry and metallogeny), Extended abstracts volume, SovGeoInfo, Moscow, 135 pp.

Thirty-one countries participated in the project: Australia, Austria, Belgium, Bulgaria, Canada, China, Czechoslovakia, France, Germany, Greece, India, Indonesia, Ireland, Japan, Korea, Malaysia, Mongolia, Myanmar, Nepal, Papua New Guinea, Philippines, Portugal, Spain, South Africa, Thailand, United Kingdom, United States, USSR/CIS, Venezuela, Viet Nam and Yugoslavia.

Activities planned

Scientific goals

The major goals for 1992 are: (1) to prepare a thematic issue of economic geology on rare-metal deposits; (2) to finalize discussion and recommendations on the nomenclature of rare-metal granites; and (3) to implement the data base of rare-metal granitoids and correlate within and between different provinces.

Meetings

(1) International Field Meeting - Rare-element Mineralization of the Baltic Shield, August 1992, Apatity, Russia.

(2) Fourth Symposium on Rare-metal Granitoids, 10-21 August 1992, Ulan Bator, Mongolia.

Publications

- Special issue of *Canadian Mineralogist* on rare-metal pegmatites.

- Preparation and review of papers for a thematic issue of economic geology on rare-metal deposits.

- Proceedings of GEOSEA VII in the *Journal of Southeast Asian Earth Sciences*.

No. 283 - GEODYNAMIC EVOLUTION AND MAIN SUTURES OF THE PALAEO-ASIAN OCEAN (1989-1993)

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N.L. Dobretsov, Institute of Geology and Geophysics, Siberian Branch, USSR Academy of Sciences, Novosibirsk-90, USSR.

R.G. Coleman, Standford University, California, United States.

Description. The project intends to study the tectonic evolution within Palaeo-Asian domains during Palaeozoic and Late Precambrian times, tracing indicative geological formations, using palaeomagnetic measurements and palinspastic tectonic methods. The focus is on the amalgamation of Precambrian blocks and relics of the Palaeo-Asian Ocean and on their transformation into the mobile belts between the Siberian and Northern China platforms.

This project calls for interdisciplinary co-operation of geologists, geophysicists and geochemists.

Achievements in 1991

Meetings

The 2nd International Symposium of IGCP Project 283 was held in Shenyang, north-east China. During this symposium a geological excursion was organized for examining the geology and tectonics of the south-east margin of the Palaeo-Asian Ocean.

General scientific achievements

(1) The principles and responsibility for compiling the tectonic map and transect on the base of existing geophysical data have been discussed and clarified. The legends for these maps have been discussed and approved.

(2) Information and documents concerning the tectonic evolution, the structures, the terranes accretion, the petrology and geochemistry of granitoid and basic-ultrabasic intrusions were collected. The high P/T metamorphic rocks and ophiolites from the central to south-eastern Palaeo-Asian Ocean (the composite megasuture) have been presented and discussed during the 2nd International Symposium of IGCP Project 283.

(3) Experimental approaches concerning the mantle convection and collision and extensional terranes were also discussed at the symposium.

(4) Geoscience transect from the Xiangshui to Mandal, Keketuohai to Aksai, China and south-western Japan and detailed deep seismic studies on the Baykal rift (USSR) were illustrated at the symposium.

Important publications

(1) Report No. 2 of IGCP Project 283 - Geodynamic Evolution and Main Sutures of Palaeo-Asian Ocean, Beijing, China, 1991.

(2) Guidebook for Field Excursion, Beijing, China, 1991.

Seven countries participated in the project: China, Hungary, Japan, Korea, Mongolia, Russia and the United States.

Activities planned

The 3rd International Symposium of IGCP Project 283 will be held as a section during the 29th International Geological Congress in Japan. The field trips will be divided into two parts: one is a short-distance excursion for examining the paired metamorphic belts in south-east Japan, and the other is to examine the geology of palaeoophiolites in central-western palaeo-Asian domain in the Urals, Russia.

Report No.3 of IGCP Project 283 will be published before the 3rd International Symposium of the project.

No. 286 - EARLY PALAEOGENE BENTHOS (1990-1994)

L. Hottinger (Switzerland) and E. Caus (Spain), c/o Professor L. Hottinger, Geologisch-Paläeontologisches Institut der Universität Basel, Bernoullistr. 30-32, 4056 Basel, Switzerland.

Description: The project intends to revise and to compare selected neritic index microfossils in order to establish a standard zonation bridging facies and province boundaries during the Early Palaeogene time-span characterized by the reconstitution of the benthic diversity after its breakdown at the Cretaceous/Tertiary boundary (faunal) recovery following the major late Cretaceous crisis).

Achievements in 1991

General scientific achievements

(1) Review of Dinaric Early Palaeogene history and biostratigraphy as described in the guidebook for excursion, serving as standard for the central Tethyan carbonate platforms.

(2) Progress in new index microfossil groups, i.e. Elphidiids and Rotaliids.

(3) Discocyclinid zonation: correlated with plankton standards.

(4) Progress in the biostratigraphic definition of shallow carbonate 'Danien'.

(5) Magnetostratigraphy in the pyrenean realm and its correlation with larger foraminiferal biozonation.

(6) Collaboration with IGCP Project 262 (Cretaceous) as to standard terminology of morphologic features in benthic foraminifera.

Meetings

(1) March 1991: Joint meeting with IGCP Project 262 in Basel, for IGCP Project 286 co-ordinators only: Spain, France, Yugoslavia and Switzerland.

(2) May 1991: Second international symposium 'Adriatic Platforms', Zadar, Yugoslavia. For IGCP Project 286: co-ordinators only (four countries).

(3) October 1991: Exploratory excursion to Hungary and Romania.

(4) October 1991: Annual meeting of IGCP Project 286 in Postojna, attended by 36 persons from four countries.

Important publications

Barnolas, Robador, Serra-Kiel and Caus (eds.). Introduction to the Early Palaeogene of the South Pyrenean Basin. Field Trip Guidebook. Inst. GeoMinero de España, Jaca, pp. 1-159.

Fourteen countries participated in the project (* indicates the countries active this year): Czechoslovakia*, France*, Hungary*, India*, Italy*, Japan, Libyan Arab Jamahiriya, Poland*, Spain*, Switzerland*, Turkey*, United Kingdom, USSR* and Yugoslavia*.

Activities planned

General goals

- Set standard for Early Palaeogene benthic biozonation in Eastern Central Tethys in facies with terrigenous influence: stratigraphy of Central Anatolia.
- Enlarge regional studies to Northern Africa and/or Pakistan.
- Prepare transatlantic correlation programme for Early Palaeogene.
- Continue work on early Palaeogene index fossils.

Meetings and field trips

IGCP Project 286 regular annual meeting will be held in Ankara, Turkey, in October 1992, with the help of MTA (Ankara).

Exploratory work (excursions with small number of participants and informal meetings) planned for southern Spain (Summer 1992).

Individual visits and exchanges foreseen: Barcelona-Basel, Toulouse-Basel, Moscow-Basel, Moscow-Ljubljana, Krakow-Basel, etc. These latter visits and exchanges are gaining rapidly in importance for the effective work done within the project.

Proposed major publications

The proceedings of the Jaca meeting (1990) and of the Postojna meeting (1991) will be combined into a volume with over 30 contributions. It will be published during 1992 as Volume 31 of 'Opera', series edited by the Slovenian Academy of Sciences and Arts.

No. 287 - TETHYAN BAUXITES (1989-1993)

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A. Mindszenty, Department of Mineralogy, L. Eötvös University, Muzeum krt 4/A, H-1088 Budapest, Hungary.

L. Simone, Department of Earth Sciences, University of Naples, Largo San Marcellino 10, 80138 Napoli, Italy.

Description: The full title of the project is 'Correlation of Mesozoic/Tertiary bauxites and related palaeokarst phenomena in the Tethyan realm'.

The objectives of the project are:

(1) to revise and summarize the available evidence on bauxites and related palaeokarst phenomena in the West Central Mediterranean realm;

(2) to correlate the major bauxite/palaeokarst horizons with orogenic, eustatic and climatic events already recognized in the region of study.

This approach will lead to a better understanding of the genesis of karst bauxites and thus promote the prediction and exploration of further bauxite deposits. In addition, it will shed light on some details of the tectonic evolution of the Mediterranean region.

Achievements in 1991

Meetings held

Symposium S-23 of the EUG-VI Conference in Strasbourg, France, on 27 March 1991, was the main annual meeting of the project. Its topic was: 'Mesozoic and Early Tertiary Karst-bauxites of the Mediterranean area and related regional non-conformities: eustatic versus tectonic control'. It had 19 project participants from eight countries (Austria, Czechoslovakia, France, Germany, Hungary, Italy, Spain and Yugoslavia). Nineteen papers were read and four posters were presented, and a round-table discussion was held. (The Abstracts have been published.)

A second meeting had originally been planned to be held in Yugoslavia (Mostar-Nikšic) and consecutively in Albania. Due to the adverse political circumstances it had to be cancelled. However, seven project members from three countries attended the field symposium organized by IGCP Project 262 'Tethyan Cretaceous Correlations in Albania' which was very relevant from the bauxite geological point of view (visit to the Dajti Mts. bauxite deposits). Seven papers were presented by members of IGCP Project 287.

Scientific achievements

- Increased research activity was performed on the sedimentology of bauxites, e.g. in Spain and Czechoslovakia.

- The first ever concise review of the karst bauxites of Albania was compiled.

- An interregional review of extraclasts from bauxites of the Transdanubian Central Range (Hungary) and the Northern Calcareous Alps (Austria) was published.

- The blending of knowledge on bauxite formation.

- Consultations with GSGP-4 on the role of bauxites in sequence stratigraphy.

Publications

Besides Newsletter 4, and the Abstracts of the Strasbourg Symposium, four papers were printed in 1991.

Eighteen countries have joined the project (* indicates the countries active in 1991): Albania*, Austria*, Bulgaria, China, Czechoslovakia*, Egypt, France*, Germany*, Greece*, Hungary*, Islamic Republic of Iran, Italy*, Jamaica, Pakistan, Romania*, Spain*, Turkey and Yugoslavia.

Activities planned

In 1992, more efforts will be made:

to improve the stratigraphy of bauxites in the region of study, in view of a better correlation;

to intensify the activity of thematic working groups; selecting and visiting key profiles;

to attempt correlation with other geological events recognized in the region;

to interact with potential users of the results of the project.

Meetings planned

- Third International Workshop of the project, in association with the 7th Congress of ICSOBA (International Commission on the Study of Bauxites, Alumina and Aluminium), at Balatonalmadi, Hungary, 22-26 June 1992, with a field trip to Gánt bauxite deposit.

- Participation in the GSGP meeting to be held in Spain, August 1992.

- The final meeting of IGCP Project 287 will be held in Tirana, Albania, in 1993.

Major publication in preparation

'Tethyan Bauxites - The State of the Art': Proceedings of the Second International Workshop of IGCP Project 287 held at Itea-Delphi, Greece, in October 1990 (eds. J. Haas, Gy. Bárdossy and A. Mindszenty) (20 papers), in *Acta Geol. Ac. Sci. Hung.*, Budapest, Hungary.

No. 288 - GONDWANALAND SUTURES AND FOLD BELTS (1990-1994)

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G.R. Sadowski, Instituto de Geociencias, Universidade de São Paulo, Cidade Universitaria, C.P. 20899, 01498 São Paulo, SP Brazil.

Description: The objective of the project is to achieve improved understanding of the following problems: (a) delineation of constituent cratons of the re-constituted Gondwana Supercontinent; (b) correlation of Proterozoic mobile belts including fold belts, sutures, shear zones and major faults and determinate their continuity on the reconstituted Gondwana Supercontinent; (c) kinematics of Proterozoic mobile belts: vergence of fold belts and thrust faults, direction of tectonic transport, sense of movement on transcurrent faults; (d) interaction of lithospheric plates during the Proterozoic and the nature of their boundaries; (e) repeated reactivation of large Proterozoic pericratonic dislocation zones.

Achievements in 1991

General scientific achievements

Evidence of the Kalahari craton of Africa forming part of East Gondwanaland has been obtained. The importance of the 820 Ma orogenic event along the eastern and southern margin of the Congo craton has been established. The hypothesis on Laurentia position along Antarctica and eastern Australia resulted in two new reconstructions of the supercontinent agglomerated in the Middle Proterozoic 1300-1100 Ma orogenic events, that partly disintegrated and reassembled in a new configuration in the Gondwanaland supercontinent cycle. These models include a new approach to Late Proterozoic kinematics and geodynamics of continental crust fragments. Late Proterozoic/Early Palaeozoic transcurrent faulting, basin formation and deformation, and basement reactivation events in western Australia have been widely recognized.

A number of co-operative projects are under way or being initiated. These include an Algerian-French project (Drs Guerrak and Fabre), a Belgian-French project (Drs Liegeois and Black), a Brazilian-French-Nigerian project in the Borborema province of Brazil (Drs Jardim de Sa, Bertrand, Ajibade), a United States-Nigeria project in Nigeria (Drs Grant and Ajibade), a German-Zambian project (Prof. H. Porada and collaborators), a Japan-India project in India and Sri Lanka (Prof. Yoshida and Drs A.T. Rao and T.R. Rao) several Brazil-United States co-operative projects (Drs S Marshak and F. Chemale, Drs R. Van Schmus, Brito Neves and others), an Egypt-Sudan-United States project (Drs M.Sultan, R. Stern and several collaborators) and others, as well as a number of national projects.

The North American working group has been organized, and decided to hold annually symposia on Gondwana assembly at spring meetings of the American Geophysical Union.

The contents of the planned Tectonic Map of the Gondwana supercontinent was outlined in several workshops and discussion sessions. The map will show the Archaean-Early Proterozoic terranes, and the Middle Proterozoic (1600-1000 Ma) mobile belts as rigid cratonic components of the Late Proterozoic Gondwana Supercontinent assembled in the 870-650 Ma time interval. The mobile belts suturing the individual cratonic components will be shown with age, vergence and sense of transcurrent motions, metamorphic grade, magmatism, ophiolites, major adjacent sedimentary basins, zones of post-tectonic thermal rejuvenation and shear zones. The map is intended to summarize the understanding of the cratonic components, their kinematics and geodynamics of the suturing mobile belts of the Gondwana supercontinent. The Geological Survey of South Africa has undertaken to carry out digital cartograhic work and to print proof copies of the planned tectonic map of the Gondwana supercontinent.

What is perhaps most important, a number of research centres are coming with new initiatives. Geoscientists in Australia, Japan, and India joined the project with great enthusiasm. The project activity is vibrant with vitality.

Meetings

(1) Thematic session: Fusion and evolution of Gondwanaland at the Spring Meeting of American Geophysical Union in Baltimore MD, May 1991, (R. Unrug and M. Sultan, conveners), 14 papers presented. Attendance: room with 150 seats full to ¾ full during the half-day session. Attendees representing several countries at the large international meeting of AGU.

(2) Business meeting of the North American working group at the same convention as (1) above. The group has been formed and decided to hold annual symposia. A consortium-type research proposal will be submitted to the National Science Foundation, this will include a workshop at the next AGU meeting in Montreal in May 1992.

(3) Gondwana 8 International Symposium in Hobart, Tasmania, Australia, June 1991. This included:

A week-long pre-symposium field workshop in the Albany mobile belt of Western Australia (Dr Lyall Harris, Leader). Six participants representing five countries took part.

Three thematic sessions with keynote addresses by P.W. Schmidt, R. Unrug and I.D.W. Dalziel: Palaeomagnetism (Dr Bryan Embleton, convener) five papers presented; Precambrian mobile belts/sutures and the Proterozoic assembly of Gondwanaland (Dr R. Unrug convener) ten papers presented; Late Precambrian/Early Palaeozoic tectonics (Professor Chris Powell and Dr John Long, conveners) 16 papers presented. The three sessions were followed by a 2-hours open discussion chaired by Professor Chris Powell, with no competing other sessions. The discussion has been recorded, and will be transcribed, edited and published along with the papers presented at the sessions in the symposium proceedings. A number of interesting new ideas emerged from this discussion. A workshop on the 500 Ma trans-Gondwana event (chair: Dr Lyall Harris) discussed the late to post-tectonic events in Gondwanaland. All this was wrapped up by the IGCP Project 288 workshop (chair: Dr R. Unrug) that discussed the work plan for 1992-1993, the concept of the tectonic map of the Gondwana supercontinent, the field workshops in South Africa and India planned for 1992 and 1993 respectively, the contributions of Australian geoscientists to the project, and the organization of the Australian working group.

Attendance at the Gondwana 8 Symposium was 120, out of this about 50 per cent were directly involved in the Gondwanaland assembly part of the programme. The attendants represented 15 countries.

Twenty-seven countries were involved in the project (* indicates the countries active this year): Argentina*, Australia* Belgium*, Botswana*, Brazil*, Burundi, Canada*, Chile*, China, France*, Germany*, India*, Italy*, Japan*, Kenya, Namibia*, New Zealand*, Nigeria*, Poland, Portugal, Senegal*, South Africa*, Tanzania*, United Kingdom*, United States of America*, Zambia and Zimbabwe*.

Activities planned

General goals

It is expected that current research projects will provide new data on the Borborema tectonic province of Brazil, and on the Albany mobile belt of Australia. It is intended to have the legend for the tectonic map of the Gondwana supercontinent ready and the plotting of data from various ex-Gondwanaland present continents under way. Invitations to potential authors of synthesizing papers for the proposed book volume will be sent out.

It is expected that new research projects will be initiated and/or started (Japan/India/Sri Lanka, United States with several co-operating countries).

Meetings

The project is organizing the following two symposia:

Gondwana supercontinent assembly and relation to Laurentia at the American Geophysical Union meeting in Montreal, May 1992 (funds will be sought to bring several speakers from overseas to this symposium) and a symposium on mobile belts of the Gondwana supercontinent at the 29th International Geological Congress in Kyoto, August-September 1992.

A field workshop in the Gariep and Saldania mobile belts of South Africa is planned (Dr P. Greese, Leader).

Proposed major publications

An early 1992 issue of the *Journal of Geodynamics* will contain papers presented at the 1991 Session on Evolution and Fusion of Gondwanaland (Editor: Dr N. Rast).

An issue of *Precambrian Research* devoted to palaeomagnetism studies is planned. Manuscripts due in February 1992 (Editor: Dr T. Onstott).

No. 290 - ANORTHOSITES AND RELATED ROCKS (1990-1994)

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Description: Anorthosite intrusions occur worldwide in various settings. However, their mode of origin and relationships with associated rocks and metamorphic events is not clear. Furthermore, the

tectonic setting and the significance of age restrictions have not been delineated. The objectives of this project are to elucidate these problems by encouraging and co-ordinating field and laboratory studies and exchange of ideas on a worldwide basis.

Achievements in 1991

General scientific achievements

(1) Geochronology - Many new uranium-lead zircon and baddeleyite ages were presented. Although these phases were formerly thought to be absent from anorthosites, careful work has revealed their presence. These high-precision crystallization ages can be used to constrain the tectonic setting of anorthosite massifs.

(2) Experiments under medium-pressure conditions have revealed aspects of the polybaric evolution of the parent magmas of anorthosites and their associated Ti-Fe oxide ore deposits.

(3) Thermodynamic approaches have permitted the determination of some intensive parameters, such as P, T, f02.

(4) Isotopic and chemical data have questioned the co-magmatic origin of the jotunites and anorthosites.

Meetings

Proterozoic massif anorthosites: Age, evolution and tectonic setting, 13-19 September 1991, Saranac Lake, NY, United States; 49 participants from 12 different countries.

Twenty-eight countries were involved in the project (* indicates the countries active this year): Australia, Belgium*, Botswana, Brazil, Burundi, Canada*, China*, Denmark, Finland*, France*, Germany, India*, Italy, Japan*, Kenya*, Korea, Malawi, Namibia, Netherlands, Norway, Senegal, South Africa*, Swaziland, Sweden, Tanzania*, United Kingdom, United States* and USSR*.

Activities planned

Meeting

'Magma chamber processes in anorthosite production', Moi, Rogaland, South Norway, June 1992. Associated field trips to anorthositic and other intrusions of the region. (Egersund - Ogna, Bjerkreim - Sokindal, Hidra).

Lew Ashwal (Rand Africans University, South Africa) will be publishing a book on anorthosite in 1992.

No. 291 - METAMORPHIC FLUIDS AND MINERAL DEPOSITS (1989-1993)

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W. Prochaska, Institut für Geowissenschaften, Montanunivesität Leoben, A-8700 Leoben, Austria.

Description: The aim of the project is to promote investigations of the role of metamorphic fluids in connection with the formation of mineral deposits. Investigations on the following subjects are in progress:

water-rock interactions in active hydrothermal systems;

regional fluid flow during metamorphism;

the role of metamorphic fluids in the formation of vein gold deposits;

fluid inclusion studies in vein mineralizations.

Close contacts were established between different working groups concerning the field of isotope analyses of fluid inclusions in vein type ore deposits.

Achievements in 1991

The annual meeting 1991 was held in Zurich, 21-23 March at the Institut für Kristallographie und Petrographie, organized by Professor V. Köppel. About 50 participants from Austria, Canada, CSFR, Germany, Greece, Italy, Norway, Spain, Sweden, Switzerland, United Kingdom, USSR and Yugoslavia reported about their works on the origin of metamorphic fluids in connection with mineral deposits.

A special issue of *Mineralogy and Petrology* dedicated to the topic of the project will be released next year (first volume 1992).

Co-operation with IGCP Project 255 'Kibaran Metallogeny' existed in the course of a joint project in Central Africa 'Talc Deposits of Rwanda'. Scientists of the Geological Survey of Rwanda were involved in this project.

Activities planned

The annual meeting 1992 will be held in Southampton, Great Britain, jointly with the Mineral Deposits Studies Group of the Geological Society of Great Britain, 27-28 May. It is anticipated that a number of overseas speakers will be attracted. The meeting will cover a range of topics including:

Fluid transport of metals.

The interactions of host rocks with metamorphic fluids.

P-T-X conditions at the time of mineralization.

The role of metamorphic processes in ore genesis.

Mineral deposits in high grade terrains.

Invited speakers will present keynote talks on some of the above-mentioned topics. The question of the extent to which ores in metamorphic hosts are derived from fluids released from metamorphic rocks undergoing devolatilization reactions will be discussed.

An abstract volume is planned to be published in 'Terra Abstracts'.

The final meeting in St Petersburg 1993 will be dominated by short courses on important aspects of the project. For this purpose the organizers of the project plan to get international experts to hold these courses. The preliminary topics of these courses will be as follows:

Fluid flow in continental crust.

Fluid inclusion studies in metamorphogenic rocks.

Chemistry of metamorphogenic fluids (stable isotope chemistry, etc.).

Epi- and mesothermal gold deposits (related to metamorphogenic events).

No. 293 - GEOCHEMICAL EVENT MARKERS IN THE PHANEROZOIC (1990-1993)

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Xu Dao-Yi, Institute of Geology, State Seismological Bureau, Beijing, 10029, People's Republic of China.

Description: This project is a successor project to IGCP Project 199 'Rare Events in Geology', but it is much more focused towards the geochemical aspects of rare events. Extraordinary and often catastrophic events have occurred a number of times in the Earth's history leaving geochemical event markers such as trace element anomalies especially of the Platinum Group Elements (PGE) - Ir, Os, Pt, Ru - and isotopic anomalies of ^{13}C, $^{18}0$, ^{34}S and ^{87}Sr. Such event markers may be geologically of extremely short duration and thus provide a precise framework for global correlation. These events seem to be related to the global destruction of biomass. The reducing environments associated with and consequent upon such events could further lead to unusual concentrations of elements and even to the formation of valuable mineral deposits. The events coincide with major geological boundaries and some of them are considered to have extraterrestrial causes as evidenced by shocked minerals, microspherules and unusual amino acids.

The principal objectives of the project are:

(1) to document and analyse geochemical aspects of synchronous global events in the Phanerozoic;

(2) to establish a stratigraphic framework based upon geochemical signatures for the whole Phanerozoic;

(3) to facilitate international and interdisciplinary (geochemistry, palaeontology, geochronology, magnetostratigraphy and sedimentology) co-operation in the study of boundary events.

Achievements in 1991

Meetings

(1) International Congress on the Permian System of the World; Perm, USSR, 5 August-10 August 1991, organized by Dr B.I. Chuvashov and Dr A.E.M. Nairn. Three sections (I-1, I-2 and I-3) dealt with the lower and upper boundaries of the Permian system. In addition two formal meetings of the International working groups on the Carboniferous-Permian and Permian-Triassic boundaries were convened during the congress. The emphasis was on biostratigraphy with only minor attention to geochemical and sedimentological aspects.

(2) Event Markers in Earth History, a joint meeting of IGCP Projects 216 (Global Bio-Events), 293 (Geochemical Event Markers) and 303 (Precambrian-Cambrian Event Stratigraphy), Calgary, Alberta, Canada from 28 to 30 August 1991, organized by Dr H.H.J. Geldsetzer. This conference was the main event of IGCP Project 293 in 1991. The meeting was attended by 80 scientists from 20 countries. During the three days of technical sessions 44 lectures and 13 posters were presented.

Two successful field trips were staged prior to and after the meeting. The pre-meeting field trip (2 days) focused on the Cretaceous-Tertiary boundary in a continental setting. During the post-meeting field trip (4 or 5 days) four boundaries were visited: the Precambrian-Cambrian, Frasnian-Famennian, Devonian-Carboniferous and the Cretaceous-Tertiary boundaries.

(3) Geological Society of America, annual meeting, San Diego, California from 21 to 24 October 1991, organized by R.G. Gastil and M.W. Hart. Boundary problems were discussed in 12 sessions with two sections devoted solely to the Cretaceous-Tertiary extinction event. This demonstrates the general acceptance of catastrophic past global changes by the geological community.

Main scientific achievements

Two independent investigations of Platinum Group Elements (PGE) by a Canadian group in Ottawa (Evans, Goodfellow and Gregoire) and by a Chinese group in Beijing (Wang and Chai) have shown that the Rutheniu/Iridium (Ru/Ir) ratios are quite distinct for chondritic and terrestrial samples. This new geochemical method has indicated an extraterrestrial origin for boundary clays at the Cretaceous/Tertiary boundary and preliminary data by the Ottawa group suggest the same for samples from the Frasnian/Farmennian section in the Montagne Noire area of southern France.

New isotope curves for carbon, sulfur and strontium have been established for a number of Phanerozoic sections. Especially active with respect to carbon isotope research are two Chinese groups in Beijing (Xu, Yang and Ye; Chen Chu, Shao and Zoug), an English group at Liverpool (Brenchley, Carden, Marshall and Robertson) and an international group (Baud, Holser and Magaritz). Important data in strontium isotope research have been provided by two American groups (Nelson, MacLeod, Ward; Martin and Macdougall).

A comparison of carbonisotopes from well preserved shelly material and marine cements has shown that they provide much more consistent results (very narrow range) than carbon isotope determinations from whole-rock samples.

Positive strontium isotope excursions are a relatively new discovery; they have been interpreted to indicate increased weathering rates at or prior to major boundaries such as the Cretaceous-Tertiary and the Permian-Triassic. No agreement has been reached whether this abnormal weathering rate is a product of acid rain triggered by a bolide impact, or simply the result of widespread continental exposure.

Another new and unexpected phenomenon is the occurrence of 'fossil' amino-acids at the Cretaceous-Tertiary boundary. The composition suggests chondritic affinities, while the general solubility of amino-acids in water precludes the preservation of such organic compounds for 66 m.y.

There is an increasing realization that the global ecosystems prior to global catastrophes were already strained (widespread anoxic conditions; emergence of continents and associated evaporitic conditions and narrow continental shelves; widespread cooling associated with glaciation). As a result of such adverse conditions normal biological activity was restricted to relatively narrow shallow-marine zones and had adjusted to a delicately balanced ecosystem which could easily be upset by major bolide impact(s) or by an abrupt pulse widespread volcanic activity.

Several non-geochemical parameters have been investigated which have great potential for interregional correlation:

Middle Ordovician ash falls have been documented in Europe and eastern North America and can be related to distinct graptolite and conodont zones. Zircon geochronology should provide rather definite absolute dates.

Microtectites have been observed along the Devonian-Carboniferous boundary and at the base of the Late Devonian *crepida* Zone.

The discovery of a 180 km wide crater in the Yucatan Peninsula of Mexico and megabreccias in Haiti contributed significant evidence for an impact hypothesis at the Cretaceous-Tertiary boundary.

Important publications

- Sharpton, V.L. and Ward, P.D. (editors), 1990: Global Catastrophes in Earth History; An Interdisciplinary Conference on Impacts, Volcanism and Mass Mortality; Geological Society of America, Special paper 247. A collection of 58 papers presented at Snowbird, Utah, United States, from 20 to 23 October 1988.

- Brasier, M. (editor), 1991: Innovations and Revolutions in the Biosphere; Historical Biology, v. 5, pp. 83-368. A collection of 22 papers presented at the 4th International Conference on Global Bio-Events (IGCP Project 216) at Oxford, England, in September 1990.

Thirty-seven countries participated in the project: Argentina, Australia, Austria, Belgium, Bulgaria, Canada, People's Republic of China, Cuba, Czechoslovakia, Denmark, Ethiopia, France, Germany, India, Iraq, Ireland, Israel, Italy, Japan, Korea (South), Mexico, Mongolia, Netherlands, New Zealand, Pakistan, Poland, Romania, South Africa, Spain, Sweden, Switzerland, Syrian Arab Republic, United Kingdom, United States, USSR, Yugoslavia and Viet Nam.

Activities planned

Scientific goals

The new and remarkably sensitive Ru/Ir ratio will be applied to additional K-T boundaries and to other boundaries such as the P-T or F-F in order to check boundary sediments for chondritic affinities.

The $^{87}Sr/^{66}Sr$ ratio is another promising tool which should be further tested at other boundaries in combination with PGE and siderophile elements. If the increased weathering rate was caused by impact-related acid rain, the $^{87}Sr/^{66}Sr$ peak may be preceded by an anomaly of PGE and/or siderophile elements.

More data are needed to verify the existence of 'fossil' amino-acids with chondritic affinities along the K-T and other boundaries.

A very important goal will be to increase the level of communication especially with those non-western countries that now enjoy a higher degree of mobility.

The establishment of a stratigraphic framework based upon geochemical signatures for the whole Phanerozoic. The foundation for such a framework is a 'Catalogue of Marine Isotopic Events in the Phanerozoic' presently being prepared by W.T. Holser, M. Margaritz and R.L. Ripperdan.

Meetings foreseen

Fifth and Final International Conference on Global Bio-Events (IGCP Project 216) 'Phanerozoic Bio-Events and Event Stratigraphy', Göttingen, Germany from 16 to 19 February 1992, organized by Dr O.H. Walliser. This conference has, like previous meetings of IGCP Project 216, attracted members of several related IGCP projects including IGCP Project 293.

Field Seminar, Devonian to Carboniferous, Montagne Noire Area, Southern France (IGCP Project 293 'Geochemical Marker Events in the Phanerozoic'), Montpellier, Mont Peyroux and Cabrière, France from 23 to 24 February 1992, organized by Dr R. Feist and Dr H.H.J. Geldsetzer. The purpose of this field seminar was to examine and sample the Devonian-Carboniferous and Frasnian-Famennian boundaries which are or have been proposed as stratotype sections based on biostratigraphic data. The aim is to determine the geochemistry, microfacies and diagenesis.

29th International Geological Congress (IGC), Kyoto, Japan from 24 August to 3 September 1992, Symposium I-3-57 'Geochemical Marker Events in the Phanerozoic' (IGCP Project 293), convened by H.H.J. Geldsetzer, K.J. Hsu and Sun Shu. This is the official meeting of IGCP Project 293 in 1992.

Guilin Field Seminar on the Frasnian-Famennian and Devonian-Carboniferous Boundary Events (IGCP Project 293); Guilin, China from 6 to 7 September or 17 to 18 September 1992, organized by Professor Hou Hong-Fei and Professor. Yan Zheng.

This meeting represents the field component of the annual meeting of IGCP Project 293 in 1992.

The last meeting of IGCP Project 293 has been scheduled for late September/early October 1993 at Kielce (Holy Cross Mountains) in eastern Poland. The meeting will be organized by Dr M. Narkiewicz (Chairman of the Polish National IGCP Committee) and Dr B. Studencka (Chairperson of the Palaeontology Section).

Publications planned

Proceedings of joint meeting of IGCP Projects 216, 293 and 303 'Event Markers in Earth History', held in August 1991 at Calgary, Canada, to be published in a special issue of the journal 'Palaeogeography, Palaeoclimatology, Palaeo-ecology'. The editors will be H.H.J. Geldsetzer and G.S. Nowlan.

No. 294 - VERY LOW GRADE METAMORPHISM (1989-1993)

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D. Robinson, Department of Geology, University of Bristol, Wills Memorial Building, Queen's Road, Bristol BS8 1RJ, United Kingdom.

Description: The aim of the project is to define more closely the conditions of very low-grade metamorphism, to advance studies by which the P-T and fluid activity of very low-grade metamorphic processes are determined, and to define, in co-operation with the IUGS Subcommission on Systematics of Metamorphic Rocks, a consistent terminology. Further aims of the project are to establish reliable means of comparison between various methods and techniques, and to compare different regions and different geodynamic settings.

Achievements in 1991

Meetings

During 1991 IGCP Project 294 organized or was represented at four international meetings and three business meetings. In addition, it organized a short course and workshop.

(1) A special session was convened by M. Frey (University of Basel) at the 6th Meeting of the European Union of Geosciences (EUG), Strasbourg, France, 24-28 March 1991. Some 26 papers were presented on the theme 'Very low-grade metamorphism'. Approximately 100 persons from more than ten different countries participated. This was followed by a three-day field meeting to examine aspects of low-grade metamorphism of the Helvetic Nappes of Switzerland, led by M. Frey. Some 16 persons from six countries participated.

(2) A special meeting was organized at the 6th Chilean Geological Congress, held in Viña del Mar, Chile, on 6 August 1991. Plans were made with geologists from Argentina, regarding the 1993 project meeting in Santiago.

(3) The major scientific meeting of the year 'Low-grade metamorphism in contrasting geodynamic settings' was held in Auckland, New Zealand, 13-15 November 1991, linked with the 13th Geothermal Workshop of the University of Auckland. The principal convenors were P. Browne and S.F. Simmons (both of the University of Auckland), and some 48 oral and poster presentations were made, with 61 persons from 16 different countries being present.

The meeting was preceded by a field excursion which examined fluid/rock interaction into the geothermal fields of North Island, New Zealand, 8-12 November, led by S.F. Simmons. This was attended by 25 scientists from 12 countries, while a post-meeting field excursion to the classic low-grade metamorphic successions led by D.S. Coombs and S.C. Cox (both University of Otago) was supported by 30 persons from 12 different countries.

(4) A one-day technical session was organized by P. Schiffman (University of California at Davis) and M.B. Underwood (University of Missouri) at the American Geophysical Union meeting in San Francisco, 9 December 1991. Some 21 papers were delivered relating to the theme of IGCP Project 294.

(5) IGCP Project 294 expanded on to the African continent, with a short course and workshop on low-grade metamorphism, organized and delivered by M. Frey (University of Basel).

In addition to these meetings, business meetings were held in China, Chile and Argentina.

Main scientific achievements

Considerable scientific advances have been achieved for IGCP Project 294, arising principally from papers presented at project meetings. One of the most significant papers presented during the year was that by Frey et al. at the project session at EUG VI, Strasbourg. This paper refined the petrogenetic grid for low-grade metabasites, on the basis of newly available thermodynamic data. The findings more closely constrain the temperatures and pressures of the various low-grade metamorphic facies. This paper, which was published during the year in the *Journal of Metamorphic Geology*, goes a long way towards realizing another of the project's declared aims.

Significant advances presented during the year also related to the character of mafic phyllosilicates in low-grade metabasites. Several papers on this theme were published in a special issue of the *Journal of Metamorphic Geology*, which highlighted the potential use of 'chlorite' as a geothermometer in low-grade metamorphic successions, and also gave an indication of its use in

the establishment of T(temperature)-t(time)-X(composition) diagrams.

Important findings relating to the relationship between illite crystallinity and crystallite size were also reported on at the EUG VI meeting, and subsequently published in *Contributions to Mineralogy and Petrology*. This work has provided a real insight into exactly what is being measured by the IC technique, in terms of the developing crystallite packages, their make-up and size.

Finally, a most stimulating paper at EUG VI described the dating of low-temperature metamorphism utilizing a Sm-Nd isotopic approach. What is apparent is that the Rare Earth Elements may, in fact, be more mobile than previously envisaged at these temperatures and pressures.

The meeting served to highlight the wide variety of tectonic settings in which low-grade metamorphism develops, papers detailing cases from fore-arc and back-arc basins, continent-continent and continent-arc collisions, the ocean basins including seamounts, foreland basins, and accretionary prisms. Compilation of data from these papers will serve to identify the varying processes responsible for the metamorphism in the various settings; for example, it was demonstrated that metamorphism in a seamount setting was similar in character to contact metamorphism, with the high thermal gradient related to the presence of a sub-seamount magma body. This metamorphic pattern contrasts with that usually found in the vicinity of oceanic spreading centres. High thermal gradients were also reported from certain parts of the Andes, in Central Chile, contrasting with the regional burial metamorphic pattern. In this case the thermal perturbation was due to hydrothermal systems developing in nested calderas, and was related to the underlying magma bodies. The thermal evolution in a propagating thrust sequence was established for the Scandinavian Caledonides, permitting development of P-T-t loops of the various nappes, and explaining the presence of inverted metamorphic gradients. A further contribution highlighted the model of extension-related metamorphism, distinguishing between pre- and post-orogenic (continental thickening) settings.

Other papers presented at meetings during the year have served to advance a regional understanding of low-grade metamorphism, and have prompted several collaborative studies between laboratories in various countries.

Important publications

- Twenty-six abstracts from the EUG VI Strasbourg meeting were published in *Terra Abstracts* for 1991, Vol. 3, No. 1, pp. 99-106.

- Thematic issues of *Clay Minerals* (Vol. 26, No. 2, 1991) and *Journal of Metamorphic Geology* (Vol. 9, No. 6, 1991) contained 17 papers arising from the 1990 project meeting entitled 'Phyllosilicates as indicators of very low-grade metamorphism and diagenesis'. In particular, the recommendations of the Illite Crystallinity Working Group were published in the special issue of the *Journal of Metamorphic Geology*.

- Two field guides arising from the New Zealand meeting have been published by the Geological Society of New Zealand (Miscellaneous Publications Nos. 57 and 58).

Forty-one countries participated in the project (* indicates the countries active this year): Argentina*, Australia*, Austria*, Belgium*, Brazil*, Canada*, Chile*, China*, Costa Rica, Czechoslovakia*, El Salvador, France*, Germany*, Greece, Hungary*, Iceland*, India*, Indonesia, Ireland, Israel*, Italy*, Japan*, Kenya*, Liberia, Mexico*, New Zealand*, Nicaragua*, Norway*, Philippines*, Poland*, Portugal, South Africa*, South Korea*, Spain*, Sweden*, Switzerland*, United Kingdom*, United States*, USSR*, Yugoslavia and Zimbabwe*.

Activities planned

Scientific goals

(1) To promote adoption of the recommendations of the Illite Crystallinity Working Group, published in the *Journal of Metamorphic Geology*, the IC Working Group is continuing under the auspices of IGCP Project 294, investigating in particular aspects of sample preparation on derived results.

(2) To address the key areas for research identified by the two project working groups, particularly in the areas of the nature of mafic phyllosilicates in low-grade metabasites, the mineralogical basis of the IC technique, the various geodynamic settings of low-grade metamorphism, and the processes responsible for metabasite genesis.

(3) To further promote the project's activities via scientific meetings, publication of papers (in particular those arising from the New Zealand meeting), reports, newsletters and abstracts, and continued support of collaborative research programmes, in particular involving scientists from developing countries.

Meetings planned

In addition to proposed business meetings in Chile, China, Argentina, Spain, Germany, United Kingdom and United States, specific meetings planned are:

(1) 24 August-3 September 1992. International Geological Congress, Kyoto, Japan. Session 1 - 3.21 'Diagenesis and very low-grade metamorphism', along with related field excursions to visit classic areas in Japan for low-grade metamorphism.

(2) 9-15 September 1992. Davis, California, United States. Thematic project meeting 'The transition from basalt to metabasalt: environments, processes and petrogenesis', and related field meetings in the Franciscan Complex of the San Francisco Bay area, and in the arc/ophiolite terrains of the northern Sierra Nevada, California.

(3) 18-21 September 1992. Field meeting to the low-grade metamorphic successions of the Upper Precambrian Keweenawan Plateau Lavas, Minnesota, United States.

Publications planned

(1) Papers presented at the New Zealand meeting as a thematic set in the *Journal of Metamorphic Geology*.

(2) Papers arising from the 1992 Davis meeting in a special volume.

No. 296 - QUATERNARY IN THE ASIA/ PACIFIC REGION (1989-1993)

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V. Šibrava, Geological Survey Prague, Malostrenokén 19, 11821 Prahe 1, Czechoslovakia.

Description: The two main aims of the project are to establish a network of Quaternary geoscientists interested in stratigraphic correlation and Quaternary Geology for Human Survival, and to make a firm chronostratigraphic classification of the Quaternary in the Asia/Pacific region compared with the development of stratotypes from both onshore and offshore areas, using biostratigraphic data and radio-metric dates.

Contacts with other Quaternary IGCP projects as well as with networks via INQUA, UNESCO and CCOP will be made.

Scientific achievements

In 1991 the problems of wider regional correlation encompassing South-East Asian countries and areas were approached. The evaluation of existing data added by new observations, joint field work and excursions, etc. have made it possible to correlate some marker horizons through the region. Those are, in particular, the transgression of the Holocene climatic optimum (Bangkok Clay in Thailand, Gula Formation in Malaysia) and corresponding transgressions in China, Viet Nam, Lao PDR and Indonesia. There, new data, including radiometric dating and palaeogeographic interpretations have been published from the east coast of Peninsular Thailand, palynological research of Holocene sediments in Malaysia and Thailand made possible the establishment of environmental conditions of their sedimentation and especially revealed the magnitude and extent of the Holocene transgression in eastern Thailand and western Malaysia.

Another transgression of the Upper Holocene has been described from several areas but its correlation needs further research. Both transgressions are reflected in continental (river) deposits as well. A correlation of Holocene sediments along the Coastal Plain of Sumatra and Java as well as the Central Plain of Thailand point to a rapid marine transgression in these areas and the possibility of sedimentological and lithological correlation of the sections. These correlations have been well documented in a series of stratigraphic cross sections along the length of the east coast of Thailand, parts of the west coast of Malaysia, the north coast of the two main Indonesian islands as well as by sections in the Red River and Mekong deltas of Viet Nam.

Another correlation horizon is represented by sediments corresponding to the Last Interglacial Stage (fossil soils, marine transgressions and river terraces) that may be followed throughout the region and correlated with the deep sea record. In the Middle Pleistocene (in its basal part) the main link horizon is represented by layers containing radiometrically dated tektites (about 0.7 m.y.) from the Asian-Australian tektite field. These tektites have been found in the lowermost beds of the Middle Pleistocene laterites, in lacustrine deposits in China,

in red eolian sands in Viet Nam, in Quaternary deposits in Sundaland area and may be followed in other regions.

Several Middle Pleistocene transgressions have been described in different areas, nevertheless their correlation requires further research. The number is substantially lower than the number of dynamic oscillations recorded in loess sections in China and in the deep sea cores (and even in the lacustrine deposits).

Attention has been paid to the study of eolian sediments of tropical humid zones. The analyses made point to close affinities of these sediments in Thailand, Viet Nam, Lao PDR and Malaysia but show a substantial difference with classical loess in China and Europe. They are Upper Pleistocene-Holocene in age, only in Viet Nam is their evidence of Middle Pleistocene eolian activity (documented by loessic sediments and eolian sands, the oldest of them with tektites). The extent of tropical loess deposits had not been previously reported (see Smalley, Ian, 1990, *Episodes*, Vol. 13, No. 2).

The position of hominid finds with regard to stratigraphic units was studied and put into a tentative stratigraphic scheme.

The Plio-Pleistocene boundary within the region was discussed and its correlation approached in China. The possibility of lowering this boundary below 1.9 m.y. exists as the beginning of the cold loess sedimentation close to Matuyama-Gauss palaeomagnetic boundary seems to be a global feature (sections in China, Europe and Tadjikhstan) correlatable with the onset of cold climate in the Alps and North-West Europe.

The tectonic studies in the region continued as well as correlation based on radiometric data (in particular in tectonically active areas, coral reefs, etc.).

As discussed at the 1991 meeting in Phuket, Thailand, more data are needed in particular for correlation in the Philippines, Indonesia and other tectonically active areas. In the Philippines the subsurface analysis of sediments laid down in a tectonically active area on the west coast of Luzon near Subic Bay and in the San Antonio Graen Plain in south-western Zambales has been implemented.

The Pantai tin mine in western Malaysia near Taiping has been studied in detail and peat layers radiometrically dated while fluvial sand layers were dated using TL (thermaluminescence). This approach has proven to be very effective in providing essential age data for the study of Quaternary sediments in areas of active and former tin quarries. The correlation of tin deposits with former sea levels has been shown to be useful in Malaysia and Thailand. New data on the terraces of the Mekong river have been brought as well as new data on Quaternary stratigraphy in the Republic of Korea. An exceptionally well studied marine section has been termed a Quaternary stratotype in the Huanghai sea (Core QC_2) in China.

In 1991 the map of Quaternary mineral deposits in Thailand was published (scale 1:2,500,000) in colour. The compilation of Quaternary mineral maps for other countries is well under way and will be completed by May of 1992.

The research results of this project have generated data for the possible correlation of Asian Quaternary with other tropical areas as well as with temperate zones. This concerns in particular the comparison of climatic cycles, relation of pluvial-interpluvial stages to glacial and interglacial stages (the research points to the correlation of glacials to interpluvials and interglacials to pluvials) as well as the correlation of lake transgressions. The studies will continue.

Lake deposits in north-eastern Thailand seem to have overflowed at about the same time that African lakes reached their highest levels. Consequently, the study of Quaternary lakes may provide a basis for the correlation of the Asian Quaternary with that of Africa. More research is required and is planned to be undertaken in late 1991 on Lake Kumpawapi, one of the largest of the Thai lakes.

Meetings

- Joint field excursion to study the Late Quaternary Correlation of North-West Peninsular Malaysia and Southern Thailand (14-19 October 1991), 21 participants, nine countries.

- Third Ad Hoc Expert Working Group Meeting on the Quaternary Stratigraphic Correlation of the Asia and Pacific Region (20-21 October 1991), Phuket, Thailand. Twenty-one participants, nine countries.

Important publications

- ESCAP Atlas of Stratigraphy X, IGCP Project 296 (1989), 149 pp, two Atlas Sheets.

- ESCAP Atlas of Stratigraphy XI, IGCP Project 296 (1990), 55 pp., three Atlas Sheets. Quaternary Mineral Map of Thailand (scale 1:2,500,000) (in colour).

- Programme and Field Guide, Late Quaternary Correlation of North-West Peninsular Malaysia and Southern Thailand, 80 pp., Geological Survey of Malaysia Contribution to IGCP Project 296, 14-19 October 1991.

- Quaternary Geology of West Coast of Southern Thailand by Niran Chaimanee, Sin Sinsakul, and Suwat Tiyapairach, Department of Mineral Resources (Thailand), October 1991, 30 pp.

- Several publications in the Geological Society of Malaysia Bulletin (as contributions to IGCP Project 296).

Nineteen countries were involved in the project (* indicates the countries active this year): Australia*, Canada, People's Republic of China*, Czechoslovakia*, Egypt, Hong Kong*, India, Indonesia*, Japan, Korea*, Lao PDR, Malaysia*, Netherlands, Pakistan, Republic of Philippines*, Sri Lanka, Thailand*, United States* and Viet Nam*.

Activities planned

General goals

- The continuation of the study of the Holocene and the Last Interglacial Transgression and the construction of palaeogeographic maps, in particular of the maximum level of the Holocene transgression showing surrounding terrestrial environments and bathymetry.

- The refining and completion of a tentative stratigraphic scheme for the region to be completed in 1993.

- Study of tectonic classification of the area and intensification of sampling and radiometric data, as well as additional palaeomagnetic data, palynological work and TL dating, especially in tectonically active areas.

- Studies on loess stratigraphy will continue in particular in South-East Asia, with special attention to the study of loessic sediments of tropical zones. Lake deposits will be studied in the north-east and northern part of Thailand to enable intra and interregional correlation.

- Allan R. Lloyd and Associates, an Australian consulting firm, has agreed to contribute an overview paper on the correlation of the marine Quaternary in 1992.

- The study of the correlation of Quaternary mineral deposits is foreseen and the compilation of Quaternary mineral maps will continue.

- Quaternary stratigraphic cross-sections will be compiled using the ESCAP legend and these cross-sections will emphasize the Holocene in 1992.

- A bibliography on Quaternary of the region is being compiled by each participating country in the region and a Roster of Quaternary experts is being compiled for the Asia and Pacific region, to be completed by 1992.

- The ESCAP Atlas of Stratigraphy XII will be published in 1992 and will present all of the papers submitted to the October 1991 meeting in Phuket.

- The significant progress made in the correlation of Quaternary in the region will be compiled and submitted as a summary paper at the end of the project in 1993.

- The Quaternary Newsletter will be expanded and published on a regular basis, no less than twice a year.

Publications

- A major review publication is scheduled for late 1993.

- Three more ESCAP Atlases of Stratigraphy will be published as follows: late 1991, mid-1992 and mid-1993.

- Quaternary mineral maps will be published for all participating developing countries.

- Holocene Paleogeographic map (scale 1:5,000,000) ESCAP.

No. 297 - GEOCRYOLOGY OF THE AMERICAS (1989-1993)

A.E. Corte, CRICYT, Salta 470, Casilla Correo 330, 5500 Mendoza, Argentina.

Description: The main objectives of the project are:

(1) to identify present and past cryogenic processes and to correlate them across the Americas and with other regions of the world;

(2) to draw up palaeoenvironmental reconstructions of former cold episodes since late Neogene times;

(3) to study geochemical processes in cold environments, distinguishing them from those going on in warm deserts;

(4) to stimulate training in the field of geocryology;

(5) to identify areas of future application and nature conservation.

Achievements in 1991

Past cryogenic activity in Argentina up to Lat. 32 is evidenced by fossil rock glaciers (33° L), cryoturbated regolith (37° L) and fossil ice-wedges (34° L).

General scientific achievements

(1) A preliminary correlation of glacigenic and cryogenic processes since the Upper Tertiary was made between the Central Andes and Patagonia (main Patagonic glaciations).

(2) Calcium carbonate and gypsum crystals are observed to be formed under present cryogenic conditions. The habit of such crystals is being studied.

(3) After 32 years of freezing and thawing in a Rocky Mountain experimental site, no sorting is observed. This site needs further analysis and will be visited during the project field excursion.

(4) Calcium carbonate is the main component of the ice-wedge casts in Mendoza and northern Patagonia, indicating cold dry environmental conditions during and after the wedge formation.

(5) Morphological evidence of a very large pingo in northern Patagonia was found. More field data is needed. If this is correct, it will be the largest pingo (hydrolacolith) on earth.

Important publications

(1) Grosso, S.A. & Corte, A.E., 1989, 'Pleistocene ice-wedge cast at 34 SL Eastern Andes piedmont, SW South America', *Geog. Ann.*, Vol. 71 A., No. 34, pp. 125-136.

(2) Corte, A.E., 1991, 'Chronostratigraphic correlation of glacigenic and cryogenic episodes in the Central Andes and Patagonia', *Permafrost and Periglacial Processes*, V No. 2, pp. 67-70.

(3) Grosso, A.S. & Corte, A.E., 1991, 'Cryoplanation surfaces in Central Andes at Lat. 35°', *Permafrost and Periglacial Processes*, Vol. 2, No. 1, pp. 41-58.

(4) A whole issue of the Journal *Permafrost and Periglacial Processes* is dedicated to this IGCP Project 297 meeting in South Africa.

(5) Corte, A.E. & Xia Zichu, 1991, 'Pleistocene glaciations in Precordillera and Cordillera Frontal del Plata, Mendoza, Argentina, Lat. 33°, XIII INQUA Congress in China (Abstract).

(6) Corte, A.E., 1991, 'Heavy minerals concentrations in cryogenic regions'. Symposium on Alluvial Gold Placers, p. 31.

Eight countries actively participated in the project: Canada, China, France, Germany, Russia, South Africa, United Kingdom and United States.

Activities planned

(1) To observe ice-wedge casts and sections in the Nebraska and Wyoming plains.

(2) To study the Green Lakes experimental site in the Boulder Watershed.

(3) To study rock glaciers in the vicinity of this site.

(4) To look for cryogenic episodes in the Canadian and American sections which can be compared to events in southern South America episodes.

Meetings

IGCP Project 297 will hold two meetings in 1992:

(1) At the University of Calgary (26-31 July) and a field trip in the Canadian Rockies to observe active and inactive rock glaciers. This meeting will be guided by Stuart Harris.

(2) At the University of Lincoln, Nebraska (1-7 August), will have two field excursions: one to the plains to see ice-wedge casts and another to the Rockies to observe lack of sorting and rock glaciers in the vicinity of the experimental site.

Publications

(1) Mountain permafrost and snow cover in the Andes (with T. Kademtsova).

(2) Rock glaciers systematics (with A. Gorbunov and N. Romanovskij).

(3) Calcium carbonate deposition in cryogenic regions - Present and past processes (with T. Vogt).

(4) Corte et al., A large pingo in northern Patagonia.

(5) Precordillera rock glaciers (in co-operation with S. Grosso, E. Buk and C. Vallero).

No. 299 - GEOLOGY, CLIMATE, HYDROLOGY AND KARST FORMATION (1990-1994)

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H. Hotzl, Department of Applied Geology, University of Karlsruhe, Karlsruhe, Federal Republic of Germany.

John W. Hess, Water Resources Centre, Desert Research Institute, 755 East Flamings Road, P.O. Box 1904, Las Vegas, Nevada 89132 0040, United States.

Description: The objectives of the project are: (1) to identify the global differences in surface and subsurface karst forms, and to clarify the regularities of their distribution; (2) to study the relationships between karstification processes and the geological climatical and hydrological conditions; (3) to identify geological evidence (palaeokarst features, fossils, isotope prints, etc.) preserved in the geological record in different karst regions thus contributing to palaeogeographic (in particular, palaeoclimatic) reconstruction; (4) to apply the results to prediction evaluation and exploitation of mineral resources and to environment protection in various karst areas.

Achievements in 1991

In July 1991 an important meeting with a scientific programme 'International symposium and field seminar on karst in the inner-plate region with monsoon climate' took place in Guilin, China. Seventy-one hydrogeologists, geographers, geomorphologists, pedologists, climatologists and physicists from nine countries participated in the symposium and had discussions on many topics, such as regional karst features, karst correlation, palaeoenvironment, soil and vegetation in karst areas, karst geochemistry, hydrogeological and environmental problems in karst regions.

Main scientific achievements

The major scientific achievements of the project in 1991 are characterized by the field correlation in mainland China for the karst in the inner-plate region with monsoon climate. The correlation trip from South China to North China totalling 6,700 km passed through the most outstanding types of karst in China, i.e. humid subtropical karst, high mountain karst and semi-arid karst. Six typical karst sites were included in the correlation, namely, the Guilin humid subtropical karst with deforestation; the Maolan virgin forest subtropical karst; the Huanglong Ravine high mountain karst; the Zhengan karst at the southern slope of Qinglin Mount and the northern border of China's subtropical karst; the Tumen and Jinan semi-arid karst in Shandong; and Beijing semi-arid karst. Detailed data of each point are available in the Guidebook of the excursion, which has been prepared under the auspices of IGCP Project 299. The results of the correlation are summarized as follows:

(1) *International Correlation*: From a global view, the background for karst development in mainland China is characterized by: hard and compact carbonate rocks before Triassic, inner-plate conditions, strong Cenozoic uplift induced by the Himalayan orogeny. The monsoon climate devoid from scouring of the great continental ice sheet of the last glaciation and the effect of allogenic water in many karst regions.

(2) *Correlation between different types of karst in China*: Three major karst types in China are identified. The humid subtropical karst in South China is a combination of tower karst, deep dolinas, red soil, deep sharp karren, surface tufa, big cave system, underground stream, with many corrosional features, and gigantic speleothem. The semi-arid karst in North China is composed of normal shaped mountains, dry valleys limestone scree with loess cover, tiny karren, small cave system with little speleothem, and big karst springs. The high mountain karst in western China, the karst feature complex is characterized by frost denudation limestone pinnacles, limestone scree, small caves with very few speleothems, and small karst springs.

(3) *Correlation on karst hydrology and environment*: The allogenic water is important in karst development because of its higher chemical aggressivity as well as its stronger mechanical erosional effect.

(4) *Suggestions to improve karst land management*: During the field seminar, many helpful suggestions to improve hydrological and environmental study and land management in karst areas were given by the participants on the basis of experiences from their own countries, such as to recover vegetation on limestone quarry in the Chichibu region, Japan; lessons from improper land reclamation in Nansei Island, Okinawa, Japan; careful use of imported plant species for recovering vegetation on limestone; suggestion to transform farmland on a natural slope in south-east Guizhou province into a terraced one, so as to mitigate soil erosion in karst area; measures from geochemical considerations to protect tufa as a scenic attraction.

(5) *Reconstruct palaeoenvironment with karst records*: Abundant karst records in China are very informative to palaeoenvironment. In South China, a sort of widely scattered Cretaceous limestone breccia which contains Atopochara flora in its laminated cement indicates a dry period product but later inundated.

Important publications

(1) IGCP Project 299 Newsletter 1991, 138 pp., ed. Lin Xinhong, supervised by Yuan Daoxian, the Institute of Karst Geology, Guilin, China.

(2) IGCP Project 299: Geology, Climate, Hydrology and Karst Formation, Yuan Daoxian, William Back, *Episodes* - International Geoscience Newsmagazine, Vol. 14, No. 1, March 1991, pp. 80-81.

(3) Karst of China, 1991, Yuan Daoxian et al., 224 pp., with 48 colour photos, nine chapters, 200 references, hard cover, published by Geological Publishing House, Beijing, China.

(4) Abstract of papers, international symposium and field seminar on karst in the inner-plate region with monsoon climate, July 1991, Guilin, China, 54 pp., eds. Lin Xinhong, Yuan Daoxian, the Institute of Karst Geology, Guilin, China.

(5) Guidebook for field excursions, international symposium and field seminar on karst in the inner-plate region with monsoon climate, July 1991, Guilin-Beijing, 72 pp., ed. Liu Zaihua, supervised by Yuan Daoxian, the Institute of Karst Geology, Guilin, China.

Scientists from 35 countries participated in the project activities: Australia, Austria, Bulgaria, Canada, China, Cuba, Czechoslovakia, Ecuador, France, Germany, Greece, Hungary, Indonesia, Iran, Ireland, Italy, Japan, Malta, Mexico, Netherlands, New Zealand, Norway, Poland, Qatar, Romania, South Africa, Spain, Switzerland, Tanzania, Thailand, Turkey, United Kingdom, United States, USSR and Yugoslavia.

Activities planned

Meetings and field trips

(1) Karst in Virginia, West Virginia and Kentucky, 15-22 August 1992. Field excursion begins and ends in Washington, D.C. and in conjunction with IGU field trip.

(2) Field symposium in Australia on humid temperate impounded karst, subhumid temperate syngenetic karst and arid temperate karst, 4-18 December 1992. Symposium in Melbourne, Australia, and field trip to Buchan, Naracoorte and Nullarbor plain.

Publications

Karst Commission of IAH: Hydrogeology of Selected Karst Region of the World will be published by Heise as 13th volume of the series 'International Contribution to Hydrogeology'.

The Institute of Karst Geology: IGCP Project 299 Newsletter 1992.

The Institute of Karst Geology: Proceedings of the International Symposium on Karst in the Inner-Plate Region with Monsoon Climate, Guilin, China, July 1991.

No. 301 - CORRELATION OF PALAEOGENE FORMATIONS OF SOUTH AMERICA (1991-1995)

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S. Benítez, CEPE, km 6.5 vía a la costas, Casilla 10829, Guayaquil, Ecuador.

Description: The aim of the project is to promote detailed investigations and correlation of Palaeogene formations especially on the western side of South America in order to produce palaeogeographic maps; biostratigraphic zonation schemes for temperate and tropical latitudes based on microfossils; and high resolution record of palaeoenvironments. Effects of

main global events in the Andean area will also be studied.

The correct correlation of Palaeogene formations is expected to help characterization of coal deposits, evaluation of sources and reservoirs of hydrocarbons in critical areas, radiolarites diatomites and phosphorites.

Achievements in 1991

Six meetings were held:

(1) At the VIIth Geological Congress of Peru, Lima, 14-19 July, attended by 16 persons from two countries.

(2) At the VIth Geological Congress of Chile, Viña del Mar, Chile, 5-9 August, attended by 15 persons from two countries, with presentation of contributions.

(3) At the VIth Geological, Mining, Petroleum and Geotechnical Engineering Congress of Ecuador, Guayaquil, Ecuador, 12-15 November, attended by 20 persons from three countries. Field trips: (a) to the Pacific coast near to Guayaquil sampling Azúcar group for stratigraphical studies, and (b) Cretaceous-tertiary boundary and Palaeocene of the Progreso Basin.

(4) At Quito, Ecuador, 18 November, attended by 15 persons from three countries.

(5) At Ingeominas, Santafé de Bogotá, Colombia, 20-28 November, micropalaeontological course, with special emphasis in Palaeogene topics of South America, attended by 15 persons.

(6) At Caracas, Venezuela, 12-14 February, attended by 15 persons.

The main objectives of the meetings at Quito, Santafé de Bogotá and Caracas were the spreading of the project among South American geoscientists and oil and coal companies, and setting up of national and thematic working groups.

A considerable number of papers were published in various journals, mainly on micropalaeontological topics.

Active participating countries are: Argentina, Chile, Colombia, Ecuador, France, Peru and Venezuela. Other involved countries are: Bolivia, Brazil, Costa Rica, New Zealand, Poland, Senegal, South Africa, United States and Uruguay.

Contacts have been made with Leaders of IGCP Projects 308 and 286. A joint meeting is planned at Punta arenas, Chile. Mutual co-operation was established with the Orstom mission at Quito.

Activities planned

A meeting in Salamanca, Spain, at the IIIrd Spanish Geological Conference and the VIIIth Latin American Geological Conference, 21-26 June 1992.

A meeting of the northern countries of South America, in Santafé de Bogotá, Colombia, at the Vth Colombian Petroleum Congress, 13-16 October 1992, a joint meeting with IGCP Projects 308 and 286, including field work and trips to main localities of marine palaeogene outcropping near to Punta Arenas (Chile) and Río turbio coal measure (Argentina), at the end of November 1992. The proceedings of this meeting will be published.

No. 302 - THE STRUCTURE AND METALLOGENESIS OF CENTRAL AFRICAN LATE PROTEROZOIC BELTS (1990-1994)

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W.M. Katekesha, Gecamines Exploitation, Likasi, BP 450, Lubumbashi, Zaire.

Description: The Late Proterozoic mobile belts of Central Africa are renowned metallogenic provinces which contain a great variety of metalliferous ore deposits. It has been established that each belt has its own characteristic pattern of mineralization. It is therefore the aim of the project to establish interrelationships between mineralization and the sedimentary, igneous, metamorphic and tectonic evolution of the belts, and to propose genetic models.

Achievements in 1991

General scientific achievements

Ghanzi Belt (Botswana)

(1) Extensive application of Remote Sensing (Landsat) was followed by detailed mapping which involved both revision of the existing maps and mapping of new areas.

(2) New stratigraphic data have been obtained. These made it possible to propose a revised stratigraphic scheme and preliminary

correlation of the western part of the Ghanzi Belt with the Nama Units in Namibia.

(3) It was found that the tectonic style in the Belt is characterized by steep, North-West dipping thrusts which makes it different from the Namibian sector.

(4) Background work aimed at the understanding of copper and gold mineralization controls has started.

(5) Ongoing research into geochemistry and petrography of metasediments is considered necessary for the planning of a detailed programme of work in the period of the next two years.

(6) The work related to better understanding of sedimentary history of deep basins in South-West Botswana has been continued.

Zambezi Belt

Work on its Zimbabwean sector, as well as a study on the correlation of the copper-mineralized Makuti Gp. between Zambia and Zimbabwe has continued.

Lufilian Arc

Field work focused on stratigraphy and tectonics of the Domes Area (Zambia) was continued. It is considered crucial for understanding of the evolution of this part of the Lufilian Arc and is expected to provide data necessary to test the ideas put forward last year.

Publications

(1) The last batch of abstracts of the Conference held in Shaba (Zaire) in 1990 has been received by the Leader for editing. All abstracts are now being prepared for publication.

(2) IGCP Project 302 Special Volume of full-size papers is in editorial preparation by the Leader (referring to the submitted papers, translation, first stage of editing).

Most important papers:

Binda, Porada - 'Observations on the Katangan breccias of Zambia'; Cailteux - 'Late Proterozoic Roan sedimentation, lithostratigraphy and metallogenesis in the Katangan: evidence from the Kambove Region'.

(3) 'Documentation/catalogue of the existing stratigraphic subdivisions and nomenclature in use on the Zambian mines' has been published by the Geological Society of Zambia.

Sixteen countries participated in the project (*indicates the countries active in 1991): Belgium*, Botswana*, Canada*, Germany*, Italy, Malawi, Portugal, Netherlands*, RSA*, Tanzania, Uganda, United Kingdom*, United States*, Zaire*, Zambia* and Zimbabwe.

Activities planned

General goals

(1) Review and consolidation of the existing data on the Lufilian Arc stratigraphy, tectonics and mineralization. This should include verification of the new hypotheses concerning the relation of the Domes Region to the Copperbelt and final proposal of uniform stratigraphic nomenclature for the Zairian and Zambian parts of the Copperbelt.

(2) Preliminary comparison of the Lufilian Arc and Damara Belt.

(3) Elucidate the regional structural relationships as well as the mineral and hydrogeological potential of the Ghanzi Belt through geophysical survey in Botswana.

Meetings

(1) Core workshop on the Ghanzi Belt in Botswana (spring 1992).

(2) Field conference in Botswana and Namibia.

It would be extremely important for both the project progress and future exploration in Zambia to have a workshop/conference there. The Zambian Co-Leader is again approaching local institutions.

Proposed publications

(1) First volume of papers as well as the Conference abstracts will be edited for publication by mid-1992.

(2) Extended abstracts of the Botswana-Namibia field conference will be published as post-conference materials.

(3) Works on preparation of maps of the selected areas of the Domes Region (Zambia) and Ghanzi Belt (Botswana) will continue.

No. 303 - LATE PRECAMBRIAN-EARLY CAMBRIAN EVENT STRATIGRAPHY (1990-1993)

M.D. Brasier, Dept. Earth Sciences, Parks Road, Oxford Ox1 3PR, United Kingdom.

Description: The aim of the project is to develop an integrated and refined biostratigraphy, chemostratigraphy, event stratigraphy and magnetostratigraphy for the Late Precambrian and Early Cambrian time. The global correlation of event markers will be explored including events in the evolution of the biosphere and the ocean-atmosphere system.

Achievements in 1991

General scientific achievements

The project is extending the awareness and use of a wider, integrated approach towards stratigraphic correlation of the Late Precambrian and Cambrian. There is now a widespread discussion of methods of collection and analysis, as seen for example at the recent joint meeting in Calgary with IGCP Projects 216 and 293.

(1) New carbon isotopic curves and palaeomagnetic data have been published for the Tommotian and Early Atdabanian of Siberia and Morocco. Data is in preparation or in press on the carbon isotope stratigraphy/ trace elements/magnetostratigraphy of the Nemakit-Daldyian, Atdabanian to Amgaian of Siberia; Cambrian of the Great Basin, United States; Late Precambrian-Early Cambrian of South-East Newfoundland; of the Lublin Slope, Poland; of Finnmark; of Senegal.

(2) New projects have been initiated on isotope stratigraphy of the Gobi-Altay Mountains, Mongolia; Mackenzie and Wernecke Mountains, Canada; Yellowhead carbonates, Canada; North-West Newfoundland, Canada; Nainital and Mussoorie synclines, India; Jiangnan Basin, China.

(3) The potential for carbon isotope and palaeomagnetic stratigraphy has been demonstrated between the Siberian Platform and Anti-Atlas, Morocco.

(4) The stable isotopic signatures in the vicinity of the South-East Newfoundland stratotype candidate for the PC-C boundary are now seen to be badly affected by burial diagenesis and plutonism.

Meetings held

- London, Burlington House, 14 February 1991. About 60 attended from 10 countries.

- Gobi-Altay, Mongolia (field meeting), 5-18 August. Ten scientists attended from four countries.

- Calgary, Alberta, Canada, 27 August-5 September. About 100 attended from 20 countries.

- Oxford (Planning meetings), November 1991. About ten attended from several countries.

Publications:

The number of publications listed by national correspondents in 1991 is 115. The following are representative:

- Brasier, M.D., 1990. Nutrients in the Early Cambrian. *Nature*, 521-2.

- Kirschvink, J.C., Magaritz, M., Ripperdan, R.G., Zhuravelv, A. Yu & Rozanov, A. Yu, 1991. The Precambrian-Cambrian Boundary: magnetostratigraphy and carbon isotopes resolved correlation problems between Siberia, Morocco and South China. ***GSA Today,*** 1, 69-91.

- Landing, E., & Murphy, J.B., 1991. Uppermost Precambrian-Lower Cambrian of mainland Nova Scotia: faunas, depositional environments, and stratigraphic revision. ***Journal of Palaeontology***, 65, 382-396.

- Luo Huilin, Jiang Zhiwen, Wu Xiche, Song Xueliang & Ouyang Lin, 1991. The global biostratigraphic correlation of the Meishucunian Stage and the Precambrian-Cambrian boundary. ***Science in China (Scientia Sinica)***, 34 (3), 377-384.

- Shergold, J.H., Rozanov, A. Yu & Palmer, A.R. (eds.), 1990. The Cambrian System on the East European Platform. Correlation chart and explanatory notes by K. Mens, J. Bergstrom and K. Lendzion. ***International Union of Geological Sciences Publication***, 25, 73 pp.

- Southgate, P.N. & Shergold, J.H., 1991. Application of sequence stratigraphic concepts to synthesis of Middle Cambrian phosphogenesis, Georgina Basin, Australia. ***BMR Journal of Australian Geology and Geophysics***, 12 (2), 119-145.

- Vidal, G. & Nystuen, J.P., 1990. Lower Cambrian acritarchs and the Proterozoic-Cambrian boundary in southern Norway. ***Norsk Geol. Tidskrift***, 70, 191-222.

Twenty-one countries were involved in the project (*indicates the countries active this year): Australia*, Canada*, People's Republic of China*, Denmark*, Ethiopia*, France*, Germany, India*, Iran*, Israel*, Italy*, Mongolia*, Morocco, Pakistan, Poland, Spain*, Sweden*, Turkey, United Kingdom*, United States* and USSR*.

Activities planned

General goals

The aim next year is to focus on the correlation of Asiatic successions in South China and India. To obtain a more complete $\delta^{13}C$ and $\delta^{18}O$ profile from the Sinian and Early Cambrian of South China. To test the role of evaporitic and anoxic water masses in perturbing the signal. To discuss the controversial palaeomagnetic correlations proposed by the Cal. Tech-Weissman Inst. Group. To put forward possible PC-C boundary reference sections for chemo- and magnetostratigraphy.

Meetings

- Participation with IGCP Project 216 - Phanerozoic Bio-Events and Event Stratigraphy, Gottingen, 16-19 February 1992.

- Participation and meeting to coincide with the 29th IGC Kyoto, Japan, August-September 1992.

- Joint Field Meeting with IGCP Project 320, Yangtze Platform, South China, September 1992.

- Field Meeting in Lesser Himalaya, India, December 1992.

Proposed publications

Historical Biology, special issue with 22 papers on 'Innovations and Revolutions in the Biosphere'. Introduction by Brasier. Journal Geol. Soc., London, thematic set on PC-C with 12 papers. Introduction by Brasier.

No. 304 - LOWER CRUSTAL PROCESSES (1990-1994)

B.J. Hensen, Department of Applied Geology, University of New South Wales, Kensington 2033, Australia.

L. Ya. Aranovich, Institute of Experimental Mineralogy, USSR Academy of Sciences, 142432 Chernogolovka, Moscow District, USSR.

Description: The project aims to improve our understanding of the tectonic and thermal evolution of the lower continental crust through integrated studies of amphibolite granulite facies metamorphic terrains. This objective is to be realized by combining a number of individual approaches including:

(1) Comparison of high-grade metamorphic terrains of different inferred origins and different ages.

(2) Testing of theoretical, geophysically based, tectono-thermal models with detailed field studies.

(3) Refinement of radiometric dating techniques to determine the timing of specific metamorphic events and improvement of geobarometric-thermometric techniques to derive reliable pressure-temperature estimates.

(4) Correlation with geophysical and petrological information on the properties of present-day lower crust.

Achievements in 1991

General scientific achievements

In several high-grade metamorphic terranes detailed zircon dating by SHRIMP - High Resolution Ion Microprobe (ANU, Canberra) has been used to provide tight constraints on the timing and duration of thermal and tectonic events. Examples include East Antarctica, the Abakuma Plateau (Japan), Sri Lanka and Central Australia.

Direct measurement of channel gases by Ion Microprobe (Edinburgh) allows a new insight into fluid composition during metamorphism. Evidence from both stable isotope and mineral equilibria studies appears to indicate fluid absence and only localized fluid mobility is common in granulites. Charnockitization is a localized phenomenon unrelated to regional dehydration in granulite terranes.

At the conference in Oulu an attempt was made to integrate geophysical studies of the lower crust with surficial observations on the metamorphic rocks.

The study of lower crustal xenolith - bearing diatremes as direct probes of the present-day lower crust is providing a new stimulus to lower crustal

studies. Integration of geophysical and petrological/geochemical data is proving very promising and further work is in progress (Macquarie University, Sydney).

The three conferences with workshops and excursions have provided a forum for the discussion of these and related topics, e.g. partial melting in the lower crust, the genesis of magmatic charnockites and the establishment of criteria to distinguish plurifacial from polycyclic metamorphism.

Meetings held

(1) 'Metamorphism, deformation and structure of the crust, with an emphasis on the deep geology of the shields', University of Oulu, Oulu, Finland: 26-28 August 1991. Excursions to Lapland and Central Finland (70 participants, 13 countries).

(2) 'Basement Geology of the East Antarctic Shield' (80 participants, 20 countries) and Workshop on Lower Crustal Processes (35 participants, 12 countries), Sixth International Symposium on Antarctic Earth Science, Tokyo, 9-13 September. Field excursions: the Hidaka and Kamui Kotan Belts, Hokkaido, 15-21 September (28 participants, 8 countries).

(3) 'Composition and Evolution of High-Grade Gneiss Terranes', field workshop and seminar, Kandy, Sri Lanka, 23-29 September (45 participants, 12 countries).

Publications

Excursion guides and abstract volumes were prepared for all meetings.

Papers of all three meetings will be published in conference proceedings in the near future. A special issue of Precambrian research with invited papers selected from the Sri Lanka meeting is planned.

A special volume issuing from the Calgary meeting last year will come out as Vol. 3 of the *Journal of Metamorphic Geology* in 1992.

Twenty-five countries participated in the project (* indicates the countries active in 1991): Algeria, Australia*, Belgium, Brazil*, Canada*, China*, Czechoslovakia*, Finland*, France*, Germany*, India*, Iran, Ireland*, Italy*, Japan*, Kenya, Netherlands*, New Zealand*, South Africa*, Sri Lanka, Sweden*, Switzerland, United Kingdom*, United States* and USSR*.

Activities planned

(1) *The comparison between low-medium pressure granulite terranes*, e.g. the Adirondack *and high pressure regions*, e.g. the Bohemian Massif. Of particular interests are the contrasting pressure-temperature paths and related tectonic histories of such areas.

(2) *The role of fluids* in metamorphism, in particular with regard to the amphibolite to granulite transition. Fluid activities during metamorphism can be studied through the study of fluid buffering phase equilibria, whereas fluid movement can be quantitatively monitored by the study of stable isotope variations.

(3) *Geophysical constraints* on thermo-tectonic models for mountain belt evolution. Information of both heat flow and seismic studies will be incorporated.

(4) *Synthesis of recent advances* in 'Lower Crustal Processes'. The IGC meeting in Kyoto will be a good forum for taking stock of recent progress in our understanding of regional metamorphism and the nature of the present-day lower crust in different parts of the globe.

Meetings

A total of four international meetings are planned for 1992.

(1) 'Stable isotopes as tracers of metamorphic processes' (in collaboration with the Metamorphic Studies Group, United Kingdom). Convenors: Drs S.L. Harley and C. Graham. Edinburgh, 8-9 April.

(2) 'A critical look at a classic granulite terrane'. Adirondack field excursion and workshop organized by Professors S.R. Bohlen, J. McLelland and J. Valley. Adirondack, United States, 16-23 May.

(3) 'High-pressure granulites - lower crustal metamorphism'. Workshop and excursions in the Bohemian (three days) and Saxon Granulite Massifs (two days). Organizing Committee: Drs B.J. Hensen and L. Ya. Aranovich with local organizers: Drs S. Vrana, E. Jelinek and J. Kotkova (Czechoslovakia), Drs P. Bankwitz, C.D. Werner and J. Rotzler. Rohanov, Cezchoslovakia, 27 June-3 July; Germany, 4-5 July.

(4) *Spatial and temporal development of metamorphic belts.* A one-day symposium at the IGC in Kyoto. Convenors: Drs L. Ya. Aranovich, B.J. Hensen, Y. Hiroi and R.J. Tracy. Kyoto, exact date to be fixed.

IGCP Project 304 will also co-sponsor a symposium entitled 'Deep crustal structure of orogenic belts and continents and seismic and geological profiles' organized by Drs L.D. Brown, D.J. Ellis, M. Komatsu and T. Yoshii.

Proposed major publications

The publications generated by the project in 1991 will be published in the proceeding volumes of the conferences and in international reviewed journals. Calls have gone out for contributions to a special issue of the Journal of Metamorphic Geology on 'Present advances in the study of southern Indian granulites' to be edited by Drs A. Mohan and B.J. Hensen.

No. 308 - PALAEOCENE/EOCENE BOUNDARY EVENTS (1990-1994)

Marie-Pierre Aubry, Laboratoire de Géologie du Quaternaire, CNRS-Lumniy, Case 907, 13288 Marseille Cedex 9, France.

Description: The objective is to delineate precisely the nature and timing of the events which occur in the marine and terrestrial records close to the Palaeocene/Eocene boundary in order to construct a basic framework for global stratigraphic correlation, to link facies evolution in the terrestrial and epicontinental domains with the Late Palaeocene and Early Eocene history of oceanic changes, and to study the correlative response of the biotas in the sea and on land. The ultimate goal is the designation of a stratotype for the Palaeocene/Eocene boundary.

Achievements in 1991

Meetings held

(1) A Cuhsman Foundation symposium entitled 'The global climate transition from the Late Palaeocene to Early Eocene' was held on 22 October during the GSA annual meeting. The convenors are K.G. Miller (Rutgers University, New Jersey) and Lowell Stott (University of Southern California, Los Angeles). The 11 speakers are members of IGCP Project 308.

In addition, W.A. Berggren has taken the initiative of organizing an informal meeting during GSA, which allowed members of IGCP Project 308 who cannot attend the annual meeting of the co-ordinators in Brussels to discuss next year's activities of the project.

(2) A field conference was held on 26 October-1 November in Tuscaloosa, Alabama and Washington D.C. The objectives: to re-examine the Upper Palaeocene-Lower Eocene stratigraphic record of the Gulf coast and the Atlantic coastal plain in the context of sequence stratigraphy, and to achieve a better understanding of its relationships with the deposits of north-west Europe. The convenors were E. Mancini (university of) and T. Gibson (United States Geological Survey, Reston, Va). Fourteen members of IGCP Project 308 attended this field conference.

(3) A joint Belgium Basin-Co-ordinator meeting, hosted by P. Laga (Belgium Geological Survey) was held in Brussels from 2 to 6 December. The objectives: (a) to examine the Upper Palaeocene-Lower Eocene stratigraphic record in Belgium and its correlation with other basins in north-west Europe; (b) to review the achievements of 1991; (c) to delineate the activities of the project for 1992. The relatively large number of attendees attests to the growing interest in the activities of IGCP Project 308.

Important publications

- Cieselski, P.F., 1991. Biostratigraphy of diverse silicoflagellate assemblages from the Early Palaeocene to Early Miocene of Holes 698A, 700B, 702B and 703A: Sub-Antarctic South Atlantic. Proc. Ocean Drilling Programme, Scientific results, 114: 123-154.

- Fenner, J.M., 1991. Taxonomy, stratigraphy and palaeoceanographic implications of Palaeocene diatoms. Proc. Ocean Drilling Programme, Scientific results, 114: 123-154.

- Fluegeman, R.H., Berggren, W.A. and Briskin, M., 1990. Palaeocene benthonic foraminiferal biostratigraphy of the eastern Gulf coastal plain. *Micropalaeontology*, 36: 56-64.

- Ingram, S.L., 1991. The Tuscahoma-Bashi section at Meridian, *Mississippi: First notice of lowstand* deposits above the Palaeocene/Eocene TP2/TE1 sequence boundary. Mississippi Geology, June 1991: 9-14.

- Kaiho, K., 1991. Global changes of Palaeogene aerobic/anaerobic benthic foraminifera and deep

sea circulation. *Palaeogeography, Palaeoclimatology, Palaeoecology*, 83: 65-85.

- Kennett, J.P. and Stott, L.D., 1991. Abrupt deep sea warming, palaeoceanographic changes and benthic extinctions at the end of the Palaeocene. *Nature*, 353: 225-229.

- Mancini, E. and Tew, B.H., 1991. Relationships of Palaeogene stage and planktonic foraminiferal zone boundaries to lithostratigraphic and allostratigraphic contacts in the eastern gulf coastal plain. *Jour. Foraminiferal research*, 21: 48-66.

- Rea, D.K., Zachos, J.C., Owen, R.M., Gingerich, P.D., 1990. Global change at the Palaeocene/Eocene boundary: climatic and evolutionary consequences of tectonic events. *Palaeogeography, Palaeoclimatology, Palaeoecology*, 79: 117-128.

- Robert, C. and Chamley, H., 1991. Development of Early Eocene warm climates, as inferred from clay mineral variations in oceanic sediments. *Palaeogeography, Palaeoclimatology, Palaeoecology*, 89: 315-331.

Twenty-one countries participated in the project (* indicates the countries active in 1991): Argentina, Australia, Barbados, Belgium*, Bulgaria*, China, Cuba, France*, Germany*, Iran*, Israel*, Italy*, Jordan*, Netherlands*, Norway, Spain*, Switzerland, United Kingdom*, United States*, USSR and Yugoslavia.

Activities planned

(1) To wrap up the results obtained during the two previous years. We are planning on preparing two books devoted to the stratigraphy of north-west Europe and the stratigraphy of the western margin of the Atlantic (Gulf coast area and Atlantic coastal plain). The format of these books will be determined at the meeting in Tuscaloosa and the meeting in Brussels.

(2) To progress on the regional studies, particularly in countries which yield a particularly good stratigraphic record around the boundary.

The working groups in Israel, Spain and the USSR have been particularly active in this respect.

(3) A major push will be made to improve the correlation between the deep sea, the shallow marine and the terrestrial environments. This, in particular, was the object of the meeting organized by W.A. Berggren during the GSA annual meeting.

Meetings

(1) A field conference in Spain, organized by E. Molina (University of Saragoza, Spain). The objectives will be: (1) to visit the sections of Zumaya and Campo which appear to be continuous across the P/E and are potential stratotypes for the P/E, and (2) to present the results of studies in progress by various members of the project.

(2) An IGCP Project 308 held in Kyoto in connection with the International Geological Congress. This meeting is of great importance because it will allow us to strengthen our collaboration with our colleagues from the Oriental countries, in particular with our Chinese colleagues. China has one of the best records of continental deposits across the P/E, and several Chinese scientists are involved in the vertebrate subgroup of the project.

(3) Field work in the North Caucasus. A collaboration programme for magnetostratigraphy and isotope stratigraphy has been established with Dr Muzylov during the recent meeting in Brussels and we are planning for a group of four or five scientists from western countries to join Dr Muzylov on the field to sample sections for magneto- and isotope stratigraphy (as a complement to existing sedimentologic and palaeontologic studies performed by our Russian colleagues). This field trip will be preliminary to a field conference that we are planning in the North Caucasus and the Mali Caucasus that Dr Muzylov and Aliyulla plan for late spring-early summer 1993.

(4) The Project Leader discussed with Dr Iturralde Vinent the logistics for a field sampling programme in Cuba during 1992 and several members of IGCP Project 308 have expressed interest in such collaboration.

In addition, several activities are already planned for 1993. We hope to organize a joint field conference in South America between IGCP Projects 301 and 308. A field conference in New Mexico will allow us to visit critical sections for vertebrate palaeontology and discuss correlations between continental and marine deposits. A meeting devoted to the Upper Palaeocene-Lower Eocene record in the North Atlantic and North Sea will be organized at the Geological Society of London.

No. 314 - ALKALINE AND CARBONATITIC MAGMATISM (1991-1995)

L. Kogarko, Vernadsky Institute of Geochemistry and Analytical Chemistry, Academy of Sciences of Russia, Kosygin str., 19, Moscow, Russia.

J. Keller, Albert-Ludwigs Universität, Albertstr. 23b, D-7800 Freiburg, Germany.

K. Bell, Dept. of Earth Sciences, Carleton University, Ottawa, Canada K13 5B6.

Description: The aim of the project is to correlate geological and tectonic position, petrology, geochemistry and metallogeny of alkaline rocks and carbonatites and besides to construct the models of formation of mineral deposits related to alkaline rocks and carbonatites. The investigation of alkaline rocks from various regions will also provide fundamental knowledge of the deepest zones of the earth since alkaline magmatism is a 'geochemical window' to the mantle.

Achievements in 1991

(1) Inaugural field trip and symposium 'Petrology, geochemistry and mineralogy of alkaline and carbonatitic rocks. Palaeozoic alkaline province of Fennoscandian Shield', Apatity, Russia, 15 July-6 August 1991 (33 papers from 14 countries were presented). Several problems were discussed and acquired substantial development on the basis of the new data:

ore potential of alkaline and carbonatitic magmas (apatite, rare metals - Zr, Nb, Ta, REEs, Ti, U, Th, phlogopite, vermiculite, Cu);

the evolution of ultramafic alkaline melts as exhibited by dyke series;

experimental studies of the genesis of ore deposits (loparite, perovskite, apatite, eudialite, sphene);

isotopic studies which demonstrated that at least two sources of alkaline and carbonatitic magmas exist: depleted lithospheric reservoir and less depleted convecting mantle;

as a result of the visit to the Kola super-deep drill hole (town of Zapolyarny) new information about subalkaline magmatism developed in the deepest zones of Fennoscandian Shield was obtained (up to 12 km);

geological and geochemical correlation of ore deposits, of the largest carbonatitic complexes (Kovdor), USSR and Phalaborwa (South Africa).

(2) The international marine expedition aimed at studying alkaline magmatism of the world ocean (islands of Trinidad, Fernando di Noronha, Martin Vaz, Gran Canaria, La Palma, Madeira, seamounts of the Colombian line, São Paulo and Romance fracture zone) took place from 21 February to 14 April 1991 on the research vessel 'Akademik Boris Petrov'. Thirty scientists participated in the expedition from the following organizations: Vernadsky Institute of Geochemistry and Analytical Chemistry, Russian Academy of Sciences (Moscow), University of São Paulo, Universidade Federal Fluminense (Brazil), University Complutense of Madrid (Spain), University of Lisbon and Municipal Museum of Funchal on the Madeira Island (Portugal). The results will be used to determine the geochemical evolution of alkaline magmatism in the hot spots of the Atlantic Ocean to contribute towards the geological correlation of oceanic islands and seamounts. The expedition was sponsored by the Russian Academy of Sciences.

(3) 8-16 September 1991 - the first international field meeting of young geologists 'New and traditional approaches to the study of crystalline shields and their quaternary cover' was held in Apatity, Russia, in co-operation with IGCP Project 275.

(4) 2-5 October 1991 - business meeting together with the IUGS Classification Subcommission on Eruptive Rocks, Moscow, Russia.

(5) 20-30 September 1991 - geological excursions to alkaline and carbonatitic rocks of the Kola peninsula (Khibina and Kovdor massifs), apatite mines, Apatity, Russia.

(6) 18 June-4 July 1991 (Brazil) - the 5th International Kimberlite Conference was held with strong emphasis on carbonatites and related economic deposits, both in sessions and field excursions. A discussion meeting was organized for participants interested in the work of IGCP Project 314.

About 20 countries were involved in the project (* indicates the countries active in 1991): Angola, Argentina, Belgium*, Brazil*, Canada*, China, Denmark*, Finland*, France, Germany*,

India*, Italy, Japan*, Norway*, Poland, Russia*, South Africa*, Spain and Viet Nam*.

Activities planned

- 19 June-12 July 1992. Field symposium (South Africa) - Genetical problems of carbonatite and alkaline magmatism. Geological excursions to the carbonatite complexes of Namibia and South Africa.

- 24 August-3 September 1992, Kyoto, Japan - Alkaline and carbonatitic magmatism and related ore deposits. The role of fluids. Special symposium of IGCP Project 314 during the 29th International Geological Congress in Kyoto, Japan - together with IGCP Project 275 - Field trip and symposium, Kola peninsula 'Bare element mineralization on the Baltic shield', August 1992.

Though the project has been functioning only for one year, about 20 countries took part in its work. The activities for involvement of other countries in the project proceed. Inasmuch as the consumption of rare metals belonging to carbonatites and alkaline rocks continually increases, the activity of the project would stimulate the rare elements prospecting in the industry of the developing and developed countries.

Twenty-five papers were published in 1991 under the auspices of the project.

No. 315 - RAPAKIVI GRANITES AND RELATED ROCKS (1991-1995)

Ilmari Haapala, Department of Geology, University of Helsinki, Snellmaninkatu 3, SF 00170 Helsinki, Finland.

Ronald F. Emslie, Geological Survey of Canada, 601 Booth Street, Ottawa, Ontario K1A 0E8, Canada.

Description: Rapakivi granites and associated basic rocks (diabase dykes, gabbros, anorthosites) have been found in Precambrian cratonic areas of different continents. In several cases, tin-tungsten-beryllium mineralization is associated with the rapakivi granites. The aim of the project is to correlate the tectonic setting, petrology, geochemistry and metallogeny of the rapakivi granites and related anorogenic granites worldwide. The main topics are: areal and temporal distribution of the granites, tectonic setting and mechanism of emplacement, relation to crustal evolution, bimodal character of the magmatism, petrographic and geochemical characteristics, metallogeny, petrogenesis, physical conditions of crystallization, and origin of the rapakivi texture.

Achievements in 1991

The inaugural meeting of the project and the first scientific symposium 'Rapakivi Granites and Related Rocks' were held in Helsinki, Finland, on 29-31 July 1991. In the inaugural meeting, the objectives of the project and the work plan for the years 1991-1995 were accepted and the leaders and secretary were elected. Sixty-seven scientists from 14 countries participated in the three-day symposium. Altogether 40 oral and 14 poster presentations were given on various topics of the project. The symposium was followed by a geological field trip to study the rapakivi granites of south-eastern Finland and Russian Karelia. A volume of abstracts and an excursion guide were published.

In the symposium the tectonic setting and magmatic associations of the rapakivi-type granites of different continents were discussed. Rapakivi granites and associated basic rocks (gabbros, anorthosites, diabase dykes) have been generated in several epochs during the geological history, mainly in the Proterozoic era. In the North Atlantic shield belt the epochs are: 1.77 to 1.75, 1.65 to 1.54, and 1.50 to 1.43 Ga. In Africa and South America, still younger Middle and Late Proterozoic rapakivi granites have been found, and in Brazil several of them contain tin-tungsten deposits. Such topics as extensional tectonic setting and bimodal magmatism with local magma mingling and mixing were emphasized in several presentations.

The field trip offered a possibility to study the topaz-bearing rapakivi granites and coeval composite silicic-basic dykes of south-eastern Finland. There also was a unique possibility to study the rapakivi granites and skarn-type mineral deposits of the classical Pitkäranta ore field in Karelia in the light of up-to-date systematic research.

Five papers relevant to the project were published in 1991:

(1) Haapala, I. and Condie, K.C. (Editors). Precambrian Granitoids - Petrogenesis, geochemistry and metallogeny. *Precambrian Research,* Special Issue, Vol. 51, 468 pp.

(2) Haapala, I., Rämö, O.T. and Salonsaari, P.T. (Editors), with contributions by Amelin, Yu., Belijaev, A., Larin, A., Neymark, L., and Stepanov, K. Salmi batholith and Pitkäranta ore field in Soviet Karelia, IGCP Project 315, Symposium Rapakivi Granites and Related Rocks, Excursion Guide. *Geological Survey of Finland, Guide 33*, 57 pp.

(3) Haapala I. and Rämö, O.T. (Editors). IGCP Project 315, Symposium on Rapakivi Granites and Related Rocks, Abstract Volume. *Geological Survey of Finland, Guide 34*, 65 pp.

(4) Rämö, O.T. Petrogenesis of the Proterozoic rapakivi granites and related basic rocks of south-eastern Fennoscandia: Nd and Pb isotopic and general geochemical constraints. *Geological Survey of Finland, Bulletin 355*, 161 pp.

(5) Suominen, V. The chronostratigraphy of south-western Finland with special reference to Postjotnian and Subjotnian diabases. *Geological Survey of Finland, Bulletin 356*, 100 pp.

Scientists from the following countries have actively participated in the project: Botswana, Brazil, Canada, China, Estonia, Finland, Germany, India, Japan, Russia, South Africa, Spain, Sweden, United Kingdom, Ukraine and United States.

Co-operation has been established with IGCP Projects 257 (Precambrian Dyke Swarms) and 290 (Anorthosites and Related Rocks).

Activities planned

In order to fulfil the aims of the project, the following symposia and field trips are planned:

1992 A project meeting will be held in conjunction with the 29th IGC in Kyoto, Japan, 24 August-3 September and it will be preceded by a field trip to the Shachang rapakivi granite complex north of Beijing, China, on 18-22 August.

1993 A meeting and field trip will be arranged on 26-30 March in Rolla, Missouri, in association with the Spring Meeting of the Geological Society of America.

1994 A joint meeting will be arranged with IGCP Project 290 (Anorthosites and Related Rocks) in Montreal, Canada, with a field trip to Labrador. Another meeting will be arranged in association with the 15th IMA General Meeting in Italy.

1995 A meeting and field trip will be arranged in Brazil.

A proceedings volume will be published after each international meeting, and a final memoir will be completed at the end of the project. The proceedings of the 1991 Symposium on Rapakivi Granites and Related Rocks, edited by I. Haapala and O.T. Rämö, will be published as a Special Issue of *Mineralogy and Petrology* in 1992.

No. 317 - PALAEOWEATHERING RECORDS AND ANCIENT CONTINENTAL SURFACES (1991-1995)

M. Thiry, J.-M. Schmitt, C.I.G. Ecole des Mines de Paris, 35, rue Saint-Honoré, 77305 Fontainebleau, France.

Description: The project aims to attract scientists involved in the study of pre-Quaternary subaerial weathering phenomena and palaeosurfaces, and in the reconstruction of palaeoenvironments. The principal goals are: to determine the major weathering episodes in Earth history, to set up an inventory of the corresponding palaeosurface records, to establish criteria and methods for palaeoenvironment reconstruction; to draw conclusions concerning global climatic changes and continental environments; and to identify palaeoweathering phenomena and palaeosurfaces of specific economic interest.

Achievements in 1991

The inaugural meeting of the project was held at Fontainebleau, France, in November 1991. It had 37 participants from 13 countries. The meeting consisted of four parts: a two-day workshop on 'Silcretes: Structure, micromorphology and their interpretation', a one-day excursion in the surroundings of Fontainebleau (Fontainebleau Sandstone Formation, etc.), a general scientific session on 'Mineralogical and geochemical records of palaeoweathering', and a working group meeting (with 22 participants).

The discussions resulted in establishing the internal organization of the projects, and the main topics of scientific activity for the two forthcoming years.

At the inaugural meeting, 17 papers were read and six posters were presented, covering the topic of palaeoweathering from the Proterozoic to the Tertiary in Australia, Africa, Europe and the Americas.

During the working group meeting, several research topics were proposed. They are now under further discussion by small expert groups, and will be formally specified at the second annual meeting of the project in October 1992. Above all, however, it has been decided to start a global inventory of palaeoweathering phenomena. R. Simon-Coinçon (CNRS-Ecoles des Mines, France), Q. Gall (Carleton University, Canada) and A.R. Milnes (CSIRO -

Adelaide, Australia) were entrusted to work out a standard description form, to be dispatched in early 1992.

Publications

- IGCP Project 317 first meeting, Programme and Abstracts (1991), Thiry, M., Schmitt, J.M. (ed.), 38 pp.

- Silcretes: Structures, micromorphology, mineralogy, and their interpretation - IGCP Project 317 Workshop (1991), Thiry M., Schmitt, J.M., and Milnes, A.R., 55 pp.

These publications as well as the inventory form are available from the co-leaders of the project.

Twenty-six countries participated in the project (* indicates the countries represented at the inaugural meeting): Argentina*, Australia*, Belgium*, Brazil, Burkina Faso*, Canada*, China, Colombia, France*, Germany*, Hungary, India, Iran, Israel, Italy, Japan, Madagascar, Malaysia, Morocco*, Portugal*, Republic of South Africa, Senegal, Thailand and United States*.

Activities planned

In 1992, the main scientific activity will be the dispatching of the inventory form, and the filing of the responses in view of subsequent evaluation. Furthermore, several thematic working groups will be established at the next meeting.

The second annual meeting of the project will take place at La Plata, Argentina, 8-17 October 1992 (convened by P. Zalba et al.). It will comprise a general scientific session on 'Landscape reconstruction', in the framework of the 4th Argentinian Meeting on Sedimentology', and a working group meeting. Two field trips will follow: a two-day one in the Sierras de Tandil, and a six-day one in Patagonia.

No. 318 - GENESIS AND CORRELATION OF MARINE POLYMETALLIC OXIDES (1991-1995)

J.R. Hein, USGS, 345 Middlefield Road, MS 999, Menlo Park, CA 94025, United States.

B.R. Bolton, BHP-Utah Int 1 Inc. 200 Fairbrook Drive, #101, Herndon, Virginia, VA 22070, United States.

Description: The project, which is a successor to IGCP Project 226 (Correlation of Manganese Sedimentation to Palaeoenvironments), intends to correlate the origin and evolution of polymetallic oxide deposits with the evolution of the oceans, to develop techniques to date such deposits and to develop genetic models that can be used in exploration. A particularly attractive and promising aspect is the inclusion of studies of recent sediments in the Pacific and Indian Oceans, and of deposits in the Precambrian shields of Africa and India. In the latter, sedimentary manganese deposits are important palaeogeographic markers and in many cases, are of economic interest.

Achievements in 1991

The inaugural meeting of the project was held in San Diego, California, United States, on 21 October 1991. Ten scientists from four countries attended the meeting. Two newsletters were prepared and distributed. The response to calls for participation in this new project has been particularly encouraging. At this time some 135 scientists from 25 countries have indicated their support. Several collaborative research projects in contemporary marine basins and Proterozoic and Phanerozoic deposits in China, Southern Africa and India have been initiated by project participants. In addition, several international and regional meetings/field workshops were organized together with plans for publication of results.

The following countries were involved in the project (* indicates the countries active this year): Australia*, Brazil, Bulgaria, Canada*, China*, Egypt, Finland, France*, Germany*, Greece*, Hungary, India*, Japan*, Korea, Mexico, Morocco, Namibia, New Zealand, South Africa*, Spain*, Switzerland, United Kingdom*, United States*, USSR* and Venezuela.

Activities planned

General goals

Consistently with the general objectives of the project, it is proposed that further efforts are made towards the characterization of marine polymetallic oxides, mineralogically, chemically, isotopically, texturally, and genetically. To this end collaborative research will be continued with emphasis on studies of recent sediments in the Pacific and Indian Oceans, and of deposits in the Precambrian shields of Africa, India, Australia and North America. These studies will achieve a comparative assessment of the process, products and environments of formation of these deposits leading to generalized models that can be used in exploration.

Meetings

The first field workshop-conference is planned to be held in conjunction with the 29th International Geological Congress in Kyoto, Japan, 24 August-3 September 1992. A field excursion to examine in detail the Cretaceous manganese and manganiferous iron deposits of Hokkaido is planned to coincide with the Congress (Post Congress Field Trip CO4 to be led by Y. Hariya and H. Miura of Hokkaido University).

A special proceedings volume is planned for selected papers arising from the Kyoto, IGC in 1992. The volume will be edited by S. Roy, R. Sorem and Y. Hariya.

No. 320 - NEOPROTEROZOIC EVENTS AND RESOURCES (1991-1995)

Nicholas Christie-Blick, Lamont-Doherty Geological Observatory of Columbia University, Palisades, NY 10964, United States.

Mikhail A. Fedonkin, Palaeontological Institute, Russian Academy of Sciences, Profsoyuznaya ul. 123, Moscow B321, 117868, Republic of Russia.

Mikhail A. Semikhatov, Geological Institute, Russian Academy of Sciences, Pyzhevskiy per. 7, Moscow 109017, Republic of Russia.

Description: The Neoproterozoic is a critically important interval in Earth history, one of profound evolutionary changes within the biosphere, of widespread glaciation, of supercontinental assembly and fragmentation, of eustatic change most likely related to both tectonic and climatic factors, and of concomitant change in seawater chemistry. The purpose of IGCP Project 320 is to promote interdisciplinary efforts in documenting and interpreting these events, and seeking connections between them. The main objectives of the project are the recognition in Neoproterozoic successions of biological, biogeochemical and palaeoenvironmental changes in a sequence stratigraphic and tectonic framework, their calibration by means of geochronology and palaeomagnetism, and their correlation on a global scale. Anticipated products are:

(1) the identification of global stratigraphic events of Neoproterozoic age;

(2) advances in the numerical dating of these events, especially by means of U-Pb geochronology;

(3) new insights about the evolution and palaeoenvironmental context of various biota (metazoans, ichnofossils, micro-organisms, stromatolites and macro-algae);

(4) improved documentation and a critical assessment of the sedimentary isotopic record (especially variations in carbon, sulphur and strontium isotopes in carbonates, evaporites and organic matter), to separate a global signal from local palaeogeographic and diagenetic factors;

(5) a preliminary interpretation, on the basis of sequence stratigraphic studies, of major eustatic events during Neoproterozoic time, and their relation to known ice ages;

(6) additional geological, isotopic and palaeomagnetic constraints on the positioning and tectonic evolution of the continents during this interval;

(7) the development of criteria needed for the definition of the lower boundary and internal zonation of a new Late Neoproterozoic system, informally termed Neoproterozoic III, and with an age provisionally set at approximately 650 Ma (Plumb, 1991); and

(8) documentation of the distribution and fundamental controls on sedimentary mineral deposits in Neoproterozoic successions (including hydrocarbons, phosphorites and stratabound mineral deposits).

Achievements in 1991

The main achievement of the first year of the project was to lay the groundwork for subsequent co-operative research.

Meetings

An organizational meeting was held at Lamont-Doherty Geological Observatory in New York, United States, for the purpose of refining objectives and setting priorities. The meeting was attended by 13 scientists from seven countries. Key items on the scientific agenda included: (1) techniques to be used; (2) specific problems in Neoproterozoic geology to be addressed; (3) the selection of potential reference sections on which studies might be focused; (4) the format and venues of future meetings and field trips; and (5) plans for publication of project results.

Amongst the more important conclusions of the meeting were: (1) a consensus that the project must be interdisciplinary not merely multinational; (2) that the project should pursue with the utmost vigour opportunities for high-resolution U-Pb geochronology of ash beds; (3) that observations should as far as possible be made in a sequence stratigraphic context (a technique still not widely applied to Proterozoic strata); and (4) that attempts should be made to develop and evaluate palinspastic reconstructions of the continents for Neoproterozoic time.

Fifteen countries participated in the project (number of participants in parentheses): Australia (10), Brazil (3), Canada (10), China (9), France (3), Germany (4), India (6), Israel (2), Norway (1), Russia (11), South Africa (1), Spain (1), Sweden (4), United Kingdom (14), United States (29).

Activities planned

The primary goal is to co-ordinate interdisciplinary research in key reference sections and to encourage research in Neoproterozoic geology in general.

Meetings foreseen

International Geological Congress, Kyoto - symposium on 'Neoproterozoic stratigraphy and Earth history' (A.H. Knoll and M.R. Walter), August 1992; field excursion with IGCP Project 303 to Yangtze platform, China (Professor Xing Yusheng), September 1992; Geological Society of America, Penrose Conference on 'Precambrian tectonics and the dawn of the Phanerozoic', Death Valley, California (I.W.D. Dalziel, A.H. Knoll and E.M. Moores), October, 1992; Geological Society of America, annual meeting, Cincinnati, Ohio - theme session on 'New discoveries in Neoproterozoic Earth history' (N. Christie-Blick and S.A. Bowring), October, 1992.

Tentative plans for 1993: field excursion with IGCP Project 303 to the Lesser Himalayas, India (G. Kumar), early in 1993; excursion to Amadeus basin and Adelaide geosyncline, Australia, possibly in mid-1993.

Priorities for future years include excursions to Namibia and Mackenzie Mountains, Canada.

Publications planned

A special volume will be published (probably in 1993) as an outgrowth of the symposium at the 29th International Geological Congress (A.H. Knoll and M.R. Walter, editors).

No. 321 - GONDWANA DISPERSION AND ASIAN ACCRETION IN THE EASTERN TETHYS AND WESTERN CIRCUM-PACIFIC REGION (1991-1995)

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S. Hada, Department of Geology, Kochi University, Kochi 780, Japan.

I. Metcalfe, Department of Geology and Geophysics, University of New England, Armidale, 2351 NSW, Australia.

Description: Asia, especially its eastern and southern sections, is not a single continent with only one large craton as its major part, but a composite continent composed of many microcontinents. Most of them came from the Proterozoic supercontinent of Gondwanaland and its adjacent regions and their evolution is nothing but the history of the dispersion and drifting of Gondwana and the accretion and formation of Asia. The major aim of the present project is to have a detailed elucidation of this process and to illustrate the relation between the eastern Tethys and western Circum-Pacific belts through the comparative studies of geology, geophysics, and geochemistry, especially palaeobiogeography, palaeomagnetics and geotectonics.

The major subjects of study planned are:

(1) Palaeontological, palaeoclimatical, palaeomagnetical and palaeotectonical evidences showing that the blocks of Indo-China, Sibumasu, East Malaya, Yangtze, Tarim, Sino-Korea, etc., were derived from the Proterozoic supercontinent of Gondwanaland and its adjacent regions.

(2) Derivation of terranes of Japan and Sikhote-Alin, and Mesozoic-Cenozoic orogenesis in East Asian Circum-Pacific.

(3) Collision and welding of Indo-China-East Malaya and Sibumasu, with more attention paid to the study of the Palaeotethys.

(4) Collision and welding of the Sino-Korea block with the Yangtze block, and the possible extension of the Qinling orogen to Korea.

(5) Collision and welding of Sino-Korea with Siberia, and the intersection of the Palaeo-Asian orogen with the Circum-Pacific.

(6) The relation of the South China fold belt to the Ogcheon belt of Korea and the North Viet Nam belt.

(7) Oblique collision and strike-slip faults in East Asia and intersection of the west Circum-Pacific and eastern Tethys tectonic belts.

(8) Types and distribution of sedimentary basins since the Phanerozoic and their relation to oil and gas.

(9) Background of distribution of mineral resources and regional metallogeny in the study area.

Obviously, the better understanding of the splitting and drifting of many provinces in continental south-eastern Asia might provide very important answers to the terrane concept in general. New results are expected relative to hydrocarbon deposits distribution and the evolution of sedimentary basins, and the relationship between tectono-magmatic activity and metallogenesis.

Achievements in 1991

The first symposium of IGCP Project 321 was held from 25 November to 1 December 1991, in Kunming, China. More than 90 extended abstracts were submitted to the symposium, 86 scientists from ten countries (Australia, China, France, Germany, India, Japan, Korea, Malaysia, Russia and United Kingdom) attended the meeting; among them 58 delivered oral presentations and 65 participated in the post-meeting field excursion. Eight major topics were set up, namely Tectonism, Palaeobiogeography, Sedimentation, Magmatism, Metamorphism, Geochemistry, Geophysics and Metallogenesis, and six advisers were invited. At the symposium the latest results of research in the Asia-Australia-Pacific region related to geotectonics, palaeobiogeography, sedimentation, magmatism, metamorphism, geochemistry, geophysics (mainly palaeomagnetism) and metallogenesis were presented. The participants showed their recent achievements in studying the Tibet-West. Yunnan-Malaya region, the Kunlun-Qinling Mountains, the Tianshan Mountains-Mongolia belt and the western Circum-Pacific belt in Asia. Ren Jishun gave a report on the scientific approach and the major tasks of the project, suggesting that microcontinents, soft collision and polycyclic suturing are the basic geodynamic features in the Phanerozoic tectonic evolution of southern and eastern Asia. I. Metcalfe spoke on 'Gondwana dispersion, amalgamation and accretion of South-East Asian terranes: progress, problems and prospect'. During the field excursion 65 scientists investigated the well-known Red River fault and the geology of the Ailaoshan Mountains. They were impressed by the intense sinistral strike-slipping of the Red River fault in the Himalayan stage and the strong Indosinian movement in the Ailaoshan belt.

It is planned that the *Journal of South-East Asian Earth Sciences* will publish a special issue for the First International Symposium of IGCP Project 321.

Publications

(1) Proceedings of the First International Symposium on the Gondwana Dispersion and Asian Accretion - Geological Evolution of Eastern Tethys, edited by Ren Jishun and Xie Guanglian, published by China University of Geosciences-Beijing, Beijing, China, pp. 314, 1991.

(2) Guidebook for the Field Excursion, by Zhang, L.S., Wang, Y., and Zhong, D.L., published by the Laboratory of Lithosphere Tectonic Evolution, Institute of Geology, Chinese Academy of Sciences, Kunming, China, pp. 22.

Fifteen countries were involved in the project: Australia, Canada, China, France, Germany, India, Japan, Korea, Malaysia, Netherlands, Russia, Thailand, United Kingdom, United States and Viet Nam.

Activities planned

Future symposia and their organizers in 1992-1995 are as follows:

1992 Second Symposium, Japan, in conjunction with the 29th IGC, Japan National Working Group, Professor S. Hada.

1993 Third Symposium, Malaysia, Malaysian National Working Group, Professor T.T. Khoo.

1994 Fourth Symposium, Korea, Korean National Working Group, Professor J.H. Kim.

1995 Fifth Symposium, Vladivostok, Russia, Russian National Working Group, Professsor A.I. Khanchuk.

A possible final meeting of the project may be held in China in 1996, in conjunction with the 30th International Geological Congress.

No. 324 - GLOBAL PALAEOENVIRONMENTAL ARCHIVES IN LACUSTRINE SYSTEMS (GLOPALS): GLOBAL LIMNO-GEOLOGY (1991-1995)

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P. Anadón, Institut de Geología 'J. Almera', CSIC, c/Martí i Franqués s/n 08028 Barcelona, Spain.

Description: This is a successor project to IGCP Project 219 (comparative lacustrine sedimentology in space and time).

It aims to complete as far as possible a compilation of our present knowledge on ancient lacustrine record (Global Geological Record of Lake Basins) and at the same time to establish new criteria and refined methodology to use lacustrine palaeoenvironmental sequences in order to understand the high resolution response of our natural system to external forcing throughout the geologic record. Controls on lacustrine systems are tectonics, climate and palaeogeography which are, of course, linked to both the earth system and the orbital functions.

Lakes are sensitive pieces of the earth system which require an increasingly multidisciplinary and global approach to understand the importance of their high resolution records. This is one of the central focuses of GLOPALS. Because lakes represent a spectrum and change rapidly in response to environmental pressures it is necessary to view them in a unified framework which considers geologic settings, chronology, salinity, depth, chemistry and biota as parts of system trends and patterns.

GLOPALS will try to tie the non-marine palaeoenvironment records closer to the contemporaneous marine records by comparing palaeogeography of time intervals. In order to achieve these results it will be necessary to stimulate the application of new techniques and technologies in dating, stable isotope geochemistry, palaeoaltimetry, palaeomagnetism and even global palaeogeography and palaeoceanography.

Achievements in 1991

This year, 1991, has been the first of activity of IGCP Project 324. The scientific achievements reached therefore have been limited and consisted of refining of the focus of the project. During this first year the project efforts have focused on finishing the activities of the precursor IGCP Project 219.

During 1991, some final publications resulted from IGCP Project 219:

'Lacustrine facies analysis' (P. Anadón, L. Cabrera & K. Kelts, eds.). International Association of Sedimentologists special publication No. 13, 317 pp. (Blackwell Scientific Public.).

'Cenozoic lacustrine systems of Spain' (in Spanish, P. Anadón & L. Cabrera, eds.). *Acta Geologica Hispanica*, 24 (3-4): 165-309.

'Comparative lacustrine sedimentation in China' (K.R. Kelts & Yana Changshu, eds.). Intergeos.

Meetings

(1) Short course on 'Geochemical methods in evaporite research. Ancient and recent case-studies'. Coord. by L. Rosell & F. Orti. Sponsored by the Inst. Cat. of Hist. Nat. and the University of Barcelona, Barcelona, 14-15 May 1991. Forty people from two countries.

(2) 'Comparative sedimentology of lacustrine sequences in Neogene strike-slip basins', Ankara, Turkey, 16-22 June 1991. (Dr I.E. Kerey, organizer). Forty people from 11 countries.

The major goal to the first meeting of the project was to discuss the signals of tectonic influence in the sedimentary record. A first initial comparison between some Turkish, European, African and North American lacustrine basins (ranging from Permian to Neogene in age) arose from the communications and related further discussions.

Despite some overall similarities, a special emphasis was made on the major differences between the sedimentary record in the various case-studies. These differences derived from the local-regional palaeotectonic features and from the rather diverse palaeoclimatic conditions. All the attendants agreed on the need of making some advances on the analysis of the internal organization of the lacustrine successions and on the knowledge of the timing of the major lacustrine sequences and cycles. Making more use of palaeomagnetic techniques was proposed for progressing in this line. Two major questions arose from the meeting:

(1) Do the lacustrine sequences developed in diverse settings show parallel development?

(2) Can they be correlated in style and climate signatures?

It was emphasized that to answer these questions we need to pay attention to new concepts of lacustrine system analysis derived from the currently developing models on tectono-sedimentation relationships. This is proposed to be a major line of progress in terms of distinguishing between tectonic and climatic forcing in ancient lake systems.

(3) 'Sedimentary and Palaeolimnological Records of Saline Lakes'. Saskatoon, Canada (13-16 August 1991. Organized by R.W. Renaut, University of Saskatchewan and W.L. Last, University of Manitoba, Canada. Eighty-five people from 13 countries.

The organizers have submitted a proposal to have the 'geological' papers published as a SEPM Special Publication. 'Biological' papers will appear as a Special Issue of the *Journal of Palaeolimnology*. There will be about 35 papers in the SEPM, ten in the JP.

(4) 'Quaternary lakes and global change' (IGCP Project 324, as Co-convenor, Dr Kerry Kelts), in the 13th INQUA Congress. Beijing, China, 2-9 August 1991.

(5) National meetings or activities of the IGCP Project 324 developed in 1991 or meetings held in the setting of major congresses:

National meeting in the setting of the 'III Coloquio del Cretácico de España' Morella, Spain, 6-8 September 1991.

National meeting in the setting of the 'Réunion du Groupe de Sedimentologie français'. Paris, November 1991.

First field trip meeting of the Spanish IGCP Project 324 Group. Granada, 13-14 November 1991.

Conference on 'Tertiary lacustrine systems in Serbia, Yugoslavia' held by Dr Jelena Obradović in Barcelona (30 April 1991). Sponsored by the University of Barcelona.

Publications

(1) Comparative sedimentology of lacustrine sequences in Neogene Strike-Slip basins. IGCP 324 Workshop. Abstracts and Field Guide. 23 pp. and eight figures. (Ilyas Erdal Kerey, ed.).

(2) First issue of the Global Geological record of Lake Basins (GGLAB): Edited by E. Gierlowski-Kordesch & K. Kelts. Fifty contributions from 11 countries. In press. Cambridge University Press.

Thirty-seven countries were involved in the project (* indicates the countries active in 1991): Argentina*, Australia*, Austria, Belgium, Brazil*, Canada*, Chile*, China*, Congo, Czechoslovakia*, Denmark*, Egypt*, France*, Germany*, Greece*, Hungary*, India, Iran*, Italy*, Kenya, Mexico, Morocco*, Netherlands, New Zealand, Nigeria, Norway*, Poland*, Spain*, Sweden*, Switzerland*, Thailand, Turkey*, United Kingdom*, United States*, Uruguay, USSR* and Yugoslavia*.

Activities planned

General goals

(1) To establish closer contact with South American and East Asian researchers interested and involved in lake deposits research (see specific meetings).

(2) To start full development of the project in its diverse items: Possibilities to compare detailed geochemical, sedimentological, and palaeo-magnetic studies in selected lacustrine sequences.

(3) To set the framework of short courses on isotopic sedimentology of lacustrine deposits and lacustrine basin analysis. First activities in this field will be developed by Dr Kelts in the Minnesota University.

The main GLOPALS objectives can be summarized in the need to develop criteria and methodologies for interpreting past lacustrine sequences:

(1) Better identify the differentiated environments within ancient lacustrine basin sequences. Try to establish which are the indicators in the sediments deposited in diverse types of basins, under diverse tectonic, geochemical and productivity conditions.

(2) To separate the influence on lacustrine systems of tectonic, climatic, sedimentary chemical, sedimentary diagenetic overprints, source area and other changes.

(3) Establishment of principle of basin analysis in terms of the special aspects applicable on lacustrine basins.

(4) Identification of long-term laminated sequences in the geological past which allow high resolution environmental analysis.

(5) Encouraging new techniques and a more structured uniform approach to understanding the high resolution environmental records within the appropriate sequences.

(6) Application of new techniques to the understanding of cycles, rhythms and abrupt events in geochemical stratigraphy.

(7) Application of new geochemical techniques and search for methods for determining palaeoprecipitation, altitude, and basin correlation as a first step towards a non-marine-marine correlation.

(8) Contributing to the teaching and training commitment for geoscientists from less developed countries and to provide guidelines for a global community of increasingly active lacustrine researchers.

Meeting

(1) IGCP Project 324/GLOPALS annual meeting: Geochemical Signals in Lacustrine Sequences, Madrid (Spain), 17-20 June 1992. The attendance of several South American colleagues is hoped.

(2) Symposium on lacustrine sedimentation and facies analysis. Sponsored by IGCP Project 324 (UNESCO-IUGS) and the Congress Organization. To be held during the III Congreso Geologico de España and VIII Congreso Latinoamericano de Geología, Salamanca (Spain), 21-26 June 1992. This symposium has been planned to enhance South American participation.

(3) Symposium on climatic versus tectonic controls on lacustrine sedimentation. 29th International Geological Congress, Kyoto (Japan), August-September 1992. The organizers of this symposium (Drs Ashley, Takemura and Horie) have been contacted in order to arrange some kind of individual participation of the members of IGCP Project 324.

Proposed major publications

(1) Global Geological Record of Lacustrine Basins (Vol. 2). Cambridge University Press (E. Gierlowski & K. Kelts).

(2) 'Modern and ancient saline lake sediments'. Submitted proposal to the SEPM (B. Last and R. Renaut, eds.), 35 papers.

(3) Special issue of *Journal of Palaeolimnology* (B. Last and R. Renaut, eds.), ten papers.

No. 325 - PALAEOGEOGRAPHY AND AUTHIGENIC MINERALS (1991-1995)

Jacques Lucas, Université Louis Pasteur, Institut de Géologie, 1, rue Blessig, F-67084 Strasbourg, France.

Liliane Prévôt, CNRS, Centre de Géochimie de la Surface, 1, rue Blessig, F-67084 Strasbourg, France.

Description: During the past decade, considerable progress has been achieved in the understanding of phosphate genesis, due in particular to IGCP Project 156, which terminated in 1988 after ten years of highly successful activity. Advances concern mainly the formation of materials (genesis of apatite) and their mineralogical, petrographic and geochemical description, as well as the inventory and detailed stratigraphic and sedimentological study of deposits.

IGCP Project 325 has been launched as a successor to IGCP Project 156. Its main goals are the following:

to define the general palaeogeographic features which make it possible to recognize and delimit in space and time bioproductite bearing provinces;

to determine the regional palaeogeographic conditions favourable for the formation of commercial phosphate deposits;

to specify the mechanism of formation of bioproductites such as chalk, chart, black shale, glauconite, and phosphorite in order to discover new deposits of such mineral raw materials in the recognized 'provinces', in particular in developing countries, and, by feedback, to improve the palaeogeographic reconstructions by taking into consideration the variations of authigenic mineral deposits.

Achievements in 1991

Approved by the IGCP Board in February 1991, the inaugural meeting of IGCP Project 325 was held in Strasbourg, France, on 26 March 1991, on the occasion of the EUG-VI Conference. It had 16 participants from seven countries.

This first year of the project was devoted to publicizing the new project, specifying its originality as compared with the previous IGCP Project 156. By the end of the year, 100 participants had registered from about 30 countries. Close and operational

relations have been established with COMEMIR (programme on Continental Margin Environments and Mineral Resources) of IOC, as well as with the Tethyan Working Group, for the plotting of palaeogeographic maps.

The project was also associated to the first Gentner Conference, a regional meeting on phosphorites and black shales held in Jerusalem, Israel, followed by a three-day field trip. About 20 per cent of the participants were members of IGCP Project 325.

Newsletter No. '0' has been sent to all members.

Activities planned

Meetings

(1) Conference in Assunt, Egypt, followed by field trip, 22 February-1 March 1992, organized by Assunt University.

(2) Participation in the national conference of Russian phosphorite specialists, to be held in Moscow, Russia, in August 1992.

The Newsletter will be regularly published and dispatched. Thematic and regional working groups will be proposed. The involvement of African and East European scientists will be enlarged.

No. 328 - PALAEOZOIC MICROVERTEBRATE BIOCHRONOLOGY AND GLOBAL MARINE/ NON-MARINE CORRELATION (1991-1995)

S. Turner, Queensland Museum, P.O. Box 300, S. Brisbane, QLD 4101, Australia.

G.C. Young, BMR, P.O. Box 378, Canerra, ACT 2601, Australia.

Description: The project will co-ordinate research on Palaeozoic microvertebrates (that is, scales and modified denticles, spines, teeth, ornamented bones), by integrating new data from developing countries to establish an effective global data base of Palaeozoic taxa. The taxonomy of the important groups will be clarified by publication and workshops. This knowledge will be applied to the solution of geological problems, specifically biocorrelation of marine and non-marine sequences, and questions of palaeoenvironment and palaeogeography. The data base will be used to analyse spaciotemporal distributions of major taxa, and improve understanding of factors which control that distribution, such as global geographic or climatic change, catastrophic events and palaeoenvironmental adaptation. Main aims are to establish global biozonation schemes using vertebrate microremains, and to publish detailed correlation tables for all Palaeozoic systems incorporating useful micro-vertebrate zone fossils.

Achievements in 1991

Meetings held

The first formal meeting of the project was held during the VIIth International Symposium on the Studies of Early Vertebrates, at the Parc de Miguasha, Quebec, 9-23 June, which was attended by about 60 delegates, from 13 countries - Australia, Canada, China, Estonia, France, Germany, Italy, Lithuania, Netherlands, Russia, Sweden, United Kingdom and United States. Four delegates, one each from Australia, China, Lithuania and Netherlands were aided by UNESCO-IUGS funds. During the first formal project meeting on 11 June, attended by 28 delegates, Dr Sue Turner (Queensland Museum) and Dr Gavin Young (B.M.R.) were elected as joint project leaders until mid-1993. Project workers contributed to various other meetings: 'Hard tissues and age of vertebrates' meeting, Bondy, France; C.A.V.E.P.S. meeting, Alice Springs; 6th Ordovician Symposium; 8th Gondwana Symposium; V.P. meetings, United Kingdom and United States; Permian Congress, USSR; XIIth Int. Carboniferous-Permian Symposium, Argentina; 2nd Indo-China Geology Conference, Viet Nam; Devonian Subcommission, Rabat, Morocco.

Main scientific achievements

Research projects in the first year were summarized in Ichthyolith Issues Numbers 6-8 distributed to a project network which has increased to 130 workers covering 43 countries. Particularly satisfying are the offers of microvertebrate collections from conodont and invertebrate workers, some of which have been passed on for study to members from developing countries. One hundred and twenty-five papers on Palaeozoic fish were listed in 1991, 53 given under the IGCP banner.

Major advances resulted from the opportunity to meet and discuss new discoveries at Miguasha, were nearly all thelodont workers and several from the Devonian and Carboniferous Groups were able to attend together for the first time. Over 50 papers on Palaeozoic fish were presented at Miguasha; half were directly relevant to IGCP Project 328, including several on the important Frasnian site in the Escuminac Formation at Miguasha which is now yielding microvertebrates; one on the classic Upper Devonian (Frasnian) reefal fish faunas of Gogo, Western Australia, which include lungfish and placoderms, some of which are now yielding microremains; new microvertebrates collected from

central Australia where they are often the only means of dating sequences; and Early Silurian microvertebrates and new articulated scale-bearing agnathans from Arctic Canada, Quebec, Nova Scotia and New Brunswick, Siberia and Tuva. Displays and workshops were held throughout - of particular note were those on Early Silurian thelodonts which demonstrated potential for biostratigraphical correlation between those regions. Important also was the similarity of Late Devonian-Early Carboniferous fish assemblages worldwide when compared by delegates from Australia, Canada, China, France, Germany, Poland, USSR and the United States, with phoebodont shark teeth emerging as potentially useful zone fossils.

Field trips included collecting the Miguasha shoreline (the classic Upper Devonian Escuminac Formation); the Upper Silurian West Point Formation, Port Daniel; Silurian sediments in the Grand Grève Formation; the Gaspé Sandstones (L.M. Devonian) including the York River Formation. A new microvertebrate layer was found in the Devonian Battery Point Formation, all on the Gaspé Peninsula, Quebec. A tour of Nova Scotia and New Brunswick enabled collecting for micro-vertebrates at some classic Lower Carboniferous sites including the famous Joggins foreshore and Horton Bluff.

Other major achievements this year include clarification of similarities between Ordovician vertebrates from Gondwana (Australia, Bolivia); strong faunal similarities between eastern Canada and Siberia in Late Ordovician-Early Silurian, which should lead to useful zonation schemes in the Northern hemisphere; realization of a new faunal realm in the Early Silurian of northern Mongolia; new Devonian material from Gondwana - central Australia, North Africa, the Middle East, southern Asia and the Falkland Islands promising better correlation schemes and new zone fossils; a study of Middle Devonian turiniid thelodonts of Antarctica was submitted; great progress in the application of Late Devonian phoebodont shark teeth based on new material from conodont-dated sequences for use as a standard from Poland, Urals, Kuznetsk Basin, Timan, Kazakhstan, Germany, France, Australia and the United States.

Field research and new sites for microvertebrate assemblages included new Devonian and Ordovician fish from central Australia; astonishing new Silurian articulated fish from Arctic Canada; new Devonian collections from Antarctica; new Ordovician and Devonian material from Bolivia; new Devonian and Permian fish from Brazil and Venezuela; new Devonian fish from Poland, Moravia, Urals, Caucasus, Kuznetsk Basin, South Africa and Viet Nam; Carboniferous of Eire and Kashmir and Kumaun Himalaya; first Permian microvertebrates from Oman, Thailand and Western Australia; new Devonian fish from the Pyrénées chain.

The possibility of setting up the proposed Palaeozoic fish data base under the auspices of CASP - Cambridge Arctic Shelf Project has been put to the participants. Dr Gavin Young was elected to head the data base subproject.

The project leaders have sought IPA recognition for the international working group on microvertebrates which it is proposed will be known as the Gross Society.

Important publications

- Vézina, D. & Arsenault, M., 1991. 7th International Symposium, Studies of Early Vertebrates, Abstracts. Parc de Miguasha, P.O. Box 183, Nouvelle (Québec): 51 pp.

- Vézina, D. & Cloutier, R., 1991. Guidebook for Field Trips, 7th International Symposium, Studies of Early Vertebrates, Parc de Miguasha, P.O. Box 183, Nouvelle (Québec): 68 pp.

- Three newsletters, Ichthyolith Issues Numbers 6-8 (ed. Dr S. Turner), covered IGCP Project 328 work in 1991. An address list/experts guide was issued with No. 8.

- Scientific articles in international journals by individual members of IGCP Project 328; full list for 1991 is lodged with the Secretariat in Paris.

Forty-four countries were involved in the project (* indicates countries active in 1991): Algeria, Argentina, Australia*, Austria, Belgium, Bolivia, Brazil*, Burma, Canada*, Chile, China*, Czechoslovakia*, Denmark, Ireland, Estonia*, France*, Germany*, Hong Kong, India, Iran*, Italy, Japan, Latvia, Libyan Arab Jamahiriya, Lithuania*, Morocco, Netherlands*, New Zealand, Norway, Oman, Poland, Romania, Russia*, South Africa, Spain, Sweden, Switzerland, Thailand, Turkey, United Kingdom*, United States*, Uruguay, Venezuela and Viet Nam.

Activities planned

Scientific goals

During 1992, plans to establish a data base for global occurrences of Palaeozoic microvertebrates, and to develop preliminary zonations for the Silurian, Devonian, and across the D/C boundary, will form the basis for longer term scientific goals. These include distinguishing marine, marginal marine, and non-marine occurrences of major taxa at different times in

the Palaeozoic, and relating these broad patterns to their biostratigraphic distribution in different palaeogeographic regions. Integrating biogeographic and biostratigraphic patterns will give insight into biological processes like global vicariance and dispersal, which in turn contribute to the knowledge base of geological processes which underpin models of continental reconstruction of Palaeozoic continental blocks, terranes, and microcontinents, and broader questions of Paleozoic palaeogeography and palaeoclimatology.

Education as a key to the use and understanding of Palaeozoic microvertebrate remains. One aim is to disseminate information on the identification, use, and importance of the remains of the seven major groups of fishes. By encouraging the introduction of the teaching of microvertebrates into palaeontology and especially micropalaeontology courses, a new generation will grow up that can utilize these fossils; some success has already been achieved in Australia. Project workshops and preparation of university course notes and guides to useful microvertebrates will encourage this trend.

Meetings foreseen

- Project workshop at the 11th Australian Geological Convention of Ballarat, Victoria, Australia, 18-25 January 1992; field meeting to the Grampians.

- Participation in Fifth and Final International Conference on Global Bio-Events (IGCP Project 216), Göttingen, Germany, 16-19 February 1992.

- Australian group workshop at the AAP meeting, Perth, 16-17 March 1992.

- Participation in the Silurian Subcommission Meeting at Prague, Czechoslovakia, 21-29 August 1992 with field trips.

- Workshop at the 29th International Geological Congress, Kyoto, Japan, 24 August-3 September 1992.

- Annual meeting and academic session at the International Symposium on the Devonian Symposium and its Economic Oil and Mineral Resources, Guilin province, China, 9-12 September 1992.

- United Kingdom workshop at the 40th Annual Vertebrate Palaeontology and Comparative Anatomy Symposium, Bristol, United Kingdom, 18-25 September 1992.

- Workshop at the Paléogéographies et Biogéographies de l'Europe Occidentale au Paléozoïque, 16-17 October 1992, Villeneuve d'Ascq, France.

- A major international IGCP Project 328 symposium will be held mid-term in Germany, probably in Göttingen in early August 1993.

- The Subcommission on Devonian Stratigraphy and IGCP Project 328 hope to hold a joint meeting in Southampton in 1994.

Publications planned

- Chapters relevant to the project in a new book on Palaeozoic Vertebrate Biostratigraphy, edited by John A. Long (Western Australian Museum) to be published by Bellhaven Press in late 1992/early 1993.

- Contributions to a major book on the Escuminac fauna and flora to be published by the University of Kansas Press in 1993.

- Contributions to the Miguasha symposium volume to be published in conjunction with University of Kansas Press in 1993.

- Abstracts and a symposium volume are planned for the International Palaeozoic Microvertebrate Meeting planned to coincide with the 90th birthday celebration of Professor Walter Gross (a pioneer Palaeozoic vertebrate microfossils worker) in mid-1993.

- A proposed atlas of microvertebrates - an atlas for specialists along the lines of the Atlas of Ostracodes or Conodont Catalogue, or a general textbook on microvertebrates is planned during the lifetime of IGCP Project 328 (provisional editors: S. Turner and P. Janvier).

- A major review on the use of the Palaeozoic microvertebrates.

IGCP projects approved and starting in 1992 (nine projects)

PROJECT 306

Title: Stratigraphic correlation of Palaeozoic and Mesozoic sediments of South-East Asia

Proposers: Tong-Dzuy Thanh, Dang Vu Khuc (Viet Nam), Ph. Janvier (France)

Address: Tong-Dzuy Thanh, Dang Vu Khuc, Palaeontological Association of Viet Nam, 6 Pham Ngu Lao, Hanoi, Viet Nam
Ph. Janvier, Institut de Paléontologie, 8, rue Buffon, 75005 Paris, France

Description

The project intends to co-ordinate the stratigraphic results obtained by the national geological surveys. It would establish standard stratigraphic schemes for each system of the Palaeozoic and the (pre-Cretaceous) Mesozoic. There is an important training component. Links with ICS subcommissions will be assured.

The proposal has obtained the preliminary endorsement of the third IGCP Regional Meeting for South-East Asia and the Pacific.

The work schedule includes a first meeting in Hanoi in 1992 during which the election of project leader and adoption of a detailed schedule are planned. Field work, a workshop and a training course are planned for 1993 in Viet Nam, and symposia in other participating countries in the following years.

Published results are expected after two years and a comprehensive publication will be prepared in the fourth (final) year of the project.

Accepted for 1992-1995.

PROJECT 319

Title: Global Palaeogeography of the Late Precambrian and Early Palaeozoic

Proposers: K. Seslavinsky (Russia), I. Murdmaa (Estonia), T.P. Crimes (United Kingdom)

Address: K. Seslavinsky, Institute of Physics of the Earth, B. Grouzinskaya 10, 123810 Moscow, Russia
I. Murdmaa, Institute of Geology, Boulv. 7, 2000QS Tallin, Estonia
T.P. Crimes, Department of Earth Sciences, University, Liverpool L69 3BX, United Kingdom

Description

The project would aim at the analysis and reconstruction of the global palaeogeography by compilation of 1:20 million scale palaeogeographic maps based on refined correlations of terminal Precambrian, Cambrian and Lower Ordovician strata, as well as at the development of sedimentological and palaeooceanographic models for the best known examples within this time-span. It would contribute also to the better knowledge of the mineral resources potential of the formations concerned.

Altogether 24 countries have already shown interest for the project.

Laboratory research would be based in Novosibirsk and Moscow (Russia), Tallin (Estonia), Nanking and Beijing (China), Boulder and San Diego (United States), Canberra and Sydney (Australia) and Liverpool (United Kingdom).

Accepted for 1992-1996.

PROJECT 322

Title: Correlation of Jurassic Events in South America
Proposer: A.C. Riccardi (Argentina)
Address: A.C. Riccardi, Museo de Ciencias Naturales, 1900 La Plata, Argentina

Description

The aims of the project are: definition and correlation of local and regional events (transgressions, regressions, changes of sea level, evolution of sedimentary basins, palaeogeographic changes, geographic and chronologic biotic changes, oceanic connections, climatic patterns, magmatic and magnetic events) on the basis of data from sedimentology, petrology, macro- and micropalaeontology, sequential stratigraphy, magnetostratigraphy, geochronology. The obtained data will be compiled in local and regional correlation charts and palaeogeographic reconstructions for each Jurassic stage. Correlation charts and palaeogeographic maps will be produced. In 1992, meetings will be held in Argentina and Chile.

Accepted for 1992-1996.

PROJECT 326

Title: Oligocene-Miocene Transition in the Northern Hemisphere (biostratigraphy, palaeogeography, palaeoclimatology, correlation of marine and continental deposits. Evolution of the Biota. Oligocene-Miocene transition in the epicontinental seas, North Atlantic and North Pacific Oceans)
Proposers: V. Yu. Reshetov, M.A. Akhmetiev (Russia)
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M.A. Akhmetiev, Geological Institute of the Academy of Sciences of Russia, Pyzhewsky 7, 109017 Moscow, Russia

Description

The objectives of the project are: (1) to organize scientists, who are studying different aspects of geology and biota of the Late Oligocene and Early Miocene, and stimulate further co-operation among geoscientists, palaeontologists and palaeobotanists; (2) to correlate the marine and continental deposits of different areas on the base of biostratigraphy, geological data and events (Late Oligocene-Lower Miocene); (3) to establish main characteristics of faunal and floristic changes in different stages; (4) to reconstruct the palaeogeography and some episodes sedimentation, transgressions and regressions of marine basins and epicontinental seas; (5) to integrate the results in palaeobiogeographical maps and special publications; (6) to study the Oligocene-Miocene transition in the Mediterranean and other epicontinental seas and also in the North Atlantic and North Pacific areas (using results of all oceanic programmes). The work will be done in co-operation with the Palaeogene and Neogene Subcommissions of the International Commission on Stratigraphy of IUGS.

Accepted for 1992-1996.

PROJECT 329

Title: Palaeogeographic and palaeo-ecologic evolution of Paratethyan basins during the Neogene and their correlation to the global scales
Proposer: N. Krstić (Serbia, Yugoslavia)
Address: N. Krstić, Geoinstitut, Y-11000 Beograd-22, Rovinjska 12, P.O. Box 42

Description

The main correlation of the Neogene of the Paratethys was fulfilled by IGCP Project 25, but it has not solved many questions of a detailed correlation inside the Paratethys or correlations with continental areas. The project will deal with these problems, using all possible methods, such as conventional macro- and micropalaeontological research (including micro-mammals) and also physical (like palaeomagnetism) and chemical methods. Tectonostratigraphy would be an important part of the research. The formation pattern should also be studied and revised.

Accepted for 1992-1996.

PROJECT 336

Title: Petrology and metallogeny of intraplate mafic and ultramafic magmatism
Proposer: M.L. Zientek (United States)
Address: M.L. Zientek, United States Geological Survey, United States Courthouse, Room 656, W. 920 Riverside Ave., Spokane WA 99201-1087

Description

The origin and mechanisms of ascent and eruption of continental flood basalts are major problems in igneous petrology but they have not been well understood. The project focuses on temporal and spatial distribution, tectonic setting and temporal changes in composition of flood basalts, magmatic evolution of layered complexes and associated mineralization.

At the beginning, participants from eight countries will co-operate in the project and two countries indicate specific interests. Field work will be carried out in major flood basalt areas in North America, South America, South Africa, Siberia and Australia. Co-operation will be established with IAGOD.

Accepted for 1992-1996.

PROJECT 339

Title: Correlation of modern geomagnetic and palaeomagnetic data in the region of the geomagnetic equator
Proposer: Nguyen Thi Kim Thoa
Address: Nguyen Thi Kim Thoa, Institute of Geophysics, P.O. Box 411, Buudien Boho, Hanoi, Viet Nam

Description

The project concerns geomagnetic variation, induced magnetization, and palaeomagnetism from 20° N. to 20° S.

The results would be used in the interpretation of palaeomagnetic data in tectonic reconstructions, mainly in South-East Asia. Co-operation has already been established with France, Germany, India, United States, Russia, Brazil and Nigeria. Australian scientists are also interested.

Meeting activity will start in October 1992. The main objectives: to recognize and analyse reversals, to study the electrojet variations and to make palaeomap reconstructions - are important topics for a worldwide correlation programme. (The geomagnetic equator touches only developing countries.) A training component is also included.

Accepted for 1992-1995.

PROJECT 342

Title: Geochronology and isotopic characterization of metallogenetic provinces in South America
Proposer: M. Zentilli (Canada)
Address: M. Zentilli, Dept. Earth Sciences, Dalhousie University, Halifax, B3H 3J5, Canada

Description

Geochronological and isotopic techniques will be used to date and characterize the most significant groups of ore deposits of the South American Plate. Radiogenic and stable isotope data will help to identify and define metallogenetic domains and allow correlation and comparison on the basis of age, chemistry, host rocks, environment and mechanism of deposition, source of metals and fluids, structural and tectonic controls, and post-ore modification.

Workshops, field visits, short courses, a Newsletter, and co-ordinated publication, will promote collaboration and standardization of analytical techniques and data reporting. A refined metallogenetic/stratigraphic analysis will result, which will enhance understanding of ore genesis, and facilitate resource assessment. Co-operation with the UNESCO-IUGS Ore Deposit Modelling Programme is foreseen.

Accepted for 1992-1996.

PROJECT 343

Title: Stratigraphic analysis of the foreland epicratonic Tethyan basins
Proposers: J. Dercourt (France), F. Cecca (Italy)
Address: J. Dercourt, UPMC, 4, place Jussieu, 75252 Paris Cédex 05, France

Description

The proposed project aims to construct stratigraphic charts based on the palaeobiogeography and subsidence history of the Peritethyan epicratonic basins from Permian to Recent, taking into consideration phenomena of faunal and floral endemism and cosmopolitanism.

Besides national geological surveys and universities, several petroleum companies are also interested.

The project is concerned with Tethyan foreland epicratonic basins in Europe, North Africa,

Western Asia and the Middle East. More participation will be arranged from Middle East and East European countries, meetings will be held in the Middle East as well as in Europe and North Africa, and co-operation with other relevant IGCP projects will be developed.

Accepted for 1992-1996.

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