Research and Postgraduate Training in Mineral Exploration

Project Findings and Recommendations

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RESEARCH AND POSTGRADUATE TRAINING
IN MINERAL EXPLORATION

Project Findings and Recommendations

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Development
Programme
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Contents</th>
<th>Paragraph No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>I.</td>
<td>INTRODUCTION</td>
<td>(1 - 15)</td>
</tr>
<tr>
<td></td>
<td>Background</td>
<td>1 - 7</td>
</tr>
<tr>
<td></td>
<td>Origin of the Project</td>
<td>8 - 11</td>
</tr>
<tr>
<td></td>
<td>Objectives</td>
<td>12 - 15</td>
</tr>
<tr>
<td>II.</td>
<td>PRELIMINARY PROJECT ACTIVITIES</td>
<td>(16 - 17)</td>
</tr>
<tr>
<td>III.</td>
<td>PROJECT OPERATIONS</td>
<td>(18 - 32)</td>
</tr>
<tr>
<td></td>
<td>Work Plan</td>
<td>18 - 19</td>
</tr>
<tr>
<td></td>
<td>Inputs</td>
<td>20 - 21</td>
</tr>
<tr>
<td></td>
<td>Trainees</td>
<td>22 - 23</td>
</tr>
<tr>
<td></td>
<td>Communication Support</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td>Development of the Programme of Studies</td>
<td>25 - 29</td>
</tr>
<tr>
<td></td>
<td>Meeting of the International Consultative Panel</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>Tripartite Review Meeting</td>
<td>31</td>
</tr>
<tr>
<td></td>
<td>Local Advisory Board</td>
<td>32</td>
</tr>
<tr>
<td>IV.</td>
<td>COMPLEMENTARY ASSISTANCE AND CO-OPERATION</td>
<td>(33 - 36)</td>
</tr>
<tr>
<td>V.</td>
<td>PROJECT ACHIEVEMENTS</td>
<td>(37 - 44)</td>
</tr>
<tr>
<td></td>
<td>Output of Graduates</td>
<td>37 - 39</td>
</tr>
<tr>
<td></td>
<td>Strengthening the Department of Geology</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>Review of Exploration Data and Establishment of Search Procedures</td>
<td>41 - 44</td>
</tr>
<tr>
<td>VI.</td>
<td>CONCLUSIONS AND RECOMMENDATIONS</td>
<td>(45 - 57)</td>
</tr>
<tr>
<td></td>
<td>Recommendations</td>
<td>50 - 57</td>
</tr>
</tbody>
</table>
### TABLE OF CONTENTS (CONTD.)

<table>
<thead>
<tr>
<th>ANNEXES</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>A.</td>
<td>15 - 17</td>
</tr>
<tr>
<td>DETAILS OF GOVERNMENT AND INTERNATIONAL INPUTS</td>
<td></td>
</tr>
<tr>
<td>ACCORDING TO THE ORIGINAL PROJECT DOCUMENT</td>
<td></td>
</tr>
<tr>
<td>B.</td>
<td>18 - 20</td>
</tr>
<tr>
<td>IMPLEMENTATION DETAILS OF INTERNATIONAL AND</td>
<td></td>
</tr>
<tr>
<td>GOVERNMENT INPUTS</td>
<td></td>
</tr>
<tr>
<td>C.</td>
<td>21</td>
</tr>
<tr>
<td>PROJECT REVISION 'P'</td>
<td></td>
</tr>
<tr>
<td>D.</td>
<td>22 - 27</td>
</tr>
<tr>
<td>PROGRAMME OF STUDY : M.SC. IN MINERAL EXPLORATION</td>
<td></td>
</tr>
<tr>
<td>E.</td>
<td>28 - 29</td>
</tr>
<tr>
<td>TITLES OF RESEARCH PROJECTS (GEY 482)</td>
<td></td>
</tr>
<tr>
<td>F.</td>
<td>30 - 31</td>
</tr>
<tr>
<td>RESEARCH TOPICS FOR DOCTORAL DISSERTATIONS</td>
<td></td>
</tr>
<tr>
<td>G.</td>
<td>32 - 36</td>
</tr>
<tr>
<td>MINUTES OF THE INAUGURAL MEETING OF THE INTERNATIONAL</td>
<td></td>
</tr>
<tr>
<td>CONSULTATIVE PANEL HELD IN THE DEPARTMENT OF GEOLOGY,</td>
<td></td>
</tr>
<tr>
<td>UNIVERSITY OF IBADAN FROM 6-8 OCTOBER 1980</td>
<td></td>
</tr>
<tr>
<td>H.</td>
<td>37 - 41</td>
</tr>
<tr>
<td>UNDP TRIPARTITE REVIEW REPORT - 24 APRIL 1981</td>
<td></td>
</tr>
<tr>
<td>I.</td>
<td>42 - 43</td>
</tr>
<tr>
<td>B.SC. SUBJECTS-COURSE OUTLINES</td>
<td></td>
</tr>
<tr>
<td>J.</td>
<td>44 - 45</td>
</tr>
<tr>
<td>M.SC. COURSE OUTLINES OF SUGGESTED SUBJECTS</td>
<td></td>
</tr>
<tr>
<td>(APPLIED PHYSICS)</td>
<td></td>
</tr>
</tbody>
</table>
I. INTRODUCTION

Background

1. At the time the project was first proposed in 1974/75, the mining and quarrying sector of the economy contributed 45.5 per cent to Nigeria's GDP as against 23.4 per cent for the agricultural sector. Although petroleum was the major contributor in the mining sector, other minerals were not overlooked. In addition to the National Oil Company, in this period, the National Mining Company and the Nigerian Steel Authority were created.

2. The country's non-petroleum mining industry at that time centred largely around unconsolidated deposits of tin-tungsten, columbite-tantalite, zircon and coal. An active and expanding Geological Survey Department in the Ministry of Mines and Power had detected possibilities of iron, copper, molybdenum, lead-zinc, silver and barite. Aeromagnetic surveys of most of the country had been undertaken.

3. The need for trained staff to meet these multiple requirements was considerable. Although there had been a satisfactory output of science graduates and holders of B.Sc's in Geology, the need for more highly specialized and qualified staff had not been met.

4. The Third National Development Plan (1975-80) of the Federal Government had already foreseen the need for establishing training programmes and projects in all the strategic sectors of the economy, among which the mining sector was one of the most important, with strong potential for diversification and increased production. The Third Plan further noted that "in contrast to the unemployment of unskilled labour, a shortage of intermediate to high-level manpower is hampering the development of the Nigerian economy".

5. The University of Ibadan was a logical choice for training in the mining sector since it was the first university to be founded in Nigeria (1948) and the first to establish a department of Geology within the Faculty of Science (1959). This has now become a large department with highly qualified staff and advanced equipment which established mutually beneficial research and operational relationships with the mining industry.

1/ Data from the Federal Office of Statistics show that, in 1975, petroleum contributed Naira 5,873 million and other mining N. 404 million to the GDP at constant prices. By 1981, the figures were N. 5,444 and N. 724 million respectively, showing a slight drop in petroleum and almost a doubling of other mining.
These factors, together with the federal character of the University, gave it a pre-eminent position among the geology departments that have subsequently grown up in other universities in the country. It was, furthermore, the first department of Geology to organize post-graduate training programmes for specialists in mineral exploration. Some measure of its status can be gleaned from the fact that the professor who was Head of the Department up to July 1981 was also President of the Geological Society of Africa.

6. Between 1964 and 1975 the Department graduated 275 B.Sc's in geology in three-year courses. Subsequently, undergraduate enrolment was restricted to allow for greater concentration of resources on graduate programmes. The Department's co-operation with the petroleum industry resulted in the creation of a chair of Petroleum Geology within the Department as well as financial assistance towards the construction of the Geology building, a 70-room complex of classrooms, laboratories, library, etc., which was available to the project.

7. The academic year of the University runs from October to July, in two semesters, with a break in February.

Origin of the Project

8. The need to strengthen the Department of Geology and to provide advanced training in Nigeria was recognized by the University Faculty in the early 1970's. In 1973, a Unesco consultant conducted a feasibility study for mounting a graduate training course in the field of Mineral Exploration Geology in co-operation with the staff of the Department of Geology.

9. The need for this advanced training arose from the fact that the overseas graduate training programmes had not generally been relevant to the local geological environment or to the locally available facilities. The Government's nigerianization policy necessitated post-graduate qualifications for Nigerians replacing expatriate staff and the Government was also expanding the work of the Geological Survey Department and intended to complement this with a new Geological Research Institute for research on the more fundamental geological and geophysical problems not normally covered by the Geological Survey Department. All these developments required professionals of the type to be produced by the advanced training proposed for the Department of Geology.

10. The findings of the feasibility study were brought to the attention of the Federal Department of Planning and the United Nations Development Programme (UNDP). The latter funded a preparatory assistance mission/consultancy in December 1975. This mission was undertaken by a faculty member of the University of New Brunswick, Canada, in order to finalize a request and to draw up a draft project document.

11. In June 1977, the UNDP Governing Council approved the Government request for assistance to the University of Ibadan for research and post-graduate training in mineral exploration, amounting to US$ 998,500, to be

Objectives

12. The immediate project objectives were:

i) to strengthen the existing faculty in the Department of Geology through fellowships and the temporary addition of international personnel experienced and qualified to lecture and conduct applied research in mineral exploration,

ii) to design, organize and jointly carry out regular programmes of academic instruction and local practical assignments of international standards for ten to twenty M.Phil or Ph.D graduates per year,

iii) to impart to the teaching and technical staff of the Department the expertise required to maintain the training and research programmes after the end of international assistance,

iv) to assist in completing and reviewing earlier exploration data from other geological projects in the country by means of consultant services and, where necessary, prepare case-history studies, and

v) to establish experimental and pilot-scale exploration data and procedures applicable to wider and more routine searches for specific types of mineral occurrences in relatively untested areas.

13. The longer-term objectives were:

i) to contribute to the objectives of the Third National Development Plan by making the department of Geology the first Nigerian facility capable of training specialists in mineral exploration at the post-graduate level, to fill intermediate to high positions in the most productive sector of the nation's economy,

ii) to contribute to diversification in mineral production by experimental pilot-study results obtained in practical field operations, essential for effective advanced training in mineral exploration.

2/ Later designated United Nations Department for Technical Co-operation and Development (UNDTCD).
14. The campus of the University of Ibadan was designated as the project site, with field operations in selected areas of the country. The Government organization with which the project was to be in direct contact for operational questions was the Department of Geology. In matters of academic policy relating to the curriculum, degree requirements, etc., the responsible Government authorities were, in order of precedence, the Board of Graduate Studies and the University Senate. The project was designed to cover three academic years, with a view to graduating three classes of M.Sc. holders.

15. Details of the Government and international inputs deemed necessary to achieve these objectives are given in Annex A. Apart from these quantifiable inputs, the project document made provision during the life of the project for external guidance based on comparative experience and local machinery to ensure that the project activities were properly related to national needs. These consisted of an International Consultative Panel (ICP) and a Local Advisory Board (LAB). Membership of ICP comprised representatives of the UN Agencies and University Departments concerned as well as a senior member of a Geology Department from another university with similar programmes and of an international consortium or corporation engaged in active mineral resource exploration and exploitation. The Government was also expected to provide the director, or equivalent, of an agency responsible for supporting geological services to industry. Membership of the LAB, except for the two external members, was similar, but also included a representative of the National Universities Commission, which was responsible for the allocation of funds between the various universities in the country. It was intended that the ICP should meet four times during the project's life and the LAB once a year. The two external members of the ICP were to be funded from the consultancy component of the project.

II. PRELIMINARY PROJECT ACTIVITIES

16. The project document, drawn up with the help of the December 1975 Preparatory Assistance Mission, foresaw the beginning of project operations in July 1977. However, it was not until December 1977 that the document was signed by all parties. This meant that the earliest possible commencement date would be in the academic year 1978/79. A request from the Government to delay project operations by one year brought the actual beginning of project operations forward to mid-1979 in preparation for the academic year 1979/80 that began in October 1979.

17. The delay in the starting date of the project's operations had adverse consequences for the future development of the programme. At the time the project was conceived and the project document prepared, the financial position of the University was very favourable. By 1977, however, the overall financial situation of the country suffered from the oil-price crisis with the result that the University and the Department of Geology budget had to be cut back.
III. PROJECT OPERATIONS

Work Plan

18. One of the first tasks of the international staff in preparation for the beginning of the academic year 1979/80 was to draw up a work plan for the project. The delay in the beginning of operations had given rise to changed conditions at the project site that did not correspond to the details in the original project document drawn up in 1975. Work on this plan was completed in November 1979 and it was issued as an annex to the revised project document, signed in December 1979.

19. Most of the changes that had occurred since 1975 were indirect or direct consequences of the cuts in University budget in the intervening years.

Inputs

20. Details of the UNDP and Government inputs (expert services, consultants, fellowships, national staff and equipment) are shown in Annex B. Various factors led to the need for a rescheduling of inputs during the life of the project. These can be summarized as follows:

i) Since the full complement of international staff was not in place before September 1979, there was not sufficient time for them to prepare new curricula and course outlines for the 1979/80 academic year. As a result that year was considered to be a preparatory year. The loss of this first academic year meant that the 18 man-months provided for both the Geophysicist and the Geochemist in the original manning table ran out half-way through the first full year of training.

ii) The Chief Technical Adviser returned to his home institution after having completed 24 out of the 39 man-months foreseen for his post.

iii) The minimum possible time to carry out the work foreseen and to achieve the bulk of the project objectives was two full years of training. With the 1979/80 academic year being only a preparatory year, completion of the two full years brought the termination date forward to the end of the 1981/82 academic year. A rescheduling to take these factors into account was undertaken toward the end of 1981, extending the Geophysicist and Geochemist posts through 1982. However, increased expert costs meant that, even with a budget increase of US$ 17,000, it was still only possible to cater for 111 man-months...
instead of the 144 man-months foreseen in the original budget. This meant that the post of Senior Geological Technician, originally foreseen for 18 man-months, had to be cut out and the consultant component reduced from 51 to 3 man-months.

iv) As a result of a meeting of the International Consultative Panel (ICP) in October 1980, the Head of the Geology Department formally requested the Vice-Chancellor of the University to approve an extension of the project until the end of 1983 with the full complement of international staff. This recommendation was communicated to the Federal Ministry of Planning and was also endorsed by the Tripartite Review meeting. However, due to the financial constraints of UNDP, the IFP for the 1982/86 programming cycle remained substantially the same as for the previous cycle, which, with cost escalations, resulted in a reduction of inputs in real terms. The best compromise that could be made in respect of the project was to ensure the continued services of the Exploration Geochemist until the end of the 1982/83 academic year and provide for a further three consultant man-months for that year. Details of the final rescheduling are given in the final budget revision, signed in May 1983 by Unesco and July '83 by UNDP (Annex C).

v) In addition to the above amendments, changes were also made in the equipment component, reallocating some funds foreseen for new equipment to repair and service contracts for existing equipment and for vehicles and related costs that the University budget was no longer able to carry. There was, however, no significant change in the overall sum (US$ 80,124.57 spent on non-expendables and US$ 13,287 on the expendables as against US$ 71,000 and US$ 26,000 foreseen in the original plan). The small equipment component in the project arose from the two facts that (a) at the time of project formulation, the Department appeared to be well supplied with new equipment from its own resources, and that (b) the Federal Government had established a policy that projects such as this one would derive their equipment component largely, if not entirely, from the capital budgets of their host institutions.

21. Government inputs in terms of counterpart staffing were provided as foreseen in the project document from the second semester of the 1979/80 academic year. At the beginning of that year, three of the Department staff were on sabbatical leave. This was one of the factors that led to the decision to make that year a preparatory one. Due to the budgetary constraints of the University, some sacrifices had to be made in other components, trainee stipends had to be stopped and the duration of field trips had to be cut. The most commendable efforts of the Head of the Geology Department in maintaining the flow of funding against considerable
competition from other University departments, all subjected to the same restrictions, should be recorded.

Trainees

22. The number of post-graduate students admitted to study under the project are shown in the following table:

<table>
<thead>
<tr>
<th>Academic Year</th>
<th>Subjects Studied</th>
<th>No. of Post-Graduate Students</th>
<th>Total No. of Post-Graduate Students</th>
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</thead>
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<tr>
<td>1979/1980</td>
<td>Economic Geology</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Applied Geophysics</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>1980/1981</td>
<td>Economic Geology</td>
<td>3</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>Applied Geophysics</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Exploration Geochemistry</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>1981/1982</td>
<td>Economic Geology</td>
<td>1</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>Applied Geophysics</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Exploration Geochemistry</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>1982/1983</td>
<td>Economic Geology</td>
<td>4</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>Applied Geophysics</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Exploration Geochemistry</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>37</strong></td>
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23. To compensate for the low enrolment in the 1979/80 preparatory year, arrangements were made, through the initiative of the Chief Technical Adviser (CTA) in consultation with the University, to take in part-time trainees. This resulted in four part-time students being enrolled, bringing the total up to six.

Communication Support

24. At the time of the international team's arrival, the existence of the project and the possibilities it offered were not widely publicized. This was also perhaps a contributory factor to the low initial enrolment. To recruit the requisite number of post-graduate students, the project mounted a vigorous information campaign with a distribution of descriptive pamphlets, newspaper announcements and personal contacts; an announcement was also placed in the March 1980 number of the Newsletter of the Commonwealth Secretariat. This information was prepared principally for the benefit of the leading organizations in Nigeria related to Earth Science such as the Geological Survey, the Steel Corporation of Nigeria, the Nigerian Mining Corporation and the Amalgamated Tin Mines of Nigeria. The success of this operation is attested by the sharp increase in enrolment in the 1980/81 academic year.
Development of the Programme of Studies

25. Although project operations only began in the 1979/80 academic year, the Department of Geology had already taken the initiative to begin a Master's programme in Mineral Exploration in 1978/79. This arrangement had the advantage of allowing the international team to observe the application of this curriculum during the 1979/80 preparatory year and to revise the course structure on the basis of experience gained during that period.

26. To qualify for an M.Sc. under the original course students had to take and pass 20 units of course work and six units of field research. The first semester consisted of ten units of general compulsory subjects, followed by a choice of options in the second semester between Mining Geology, Applied Geophysics and Exploration Geochemistry for the remaining ten units of course work. Field research was common to each of the above options with its six credit units.

27. The revised course, drawn up with the assistance of the international team, was introduced in the 1980/81 academic year after approval by the University's Board of Graduate Studies. Under this programme a student would have to register for a minimum of 32 units and a maximum of 36 units of course work as well as six units of field research. To qualify for an M.Sc. in Mineral Exploration he would have to pass in at least 30 of these units, including all the compulsory courses which accounted for 20 units. Details of the original and revised course structures and syllabi outlines are given in Annex D.

28. Field research projects in the M.Sc. programme were carried out in the February break between the first and second semesters of the academic year, so as not to interrupt the course work. Laboratory analyses and measurements on the samples collected could then be carried out during the second semester along with the writing of reports on the research under the supervision of the national and expatriate staff. Some of the more interesting research projects were completed during the July to September vacations. Many of these research projects were of considerable practical relevance to the development of the mining industry and related research, and merit publication in international journals. The titles of the research projects for the M.Sc. (1979 to 1983) are given in Annex E.

29. In the course of the project four candidates in all registered for the Ph.D programme, of whom two began in the 1980/81 academic year (Economic Geology and Applied Geophysics), one in 1981/82 (Exploration Geochemistry) and one in 1982/83 (Applied Geophysics). Two of the candidates (in 1980 and 1981 respectively) were from the Nigerian Mining Corporation and two others, one from the Geology Department of the University of Calabar in 1980 and the other from the University of Maiduguri in 1982. Details of the thesis work is given in Annex F. Since the completion of a Ph.D thesis normally requires a minimum of three years
full-time study, the project was not able to see this work carried to its completion. Moreover, because of their employment positions, all four candidates were registered on a part-time basis which meant that their theses would probably not be ready for submission inside five or six years.

Meeting of International Consultative Panel (ICP)

30. A meeting of this panel took place at the Department of Geology from 6 to 8 October 1980. The panel members discussed at some length the scope and content of the revised postgraduate programme in mineral exploration in the light of comparative experience elsewhere. The question of the consultant services to be provided to tie in with the proposed programme was also debated. The Head of the Geology Department, in his capacity as Chairman, informed the panel of the University's wish to see the project extended for a further year to cover the academic year 1982/83, with the full complement of international staff. Other panel members suggested a greater use of technical journals in the programme and co-operation with the Department of Forestry in Ibadan which had recently received FAO assistance in the establishment of remote sensing techniques and access to SLAR/LANDSAT data. The list of participants and minutes of the meeting are attached at Annex G. This panel meeting provided useful professional guidance to the project in respect of its future development. The points discussed were duly followed up and some modifications were introduced into the graduate curriculum as a result of detailed subsequent discussions with the University's Graduate Studies Board. The first versions of the curriculum and course outline are given in Annex I:

Tripartite Review Meeting

31. A tripartite meeting comprising representatives from UNDP, the University and Unesco was held in Ibadan on 24 April 1981. The principal concern of this meeting was the financial situation and the rescheduling of the international inputs that had become necessary due, inter alia, to the imminent departure of the CTA. The meeting endorsed the University's request raised at the ICP meeting (see para. 30 above) for an extension of the project to the end of the 1982/83 academic year, though UNDP cautioned the meeting that the new programming cycle for 1982/86 had not yet been worked out and that there might not be a sufficient increase in the IPF. The list of participants and minutes of the meeting are shown in Annex G.

Local Advisory Board

32. Although this Board, identified in the Project Document, was not formally constituted during the course of the project, useful informal contacts were made with various members and officials of Nigerian geological institutions and mining concerns which, to all intents and purposes, fulfilled the original intention of the Board.

- B.Sc.
IV. COMPLEMENTARY ASSISTANCE AND CO-OPERATION

33. The Department of Geology established fruitful co-operation with the University of Edinburgh for research in a geological age-dating programme.

34. Active co-operation was maintained with the mining industry and the Geological Survey Department of the Ministry of Mines and Power. Close working relationships were maintained with the Nigerian Steel Development Authority and, following upon the recommendations of the International Consultative Panel, with the Federal Department of Forestry in Ibadan.

35. The Canadian International Development Agency (CIDA) has sponsored the Institute of Applied Sciences and Technology at the University of Ibadan, designed to form the core of a future engineering faculty which would maintain useful links with the Department of Geology.

36. In 1982, a French bilateral expert was assigned as a "coopérant" to the Department of Geology. He assisted the remaining Unesco team member in the 1982/83 academic year and is due to stay on for another two years, which will ensure useful continuity.

V. PROJECT ACHIEVEMENTS

Output of Graduates

37. The final output from the project during its two fully operational years was 23 M.Sc. graduates in Mineral Exploration, with 14 more admitted into the 1982/83 programme. Four candidates were registered in the Ph.D programmes and substantial assistance was given to two on-going M.Phil candidates. This result can be considered as a satisfactory attainment of the original project objective of graduating ten M.Sc's in the first year of operation, rising to 15-20 in the second year, especially as the project was operating under financial restraints that affected both the national and the international elements.

38. Apart from these quantitative aspects, the revision of the curricula resulted in qualitative improvements. It enabled the specialization in mineral exploration to be undertaken at the M.Sc. level, which previously had only been available to candidates at the M.Phil level, University regulations stipulating that an M.Sc. course in general geology must be taken first. There was a considerable increase in the course work and depth of subject matter, with better defined subject areas. Perhaps the most important qualitative improvement lay in the implementation of the practical work and the field research projects, which trained students in field methods, instrument handling and specific problem-oriented field investigations of the type that they would eventually undertake in their professional lives.
The Project Document's secondary objective of making the courses available to students from other countries in the region was also fulfilled with the enrolment of two students from the Cameroon in the 1982/82 programme.

**Strengthening the Department of Geology**

The implementation of the revised curricula in the course of the project resulted in a notable qualitative advance from the academic point of view. It was also fortunate that means were found to extend the post of the expert in Exploration Geochemistry until the end of the 1982/83 academic year, fortuitously assisted by a French bilateral expert, as this allowed for a reinforcement of the practical aspects of the programme of training.

**Review of Exploration Data and Establishment of Search Procedures**

The significant innovative and qualitative outputs from the project in these fields not only built a previously under-emphasized practical dimension into the academic training, but also resulted in a number of practical findings of interest in the general field of applied geological research and of use to mining concerns in specific fields.

The first two-week field school organized as part of the programme between the first and second semesters of 1980/81 took the form of practical training in Exploration Geophysics in the Ilesha forest area. This activity was of longer-term importance to the University in the sense that Ibadan had not been offering courses in Applied Geophysics, which had, however, recently been introduced by some of the newer geological departments of other Nigerian universities. A further practical outcome in the field of applied geochemistry was to show that the anomalously high copper content in base and slope soil samples located in the Ilesha gold fields area was due to contamination from copper-containing fungicides used by cocoa farmers in the area. This knowledge can now be used to eliminate non-significant anomalies of this metal in this forest belt.

The second field school, held the following year, proved that the Nigerian Mining Corporation was losing significant quantities of gold in their primary concentration process of the bulk sampling programme. Gold was found in all their panned concentrates taken from the tailings. This showed that they were undervaluing the deposit. The project then elaborated methods of reducing the loss through less vigorous de-sliming and primary concentration, followed by magnetic separation of the ilmenite.

The high proportion of practical work in the M.Sc. theses and the Surveying and Exploration Geochemistry courses brought out a number of interesting findings, namely:

i) it was found that untreated aeromagnetic data covering the Jos area were so heavily disfigured by high-frequency noise that conventional interpretation by the air survey
did not yield any useful geological information. The project developed a smoothing technique to suppress this near-surface noise and enhance the signal from deeper and large-scale geology. The smoothed map thus developed can now be reliably used to prepare sub-surface maps for the Younger Granites and the basic gabbro-dolerite suite. This is important because primary tin mineralization in that area is mainly associated with Younger Granite plutons;

ii) A study undertaken of aeromagnetic data for the Ilesha region revealed the presence of three sub-parallel ENE-WSW faults, over 50 kms long, indicating the presence of mineralization that was hitherto geologically unknown;

iii) A study of the soil chemistry around the abandoned Nkpuma Akpatakpa lead-zinc mine detected possible extensions to the mineralization up to 150 metres beyond the known mineralization;

iv) The Nigerian Mining Corporation had been drilling in the Ameka-Enyegba area of Abakaliki on the basis of geophysical indications, but with little success. It was found that these indications could be misleading because the best electrical conductors in the area happen to be marcasite, which bears an inconsistent relationship to the important lead-zinc mineralization within the same structures. The project recommended that drilling be based on geochemical studies, while cross checking the conductors with their surface geochemical expression would facilitate proper identification of the zones.

VI. CONCLUSIONS AND RECOMMENDATIONS

45. Considering the initial delays in project implementation and the severe financial constraints to which both the international and national partners were subject to at that time, the results obtained were remarkably satisfactory. It is self-evident that much greater qualitative advances could have been made had the project had a longer life-span, sufficient to fully test and establish the revised curricula; place the practical work on a firmer footing and make other arrangements within the University for up-grading the M.Sc.-level students in certain basic subject areas, such as mathematics and physics.

46. The principal constraints encountered in the project revolved in one way or another around the financial question. There was not only the direct shortage of University funds for field-work, maintenance of equipment, purchase of spare parts, etc., but also indirect consequences, such as many of the trainees having to take up consultancy work to compensate for the cancellation of the stipends provided for in the original
plan. Although these consultancies provided good practical experience, they tended to overshadow the training programme.

47. The close contacts that were established with the various institutions and enterprises in the mineral exploration and exploitation field, coupled with the fact that several of the trainees were on study leave (full-time or part-time) from such institutions, meant that the training programme was known and appreciated by them, especially the introduction of practical dimensions into the course work. This, in turn, had meant that the graduates have had no difficulty in finding employment in their field.

48. Serendipitous benefits of the project included:

i) assistance by project staff to archaeologists in identifying material in artefacts; and

ii) advice to a field project at the Department of Preventive and Social Medicine on reasons for the collapse of certain wells at certain seasons of the year which led to infection.

This is an indication of the innovative impact that a project of this type can have on the surrounding communities.

49. The project could have benefitted from a fuller implementation of the consultant component, which had to be reduced in order to cover cost escalation of expert services. However, it is worth noting from the experience gained that it is vital that specialized consultants arrive at an appropriate time within the academic cycle, and that repeated visits, at similar times, are required for each successive year.

**Recommendations**

50. In terms of institution building and strengthening, the duration of this project was relatively short. In the light of the positive results obtained in this relatively short span of two academic years, with the full complement of experts, the provision of some further assistance is warranted. Such assistance could take the form of the provision of additional consultants' services similar to those provided during the project life; it would be especially valuable if the same persons could return for periods of five to six weeks at appropriate times during the academic cycle to give special lecture courses and to help guide laboratory and field work. Such an eventuality had been foreseen at the time of the project formulation.
51. Should the budgetary and/or foreign exchange position of the University remain constrained, further implementation of the fellowship component should be envisaged, especially in the subject areas foreseen in the original Project Document and sufficient to allow the present Ph.D. candidates to acquire their degrees.

52. Undergraduate preparation in the conventional three-year course for the B.Sc. in Geology is quite weak in physics, while the undergraduate course in physics has practically no earth science in it. It is recommended that the University contemplate the establishment of an undergraduate course in geophysics which would better prepare students for postgraduate studies in exploration (or applied) geophysics.

53. Appendix I presents the outlines of undergraduate subjects which should be included in such a B.Sc. course.

54. Appendix J presents the structure of a proposed M.Sc. course in applied geophysics, together with the outlines of the subjects to be included: it pre-supposes adequate preparation in both physics and geology.

55. An alternative would be a postgraduate diploma course in geophysics, with options providing the additional subjects required by physics and geology graduates, respectively: this additional year of study should be recognized by the award of a second B.Sc. degree or a recognized postgraduate diploma. (If this diploma were considered equivalent to an M.Sc. degree, then a second M.Sc. degree could be earned in Exploration Geophysics or in Geophysics for Mineral Exploration).

56. The pre-eminent position that the Ibadan Department of Geology had acquired is well worth maintaining and could now be assured with quite modest inputs as described above.

57. In view of the considerable delay between project formulation and implementation, it might have been advisable to ascertain (for instance, by a consultative mission) whether there have been, in the intervening period, changes in the institutional base or in the local conditions that would require budgetary, administrative or even conceptual revisions of the project document before full implementation. In the case of this project, authorization was given in December 1977 to incur expenditure against the project budget, from which funds for a mission of that type could have been drawn. This would have enabled the cost-overrun problems to be solved and possibly also a more rational allocation of project funds to compensate for the cuts in the University's budget. In the interval between project approval (December 1977) and implementation, a fellowship training programme could usefully have been initiated.
ANNEX A

DETAILS OF
GOVERNMENT AND INTERNATIONAL INPUTS
ACCORDING TO THE ORIGINAL PROJECT DOCUMENT

GOVERNMENT INPUTS

Personnel:
- 6 Teaching and Research staff (including Project Director)
- 1 Administrative assistant
- 1 Senior Technician
- 2 Typists
- 1 Draughtsman (half-time)
- 1 Librarian

Ancillary personnel:
Analysts, instrument operators, drivers, cooks and labourers to be provided as required by the project from the existing staff of the Geology Department.

Trainees:
Not less than ten qualified graduate students per year. Nigerian trainees to receive adequate scholarships or salary to complete their studies without financial impediment.

Buildings & Services:
To be made available from the existing facilities of the Department of Geology, as follows:
- 3 well-illuminated, air-conditioned offices of not less than 100 sq.m., equipped with standard furniture;
- A general office for project administrative assistant, typists, files and reprographic facilities, 120 sq.m. with standard furniture and visitors reception space;
- Cubicles for graduate assistants;
- Use of bench space for geochemical training for 20 students x 4 hours weekly;
- Use of the atomic absorption spectrophotometer laboratory for 10-20 students x 5 hours demonstration and 10 hours practice per week;
- Availability of a geophysical instrument service and repair room with test instruments and supplies, 25 sq.m. approximately;
- A permanent display room for static models and demonstration approximately 80 sq.m.;
- Access to existing facilities in economic geology - crushing, grinding, polishing, photography, potogeology, petrographic and ore microscopy for 10-20 students x 200 hours approximately annually, predominantly in the second semester;
- Storage facilities for maps and samples as well as individual small lockers for 20 students.

**Housing:** Furnished housing was to be allocated to the international staff at Government standard rent by the University, consistent with the housing policy applied to senior university staff.

**Equipment:** In addition to the equipment already available in the Department of Geology the project would require:

- 1 staff vehicle N. 7,000
- 3 typewriters 2,000
- 1 photocopier + supplies 1,500

**Miscellaneous:** Local operating costs, maintenance of equipment, communications, etc., together with a revolving petty cash fund of N. 500 for local project needs to be accounted for by the senior experts and the national director.
**UNDP Inputs**

<table>
<thead>
<tr>
<th>Personnel</th>
<th>1 Economic Geologist (Chief Technical Adviser)</th>
<th>39 m/m</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1 Exploration Geochemist</td>
<td>18 m/m</td>
</tr>
<tr>
<td></td>
<td>1 Applied Geophysicist</td>
<td>18 m/m</td>
</tr>
<tr>
<td></td>
<td>1 Senior Geological Technician (Chief)</td>
<td>18 m/m</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Consultants:</th>
<th>51 man-months</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Fellowships:</td>
<td>60 man-months</td>
<td></td>
</tr>
</tbody>
</table>

**Group Training:** To cover the international costs for visits by small groups of counterparts to other UNDP-assisted mineral exploration/evaluation programmes outside Nigeria.

**Equipment:** Geophysical instruments and transport:

- 1 induced polarization unit  
  US$ 25,000
- 2 radiometric instruments  
  US$ 3,000
- 2 magnetometers            
  US$ 4,000
- 1 communications system    
  US$ 20,000
- 2 field vehicles            
  US$ 13,000

**Miscellaneous:** Miscellaneous costs for standard and sundry items commonly included in this component  
US$ 26,000

---

1/ For detailed list, see Annex B.
1. International Experts and Consultants

(a) Experts:

<table>
<thead>
<tr>
<th>Name of Expert</th>
<th>Country of Origin</th>
<th>Field of Specialization</th>
<th>Duration of contract</th>
</tr>
</thead>
<tbody>
<tr>
<td>BERNARD, Jan H.</td>
<td>CZE</td>
<td>Chief Technical Adviser</td>
<td>03.09.79 - 20.07.81</td>
</tr>
<tr>
<td>ROY, Amalendu</td>
<td>IND</td>
<td>Applied Geophysics</td>
<td>16.06.79 - 31.12.82</td>
</tr>
<tr>
<td>SCHOLS, Malcolm M.</td>
<td>UK</td>
<td>Exploration Geochemistry</td>
<td>31.08.79 - 30.07.83</td>
</tr>
</tbody>
</table>

(b) Consultant¹:

<table>
<thead>
<tr>
<th>Name of Consultant</th>
<th>Country of Origin</th>
<th>Field of Specialization</th>
<th>Duration of contract</th>
</tr>
</thead>
<tbody>
<tr>
<td>HALE, E.W.</td>
<td>CAN</td>
<td>Lectures and laboratory courses in mining geology &amp; mineral economics</td>
<td>06.02.82 - 06.03.82</td>
</tr>
<tr>
<td>FLETCHER, M.K.</td>
<td>CAN</td>
<td>Lecture series in geo-chemical exploration for minerals</td>
<td>09.05.82 - 25.05.82</td>
</tr>
<tr>
<td>MIKUSKA, Brno &quot;Geofyzika&quot;</td>
<td>CZE</td>
<td>Lecture series in geo-electrical &amp; radiometric methods of applied geophysics</td>
<td>24.06.83 - 27.07.83</td>
</tr>
</tbody>
</table>

¹/ The consultancy component was executed by the United Nations Department for Technical Co-operation and Development (UNDTCD) on the basis of an agreement signed with Unesco on 20 February 1981, covering the provision of 17 consultants.
(i) Fellowships

<table>
<thead>
<tr>
<th>Field of study</th>
<th>Place of Study</th>
<th>Name of fellow</th>
<th>Period of study</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geochemical field and laboratory techniques</td>
<td>Atlantic Analytical Services, Canada</td>
<td>BADEJOKO, T.A.</td>
<td>Jul-Oct. 1981 (fellowship awarded for six months but fellow had to return for family reasons)</td>
</tr>
</tbody>
</table>

(ii) Group training

| The Precambian of Africa and its Mineral Resources (Seminar) | International Union of Geological Science meeting in Accra | OLADE, M.A. | 19.01-21.01.81 |
| Uranium Exploration in Wet Tropical Environments | IAEA, Vienna | OLADE, M.A. | 16.11-19.11.81 |
| BERNARD, J.H. | Chief Technical Adviser and Expert in Economic Geology |

3. Equipment

<table>
<thead>
<tr>
<th>Item</th>
<th>Quantity</th>
<th>Total cost US$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paulin Altimeter</td>
<td>4</td>
<td>3,320.00</td>
</tr>
<tr>
<td>Scintillation Counter</td>
<td>1</td>
<td>1,375.00</td>
</tr>
<tr>
<td>Physical Properties/core testing system with IP Module, sample holder, rechargeable battery kit and charger</td>
<td>1</td>
<td>5,280.07</td>
</tr>
<tr>
<td>Proton Procession Magnetometer</td>
<td>1</td>
<td>3,495.69</td>
</tr>
<tr>
<td>Polarizing microscope (Leitz), Orthoplan-pol &amp; microhardness tester with accessories</td>
<td>1</td>
<td>18,005.73</td>
</tr>
<tr>
<td>Engineer's theodolite complete with builders' level and stand</td>
<td>1</td>
<td>2,950.00</td>
</tr>
<tr>
<td>Precision torsion balance</td>
<td>1</td>
<td>800.00</td>
</tr>
<tr>
<td>Landrover Station-wagon</td>
<td>3</td>
<td>34,004.46</td>
</tr>
<tr>
<td>Peugeot 504 Station-wagon</td>
<td>1</td>
<td>10,853.57</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>80,114.57</strong></td>
</tr>
</tbody>
</table>

Expendable equipment:

- Instrument spares, service contracts, laboratory equipment, teaching aids and books | 13,287.00 |
- Study Expenses (transport, insurance, etc.) | 14,766.00 |

**Total** | 103,167.00
GOVERNMENT INPUTS

1. National Staff

<table>
<thead>
<tr>
<th>Name</th>
<th>Function</th>
<th>Period of Service</th>
</tr>
</thead>
<tbody>
<tr>
<td>OYOWOYA, M.O.</td>
<td>Professor and Head of Department</td>
<td>Pre-project Mid-79</td>
</tr>
<tr>
<td>FAYOSE, E.A.</td>
<td>Professor</td>
<td>Pre-project 31.07.81</td>
</tr>
<tr>
<td>OLADE, M.A.</td>
<td>Head of Department</td>
<td>Mid-79</td>
</tr>
<tr>
<td>OFFREY, O.</td>
<td>Senior Lecturer</td>
<td>Sept. 1979 31.07.81</td>
</tr>
<tr>
<td>ADIGHIJE, C.L.</td>
<td>Lecturer, Applied Geophysics</td>
<td>01.08.81</td>
</tr>
<tr>
<td>VANDER KROATZ, A.</td>
<td>Instrumentation Engineer (Netherlands Bilateral Assistance)</td>
<td>Sept. 1979 -</td>
</tr>
<tr>
<td>BADEJOKO, T.A.</td>
<td>Lecturer, Exploration Geology</td>
<td>1977 1979</td>
</tr>
<tr>
<td>ELEUZE, A.A.</td>
<td>Senior Lecturer, Geochemistry</td>
<td>Sept. 1979 -</td>
</tr>
<tr>
<td>IMEOKPARIA, E.G.</td>
<td>Lecturer, Exploration Geochemistry</td>
<td>Aug. 1981 -</td>
</tr>
<tr>
<td>ODEYEMI, I.B.</td>
<td>Lecturer, Structural Geology and Photogeology</td>
<td>Feb. 1980 -</td>
</tr>
<tr>
<td>AJAI, J.O.</td>
<td>Principal Technologist, Workshops</td>
<td>Mar. 1980 - June 1983</td>
</tr>
</tbody>
</table>

2. Buildings and Services

Provided as indicated in Project Document.

3. Housing

Staff houses of senior lecturer standard were provided for two of the international staff: the third was housed in the University Guest House.

4. Equipment

Budgetary constraints reduced the University's ability fully to meet the Project Document requirements, but arrangements were made to compensate from project funds.
### ANNEX C

#### PROJECT REVISION 'P'

**PROJECT BUDGET COVERING UNDP CONTRIBUTION**

(in U.S. Dollars)

<table>
<thead>
<tr>
<th></th>
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<tr>
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<td>m/m $</td>
<td>m/m $</td>
<td>m/m $</td>
<td>m/m $</td>
<td>m/m $</td>
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<tr>
<td>10. PROJECT PERSONNEL</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>11. Experts</td>
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<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>11.01 Eco. Geologist/Project Coordinator</td>
<td>24</td>
<td>157,781</td>
<td>-</td>
<td>-</td>
<td>4.9</td>
<td>27,740</td>
<td>12</td>
<td>79,987</td>
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<tr>
<td>11.02 Geophysicist</td>
<td>43.1</td>
<td>269,129</td>
<td>-</td>
<td>-</td>
<td>7.1</td>
<td>36,664</td>
<td>12</td>
<td>71,869</td>
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<tr>
<td>11.03 Geochemist</td>
<td>48.9</td>
<td>317,673</td>
<td>-</td>
<td>-</td>
<td>4.9</td>
<td>25,736</td>
<td>12</td>
<td>73,157</td>
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<tr>
<td>11.04 Consultants</td>
<td>6</td>
<td>50,480</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>150</td>
<td>-</td>
<td>-</td>
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<tr>
<td>11.05 Savings/Overrun 1980</td>
<td>(199)</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>11.99 Sub-total</td>
<td>122</td>
<td>794,864</td>
<td>-</td>
<td>-</td>
<td>16.2</td>
<td>90,290</td>
<td>36</td>
<td>225,013</td>
</tr>
<tr>
<td>13. Adm. support Personnel</td>
<td>24,977</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>15. Official travel</td>
<td>28,273</td>
<td>3,054</td>
<td>(955)</td>
<td></td>
<td>3,500</td>
<td>10,917</td>
<td>8,805</td>
<td>3,144</td>
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<tr>
<td>16. Other costs</td>
<td>28,802</td>
<td>3,054</td>
<td>(955)</td>
<td></td>
<td>5,984</td>
<td>12,570</td>
<td>5,005</td>
<td>3,144</td>
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<tr>
<td>19. Component Total</td>
<td>876,916</td>
<td>3,054</td>
<td>(955)</td>
<td>99,774</td>
<td>256,023</td>
<td>228,635</td>
<td>194,385</td>
<td>96,000</td>
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<tr>
<td>30. TRAINING</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>31. Individual Fellowships</td>
<td>16,027</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>7,400</td>
<td>8,627</td>
<td></td>
</tr>
<tr>
<td>32. Group Training</td>
<td>9,260</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>7,518</td>
<td>1,900</td>
<td>(158)</td>
</tr>
<tr>
<td>32.80 Saving/Overrun 1980</td>
<td>(2,282)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>39. Component Total</td>
<td>23,005</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>7,518</td>
<td>7,018</td>
<td>8,469</td>
</tr>
<tr>
<td>49. EQUIPMENT</td>
<td>108,167</td>
<td>-</td>
<td>24,663</td>
<td>3,671</td>
<td>77,695</td>
<td>138</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>59. MISCELLANEOUS + Reporting Costs</td>
<td>38,426</td>
<td>59</td>
<td>69</td>
<td>1,904</td>
<td>8,228</td>
<td>7,066</td>
<td>13,137</td>
<td>8,009</td>
</tr>
<tr>
<td>99. GRAND TOTAL</td>
<td>1,046,514</td>
<td>3,113</td>
<td>23,777</td>
<td>107,349</td>
<td>349,464</td>
<td>242,811</td>
<td>215,991</td>
<td>104,009</td>
</tr>
</tbody>
</table>
ANNEX D

PROGRAMMES OF STUDY: M.SC. IN MINERAL EXPLORATION


First Semester

GEY 414 : Advanced Structural Geology 4 units
GEY 451 : Global Tectonics 2 units
GEY 452 : Research Methods in Geology 4 units

Second Semester

(a) Mining Geology Option:
GEY 436 : Advanced Geochemistry 4 units
GEY 514 : Ore Deposits 2 units
TPE 203 : Surveying 2 units
GEY 480 : Postgraduate Seminar 2 units

(b) Applied Geophysics Option:
GEY 440 : Advanced Exploration Geophysics I (Gravity & Magnetic methods) 4 units
GEY 441 : Advanced Exploration Geophysics II 4 units
GEY 480 : Postgraduate Seminar 2 units

(c) Exploration Geochemistry Option:
GEY 436 : Advanced Geochemistry 4 units
GEY 412 : Mineralogy of Soils & Sediments 4 units
GEY 480 : Postgraduate seminar 2 units

Common to all Options

GEY 482 : Research Project 6 units
3. Revised Programme introduced 1980/81 onwards

(a) Compulsory courses (to be taken and passed)

- GEY 415 : Mineral Prospecting & Exploration 3 units
- GEY 423 : Advanced Structural Geology 2 units
- GEY 424 : Photogeology & Remote Sensing 2 units
- GEY 444 : Exploration Geophysics 3 units
- GEY 475 : Surveying for Geologists 2 units
- GEY 481 : Two-week Field School 2 units
- GEY 482 : Research Project (4 weeks of field work) 6 units
  (four weeks of field work)
  20 units

(b) Required courses (to be taken but not necessarily passed)

- GEY 416 : Ore Deposits 3 units
- GEY 417 : Ore Mineralogy 2 units
- GEY 418 : Industrial Minerals 3 units
- GEY 419 : Mining Geology 2 units
- GEY 437 : Geochemical Exploration I 3 units
  13 units

Applied Geophysics Option

- GEY 416 : Ore Deposits 3 units
- GEY 440 : Gravity and Magnetic Methods 3 units
- GEY 441 : Seisimics and Well Logging Methods 3 units
- GEY 442 : Electrical and Radioactivity Methods 3 units
- GEY 460 : Advanced Geohydrology 3 units
  15 units

Exploration Geochemistry Option

- GEY 416 : Ore Deposits 3 units
- GEY 418 : Industrial Minerals 3 units
- GEY 419 : Mining Geology 2 units
- GEY 437 : Geochemical Exploration I 3 units
- GEY 438 : Geochemical Exploration II 3 units
  14 units
C. **Elective Courses** (may be taken and passed to meet the total units requirement)

**GEY 480 : Postgraduate seminar**

- Any relevant 400-level course in Geology, Chemistry, Physics, Mathematics and Statistics in any Department of the University of Ibadan

To qualify for the degree M.Sc. in Mineral Exploration, a student must register for a minimum of 32 and a maximum of 36 units, excluding GEY 482 (Research Project), and pass at least 30 units, including all of the compulsory courses.

**OUTLINES OF SYLLABI**

**GEY 415 : Mineral Prospecting & Exploration (3 units : 45 lectures)**


**GEY 423 : Advanced Structural Geology (2 units : 20 lectures and ten lab-assignments)**


**GEY 424 : Photogeology & Remote Sensing (2 units : 15 lectures and 15 lab-assignments)**

GEY 444: Exploration Geophysics (3 units: 30 lectures and 15 lab assignments)

Role of geophysics in mineral exploration. Basic physical laws, physical properties of rocks and minerals, instruments, field procedure, data reduction and interpretation relating to gravity, magnetic, self potential, resistivity, induced polarisation, electromagnetic, seismic reflection and refraction, and radioactivity methods. Geophysical well logging. Applicability of various methods, field examples, relative costs and survey planning.

GEY 475: Surveying for Geologists (2 units: 15 lectures and 15 lab/field assignments)


GEY 416: Ore Deposits (3 units: 30 lectures and 15 lab assignments)


GEY 417: Ore Mineralogy (2 units: 15 lectures and 15 lab assignments)


GEY 418: Industrial Minerals (3 units: 30 lectures and 15 lab assignments)

Geology of common industrial minerals and rocks. Review of technology of major raw materials including clays, ceramic, refractory and glass raw materials, cements, and other constructional materials. Mineralogical, geotechnical and chemical determinative methods.
GET 419 : Mining Geology (2 units : 30 lectures)


GET 437: Geochemical Exploration I (3 units : 30 lectures and 15 lab. assignments)


GET 440 : Gravity and Magnetic Methods (3 units : 30 lectures and 15 lab. assignments)


GET 441 : Seismic and Well Logging Methods (3 units : 30 lectures and 15 lab. assignments)


GET 442 : Electrical and Radioactivity Methods (3 units : 30 lectures and 15 lab. assignments)

Electrical properties of earth materials. Self potential method. Resistivity methods - theory instruments, array systems, sounding and profiling, and depth of investigation. Induced polarisation methods in time and frequency domains. Electromagnetic methods - magnetotelluric, dipole-dipole, turam, large loop, transient and continuous wave methods, airborne em surveys, etc. Applicability and field examples.

**GEY 460 : Advanced Geophysics** (3 units: 30 lectures and 15 lab. assignments)


**GEY 438 : Geochemical Exploration II** (3 units: 30 lectures and 15 lab. assignments)

TITLES OF RESEARCH PROJECTS (GEY 482)
(Required for completion of M.Sc. in Mineral Exploration)

1979/80:
Interpretation of an aeromagnetic map of the Jos area (one student)
Geochemical characteristics of Ririwei Zinc-tin deposit at depth (one student)
Total: 2 students

1980/81:
Self potential and resistivity prospecting for lead-zinc mineralization around Nkpuma Akpatakpa, Abakaliki district (two students)
Interpretation of aeromagnetic data on Ilesha area for assessing geological structure (two students)
Gravity and Resistivity measurements for delineation and reserve estimate of clay deposits near Omi Adio, Ibadan (three students)
Investigation of industrial properties of clay deposit near Ifon for ceramic manufacture (one student)
Economic Geology and Mineralogy of iron deposits near Okone for iron and steel manufacture (one student)
Economic evaluation of Ishiagbu lead-zinc deposit (one student)
Soil Geochemistry applied to lead-zinc prospecting around Nkpuma Akpatakpa mine, Abakaliki (one student)
Stream sediment studies for lead-zinc prospecting around Nkpuma Akpatakpa mine, Abakaliki (one student)
Total: 12 students

1981/82:
Mineralogical and chemical studies of talc bodies at Wonu, Apomu area Western Nigeria, in relation to their industrial properties (one student)
Interpretation of off-shore seismic data over Niger Delta (two students)
Interpretation of Koton Kafiri aeromagnetic map (one student)
Study of soil chemistry in and around Ameka, S. Nigeria (one student)
Groundwater prospecting at Offa, Kwara State, by direct current resistivity methods (two students)

Geological structure from aeromagnetic data from Abakaliki area of Benue Trough (one student)

Geological interpretation of aeromagnetic map of Akiri area (one student)

Total: 9 students

1982/83

Ground magnetic studies in a section of Basement in Bauchi State (one student)

Vertical electrical sounding for water in various districts of Kaduna State (six students) 1/

Studies of off-shore or on-shore seismic profiles in the environs of the Niger delta (two students) 1/

Interpretation of some geophysical well logs from the Niger delta (one student) 1/

Geochemical studies in the Ilesha gold field using soils pseudo-gossan and gold compositional analysis to try to find the ultimate origin of the alluvial gold (one student)

Structure, geochemistry, petrology and possible use of the Jakura marble deposit (one student)

The petrology and geochemistry of the Toto iron ore deposit (one student)

Mineralogical and chemical properties of a talc deposit near Ilesha (one student)

Physical, chemical and mineralogical properties of the clay deposit near Ifon (one student)

Total: 15 students

1/ desk studies
Four students registered as candidates for the Ph.D. degree during the course of the project:

1. With a tentative title of 'Economic Geology of Primary Tin Mineralization in Liruei, Kogo, Daga Allah, and Tibuchi-Yelli Younger Granites', Mr U.M. Turaki's investigations have the potential for discovering new economic tin deposits in these rocks. Mineralogical studies on diamond-drilled cores of the greisen-bordered veins and establishment of pressure-temperature conditions at the time of its formation may very well indicate a concealed tin zone beneath the otherwise subecononic near-surface rocks. Fluid inclusion and stable isotope studies are being carried out in Czechoslovakia and the United Kingdom. Emphasis is to be laid on the evaluation of the deposit on the basis of free recoverable, not total, tin and tungsten.

2. Mr Benedict E. Odia is an M.Sc. in Mineral Exploration from the Geology Department and his topic 'Subsurface Geophysical Mapping of Younger Granites in Jos Area' is an outgrowth of his M.Sc. Research Project. The objective is to prepare a subsurface map of the Younger Granites from aeromagnetic and newly measured gravity data, through a processing technique devised by him for extracting geological information from highly noisy magnetic field contours. Primary tin mineralization is suspected to be associated with the crests of Younger Granite plutons or cupolas.

3. Mr O. Fakorede is working on the 'Economic Geology and Geochemistry of an Area of Known Gold Mineralisation East of Minna'. Like that of Mr U.M. Turaki, this investigation also relates to Mr Fakorede's responsibilities in the Nigerian Mining Corporation for the economic evaluation of the area.

4. Mr O.T. Nkeruewem is a Master's degree holder from the USSR in Applied Geophysics and the provisional title of his thesis is 'Geophysical Investigations for Groundwater on Shani-Gula Area, Borno State, Nigeria'. He proposes to collect geohydrological data, make surface geophysical measurements with the resistivity and the seismic refraction methods, and analyse well logs in order to prepare a comprehensive document on the availability of groundwater in the area and its optimum development/utilization plan.

In addition, two previously registered candidates received a great deal of assistance from the project staff: they were able to complete their research work and successfully defend their theses during the course of the project:

5. Mr M.O. Ojo of the Nigerian Mining Corporation with a thesis title 'Geology and Stream Sediment Geochemical Surveys of the Middle Gongola Basin, Benue Trough'.
6. Mr S. Ekwere of the University of Illerin with a dissertation on 'Economic Geology and Lithogeochemistry of Tin-Zinc-Copper Bearing Rocks of Ririwei and Banke Younger Granite Complexes, Northern Nigeria'.

Both these candidates completed their work and defended their theses during the project's life.
MINUTES OF THE INAUGURAL MEETING OF THE INTERNATIONAL CONSULTATIVE PANEL OF THE PROJECT HELD IN THE DEPARTMENT OF GEOLOGY, UNIVERSITY OF IBADAN FROM 6 TO 8 OCTOBER 1980

1. Present

Prof E.A. Fayose, Head, Department of Geology (Chairman)
Dr C.H. James, University of Leicester, England
Dr J. Vecck, Director, Geological Survey of Czechoslovakia
Dr W.E. Hale, New Brunswick, Canada
Dr C. Lepeltier, UNDTCH, New York, U.S.A.
Mr G.E. Kesse, Director, Geological Survey of Ghana
Mr A.A. van der Sluijs, Unesco Headquarters, Paris, France
Mr G.C. Ezeogu, UNDP/Unesco, Lagos
Mrs Walker, UNDP/Unesco, Lagos

Absent
Dr Barry Scott, Bucks, England

Invited by Chairman
Prof J. Bernard, Unesco C.T.A., Department of Geology
Dr M.A. Olade, National Director, Department of Geology

2. The meeting was officially declared open at 9.50 a.m. by the Chairman, Prof E.A. Fayose, who apologised for the unavoidable absence of the Dean of Science, Prof J.I. Okogun. He further introduced the Acting Vice-Chancellor, Prof S. Afolabi-Toye, to the members of the Panel.

In his address the Acting Vice-Chancellor, Prof Afolabi-Toye, welcomed all members to the University of Ibadan campus and emphasized the importance to the nation of the Postgraduate programme in Mineral Exploration being currently run in the Department of Geology, University of Ibadan. The Chairman thanked the Acting Vice-Chancellor for his speech. He later informed the members that he had invited to the meeting the Chief Technical Adviser of the Project, Prof J. Bernard and the Nigerian counterpart Director, Dr M.A. Olade.

3. The Chairman went through the programme of the meeting with the Panel. He informed the Panel of an excursion to Jos which had been arranged for Thursday, 9 October 1980, and invited interested members to submit their names afterwards. The programme was accepted by everybody without any change.

4. Visit to Laboratories

Members of the ICP were conducted to all the laboratories and workshops in the Department by the National Director of the Project, Dr M.A. Olade. Members were able to meet and discuss with the technical and academic staff of the Department in the various laboratories.
5. The first substantive meeting of the ICP was held in the afternoon of Monday, 6 October 1980, to discuss the following items:

(a) Comparison of the existing programme with programmes elsewhere. Members discussed extensively the curriculum for the postgraduate programme in mineral exploration. Many different views were expressed and the Chairman, in order to save time, set up a sub-committee of three comprising Prof Hale, Dr Kesse and Dr James to be assisted by the Project Director and the National Director of the programme. It was agreed that this committee should study the existing syllabus and present recommendations afterwards. With respect to the subject of consultants and visiting professors, another sub-committee was set up comprising Prof Bernard, Dr Lepeltier and Van der Sluijs. The Chairman suggested that attention should be drawn to technical experts as well.

(b) In discussing the technical advances in the field of mineral exploration, Prof Hale suggested that considerable information could be found in journals related to mineral exploration. Dr Kesse suggested that the AGID/IGCP, if consulted, might prove very useful.

(c) The Panel discussed the subject of placement of project graduates and agreed that if the programme is efficiently run, the graduates will have no problem in securing appointments.

Tuesday, 7 October 1980

6. During the morning session of the ICP meeting, the Chief Technical Adviser of the project presented a detailed progress report on the programme under the following headings:

(a) Commencement of the Project;
(b) Revision of the detailed work plan for 1980;
(c) Postgraduate curriculum in mineral exploration;
(d) Presentation of the results of the project field work;
(e) Consultants;
(f) Fellowships for Nigerian counterpart staff;
(g) Equipment;
(h) Recruitment of students for the 1980/81 session;
(i) Improvement of the Department Laboratories; and
(j) Revision of the project budget.

Prof Bernard's progress report was generally accepted by the Panel and was subsequently discussed in detail. It was suggested that attention should be paid to the training of local technical staff. The Panel was told of the common problems of certain trained technical staff leaving the University to take jobs elsewhere especially in the industries where the pay is higher. It was therefore suggested that more than one technical
staff should be trained in a particular field to avoid this problem. The national director informed the panel of the three junior counterpart staff who are being trained in the various fields of Geochemistry, Geophysics, and Economic Geology. These staff members are Messrs G. Ihekporia (Geochetist), A.A. Elueze (Economic Geologist), and J.O. Ajayi (Mineralogy/Mineral Treatment).

7. The Panel discussed the admission of students to this programme and agreed that 15 to 20 a year would be an acceptable number. The Panel also noted that the admission had risen from two M.Sc. students last session to 15 M.Sc. plus two Ph.D. students during the session 1980/81.

8. **Vehicle**

   The Chairman informed the Panel of the possibility of asking the University of Ibadan to insure the project vehicles which are not normally insured by Unesco and promised to discuss this with the University authorities.

9. **Equipment**

   In terms of equipment in the Department, the Panel agreed in general with the items purchased. Relevant to the subject of equipment was the suggestion that instruction films in Geophysics and Geochemistry should be purchased from Unesco and Leicester University for the programme. It was suggested that ore and rock specimens should be properly collected locally with the view to exchanging some of these with specimens from abroad. The Panel was informed of the cancellation of the post of a senior geological technician which has been replaced with three posts of technical consultants in different fields of specialization. The Chairman informed the Panel of the proposed appointment of an instrument engineer who will be based in the Department of Geology but could also assist in other departments.

10. **Field Work**

    The success of the last postgraduate field work was noted by the Panel. It was suggested that more than one field meeting should be arranged for the postgraduate students. The Panel was however informed of the practical problems that would arise should such field meetings be planned. The subject of fellowships was raised and some members promised to contact appropriate institutions to this effect. The afternoon session was preceded by a meeting of two sub-committees on 'Consultants' and 'Curriculum'. Later in the afternoon members discussed recommendations of the sub-committees.

11. **Consultants**

    The Panel first decided on the best periods of the year to invite consultants. It was agreed that March to June and October to December will be appropriate. It was further suggested that consultants should be invited in order of priority. The Panel later accepted the following fields: Mineral Economics and Mining Geology; Exploration Geochemistry; Geophysical
Instrumentation and Instrument Technology. A member of the Panel advised that the Department of Forestry in Ibadan should be contacted because of the establishment in it of a new United Nations Project in Remote Sensing.

12. **Curriculum**

The subject of the M.Sc. postgraduate syllabus was exhaustively discussed. The present programme was criticized by some members as an encouraging specialization which is difficult to achieve within one year. The Panel finally agreed to adopt the following M.Sc. programme for the 1980/81 session. It noted however that this programme will have to be revised during the next ICP meeting in April 1981.

**Common to all students - First Semester**

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<tr>
<th>Course Code</th>
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<th>Units</th>
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<tr>
<td>GEY 471</td>
<td>Photogeology and Structures</td>
<td>3</td>
</tr>
<tr>
<td>GEY 417</td>
<td>Ore Mineralogy</td>
<td>2</td>
</tr>
<tr>
<td>GEY 418</td>
<td>Industrial Mineralogy</td>
<td>4</td>
</tr>
<tr>
<td>GEY 475</td>
<td>Survey</td>
<td>2</td>
</tr>
<tr>
<td>GEY 438</td>
<td>Geochemical Exploration</td>
<td>3</td>
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<tr>
<td></td>
<td>New Geophysics</td>
<td>3</td>
</tr>
<tr>
<td>GEY 415</td>
<td>Mineral Prospecting &amp; Exploration</td>
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**Total** 21 units

**Second Semester**

**Geologists**

<table>
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<tr>
<th>Course Code</th>
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<tr>
<td>416 Ore Deposit</td>
<td></td>
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</tr>
<tr>
<td>417 Mining Geol.</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>439 Case Histories</td>
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**Geochemistry**

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<tr>
<td>Adv. Hydrog.</td>
<td>Gravity I</td>
<td>4</td>
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<tr>
<td>Geophysics II</td>
<td>Geoch II</td>
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**Geophysics**

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<tr>
<td></td>
<td>Mag. Elect.</td>
<td>4</td>
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<tr>
<td></td>
<td>Gravity I</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Geophysics</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Seismic &amp; well logging</td>
<td>4</td>
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</tbody>
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**Total** 6 units

*Project and Report = 6 units

13. **Budget**

The Chairman during the morning session on Wednesday, 8 October 1980, informed the Panel of the wish of the University to have the present project extended to December 1983. He gave among his reasons the following:
(a) The need for the junior counterpart staff to gain enough experience which would in the future help them to assist the senior Nigerian counterpart staff;

(b) Secondly, the 1979/80 session was a preparatory session and there is need for three more sessions to develop the programme fully;

(c) The extension being sought is necessary to give Nigerian counterpart staff the opportunity to undertake fellowship programmes.

This request was unanimously supported by the Panel. The Panel directed that this request be forwarded officially by the University of Ibadan to the Ministry of Economic Planning and Statistics, UNDP in Lagos and Unesco in Paris as soon as possible. It was also brought to the notice of the meeting that it was possible to utilize funds from certain items of the budget to extend the posts of the Geochemists and Geophysicists to the end of the current plan period. It was suggested that the request for the extension of the project for the years 1982 and 1983 should be submitted to UNDP New York for inclusion in the next plan period which starts in January 1982.

14. **Date of next Meeting**

It was agreed that the next ICP meeting should be held in Ibadan in April 1981. Members were advised to contact the Chief Technical Adviser as soon as they know their official schedule for next year so that a definite suitable period could be fixed and communicated to members.

15. **Meeting of the Project Staff and ICP Members**

Later in the morning the project staff joined the meeting. They were introduced to the ICP by the Chairman while the CTA introduced the ICP members to the project staff. During the detailed discussion that followed emphasis was placed on the postgraduate curriculum. It was finally agreed that the one-year M.Sc. programme in mineral exploration should be designed for broad training in mineral exploration. Students who wish to specialize in any of the fields of mineral exploration and who have satisfied the University of Ibadan postgraduate regulations for higher degrees can proceed to the M.Phil. or Ph.D. programmes as the case may be.

It was also mentioned that it will be desirable to invite a consultant for mineral development over the past twenty years. This was discussed and generally supported by the Panel.

On the question of the sources of the postgraduate students being admitted into the programme, the Chairman explained that students are at present being drawn from the different Nigerian universities, government corporations and industries. He further expressed the hope that students would be drawn in future from other African countries. The Director of the Geological Survey of Ghana promised to introduce the programme to his staff and send some for training in the near future.

16. **The meeting rose at 12.00 noon.**
UNITED NATIONS DEVELOPMENT PROGRAMME

TRIPARTITE REVIEW REPORT

24 April 1981

1. Attendance

University of Ibadan
Professor E.A. Fayose Head, Dept. of Geology (Chairman)

United Nations Development Programme
Mr Ross H. Milley Resident Representative, a.i.
Mrs Norma V. Walker Assistant Resident Representative
Mr G.C. Ezeogu Programme Officer

United Nations Educational, Scientific and Cultural Organization
Mr A. Callaway Unesco Representative, a.i.
Mr B. Robinson Programme Specialist, Sector for the Natural Sciences and their Application to Development, Unesco Headquarters
Professor J. Bernard Chief Technical Adviser, NIR/75/117
Mr G. Duyfjes Associate Expert

The meeting was held in the Committee Room of the Department of Geology, University of Ibadan under the Chairmanship of the Head of Department, Professor Fayose. A background paper prepared by the Chief Technical Adviser, and the latest project six-monthly progress report, formed the basis for the discussion.

In a brief opening address, the Dean of the Faculty of Science, Professor Okogun, speaking in a dual capacity as Dean and as representative of the Vice-Chancellor, expressed the appreciation of the University for the assistance which UNDP/Unesco had extended to the University through the project. He recalled the delays encountered in the initial implementation of the project which were due, in the main, to the acute financial, technical and manpower inadequacies with which the Department was initially confronted. He was pleased to be able to report a considerable improvement in the overall situation and pledged the continued commitment of the University to the project and expressed optimism that its objectives would eventually be achieved. Finally, he drew attention to the recommendations contained in the Chief Technical Adviser's report and expressed the desire of the University that they be carefully and critically reviewed.

On the Dean's departure, the Chairman called upon the Chief Technical Adviser to present his report.
Project Activities and Outputs

In presenting his report, the Chief Technical Adviser recalled that the Third National Development Plan (1975-1980) had envisaged among its objectives the establishment of training programmes and projects in all major sectors of the economy. In the realization of the strategic character and importance of the mining sector, the University of Ibadan had requested UNDP/Unesco assistance for the establishment of this project with long-term functional emphasis on institution building and strengthening of the University's Department of Geology. The project's aims were to achieve and maintain international standards of advanced teaching and training in mineral exploration to produce the requisite flow of highly skilled and trained graduates with strong practical orientation. UNDP/Unesco inputs would be a team of experienced teaching geoscientists, qualified to lecture and engage in applied research in mineral exploration and able to design, organize and jointly carry out a regular programme of academic instruction and local practical assignment for about 10-20 postgraduate students each year.

Given the unsatisfactory state of the Department of Geology, as already mentioned by the Dean, at the time the project activities commenced, it proved to be unrealistic to regard the first year as anything except preparatory. During this period, the UNDP/Unesco team focussed activities mainly on comparing the then current conditions of the Department with those foreseen by the project. As a result, a detailed work-plan with realistic targets was devised by the CTA, additional to the project document as signed in December 1979.

A number of positive steps had been taken during this preparatory phase which included the following activities:

(a) The development of a future programme and the reactivation of all laboratories. A series of postgraduate lectures and seminars were organized for the first and second semesters of the 1979/80 academic year. During this same period, a two-week field school in mineral exploration was organized.

(b) The first meeting of the International Consultative Panel (ICP) was held in October 1980. The most important outcome of the ICP was its recommendations in respect of limited specialization in the programme at the M.Sc. and M.Phil. levels, the training of departmental technicians and the specialization of the consultants to be recruited by UN/DTCD.

(c) Action was initiated to ensure the attainment of a full staffing complement for the Department. Equipment had been ordered and efforts intensified to discover suitable placings for the Department's fellows in private mining institutions.

(d) The project had engaged in a public relations information exercise, designed to draw attention to the programme and using pamphlets, newspaper announcements, and personal contacts with the management of various Nigerian exploration and mining corporations.
Progress had been satisfactory in meeting the limited targets which had been set and the CTA expressed appreciation of the remarkable support provided by the Head of the Department, the Vice Chancellor and UNDP/Unesco. Good cooperation had been established with the management of the Nigerian Mining Corporation, Jos, both in prospecting and laboratory work and the exchange of information on technical progress. The Corporation had permitted access to its exploitations and exploration areas as well as making facilities available for field work.

Nevertheless, it had to be recognized that the output of the project in its first year was too low. However, with student intake rising from only two in the first year to fifteen in the second and a full staff complement now achieved, future prospects were considerably brighter.

Fellowship delivery had also been lagging. So far only one fellowship for six man-months had been utilized. To some extent, the under-utilization was due to a certain lack of cooperation from mineral exploration companies. It was envisaged, however, that three more fellowships would start towards the end of the 1981/82 academic year.

The consultancy input to the project was also behind schedule. However, a list of required specialists had been forwarded to UNDTCD and so far four nominations had been received and submitted to the Vice-Chancellor.

The Chairman thanked the CTA for his report and reaffirmed the University's continued financial support for the programme. A paper had been submitted to the Dean of the Postgraduate School which would enable students to continue to M.Phil. after their M.Sc.

The UNDP Resident Representative, a.i., re-emphasized the importance which UNDP attached to practical training in the programme as envisaged in the original project document. The initial low enrolment had been extremely disappointing. If the UNDP field office is to justify to UNDP Headquarters continued support for inputs to the project, it was clear that the implementation rate of the project should be improved. This, as all other projects in which UNDP/Unesco were associated in Nigeria, is a project of the Government and while aware of the special circumstances, unfortunately the University had not been able to make its own inputs in a satisfactory and timely manner. In so far as the International Consultative Panel was concerned, Mr Milley regretted that no formal report on its deliberations had been issued, making it difficult to assess its impact and hence its value and more importantly its future role.

Mr Robinson touched briefly on the issues of fellowships and consultants. Placement had proved to be a problem in privately-owned mining corporations but Unesco would endeavour to continue its efforts in this regard. He regretted the delay in the submission of the consultancy candidates, which was the responsibility of the associated agency, UNDTCD.
3. Prospects of Achieving Project Objectives

It was recognized by all participants that as the project became fully operational in the 1980/81 academic year, it would be premature to assess the full impact of the project. Indications were that, barring further unexpected constraints in delivery, the project could eventually achieve its objectives. Results so far achieved included:

(a) the implementation of the education and training of the planned number of national project staff;
(b) the full involvement of the national project staff;
(c) the reactivation of laboratory facilities;
(d) increased enrolment in the programme; and
(e) the successful field work which had been undertaken.

Given the initial delays, it would not be possible for the project to achieve its objectives within the time limits originally set for completion. For this reason, the International Consultative Panel and the University had recommended an extension of the project until the end of 1983 with a full complement of three experts.

The UNDP Resident Representative, a.i., whilst recognising the logic of the request, pointed out the limitation of UNDP funds available. The next UNDP Country Programme cycle, covering the period 1982-86, was presently being drawn up with the Federal Ministry of National Planning and the overall total programme funds available were expected to be approximately the same as for the present cycle. Given the inflationary factor, this meant a reduction in real terms. The request for extension, therefore, would have to be considered in the context of the Country Programme exercise and would be dependent upon the priority which the Government accorded to it.

4. Utilization of Project Results

It was noted that, given the strategic importance of the mining sector in the Nigerian economy, the current and projected demand for, and the shortages in, the output of geologists, there were excellent prospects for employment for the postgraduates in the NMC, Iron and Steel Company, Geological Departments, etc. Ghana had also indicated interest in utilizing the services of graduates of the programme in its mining corporations.

5. Project Design

Although the project now seemed to be taking the right direction, it was acknowledged that perhaps the original project design had been too ambitious for the first year of operations. Corrective measures were also being taken in redesigning the curriculum based upon the recommendations of the ICP.
6. Conclusions, Decisions and/or Recommendations

The following recommendations were made:

(a) that a new curriculum for postgraduate training in mineral exploration should be designed which would make the M.Sc. more general and the M.Phil. more specialized;

(b) that the University of Ibadan be requested to provide more support to the Department by granting special funds for field work and scholarships to enable the Department to achieve its target of an enrolment figure of 15-20 students per year;

(c) that additional attention and support be given to the training of junior staff and laboratory technicians and that they be involved more closely both with on-campus and field activities;

(d) that the project be extended at full expert strength through 1983;

(e) that the need for continuation of formal meetings of the ICP, as envisaged in the original project document, be re-examined taking into account what had been achieved at the initial meeting and the cost thereof; while noting further that because at least one of the proposed 'consultants' is a member of the Panel, it might not be necessary for any more full Panel meetings in Ibadan.
Physics of the Earth


Introduction to Geophysical Methods

Historical perspective. Geophysical methods as geological tools. Physical properties of rocks and minerals. Gravity, magnetic, electrical and electromagnetic, seismic, radiometric and well logging methods: their principles, instruments, field operation, data reduction and processing, geological interpretation and applicabilities. Exploration planning and cost estimates.

Gravity and Magnetic Methods

Earth's gravitational field. Theory of gravimeters and their principles of construction. Elements of geomagnetic field. Mechanical, fluxgate, proton precession and alkali vapour magnetometers. Qualitative and quantitative interpretation. Simple idealized targets, typical anomalies and depth rules. Variation of magnetic anomalies with latitude, orientation of body, direction of magnetisation, etc. Computation of gravity and magnetic anomalies of two dimensional bodies.

Electrical and Electromagnetic Methods


Seismic and Radiometric Methods

Well Logging Methods

COURSE STRUCTURE

First Semester:
- Exploration Geophysics: 3 units
- Surveying for Geologists: 2 units
- Static & Time-Varying Field Theory: 3 units
- Mathematics for Geophysics: 3 units
- Computer Programming: 1 unit

Second Semester:
- Gravity and Magnetic Methods: 3 units
- Direct Current Electrical Methods: 3 units
- Electromagnetic Methods: 2 units
- Seismic Methods: 3 units
- Geophysical Well Logging Methods: 2 units
- Postgraduate Seminar: 1 unit

SUBJECT OUTLINES

1. Exploration Geophysics
   As in GEY 444 (Annex D).

2. Surveying for Geologists
   As in GEY 475 (Annex D).

3. Static and Time-Varying Field Theory

4. Mathematics for Geophysics
5. **Gravity and Magnetic Methods**


6. **Direct Current Electrical Methods**


7. **Electromagnetic Methods**


8. **Seismic Methods**


9. **Geophysical Well Logging Methods**