Restricted
Technical Report
RP/1992-1993/III.3

JORDAN

International safeguarding campaigns, training and enhancement of the cultural heritage

Draft Management Plan for Petra Archaeological and Natural Park

by

C. Assante di Panzillo
B. Bousquet
C. Jouffray
B. Lane
P. Laureano
A. Ohannessian-Charpin
J. Rewerski
F. Zayadine

Serial No. FMR/CLT/CH/93/105

United Nations Educational, Scientific and Cultural Organization

Paris, 1993

JORDAN

DRAFT MANAGEMENT PLAN FOR PETRA ARCHAEOLOGICAL AND NATURAL PARK

by

C. Assante di Panzillo
B. Bousquet
C. Jouffray
B. Lane
P. Laureano
A. Ohannessian-Charpin
J. Rewerski
F. Zayadine

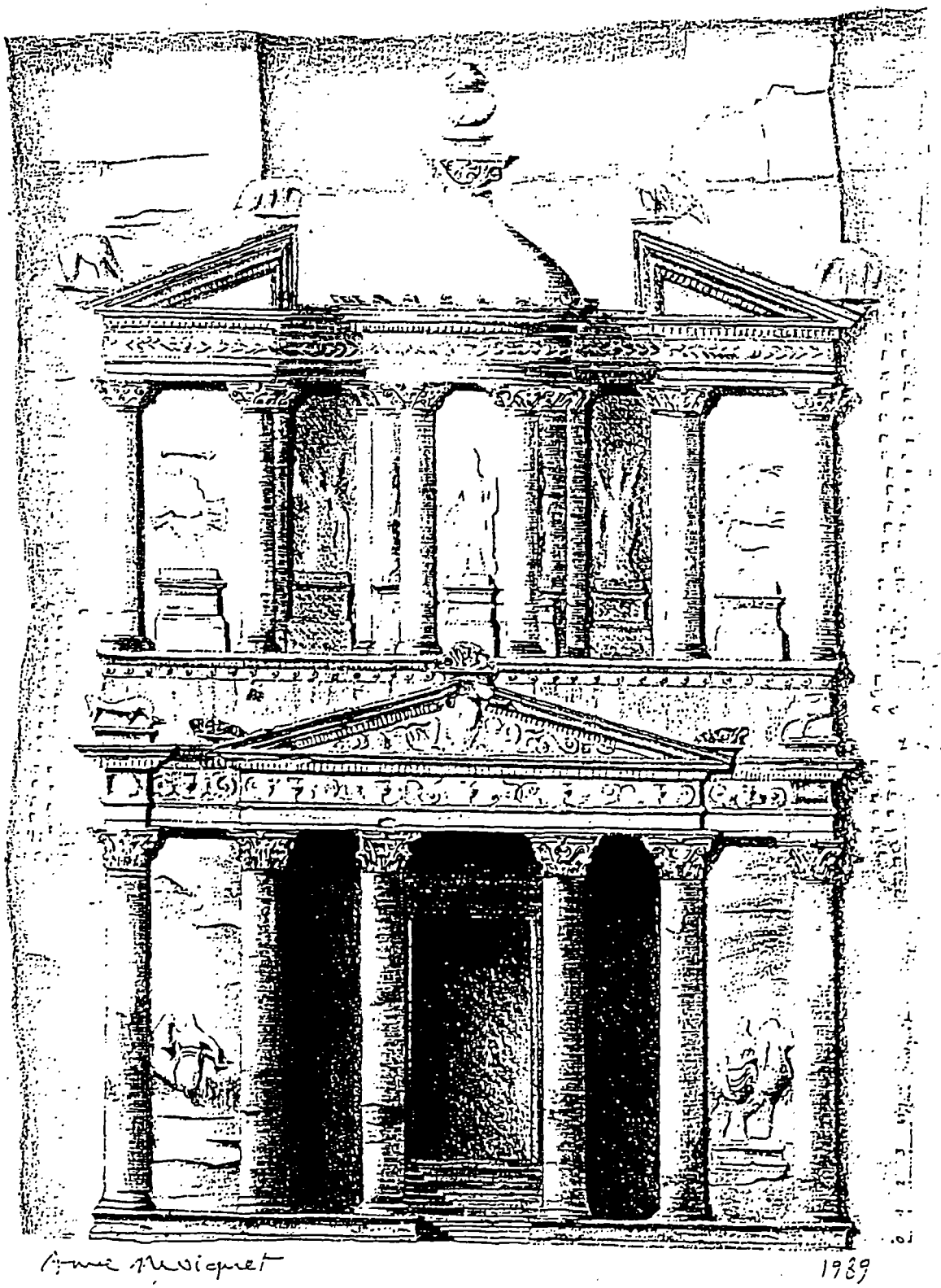
Report prepared for the Government of the Hashemite Kingdom of Jordan by the United Nations Educational, Scientific and Cultural Organization (UNESCO)

UNESCO

Technical Report
RP/1992-1993/III.3
FMR/CLT/CH/93/105 (Assante di Panzillo/Bousquet/Jouffray/Lane/Laureano/
1 June 1993 Ohannessian-Charpin/Rewerski/Zayadine)

Printed in France

HASHEMITE KINGDOM OF JORDAN



DRAFT MANAGEMENT PLAN FOR PETRA ARCHAEOLOGICAL AND NATURAL PARK

CONTENTS

EXECUTIVE SUMMARY

In response to a letter addressed by H.M. Queen Nur al Hussein to Mr. Federico Mayor, Director-General of UNESCO, outlining the major problems threatening the integrity of the World Heritage site of Petra, and following a mission by Mounir Bouchenaki, Director of UNESCO's Cultural Heritage Division, in 1992, a positive response was given to Her Majesty's request for the Organization's assistance in preparing a masterplan for the entire Petra region. A UNESCO mission, composed of international and national experts in various fields of specialization, was sent to Jordan from 24 October to 24 November 1992.

During the course of the mission, the team was able to meet and participate in discussions with representatives of all the other concerned Government bodies and NGOs, as well as representatives of the principal donor countries, research institutes and technical cooperation agencies involved in safeguarding or research activities in Petra. Towards the end of the mission, the team was invited by Their Majesties King Hussein and HM Queen Nur to present the principal findings and recommendations of the mission.

MAJOR ISSUES IDENTIFIED

During the course of the mission, the team was able to evaluate the principal threats to the integrity of the World Heritage site from a combination of human and environmental factors. The main problems can be resumed as:

Erosion. Lack of maintenance of the ancient dams, agricultural terraces, water channels and cisterns; deforestation of the catchment area; uncontrolled grazing; and the abandon of traditional farming practices, have destroyed ground cover and accelerated soil erosion, with a resulting increase in the quantity of flood-water and silt carried down to Petra during the rainy season, and in the amount of wind-blown sand.

Uncontrolled development of the villages in the catchment area (Wadi Musa, Um Sayhun), encroaching on the site and visible from it. Um Sayhun expansion blocked to the south by the archaeological site, and to the north by surrounding land traditionally cultivated by another tribe, the Layathneh.

Abandon of traditional stone-built villages and their agricultural terraces.

Lack of control of visitor circulation. Horses' hooves are damaging the archaeological remains, and the problems of dust and smells from horses are creating unsanitary conditions in the siq.

Antiquities at risk from illegal excavations, sale by local populations. Tamarisk and Juniper trees damaged and burned for firewood to make tea.

The spread of commercial activities throughout the site destroys its harmony, and creates congestion. The design of the wooden stalls is intrusive.

Lack of sanitary facilities between the visitors' centre and the restaurant, either for visitors or shopkeepers.

Lack of information on possibility of other circuits and tourist trails, for visitors wishing to stay for longer periods in Petra Park. Lack of explanatory material, comprehensive guidebook in the Visitors'centre.

Ticketing. Lack of correspondence between price of ticket and importance of site. Proceeds do not benefit the site.

Hotels. Lack of accommodation for staying longer periods in Petra region. 5 hotel projects planned by Ministry to increase hotel capacity to 1,000 rooms, all **located in catchment area above the line of natural springs** between Wadi musa and Tayiba. No environmental impact study done.

Damage to monuments, from: horses hooves and trucks; capillary action of ground water; wind-borne sand; rain-water run-off; natural faults in the rock; infiltration of water and growth of plants in rock fissures; exposure of unconsolidated archaeological remains (Winged Lion Temple, Beida).

Consolidation of some stone masonry structures needed if not to fall (Palace Tomb, Qasr al Bint, arched aqueduct).

Quality of restoration works leaves much to be desired. Abusive restoration of Qasr al Bint using concrete, etc. Necessity to have trained conservator/restorers on site.

shortage of space for archaeological teams at Nazal Camp.

Management. Many government departments and other institutions responsible for site and its surrounding environment. No efficient mechanism to manage park and coordinate inputs.

PRINCIPAL RECOMMENDATIONS
The Draft Management Plan includes proposals for:

Creation of an independent Park Authority with financial autonomy and directly dependant on the Prime Minister's Cabinet or the Royal Court to manage the Petra Archaeological and Natural Park. Its Management Committee would include representatives of each of the concerned Government bodies, as well as the Higher Council, the Petra National Trust, Yarmouk University, major sponsors, etc., and representatives of the various communities living in the area.

Adjustment of the park boundary to the east to include the western slopes of the limestone plateau and the upper catchment of several wadis running westward through the park; an extension to the south to include Sabra; the western boundary could be moved eastward towards the escarpment to compensate.

The creation, within the park boundaries, of seven **zones of protection** including: Archaeological and Natural Sanctuaries; Botanical and wildlife reserves; Silvo-Pastoral Zones; Agro-Pastoral Zones; Afforestation Zone; Village Zone; Transit Zone, as well as the establishment of a buffer zone to control village and hotel development.

Control of visitor circulation. Horses and other animals should not be allowed to circulate freely inside the natural and archaeological sanctuary areas. Creation of a minibus service from Turkmaniya area via Um Sayhun. Development of horse, camel and donkey trails around the park. Necessity for thorough environmental impact study.

Mounted park ranger service to patrol site regularly.

Sanitary Facilities. 11 possible sites identified.

Commerce. Introduction of rents; Removal of intrusive wooden structures and tables; Grouping of shops in fewer places; new stone-built suq at entrance to site; new shop to sell replicas of museum objects in restaurant bldg; removal of all shops from in front of Khazne, and replanting.

Orientation centre will interpret and explain site to visitor. Relief map of park showing visitors' trails. Permanent multi-slide projector show. Comprehensive guidebook.

Museums. Present museum to house domestic objects and new finds from archaeological sites. Replicas of museum objects to be sold in restaurant souvenir shop; Urn tomb to become a museum of monumental sculpture. Orientation table positioned on terrace will explain panoramic view of central Petra.

New Signposting of appropriate quality.

Agro-Tourism Projects. Combination of farming, agricultural activities with tourism in restored stone villages will help make villagers less dependant on tourism.

Flood Protection Measures are under study by EDF/Spot Images (proposal to be submitted through UNESCO). Study must take into account re-use where possible of the ancient hydrological system and agricultural terraces.

Conservation. First priority is to **arrest the principal causes** of weathering by repairing the terraces, dams, rainwater channels and cisterns. Afforestation of the catchment area and reinstatement of ground cover will reduce the quantity of water and silt carried down into the wadis during torrential rain, and fix the soil, reducing erosion by wind-blown sand.

Training. An International Workshop could be organized in Petra on stone conservation. Training is needed for Jordanian conservators.

Rainwater run-off can be lessened by repairing and reinstating some of the worn away protective drainage channels, drips and cornices. The problem of **ground water rising by capillary action** is being studied by EDF, who have patented a process for hardening the rock and rendering it impervious to water, while enabling it to breathe. This technique, which is still in the experimental stage, should not be tried out immediately on a major monument until the long-term effects can be assessed.

Conservation, consolidation of exposed archaeological ruins (Winged Lion Tomb, Beida Neolithic village, Byzantine Cathedral).

Consolidation of Qasr al Bint. (S.E. cornice, entrance arch, wooden ring beams) and arched aqueduct. Necessity for trained architect/restorer to supervise work.

Thorough study of stability of Palace Tomb carried out by a geological engineer. Temporary closure of area in front of tomb to visitors.

It was not possible, within time available, to produce a complete Master Plan. However, the proposals, should, once Government approval is obtained, form a sound basis for the next phase; the preparation of a detailed project for submission to international development agencies.

ACRONYMS

ACOR	The American Center of Oriental Research in Jordan
ADAC	Assistant Director for Archaeological Conservation
ADED	Assistant Director for Ecodevelopment
ADNRC	Assistant Director for Natural Resources Conservation
ADT	Assistant Director for Tourism
CERMOC	Centre d'Etudes et de Recherches sur le Moyen-Orient Contemporain
CNRS	Centre National de Recherche Scientifique
CTA	Chief Technical Adviser
DOA	Department of Antiquities (MTA)
DOAF	Department of Afforestation and Forestry (MOA)
DOE	Department of Environment (MMRA&E)
DWR	Dana Wildlife Refuge (RSCN)
EDF	Electricité de France
EIA	Environmental Impact Assessment
GIS	Geographical Information System
GOJ	Government of Jordan
GPS	Geographical Positioning System
GTZ	Deutsche Geselleschaft für Technische Zusammenarbeit
HCST	The Higher Council for Science and Technology
ICOMOS	International Council on Monuments and Sites
IFAPO	Institut français d'Archéologie du Proche-Orient
IGN	Institut géographique national
MMRA&E	Ministry of Municipal, Rural Affairs & Environnement
MOA	Ministry of Agriculture
MTA/MOTA	Ministry of Tourism & Antiquities
NGO	Non-Governmental Organizations
PANP	Petra Archaeological & Natural Park
PNT	Petra National Trust
RJGC	Royal Jordanian Geographic Center
RSCN	Royal Society for the Conservation of Nature
UNDP	United Nations Development Programme
USAID	United States Agency for International Development

PERSONALITIES MET

H.M. King Hussein and H.M. Queen Nur al Hussein of Jordan

H.H. Prince Raad Bin Zeid	President of the PNT
H.H. Princess Majda	and members of the Board of Trustees of the PNT.
H.E. Yanal Hikmat	Minister of Tourism and Antiquities
Mr. Safwan Tell	Director-General of Antiquities Department
Mr. Nasri Attala	Director-General of Tourism
Mr. Ghazi Bisha	Ex Director-General of Antiquities
Mr. Fawzi Zayadine	Assistant Director Antiquities Department
Mr. Suleiman Farajat	Director Antiquities, Ma'an Region
Mr. Nyazi Shabaan	Director, Petra Tourism
Mr. Anis Mouasher	President of the RSCN
Mr. Maher Abu Jafar	General Director of the RSCN
Mr. Omar Hayek	Executive Director, PNT
Mr. Talal Akasheh	Director Environment Sector, HCST
Mr. Mahmmod Al-Tuisi	Chief of Agriculture & Research at Shaubak
Mr. Darwish Jaser	Natural Resources Authority
Mr. Dawud Al-Eisawi	Faculty of Science, University of Jordan

Their Excellencies the Ambassadors of France, Great Britain, and Italy to Jordan

Mr. O. Hashim	UNDP Resident Representative to Jordan
Mr. A. Al-Attrash	Director, UNESCO/UNEDBAS Regional Office, Amman
Mr. Philippe Cardinal	Cultural Attaché, French Embassy, Amman
Mr. Jacques Seigne	Director, IFAPO, Amman
Mr. Marc Lavergne	CNRS
Mr. Eid Sweiss	USAID
Mr. Carl A. Dutto.	USAID
Mr. Dedo Geinitz	GTZ
Ms. Jane Taylor	Author, photographer
Ms. Ann Hills	Journalist, *History Today*

INTRODUCTION AND BACKGROUND

In response to a letter addressed by H.M. Queen Nur al Hussein to Mr. Federico Mayor, Director-General of UNESCO, outlining the major problems threatening the integrity of the World Heritage site of Petra, and following the mission of Mr. Mounir Bouchenaki, Director of UNESCO's Cultural Heritage Division, to Jordan in 1992, a positive response was given to Her Majesty's request for the Organization's assistance in preparing a masterplan for the entire Petra region. The funds allocated for this project allowed a UNESCO mission to travel to Jordan from 24 October to 24 November 1992. The mission was composed of international and national experts in various fields of specialization, including:

Mr. Barry Lane	Mission coordinator/conservation
Mr. Pietro Laureano	Town Planner/hydrologist
Mr. Bernard Bousquet	Ecologist/Parks Management
Mr. J. Rewerski	Geomorphologist
Mr. Christian Assante di Panzillo	Cultural Tourism/tourism impact
Ms. Claire Jouffray	Tourism engineering exportation
Ms. Anna Ohannessian-Charpin	Social Anthropologist
Mr. Faouzi Zayadine	Archaeologist/historian

PRINCIPAL ACTIVITIES DURING THE MISSION

On arrival in Amman, the team leader was asked by the Director of Tourism to give a short statement to Jordanian Television. During the course of the mission, the team was able to meet and participate in discussions with a number of Jordanian officials, including the Minister of Tourism and Antiquities, the Board of Trustees of the Petra National Trust headed by H.H. Prince Raad, the Governor of Ma'an region, and representatives of all the other concerned Government bodies, as well as representatives of the principal donor countries, research institutes and technical cooperation agencies, notably GTZ and USAID, who expressed an interest in coordinating the UNESCO document with their on-going stone conservation and Cultural Resources Management projects. After the end of the mission, a coordination meeting was held at UNESCO Headquarters in Paris with the UNDP Resident Representative to Jordan, who expressed interest in supporting the next stage of the study. A measure of the support received from the national authorities is the three-hour helicopter flight arranged for the team over the entire Petra National Park area.

Towards the end of the mission, the team was received by H.M. Queen Nur. At the end of the discussions, the mission leader was asked by Her Majesty to give a five-minute presentation to King Hussein on the principal findings and recommendations of the mission. Their Majesties promised to give their **full support** in ensuring the implementation of the recommendations of the UNESCO master plan at government level, as did all of the national officials encountered during the mission.

The mission team would like to express its sincere gratitude to the Jordanian Authorities for the facilities put at its disposal during the course of the mission, and to acknowledge the assistance of the Board of Trustees of the PNT, Mr. Talal Akashe, HCST, and Mr. Jacques Seigne, Director of IFAPO, who provided many of the maps and other documentation incorporated in this report.

DEFINITION AND JUSTIFICATION OF THE MANAGEMENT PLAN

The lack of planning is the strongest constraint, among others, to good management of protected areas. These are analysed in the first chapter, and include such factors as erosion, tourism impacts, overgrazing, deforestation, poaching, social unbalance, urban encroachment, lack of training, poor coordination, financial constraints.

In this context, a Management Plan offers the best means for defeating constraints. It is now universally accepted that every national park should be provided with such a "biotool", to guide and control the management of a park's resources, the uses of the area, and the infrastructural development needed to support that management and use. It is a working document which aims at identifying the park's requirements, setting priorities, and facilitating all activities and management actions to be implemented.

Before it can become operational, the Management Plan will have to be approved by the Government and concerned administrations, as many activities (e.g., land uses) involves important policy decisions.

A Management Plan is a also a useful tool for promotion and fund-raising. It does assist relevant conservation by providing continuity in management policy over time, and ensuring consistency during staff transfers. A Management Plan is an evolutive document, needing periodical adjustments, justified by the local context and the results of studies.

ORGANIZATION OF THE DRAFT MANAGEMENT PLAN

The consistency of the objectives and the management programmes relies upon the quality of the analysis which has been carried out. Unfortunately, due to the lack of time and basic materials (aerial photographs, satellite imagery for the Park's area, detailed maps,...), it has not been possible to deal with all the issues and geographical zones concerned. Under such conditions, the global perception of complete existing relationships between men and resources were difficult to address. The proposed Draft Management Plan is therefore a semi-detailed and incomplete document. One should consider it as an evolutive tool, that will be refined simultaneously with the advancement of knowledge and the better understanding of mechanisms governing the relationship between human and natural resources. Relevant studies and actions to achieve this goal (at least substantially) are included in the present.

CHAPTER ONE ANALYSIS

1. THE PHYSICAL ENVIRONMENT

1.1. LOCATION

The antique city of Petra is situated in south-west Jordan, half-way between the Red Sea and the Dead Sea, in a mountainous region (the Shera Mountains) dominating the depression of 'Araba to the west. The mean altitude is 1,000 m., varying from 1,500 in the east and 300 m. in the west. This is the eastern slope of the Rift Valley.

1.2. CLIMATE

South Jordan belongs to the very degraded mediterranean climatic zone. Petra is situated in a semi-desertic region with a precipitation of around 200 mm. per year, concentrated exclusively in the winter period:

- 250 mm. on Shera mountain
- 150 mm. at Petra
- less than 50 mm. at the foot of the massif of Petra, in the desert of Wadi 'Araba.

TABLE **Annual Rainfall at Wadi-Musa.**

Year	*Annual Rainfall*
1984	212
1985	221
1986	193
1987	300
1988	222
1989	231
1990	267
1991	267

The pluviometric gradient follows the hypsometric gradient here. The precipitations on the plateau and at Petra are mainly of orographic origin.

Seasonal mean temperatures at Petra vary from 6°c in January to 22°c in July, reaching maxima of around 39° in summer and 0° in winter. Frost and snow are possible on the plateau, and even (most recently in the winter of 1991/92) on the site of Petra. The dominant winds are the west and south-west.

It is important to point out that the present day climatic conditions correspond to the rhexistatic context (strong erosional activity provoked by the scarcity of ground cover), which seems to have taken hold of the near and middle east around 4,000 B.C. with the establishment of the belt of high pressure within the present limits.

It therefore seems probable that the environment and climatic conditions at the time of the Nabataeans were essentially the same as those obtaining today. This hypothesis is confirmed by the ancient terraces on the slopes. The Nabataeans built these terraces in order to protect their cultures against the violence of the run-off and to prevent the disparition of the soils. The retaining walls were built on a surface already submitted to erosion.

1.3. HYDROLOGY

1.3.1. Hydrological basin

The regional hydrology is characterized by a strong hypsometric gradient. From the summits of the Esh Shara mountain (1,500 to 1,700 m.) to the depression of Wadi 'Araba, the difference in height is more than 1,500 m. over less than 35 km. The water courses, following the slope of the land, flow westward. In fact, Esh Shara mountain represents the watershed between the east and the west. Precipitation, although weak, is concentrated over an average period of 20 days in winter. The steepness of the slopes and the erosion of the lands combine to provoke a very heavy run-off leading to torrential floods in the principal wadis. The big wadis pass in succession through the different geographical and geological units (limestone plateau to sandstone massif to crystalline substratum), before spilling out into Wadi Araba via wide alluvial cones of different colours varying according to the lithological origin of the wadis upstream.

Wadi Musa

The cartography of the hydrological basin of Wadi Musa shows a considerable densification of the network in the lower catchment area, which belongs, from a lithological point of view, to the sandstone series. The upper catchment area is in the limestone plateau, much less dense, but covering a relatively vast surface. It is above all in this zone that Wadi Musa gathers water and debris.

Erosion and accumulation combine their action, as the current either abandons the material it sweeps along en route, or digs deep or wide channels according to its load. Globally, the transporting action dominates, although at every interruption of the slope there is an acceleration and at every flat surface the deposit is accentuated. Downstream, the wadi abandons the materials it has washed along. In so doing, the river bed is raised at the end, forming large alluvial cones which finish by dominating the region. A vast network of channels is thus formed in the huge "fans" of the alluvial cones so characteristic of Wadi 'Araba.

1.3.2. Underground flow and springs

The torrential downpours at Petra provoke a flushing action which results in a loss of water for the region. Only the region of Jebel Shara, of limestone formation, shows (carstic) infiltrations. These infiltrations reappear on the slopes, in contact with the marl sandstones of the lower Cenomanian, giving a line of perennial springs at an altitude of around 1400 m. 'Ain Musa ("Moses' Spring") at Wadi Musa is the most abundant, giving 540 m3 per day, or around 6 litres per second.

A series of villages developed along this line of perennial springs: Bdebdebe at the sources of Wadi Beida to the north, El Haya and Khirbat al-Nawafle on the Wadi Musa, the Wadi Musa settlement itself to the east, and Bareaq and Taiyibe on the southern ridge. Thus a circle of water points situated at the beginning of the ramified network of wadis surrounds the site of Petra, located among the deep fissures, canyons and cliffs of the sandstone layer that provide a formidable natural defence and a system of channels used by the waters that flow towards Petra as if into an enormous funnel (**Figs. 1 to 3**).

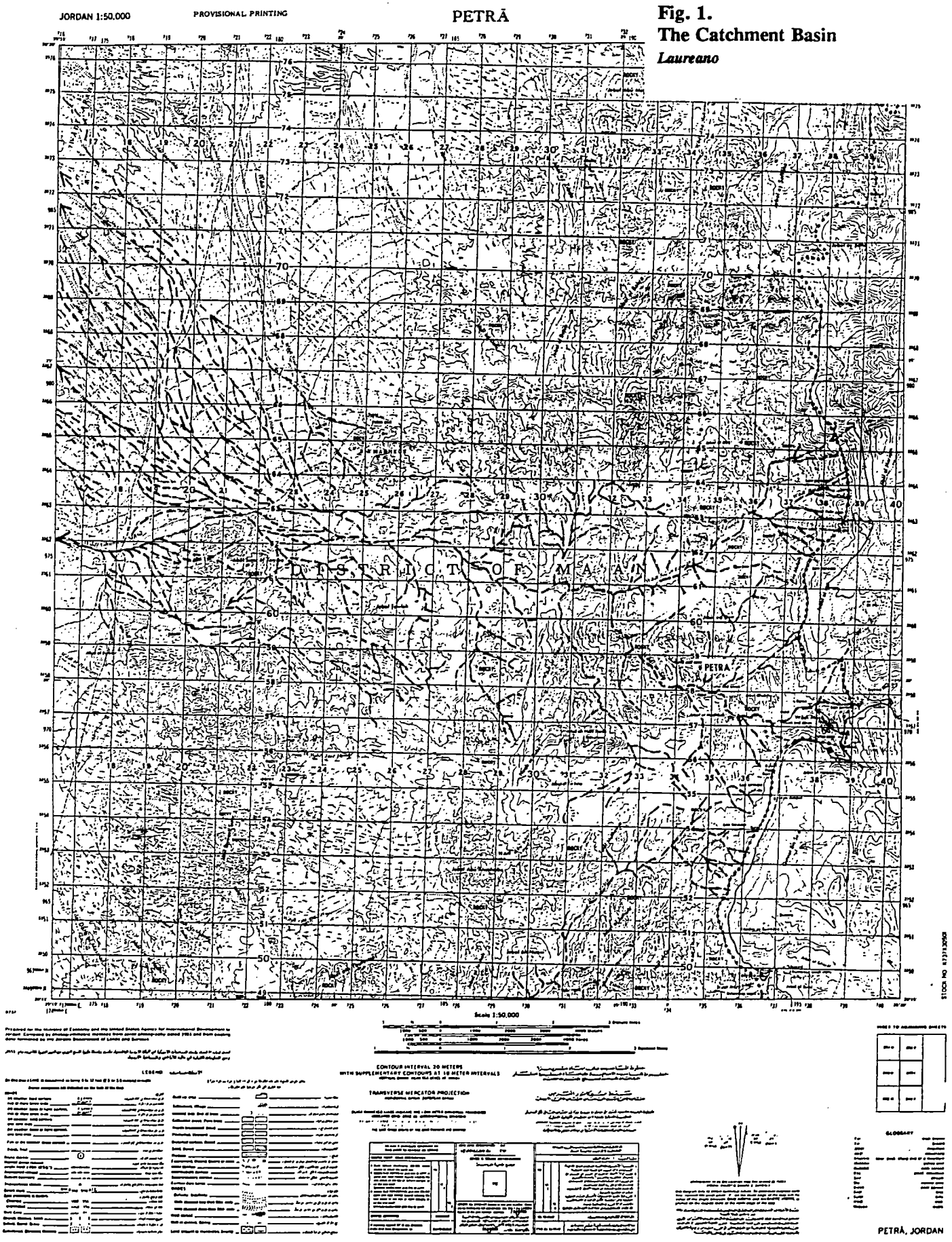


Fig. 1.
The Catchment Basin
Laureano

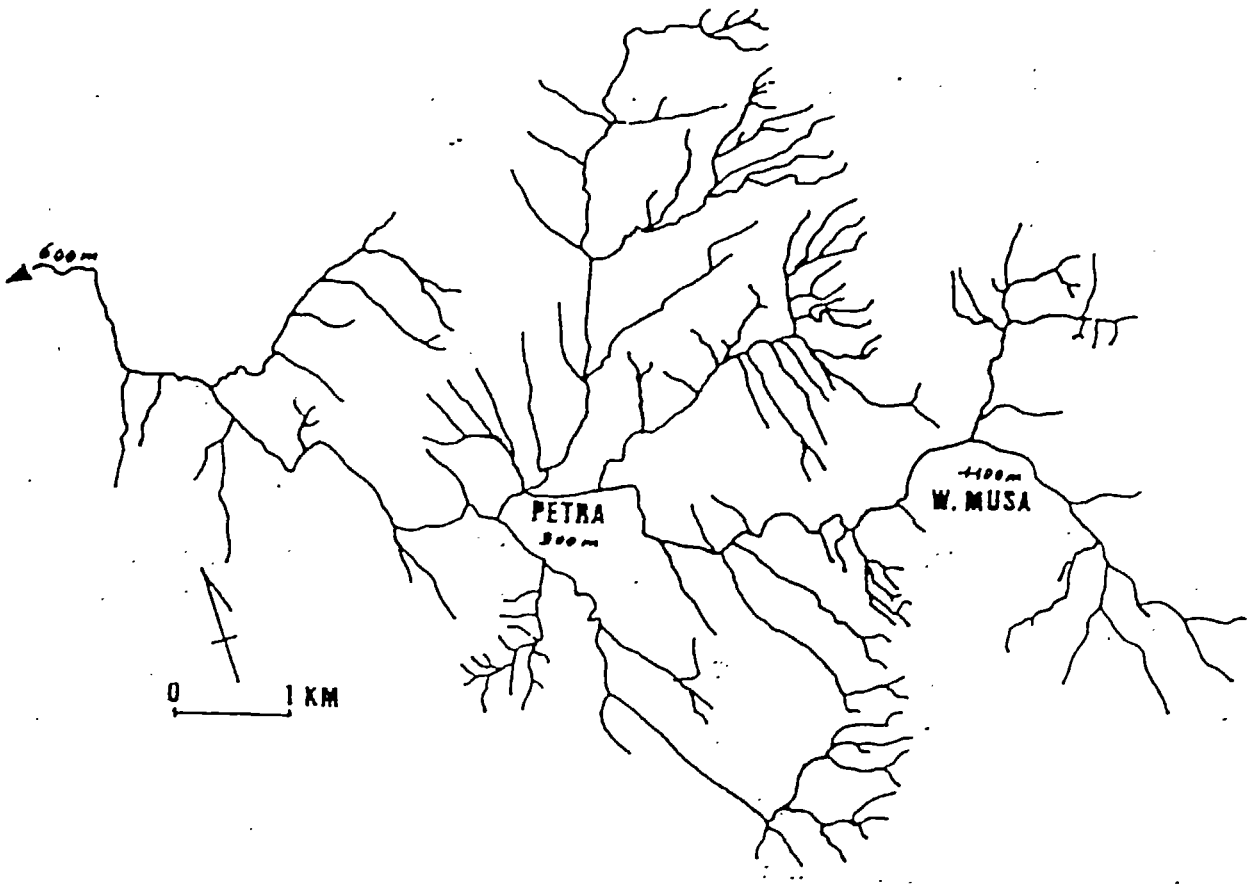


Fig. 2.
Hydrological network of the catchment of Wadi al ghurab (Beida)
Rewerski

Fig. 3.
Hydrological network of the catchment of Wadi Musa
Rewerski

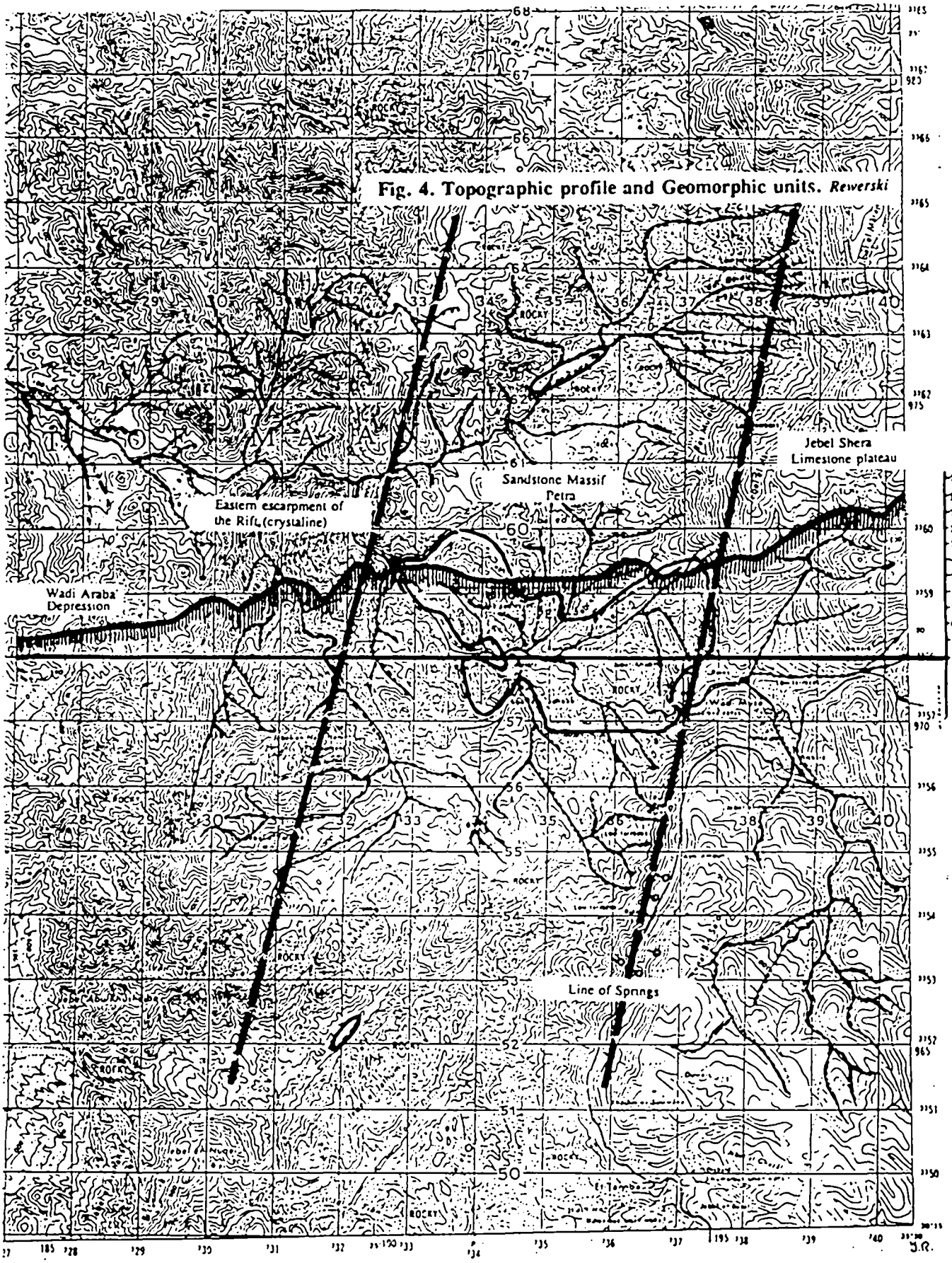
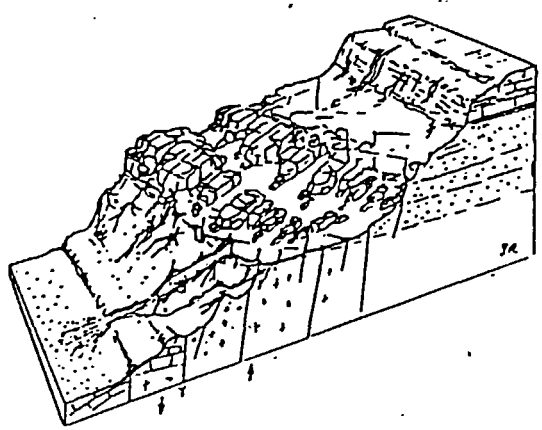


Fig. 4. Topographic profile and Geomorphic units. *Rewerski*



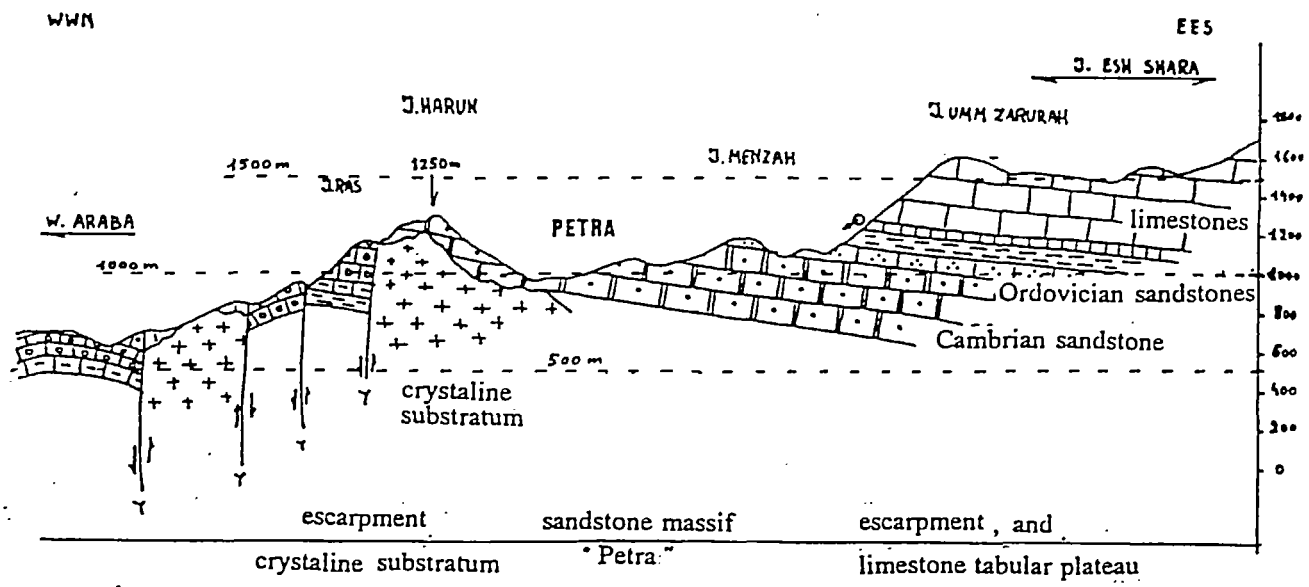


Fig. 5. Simplified geological section through the Petra Region. *Rewerski*

1.4. GEOLOGY

Although formed by ancient rocks (paleosoic sandstones of the substratum), the landscape of Petra is very young. It is directly related to the collapse of the Rift (Red Sea-Jordan Valley), mainly formed during the Plio-Pleistocene period (less than 4 million years ago). The result was a drop of nearly 1,500 m. over 30 km., nearly vertical at the edge of the rift, over almost 300 m. at the point of apparition of the substratum. This abrupt and brutal rupture in the topography accounts for the heavy linear erosion, mainly due to run-off, which cuts into the massif all the more easily because the latter is already heavily fractured by the tectonics.

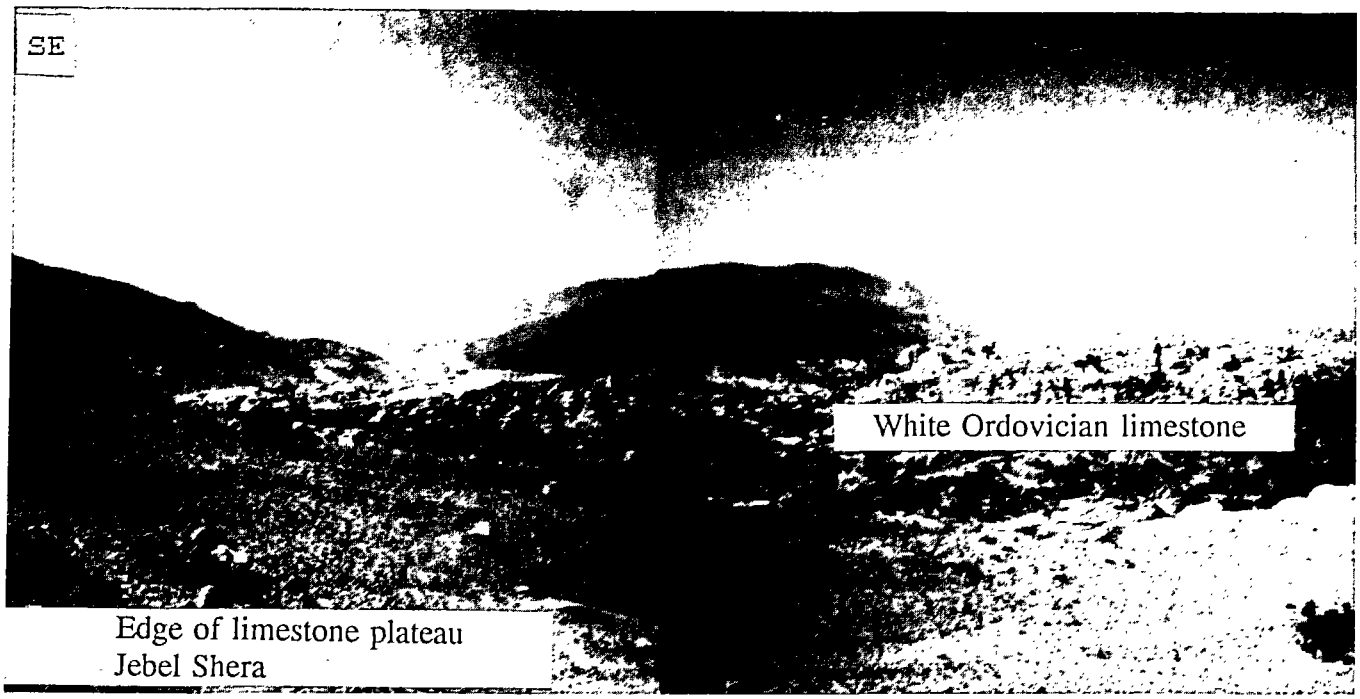
A geological tour of Petra is particularly edifying:

To the east, the site is dominated by the high limestone tabular plateau, formed during the Cretacian; Shera Mountain (1,500 m.). A series of springs ('Ain Musa and along the road to Taiyibe) appear at the base of this series, at the junction of the Cretacian limestones and the Paleozoic sandstones.

Inside Petra, the sandstone massif is formed, at the upper level of its stratigraphy (visible in the eastern half of the massif), of white Ordovician sandstones, and to the west, at the lower level, of the characteristic striated Cambrian sandstones making up the greater part of the massif.

Towards the western limits of the massif, at the level of the eastern escarpment of the Rift, the crystalline substratum appears from below the Cambrian sandstone.

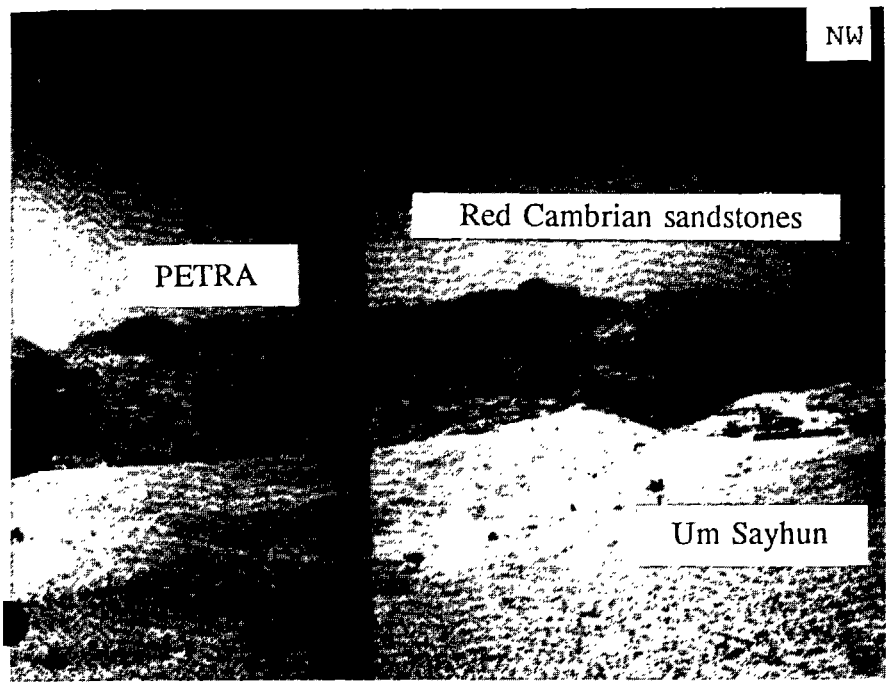
This diversity makes the development of specific geological visitors' trails inside the National Park of great potential interest.



Panoramic photograph of the slopes of Jebel al Hayy looking south-west.

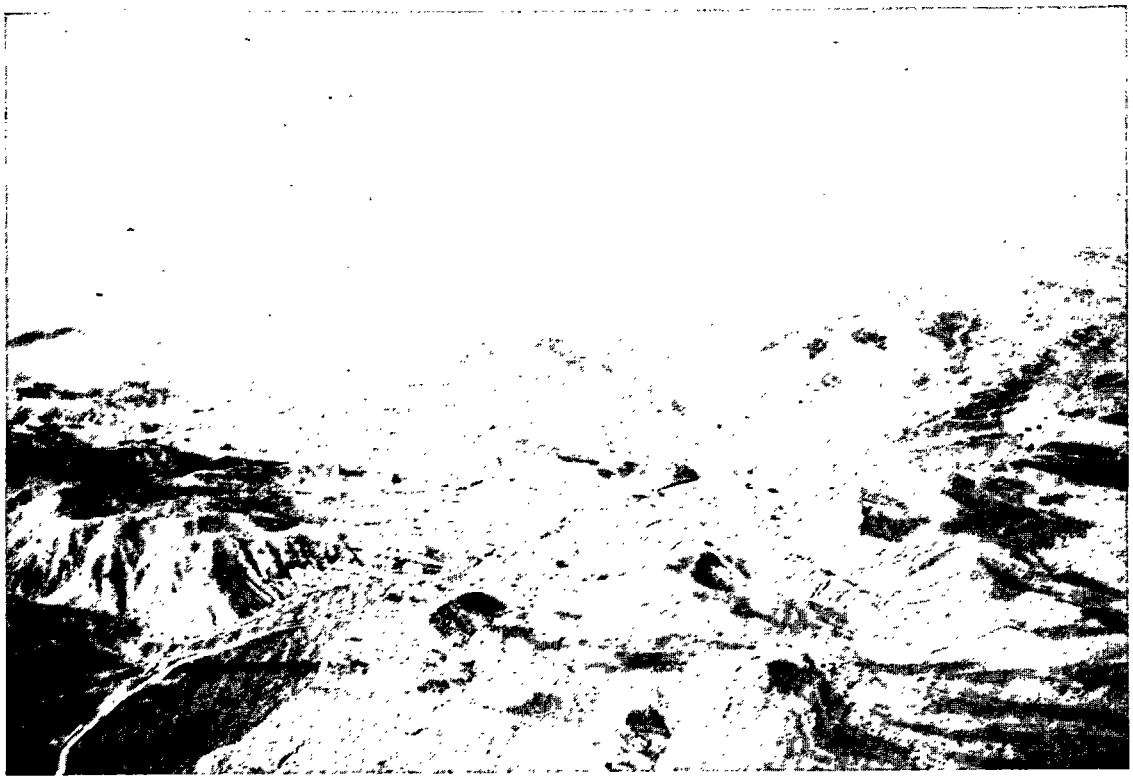
Rewerski

Aerial vue of the limestone plateau of Jebel Shera - an element of the upper catchment of Wadi Musa *Rewerski*



Vue of the Terraces of Wadi Musa and the Massif of Petra.

Rewerski



Alluvial cone of Wadi Musa in the Desert of Wadi Araba.

Rewerski

Aeolian modelling in 'whale's back' form in the white limestone at the entrance to Petra.

Rewerski

2. NATURAL, CULTURAL, SOCIO-ANTHROPOLOGICAL AND ECONOMIC VALUES

2.1. NATURAL VALUES

2.1.1. Flora and Vegetation

i/ Bioclimatological regions included within the Park

The proposed Park, which ranges from 700 to 1700m, will incorporate 4-5 bioclimatological regions, defined according to the Emberger Pluvithermic quotient ("Q") as:

- semi-arid mediterranean bioclimate, cool variety (eastern plateau),
- semi-arid mediterranean bioclimate, warm variety (slopes of the eastern plateau)
- arid mediterranean bioclimate, cool variety,
- arid mediterranean bioclimate, warm variety.

The buffer zone in the western zone (Wadi-Araba) will add a new one:

- saharan mediterranean bioclimate, very warm variety.

ii/ The ecological units of the PANP

The above-described regions are intermingled and not easy to delineate at the Park scale, due to the lack of climatic data (only one small meteorological station at Wadi-Musa !). The abrupt western escarpment creates narrow parallel strips of vegetation, which in a certain manner, reflect the bioclimatological zones. Altitude is here the predominant parameter of the zoning of vegetation. The other major parameters are: substratum, soil, water availability, exposure, and human pressure (grazing).

It is however possible to distinguish 5 major clear-cut ecological units within the proposed Park area. They correspond to geomorphological areas and bioclimatological zones, and are roughly parallel (except the wadis and the alluvial fans), stretching North/South on the upper part of the Jordanian Rift Valley escarpment (between 700 and 1700m). Each unit has specific vegetal communities and land use.

The central corridor

Artemisia herba-alba is the most characteristic plant of the roughly flat steppic areas stretching north-south and located on the sandstone central depression, both north and south of Petra Central City Area. *Retama raetam* is dominant on the sandy/sandy-loam areas wherever they occur: bottom of wadis, plains or small plateaux.
The area surrounding Petra Central City is covered with a sparse and degraded shrub steppic vegetation. Due to the anthropic pressures, uneven terrain, and erodable soils, perennial plants are extremely scattered (sometimes non-existent) and poorly diversified. The landscape is different during spring time when annual vegetation and bulb plants are growing and flowering. Most common plants are: *Ononis natrix* (on most degraded areas), *Urginea maritima, Marrubium vulgare, Retama raetam,...*

A tiny stand of scattered junipers is growing on small Jebel Ras-Sleman.

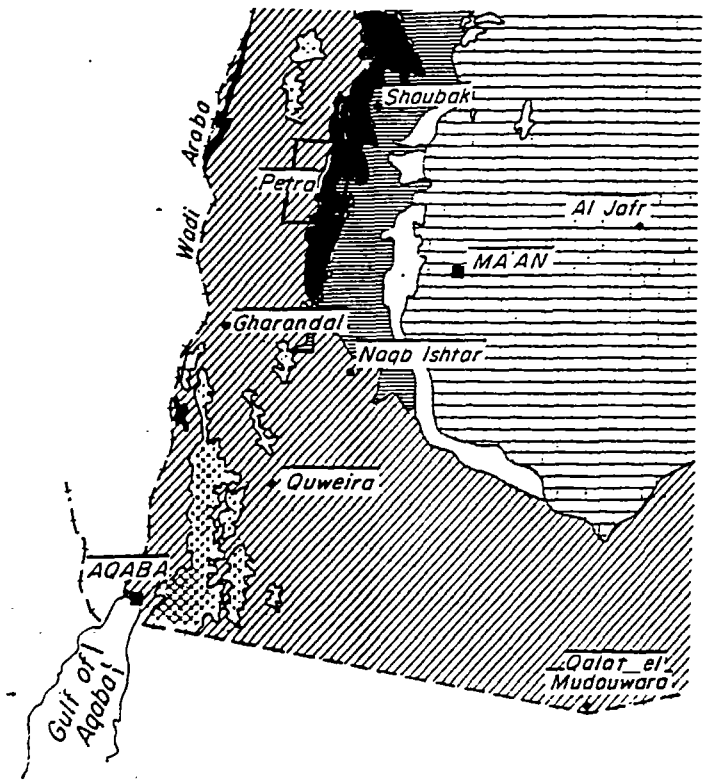


Fig. 6.

Vegetation Map

Limestone desert.

Sandstone and granite desert.

Brush steppe.

Oak woodland in the south.

Juniper woodland in the south.

Acacia woodland.

Transition areas.

Salines.

Appx. National Park Area

taken from: Poore & Robertson, 1963

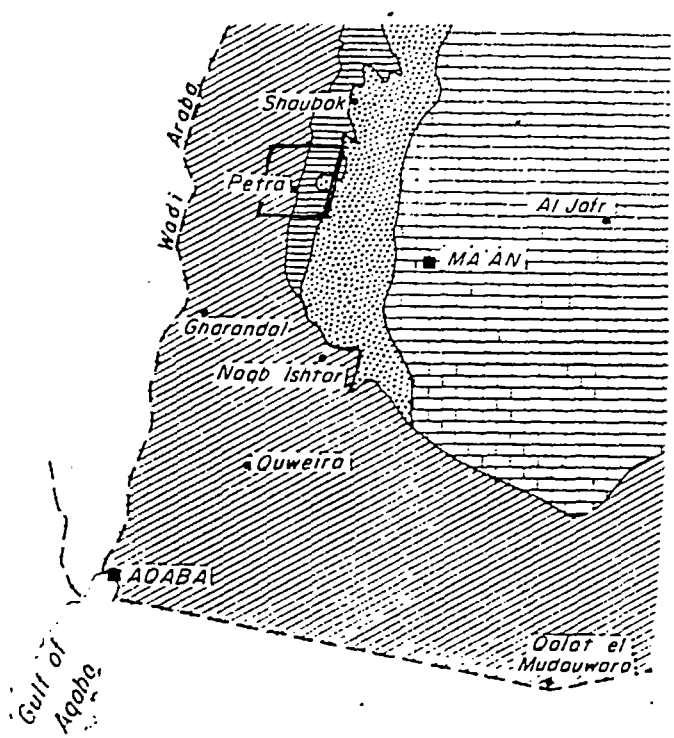


Fig. 7.

Range Classification

Limestone and basalt desert region.

Sandstone and granite desert region.

Steppe region.

Mediterranean region.

The central sandstone massifs

The most common trees and shrubs found within this unit are: *Juniper phoenicia, Daphne linearifolia, Capparis spinosa, Pistacia palaestina, Crataegus azarolus.* Some other trees/shrubs are less common: *Pistacia atlantica, Olea europea,...*

Very narrow clefts deeply cut these sandstone massifs, creating micro-climatic conditions favouring several species normally found in more humid climate.

The eastern limestone range

The slopes and plateaux of the limestone massif bordering the Park along its eastern side are essentially covered with a steppe formation dominated by *Artemisia herba-alba* ("Shir").

From the north to the south, one can successively encounter:

- the western slopes of the Jebel-es-Saha and the Jebel Hisha, included between 1500 and 1700m contour lines, where the Shir steppe area is scattered with *Juniperus phoenicia* 1400/1500m, and *Quercus calliprinos* (evergreen oak) above;

- the undulated plateau of Jebel Hisha (1500-1700m), containing the remarkable Hisha oak forest, the most meridional of its kind in Jordan;

- the conical upper catchment of the wadi-Beida hydrological complex (several springs), between 1100 and 1600m, the junipers being rather concentrated on the Ras-Muleih slopes;

- the upper catchment of the wadis Mataha and Turkmania, joining wadi Musa at Petra Central City Area, is composed with a Shir steppe area scattered with phoenician junipers on the steepest slopes, above the road from Wadi-Musa city to Um-Sayhun village;

- the western slopes of the Jebel Qurnat-Bin-Sa'd, on both sides of the road from Wadi-Musa to Et-Taiyiba, has the same floristic community, but mixed here with row planted trees on contour benches (*Pinus halepensis, Cupressus sempervirens,...*), down to the road.

The western alluvial run-off hammadas and fans

They form the mouth of the wadis crossing the mountain range from the limestone plateau and draining to the Wadi-Araba depression. They have not been investigated by the present mission. Acacias *(A. raddiana, A. seyal ?)* can easily be observed in the depressions.

The wadis

Two major types of wadis can be distinguished: the dry wadis and the wadis where groundwater table is near (or appears at) the surface. The first category is dominated by *Retama raetam, Thymelaea hirsuta* and *Daphne linearifolia*. The second category include more soil-moisture related plants like tamarisk, oleanders,... and in the best case, water-related plants such as reeds and ferns.

Owing to lack of time, only a few wadis have been partially investigated.

Wadi Sabra

This Wadi facilitates the penetration of desert plants towards the north-east, close to Petra. The most noticeable desert trees living in Wadi sabra are *Tamarix sp., Acacia raddiana, Lycium shawii.* Other desert plants include: *Hammada salicornica, Citrullus colocynthis, Zygophyllum dumosum, Anabasis articulata,...* However, *Calligonum comusum*, abundant in the hot Wadi 'Araba depression has not been found here, at least up to the 700m contour (extreme southern part of the proposed protected area).

A small stand of very old tamarisk is lying within the sandy bed of the wadi, near the Sabra theatre. Young branches with fresh leaves are frequently taken from these trees by the nomads who feed their camels with it. It seems that there is a balance between cutting and tree production, but the development of touristic camel riding could impair this fragile equilibrium.

There is an oasis slightly downstream Wadi-Sabra, where some water holes appear on the sandy surface. The moisture of the soil has favoured the growth of a lush stand of intermingled *Nerium oleander, Inula viscosa, Arundo sp., Phragmites sp.*, and *Juncus sp.*. A unique palm tree stands alone here.

Wadi-Siyagh

Down to the Petra City Centre Area, Wadi Musa becomes Wadi Siyagh (or wadi es-Siq), before changing back to its original name as it enters the wadi 'Araba plain.

This wadi could be the major floristic area of the PANP with 90 species recorded here, out of 240 for the whole Petra region (*in* Lindner, 1989). Of particular interest are plants like *Pistacia atlantica, Pistacia khinjuk* (rare), *Aloe vera* (a splendid natural "hanging garden" can be seen near the entrance of the wadi into the gorge), *Adiantum capillus-veneris* (a little fern growing in the shadow of spring Siyagh), *Lonicera etrusca* (a honeysuckle), *Hammada salicornica* (a desert plant), *Rhamnus dispermus*. In some places, e.g., close to the ancient monumental quarry, unpruned grapes climb up on the oleanders, which sometimes form thick stands of old trees.

The bed of this deep wadi is occupied by some tiny Bedouin terraced gardens (olive, fig and apricot trees, grape vines,...).

Wadi Um-el-Hiran

This small wadi, a few kilometres north of Beida, includes a remarkable stand of old oaks *(Quercus calliprinos)*, with some pistachio and juniper trees. Unfortunately, the road to Wadi 'Araba (paved section) passes through this narrow wadi.

The Siq

At present, the vegetation of the Siq is extremely depleted, due to the constant stream of tourists, horses and carriages that follow this 2 km long narrow gorge between 6 a.m. and 6 p.m. every day of the year. The thick cover of dust deposited on the last remaining plants ***(Ficus sp., Nerium oleander)*** is steadily killing them.

iii/ The forests

As shown on the map Fig. 6, the proposed protected area will incorporate several climax communities, which are of special interest to Jordan, because they extend in limited areas and are often threatened by human activities. The **Juniper forest** *(Juniperus phoenicia)*, which in Jordan only occurs in the southern mountain range (only 7700 ha remain) and the evergreen **Oak forest** *(Quercus calliprinos)*, (the most southern of Jordan), are the most remarkable. To these trees are associated specific plants, many of which are being depleted by overgrazing.

iv/ The rangelands

In Jordan, rangelands are located in arid and semi-arid areas where annual rainfall is below 200 mm. The rangelands are deteriorating, owing to unwise human intervention, particularly overgrazing and cereal cultivation. Loss of the plant cover accelerates soil erosion and the desertification process. These negative environmental trends can be found within the proposed PANP, mostly composed of rangelands.

To protect the rangelands of Jordan, the MOA has established 17 grazing reserves all over the country, where controlled areas and forage plantations are implemented. There is none within the proposed PANP, but the UNDP/FAO "Forest and Range Strengthening" Project may carry out several activities related to the sustainable use of rangelands in Ma'an and Shawbak Districts.

v/Flora of the PANP

Floristic regions

The PANP and its buffer zone will incorporate areas belonging to 3 floristic regions (see map Fig. 6):

- the Mediterranean Floristic region,
- the Irano-turanian Floristic region,
- the Saharo-arabic Floristic region.

List of plants

A comprehensive study of the flora has been carried out by the "Naturhistorischen Gesellschaft Nürnberg" during several successive archaeological expeditions[1].

Remarkable floristic elements

As already underlined, *Quercus calliprinos* and *Juniper phoenicia* are in Petra at the south-eastern limit of their distribution.
The caroub tree *(Ceratonia siliqua)* is represented by a few specimens, for example in shadowed ancient cisterns at Sabra theatre and at Beida. *Acacia raddiana* and the date-palm tree *(Phoenix dactylifera)* are rare outside Wadi-Araba depression. Unique specimens grow in upper Wadi-Sabra, where uncommon tamarix (for Petra) can also be found.

---

[1] Lindner, 1989. pp. 233-256.

On the road to Beida grows a unique exemplary of *Crataegus aronia*, and only in Wadi-Siyagh grow one small stand of *Salix acmophylla* (*in* Lindner, 1989), as well as the fern *Adiantum capillus-veneris* (near the spring).
Restricted to small sectors of the Petra depression, are: *Psoralea flaccida, Polygala sinaica, Lycium petraeum.*

At Wadi-Musa city, some poplars *(Populus alba* or *P. euphratica* ?) grow along the wadi.

The PANP incorporates **endemic plant species**, as *Iris petrana, Lycium petraeum, Iris edomensis* (endemic ?), *Daphne linearifolia* (endemic in Jordan), *Verbascum transjordanicum* (endemic in Jordan).

2.1.2. Wildlife

i/ Methodology and results

Owing to the rarity of wild animals (large mammals), the topography and related difficulties of access, as well as the short time of the mission, it was not possible to carry out a detailed study of wildlife.

However, through talks with the local population, and observations of indirect signs of the presence of wild animals (faeces, footprints), one can assess that the situation of wild large mammal populations is critical in the Petra region. The only signs of occurrence have been footprints of one wolf in the upper Wadi-Sabra and the remains (one leg) of a trapped fox in the wadi al-Mudhlim (downstream to the Nabataean diversion tunnel).

The remaining large mammals (especially ungulates: nubian ibex *(Capra ibex)*, mountain gazelle *(Gazella gazella pallas)*, dorcas gazelle *(Gazella dorcas)*, and predators: wolf, striped hyaena *(Hyaena hyaena)*, red fox *(Canis vulpes)*, jackal *(Canis aureus)*) are rare, if not exterminated, in the Petra region. There is no recent record of Persian fallow deer *(Cervus dama mesopotamica)*, cheetah *(Acinonyx jubatus)*, and leopard *(Felis panthera)*. Rarety of prey can not allow many large predators to survive[1].

According to the species occurring in the vicinity of Dana Wildlife Refuge, the PANP could as well include: badger *(Mellivora capensis)*, Indian crested porcupine *(Hystrix indica indica)*, rock hyrax *(Procavia capensis)*, hare *(Lepus capensis)* and wild rabbit.

At least 130 species of birds have been observed in the Petra region. Among them, several endemic birds, like Tristram's Grackle (Petra, Dana, Sinai,...), Fan-tailed raven, Sinai rose-finch,...., and broad-distribution birds, like "ammomane du désert", "chouette chevêche", "pigeon biset", Chukar partridge,... Bonelli's eagle is known to use the site at least in migration (breeding ?). The bondrée apivore is a migrator. A buzzard (probably "buse féroce") has been observed over Wadi-Sabra.

A census has not yet been taken of the Reptile species.

ii/ Causes of depletion

Pressures on wildlife resources are direct and indirect.
Hunting is a common practice, as many people have one rifle. Destruction of large mammals has now diverted the pressure on birds.
Indirect pressures are many:

***Destruction of the plant cover**, through:*

- ***agricultural development**, at the expense of rangeland, is probably the most damaging to the wildlife of the steppe zone;*

[1] Although there has been evidence of one goat having been killed by a wolf in the Wadi-Sabra, livestock is relatively well kept and rarely attacked.

- *overgrazing (mainly due to goats) is another major threat to wildlife: competition for water (springs, wadis), for grasses, herbs, shrubs and trees. Overgrazing on marginal lands (rocky massifs, steep slopes,...) results in impoverishment of the flora, soil erosion, and finally desertification;*

- *fires are often set in the north of Jordan for various purposes (agricultural and rangeland practice, land tenure conflicts, revenges,...). Occurrence of fire has not been observed in the Park's area. The scarcity of the vegetal cover is the main reason. This is why one should be careful in establishing permanent grazing or botanical reserves, which could raise the risk of deliberate or accidental fires. A monitoring of the grass cover will be required.*

Urban expansion and/or tourism development

Urban expansion and/or tourism development sometimes threaten wildlife, when vital resources, like springs, are appropriated (fences, dams, stone walls, canalization,...), and where restricted vegetation is destroyed. This problem should be tackled as a required condition for the return of large wild animals to suitable areas.

Road development

The recently built Wadi 'Araba track/road, designed without any EIA study, passes through important ecological sites, e.g., the Um al-Hiran gorge, wadi Siq-Um-el-Alda,..., where old stands of juniper, oak, and pistachio trees (other lush wadis vegetation alike), have been destroyed. Many tracks have also been built in the eastern part of the Park, the most damaging being the new Beidha/Shawbak road through the Hisha oak forest. As a result, uncontrolled movement and penetration of vehicles occur now in until recently preserved areas. Tanker trucks bringing water for the livestock would help in prolonging stays of domestic animals and/or in using new grazing areas. The penetration of tractors will also be facilitated and new plots of lands ploughed. All these factors combined will aggravate the desertification process.

iii/ Further development

Wildlife recovery could be achieved through actions such as:

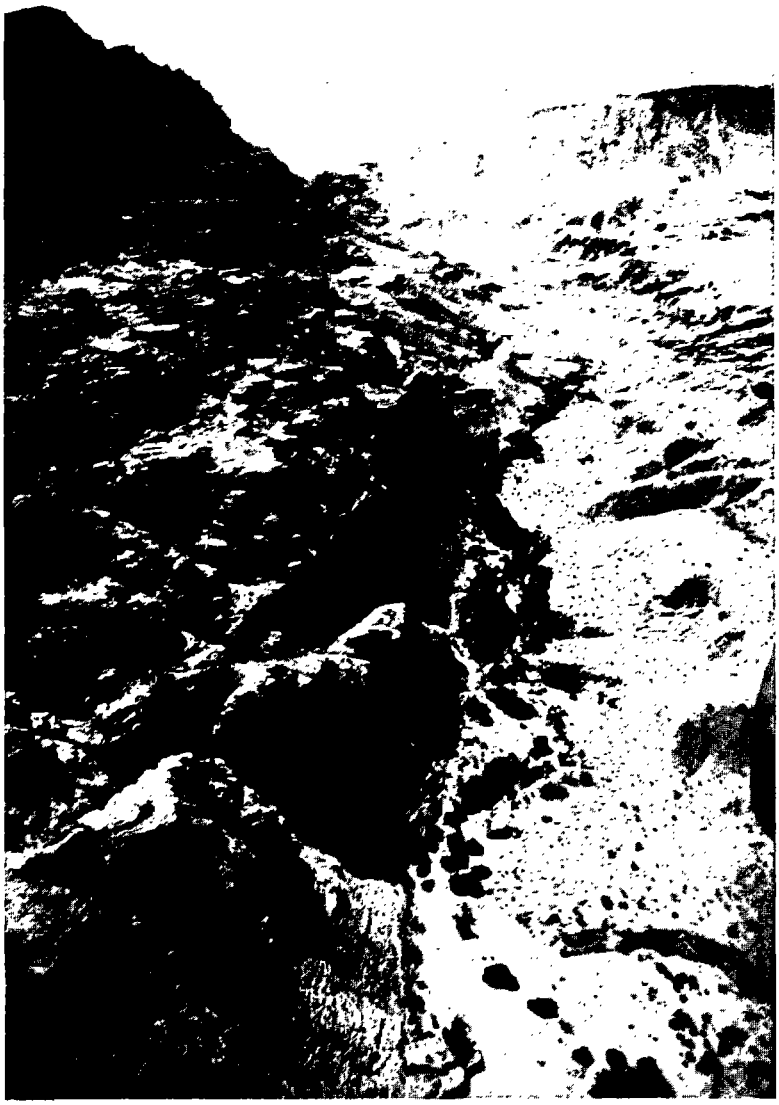
- strict hunting prohibition and law enforcement,
- establishment of suitable conditions of habitat
- facilitating the eventual immigration of large mammals from the North (creation of a "wildlife corridor" between PANP and DWR),
- re-introduction of species.

Only the first three actions should be considered. The re-introduction of species is not a priority under the present Plan. However, the PANP could be used as a receptive territory, should wild populations in other areas be split (mainly to avoid disastrous consequences of severe epizooties). In this case, funding should be external.

SIQ UMM-AL-ALDAH
Impact of the new road to Wadi Araba through
oak and pistacio natural stand *Bousquet*

WADI SABRA
Tiny tamarix stand browsed by camels in the bed of the Wadi

Bousquet



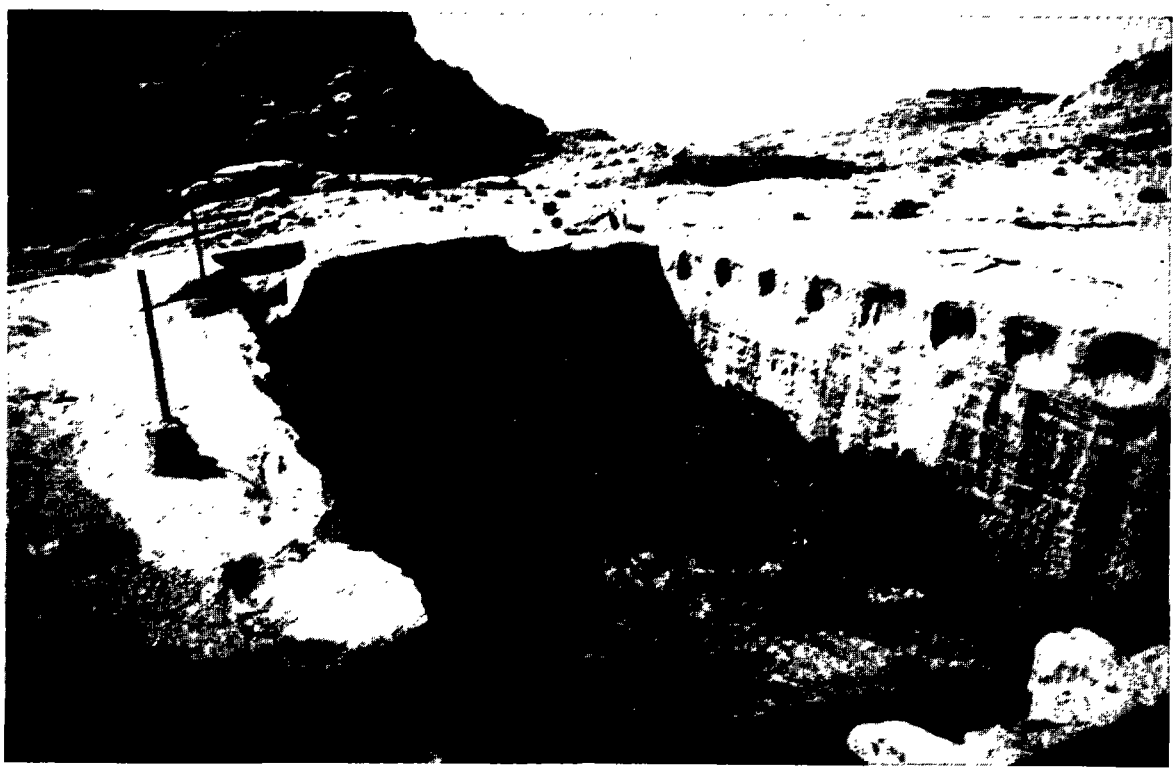
WADI SABRA
Spring and water emergence of the Wadi surrounded with dense vegetation

Bousquet

RAS SLEISEL
Nabatean terrace used by Bdul for cereal cultivation

Bousquet

HISHA
Extension of agriculture (use of tractors) and road development jeopardize steppe and oak forest integrity *Bousquet*



BEIDA
Cultivated Nabatean cistern (olive tree, figs, pomme grenade...)

Bousquet

ROAD TO WADI ARABA
Cutting evidence of Juniper tree
Bousquet

SIQ EL BERID
Broken *Daphne linearifolia*
Bousquet

2.2. CULTURAL VALUES

2.2.1. Interaction of man and nature

The site of Petra has been under continuous transformation and development since early geological eras, in a process that determines the spectacular morphology of the places but that also decrees their destruction in the course of time. Man's action has entered into the natural process, drawing inspiration from the natural forms, exploiting the shelters and winding ravines and using the environment to his own advantage.

Petra is a citadel protected by a maze of sandstone canyons and fortresses at the crossroads of important north-south and east-west caravan routes. The trails start at the foot of the Um el Biyara cliff among the monuments of Zibb el Faraon, and Qasr el Bint, and head in all four directions: to the south, through Sabra they reach Aqaba; to the west they lead to Wadi Araba, passing by the foot of Djebel Harun towards the Negev and the Nile Delta, or along the Wadi Musa to reach Gaza and the Mediterranean; to the north, after Beida, they continue with the Road of the Kings towards Lebanon and the Silk Road; to the south-east, after Ma'an, they head towards southern Arabia along the Incense Road (**Fig. 8**). This is the geographical space of the first human group to which there is a historical reference, the Edomites, mentioned in the Bible, who controlled this important trading post between the ancient empires of Egypt, Mesopotamia, Southern Arabia and the nascent Mediterranean civilizations. The region's inhabitants were nomads, great caravan leaders mentioned by Diodorus of Sicily who in 312 BC. already called them Nabataeans and relates how in moments of need they took refuge in an impregnable fortress: Petra.

The natural setting provided the basis for the development of a society whose essential activities were nomadism, goat-herding, trade, agricultural and mining activities, and who possessed the advanced knowledge of hydraulic and construction methods necessary to carry out these activities. The sudden change in altitude due to the geological conformation of the Rift Valley creates different ecosystems in a very limited space, favouring transhumance for agriculture and goat-herding. Until today, Bedu groups move alternately from the desert depression of Araba to the higher altitudes, according to the season. The small seasonal transhumance gives rise to a propensity to travel, and leads to the great nomad caravan journeys that control trade over long distances. The high places with their many winding gorges in the sandstone hills of Petra afford protection to animals, products and goods, and become fortresses, centres of accumulation and trade, meeting places and places of worship.

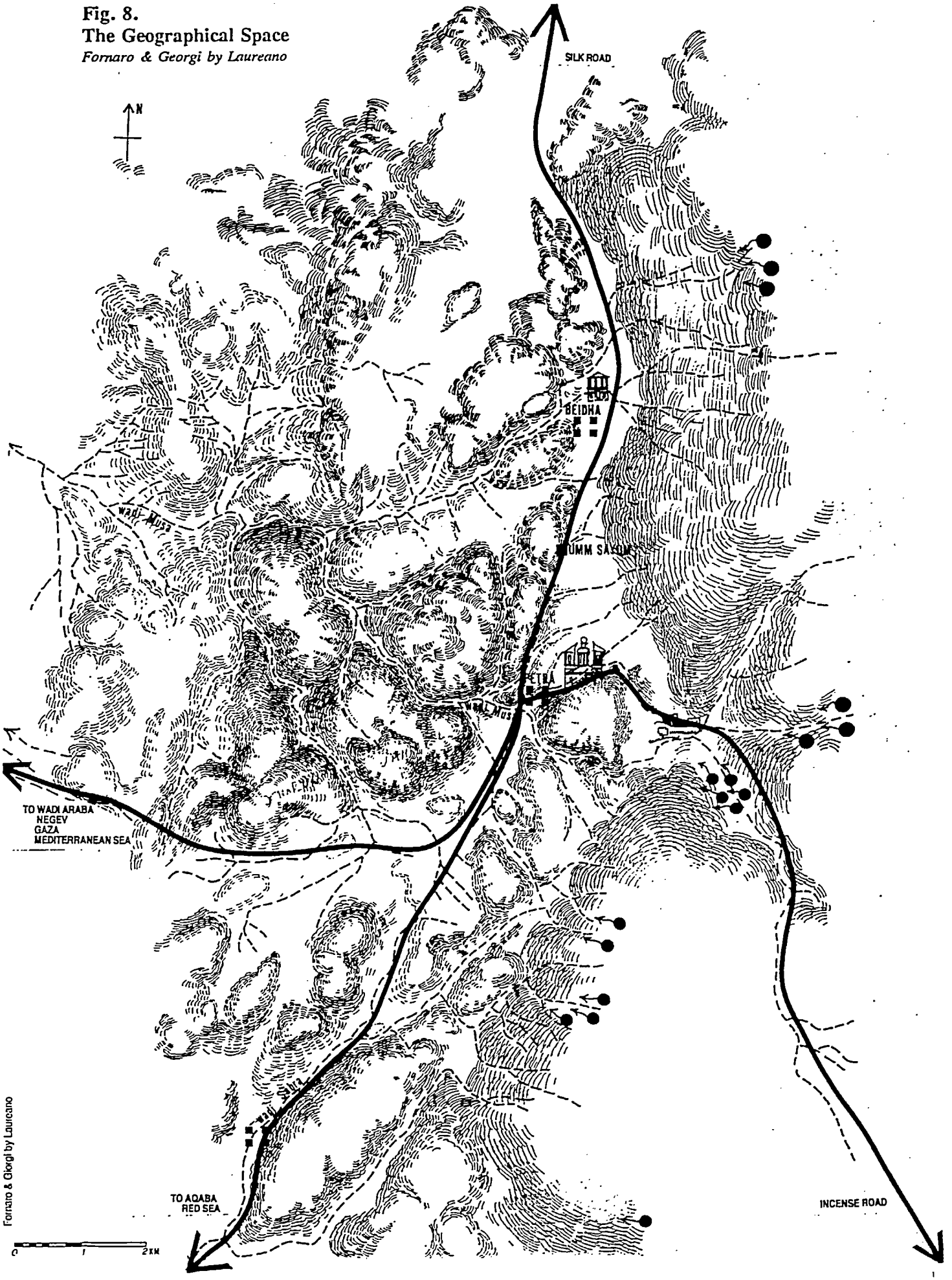
2.2.2. Historical Periods of Occupation

The visitor to the Petra archaeological and Natural Park will no doubt be surprised by the variety of its physical and cultural heritage attesting to successive periods of occupation of the site from the eighth millenium BC through the mediaeval Islamic periods, to the stone-built hillside villages and bedouin settlements.

i/ Neolithic Period

There is evidence of a stable settlement from the early Neolithic, as shown by the numerous vestiges including the partially excavated pre-ceramic Neolithic village of Beida, the completely intact site of Shakaret Musei'ed, and al-Damman, in Wadi Sabra.

Fig. 8.
The Geographical Space
Fornaro & Georgi by Laureano



Beida

To the north of Petra, the neolithic village of Beida, the largest site of its kind yet excavated, shows the development of domestic patterns from 7000 to 6500 B.C. Six main architectural levels were identified by Mrs. Diana Kirkbride, who excavated the site between 1958 and 1986 on behalf of the British Institute for Archaeology and History.

Burials of young children below the ruined houses are evidence of ritual practices. Another aspect of the cult is illustrated by three structures to the east of the village. The largest semi-subterranean enclosure is paved, and contains a large standing stone and a shallow basin carved in one piece from a huge stone slab with a drain in the rim. The complex is interpreted as a sanctuary and demonstrates the religious preoccupations of the early settlers of Petra region, who practiced agriculture, hunting and animal husbandry. Flint and horn tools were found on this site, together with beads of shell and bone, and exotic stones such as obsidian are evidence of wide commercial relations.

Shakaret Musei'ed and al Daman

The remains of two other important neolithic villages lie within the Park Boundaries. The first, 10 km. to the north of Beida on the route to Hamala, has been damaged by the opening of the new road, and requires urgent protection. Neither this site nor al Daman, in Wadi Sabra, has been excavated.

ii/ Chalcolithic and Bronze Age

Um al-Biyara

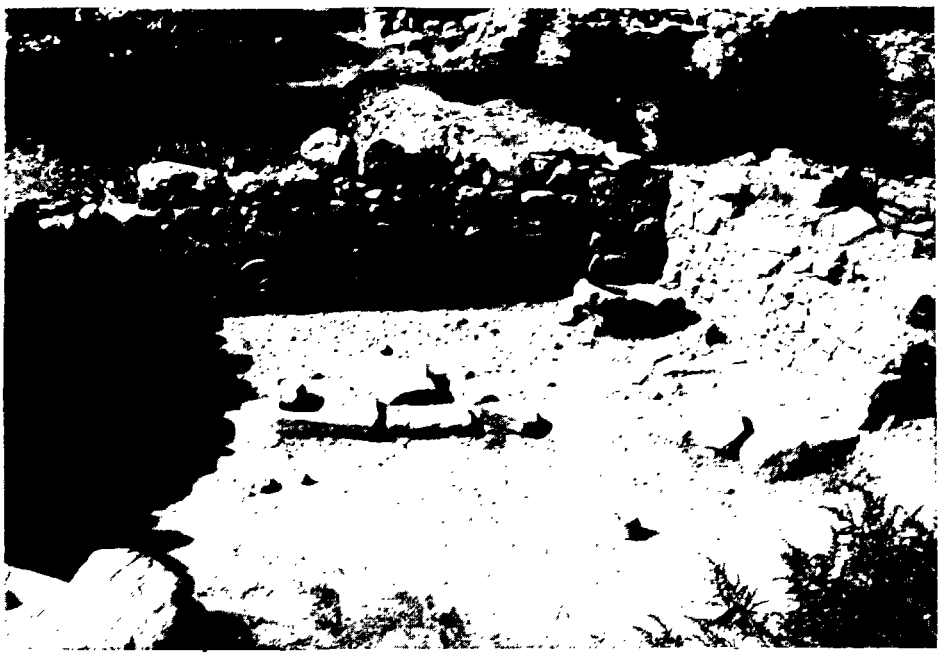
At Petra on the Um el Biyara cliff, vestiges have been found of the earliest Chalcolithic settlements, already organized with cisterns and pits for storage.

Copper Mines

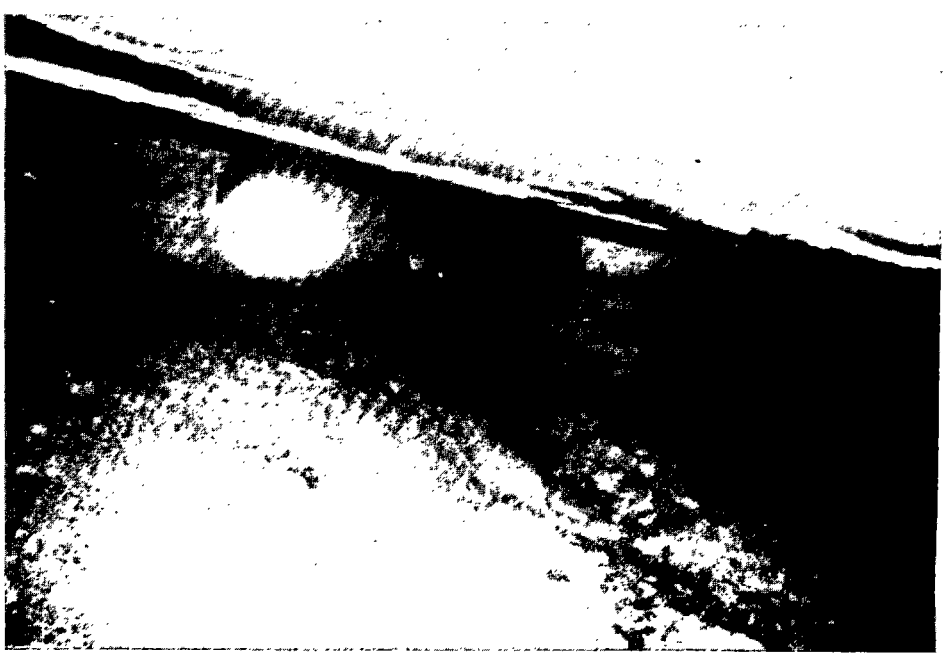
The presence of mineral resources brought to light by the tectonic movements of the Rift Valley has made the region important for mining since the earliest times. Bitumen from the Dead Sea has been marketed since the most ancient times, but copper, the mineral that opened up for humanity the technology of metals, is the main resource. The copper mines in the Araba valley were among the first ever exploited. They were dug in the Chalcolithic and between the early and middle Bronze Age and again between the XVIII and XIII centuries BC. by the Edomites. Later they contributed to the economic power of the Kingdom of Solomon and continued to be used until the Islamic era.

Al Saddeh

The discovery of an early Bronze Age settlement dating from the third millennium B.C. within the archaeological park, is of the greatest interest. About 25 well-built houses were identified by M. Lindner during an expedition of the Nürenberg Naturhistorische Gesellschaft expedition of 1990 to al Sadeh, 13 km. to the south of Petra on the plateau of Um al 'Ala, at around 700 m. above sea level. A storage jar excavated in a trial sounding links the site with other Palestinian settlements contemporary with the 1st. Egyptian dynasty.



Beida, pre-pottery Neolithic house
Zayadine



The Chalcolithic copper mine at Um al'Awad
Zyadine

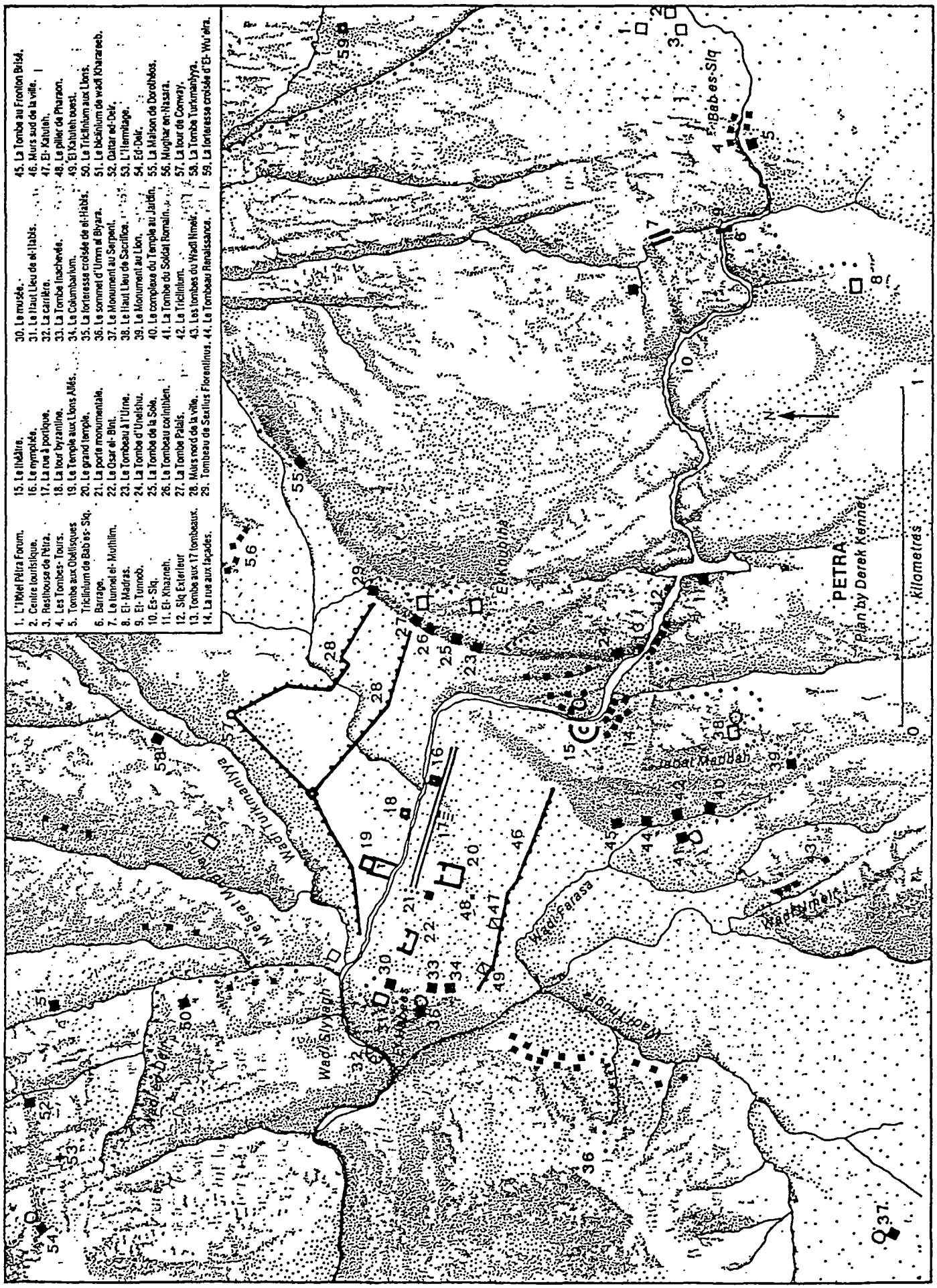


Fig. 9. Principal archaeological sites, Petra. *Plan by David Kennet*

iii/ Iron Age

An Edomite settlement from the Iron Age, also identified at Um al 'Ala, can be paralleled with the Edomite village of Um al-Biyarah, the stronghold inside Petra which was excavated by the late C.M.Bennet, Ba'ja, another inaccessible fortress north of Beida, on the route to Namaleh, and Buseirah, near Tafileh, as well as Tawilan, at the north-east entrance to Wadi Musa, also excavated by Bennet. A rich treasure of gold jewelry and beads, together with a cuneiform tablet probably dating from the period of Darius I, was discovered there in 1982. Tawilan is easily accessible to tourists, and should be adequately protected and consolidated.

It is remarkable that most of these sites are "eagles' nests"; a feature which can be easily explained when the early history of Jordan is considered. During the New Kingdom in Egypt (14-12 c. B.C.) Ramses II and III organized frequent raids against the bedouin Shosu of the land of Se'ir (Southern Jordan). Later, King David clashed with the Edomites in the Valley of Salt (Wadi 'Arah). Solomon, who was interested in the mines of Um al 'Awad (photo p.28) and Feinan built the city of 'Esion-Geber (Tell-Khalifeh, near Aqaba). Trade with southern Arabia was also a major factor for their territorial expansion. The caution of the Edomites is thus understandable.

The mining experience laid the technical basis for digging quarries and rock dwellings in the sandstone rock face and for boring tunnels to create impressive water systems. Man intervened in the incessant process of erosion of the environment in a titanic struggle for the protection of the land, the organization of arable land, water collection, the organization of a habitat which had achieved an amazing degree of integration with the natural resources.

iv/ The Arrival of the Nabataeans

There is no clear evidence of the migration of the Arab Nabataeans into the land of Edom in the 6th century B.C. The evidence can be deduced, however, from the destruction of the country by Nabonius, the last neo-Babylonian king, and the deportation of its population, leaving a vacuum soon to be filled by the newcomers. The problem of continuity from the Persian-Achaemenid period to the arrival of the Nabataeans or their appearance in the early 4th century has been a subject of thorough dispute. Whereas some scholars see no continuity in the settlements and the material culture, Bartlett argues for continuity; "the people remained and the emphasis moved to pasturing animals and life in tents and caves.."[1]. In fact, the early Hellenistic period is scantily attested in the whole area of Trans-Jordan, but we know from historical records that the Nabataean tribes were present and that they practiced pasturing, brigandage and piracy in the Red Sea. They were also engaged in the trade of spices and the exploitation of Dead Sea bitumen[2].

In the second century B.C., Aretas, the first Nabataean king, was established at Petra[3]. From this early period there is still no firm evidence, except for some coins and poor architectural remains excavated by P.J. Parr in the colonnaded street[4]. A Nabataean sanctuary was recognized at Um el-Biyarah by C.M. Bennet, but not excavated[5]. The investigation of this monument will be of high interest, and may reveal the missing link between the Edomite and the early Hellenistic period. For the time being, the

---

[1] Bartlett, 1990: 25-34

[2] Diodorus of Sicily III, 43: 4-5

[3] 2 Maccabees, 5.8

[4] Parr, 1990: 15-16

[5] Bennet, 1980, pp 208-211

Nabataean occupation of Petra can be dated with relative certainty from the first century B.C. to the second century A.D., the oldest monuments still standing being the temple of Qasr al Bint.

"Greater Petra"

With its many sanctuaries and vast necropolis, Petra played the role of religious centre and sacred city of the dead. It was also the administrative seat where the governor of the Province held his assizes and military troops garrisoned. Little research, however, has been carried out to date on the surroundings of the Nabataean capital. Since the rediscovery of Petra at the beginning of the nineteenth century, the efforts of scholars have mainly been concentrated on the central part of the site, the peripheral areas being the object of brief descriptions only. This can be explained by the density and monumental character of the rock-carved and stone-built temples and tombs occupying the central basin, as well as the dominant influence of the Greco-Roman model on the concepts of ancient town planning at that time.

In the light of current research, however, it is evident that the site of Petra must be understood as a whole: it should not be forgotten that this was the capital city of the kingdom of a sedenterized nomadic people, whose prosperity was based on the control of the two principal elements of the caravan trade: the merchandise and the communication routes. Its role as principal centre of commercial exchange presupposes the existence of economic, civil, military and agricultural infrastructure which would have been needed in order to ensure the survival and prosperity of this centre of prestige of the Hellenized Nabataean kingdom. No less than seven routes, from Arabia, Sinai or Syria, converged towards the central basin:

- N.W. route from Wadi Musa to Namala via Sleisel and Beida
- S.W. route to Gaza and Sinai by Delagha and Gharandal
- S.W. route to Sinai and Egypt via Naqb al Ruba'i and Naqb Abu Khusheibah
- Southern route from Qasr al Bint to Wadi Sabra
- Route east from Wadi Musa to Wadi Sabra
- Route east from Wadi Musa to Ma'an
- The Kings' Road, from Syria to the Red Sea

At the terminus of each route are impressive caravan halts, supplied with wells or water reservoirs, and in several cases, with extensive agricultural installations. These peripheral settlements of "Greater Petra" were designed to be economically and strategically independent, since not all of the caravans halted in the city centre, to avoid constraint and heavy tolls.

Beida

Only Beida seems to have had an essentially agricultural function, attested by the many farms, presses, water tanks and traces of ancient agricultural terraces throughout the plain. Beida also played an important role as caravan stop. The caravans leaving Petra from the North and those arriving from Siq Um al 'Aldah, transited through Beida. They probably stayed around the mouth of Wadi al Amti, where the remains of a what was probably a caravanserai may be seen. It seems probable that most of the provisions for Petra came from Beida, which was the closest urban agglomeration to the centre and also the most important by the extent of its cultivated lands and by the monumentality of its urban installations, as witnessed by Siq al Barid, which has been called "the little Petra".

Sleisel

By its position a few kilometers downstream from Beida, and above the Sleisel falls, Sleisal and its tributary wadis can be considered the extreme limit of the area of intensive agriculture around Beida, rather than belonging to the "Roman gardens" sector. The siting of Sleisel at such a distance from Beida probably answered the strategic need to ensure the surveillance at regular intervals. Its position dominating the landscape to the west lent itself particularly well to this function.

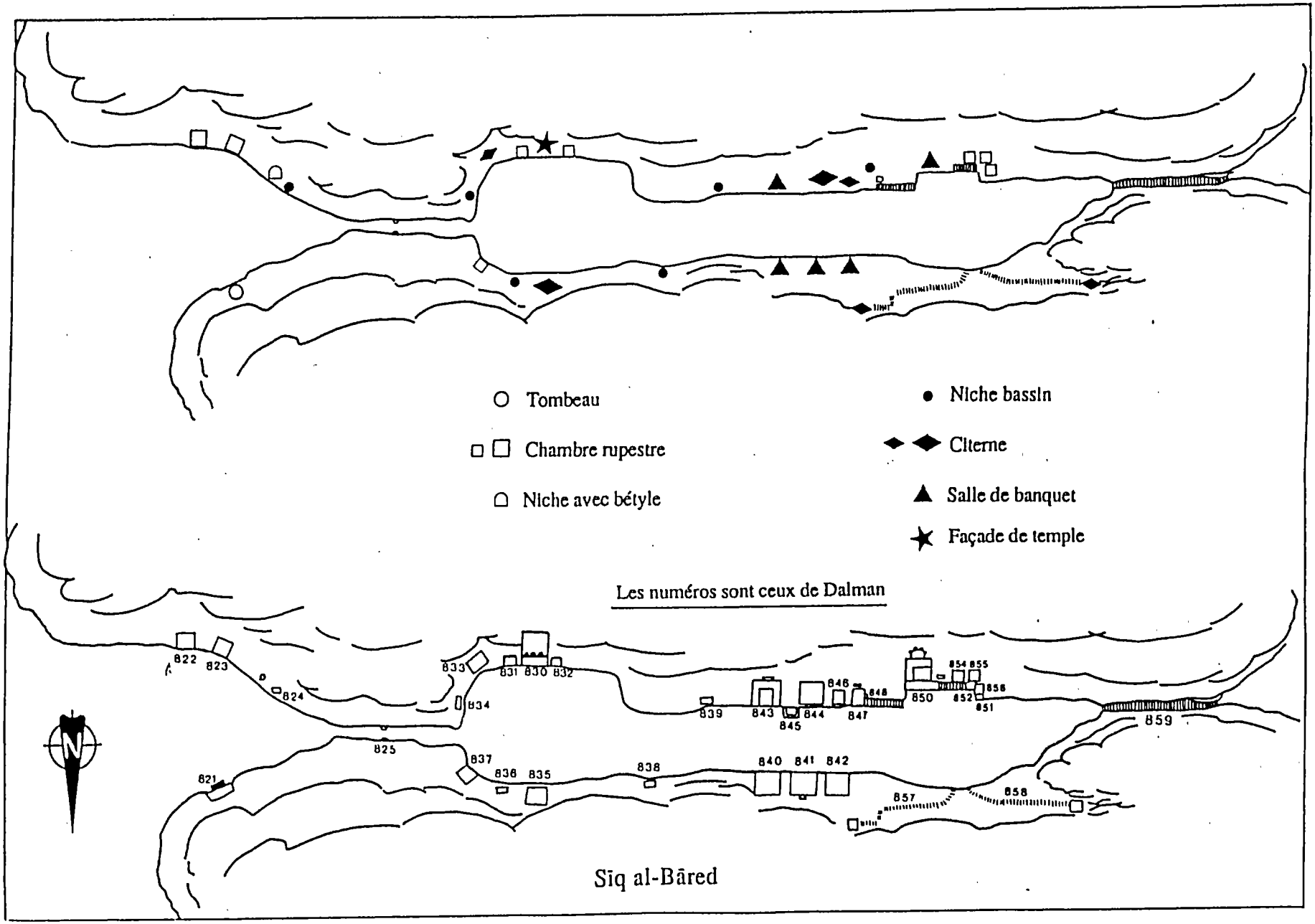


Fig. 10. Plan of Siq al Barid, Beida. *Drg. by Leila Nehme*

Karte von **Wâdî** Sabra, nach Laborde pl. 31a

Zu Brünnow, Provincia Arabia Tafel XXI. S. 424

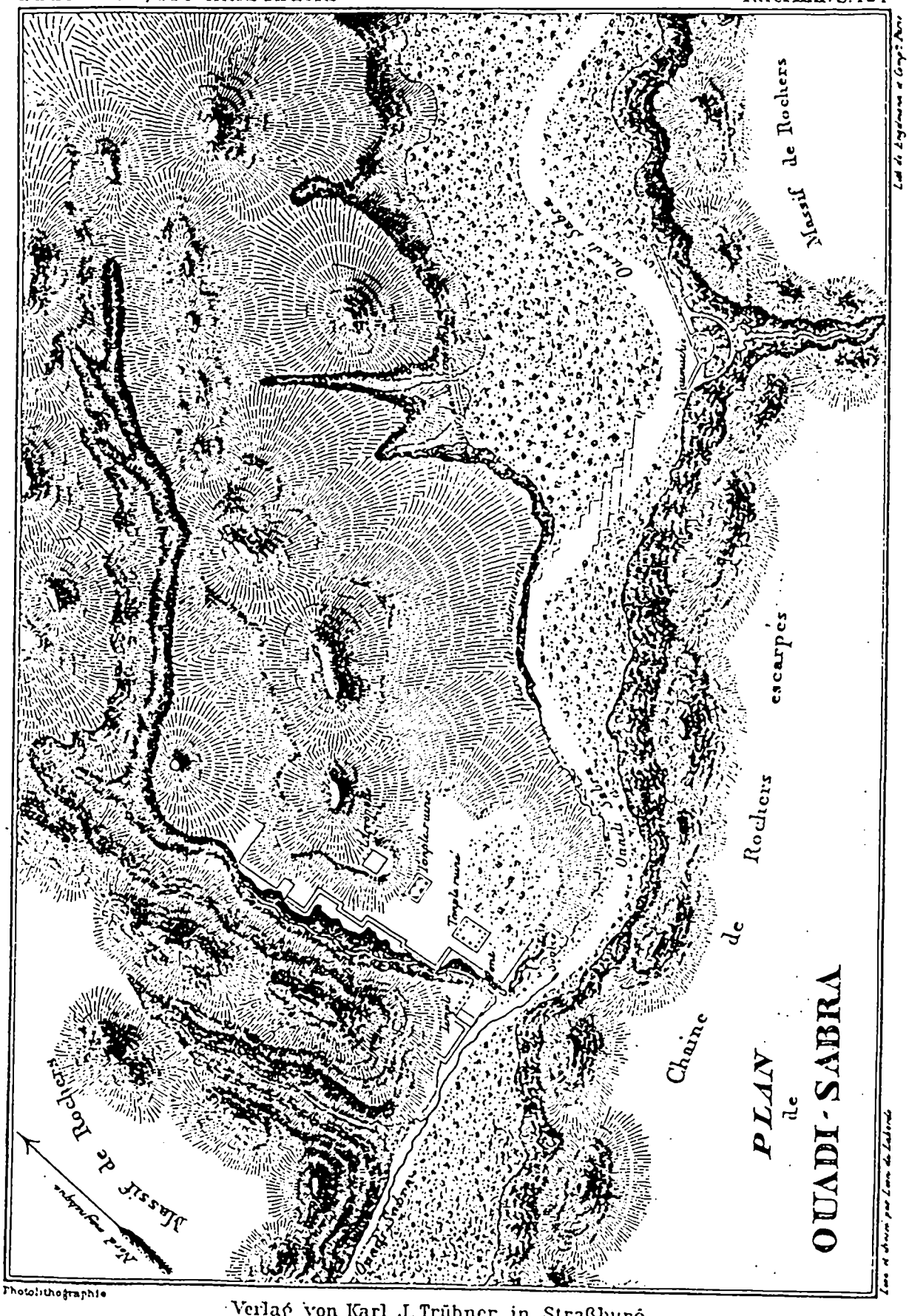
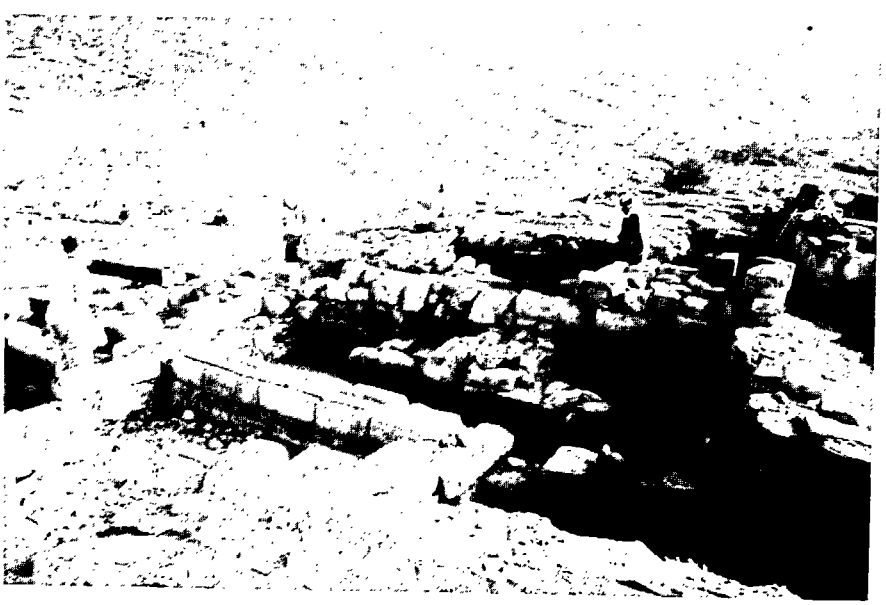


Fig. 11. Plan of Wadi Sabra by Brünnow after Laborde

Wadi Sabra theatre. Dam in the background.
Zayadine.



Petra. Late Roman house at Zantur.
Zayadine

Petra. The ACOR/USAID excavation project at the Byzantine church site. *Lane*

Petra. The ACOR/USAID excavation project at the Byzantine church site. *Lane*

Sabra and Ba'ja

Situated at the two extremities of the north-east/south-west axis, Sabra and Ba'ja were relatively important settlements in antiquity. Although little known, Ba'ja shows the traces of around fifty houses. The first explorers to Sabra were surprised by the extent of the urban infrastructure, which included an acropolis, sanctuaries, a theatre, and above all an ingenious system of dams and water channels. The location of the agglomerations of Ba'ja, Beida and Sabra along the edges of the north-east/south-west axis confirms the hypothesis that this was the principal axis of sedentary occupation of space of the Petra region in antiquity.

Qasr Amm Rattam and Abu Khusheibeh

These two sites constituted the last (known) caravan relays before reaching Wadi 'Araba and the western limits of greater Petra, where they mark the entrance and exit to the site, and served the functions of surveillance and customs control.

Siq Um al Aldah

Siq Um al Aldah served as a passage way ensuring the link between Beida and Ba'ja. Its sacred character is affirmed by the niches and nefesh carved in the rock face.

v/ The Roman period

Although inscriptions of the Roman period and rock-cut monuments such as the tomb of Sextus Florentinus, the Roman Legate of Arabia, are known, it is only in recent times that the Swiss excavations at ez-Zantur unearthed a complete domestic complex from the third to fourth centuries A.D.[1] (photo p. 45). This gap in our knowledge of a long and important period can be explained only by the lack of excavation projects to date in the city centre area.

vi/ The Byzantine Period

Of the Byzantine period, the excavations of the Church by ACOR and the Department of Antiquities, well advanced and scheduled to finish in 1993, have already revealed a splendid mosaic floor and important marble fragments, and should contribute greatly to our knowledge of this important period, well documented in other parts of Jordan. The next phase of work is planned to include the construction of a permanent roof over the site to protect the ruins from rain and dust.

vii/ The Islamic period

The long Islamic period is badly documented at Petra. For example, although southern Jordan received the message of Islam earlier than the north, there is no reference to Petra or Wadi Musa during the conquest. This may be because the region was abandoned and the See of the Bishop transferred to Rabbat Moab in the Umayyad period, as evidenced by a Greek inscription dated 687[2].

However, two mediaeval fortresses are famous within the site: Al-Habis and Wu'eirah. Only al-Habis has been documented, by Hammond in 1970, while the latter is under study by the team of Guido Vannini from the University of Florence. According to their research, this citadel, which contains evidence of earlier occupation during the Nabataean and Islamic periods, was probably abandoned soon

---

[1] Stucky, R. 1991-1992

[2] Zayadine, F. 1971: 75-76

after the defeat of the Crusaders at Hittin in 1187, whereas al-Habis, known as al-Aswit, was still a thriving fortification when Sultan Baybars visited it in 1276[1].

2.2.3. Great Petra today: the villages of the Petra basin

Until relatively recently, a number of traditional villages with low stone-built houses and agricultural terraces thrived on the slopes overlooking the Petra basin. At the entrance to Petra, Wadi Musa itself is an agglomeration of small villages. Vestiges of these now abandoned villages still exist at Khirbat al-Nawafle, al-Hayy, Taiyibe, Beida and Bdebdebe.

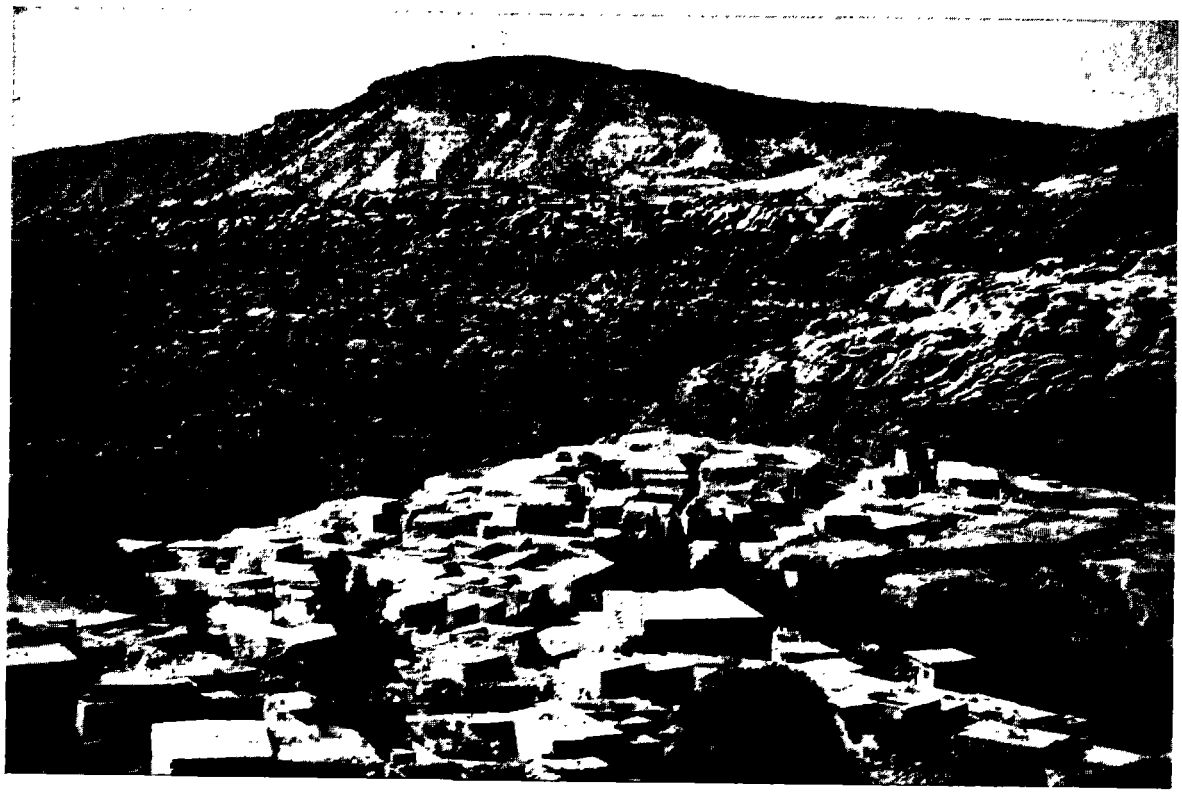
In ancient times the Petra area enclosed a space that stretched in an east-west direction along the mountain escarpment, from the 1500m of the limestone platform of Djebel Shara to the depression of the Araba valley, and in a north-south direction it included the entire arc, of approximately 15Km in length, on a level with the springs at the beginning of the ramified system of wadis. This space, corresponding to the catchment areas of wadi Musa and wadi Sabra was organized and structured over the years, and may rightly be defined as the Great Petra area.

The ancient urban structure had its strongholds in Beida to the north, Sabra to the south and Petra in the centre, but it stretched from east to west with farms, fortifications, temples and large collecting tanks at higher altitudes, secondary agglomerations and agricultural settlements along the wadi courses and the garrisons right into the desert in the Araba valley. With the abandonment of the site of Petra and the destruction of the water collecting and supply systems that made it possible to live further down the valley, the stable settlement remained in the higher places, along the circle of springs in the traditional villages of Bedebdeh, Beida, El Haya, Nawafle, Wadi Musa and Taiyibe. In these localities people continued for a long time to use the traditional stone Arab houses, to cultivate the land on artificial terraces and to keep the water supply system working.

In modern times with the attractions and changes wrought by tourism, the traditional villages of Bedebdeh, Beida, El Haya and Nawafle have been completely abandoned, and replaced by the modern buildings in Wadi Musa, Um Sayhun and Beida. The impact of these settlements on the Park is discussed in section 4: environmental impacts of existing activities.

---

[1] Zayadine, F. 1985: 159-174



DANA WILDLIFE REFUGE

An example of project dealing with traditional architecture

Bousquet

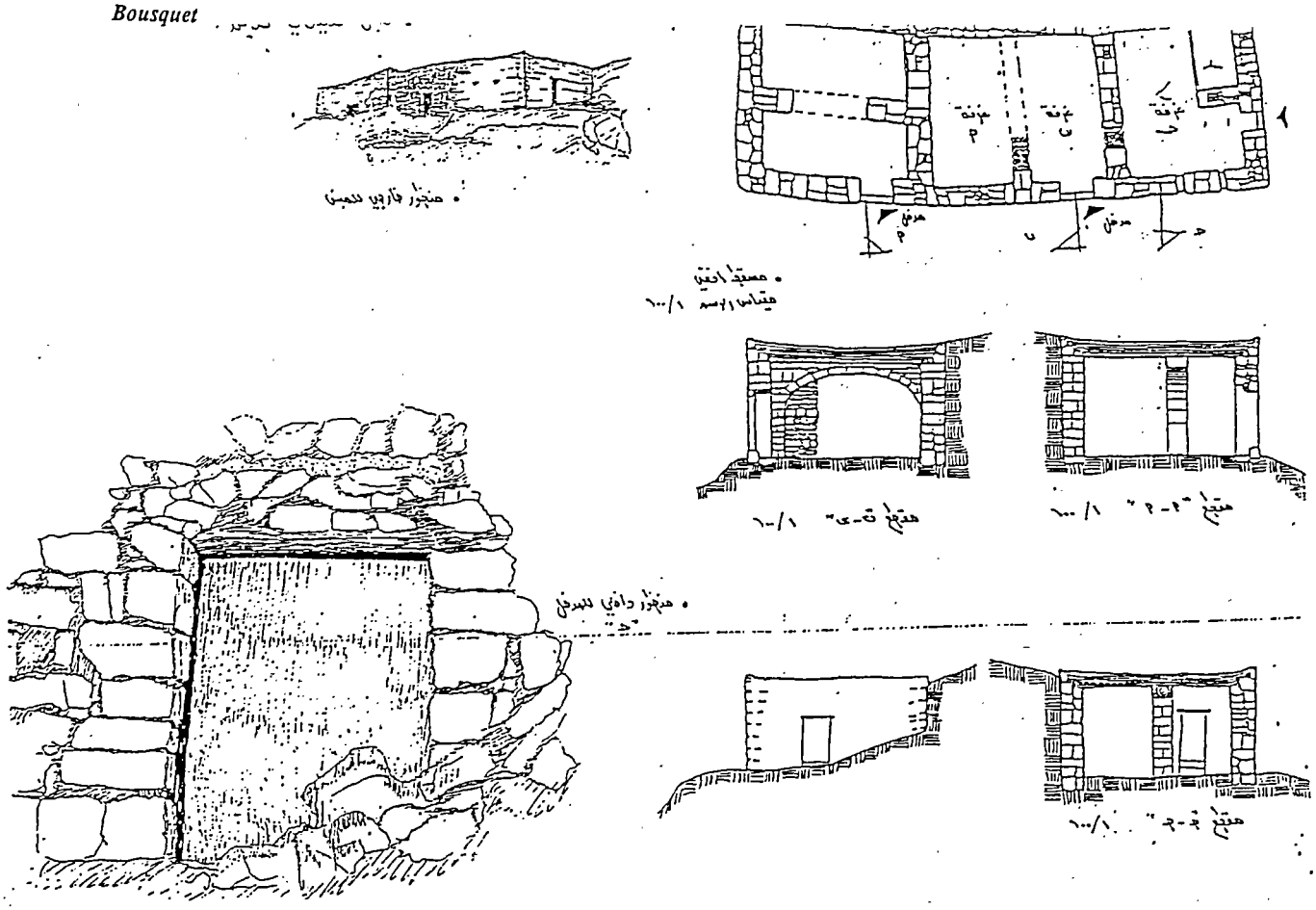


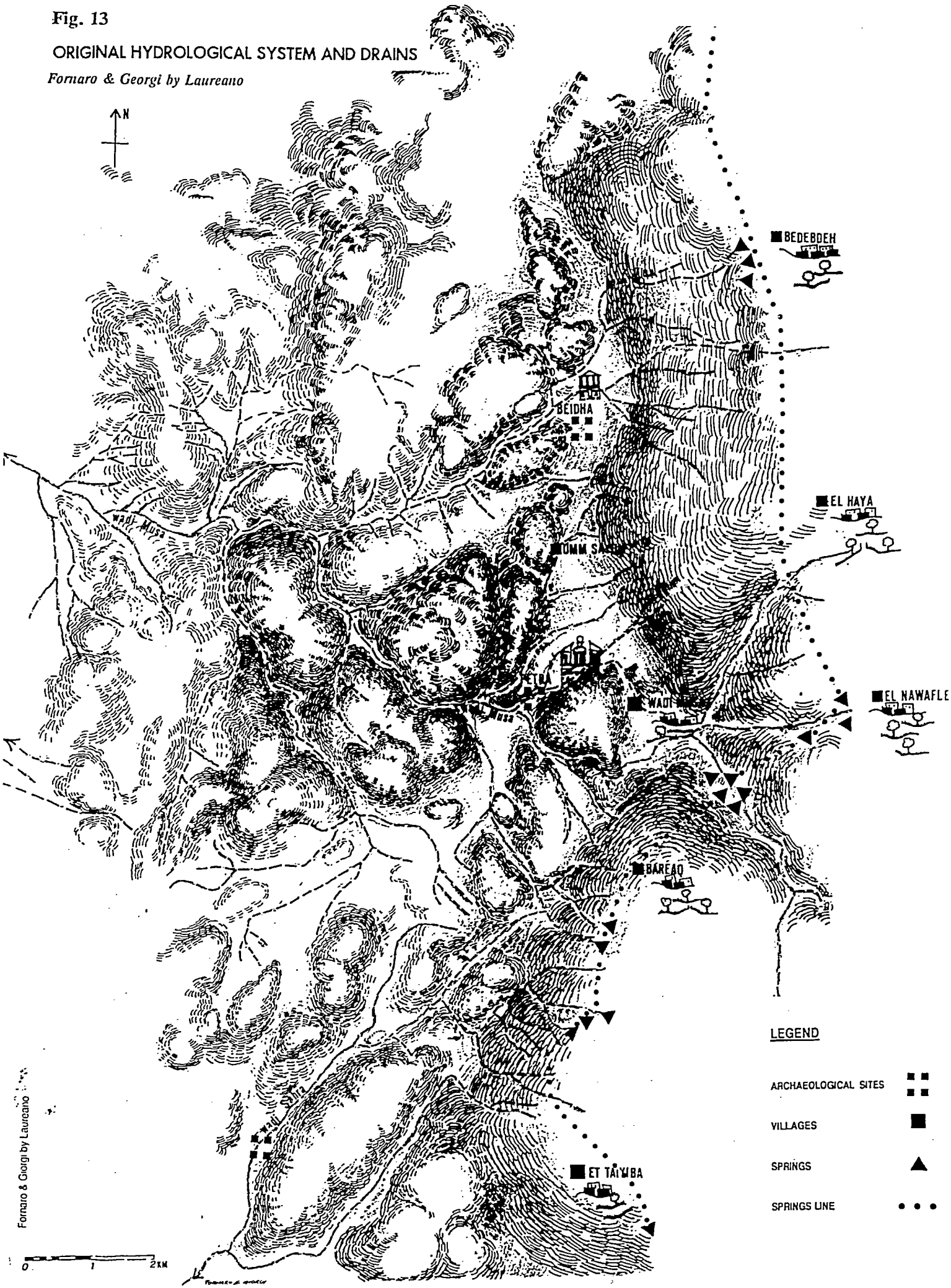
Fig. 12

Typical architectural details of old stone houses, Wadi Musa. Drg. by students of Univ. of Jordan

Fig. 13

ORIGINAL HYDROLOGICAL SYSTEM AND DRAINS

Fornaro & Georgi by Laureano



2.2.4. Original hydrological system and drains: function and present condition.

i/ Historical evidence

The commemorative inscriptions found at Petra are proof of the Nabataeans' dedication to the hydraulic works already mentioned by Diodorus of Sicily; while quoting them as being a nomadic people, he describes the creation of large underground cisterns with small openings (Historical Library 19, 94, 6-8). In the Nabataean king Aslah's triclinium, the inscription commemorates the cisterns and buildings he ordered to be built. In the Turkmania the inscription cites the courtyard that is before the triclinium and the wells in the rock. The geographer Strabo describes Petra as abounding in water that irrigates luxuriant gardens and supplies the houses of rich tradesmen (Geography 16, 4, 21). It seems impossible today to imagine Petra decorated with fountains and ponds, with luxuriant trees and cultivated fields, and yet this picture is confirmed by archaeological evidence and by an analysis of the environment.

ii/ Function

Four main types of hydrological and drainage systems can be distinguished: **a**) protection and support along the slopes and wadi courses to produce arable soil and land; **b**) diversion of the infrequent, but overwhelming and violent floods; **c**) channelling of spring water; **d**) the organization of pools, cisterns and eaves to collect rainwater and micro-infiltrations, and for the protection of the sandstone walls (**Fig. 13**).

Still nowadays, at the foot of the limestone platform at the height of the line of springs, the highest levels of the ramified system of wadis below Bedebdeh and El Hai, all around the present settlement of Wadi Musa and along the road to Taiyibe, are arranged in terraces supported by walls that break the force of the floods, hold back the soil, preventing erosion and allowing the water to infiltrate and enabling fields to be cultivated. The system, similar to the one used in southern Arabia must once have been used throughout the Wadi Musa basin, as clearly shown by reconnaissance work and photogrammetric surveys. In wadi Siq el Ghurab it can be seen that the entire river bed has been organized with small dams, the **khaur**, placed perpendicularly to the direction of the water flow that is guided to each side, depositing silt and creating arable land, supported by low dry-stone walls called **sleisel**. This technique, widely used also in the Negev desert, has been defined as belonging to the **Nabataean farms**, and shows how the ancient inhabitants used to control soil erosion and how they operated on a wide scale throughout the countryside to create their farmland.

The central area of Petra has been protected from the violent Wadi Musa floods through the digging of a tunnel that frees the course of the Siq and deviates the floods, sending the water right round Djebel el Khubtha to the north and bringing it back into the central course of Wadi Musa level with the monumental road where the grotto was placed. The beds of Wadi al Mudhlim and Wadi Sadd al Ma'jan, used for this diversion, were provided with a system of dams and sluices to act as reservoirs for irrigating the fields laid out on artificial terraces along the banks of Wadi al Mataha.

Along the line of the springs a system of large, rectangular pools built of limestone blocks collected drinking water and distributed it by means of gravity to the residential area of Petra through a vast system of canals cut into the sandstone walls, suspended footpaths, clay aqueducts and conduits, the fruit of an elaborate knowledge of hydraulics. Two series of aqueducts branched off from the big Zurraba pool at a height of 1050m. One of them followed the course of the Siq, where the cut along the sandstone walls is visible, crossing the openings of the tributaries onto the dams by means of clay conduits and filling cisterns and pools close to the monuments. The other follows a spectacular path along the right-hand wall of wadi Shib Qays and crosses wadi Sadd al Ma'jan with a daring aqueduct supported by arches, and descends it on the right bank, returning to the left bank by crossing wadi al

Mudhlim before the rock Pantheon, and finally it accompanies the right wall of wadi al Mataha and fills the big Palace Tomb pools. The course is precisely defined by the votive places and triclinia, the cisterns and private houses that received running water from this extraordinary creation. Another impressive hydraulic system carried water from the Bedebdeh springs to Qasr el Bint. An important feature of this system is that the Um Sayhun area is crossed by means of a tunnel equipped with ventilation shafts like the system of drained tunnels called **qanat** in Persia and **foggara** in North Africa.

The collection of rainwater in the high places and along the bare sandstone rock face is the most archaic system of procuring a water supply extensively used at Petra in the most diverse ways and measures. There are countless types of cisterns excavated in the rock and plastered to make them impermeable. There are small wells, dug horizontally, to collect flowing water on the upland plains, and there are square or rectangular cisterns at the foot of the natural drips, and there are cavities like huge chambers cut into the vertical rock face within which complex systems of channels and conduits flow. Every slope and every surface becomes a useful impluvium for collecting rainwater, and any quantity of running water, from the smallest drop to the big floods, was stored. At the summit of Djebel Harun a large cistern with a covering resting on arches, supplied by rainwater drained down the mountain face. At the foot of Ras es Slimane an enormous underground chamber, 9m under the wadi bed forms an authentic trap for flood water, and is similar, with its small water outlets and its settling tanks, to the cisterns described by Diodorus of Sicily. At the top of the Sabra theatre, cut into the rock, conduits from high up on the mountain convey rainwater into an enormous basin. Even the smallest infiltrations of humidity are collected and in fogs and frosts the subtle principles of condensation are exploited. Along the Deir rise, the **qattara** are extraordinary devices to supply water throughout the year: the tiniest exudations from the wall from condensation at high altitudes are collected by means of dripstones in pools and cisterns.

Water was not only used for domestic purposes, but also for rituals and for fountains and gardens. The system of impluvia and channels supplying the large cistern of the Garden tomb and the monumental fountain of the Lion is quite spectacular. The enigmatic Palace Tomb, lying at the top of the impressive system of channels and cultivated terraces, with its big pools and gardens, was probably a water palace, a monument to irrigation and vegetation, where, as in Alexandria, rare plants and animals were collected and selected.

iii/ present condition

At present this complex system is completely abandoned and both the archaeological and monumental part and the structure of the entire territory is in danger owing to the destruction of the water drainage and supply system, the collapse of the terraces and the state of abandonment of the gardens. The recently-built dams to retain flood water at the entrance to the Siq are inadequate because the whole differentiated system distributed over the network of wadis and tributaries, and that used to control the floods has been destroyed. The barrages and dykes no longer exist, the subsidence of the dry-stone walls has left the terraces unprotected and the rains have destroyed the soil, drawing detritus into the central Petra area. In the city, waterworks protected the monuments and sandstone walls from running water and drained the terraces of water infiltrations. It may be said that in the present situation, each of Petra's mountains is like a house that has lost its gutters and disposal systems. The disappearance of crops and city gardens made possible by water retention has eliminated the covering vegetation. The crops prevented the soil turning into sand, removing an abrasive component from the wind, and the trees broke its force. Thus the environment of Petra witnesses an acceleration of the erosion process that had been held up by human intervention.

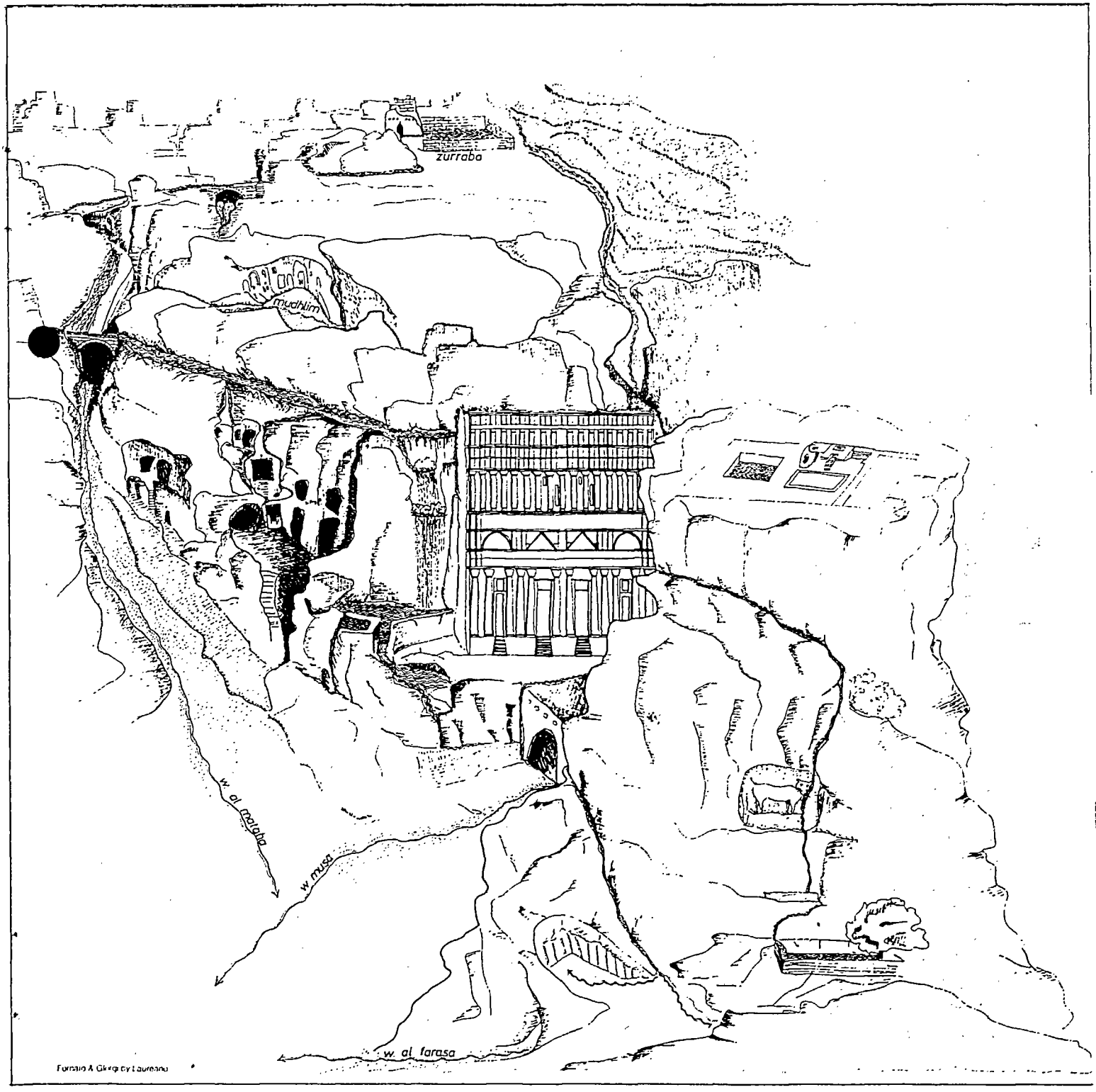
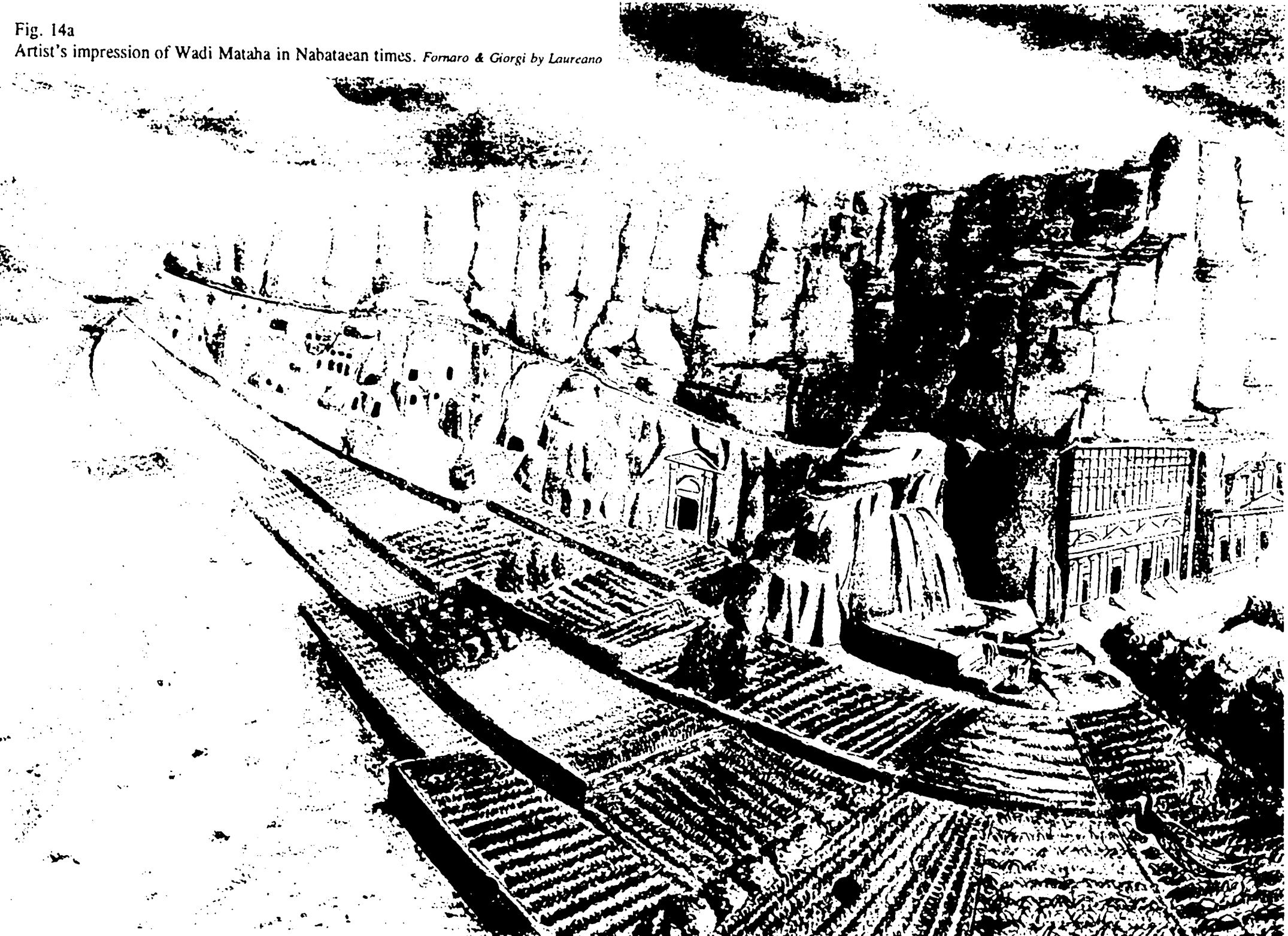


Fig. 14
System of channels and Aqueducts:
Wadi Mataha, Wadi Mudhlim and the High Place
Fornaro and Giorgi by Laureano

Fig. 14a
Artist's impression of Wadi Mataha in Nabataean times. *Fornaro & Giorgi by Laureano*



iv/ Wadi Mataha.

One of the most extensive and remarkable of these systems is to be sejkjgen in Wadi Mataha. In ancient times Wadi Mataha was cultivated with vegetable gardens. Along its banks were the rock dwellings of wealthy Nabataeans such as the Dorotheus House. These complexes are rarely visited as a rule nowadays and their original structure is certainly not understood. They had hanging gardens where aromatic plants were grown, monumental fountains and cisterns supplied by the impressive system of channels and aqueducts that begins at the Zurraba cistern and ends at the Palace Tomb (**Fig. 14**).

A project for the integrated restoration of Wadi Mataha would be a pilot example of the possibilities of achieving an archaeological and environmental type of integrated rehabilitation with strong social values through the presence of the local population as employees and managers.

The aim of the project would be to restore the system of water conduits in the terraces and gardens and make an inhabited environment of ancient Petra worth visiting. The diverting dams and cisterns and cultivation of the Wadi el Mataha will be reactivated. The area would be managed by the Bdul groups of Um Sayhun, who would be responsible for maintaining and cultivating it and who will exploit it economically for tourism and agriculture. This highly prestigious project would provide an added attraction for a visit to Petra, and will enable the effects of the environmental restoration to be tested on the protection of the monuments and the possibility of involving the local population in the managing and maintenance of the territory, the only guarantee of long-term protection (**Fig. 14a**).

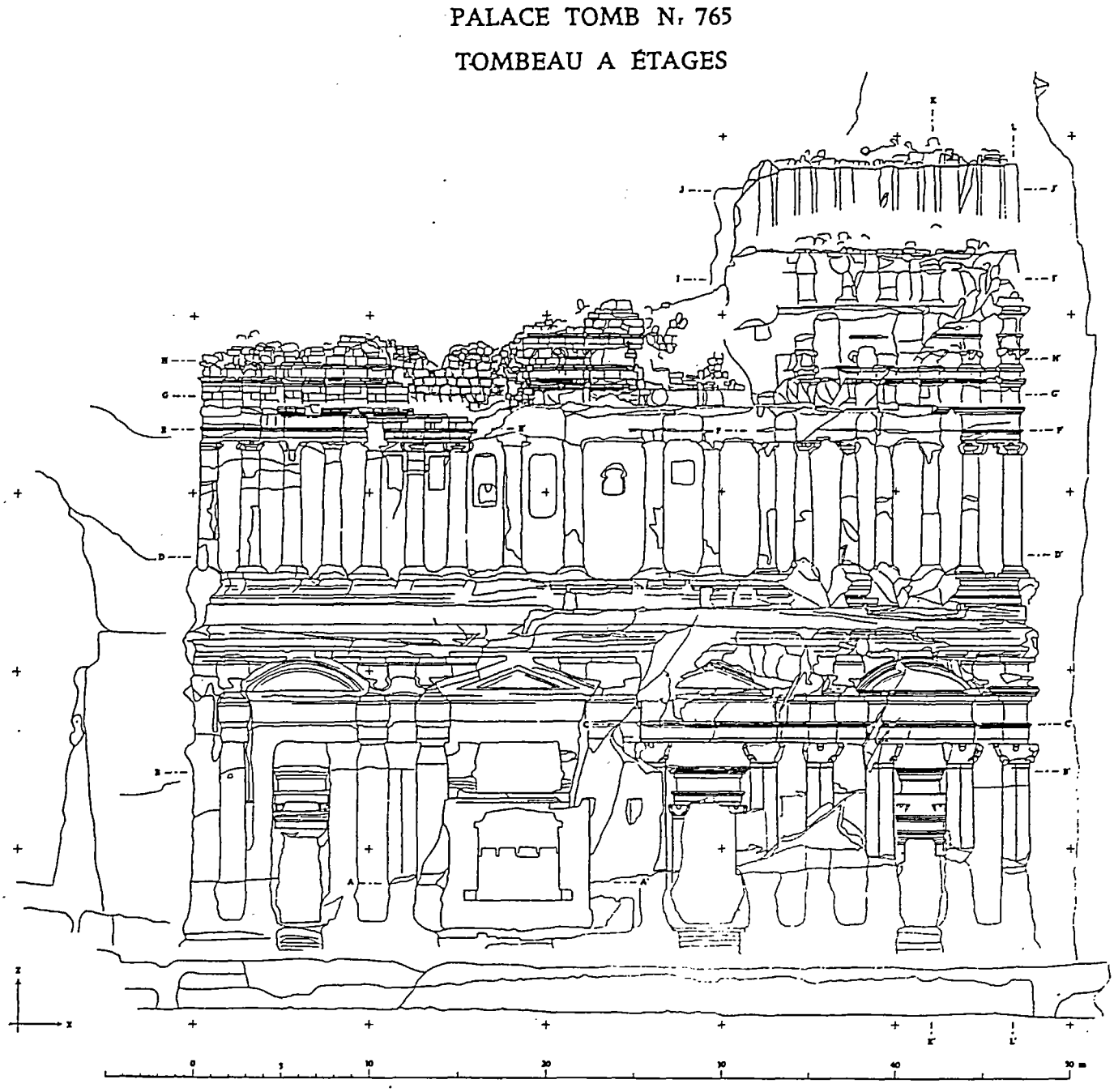


Fig. 15. Photogrammetric survey by IGN of the Palace Tomb Facade

2.2.5. Conservation of the Monuments

i/ The rock-carved monuments

The agents and mechanisms of destruction are analyzed in section 4.1. A considerable amount of research work has already been carried out by national institutions such as the HCST and Yarmouk University. Unsuccessful experiments were carried out in the '70s using a rock-hardener known as 'Pencapsulum'. Recent research work by the Ministry of Energy and Mineral Resources has produced extremely valuable data on the engineering characteristics of the sandstones, their lithology and distribution, faulting, causes of erosion, and weathering patterns.

Within the framework of bilateral cooperation between Germany and Jordan, Dr. B. Fitzner of the University of Aachen has recorded and analyzed the different types of weathering, variations in facies, and thermal mapping of the façades, and GTZ has signed a cooperation agreement with the Jordanian Government to support the stone-conservation laboratory of Yarmouk University, train conservators and carry out a limited amount of practical on-site conservation work.

As part of its programme for the sponsorship of scientific and technological research, EDF is currently working in collaboration with the University of Nancy on the sample "carrots" removed in 1992 from the Palace Tomb. Experiments are under way to determine the degree of weathering in depth of the rock walls, in every direction starting from the cavity. This is a first step towards finding an eventual treatment.

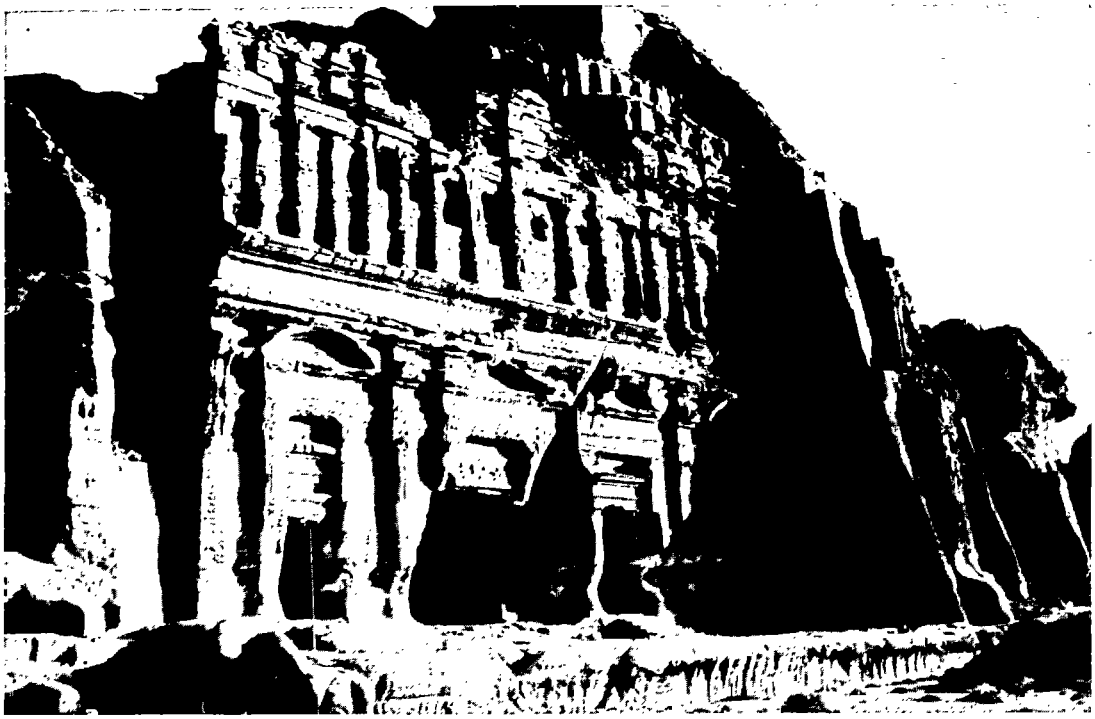
The Palace Tomb

The Palace Tomb is generally considered to be one of the finest of the rock-carved monuments of Petra, although the upper part of the façade is partly built of masonry. Its façade, crossed by several natural joints, shows many of the typical forms of weathering seen at Petra. The erosion done by rainwater run-off is most severe where the protective cornices and gutters have been breached by the action of water infiltrating into the joints.

In the winter of 1988, block failure and major cracking occurred in the Palace Tomb,[1] and several blocks of stone fell down from its masonry superstructure. In answer to an appeal by the Jordanian Authorities, UNESCO provided financial assistance from the World Heritage Fund in order to enable the DOA to purchase scaffolding and carry out urgent consolidation works. As a result, the DOA was able to build a 50 metre high scaffolding to reach the upper storey. The cause of collapse of the masonry was found to be a break in the water channel which collected the rainwater from behind the monument to a large reservoir in a corner of the roof terrace. Some repairs were carried out to the stonework, under the direction of Mr. Abed Majid Mujelli of the DOA, as well as clearing of some of the accumulated earth from the cistern on its roof terrace. No crane was available to lift the building materials to the inaccessible roof of the monuments, only pulleys being available, and the parapet was only partly consolidated.

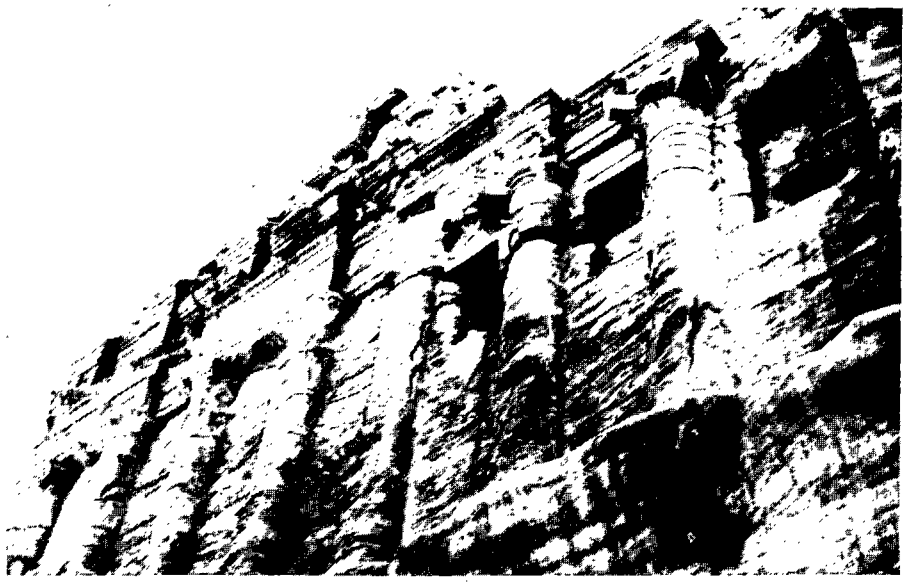
---

[1] Jaser, Bargus. Geotechnical Studies and Geological Mapping of Ancient Petra City. Jordanian Ministry of Energy and Natural Resources. Amman, 1992



Palace Tomb. Severe weathering and erosion to the main facade
Lane

Detached rock fragment in danger of falling inside entrance of Palace Tomb



The upper storey of the Palace Tomb, showing erosion and fractures in rock
Zayadine

The roof terrace of the Palace Tomb. Partly consolidated parapet. Drainage channel in background
Zayadine

A rapid visual inspection at roof terrace level during the UNESCO mission of 1992 confirmed that the consolidation of the stone masonry is far from complete. The construction of the parapet, with its triple wall and double cavity, is extremely curious, and needs further study to determine its precise function. It is the outer leaf which failed owing to water infiltrations in the thickness of the wall, and was partially repaired. However, large sections of loose stones and eroded stonework held loosely together by mud mortar are still in danger of falling from the parapet wall. The clearing of the terrace and cistern is far from complete, and the quantity of accumulated earth behind the façade and in the drain suggests that water will continue to accumulate behind the façade and infiltrate into the joints, resulting in the deposition of clay-like materials and salts which expand when saturated and cause high pressure on the face of the monuments, leading to a failure of the building stone.

An inclined fissure in the upper left-hand corner of the façade, in front of the blocked cistern and drain, appears to coincide with the slip plane of a natural joint, possibly composed of a thin bed of shale. It appears likely that this important rock mass and its masonry superstructure are in danger of sliding and collapse. A similar situation exists inside the tomb, where a large wedge-shaped block has become detached along the slip-plane of a joint and is in danger of falling.

A new programme of restoration, preceded by careful studies of the structural stability of the monument and experimentation with suitable means of securing the rock fragments, such as dowels and bolts. In the mean-time, the area immediately in front of the tomb should probably be fenced off and closed to the public until it has been possible to carry out remedial work.

The Siq and its Roman Pavement

The level of the present road is between 50cm to one metre lower than the original level, which was originally paved with large stone slabs. Three large fragments exist of this original paving of the Siq. All three fragments, solidly set on mortar, are well-preserved, showing only traces of ancient wear. The existing roadway, which is generally the natural bedrock of the Siq, also shows little sign of deterioration, apart from that caused by rainwater.

It has been suggested by the National Authorities that the traffic conditions along the Siq could be improved by paving the road with stone slabs. This would not be advisable, for several reasons:

- Firstly, there is not enough evidence as to the original appearance and extent of the ancient paving; the remaining fragments, of which only 600 square metres have survived, are subject to various interpretations.
- Secondly, in order to raise the level of the road surface and pave the remainder of the Siq, it has been calculated that around 7,400 square metres of entirely new pavement would have to be built, on 3,700 cubic metres of fill.[1]
- Thirdly, the remaining fragments would lose their value as unique historic documents if they were to be absorbed into a mass of new paving.
- Fourthly, the past cannot be re-created. The Siq has attained its present wild and romantic appearance over the course of two thousand years, and it is this very atmosphere which has attracted visitors since the time of Burckhardt up to the present day, and which it is important to safeguard.

---

[1]Anthony Ostrasz: Es-Siq of Petra. An opinion on the planned improvement of the roadway. Unpublished report commissioned by PNT.

Fine dust deposits on the walls and monuments of the Siq, and one of the few remaining fragments of the original pavement. Note ugly signpost. *Lane*

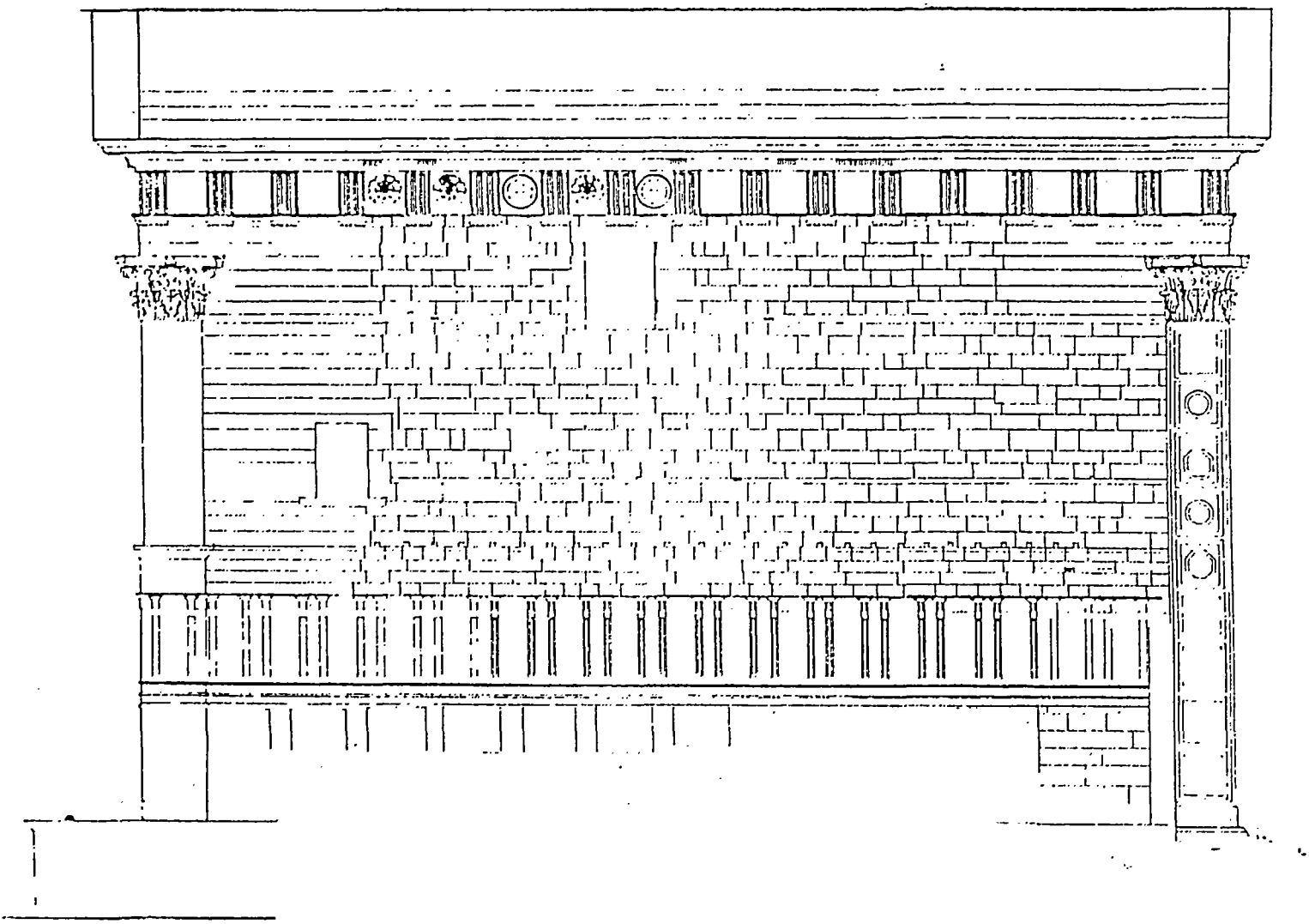


Fig. 16
Restitution of the eastern facade of Qasr al Bint.
Larcher after photogrammetric survey by IGN

A less costly proposal, evaluated by DOA at 100,000 dinars, was to pave the bed of the Siq at the existing level. This would also detract from the value of the original fragments, and from the natural beauty of the scenery.

Other proposals included the building of a road with fine gravel set in lime. Such a feature would be completely alien to the character of the Siq.

The simplest and more appropriate solution would involve

- clearing out the larger stones deposited by the flood
- clearing out sand where possible from level sections
- levelling cavities and large hollows with consolidated fill and surfacing with a crushed stone/lime mortar.

Although apparently simple, such a treatment would need careful preliminary studies including detailed plans and specifications, a thorough survey, and on-site testing of materials in order to test its suitability. The work should be carried out under the close supervision of a skilled conservator.

ii/ The Built Monuments

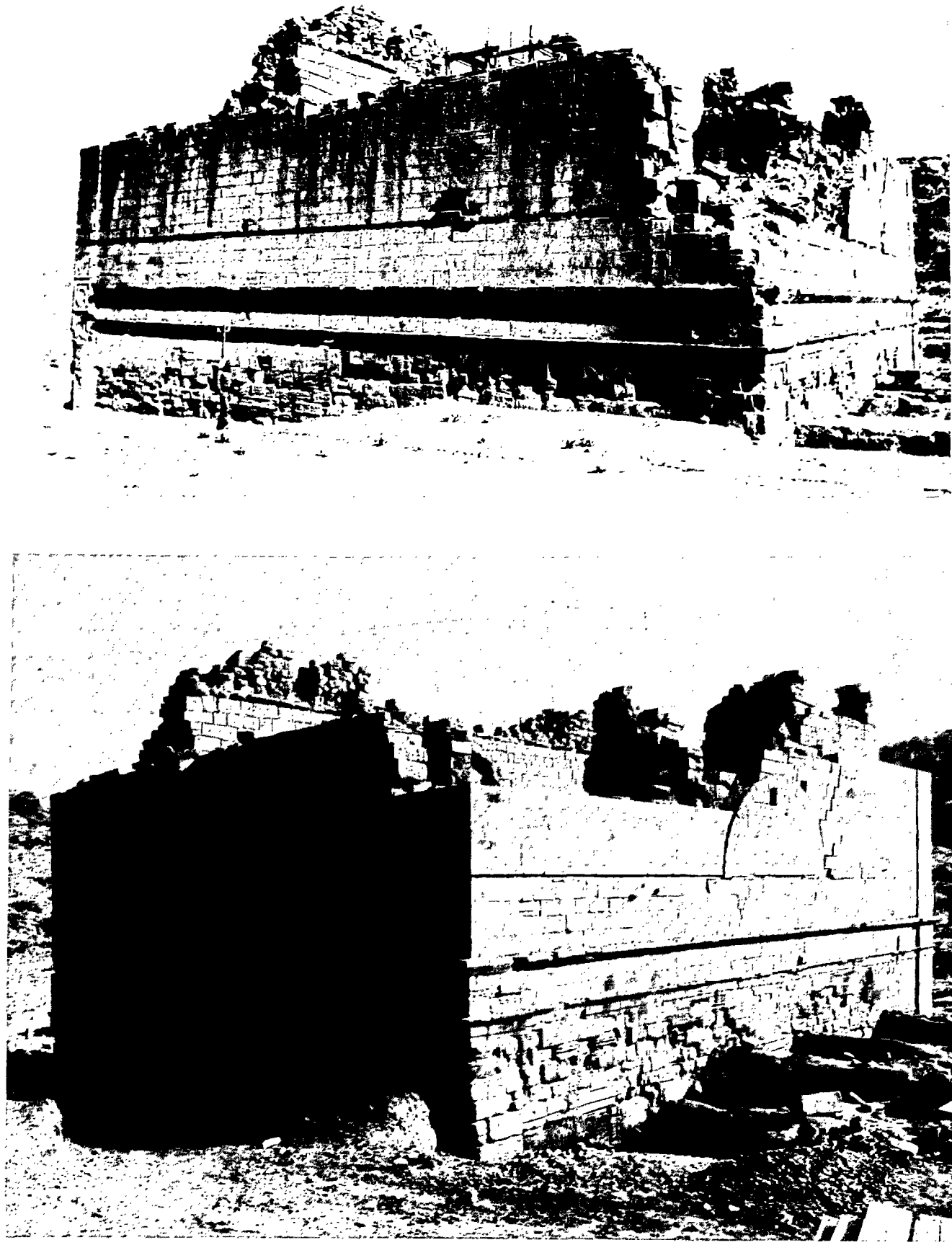
Qasr al-Bint

The Nabataean temple of Qasr al-Bint, located at the end of the Cardo Maximus, is one of only three built monuments, along with the theatre and the Winged Lion Temple, to have been discovered at Petra. Exceptionally intact, its ruins rising to a height of 23 metres within a large paved temenos, it provides unique evidence of the construction techniques and stucco revetment of the period. Horizontal string courses of Juniper wood inserted at regular intervals between the ashlar sandstone courses gave the structure a degree of elasticity, enabling it to withstand earthquake tremors. These wooden members have disappeared in many places, placing the walls in a precarious state. The traces of the ancient earthquake tremors which brought about the monument's collapse are clearly visible in the upper courses of the east façade, which were unseated by the tremor, and are in permanent danger of falling, even though the monument has remained in that state for over one and a half thousand years. Most importantly, the upper part of the east wall, the only remaining wall to have remained intact to its full height and to have retained a section of its cornice *in situ*, is seriously out of plumb and in danger of falling.

The earliest plans of the building were published by architect Kohl in 1910, but it was not until 1958-59 that the first sounding in and around the temple were undertaken by the Department of antiquities and the British School of Archaeology, under the direction of P.J.Parr and architect G.R.H.Wright. Excavations in 1964-65 confirmed the Nabataean date of the monument when a dedication to the statue of Aretas IV (9 BC-40 AD) was discovered in the bench added to the peribolos. Another dedication to the same king was discovered in 1991 in the south-eastern corner of the temenos.

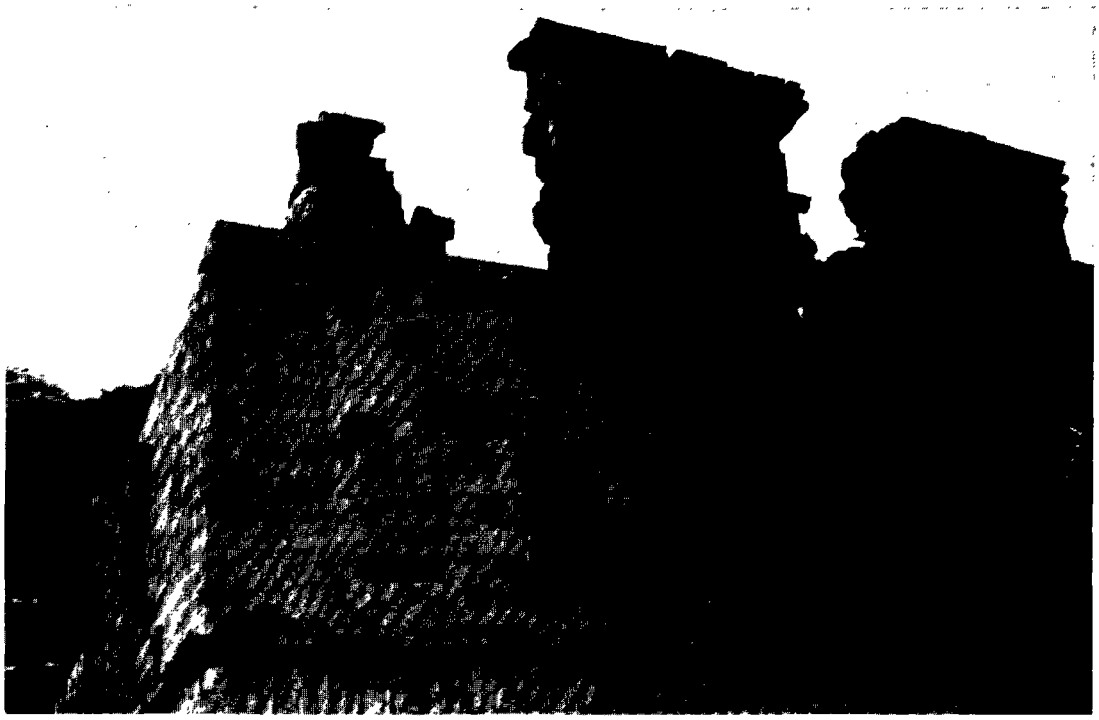
In 1979, the Department of Antiquities restored, with World Bank funding, the main entrance arch and excavated along the south wall[1]. Another campaign was initiated in 1983-84 to excavate the cella and

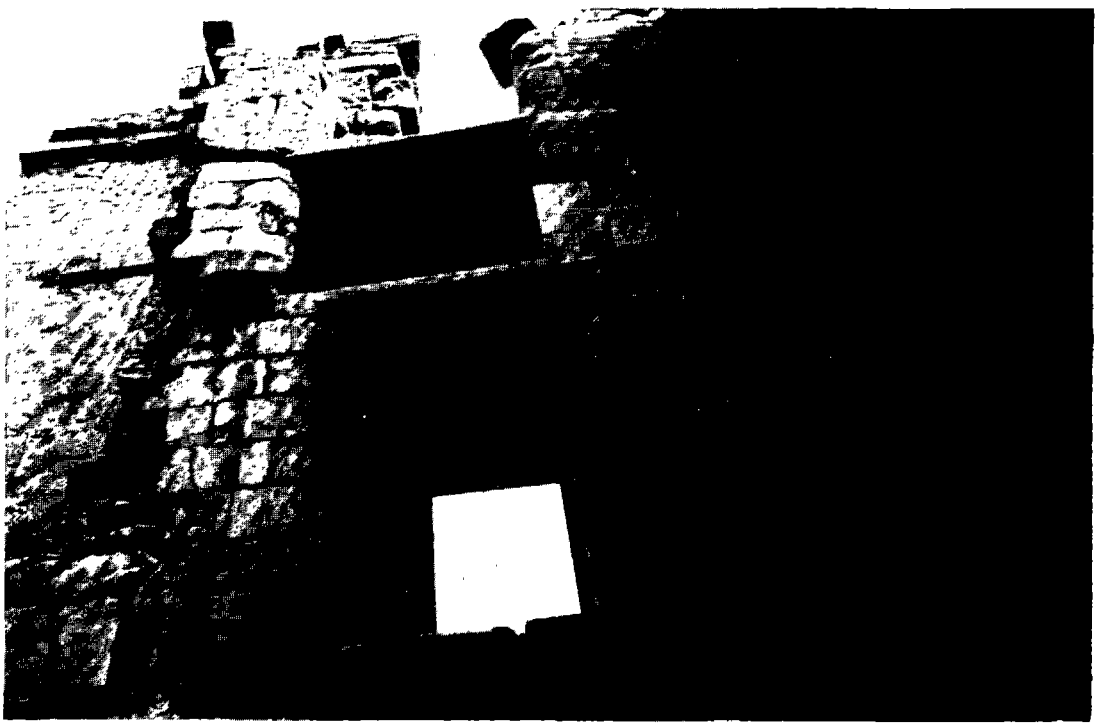
[1]ADAJ, 26, 1982; pp.374-80



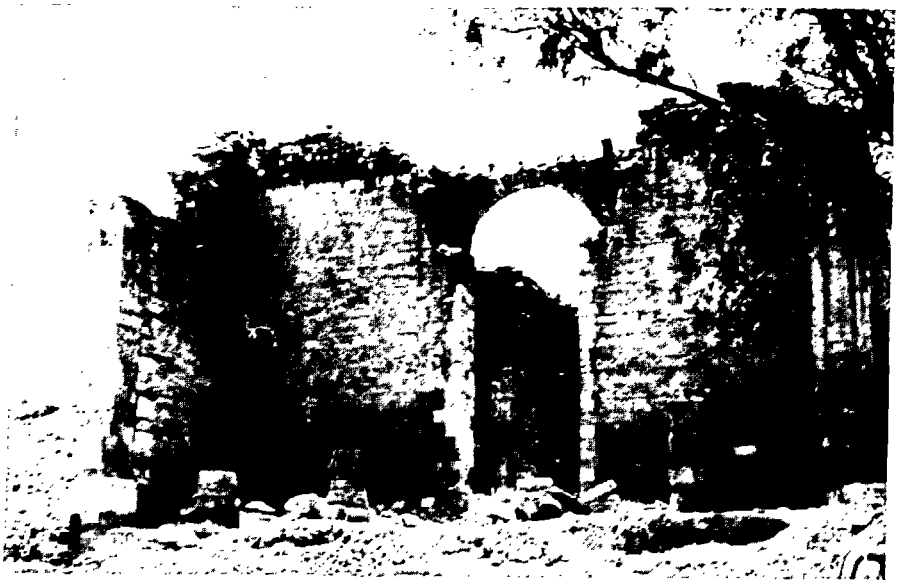
Qasr al Bint. South-west corner before and after restoration. Note loose stones displaced by an earthquake in antiquity. Unprotected excavation trenches left open at the base of walls may put the foundations at risk from rain.

photos: Zayadine





Reconstructed south-east corner showing extant section of cornice and freize leaning out of plumb. Note ugly and inappropriate use of exposed concrete to strengthen staircase.
Lane



Consolidated entrance arch and cleared inner compartment of Qasr al Bint.
photos: Zayadine

restore the south-eastern anta, which was dismantled and later rebuilt [1]. The eastern podium was completely cleared in the 1990 campaign, except for a control section 1 metre high by 3 metres wide. It is to be regretted that the excavated stones and fragments of stucco do not appear to have been systematically recorded during excavations, and that the possibility of carrying out a partial anastylosis of the fallen fragments has thus been lost.

The use of exposed reinforced concrete in the reconstruction of the staircase wall and the systematic re-cutting of stones used in the more recent restoration works have greatly detracted from the authenticity of the monument, giving it a modern appearance. It is also alarming that excavations down to foundation level have not been accompanied by consolidation works or drainage, putting the wall, already in a state of disequilibrium, and its foundations, in potential danger of collapse.

The Department of Antiquities is planning to excavate the southern and western sides together with the western compartment, and to restore the eastern façade and the inner south wall of the cella. In view of the outstanding importance of this monument and its structural instability, it is essential that any future restoration works be preceded by thorough technical studies and carried out under the supervision of a highly qualified architect/conservator in association with a structural engineer.

The Winged Lion Temple

Discovered by the American Expedition to Petra in 1974, the Temple of the Winged Lions has been excavated, and its stratigraphy, construction and decoration thoroughly analyzed, by a team led by Dr. Philip C. Hammond of Utah University. Although destroyed by an earthquake in 363 A.D., the ruins permit a fairly complete understanding of the original plan, constructional details and decoration of the monument.

Unfortunately, the ruins have been exposed to the action of wind, rain and sand since their excavation, and have not been consolidated. The action of water rising from the ground by capillary action has resulted in the deposit of salts on the surface of the stone, forming a fragile crust which is rapidly worn away by the action of wind-blown sand. As a result, the stone columns and walls, along with their fragile stucco coating, have decayed almost to the point where it may soon be impossible to save them. Ancillary buildings excavated to the west of the temple were seriously damaged by heavy rain, some walls have collapsed through lack of consolidation, and some column drums lie broken on the ground and are gradually being eroded away.

A restoration project prepared by Dr. Hammond (figs. 17-19) proposes a complete reconstruction of the temple, starting with the main temple structure. Such a project would undoubtedly detract from the authenticity of the ruins and diminish their interest to visitors, who come to Petra to see the achievements of the Nabataeans, and not a modern reconstruction.

The restoration project should be limited to:

- layout of site and protection against erosion by planting the surrounding area with suitable ground-cover plants
- protection of the site against flooding by proper drainage

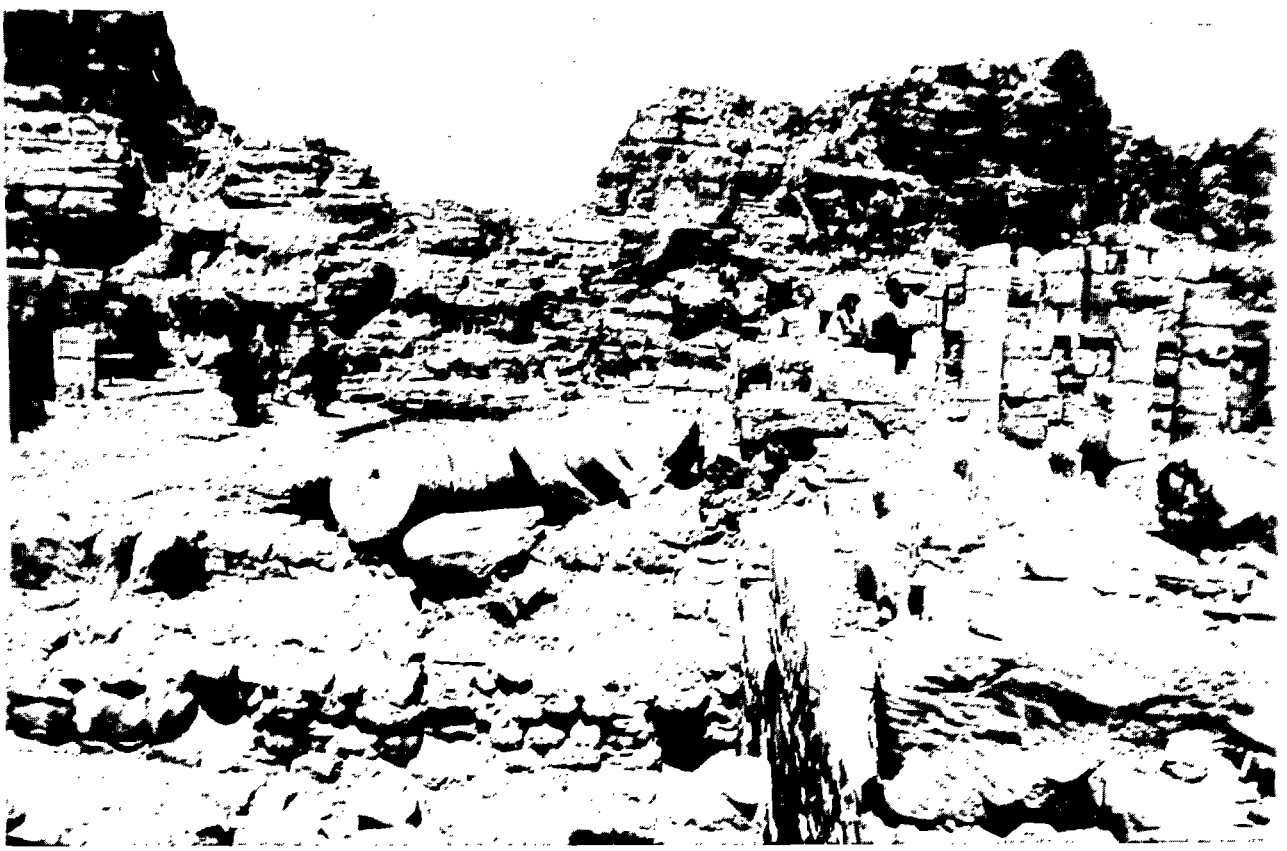
---

[1] ADAJ, 29, 1985; pp. 239-49

- protection of walls and column drums against rising damp, either by insertion of a damp-proof course, or by a patented electro-magnetic process (subject to prior testing).
- leaching out salts in the stonework.
- consolidation *in situ* of the existing ruins, stonework and stucco.

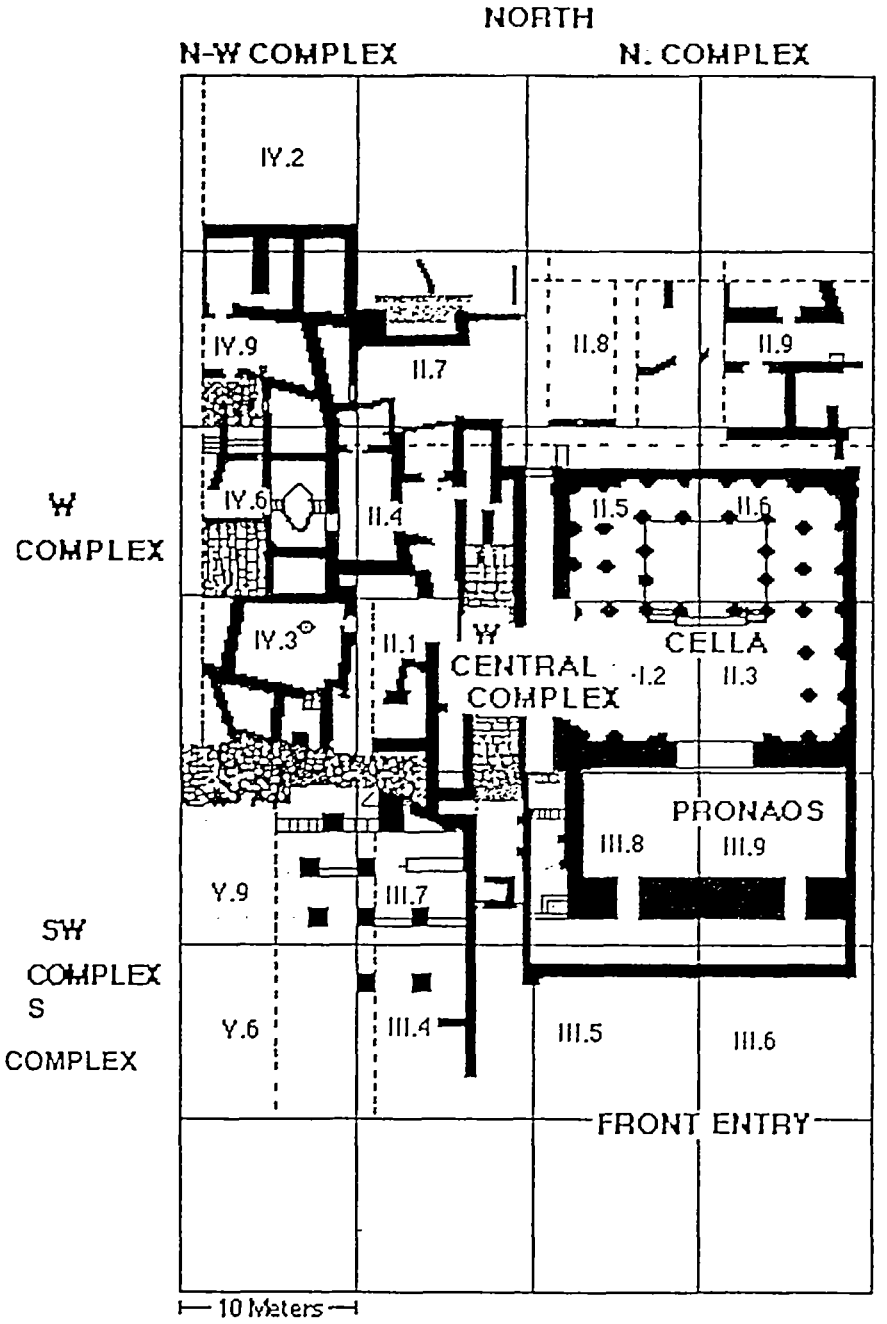
However, a partial anastylosis, using original elements, could be envisaged, provided that the proper evidence is available, in order to restore to the monument its vanished vertical dimension and increase its legibility.

The original appearance and function of the monument could be explained by graphic and information panels on site and a scale model, or even a computer-generated "virtual reality" reconstruction, exhibited in the visitors' centre.



The Winged Lion Temple. Note heavily eroded column drums
Zayadine

The Winged Lion Temple. Note heavily eroded column drums
Zayadine



TEMPLE OF THE WINGED LIONS, PETRA

Computer generated Sketch Plan

P.C.H. 1990

Fig. 17
Hammond

The Temple of the Winged Lions

Petra, Jordan (Orthographic Projection)

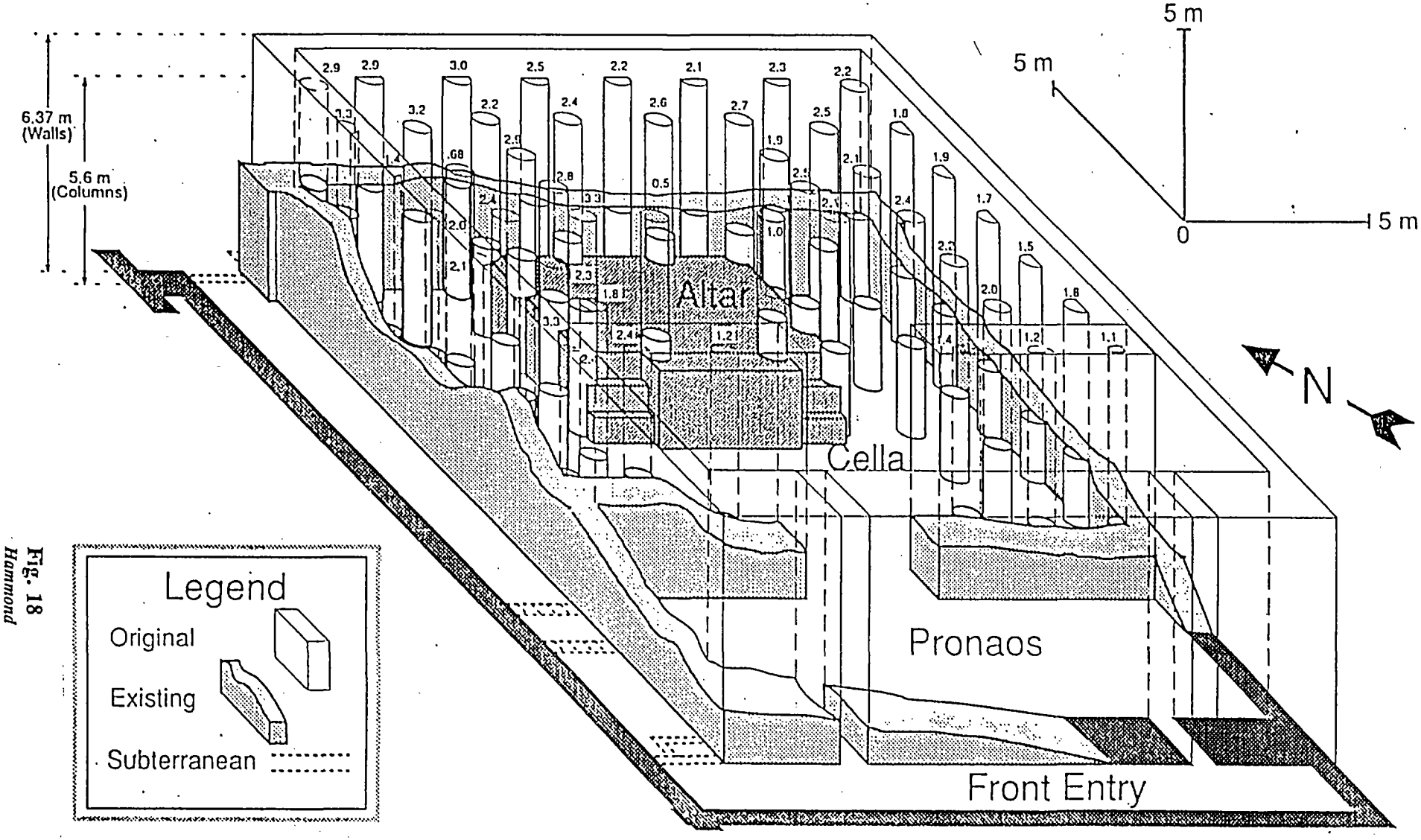


Fig. 18
Hammond

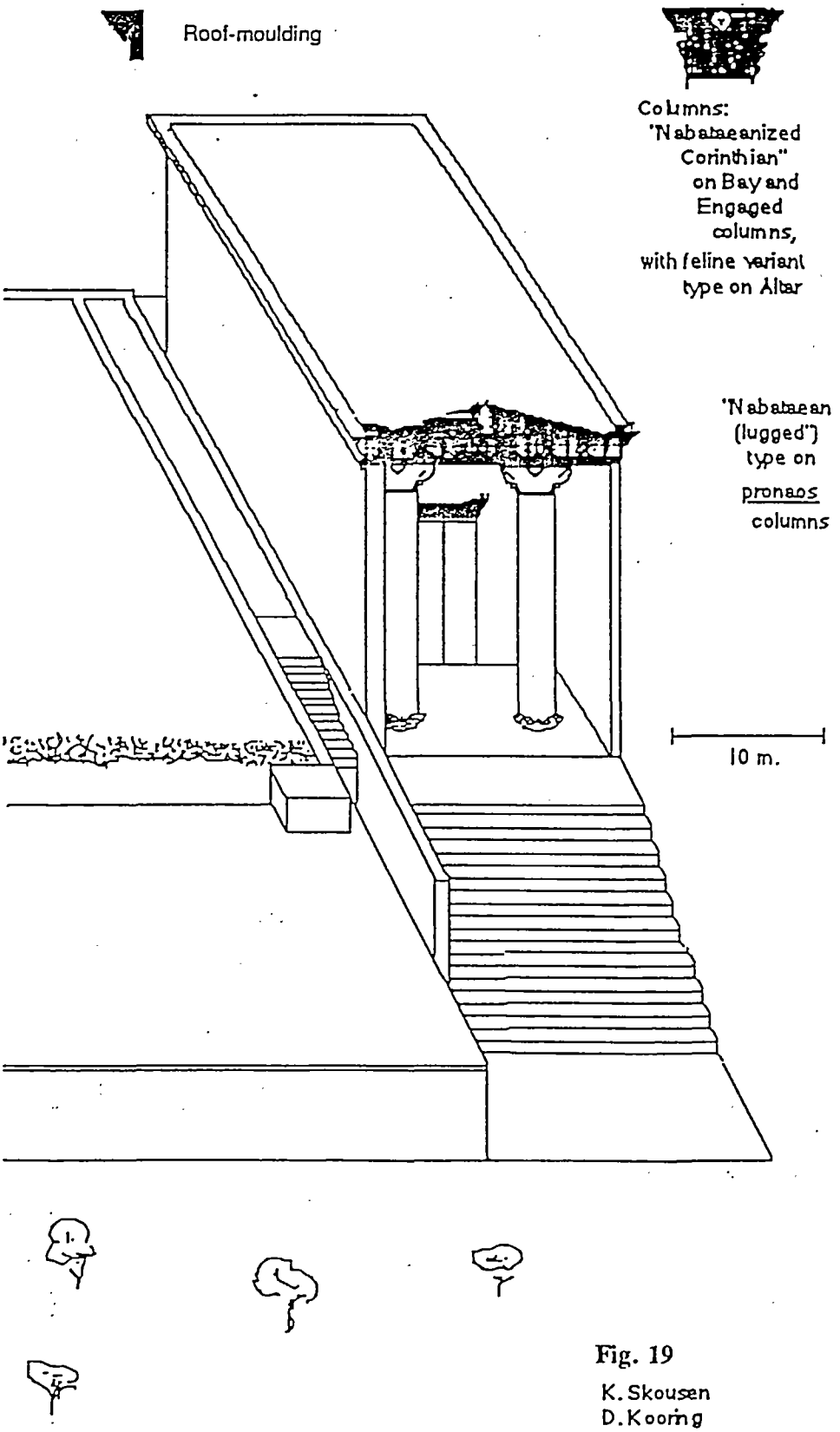


Fig. 19

K. Skousen
D. Kooring
P.C. Hammond '92

Old stone villages

A number of fine old stone villages and groups of houses, mostly abandoned, exists in the Petra area. At Taiyibe, the remains of the old village are being restored as a hotel. Similar abandoned villages exist at Khirbat al-Nawafle, al-Hayy and Bdebdebe.

The old suq of Wadi Musa was the subject of a study sponsored by the PNT. Funds for its restoration have been contributed by the Canadian government. The future use will probably be a suq for traditional crafts. Another important group of stone buildings with characteristic stone arches exists nearby.

The few remaining examples of this fine vernacular architectural heritage deserve to be restored before it is too late, and re-integrated in the economic and cultural life of the area. Some propositions are given in the Tourism programme of the draft Management Plan.

iii/ Archaeological sites

Neolithic village, Beida

The archaeological remains at Beida are in need of consolidation and adequate protection from intrusion by goats and other animals (the existing wire fence and gate are damaged). If the site is to receive more visitors in the future, proper visitors' paths and adequate sign-posting will also be needed.

Wu'eira

It should be noted that the site of Wu'eira, unprotected and unguarded between archaeological missions, has been defaced by graffiti in places, and there was evidence of the activity of treasure-hunters, who had dug into the base of the wall of the only remaining guard-tower, undermining the structure. Urgent consolidation work is needed here, as well as adequate protection of the site. Wu'eira, easily reached from Wadi Musa, is a potential tourist attraction, but needs adequate site layout work, visitors' pathways and sign-posting.

iv/ Mural Paintings and Stucco Decoration

The frescoes of the painted cave at Siq al-Barid, Beida, are the finest and most extensive of the very rare fragments of Nabataean mural painting of the Alexandrian/Pompeian style which have survived to the present day. Dimly visible through the thick coat of soot deposited on them through years of open fires having being lit underneath, they depict tree branches with cupids and singing birds. Cleaning and consolidation of the paint layer are needed. Other examples of mural painting exist in the painted cave in Wadi Siyagh, and fragments of painted stucco decoration have been discovered recently in the therms.

Rare fragments of painted stucco mural decoration inside a cave dwelling, Wadi Siyagh
Lane

Sheikh Hussein Abu Mohammad of the 'Alâwîn section of the Ḥuweiṭât (شيخ حسين ابو محمد العلاوين), as drawn by the Rev. Henry Formby at 'Aqaba in 1840 (1843:252). Hussein is shown counting the gold five-piaster pieces paid to him by a large group of Europeans in order to visit Petra under his guidance and provisioning and protection.

Fig. 20.

Hammond

2.3. SOCIO-ANTHROPOLOGICAL VALUES

2.3.1. Historical Background: The pilgrims' roads in the XIXth century

Once an important meeting point for the caravans of Arabia, Petra is nowadays a focal point in the tourist itineraries of Jordan and the Holy Land.

John Lewis Burckhardt rediscovered this city in 1806[1]. He was soon followed by a great number of travellers who described its monuments and the conditions of their visits. These accounts are now invaluable documents, enabling us to grasp the situation in this part of the country under Ottoman rule. They also help us to understand, through the accounts of their journeys, the relations of the various tribes with each other and with existing villages at that time.

On the other hand, the situation and the history of south Jordan in the XIXth century is related to the Pilgrims' Caravan Roads. Two crossed Jordan: the Damascus Road, replaced in the early XXth century by the Hijaz railway, and the Egyptian Road, which crossed the Sinai Peninsula and was virtually abandoned after the opening of the Suez Canal, which made possible the journey by sea. These two roads passed through tribal territories inside Jordan. In order to ensure the security of the caravans and of the pilgrims, these roads were put under the protection of the tribes. Thus, important tribes controlled the roads and were paid the "surrah" by the Khedive of Egypt or the Pasha of Damascus.

The Damascus Road almost follows the actual Desert Highway in this part of the country. Ma'an was the important halt where the pilgrims rested for two days before tackling the difficult path of the Batn al Ghoul. The quiet town of Ma'an was completely transformed into a huge market place during those two days. Peasants from the Shara mountains, bedouin from the eastern desert and the west, and merchants coming from Ghazza, Bir Saba'a or Khalil flocked in to sell their wares. The same situation arose in the town of Aqaba, with its fortress where pilgrims rested for two days after having traversed the perilous Wadi Araba without a halt, there being no water point after Nakhl.

These caravan roads passed to the east and west of Petra and the Shara mountains. The important tribes which used to ensure the security of the caravans and the protection of the pilgrims in that area were the Huwaytat tribes. The eastern road, with the town of Ma'an, was under the control of the Ibn Jazi, while the western road, from Nakhil to 'Aqaba being controlled by the 'Alaween. Both are important tribal sections of the Huwaytat. In the present study, we shall be more concerned with the 'Alaween, although the Shara mountains and the east of Petra were an Ibn Jazi "protection area".

When reading travellers' accounts concerning Petra, we very often come across the 'Alaween, together with the Lyathne. The latter were, and still are, the inhabitants of the village of Wadi Musa.

i/ The Lyathne

The Lyathne, or "Bani Lyath", describe themselves as *Fellahin* (peasants), although their lifestyle, especially up to the last century, did not differ from that of the bedouin tribes. They are divided into

---

[1] See J.L.Burkhardt. "Travels in Syria and the Holy Land", London.

. Frontal view of a fully-cloaked and armed Bidûl male at Petra in 1843, as drawn by John Wilson (1857:287).

Fig. 21.

Hammond

three sections: the 'Ayala, the 'Obeidat and the Bani 'Ata, all of which trace their origins to Wadi Lyath in Arabia.

Mainly agro-pasturalists, the Lyathne moved with their *Beit Sha'ar* and their herds in search of pasture lands. Their village, Elji, then famous for its orchards, was composed of three compounds, each belonging to one of the tribal sections; The stone houses were mainly used as granaries for the inhabitants, who lived in tents for most of the time. This was the situation throughout the south of Jordan. In the rainy season, they found shelter and warmth in the caves of Petra, up to the entrance to the Siq.

The tribal territory of the Lyathne stretched from the village of Elji to Beidha in the north, thus including the entrance and the Siq of Petra. This is confirmed by travellers' accounts; starting from Burkhardt, all those who came from the north-east and entered Petra from the Siq were confronted by the "ferocious" Lyathne who controlled the entrance and considered the presence of Westerners an unwelcome intrusion. This was for two reasons:

Firstly, the sacred tomb of Nabi Harun[1], located on the mountain that bears its name, was an important pilgrimage spot frequently visited by all the inhabitants of the area. Devoted pilgrims would walk up to the summit and sacrifice an animal on the tomb[2]. The Lyathnes' task was to forbid all foreign presence in this sacred place.

Secondly, the Lyathne used to think that the monuments of Petra belonged to the western heritage and that the visitors had come to take back their rights. Thus their attitudes towards Petra and towards the visitors was one of suspicion and distrust. They also thought that the monuments were hiding treasures which the travellers were looking for.

ii/ The 'Alaween and the Bdul

The travellers who came from Egypt and the Sinai following the pilgrims' caravans arrived at Petra from Wadi 'Araba, guided by the 'Alaween (See Roberts' sketch "the Alloen in Wadi 'Araba, 1835), who guided them to Petra from the south, through Wadi Sabra until the limits of their territory, which is around the foothills of Um al Biyarah.

The 'Alaween are an important section of the Huwaytat. Several tribes were grouped under this name in a confederacy under the supremacy of the Njadat[3]. Among these tribes was that of the Bdul. So, although we very rarely find this name in the travellers' accounts, every reference to the 'Alaween also refers to them, as the southern part of Petra was inside their tribal territory. The Bdul also present themselves as being 'Alaween and 'Alwan as their ancestor.

---

[1] The Prophet Harun, or Aaron, the brother of Moses.

[2] Burkhardt also entered Petra on the pretext of visiting the sacred tomb. Otherwise the Lyathneh would never have accepted to let him in. But, as the famous orientalist and traveller underlines in his account, they could not refuse a visit and a sacrifice to the Nabi for fear of divine punishment.

[3] Von Oppenheimer gives a fairly complete list of the tribes comprising the 'Alaween confederacy.

The Bdul, through the 'Alaween and with their famous Sheikh from the Ibn Zaytun descent group, were engaged in the protection of the pilgrims' caravans which crossed Wadi 'Araba. They were mostly the *Ghafirs*, guides and guards of the caravans, and also of individuals. It is with this attitude that the Bdul guided visitors to Petra from the south.

The opening of the Suez Canal and the abandon of the pilgrims' caravan route at the end of the XIXth century lessened the importance of the tribe. The 'Alaween, as well as all the other tribes in the region, including the *Fellah* Lyathne, continued to cross the Sinai, heading now for the markets of Bir as-Saba'a, Ghazza and those of Egypt. The road they used to take passed through Petra.

The creation of the state of Israel and the closing of the borders stopped even these commercial activities in the middle of this century. These markets were replaced by local ones. Transportation, which was an important element in the economy of the bedouin and a reason for camel breeding, came to a halt. The bedouin stopped their commercial itineraries, and the confederacy split apart.

The Bdul, like all the small tribes, found themselves in great difficulties. They could no longer continue their camel transport activities, and neither could they count on the protection of the confederacy of the important tribes of the Ibn Jazi and the Njadat.

The only possible economic activities left were animal breeding and herding. For some time, until the arrival of the tourists, they retreated into the mountains of Petra along with their herds of sheep and goats. Stricken by poverty, the Bdul sold all their dairy products *(laban and saman)* and even the goats' hair (used for weaving the tents) in Wadi Musa in order to survive. They camped in the open air or in rock shelters on the mountains of Petra, occupying the tombs in winter and the rainy season.

With the arrival of the tourists, the Bdul gradually came closer to the archaeological site, and again, gradually, from the sixties onwards, started to intensify their occupation of the site, living inside the caves near the monuments and tilling the land. They worked as labourers in archaeological excavations, where their knowledge of the site was very much appreciated. Most of them, however, were engaged to guide the tourists through the site, like their 'Alaween ancestors.

In 1985, the Bdul left Petra for the new houses built for them on the hills of Um Sayhun.

The departure of the Bdul from Petra

In order to give Petra the statute of a National park, a master plan was drawn up in 1968 by a Jordano-American team. The development of tourism was one of the main objectives of this plan. Most of the recommendations concerning the development of tourism facilities were realized: daily transport from Amman, the construction of a first class hotel and a visitors' centre, etc.

The removal of the Bdul from the site was presented as an urgent action. Urgent because the presence of this tribe was considered to be an obstacle:

> To the preservation of the antiquities; the agricultural and pastoral activities of the Bdul, their living in the caves, and their inofficial excavations and sale of ancient artefacts, were all said to be major factors in the deterioration of the site. In addition, it was considered necessary in the 1960s to present the archaeological site in as neat and tidy a way as possible, banishing any unnecessary human presence;

To the development of tourism; Petra having become, through tourism, a window on Jordan, living in caves was considered to be a sign of backwardness, and the presence of the Bdul a counter publicity for the country.

The idea of sedentarisation and development

The Master Plan presented the removal of the bedouin from Petra as a necessary pre-condition. The construction of a new village was presented by the Plan as a possible "sedentarisation" project for the bedouin, citing as examples, the projects which had already been implemented since the beginning of the 'sixties: the al-Jafra and al-Hussayniyye projects.

These two sedentarisation projects, the first in Jordan, concerned two important tribes of the Huwaytat. Each had two main components: the construction of a village followed by an agricultural project. In those days, a sedentarisation project involved not only fixing the living place; the economy and agriculture were the main points.

These projects did not consider that the bedouin were first and foremost shepherds, used to animal husbandry, rather than farmers. No animal breeding project was presented in the seventies; these came much later, in the middle of the 'eighties. The bedouin were thus forced to shift not only from a nomadic to a sedentary life, but also from animal husbandry to agriculture.

The success or failure of these projects is another issue, but they were very fashionable throughout the world at the time when the Master Plan was formulated. It was in its realization, however, that certain anomalies arose.

An important point to be underlined here is that the sedentarisation projects of al-Jafra and al-Hussayniyye were realized under the guidance of the Ministry of Agriculture.

Um Sayhun Village and the sedentarisation of the Bdul

For the bedouin of Petra, things went differently. Under the title of a "sedentarisation project", only a village was built. Firstly, no agricultural or any other economic projects whatsoever followed to ensure a living after the changes following their removal from Petra. Secondly, the complete project was realized by the Ministry of Tourism. The Ministries of Agriculture, Rural Affairs, etc. did not participate.

The Bdul refused at first to move out of Petra, then they argued about the site for the new village. Finally, they criticized the houses. Some of their main objections may be summarized as follows:

1. While their removal was not accompanied by any economic project, their presence inside Petra was to be organized and controlled. This meant that only a certain number of them, those with a license to have shops, could have access to the site. Thus a whole part of an informal touristic economy, mostly managed by women and children, was to disappear without any alternative activities being given.

2. The houses were too small and uncomfortable. For the Bdul, used to living in the open air or in the caves of Petra, using as many caves as they needed, extending from one valley to another, the houses seemed tiny and cramped. No pens were provided for sheep and goats, or stables for the camels and horses. They had, on the other hand, accepted to move out of their caves on the basis of another plan prepared by UNESCO consultant architect 'Abd al-Wahed al-Wakil, for self-build stone houses with

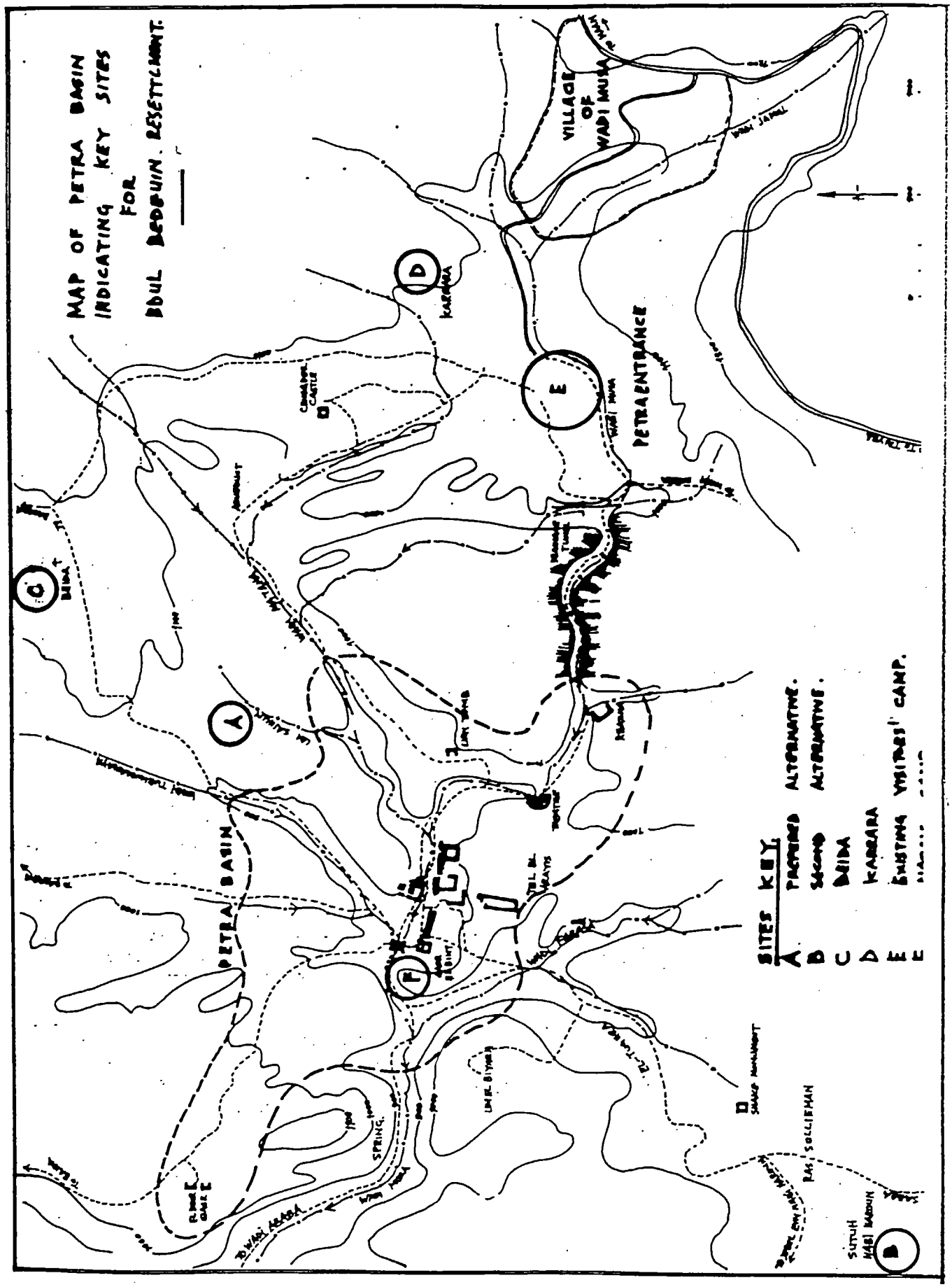
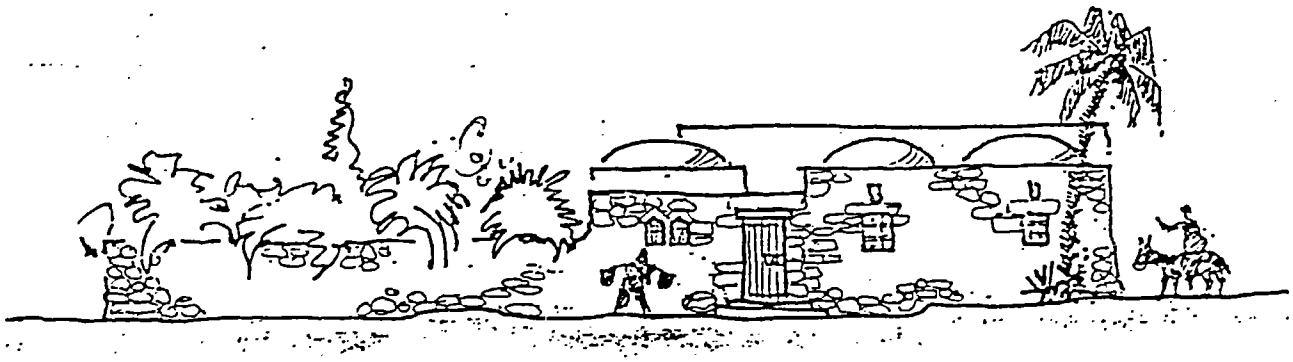
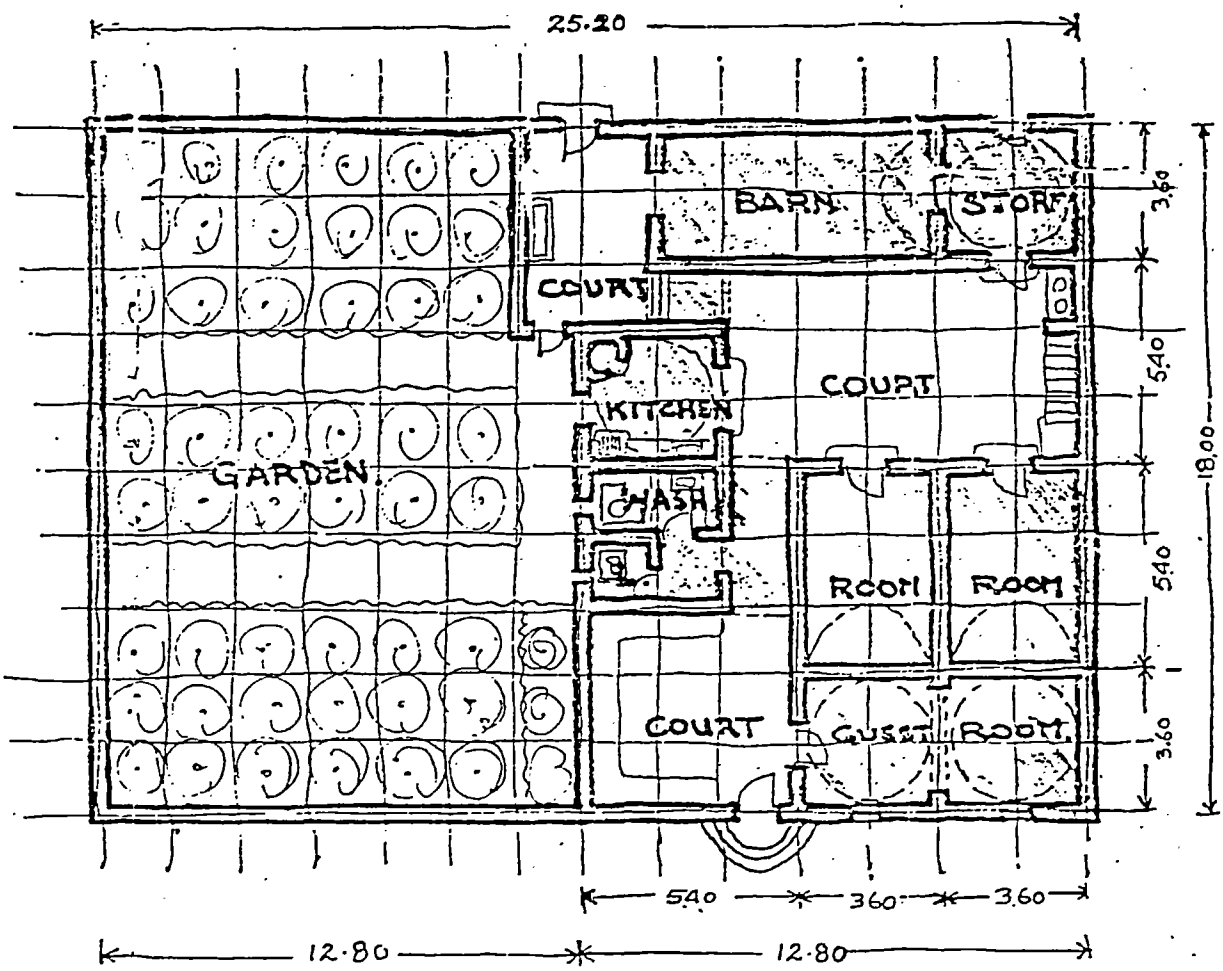


Fig. 22
Drg. by Sharif Nasser. Bdul bedouin Resettlement. UNESCO

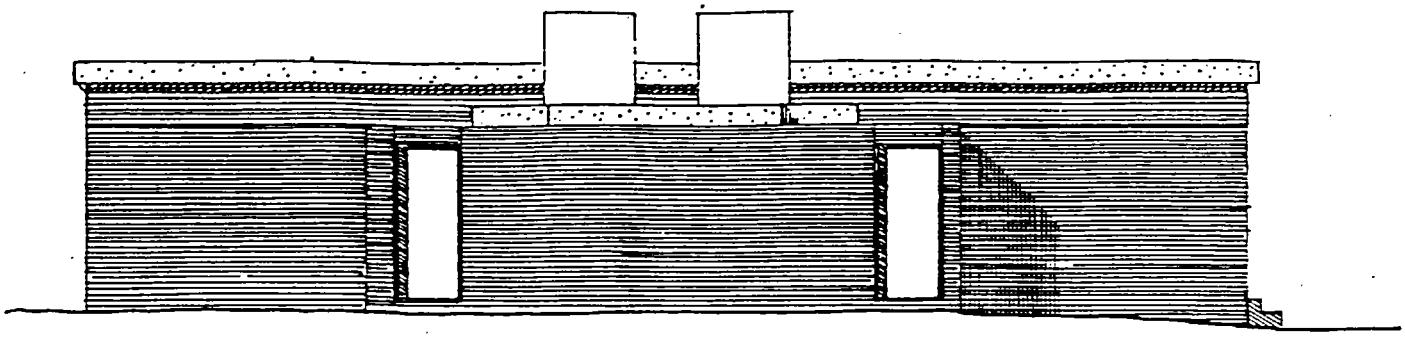




BDUL HOUSE TYPE A. ARCHITECT: A Wakil.

SCALE : 1:200

Fig. 23
Plan for Bdul housing unit in traditional stone construction as proposed by Abd al Wahed al Wakil for UNESCO and accepted by the Bdul.



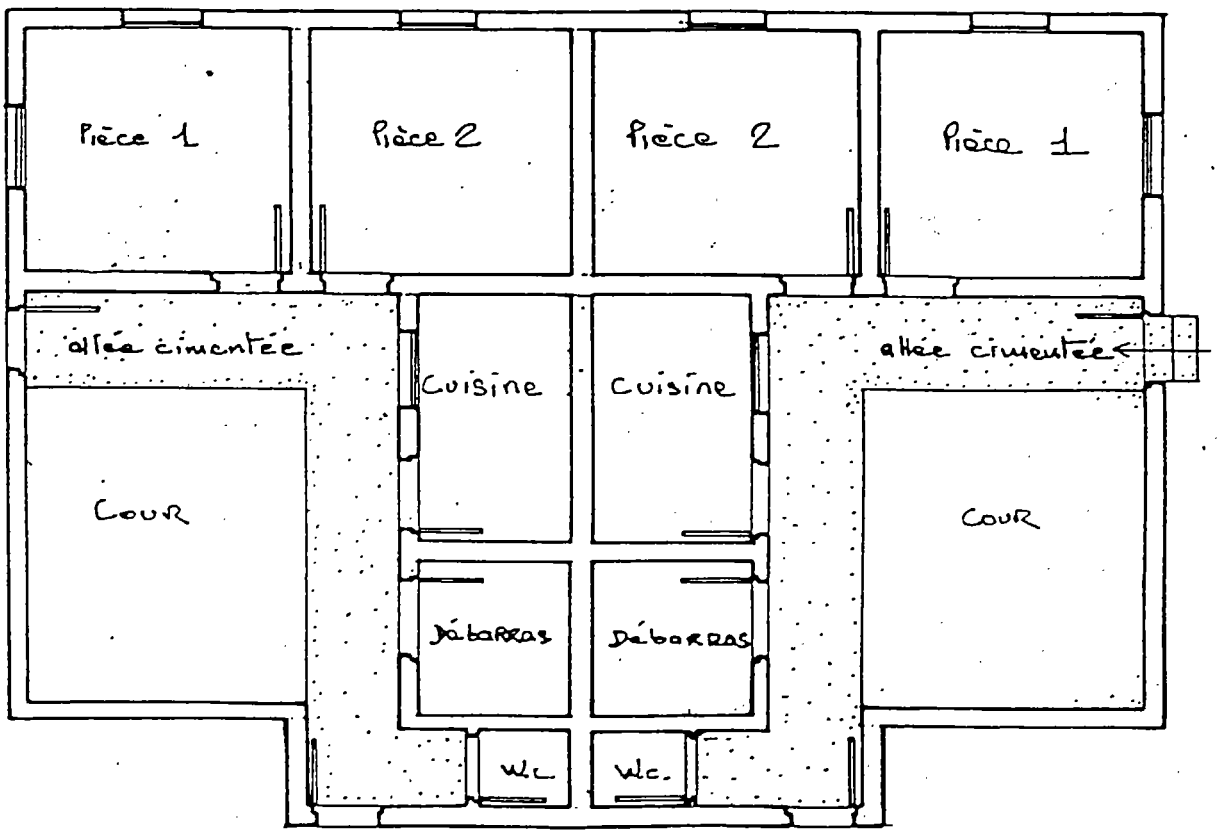


Fig. 24
Plan of typical pair of housing units, Um Sayhun, as built. Drg. by A. de Reynal

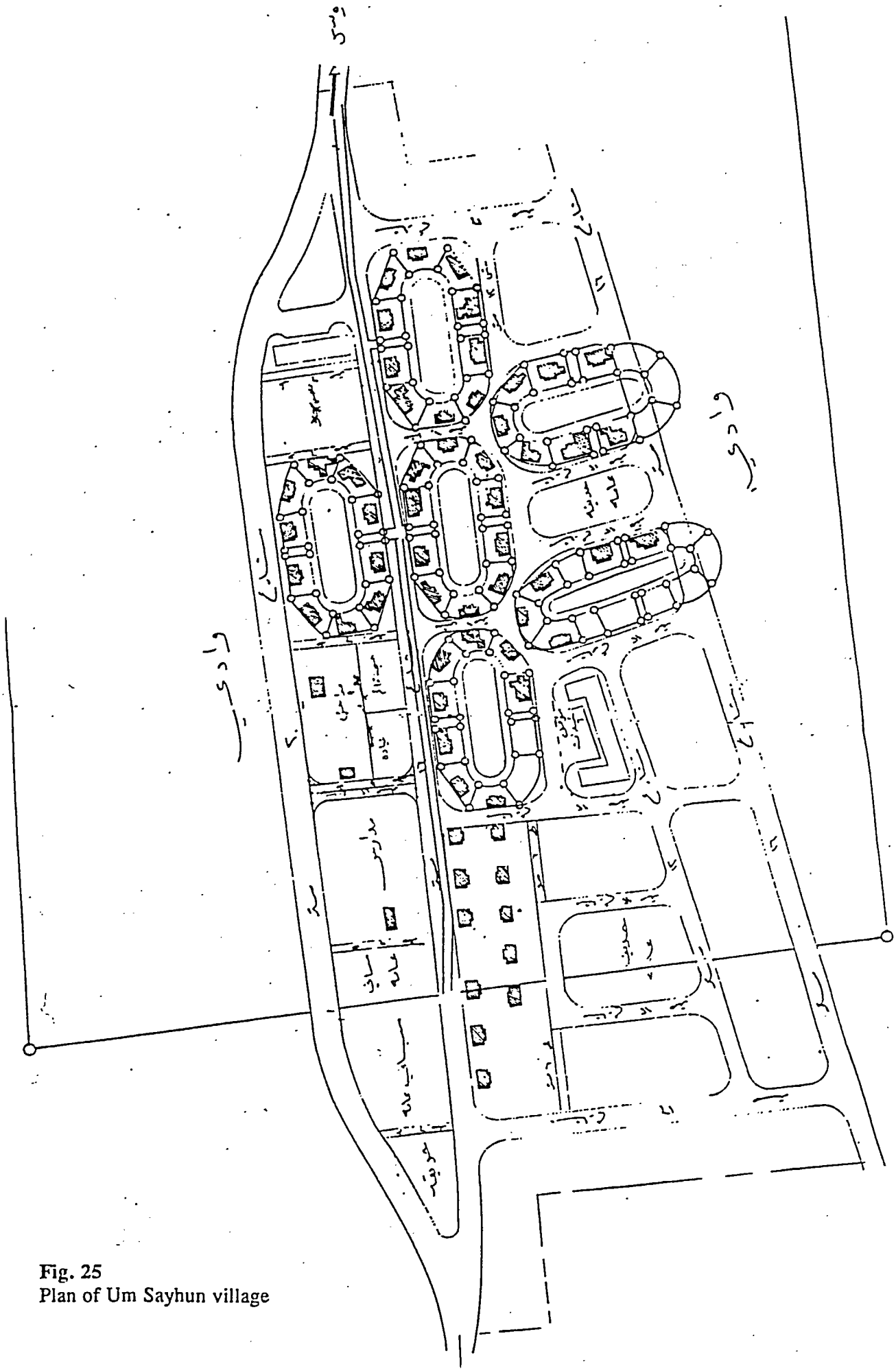


Fig. 25
Plan of Um Sayhun village

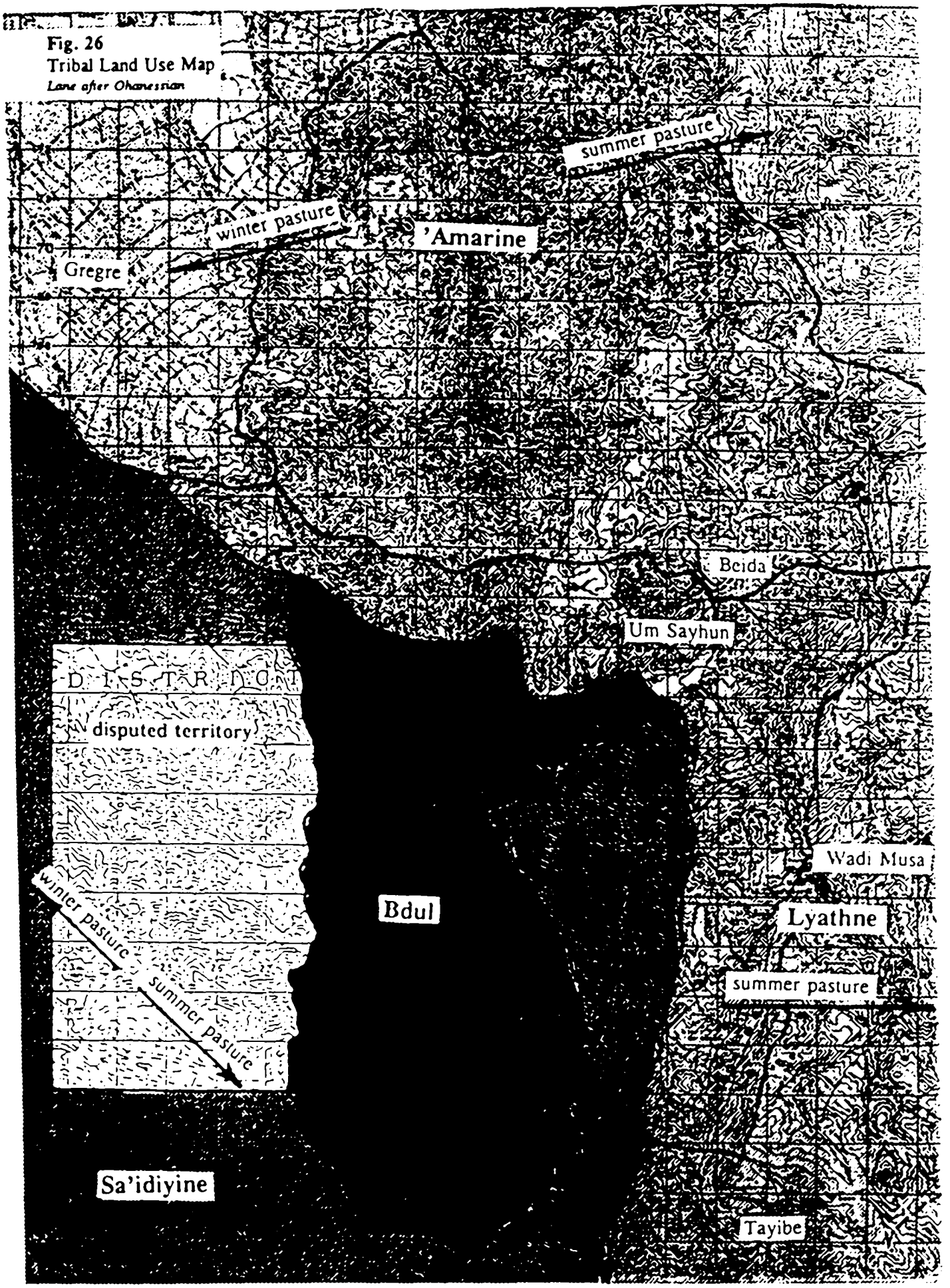


Fig. 26
Tribal Land Use Map
Lane after Ohannessian

walled gardens and places for animals. The first step the Bdul took, therefore, once they moved into the new village in April 1985, was to build sheepfolds, rooms and garden enclosures, at their own expense. The tourist season of 86 was very weak; external political events resulted in a reduction in the number of visitors, hitting the Bdul very hard, as they had sold their herds and horses to build the missing rooms, counting on the tourist season to make good their losses.

3. The most important problem remains that of land ownership. The village of Um Sayhun was built on the tribal territory of a descent group of the Lyathne: the Hassanat of the Obeidiyye tribal section. Before the site of Um Sayhun was accepted, the authorities of Wadi Musa proposed Garara. The Bdul refused Garara because of its proximity to Wadi Musa and the Lyathne, fearing future problems and clashes. On the other hand, they asked to have their village on their own tribal territory, near their fields, to the south of Jebel Harun. This site was rejected because it had no access other than crossing the site of Petra. Finally, the hill of Um Sayhun was decided on as the most suitable place for the village.

The Hassanat, in order to defend their tribal land on the hill, which they had been cultivating for many years, started planting olive trees there. The Bdul again refused to move, arguing that they could not live with their sheep and goats among the olive trees. Finally the olive trees were pulled out and the Bdul moved in, but the Hassanat were compensated neither for the land for which they had the usufruct, nor for their olive trees.

These details are important in order to understand the present situation. To date, the socio-economic and legislative studies which should have accompanied the Master Plan project have not been done.

2.3.2. Mirri Land and the notion of tribal territory

As has already been said, the land of Um Sayhun was part of the tribal lands of the Hassanat. In other words, they enjoyed the usufruct of it, but did not own it. The land has the status of Mirri land, i.e. it is state or government owned. This notion of Mirri land dates back to the Tanzimat (reforms) period of the Ottoman empire, in the mid XIXth century.[1]

Mirri land was leased by the State to individuals, who paid dues or taxes in return for its exploitation. The bedouin cultivated these lands on a collective, not an individual, basis. Plots of land suitable for agriculture were divided regularly between the tribal members *Taksimat 'Acha'iri*. In the same way, the Hassanat used to divide their fields as well as their pasture lands among themselves, and used to pay the necessary taxes. This situation continued until the 1940's, when these taxes were abolished, but the right to cultivate Mirri land remained, particularly that which was part of, or included in, *Wajhat 'Acha'iri*, i.e. tribal territories.

It should be noted that all tribal land is Mirri. The two sedentarization projects which were cited as examples in the Master Plan were situated in the territories of the tribes concerned, and through the agricultural projects, the tribesmen had to buy the land and register it individually.

The land on which the Um Sayhun village was built, on the other hand, was not bought - in one way or another - from the Hassanat, who were not compensated for their olive trees either. This lack of

---

[1] Omar M. Razzaz, "Law, Urban Land Tenure and Property Disputes in Contested Settlements: the Case of Jordan", PhD Thesis, Harvard, 1991.

negotiation at the outset created major problems for which solutions have still not been found and have now become the basis of several clashes and acute problems in Petra and between the two concerned tribes.

2.3.3. The present situation

i/ The Hassanat

The Hassanat consider themselves as the losers: of more than 500 dunums of land and 300 olive trees. They ask for *badal ardh*, other fields instead. From this it is clear that they will not accept losing or being dispossessed of more land. "The land problem is a problem of dignity. If you lose your land it means you don't have dignity" (a Hassanat). They have proposed some terms of negotiation and are willing to take some land elsewhere, either:

1. Mirri lands situated between Udhruh and Ma'an. These are not tribal lands, and have not been cultivated. However, since this land is less prosperous and fertile than those they have lost in Um Sayhun, they are asking for twice and even three times more;

2. Lands inside Wadi Musa where the Department of Forestry is carrying out part of its afforestation programme. They consider that, since this land is of much better quality than that they have, almost, 100 dunums would suffice.

Some other terms of negotiation will be suggested in the draft Management Plan.

ii/ The Bdul

The problems of the Bdul are different, although related to, and emanating from, this initial land problem.

The Bdul also consider themselves the losers. They have been displaced, and they have lost their lands and fields in Petra. They too are asking for *badal ardh* in exchange. They used to cultivate the Stouh of Jebel Harun and the fields in Wadi Sabra, Ragabat al Sughra and Ras Sleisel. Since their departure, some of these lands are still cultivated, but only by a small number of families who still live in those areas and have no housing yet.

The Bdul are asking for more land, for cultivation, but also for expansion of their village, since their number is also increasing. The demand for agricultural land means that they are aware that tourism is not forever a viable economy, and that agriculture is a more stable one.

Concerning the problem of expansion of Um Sayhun, the lands surrounding the village belong, as we have seen, to the Hassanat, and not to the Bdul, which makes any extension of the village impossible.

In the planning of the village, the number of houses built was even less than the number of families at that time[1]. Any increase in the number or size of the families was not taken into consideration, with the result that the Bdul are not able to build either inside or around the village, and cannot extend the limits (which have still not been defined) of the village.

---

[1] More than thirty Bdul families who do not have a house in the village

The Bdul are asking for the delimitation of Um Sayhun and an extension of 1 km. northwards, which means on the Mirri lands of the Hassanat. During the winter of '91-92, the Hassanat sowed all the lands close to the village of the Bdul.

The latter, instead of entering into disputes with the Hassanat, preferred to adopt a more striking course of action; they returned to their caves in Petra.

The action was a very visible one, since Petra was involved. It was also critical because the Bdul refused to talk to anyone apart from the Royal Family. His Highness Prince Ra'ad undertook the negotiations. Four distinct conditions were stipulated by the Bdul for their return to Um Sayhun:

1. Agricultural land to replace that in Petra.

2. They would keep in their actual places the commercial enterprises inside Petra.

3. The extension of the village 1 km. northwards.

4. They would keep intact the gardens and orchards they have in Wadi Siyagh.

All of these propositions should be taken into account when attempting to find suitable solutions in the formulation of the Management Plan; solutions which can be carried out in practice.

Importance of social recognition

It is important to take into consideration: the situation of the Bdul as a bedouin tribe, as a displaced population, and also as a group which derives an income mainly from tourism. These three factors have combined to create conditions which have generated some important collective strategies. When these strategies are analysed, it becomes clear that they are all directed towards a common aim: the need for social and national recognition.

The Bdul seek recognition from other bedouin tribes, from Jordanians and from the State. Although Um Sayhun village causes many problems, and they refused at first to move in, this village has given the Bdul a certain measure of national recognition which they did not have in Petra and which they were seeking. Every negotiation and every proposal should be handled in such a way as to satisfy this need.

iii/ The Sa'idiyyine

A bedouin tribe occupying the south-west limits of the Park, the Sa'idiyyine have their tribal territory mainly in Wadi 'Araba, with Risha being the main village and Bir Mazkhur a focal point. The second Sa'idiyyine village is Dlagha on the southern slopes of the Petra mountainous area.

Related to the Huwaytat, they are not an 'Alaween tribe, but were, in the XIXth century, close to, and in alliance with, this confederacy.

The Sa'idiyyine live on the periphery of the park, moving towards the mountainous areas in spring and summer, as far as the Beidha heights in the north. In the cold and rainy season, they take refuge in Wadi 'Araba. Thus, their presence in the park is seasonal, mainly in springtime for grazing.

A stretch of land in Wadi Jurf Himar, between their tribal territory and that of the Bdul, is claimed by both and is a "no-man's land" used only as rangeland by both tribes under the control of the Authorities.

The Sa'idiyyine are currently engaged in an agricultural project, proposed by the Sharif Nasser, in Wadi 'Araba.

iv/ The 'Amarine of Beidha

This Bedouin tribe occupies the northern limits of the Park, extending from the north-east of the Shara mountains to the north-west in Wadi 'Araba and Wadi Feinan.

The 'Amarine say they are a branch of the Bani 'Atiye tribe, and thus not affiliated with the Huwaytat, although a territorial relation, and sometimes dependency, has always existed.

The main villages of the 'Amarine are Bir ad-Dabbaghat on the mountains near Shawbak, and Gregre in Wadi 'Araba. Their tribal territory extends between the two and includes Beidha. The pastoral movements of the 'Amarine follow these two points: winter is spent in Wadi 'Araba in the west; with spring, the herds head eastward towards the Shara mountains up to Bir ad-Dabbaghat.

The 'Amarine of Gregre are also engaged in an agricultural project in Wadi 'Araba, and so have fewer herds and move less.

The 'Amarine village

In the second half of the 'eighties, the 'Ial 'Awadh obtained new houses in Beidha[1]. A total of 52 houses was planned, but only 42 were finally built, for 35 families. Ten houses were given to the Bdul of Um Sayhun.

The new houses have water from Wadi Musa, but no electricity supply. They are small, and individual family plots have not been delimited, or the property registered, with the result that the inhabitants cannot build on the additional rooms or outbuildings which will be needed.

The 'Amarine 'Ial 'Awadh are mainly agro-pastoralists. They cultivate almost 20,000 dunums of land in Beidha. The land is usually left to lie fallow every other year. The economic situation of this tribe is not very easy. Apart from farming and one family which guards Siq al Barid, nine persons are in the army.

One of the 'Amarine of Gregre has cleaned and restored a small dam near Jebel Baja' in the north (5m deep x 22m long x 5m wide). It cost him almost 2,000 JD, but is used by all the 'Amarine who move eastward in spring, as well as the Bdul and the Sa'idiyyine, for their herds. This kind of private initiative should be encouraged and supported under the Management Plan. All the 'Amarine are ready to build dams and clean out water tanks if they are given the means to do so. All together, ten cisterns and dams will need to be put back into working order in order to encourage them to plant fruit trees.

---

[1] The houses were built under the auspices of HRH Crown Prince Hassan.

Propositions for the 'Amarine

Apart from the interventions for agricultural techniques and land tenure, the water resources and rangelands, which will be presented in general and for all the inhabitants of the Park, the 'Amarine can play an important role in Beidha. The following activities can be considered:

- Tourist halts. On the way to Beidha, the tribe possesses a group of ten old stone buildings, mainly of one room each, which they use as granaries. These are built on a small hill, close to Siq al Barid and containing a Nabataean grape-press. Restored, they could easily be adapted to furnish "bed and breakfast" for small groups of tourists on two or three day circuits.

A similar group of old stone granaries on the summit of Jebel Garun, belonging to another section of the 'Iyal 'Awadh. This could be a second halt; an important one for its view of Wadi 'Araba.

In Beidha, a group of bedouin tents could also give shelter to tourists on their way to the north.

The 'Amarine owning the stone-built rooms and tents are willing to transform their granaries into rooms and offer a bed, and bed and breakfast service. They will, of course, need the assistance of the Park Project, for its organization, but are ready to participate by providing tea, *Saj* or *Taboun* breads, and fruits, olives and dairy products of their own making.

2.4. ECONOMIC VALUES: TOURISM

2.4.1. Identity and Concept of Site

The first question raised by the site of Petra is that of its identity. Only by starting from this identity can a marketing concept be developed in terms of tourism products, information and promotion.

This methodological approach is essential in order to guarantee the quality and authenticity of the cultural and educational "product" to be sold abroad, and to be experienced on the spot by tourists [1] (both national and international) and by excursionists [2] (the population of Amman).

The members of the mission team identified several scientific approaches to the site: historical, artistic, urbanistic, ecological, geological, anthropological, hydrological, and ritual. These approaches can and should nourish the cultural content of the different "discovery products" of the PANP, in keeping with the spirit of the place, and with its permanent function of transmitting a national and world cultural heritage.

The theme of water can be said to be the foundation of the identity of the site; water in its desert environment. This duality functions as the two faces of a coin. and takes the form of a dyad: Water/desert, which is the central theme of our reflections, running through each of the propositions in this report.

It is water which gives the ancient city its identity. In this sense, Petra bears a message of life, science and art which is a valuable lesson for today. Its system of water distribution is particularly remarkable and elaborate. Water is also an essential element in the religious practices of the Nabataeans, in which ablution was the principal practice for ritual purification. On the other hand, water is also a symbol of death for the city, because of its destructive action on the monuments.

The dyad water/desert is not only the foundation of the cultural identity of Petra, but also at the heart of the cultural and political identity of the modern state of Jordan, which has drawn its international juridical recognition from the River Jordan, whereas 85% of its total area is composed of desert steppes.

At the time of the caravan routes, the desert was a vital link, Petra being one of the most important stops. Up to the present time, the desert is still this vital link, opening two doors to Jordan: the way to Iraq in the east, and the way to Saudi Arabia and the Gulf States to the south-east.

In fact, water is a problem whose solution is political since the principal rivers of Jordan lie on its borders. To the north, the Yarmouk River, a tributary of the Jordan which forms the frontier with Syria and occupied Golan, could bring some 350,000,000 m3 of water to be divided between the residents on each side, but this "dam of unity" has not yet been built.

In this domain, as in that of the development of tourism, the Jordanian authorities are convinced of the imperious necessity for peace in the region.

---

[1] Economic definition: a stay of more than 24 hours and less than 4 months away from habitual place of residence.

[2] Economic definition: one day outing with return to habitual place of residence in the evening.

2.4.2. Tourism in Jordan

Jordan represents a crossroads of civilization. This is why the state, founded less than 70 years ago, has emphasized the development of tourism. Cultural tourism, as a means of exchange and encounter between peoples and cultures, while respecting their equilibrium with their environment, represents a real opportunity for the future.

This sector of activity represents the second source of revenue for the country, or 15% of the GNP, earning US$ 510,000,000 in 1990, and US$ 315,000,000 in 1989. After a drastic cut-off due to the Gulf Crisis, tourism is developing again. This renewal is organized around six axes:

- most importantly, **"incentive" and "cultural"** (redeployment of the traditional clientele for Egypt to Jordan).

- then, more specialized interests such as **adventure, pilgrimages, diving and health tourism.**

In fact, Jordan offers an extremely varied tourist potential:

i/ Cultural Tourism Linked to Archaeology

Petra:

Works financed by Jordanian public and private investors are under way to increase the present hotel capacity.

Jerash

Excavation and restoration works are under way to this exceptional Graeco-Roman site. Recent finds, including traces of Pompaean style frescos, will add to its interest. Also, the Amman-Jerash route has been improved, allowing easier access.

Madaba-Mount Nebo

The work of restoration and presentation of the mosaics of this region is a success.

Desert Castles: Macheronte, Pella, Um Qais:

A new route was put into service in 1989, starting from Amman, facilitating access to these castles.

On-going archaeological research projects are being carried out by a number of institutions, including the Institut Français d'Archéologie du Proche-Orient, the CNRS, the American Centre for Oriental Research, Utah University, the University of Florence, and the University of Nurenberg.

ii/ Tourism of Discovery

Owing to the diversity of sites and landscapes in Jordan, many itineraries are open to the visitor wishing to discover the country.

Tourists have the possibility of hiring a four-wheel drive vehicle, or of using the air-conditioned bus service run by Jordan Express Tours Transport (JETT).

iii/ Sea-side Tourism

Aqaba is the principal centre for bathing and sea-sports in the region.

A considerable expansion of the hotel stock is planned at Aqaba, which actually counts seven 3 and 4 star, and fourteen lower rated establishments.

iv/ Spa Tourism

A first thermal springs establishment (state-owned) was opened in 1987 at Ma'in Spa Village, with a rheumatology clinic. A second centre, inaugurated in 1990, is situated on the Dead Sea.

This brief account gives an indication of the immense tourist potential of Jordan. It is, however, necessary to control the future expansion of the sector, in order to preserve the natural and cultural heritage, while offering tourists high-quality services. An agreement has recently been signed for cooperation in the field of tourism development between Jordan and France.

2.4.3. Inadequacy of Accommodation for Tourists.

In the south of Jordan, the number of hotels is insufficient, and extension programmes are foreseen for Aqaba.

At Petra, the problem of tourist accommodation is more difficult to resolve owing to the overriding need to protect and preserve the archaeological, natural and scenic values of the site.

i/ Present Capacity at Petra.

Presently, there are two major hotels in Petra, both at the entrance to the site:

The Petra Forum:

82 beds, with a 65 bed extension foreseen. The average annual occupation rate is 72%. However, in the high season, the present capacity is insufficient, with the result that the length of stay cannot in general exceed one night.

The Rest House:

35 beds capacity. The situation concerning the present capacity is the same as the Petra Forum.

Other smaller hotels exist, bringing the total capacity to 130 beds in the village.

ii/ Possible Hotel Projects:

In any case, it is not possible to increase the hotel infrastructure at Petra *ad infinitum*. Therefore, several projects outside Petra can be studied:

Hotel tourism

The creation of a tourism and hotel centre at Wadi Musa with the construction of luxury hotels. Such a development in Wadi Musa, however, should not be permitted until such time as a coherent Urban Plan including a land use plan has been drawn up. The Municipality should have the power of pre-emption of land in order to improve its capacity for managing land resources.

Agro-tourism

Restoration of abandoned stone villages and agricultural terraces as agro-tourism centres offering holiday accommodation (particularly for a younger clientele) and the development of handicraft centres. This approach has already been started at Taiyibe with considerable success.

Similar projects could be developed at:

Khirbat al Nawafle (Wadi Musa)
Al Hayy
Bdebdebe (with exploitation of a natural spring)

Nomadic Tourism

The PANP and its surrounding area is so large and offers such a variety of landscapes that an exhaustive visit can only be afforded by an itinerant tourism. The trip with guides, on foot, on horseback, by camel or with donkeys, could be made, by small groups using temporary accommodation and tents. Evidently, sufficient preparation of the itineraries, a thorough assessment of the impact on the natural environment, and guides with a thorough knowledge of the terrain would be necessary, and no initiative outside the appointed plans should be allowed.

These programmes are developed in more detail in the draft Management Plan. Until a new administrative structure is set up to manage the Park, the Petra National Trust should be consulted concerning all projects for the construction of hotels in the Petra region.

2.4.4. Poor technical performance of the site

Access and facilities in the archaeological area of Petra are generally inadequate. The most urgent problems concern access on horseback through the Siq, the lack of lavatories and public facilities, and the complete anarchy reigning among vendors of souvenirs.

i/Circulation

No visitors' trails or circulation circuits have been organized. The visitors are virtually obliged to return by the same way they came in, via the siq, crossing the newcomers in the process.

Visitors' trails and a one-way circulation route need to be defined. The creation of a minibus service with a small fleet of 5 to 6 vehicles could be envisaged to pick up visitors at the end of their visit and take them back to their hotels.

(Above) Important extension of the Rest House under construction on the rocks overlooking the entrance to, and visible from, the site.
The restaurant building, situated below the museum and opposite Qasr al bint, also houses the staff.
Lane

Transitional measures:

The horses entering the Siq should be obliged to carry a visitor-tourist. The return to the entrance of the site to take another passenger should be by another route than the Siq (there is another route via the mountain). This first transitory measure should be accompanied by:

- The establishment of the mini-bus service which will take the visitors from behind the old school at the end of the principal circuit. The minibus company which will take the tourists back to their hotels should be created as a legal entity and minority shares given to the Bduls;

- The autonomous management of the park should be set up at the same time these new measures are introduced. An advance on one year's profits could be given to the owners of horses from Wadi Musa, in order to enable them to reconvert to other activities;

- exploitation of other circuits in the park;

- training in the various activities related to the operation and maintenance of the Park commerce.

Definitive Measures:

Prohibition of horse traffic in the Siq and the archaeological sanctuary area. This measure will be applicable in one or two years, once the interim measures have been accepted, and above all once the new activities will have been seen by the local community as beneficial to themselves and their children.

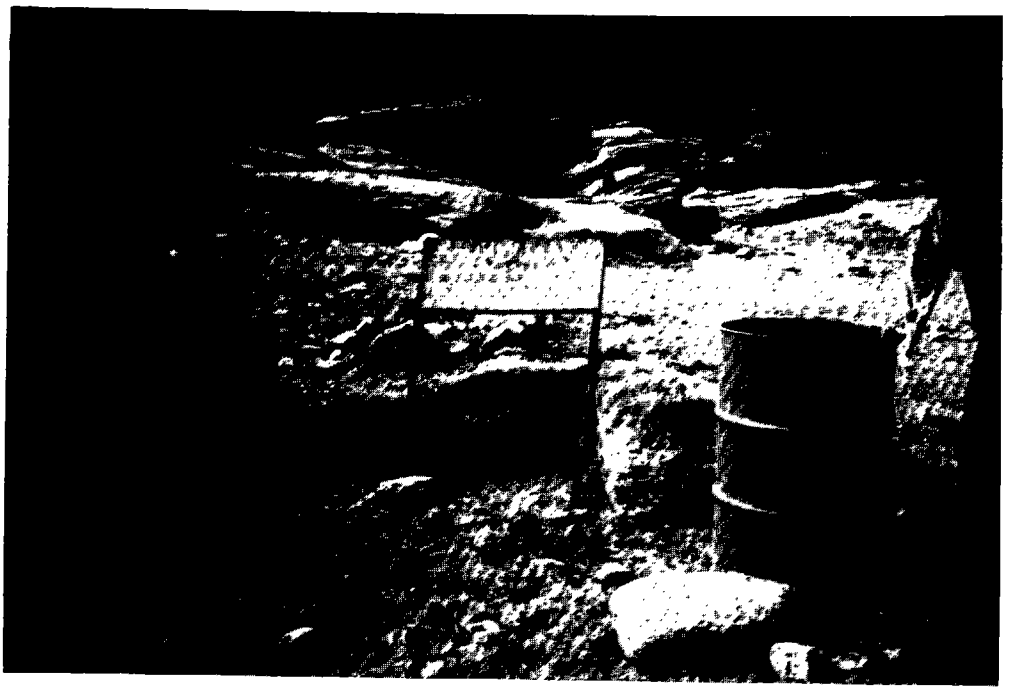
ii/ Absence of Sign posting

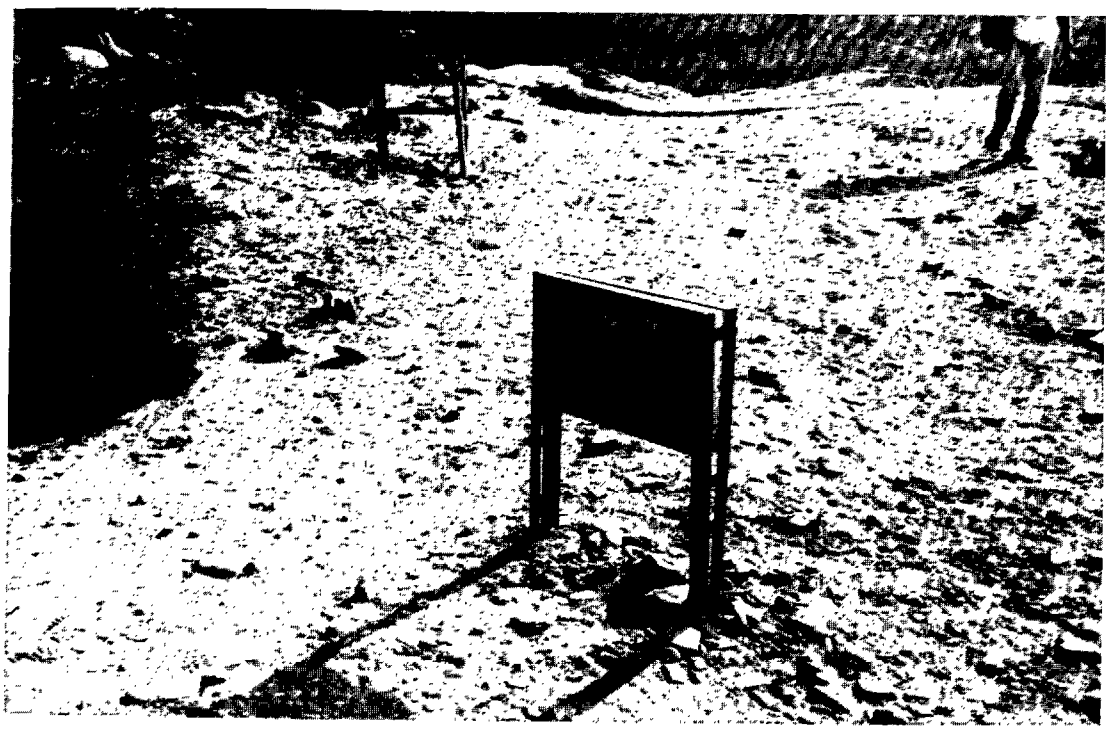
The almost total absence of sign posting makes the site difficult to "read" and understand. The design and manufacture of those information panels which do exist is of poor quality and lacks coherence. Qualified guides are few and far between, and in any case it is essential, for individual tourists as well as groups, to provide some information on the history of the tombs, temples, sanctuaries, theatre, etc.

In order to respect the harmony of the site, conventional signboards should be excluded. There is a need for a specially designed and well-coordinated signalization system, designed by a specialized graphic designer, for Petra.

iii/ Absence of Sanitary Facilities

Without any further comment, it is sufficient to follow any group of tourists, as was done during the mission, particularly groups of elderly people, in order to realize that the lack of sanitary facilities does not incite people to prolong the duration of their stay. The archaeological zone of Petra needs an adequate number of lavatories, discretely hidden from view, organized in specially planned spaces, with water supply systems and dispersion tanks. Further details are given in the management programmes.





Broken signposts. A new, global graphic design concept and "corporate image" is needed.
Lane

iv/ Harmful Effect of Uncontrolled Trade

The proliferation of disorganized trade and the disorganization of refreshment facilities along the itineraries are prejudicial to the aesthetic unity of the site. Other solutions must be found, without depriving the visitors of their purchases or the merchants of their livelihood.

Two or three "tea shops" inside some of the less important caves would make the visit more comfortable and facilitate contacts with the bedouins. Grouping of the shops in three main covered sales places could be envisaged as follows:

- Construction of a permanent "suq" at the entrance to the site (in place of the public lavatories which double those in the visitors' centre) selling guide books, films, postcards and national handicrafts, to replace the existing temporary structures;

- A souvenir shop at the end of the principal itinerary, in the restaurant building (in the small space actually reserved for, but too small for, a site museum). This shop would sell certified copies of archaeological objects in the museum's collections;

- In the centre of the site, just after the theatre, a group of shops inside the series of less important caves below the royal tombs.

v/ Disturbance Due to Pollution and Noise

The electricity generator behind the restaurant is particularly noisy and disturbing; its presence does not encourage the visitor to continue the visit as far as Al Deir. The generator could be buried underground. A better, long-term solution would be to provide an electricity supply line to the site.

Lastly, the clouds of dust raised by the horses are a nuisance for visitors, who are obliged to cover their faces. This dust is also tarnishing and damaging the walls of the Siq. The solutions foreseen for this problem, including transitional measures and long-term solutions, are outlined in para. 7.4.1, 7.4.2.

2.4.5. Under-exploitation of Cultural and Natural resources

Bearing in mind that the strategy of tourism development to be adopted for Petra should be to encourage visitors to stay longer than one day and one night, it will be necessary to:

- Intensify the attraction of the archaeological site,
- Diversify the products offered to tourists both outside the site and inside the park; (Horse, camel and donkey treks).

The various propositions set out below present the advantage of avoiding too great a concentration of visitors inside Petra, and thus to preserve the natural heritage of the region.

i/ Museums

It will be necessary to separate the existing collections of the museum, too small, into two themes, and enrich them with some objects lent by the National Museum at Amman: a monumental sculpture museum, and a museum of everyday life in Nabataean times. These projects are developed in more detail in the draft management programmes.

ii/ Nabataean gardens

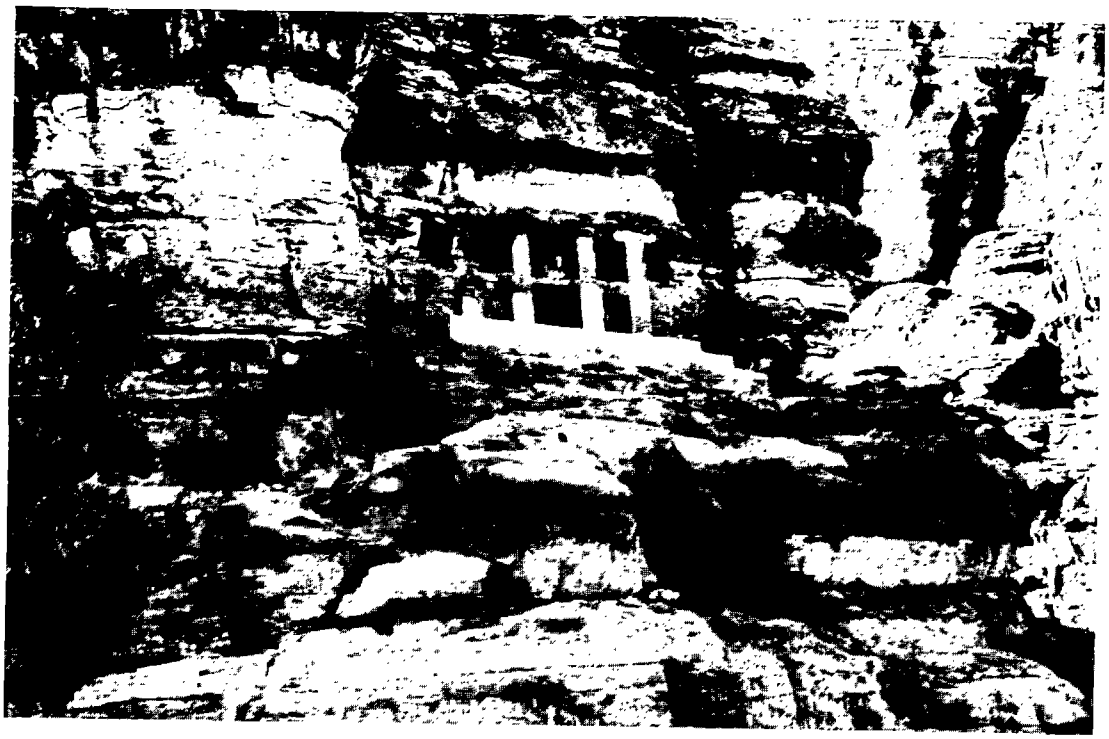
The irrigation and re-planting of Wadi Farasa would be one of the most important new attractions of Petra. It would occupy a central place in the Visitors' Centre, for the reason underlying all of the reflections of this report: the dyad water/desert can be exhibited life size, opening out like a vine leaf or an olive branch, following the image of the admirable frescoes of the painted cave at Beida; the distribution of water in order to transform these lands into an oasis of beauty, an art of equilibrium with the environment. The irrigation would also involve the replanting of the terraces and orchards as they must have appeared in antiquity. Wadi Mataha would also be the subject of an integrated restoration project of exemplary value for modern times, giving a striking example of the victory of harmony with a particularly difficult natural environment.

iii/ Presentation of Archaeological Digs

An archaeological site as important as Petra, still under excavation, should be able to propose to visitors, particularly schoolchildren, commentated visits to explain the progress of the digs, the stratigraphy, important finds, techniques of dating, conservation problems, etc. This type of visit could be a "cultural tourism product" which would be particularly appreciated by a small foreign clientele, and answer a real, if expressed, need for a deeper understanding of the site.

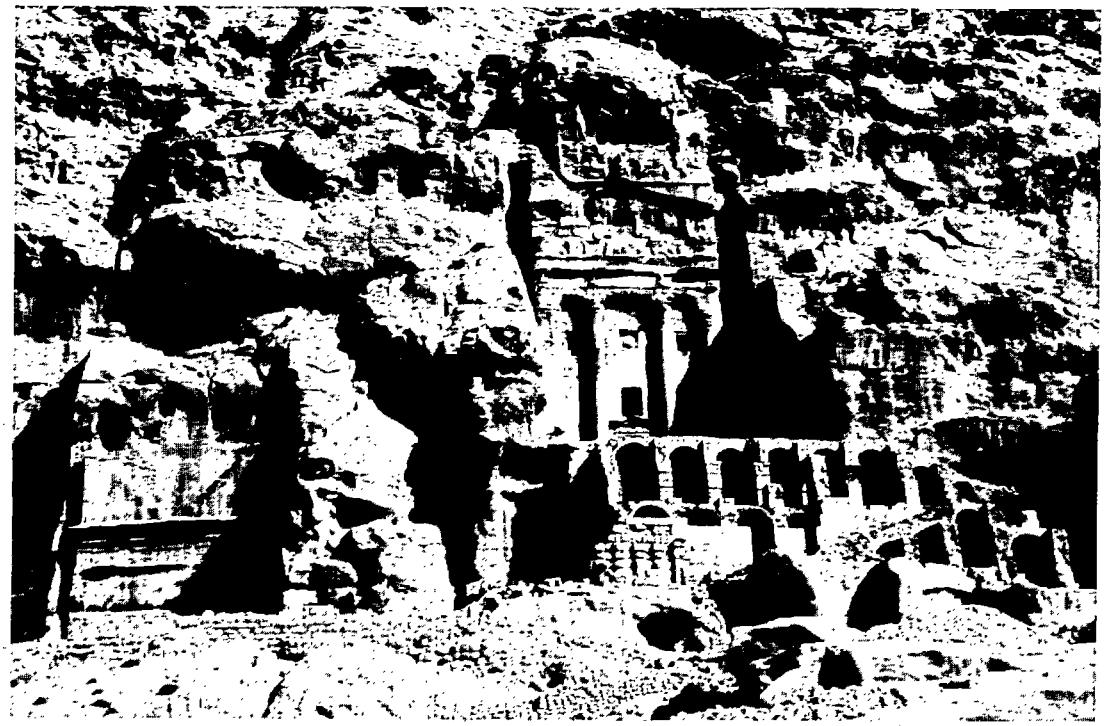
iv/ Beida

The presentation of the "Little Petra" is absolutely indispensable. Excavations should be carried out rapidly in order to uncover the partly visible remains of the paving of the Ṣiq. This site possesses an undeniable charm, and presents the economic advantage of becoming a destination for horse or camel rides: a "product" to be proposed for a second day's stay in Petra.



The small existing museum, situated in a Nabataean cave dwelling, is proposed as a museum of Nabataean life, and would contain small-scale domestic objects.
Lane

A fine example of monumental Hellenistic sculpture in the museum
Lane



The Palace Tomb. A noble setting for selected pieces of monumental stone sculpture
Lane

Rock-carved steps down from the High Place and the Lion Fountain with its hanging gardens and water channels.
Lane

The Garden Triclinium and Wadi Farasa, to be replanted. A small ethnographic museum is proposed in a set of caves in Wadi Farasa with the possibility of serving tea and home-made bread.
Lane

The visitor's first view of the Khazne. Note fine powder deposited on rocks.
Lane

v/ The Khazne

Here, the stage would be set for a recreation of the first "image of the nineteenth century travellers who rediscovered the monument. This image is that which is sold throughout Jordan through postcards and posters, and corresponds to a real desire for revery on the part of the new voyagers. The idea would be to give back to this sublime space its character at the time of its rediscovery, by recreating the landscape engraved by David Roberts.

2.4.6. Weakness of Information Policy

i/ The Visitors' Centre

The poor legibility of the antique city is a fact which must be remedied, as it leads to misinterpretation. The most important themes which should be explained in this centre in order to acquire a frame of reference for understanding the site, are:

The mountain mass of Petra: the history of its geological formation,
Successive periods of occupation,
The history and extent of the Nabataean empire and the history of the capital,
The principles of its ecological equilibrium,
The ancient city and its water supply network,
The characteristics of its monumental architecture,
The gods of the Nabataeans and ritual practices,
Itineraries for archaeological discovery,
Itineraries for discovery of the natural site (birds, plants, the rift valley, scenic routes).

The possibilities for hiring a guide, visiting an archaeological dig, reserving for a horse or camel trek, etc., will be indicated precisely. Reservations would be made at the tourism office's counter in the Visitors' Centre. The major themes would be developed in the form of relief models, maps, graphic panels and showcases housing selected objects from each historic period. The existing lecture theatre would be equipped with a permanent audiovisual show using multi-slide projectors to give a lively, panoramic presentation of the site in all its aspects.

ii/ Publications

A comprehensive individual guide book of a high standard needs to be developed, as well as a cheap fold-out map and guide with itineraries. In addition, video documentaries on the principal themes, proposing the various "products" offered by the Park should be available. These films could be broadcast by the internal video channels of hotels in Petra on the one hand, as well as being commercialized and sold, to adherents of the Petra National Trust, for example.

2.4.7. Absence of a National Strategy for Handicraft Production

It is regrettable that most of the articles sold in Jordan are not the products of a national handicraft industry, but are imported from Syria, Egypt, Yemen or Iraq.

Local handicrafts should be encouraged by the creation of pilot workshops. A feasibility study is needed, taking into account the possibilities of each tribal group. The Lyathne of Wadi Musa, for example, being fellahin, have traditional handicrafts which should be encouraged and developed. These include basket weaving, pottery making and ironwork. These can be supplemented by traditional foods such as dried figs, raisins and tomatoes, honey, olive oil, traditional medicinal plants and herbs. Other

traditional crafts which could be developed within the framework of an integrated development plan for the Park are:

i/ Rug weaving

A women's task which involves the preparation of the wool, dying, etc. Technical assistance will be needed to give ideas for the products, designs, sizes, colours, etc., and a place will be needed to display and sell them. Rugs and blankets should be small in size (not more than 2 m long). Cushions and bags are other possible products. Leather work could be another craft to be developed.

Rug weaving will probably not be a major handicraft project at Petra, however, as there are already several projects in Jordan promoting this feminine activity in regions where alternative economic activities are rare. Petra has its tourists, and it may not prove to be economically interesting to promote handicrafts which can be found elsewhere.

ii/ Stone and wood sculpture

Some bedouin have already made sculptures of the monuments of Petra in wood or stone. These usually suffer from being badly proportioned and rather crudely made. Accurate copies of high quality, perhaps molded in reconstructed stone, could be interesting to tourists as souvenirs.

iii/ Copies of archaeological objects

The extraordinary finesse of Nabataean pottery and its painted decorations makes it extremely attractive to visitors. a brisk trade, mostly organized by bedouin women and children, exists in pottery sheds and other unofficially excavated antiquities, as well as fakes of variable quality, often sold to gullible tourists as genuine antiquities.

A successful, but as yet small-scale project, financed by the Princess 'Alia Fund and directed by Mr. Jim Mason, has already been started for the production of pottery according to Nabataean techniques.

Copies of Nabataean lamps, moulded in plaster and given an artificial patina, and copies of ancient coins, are manufactured locally and sold by bedouin on site. Other possible products would be copies of the small clay Nabataean figurines.

There would certainly be a market for high-quality reproductions of some of the outstanding pieces from the museum: Nabataean bowls and dishes, *betels*, small moulded clay figurines, Hellenistic jewelry, casts of antique sculptured figures and base-reliefs, inscriptions, etc., which could be sold, suitably stamped and accompanied by a certificate, in the museum shop.

The clandestine excavation and sale of antiquities should be strictly forbidden on penalty of a heavy fine.

iv/ Sand bottles and Petra stone

The production of decorative sand bottles is already well developed by the bedouin, and is a great success with tourists, who can, for a little extra cost, have their names written in the bottle in sand. A negative side-effect is that stone is sometimes removed from the rocks inside Petra to prepare the multi-coloured sand, this activity has to be controlled and, eventually, a quarry set aside for the purpose.

A detailed study is needed in Wadi Musa and the surrounding villages in order to see how all these traditional activities can be encouraged and commercialized.

A suitable place to exhibit and sell such products would be the old suq which is now owned by the Municipality. The Petra National Trust has already carried out preliminary technical studies and has found a source of finance for its restoration.

v/ Food related crafts

As for the Bedouin (the 'Amarine and the Bdul), their main hand-made product at present are the sand bottles.

The same products cannot be expected from nomadic populations as from sedentary ones; the Fellahin of Wadi Musa have a long tradition of farming and village and sedentary life, with all the activities that accompany it, whereas the bedouin, *rouhhal*, nomads, are well known for their very reduced material culture. Their handicrafts will never be able to compete with those of the Lyathne, because they will not have been learned in a traditional way but acquired through training.

The bedouin, however, have other activities which we would like to present here as "handicrafts", for they require specialized knowledge and *savoir faire*, and can be commercialized. Their culture has many characteristics unique to this part of the world:

Firstly, the tea and the *Saj* and *Tabun* breads already mentioned. The bedouin know how to make tea (usually flavoured with Shi', or wild sage) and coffee (usually with cardamum), and how to welcome a passer-by into their tent and make him feel comfortable. These things are important activities, some of which already exist in Petra. What is needed is encouragement and help to improve the quality of the services.

vi/ Other tourism-related activities for the Bedouin

The bedouin, and particularly the Bdul, have always been guides and guards, as were their ancestors the 'Alaween. Their knowledge of the site is very accurate, and they can be its best guards and park rangers, on horseback and camel. Properly trained, they can enforce the regulations for the protection of the natural resources and flora and fauna of the Park. They can also guide the tourists in the park, and propose circuits of two or three days with tents for halts or, as mentioned above, in restored stone houses.

Their knowledge of the Park and their traditional character as *Ghaffirs* are the best services they can render to the tourists. Their knowledge of Petra and of the whole Park area and of its natural resources are important points for the promotion of tourism, as well as for the conservation of nature and of the monuments.

2.4.8. Lack of Knowledge of Visitors' Expectations

Above all, there is a lack of knowledge of the index of visitor satisfaction.

A regular survey carried out at Amman airport departure terminal is needed.

The management structure of the Park should include a "qualitician", who would check the quality of all the tourist and cultural services and ensure their conformity with the overall aim of quality and efficiency.

2.4.9. Training

Training is of course one of the key elements for the success of the project. International cooperation could be mobilized to this effect, but also bilateral cooperation (for example, an expert from the "Grande Traversée des Alpes", could carry out a mission to Petra in 1993 to develop and commercialize products for rambling, as well as horse, donkey and camel trekking).

Training for the guides, gardeners and maintenance workers, guards, park rangers and craftsmen is foreseen in the project budget. Training for the minibus drivers and car mechanics would be included in the purchase order for the vehicles.

2.4.10. Sources of finance

i/ Ticketing Policy

The entrance fee for the site is too little. To ask a tourist who has paid 50 JD for a room at the Petra Forum, or 20 JD at the Rest House, the pitiful sum of 1 JD is counterproductive, and a psychological error which leads to the devaluation of a World Heritage site. It is also illogical that at least some of the income from ticket sales is not channelled back into the site for its maintenance.

The price of the entrance ticket should be increased to 6 JD for tourists, 1 JD for Jordanian Nationals and be free for school groups. Tourists should be encouraged to join the Petra National Trust as active members. In exchange for a membership fee of 20 JD, they would receive a newsletter at six-monthly or yearly intervals, informing them of the latest actions and realizations. This would create an "after-sales service" particularly useful in the case of cultural tourism. (This form of tourism owes more to word-of-mouth recommendations than other more classical forms of promotion and publicity).

ii/ Income from tourism

One can start from the hypothesis that the volume of tourism will double in one year, reaching 1,000 foreign tourists per day over the next five years. (ef: increase in hotel capacity, promotional activities, etc.). This phenomenon, plus the increased resources generated by the re-evaluation of the entry ticket, should permit the purchase of 6 mini-buses (unit cost approx. $35,000) and the establishment of a mechanical workshop (cost approx. $35,000). The creation of the suq and the souvenir shop could be financed from the same resources.

3. EXISTING MANAGEMENT CONDITIONS

3.1. Environmental and Conservation context

i/ Institutional context

There is no coordinating mechanism, and little cooperation, between the different agencies involved with environment and conservation in Jordan. Therefore, there is a loss of efficiency and a wastage of national expertise available in the country. As a result, many decisions are overlapping or contradictory. The land tenure situation is perhaps the most serious problem to face, as many environmental problems stem from it.

ii/ Maintenance of archaeological remains

The DOA is handicapped in its efforts to preserve the archaeological heritage by a lack of trained conservators. International institutions assist the GOJ through many projects of new excavations and explorations, but **quite a few assist in the maintenance of the existing archaeological sites.** The load of the DOA is therefore heavier, year after year, and as a result the national cultural heritage gets degraded. As tourism is relying on Antiquities in Jordan, this steady depreciation could have economic consequences in the long term.

Ongoing archaeological missions at Petra in 1992 included:

. American Expedition led by Prof. Ph. Hammond, of Utah University (Winged Lion Temple),
. ACOR (Byzantine church site),
. Florence University team led by Dr. Guido Vannini (excavations at Wu'eira Castle),
. Nurenberg University (Urn Tomb and Shaft Tombs).

In some cases, excavations accelerate the process of the degradation of the antiquities remains. For example, at Petra the Winged Lion Temple, excavated since 1974, shows salt efflorescence and crumbling and spalling, due to erosion of the superficial sandstone layers of the walls and columns. Deposits of silt around the site constitute new deflation areas for the wind and an unsympathetic visual impact.

Existing conservation staff employed by the Department of Antiquities is limited to two coin restorers and one ceramics conservator. A school of mosaic conservation, to be financed by Italy and USAID, is planned at Madaba, with programmes of training on-site and at Ravenna.

There are no painting restorers at present, although the mission was informed that two German specialists in painting restoration had been sent to Yarmouk university for two years. GTZ has signed an agreement with the GOJ to reinforce the stone conservation laboratory at Yarmouk University and carry out a limited amount of practical conservation work, possibly at the palace Tomb and one or two other monuments at Petra.

iii/ Forestry

The local Forestry Service (Subdivision of Agriculture and Research in Shaubak), experiences land tenure problems which greatly hamper its efficiency. Therefore, major foreseen forestry programmes are reduced to planting rows of trees along roads. Poorly staffed in Wadi-Musa area (7 guards

+ 1 chief warden), this Service has difficulties in carrying out law enforcement within the area included in the proposed Park.

However, the Forestry Service has carried out an important re-afforestation programme of the Wadi Musa left side upper catchment. Even if the rate of success is very low (provenance of trees appear not suitable to the local ecological conditions, nursery problems,...), many banks on contour lines have been built, reducing the erosion process in this area, with a probable positive impact on the archaeological site.

A UNDP/FAO funded Project aims at strengthening Forest & Range Management in the country. It has started by the training of national skills of the DOAF staff (Management Plan, Working Plan). Field activities are foreseen in every District. In Ma'an & Shaubak Districts, the Project aims at carrying out reconnaissance and survey of rangelands, at preparing a range management plan and at establishing pilot areas involving semi-nomadic livestock rearers willing and able to participate (UNDP/FAO, 1992).

3.2. LEGISLATION IN JORDAN

The existing Antiquities Law (n°21, 1988) is strong enough for the protection of the archaeological remains, but owing to lack of funds, law enforcement is very weak, even in a world famous site like Petra. Moreover, this law is inadequate for the preservation of the surroundings of the antiquities, and EIA studies are rarely carried out.This explains the unattractive settings which can be seen in the vicinity of Petra (rest house, electrical power line,...), and that new constructions projects are still going on. Furthermore, there is no special law governing land use to protect archaeological sites.

3.2.1. Antiquities

The Organization of Natural Affairs Law (n°12, 1968 - as revised -) stipulates (art. 33), that no exploration permit, prospecting license or mining right can occur without the prior approval of the concerned authorities, in Antiquity sites and Forest areas (amongst others). The Department of Antiquities is responsible for administering, supervising, protecting and maintaining antiquities in Jordan.

3.2.2. Natural environment

The MOA is responsible for developing and protecting Jordan's forest resources and rangelands (Agricultural Law, n° 20, 1973). The law prohibits encroachment on Government Forest Lands, as well as cutting trees and burning. Unfortunately, grazing regulations in forest are non existent in this law. The Agricultural Law is weak regarding grazing lands, especially the implementation of suitable land use regulations and the lack of suitable punishments for violations (DOE, 1991).

As regard to wildlife species, Jordanian legislation is restricted to laws protecting birds and game animals in forests (DOE, 1991).

The DOA focuses its preservation efforts on monuments, excavations, restoration and museum collection. There is, until now, no consideration of the natural environment of the archaeological remains.

3.3. ADMINISTRATIVE STRUCTURE

Under the present situation, conservation is restricted to the monuments of Petra. Until now, no action has been taken to preserve the natural habitats, in and around Petra.

3.3.1. Antiquities staff on site

i/ senior staff

The director of Petra site is an Inspector of Antiquities. Under his responsibility is not only Petra, but the whole region from Wadi-Musa, Petra, Shaubak, Ma'an, to the border with Saudi Arabia (40% of Jordan !).

The Inspector is assisted by 2 assistants (archaeologists), one working at the Museum (Petra Central City Area).

ii/ junior & other staff

- 2 technical workers, trained on the spot
- 6 employees, working at entrances:
  * 2 selling tickets
  * 2 inspectors for tickets
  * 2 patrolling guards (on foot)
  * 2 drivers
  * 4 cleaners (1 for buildings, 3 for site incl. Siq).

iii/ temporary staff

Restoration, excavations:

In 1991, the Antiquities employed the following labourers, including stone-masons, on a part-time basis to assist in excavation and restoration work:

10 workmen for 6 months for Qasr al-Bint restoration.
12 workmen for 6 months for Palace Tomb restoration.

3.3.2. Tourism staff on site

i/ senior staff

The Director and Deputy-Director of Tourism for the region have their offices in the Visitors' Centre.

ii/ junior staff

3 part-time cashiers/accountants, working in rotation, sit behind the information desk.
There are no secretaries; all correspondence is hand-written.
2 staff, working in shifts, allocate horses to tourists at entrance to site.

iii/ maintenance

1 cleaner cleans the lavatories and inside the visitors' centre.
2 sweepers to clean outside visitors' centre, parking area, shopping area.

iv/ guides

23 authorized guides, licensed by the Department of Tourism, are independent, and remunerated directly by the visitors. Some have been working for the last thirty years as guides. All are English-speaking, while two speak English and Italian. None speaks French or German. The Ministry of Tourism and Antiquities has instituted training courses for guides at the Universities of Jordan and Yarmouk.

v/ Tourist police

4 or 5 tourist police from the Department of Public Security, working in shifts of 2 at a time, man the small station in Wadi Musa. All have received specialized training, and have passed the British Council examination in English. Their main duties are to look after the security of tourists, receive complaints and organize rescue work.

- Search and Rescue work is carried out by local bedouin tribes.
- 2 guards, working in shifts, to guard the visitors' centre.

3.4. BUILDINGS AND EQUIPMENT

3.4.1. Antiquities buildings and equipment

A small site museum is located in a Nabataean cave carved into the face of al-Habis, overlooking Qasr al-Bint. It consists of a central space with an alcove at each end. Three adjoining caves are used for reserves.

The Antiquities staff on site have their offices in the restaurant building, which is managed by the Department of Social Security. The following spaces are allocated to the Department of Antiquities:

- 2 offices (1 for the Inspector, 1 for the 2 assistants)
- 4 storerooms + 2 inside the museum
- 1 documentation centre (slide collection, ...)
- A small space for temporary exhibitions

The Nazal Camp houses visiting archaeological missions (principally ACOR). It contains workshops, laboratories a dining room and an open-air forecourt where fragments of pottery are stored and pieced together, on the ground floor, and dormitories on the upper floor.

The Antiquities staff are housed in Wadi Musa, in private houses.
The Department also has several furnished caves, some with cooking and sanitary facilities, for accommodating visiting archaeologists.

The equipment is composed of:

2 cars
1 truck
wooden scaffolding.

Vehicles are repaired in Wadi Musa, sometimes in Amman. There is no fax, no photocopy machine, no telephone, no radio-communication system (e.g. walkie-talkie), no computer, no maps, no aerial photographs.

3.4.2. Tourism buildings and equipment

The Visitors' Centre, built in 1969 of reinforced concrete, clad in cut stone, has a ground floor and semi-basement. The ground floor, rebuilt in 1989, accommodates a large exhibition space, lecture hall, the offices of the Tourism staff, a branch bank, and public lavatories.

The lower floor, the same area as the ground floor, is empty and largely unused, apart from a branch post office/telephone exchange opening to the lower street level.

The exhibition space is completely empty, except for an aerial photograph of the park. The Director's office is equipped with a telephone. The lecture room is furnished with chairs and one table, but has no audio-visual equipment.

The restaurant in the visitors' building opposite the museum and Qasr al-Bint, is run by the Forum Hotel.

Tourist Police are located in a small police station in Wadi Musa. They are equipped with walkie-talkie sets and a telephone.

3.5. FINANCIAL PROCEDURES

With the present financial procedures, there is little chance that income from tourism can flow into the conservation budget, specially the public agency like the Department of Antiquities (DOE, 1991). A new law would be necessary to allow the proposed PANP its financial autonomy.

Private agencies such as the Petra National Trust, the Higher Council for Research and Technology, and the Royal Society for the Conservation of Nature, are fortunately excellent opportunities to assist the PANP/DOA, in implementing several management programmes.

4. ENVIRONMENTAL IMPACTS OF EXISTING ACTIVITIES

4.1. THE AGENTS OF EROSION

4.1.1. Tectonics

The sandstone massif of Petra is cut into by many very narrow corridors (gorges, canyons), whose directions correspond to the grid of fractures and fault lines (N-S, NW-SE, NE-SW) which cross it. In the centre of the Massif, a vast depression running north-south, corresponding to a zone of collapse delimitated by major fault lines, was the site of the ancient (built) city, now almost completely buried.

The sandstones of Petra, above all the Cambrian, form a ruined landscape resulting from the opening up of fracture lines (diaclases and faults), combined with the exposure of structural planes (stratified rocks). The Siq, like the other gorges, corresponds to the fluviatile and eolian erosion of a network of fissures and diaclases cutting into the massif.

The retreat of the walls of these gorges by the detachment of plates can be attributed partly to decompression, but is more often due to the opening up of fissures by run-off and of the very tight network of fractures, parallel to each other and to the gorge, by the wind. Since it is these walls of these same gorges which contain the rock-carved monuments, it is easy to imagine the consequences.

Lithology

From a purely lithographic point of view, the Cambrian sandstone of Petra is a sedimentary rock with a fine grain (0.25mm) and fairly porous (10 to 20% of volume). The granular skeleton, formed almost exclusively of monocrystalline quartz, dominates the cement, which is made up of:

microcrystalline carbonate
streaked clayey material
ferrous matter
secondary silicious cement

The crusts, so characteristic of the stone pathology at Petra, are around 1mm in thickness. The mineralogical analysis of a sample from the façade of al Deir indicates a considerable increase in ferric substances and above all in calcite (up to 4% of the weight), but also in salts.

Compared with the "healthy" rock, the surface of the weathered rock, and above all, the crust, is noticeably richer in calcite and ferric substances, whereas, in the healthy rock, calcite is practically absent. This phenomenon is due to the "washing out" action of water rising by capillary action, which results in the re-crystallization of the carbonates and salts after the evaporation of water from the surface. The friable crust thus formed falls away in scales from the weathered façades, gradually effacing the architectural details.

The washing out of the rock through capillary action (erosion *"per ascensum"*) is visible on the rock-carved façades in the form of a systematic weathering of the surface at the base of the monuments, the upper limit of the altered zone sloping downwards towards the door openings, corresponding to the increase in evaporation at that point due to the greater surface area. The pumping action is increased by the heating up of the rock by the sun and by the dryness of the air. From the point of view of the structure of the rock, the finer the capillaries, the stronger the ascension.

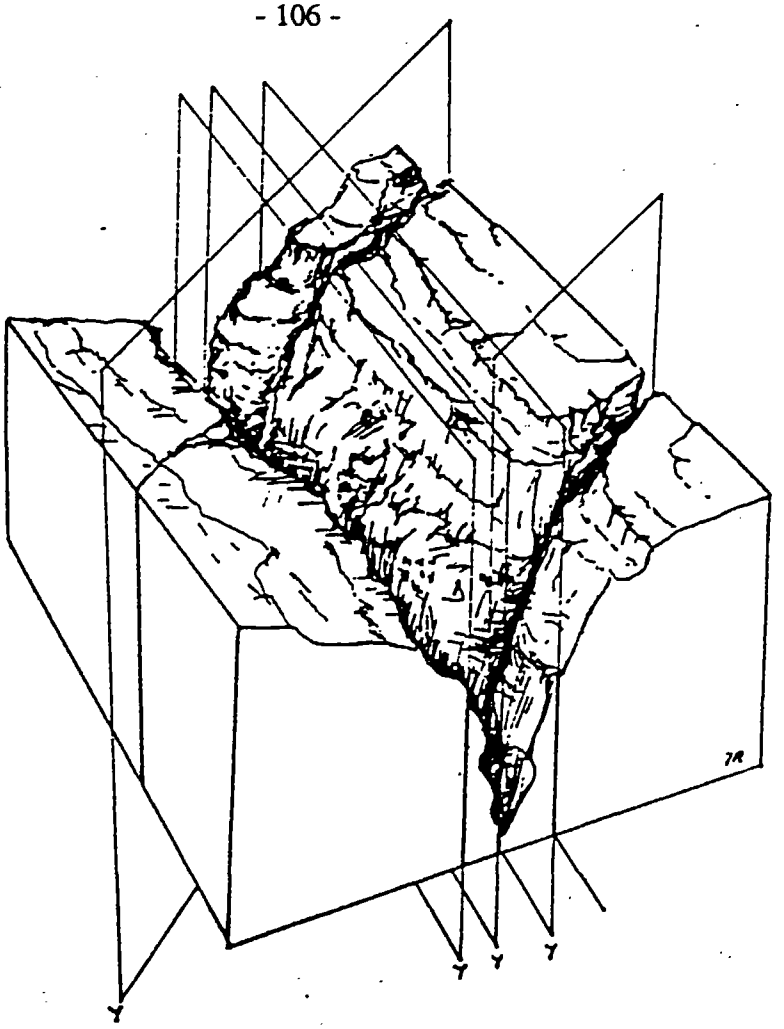


Fig. 27

The Siq and tectonics.

Rewerski

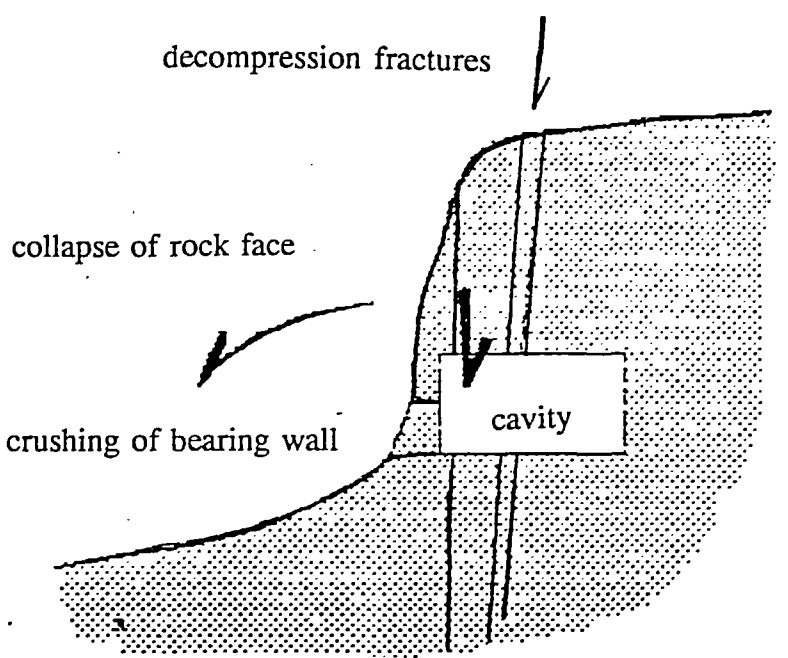


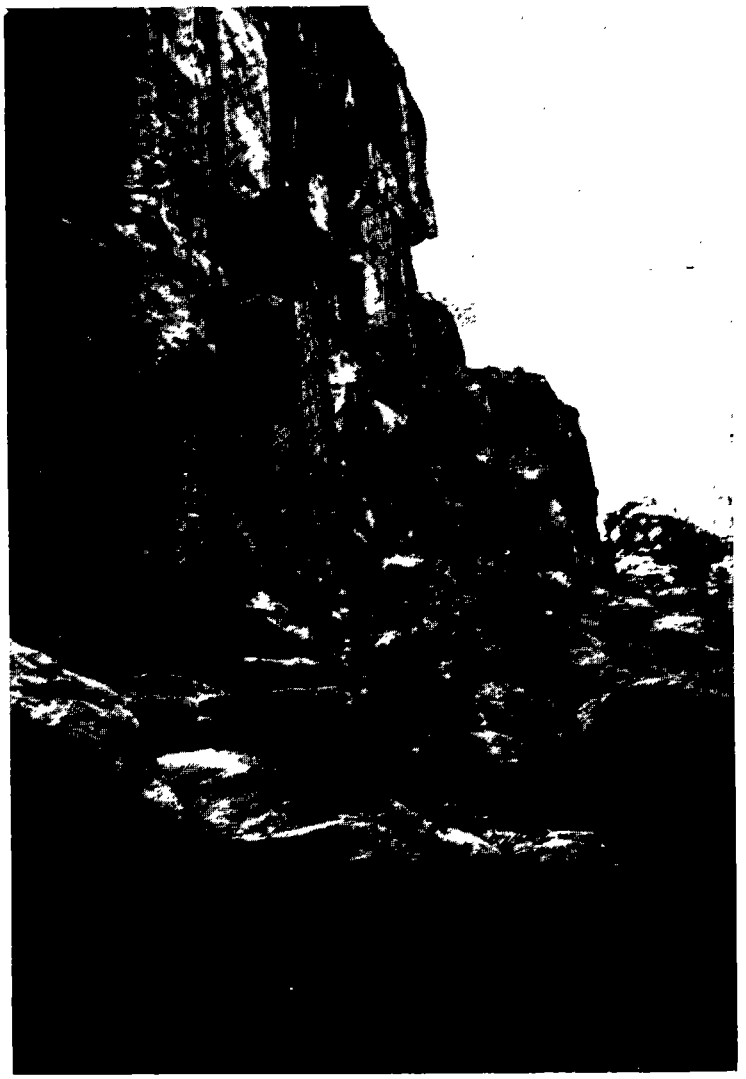
Fig. 28

Retreat of the rock face by splitting away of plates (diaclases and fault lines).

Rewerski

The troglodític quarters exploit the structural banks which result from the exposure by differential erosion of the structural planes. (Centre of Petra).

Rewerski



Fracturing of the Massif. The opening of diaclases gives birth to 'corridors' such as the Siq. Very tight fracturation causes the detachment of lamina of sandstone.

Rewerski

Damage to rock-carved monument crushed by the collapse of a slab of rock
Lane

Fissures in the ceiling and walls of the Khazne corresponding to fracture lines may still be active, and should be monitored.
Lane

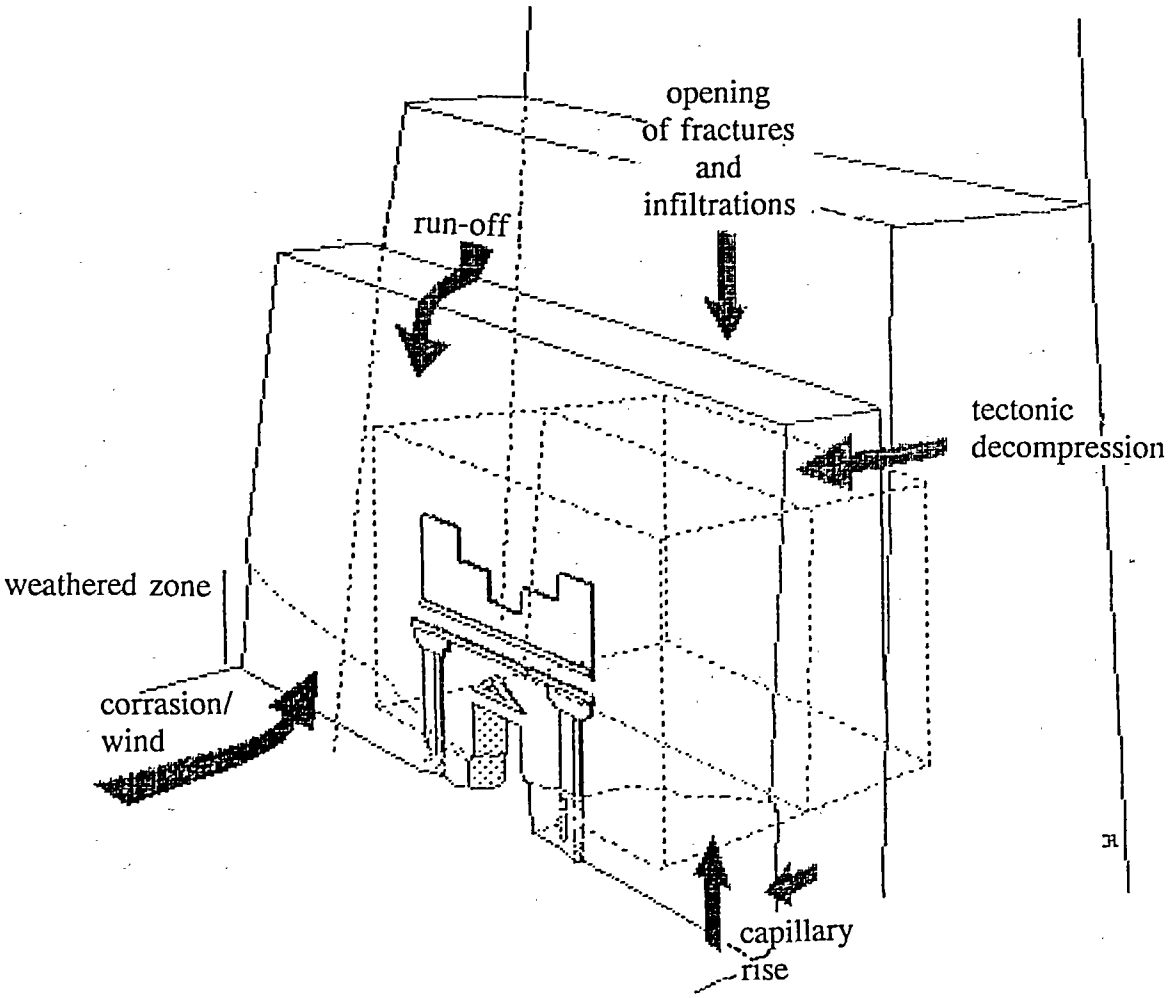


Fig. 29

The principal agents of aggression on a rupestral monument
Rewerski

4.1.2. The Wind

Eolian erosion is very important but not primordial. The monuments exposed to the winds (west) can present a pronounced corrosion (erosion due to the action of wind-blown sand). This is most striking in the case of the white (Ordovician) sandstones, where wind erosion has produced the characteristic domed shapes known as "whales' backs". The importance of the corrosion depends on the intensity of the wind, but above all on its permanence. The wind exercising its greatest thrust close to the ground, its corrosive action is most critical on the lower parts of the monuments (1 to 2 metres), all the more so because there it comes into contact with the sand, the principal agent of abrasion. The systematic destruction of the base of the monuments is not, however, caused mainly by corrosion, but by water rising by capillary action. This renders the rock fragile and facilitates the work of the wind.

It should be noted that every wind is not necessarily a sandstorm, for which a critical velocity of 6 to 8 m/s is needed. In order to quantify the problem, it will be necessary to take regular measurements of wind speeds.

4.1.3. Water

i/ Flood damage

The climate and oragraphy give rise to a catastrophic type of water system. Long periods of drought follow violent downpours and torrential floods that the steep slopes make even more overwhelming and destructive. The water is unable to infiltrate the bare surfaces and it is quickly carried downstream, taking sediments with it and preventing the stabilization of the soils and the formation of humus.

The spring storms are the most dangerous for the Petra monuments and their visitors. In April 1963, the rain that poured down into the basin amounting to a million cubic metres, caused the death of 24 tourists. A subsequent flood washed away all the control instruments, with the result that no estimate of water shed was available.

The most dangerous of the wadis is the Wadi Musa torrent. Aware of its fury, the Nabataeans diverted the flood through a long tunnel, carved out of the rock. This diversion channel, Wadi Mudhlim, was controlled by a dam, now broken, but which can easily be repaired. A huge stone retaining wall at the mouth of Sadd al-Ma'jan, badly damaged by the violence of the floods, risks total collapse if it is not protected by gabions.

The tributary Wadi Mutaha, which flows into the city centre, was also dammed in several places. The flood of 1991 caused the destruction of bridges and gabions, and reached Qasr al-Bint. The huge cost of repair of the infrastructure of the site was born by the Government. it would certainly be wiser and less expensive to repair as many as possible of the ancient dams built in the valleys by the Nabataeans and the Romans.

EDF and SPOT (Système probatoire d'observation de la terre) images have proposed a joint project to prepare, using satellite imagery, a three-dimensional survey of the catchment area which will serve as the basis for a flood protection project. It is vitally important that these proposals be integrated in a global study taking into account the possibility of repairing and re-using the ancient hydrological system.

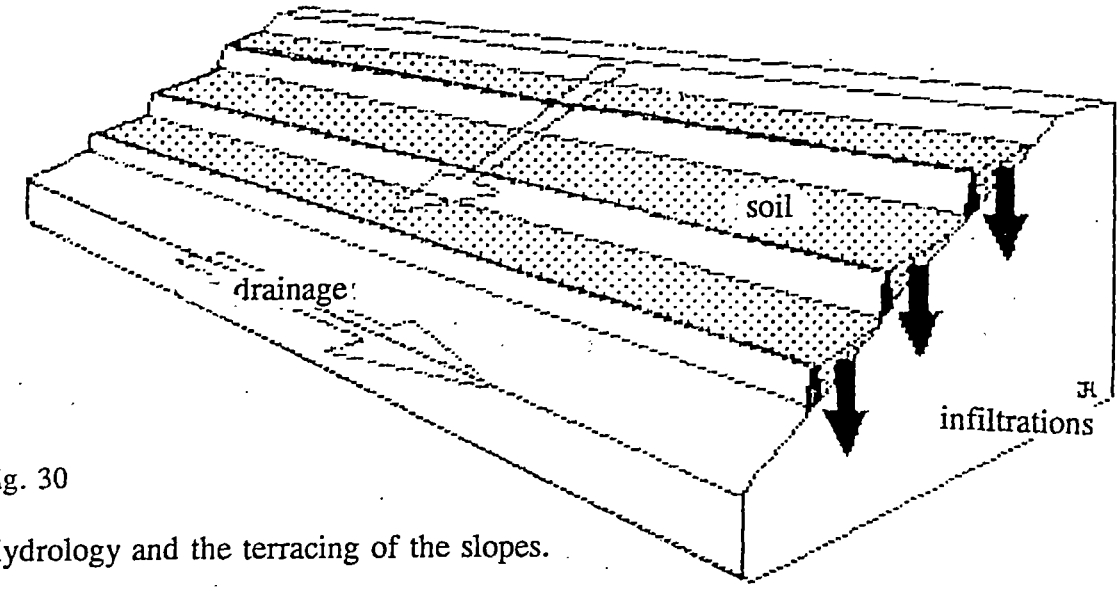


Fig. 30

Hydrology and the terracing of the slopes.

Rewerski

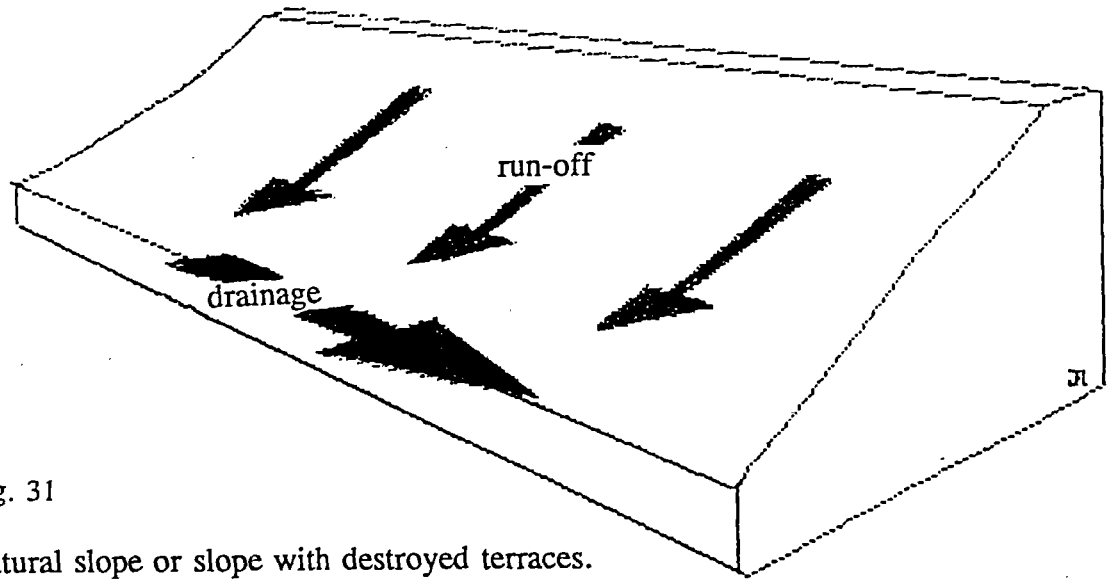


Fig. 31

Natural slope or slope with destroyed terraces.

Rewerski

Gullying

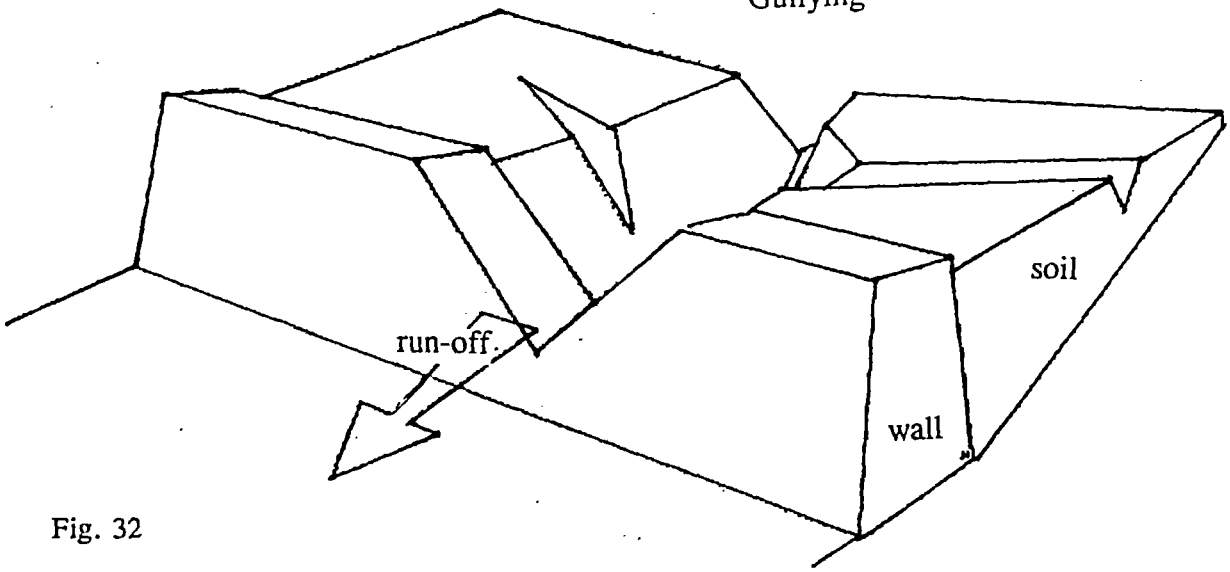


Fig. 32

Gullying of the terraces following the destruction of a retaining wall.

Rewerski

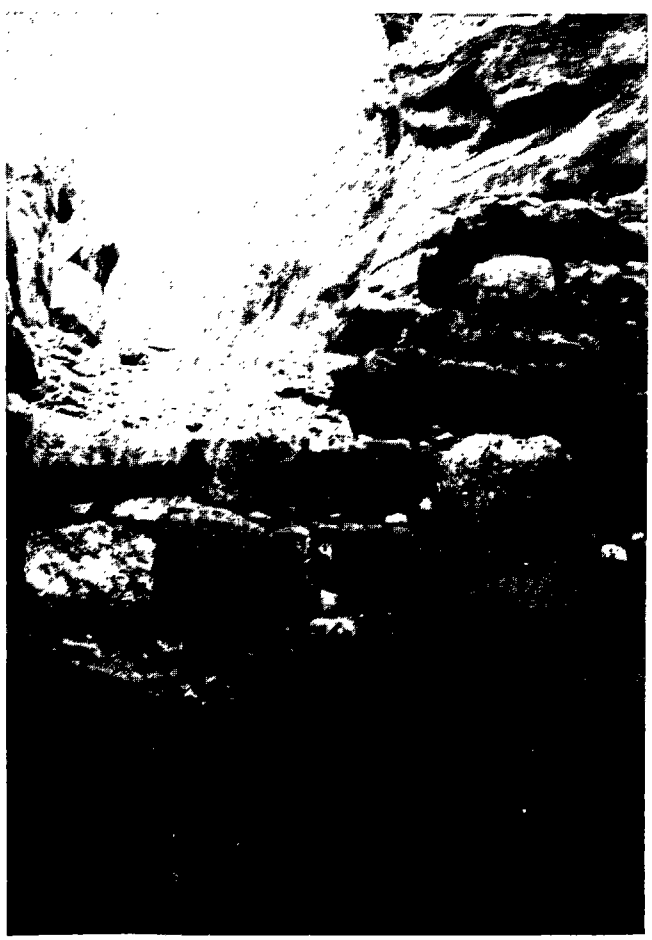
The impending collapse of the retaining wall in front of the Soldier Tomb in Wadi Farasa could lead to the furrowing and disappearance of the terrace, rendering access to the tomb and Garden Triclinium difficult.

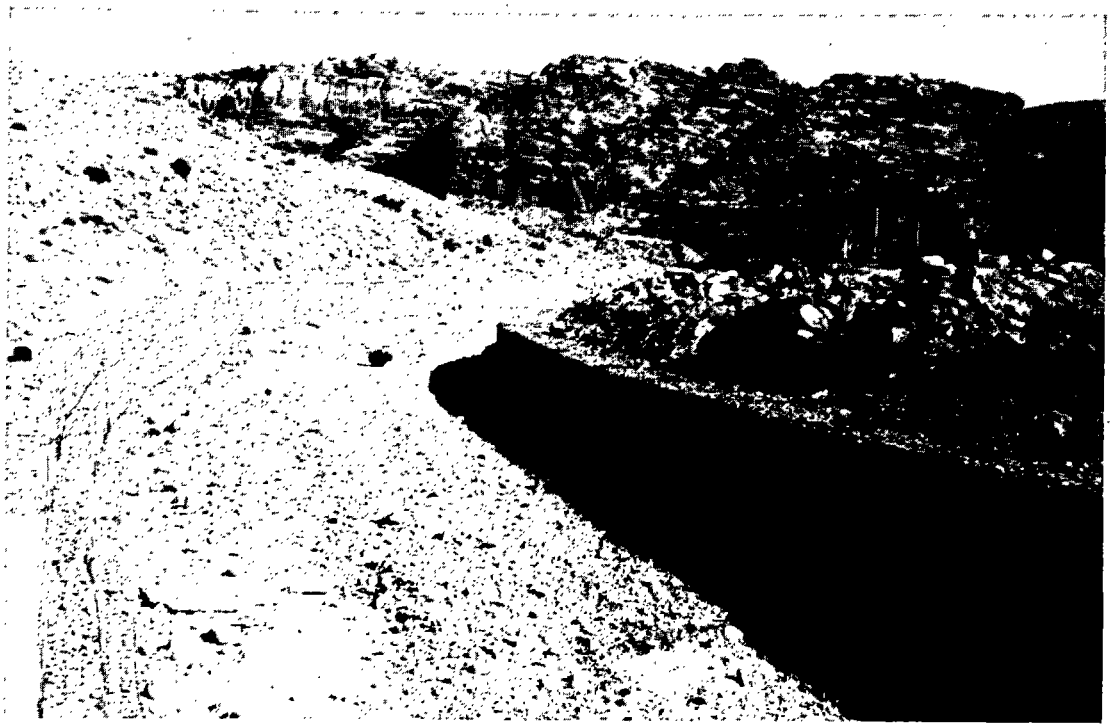
Rewerski

The gullying of a terrace in Wadi Ghurab is the result of the recent collapse of a retaining wall.

Rewerski

Nabataean retaining wall and dam in Wadi Mataha damaged by floods and in need of repair
Zayadine





Flood prevention works in front of the Nabataean diverting tunnel at the Siq entrance and beside the Cardo. *Lane*

On Wadi Turkmaniya, the Bdul rebuilt a dam and used the water for irrigation. It is maintained by them, although they will need Government assistance in the future in order to help them continue to repair this ancient dam, which also helps protect the historic city centre of Petra from the torrent.

Tens of wadis require an overall programme of water control. The water can be re-used for the creation of new replanting and afforestation programmes which will halt soil erosion and help the bedouin develop agricultural and agro-tourism activities.

Although Petra is situated in a semi-desertic region, water plays an important role in the erosion of the monuments. This is borne out by the damage suffered by many monuments at their base, but also by weathering due to run-off, alveolus related to stratification, and the widespread presence of tafoni.

ii/ Rainwater run-off

One of the main causes of deterioration of the rock-cut monuments is rainwater run-off. The damage is particularly severe in places where the Nabataean drains and gutters, which used to protect the façades, have been destroyed. The action of rainwater run-off is plainly visible on the carved walls, where architectural detail has been destroyed below the "funnels" concentrating the run-off in natural drains formed by the opening of fracture and fault lines and the erosion of cornices, drips and drainage channels.

iii/ Capillary action

At the base of the monuments, the rise of water by capillary action provokes powdering or spalling, resulting in severe weathering of the base of the façades; weathering "*per ascensum*". The transition to the healthy part of the façade takes place along a line roughly parallel to the ground. The presence of an opening (door) creates a zone of more intense evaporation, which systematically lowers the level of the weathered zone (natural drainage). This represents one of the principal types of weathering observed in the monuments of Petra.

iv/ Tafonis

Tafonis result from an intense and selective chemical erosion caused by an internal circulation of water inside the rock and a localized dissolution of the cement. The granular disintegration activated by the wind gives rise to niches topped by overhangs cemented by oxides following surface run-off. The tafoni develop naturally in the sandstones of the massif of Petra, but they also affect the rock-cut façades, starting in the sheltered parts such as the underside of cornices (e.g. Al Deir). Both alveolus and tafoni are still active in Petra.

The presence of humidity in the rock is confirmed by measurements taken during a previous mission in 1989 in the "Painted Tomb". This small decorated tomb, orientated towards the south, is situated towards the entrance of the "Western Siq". Very slight variations in temperature between day and night were registered (max. 23°C, minimum 21°C). On the other hand, variations in humidity were very important: the maximum of 65% corresponds to the minimum (night time) temperature, while the minimum r.h. reaches little more than 40% during the day.

v/ Saturation

In some cases, water infiltrating through natural faults in the rock carries with it clay materials, which in time result in joints opening following the expansion of clay by saturation.

Saturation of the rock can also cause the thin beds of silty shale in the sandstone to swell, resulting in blocks of stone becoming detached and sliding along these beds, particularly in cases where the thin beds of shale coincide with the joints. Examples may be seen at the Palace Tomb and near the theatre.

4.1.4. Other Agents...

i/ Thermal shock

Mechanical disaggregation due to thermal shock is not *a priori* a major factor, but cannot nevertheless be totally neglected, above all in a grainy, striped rock, and in a region with marked variations in temperature. The stress resulting from the differential expansion of the various minerals and grains can bring about the fatigue of the rock and its progressive disintegration.

ii/ Efflorescence

Efflorescence plays an important role owing to the natural salinity of the Petra sandstone, and probably to some extent through salts carried by the wind from the Dead Sea. This major problem is directly related to the action of water, and particularly to weathering "*par ascensum*".

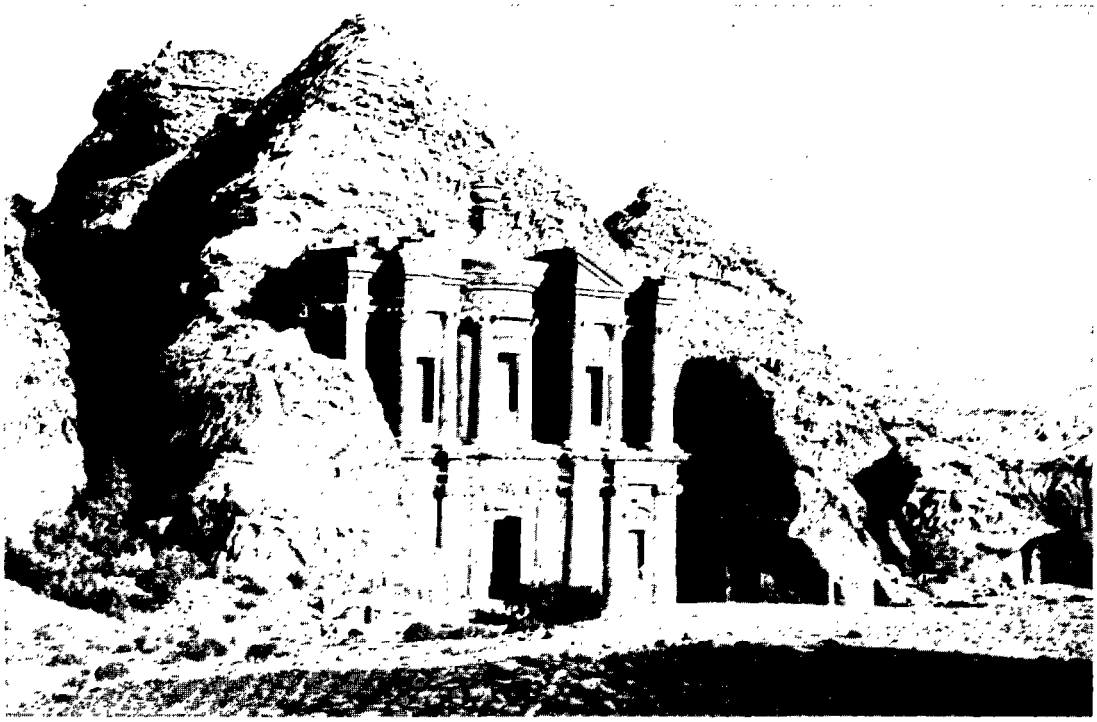
A Nabataean protective coating ?

Research by Dr. Jaser of the Ministry of Energy and Mineral Resources indicates that the Nabataeans may have protected the façades of the rock-monuments with a protective lime-wash. The action of rainwater on the façades would have reacted with the plastered material, forming a sulphate compound which attacked the cementing material of the sandstone and destroyed the architectural detail.

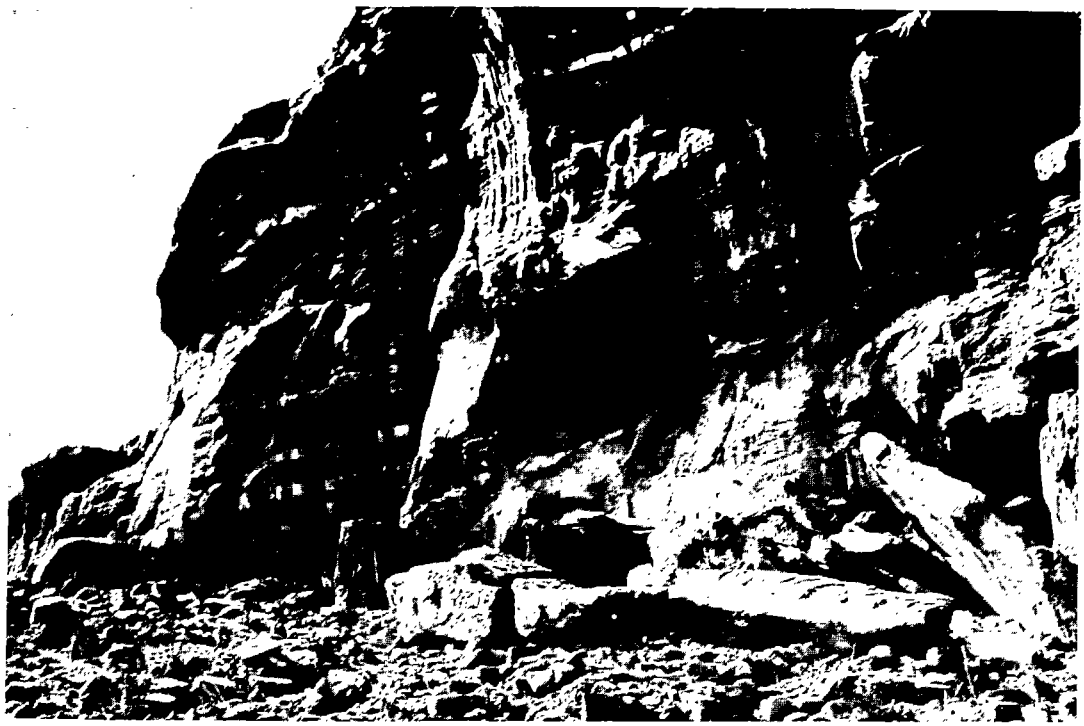
iii/ Plants

The presence of water has facilitated the growth of plants on the façades, in fissures and in rainwater channels, causing destruction of the sculptured detail and sometimes widening fissures. Examples are the façade of the Corinthian Tomb, and the Khazne, where shrubs and trees are growing in the natural fissures in the rock above the monument.

Al Deir. Rainwater channels and gutters also served to protect the stone façades against erosion due to runoff
Lane



Al Deir. Scarcity of ground cover due to trampling and grazing increases the problem of erosion. Destruction of architectural detail caused by rainwater runoff where the cornice has been worn away. *Lane*



The collapse of the cliff face is facilitated by the cavities at the base of the cliff.

Rewerski

The Urn Tomb, or 'Cathedral'. Severe weathering 'per ascensum', with characteristic dipping down of the weathered section towards the door. Weathering by run-off and alveolisation of the upper part of the facade.

Rewerski

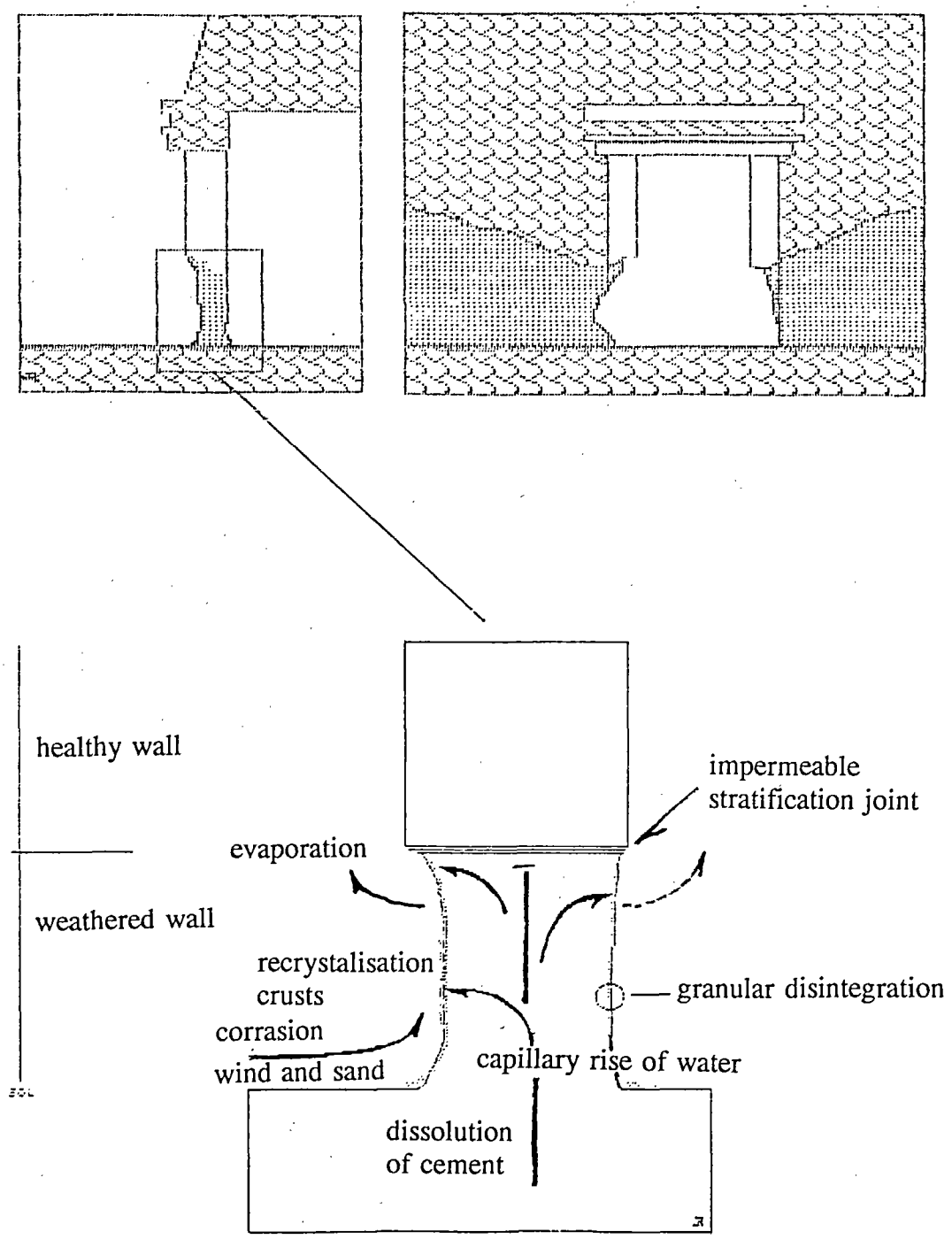


Fig. 33

Weathering "per ascensum" is sometimes blocked by impermeable stratification joints

Rewerski

Total destruction of the architectural details at the base of the Palace Tomb due to the capillary circulation of water through the rock. Erosion 'per ascensum'.

Detail of weathering at the entrance to the Palace Tomb.

Rewerski

The colours of the Petra sandstones are the result of the coloration of oxides contained in the rock due to the capillary circulation of water. It is therefore a visible symptom of the stone sickness which is eating away the monuments of Petra. *Rewerski*

Rewerski

A tomb in the white Ordivician limestone at the entrance to siq al Barid, Beida. Note the weathering due to the capillary action of water at the base of the monument.

Detail of weathering 'per ascensum' of previous photograph.

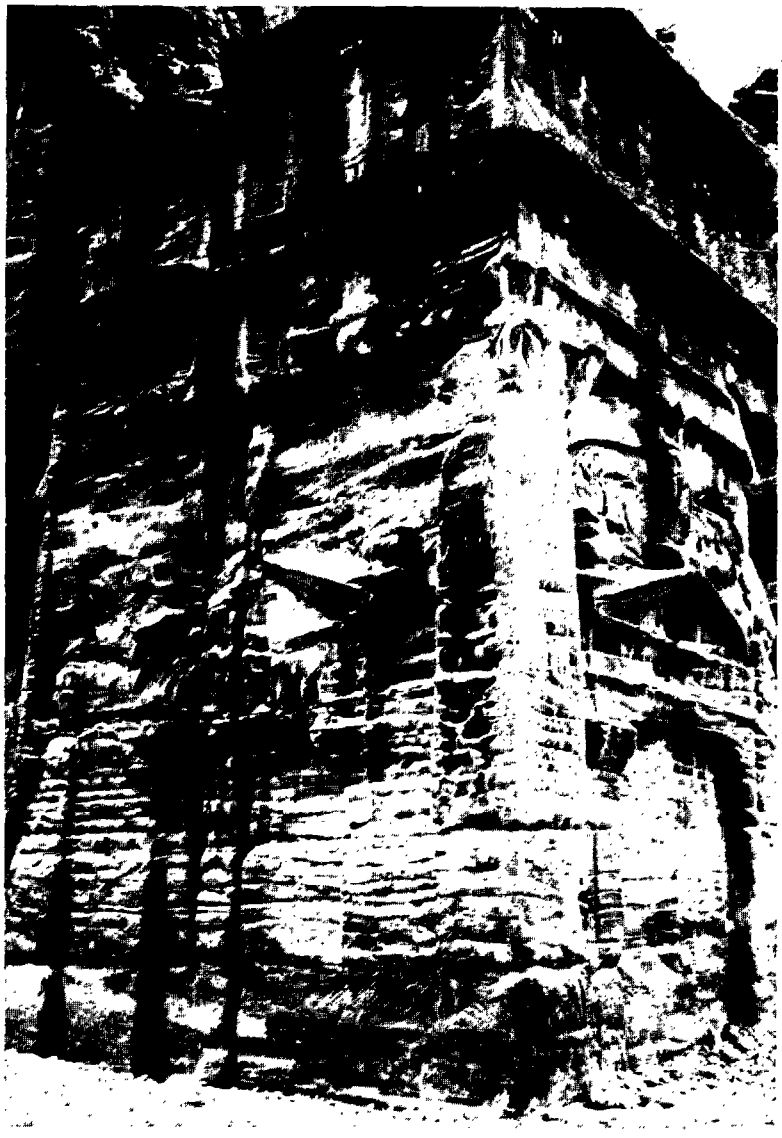
Rewerski

Example of weathering blocked by an impermeable stratification joint.

Rewerski

The 'Renaissance Tomb', in Wadi Farasa. Note the formation of a Tafoni below the urnm the vertical traces of run-off on the facade directly below the destroyed portions of the cornice, and the weathering at the base of the monument.

Rewerski



Obliteration by erosion of the architectural details of a rock-carved monument (Brünnow Tomb). Note the enlargement of the diaclase, the alveoles exploiting the stratification, and the start of the formation of tafoni below the cornice.

Rewerski

The alveoles in the dressed stone of the facade of the Khazne indicate that the tafonisation and formation of alveoles are active in the present climatic conditions, and that the phenomenon is evolving rapidly.

Rewerski

4.2. TOURISM

4.2.1. Uncontrolled Circulation

Although the total number of tourists is not very high (average of 500 per day), taking into account the 26,000 ha of the proposed protected area, the concentration of people in only a few places (the Siq, Petra central City, Ed-Deir) is deleterious both to the archaeological and the natural values of this area.

A great part of the Petra Central City area is extensively used by visitors and animals (horses, camels, donkeys), as visitors' trails are not marked, and no channelling exists (trespassing is not advised, rather than being prohibited !). As a result, much damage is being done to the antiquities and to the vegetation.

Horses

The most immediately obvious impact on the site from tourist-related activities is that of the 350 horses, mostly owned by Lyathne families from Wadi Musa, covering the wadi bed at the entrance to the site, and kept under ugly wooden shelters. The Brookes clinic, a well-designed single-storey stone building built on the slope of the wadi, looks after the often badly-treated animals.

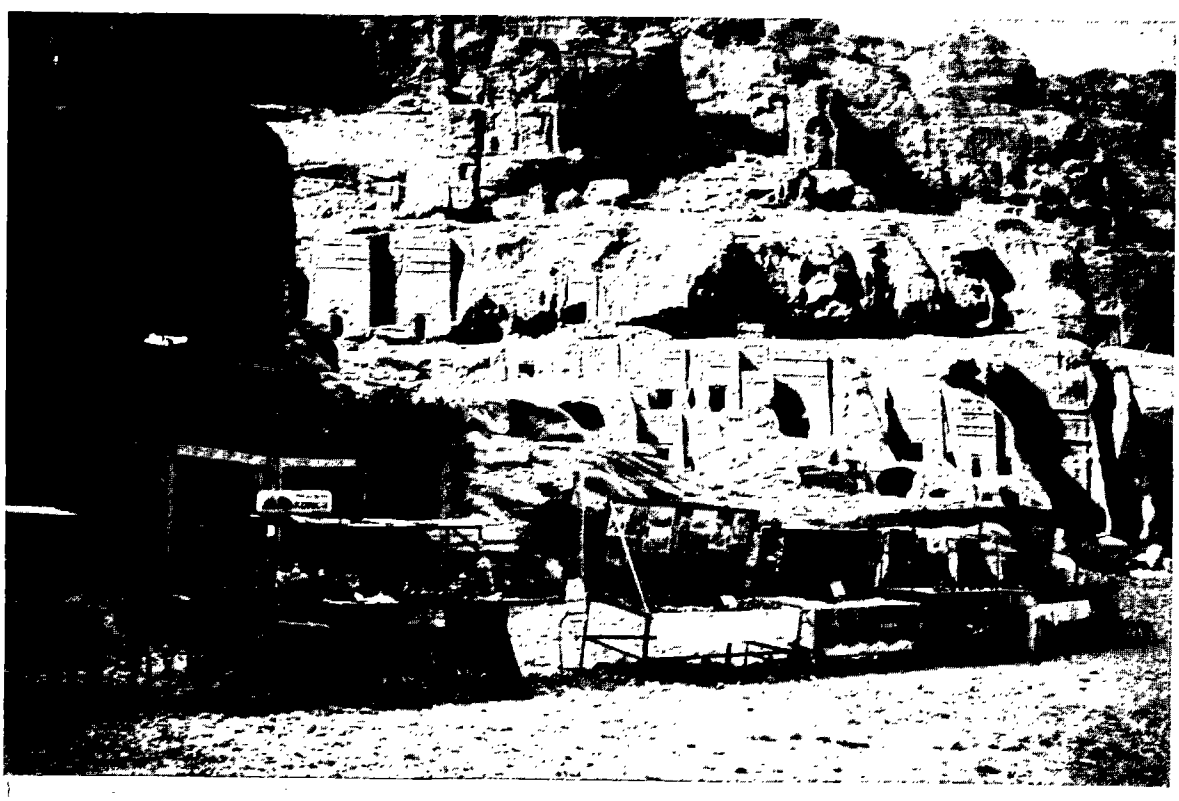
Horse rides have become the most profitable activity for the local tribes since the Gulf crisis, when the number of tourists diminished and the official rate for a horse ride was raised by the Department of Tourism to compensate for the loss in trade. However, it is immediately apparent that the quantity of horses greatly exceeds the demand and the capacity of the archaeological site of Petra. As a result, horses and riders in search of passengers jostle for space in the narrow siq, and create a 'traffic jam' below the theatre where the most popular tea shop is located.

The MTA, in an effort to lessen congestion, introduced horse-drawn carts which could transport more visitors at one time, but this measure has not succeeded in reducing number of horses. A number of suggestions are given in the draft Management Plan. Any successful solution must aim at finding alternative sources of income, at redeploying the horses for other uses, at achieving a one-way circulation system, and at dispersing them around the site by alternative visitors trails.

Dust and smells

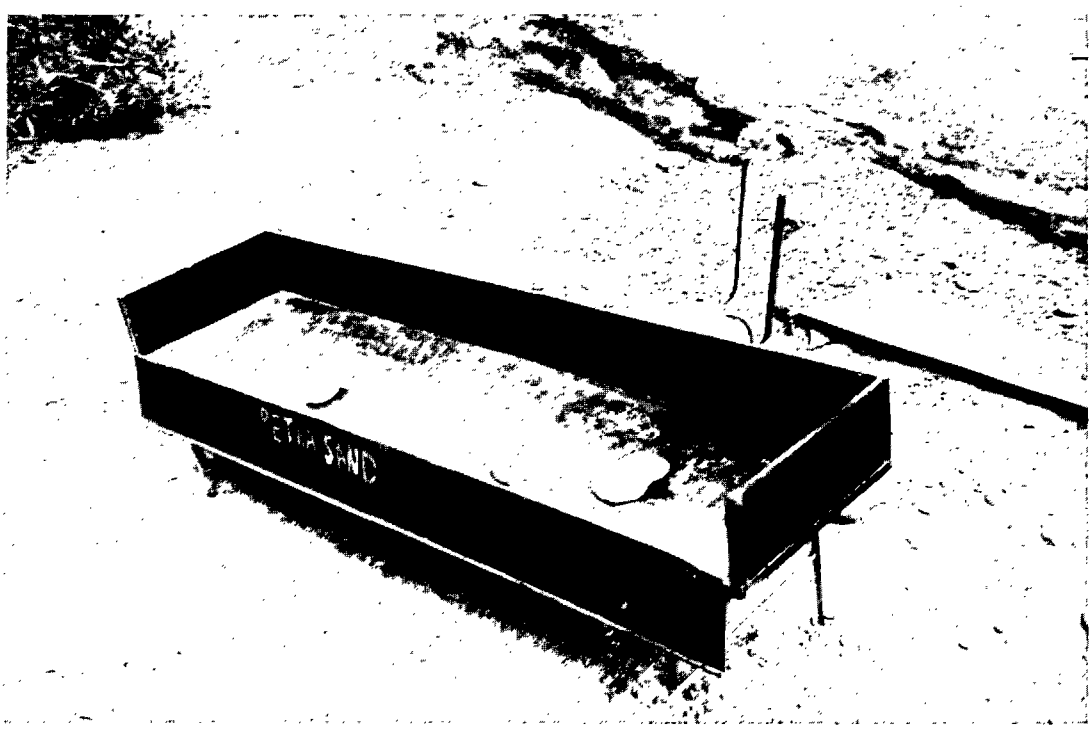
Added to these problems is the smell of horse droppings and urine in the Siq, and the dust raised by the movement of animals through the narrow canyon. This leads to extremely uncomfortable conditions for visitors during the 2 km length of the trip (some people wear a mask). Many horsemen gallop along without any consideration to the walkers. The dust and trampling of animals are killing the remaining plants of the gorge. The natural rocky façades of the Siq are covered with a disfiguring layer of fine powder. More worrying is the deposit of dust on the monuments (al-Khazneh,...), reducing the brightness of the natural sandstone colours and their visual impact. Every year, after the rainy season or after heavy rains, the Department of Antiquities brings sand to replenish the ground of the gorge. But, due to the high rate of silt or calcareous powder in the material extracted, the Department unwittingly contributes to feeding this process.

The problems of dust and animal droppings led to the suggestion by the DOA of paving the Siq. The arguments for and against this project are set out in the section on Conservation of Antiquities, and in the proposed draft Management Plan (7.1).



Horses and the Brooke clinic at the entrance to the site. *Lane*
Petra centre. Uncontrolled development of shops along touristic foot trails. *Bousquet*

Dust and smells near an ancient fragment of pavement in the Siq. Uncontrolled movement of animals among the fragile archaeological ruins in Petra centre.
Lane



An "antique dealer" and a "Petra sand" stall.
Lane

Alternative Trails

One should carefully examine the creation of new itineraries before actions are taken. Indeed, in the worst cases, negative impacts on antiquities and vegetation could be extended to other sites. For example, regular camel riding to Wadi-Sabra could increase browsing pressure on fragile wadi vegetation, with biological and ecological consequences.

A careful impact assessment should be carried out for any proposal. Therefore, a detailed plan of touristical trails can not be designed here. A preliminary study is needed.

4.2.2. Noise Pollution

The electricity generator behind the restaurant is particularly noisy and disturbing; its presence does not encourage the visitor to continue the visit as far as al Deir.

The generator could be buried underground. A better, long-term solution would be to provide an electricity supply line to the site.

4.2.3. Hotel development

Tourism development induces new accommodation structures such as hotels, bed-and-breakfast.... Constructions like hotels are built without any EIA. Their location, size, style and waste water system are not often defined according to environmental criteria. The Archaeological law overlooks these serious points.

Construction has begun on a very high level hotel with a capacity of 240 beds, which is due to be handed over in 1994, at a cost of JD 3,000,000.

Restoration and adaptive re-use as a 152 bed hotel of the traditional stone village of Taiyibe. Construction started in July 1992, and is scheduled for completion in January 1994 at a cost of JD 3,200,000.

Two other projects are being studied:

- a 220 bed hotel initiated by the proprietors of Coral Beach Hotel, Aqaba, and
- a 160 bed hotel by the proprietors of the Shepperds Hotel, Amman

Thus, a total of 772 additional beds is planned in the Petra region.

This extension must be perfectly controlled, in order to preserve the environment, and conserve the image of quality and high level tourism at Petra. The Jordanian Ministry of Tourism being very sensitive to this problem, legislation has been instituted to limit the height of constructions to two stories, and their maximum capacity to 200 beds.

Notwithstanding, the Ministry of Tourism has approved the construction of four hotels on the hillside overlooking Petra between Wadi Musa and Taiyibe, in a position visible from the site, above the line of natural springs. This project raises a double problem:

- damage to the view from the site

- evacuation of drainage

It seems advisable to build only one hotel in this area, for several reasons:

- The Petra Forum has already foreseen an extension of its capacity of accommodation,
- Too strong a concentration of hotels does not necessarily meet the demand of the clientele wishing to "appropriate" the site,
- The rare and precious character of water in Jordan imposes the respect and the limitation of its utilization.

For all these reasons, it is important to ensure that these hotels are not concentrated in one place where the most important water sources of the basin are concentrated, and to exercise the utmost caution in the treatment of sewerage and waste water for any hotels in the Petra area.

It should be noted in this connection that, in spite of the risks, water is one of the principal resources of the country. Jordan has a capacity of 120,000,000 m3 including 52,000,000 m3 for Zarqa. The Government plans to add 10,000,000 m3 by building four dams, including one at Karameh with a capacity of 55,000,000 m3.

Irreparable damage has been done, however, in the oasis of Al Azraq, to the east of Amman, which has been dried up by excessive pumping carried out by pipe to serve the capital; one of the reservoirs of the five dams of the country has also been polluted by waste matter concentrated by rainwater run-off.

The present level of consumption is 730,000,000 m3, with an increase of between three and five per cent per year, not counting the influx of repatriates from the Gulf who have increased the requirements by fifteen per cent in a few months. (Source: World Bank).

4.2.4. Trade Outlets

Several souvenir shops spoil the setting of some of the principal monuments (El-Khazneh, Urn tomb). Tourists agglutinate around and give the monumental area a market atmosphere. An extensive area of shops, 'buvettes', shelters for animals, caves for horse people,... is situated at the mouth of the wadi Musa, at its entrance into the plain.

The development of cafes and souvenir shops creates serious environmental problems: many branches and trunks of valuable species like Juniper and Daphne have been broken or cut along the trails leading to their shops, which means on the visitors trails, in the vicinity of the major monuments (e.g., Ed-Deir, the High Place,...). Wood is used for many purposes, including tea preparation (juniper fuel wood at Ed-Deir). Donkeys are often used to carry various loads to the shops: their passage twice a day erode the carved stairs. When unemployed, donkeys graze, browse or trample the scattered vegetation close to the monuments. The vicinity of the shops are polluted with garbage and unaesthetic items (emptied bottles,...).

The abundance of disorganized trade is prejudicial to the aesthetic unity of the site. Other solutions must be found, without depriving the visitors of their purchases or the merchants of their livelihood.

4.2.5. Petra sand bottles and souvenir stones

A somewhat preoccupying side effect of this activity is the removal of fragments of the multi-coloured sandstone from the rock-face and its crushing to produce the different colours for the sand bottles. The evidence may be seen in abandoned partly-crushed stones littering parts of the site, Particularly interesting striped samples are sold intact as souvenirs to the tourists. If this activity is allowed to be developed, areas where quarrying is permitted must be regulated and set aside for the purpose; otherwise it is not difficult to imagine that at some time in the future the monuments themselves could start to be attacked.

4.3. OTHER VISITORS

During weekends and school holidays, Petra is invaded by groups of uncontrolled young urban people. They make great noise, use transistors and sometimes commit vandalism (degradation of antiquities). Their deleterious acts are often attributed to Bedouins.

4.4. LOCAL TRIBAL GROUPS

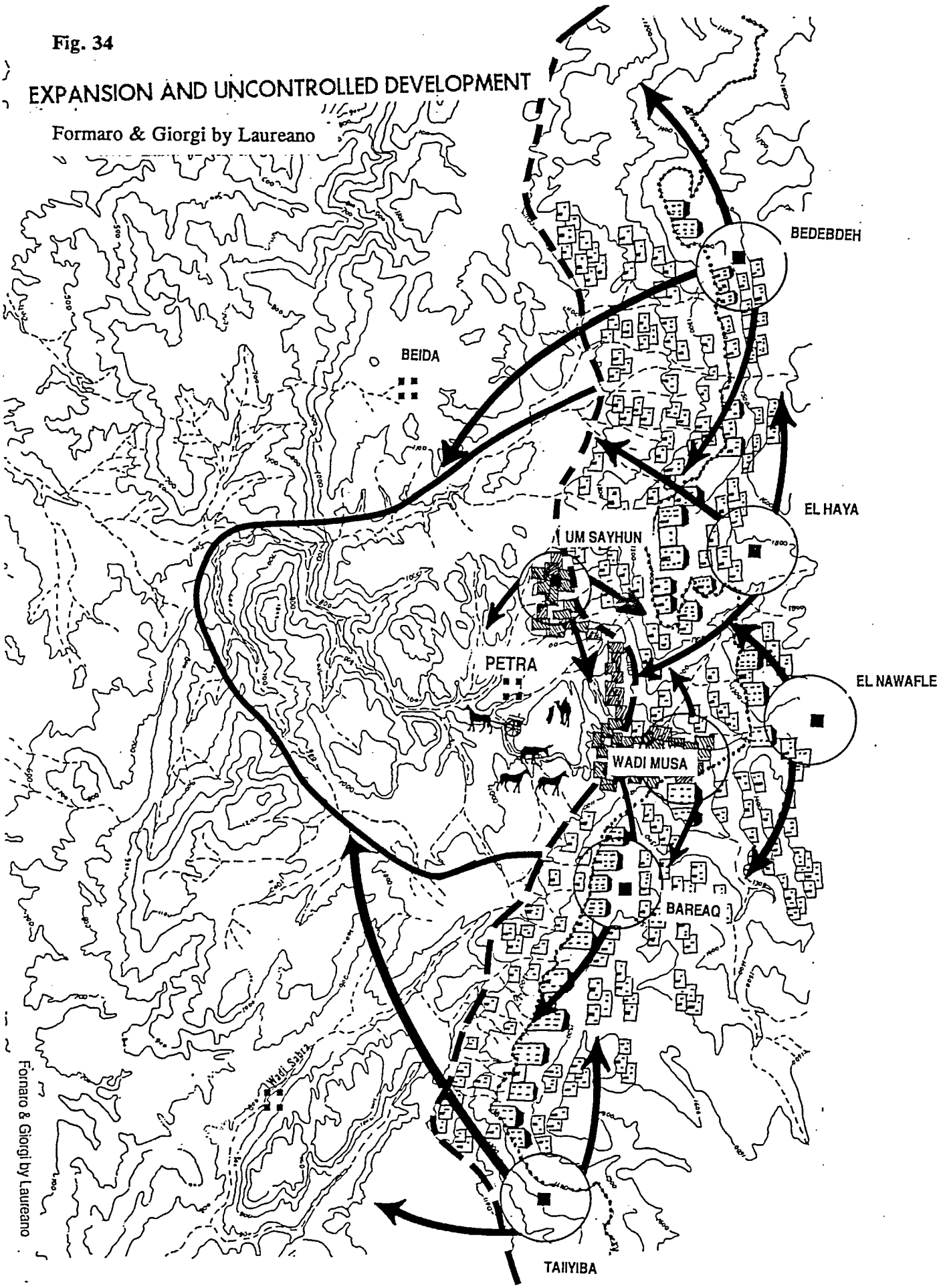
The horsemen (mainly from Wadi-Musa), the remaining inhabitants of the caves (deforestation and overgrazing on the site, garbage in the vicinity,...), the shop keepers (see above) and peddlers of antiquities also have negative impacts on the Park.

Goats and sheep pass twice a day through the area. Some herds spend the night parked inside caves or Nabataean carved basins. Vegetation is therefore very scarce, comprising only a small number of unpalatable shrub species (retam, *Ononis natrix*,...).

Fig. 34

EXPANSION AND UNCONTROLLED DEVELOPMENT

Formaro & Giorgi by Laureano



4.5. RURAL INFRASTRUCTURE

4.5.1. Expansion and uncontrolled development of villages.

The effects of the new economies linked to tourism are being felt in the region. The approximately 300 people who carry tourists on horseback along the Siq have abandoned all forms of agricultural work for a faster and easier gain. Souvenir traders, the owners of small catering businesses have seen their incomes rise enormously in the space of a few years. These resources are mostly invested in building new, larger houses. So the entire upper basin of Wadi Musa is involved in a process of rapid, uncontrolled development. The buildings stretch along the terraces once used for farming, replacing the gardens and blocking the wadi courses. Everyone builds on his own plot of land according to a system of highly fragmented properties with no regulations or planning. Concrete occupies the areas once occupied by crops and trees, and there is no longer any maintenance of the dry-stone walls that prevented soil erosion or of the system of water drainage channels.

The uncontrolled growth of the urban areas leads to ever-increasing infrastructure costs. The drinking water supply system and the water disposal system are inadequate or non-existent. The risk of violent floods on the abandoned slopes is more and more serious and the whole environmental system is in danger of total collapse (**Fig. 34**).

The present trend is to create a large agglomeration that, following the line of the springs, embraces the whole archaeological site of Petra. Thus instead of being a unique place in the world for its monuments that are totally immersed in history and nature, this site runs the risk of becoming, like the Pyramids at Cairo, the theatre of Amman and the vestiges of Gerasa, an archaeological centre, incorporated into and suffocated by uncontrolled development. This process is all the more dangerous for the monuments of Petra because the area in question is that of the upper basin of Wadi Musa, overlooking the ancient city. The area is of archaeological interest because the Nabataean hydraulic works started from here, and it is of vital ecological and environmental interest for the city: everything that is discharged at the level of the springs from Beida, Wadi Musa and Taiyibe will end up in Petra, and everything that is done in this area will have repercussions on the protection of the Nabataean city.

i/ Wadi Musa

In 1968, when the U.S. National Parks Service prepared the first master plan for Petra, a drive through Wadi Musa was an important bonus for visitors. An attractive and well-watered oasis with low, stone-built houses and terraced gardens planted with vines and cactus, it offered visitors a scene of traditional village life in Jordan.

Today, Wadi Musa has become the largest agglomeration in the Petra region, with a population in 1990 of 10,217, subdivided among 1,100 houses. Of the people employed, 2,200 work in the public administration, education and the army; 250 have commercial activities, 120 are employed in hotels, 290 in tourism using horses and 20 as guides.

The traditional habitat has largely been destroyed to make way for new developments of mediocre concrete buildings. Much of the cultivated land has been built on; a land use chart for 1910-30 shows 96% green areas at that time. This had diminished to only 49% by 1990[1]. and many of the stone retaining walls supporting the agricultural terraces have been torn down, with unpredictable long-term consequences on the stability of the houses.

In 1990, the PNT sponsored and funded a group of students and professors from the University of Jordan architecture department to carry out a town planning study of Wadi Musa.

This study led to the creation of a joint committee between the University of Jordan and the Ministry of Municipalities, with a view to formulate an up-dated development plan. The principal aims of the PNT in this initiative were to ensure a balanced development of Wadi Musa, to preserve its agricultural land and its few remaining traditional buildings, and to prevent any new building development in the vicinity of the World Heritage site of Petra. Recently, the PNT was able to prevent the re-zoning of a stretch of agricultural land at the entrance to the site and its redevelopment for housing.

ii/ Um Sayhun

Um Sayhun is the result of the return home of the Bdul, when, in accordance with the recommendations of the first Petra Master Plan (USAID, 1968), the members of the Bdul tribe, originally living in the caves of Petra were resettled in the village of Um-Sayhun, specially built for them. The modern village is already too small for the population of 1400 inhabitants and which is growing fast. Agricultural and goat-herding activities once carried on in the Petra area have now almost entirely been replaced by a small souvenir trade for the tourists and the provision of refreshments at the historical site.

Unfortunately, this village is not located on traditional Bdul tribe land. Although the land theoretically belongs to the Government (as does the greater part of the Park area), it is traditionally reclaimed by the people from Wadi-Musa (the Lyathne). The Bdul have requested the permission to be allocated a strip of land around their new village (appx. 1 km wide).

Owing to the growth of the Bdul population the village is now expanding without any development scheme. Some ugly constructions are located along the southern ridge, making them visible from the Petra archeological site.

The village area, located on a steep hill between two wadis, is extremely eroded. Soil erosion feeds Wadi al-Mataha, Wadi Abu-Ullayqa and Wadi Um-Sayhun, joining Wadi Musa in Petra Central City area.

Several families have not been relocated in the village, owing to the lack of village houses. Therefore, 30 to 50 Bdul families still live in caves, in the proposed Petra Sanctuary, with a high population growth rate. As a result, the vegetal cover surrounding these caves is degraded (wood for cooking and

[1] University of Jordan Architecture Department, 1990. Urban study of Wadi Musa.

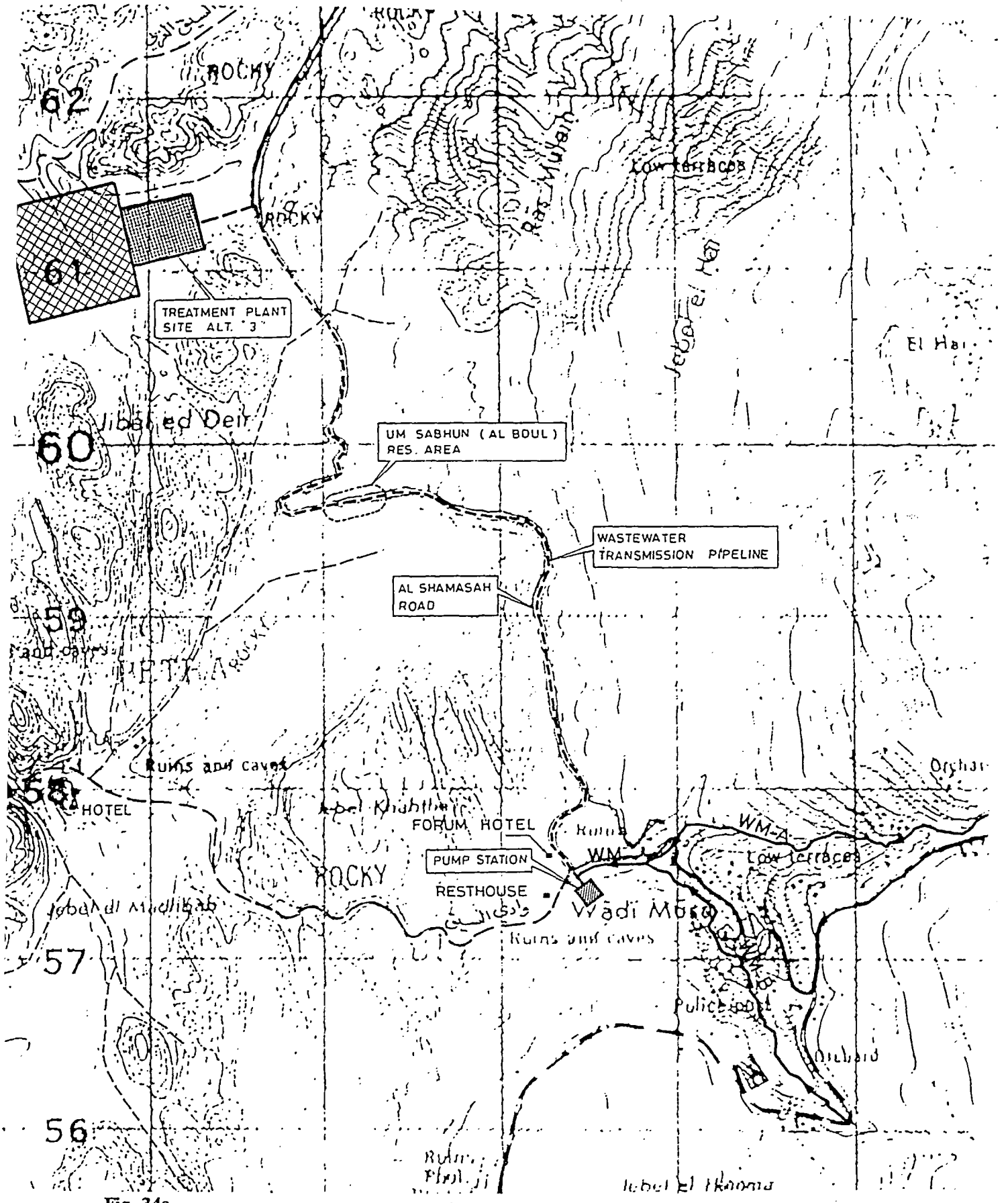
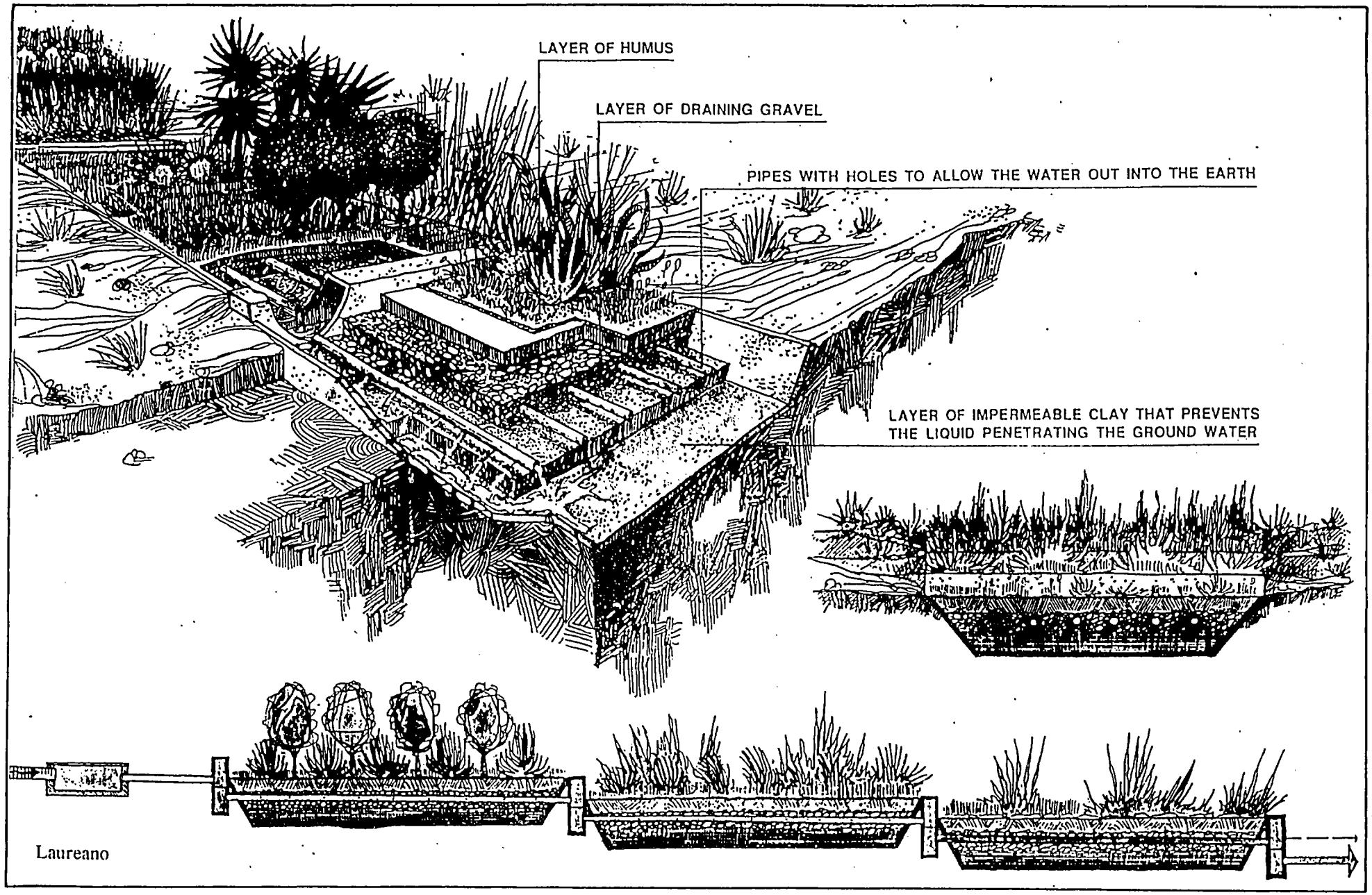


Fig. 34a
Environmentally damaging project for a sewerage treatment plant next to the archaeological and natural park.

Fig. 35

THE ABSORBENT BASINS



heating), and family members (mainly children and women) practice uncontrolled activities linked to tourism frequentation. The Bdul's tribal land being located south of Petra Central City Area, farmers will have to cross the proposed Sanctuary in order to reach their fields and rangeland.

iii/ Beida

The new agglomeration of Beida consists of only 42 houses which are still without electricity or telephones. A major constraint is that the land is not registered in the names of the inhabitants, making it impossible to erect fences or build on extensions. The inhabitants do not as yet seem to benefit from tourism, and are mostly engaged in goat-herding.

iv/ Taiyibe

Only in Taiyibe has a certain balance been retained between the traditional town fabric and the new growth. An important project for the rehabilitation of housing for the purposes of tourism is almost complete and will provide an excellent example of safeguarding the ancient houses and of economic promotion.

4.5.2. Soil Waste Disposal

There is no disposal system for used water. At Wadi Musa two alternative projects (**Fig. 34a**) involve **I**) conveying all the water down to the entrance to the archaeological area near the Rest house and **II**) pumping it to a higher level and treat it near Um Sayhun, are both **unadvisable, and should be halted immediately** until alternative proposals have been prepared. The first, because it would require a huge depuration plant right at the entrance to Petra's monuments. On the one hand this plant would have a heavy environmental impact in an area crossed by tourist flows, and on the other it uses a type of technology that is unreliable in arid zones, and hazardous because it lies on the wadi course. In the event of breakdowns or floods, everything would be carried down to the Petra site. The second solution, with the need to raise and pump the water, would increase the risks of obstructions and breakdowns, without entirely removing the dangers from Petra.

A correct system for disposing of used waters should be organized by means of a non-centralized water disposal system, divided into sectors using the morphology of the site itself created by descending terraces like large sloping basins (**Fig. 35**). The purification of used waters utilizes these same terraces as a system of dispersion tanks in the soil itself, filtering the water and using it to irrigate green areas. These become areas where building is not allowed, to check urban expansion.

4.5.3. Depletion of water resources

The local population should have priority over the water resources, whereas the needs of tourism are likely to grow, and even exceed, the carrying capacity of the region. Already, with new hotel projects being planned in the area, worries about the adequacy of the water resources were expressed to the team by the Municipality of Wadi Musa.

On the other hand, Petra is an immense water well. The Nabataeans developed an exceptional hydrological system for stocking and distributing rain water. In order to promote agriculture, it will be necessary to rehabilitate as many as possible of the ancient cisterns and dams.

4.6. LAND USE AND CONSEQUENCES

4.6.1. Expansion of rainfed agriculture

The PANP is composed of relatively well distinct ecological units, that the geomorphological map underlines (see map Fig. 4). The rocky mountains and the steep gorges of several wadis are traditionally Bedouin rangeland, whereas the "plains" are both rangeland and agricultural land divided into several tribes: Bdul of Um-Sayhun, Amarine, Lyathne of Wadi-Musa (the Sa'idiyine keep themselves to the west, down to Wadi 'Araba, out of the proposed PANP boundaries but inside the Buffer zone).

Extensive grazing was the major land use until very recently. But since two generations ago, cropping is expanding within these plains. Rainfed cereal cultivation (mainly barley and wheat) occur in depressions, valley bottoms, alluvial terraces of some wadis, small plateaux, and terraces on slopes (among them several old Nabataean terraces). It is probable that expansion of fields is correlated with that of the population, although land appropriation could be another reason (see section 2.3.2). As most of the suitable agricultural areas are already cultivated, this development is now occurring at the expense of rangeland (e.g., *Artemisia* steppe), even on relatively steep slopes.

Example: The plain south of Petra Central City Area was traditional Bdul rangeland. At present, culture of cereals covers the areas where some soil remains. Until 3 years ago, the donkey was used for ploughing and cultivated areas were limited to 15 ha, then, due to the use of the tractor (rented by Wadi-Musa people 30-35 JD/day to the Bdul), these areas have increased to roughly 60 ha. The yields are appx. 700 kg/ha (under normal climatic conditions) the first years of cultivation, but after 5 years without fallow, they drop down to 500 kg/ha (loss of 6% per year !).

4.6.2. Overgrazing

Extensive grazing and browsing by goats still remain the major threat to the bio-diversity and to the main ecological processes of the Petra area. Rangeland reduction adds to the extreme pressure of grazing on the remaining areas. The herds belong to the nomadic and the semi nomadic bedouins. Tribal distribution of pasture lands is displayed in section 2.3.3.

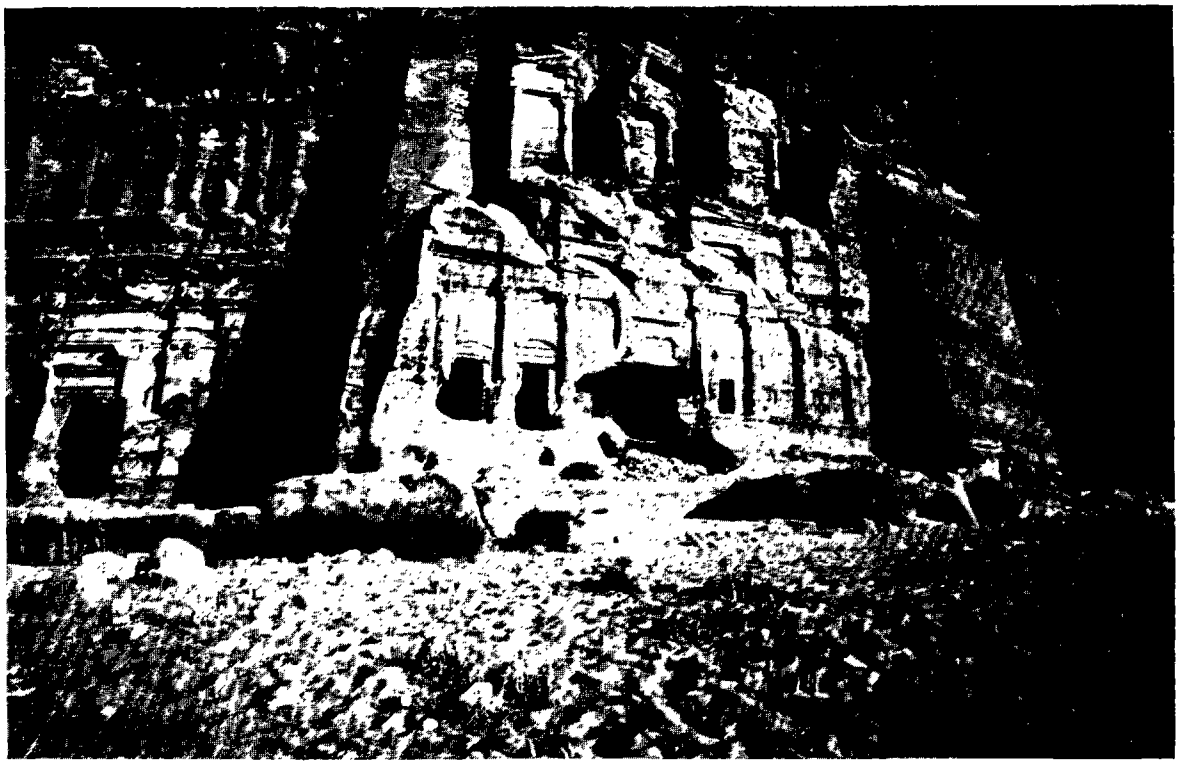
4.6.3. Erosion

As a result of the above factors, soil erosion due to wind rainwater runoff is high, all together converting the region into a desert. Fine particles of soil are washed away by wind. Water runoff carries a huge quantity of sediment during heavy rains, rising up the bottom of some wadis. For example, in the Wadi-Siyyagh gorge, the level of the water course has reached the bottom of some Nabataean carved niches in the rock face.

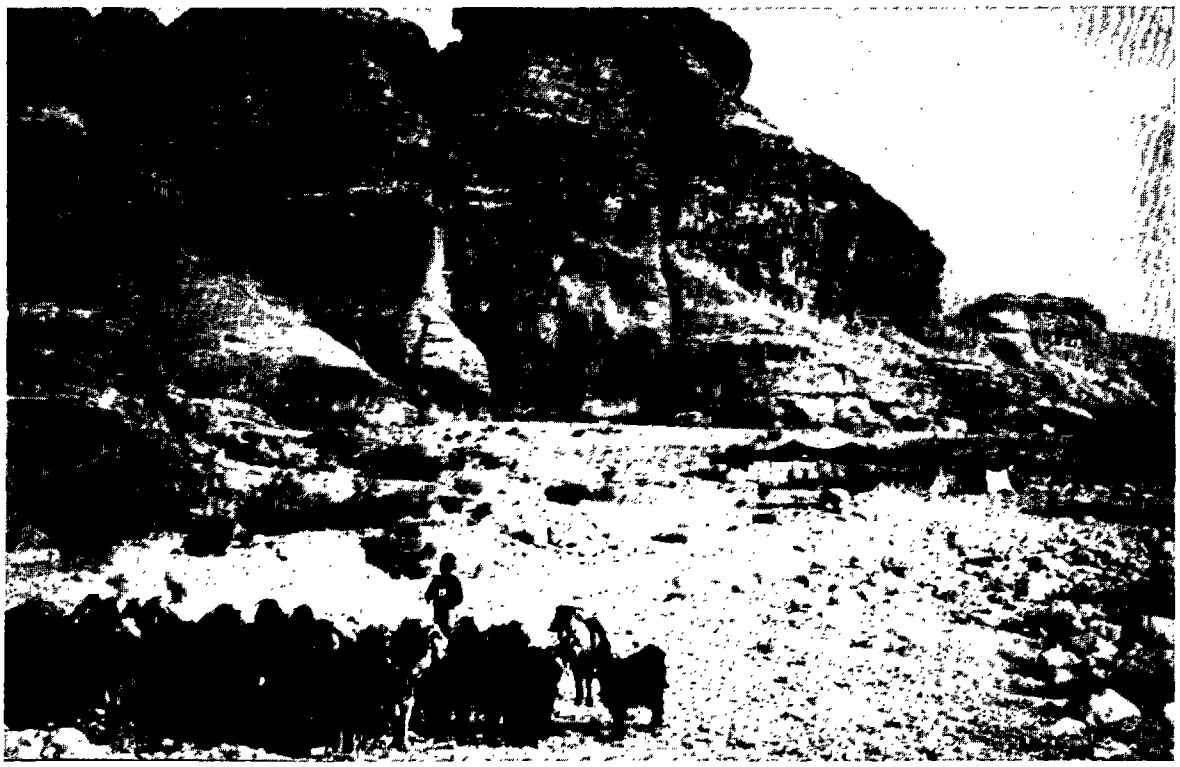
This process, which the entire local population is involved in, is steadily converting the area into a sterile land. Several mismanagement practices add to this desertification process:

- agriculture under 300mm of annual rainfall is uncertain, especially on filtering soils,
- the use of mechanization (tractor) is not adapted to the fragile soils,
- the use of tractors is not compatible with contour line cultivation, on slopes of over 16%,
- although prohibited, shrub destruction quickly occurs within every field,
- the lack of any windbreaks,
- the duration of time between ploughing and efficient cereal cover of the soil (1 to 2 months !).

Note: the average annual rainfall is slightly higher in Shaubak (275 mm), where evapotranspiration is also lower (altitude = 1400 m) than in Wadi-Musa/Petra.

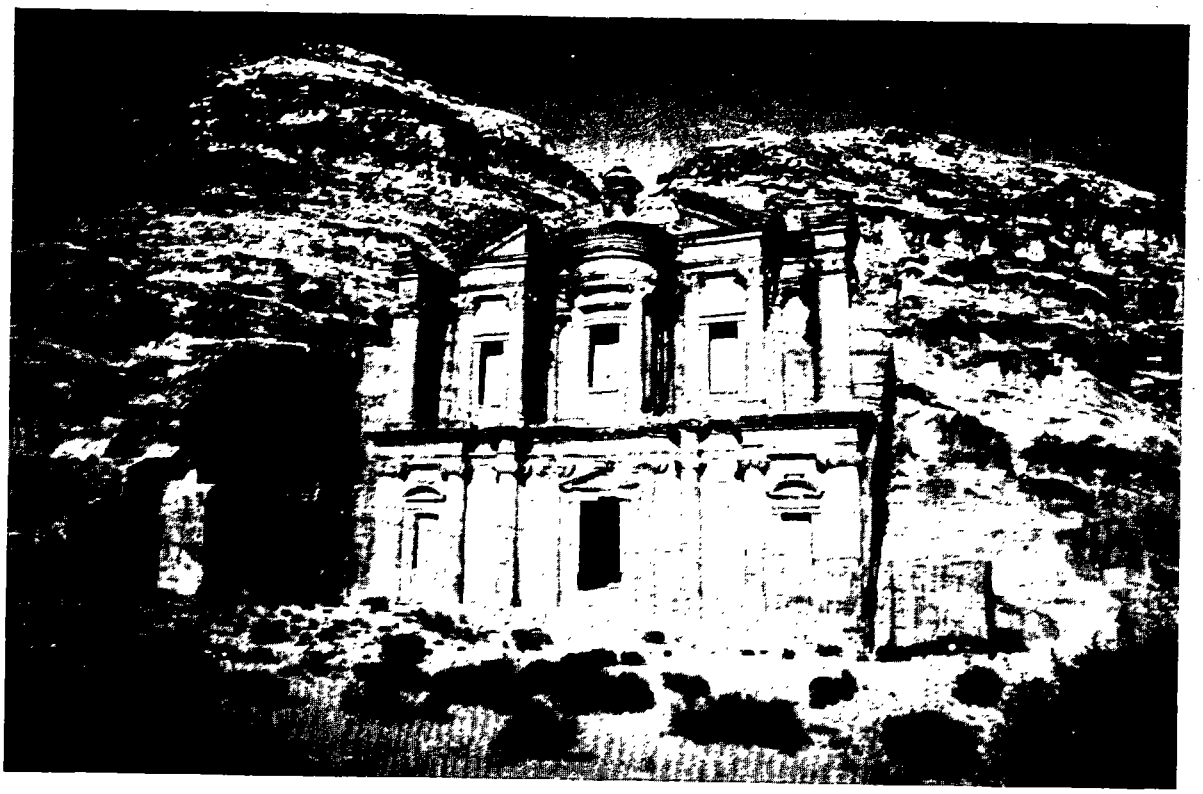


PALACE & CORINTHIAN TOMBS *Bousquet*
Shrubs roots are fragmenting monuments
Monument's environment is eroded by
overgrazing and visitor's trampling



BEIDA
Flock of goats conducted by a young Bdul shepherd in a Wadi bed

Bousquet



ED–DEIR
Sandstone erosion is accelerated by the rarity
of the vegetation cover (overgrazing, trampling, cutting)
Bousquet

BEIDA
Artemisia steppe encroached
by cereal cultivation

Bousquet

CHAPTER TWO THE MANAGEMENT PLAN

5. ZONING

5.1. THE PARK'S BOUNDARIES

The limits proposed by the DOA have several major drawbacks:

- they have been chosen from the unique criteria of archaeology,
- the boundary demarcation operation would be difficult, if not impossible, to implement, based on the present zigzag line,
- important areas of the western region incorporate neither cultural nor natural values,
- access difficulties to the western part (bad tracks), would be a considerable burden to Park's control capacity, maintenance and budget.

Some modifications are therefore proposed (see maps, **Fig. 36 & 43**):

- **east boundary:** would include the western slopes of the limestone plateau (jebel al-Hayy, al-Marajim, as-Saha), north to Wadi-Musa, and the same south to Wadi-Musa (Qurna). These boundaries would have several advantages, by:

1) including the eastern paved roads (to Um Sayhun/Beida/Hisha north and to Taiyibe south), allowing the Park's control over any further development which could occur along these roads;

2) including upper catchments of several wadis running westward through the Park (wadi Musa, wadi al-Mataha,...);

3) including the Hisha oak forest;

4) incorporating State owned lands.

- **west boundary:** as a compensation for the extension of the Park eastward, its western boundary could be moved closer to the escarpment. The archaeological importance of several remains such as the Chalcolithic copper mine, Mukheifer, Roman terraces and ancient caravanserais, would justify the creation of small isolated Sanctuaries related to and managed by the PANP.

- **north boundary:** the unpaved road to Wadi 'Araba would become an ideal limit in the section from Wadi Abu Mahmud to its entrance in the plain near Jebel ez-Zibda.

- **south boundary:** the necessity to incorporate in the Park as much as possible of Wadi Sabra extends its southern boundary to approx. latitude 30° 15'. The crest line between the sub-catchments of Wadi Sabra and Wadi ar-Raqui (Jebel al-Jathum), could be the limit.

Note: One must underline the lack of any documents allowing the exact location on the available map of existing roads and antiquities, preventing us from mapping the Park's boundaries.

Fig. 36
PROPOSED PARK BOUNDARIES *Lane*

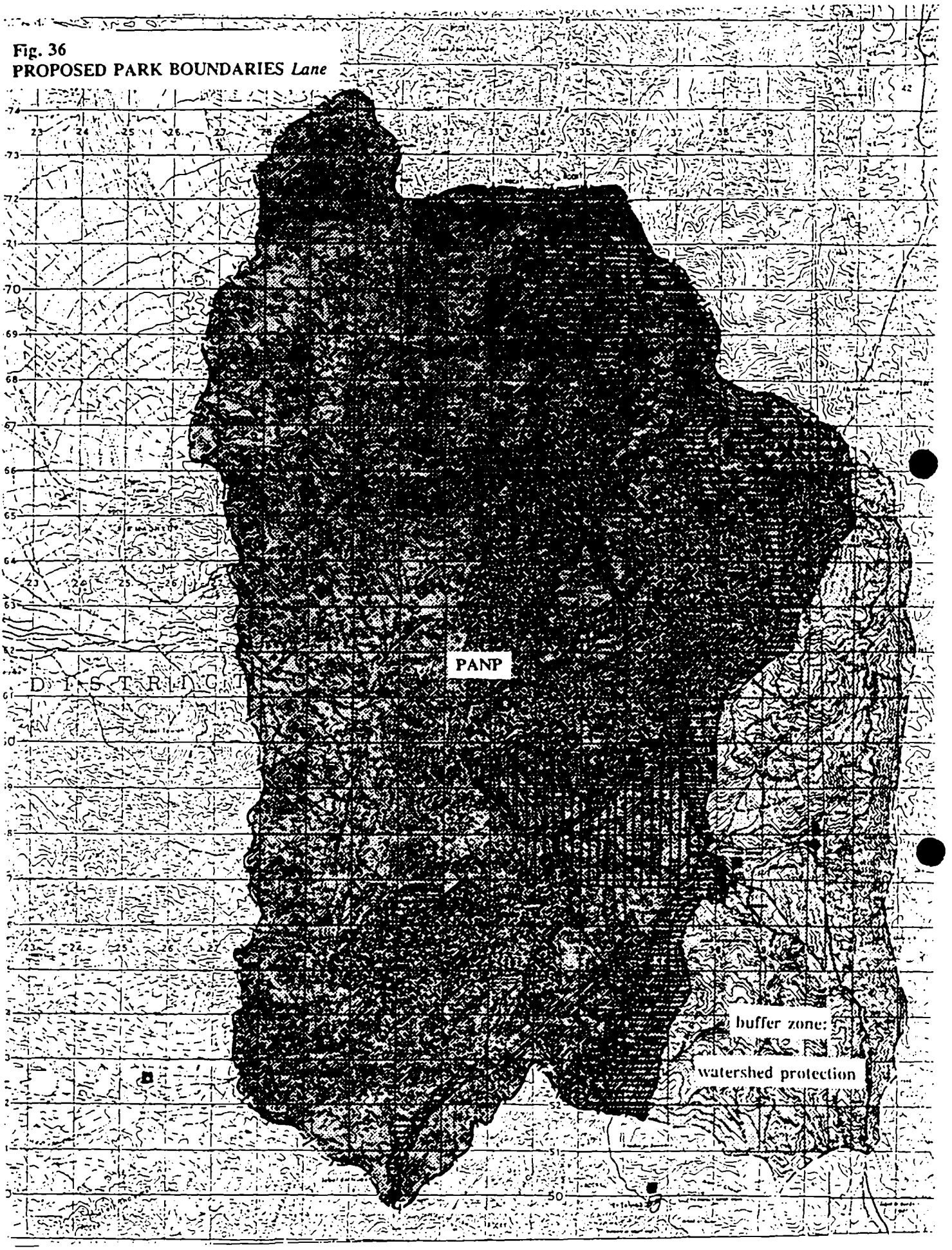
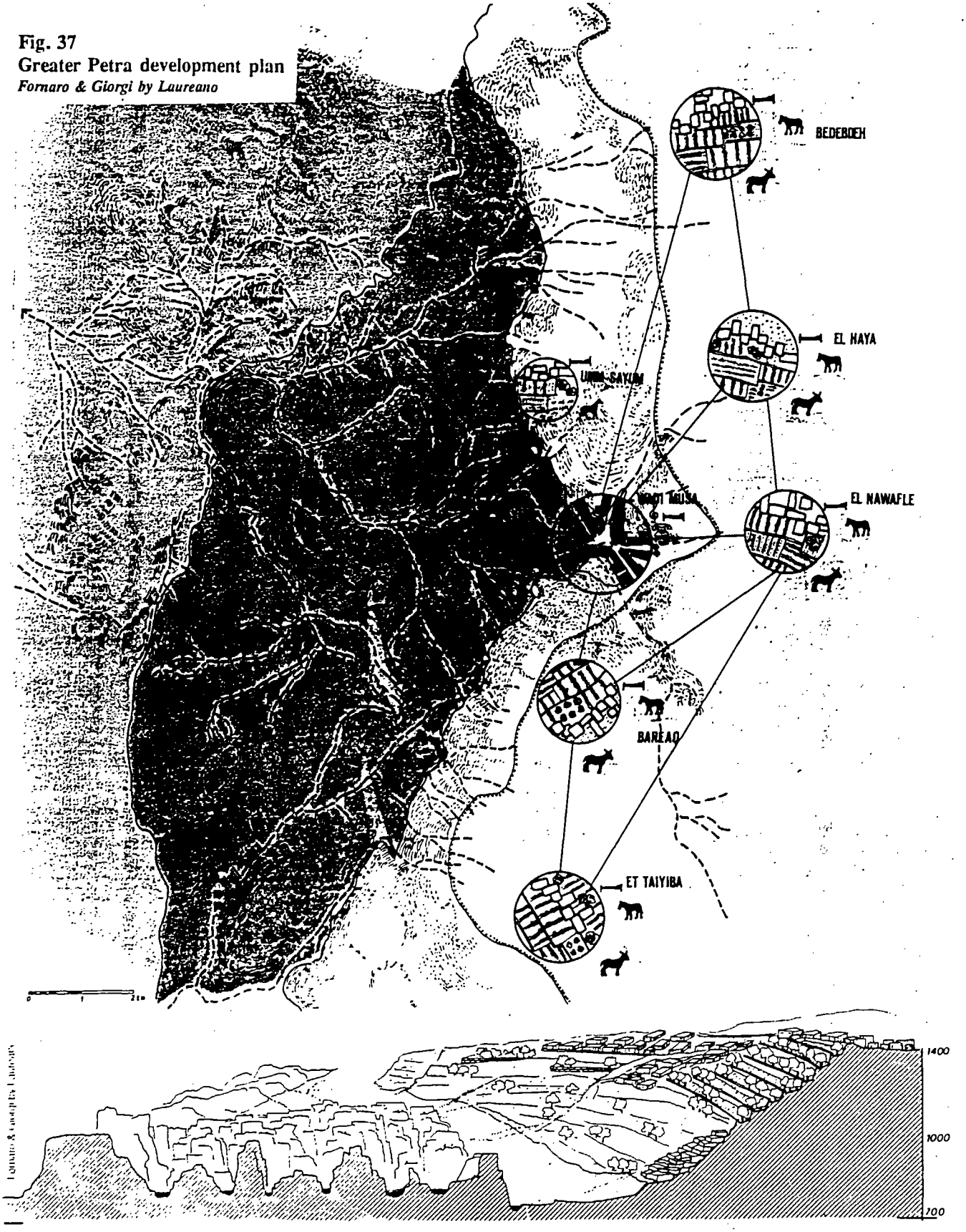
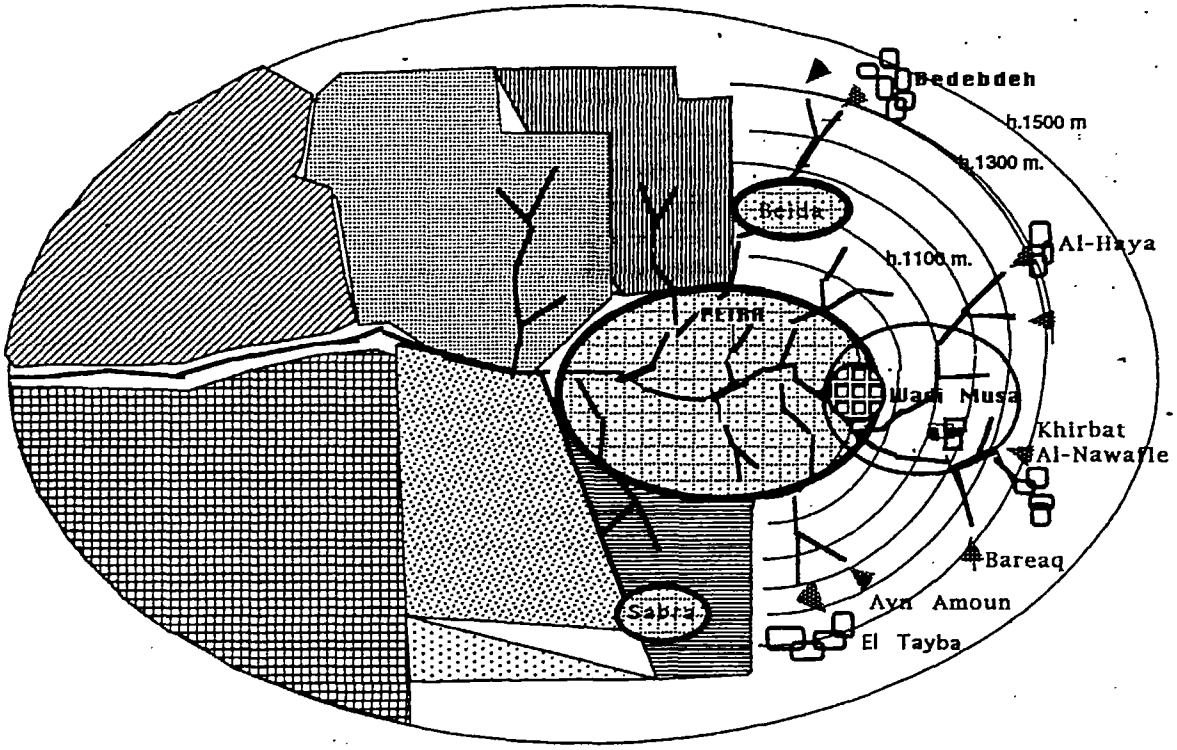


Fig. 37
Greater Petra development plan
Fornaro & Giorgi by Laureano





LEGEND

SANCTUARY AREA

WADI MUSA
WATER SHED

SPRINGS

RESTORATION OF TRADITIONAL
VILLAGES FOR AGRO-TOURISM

CENTRAL AREA UPGRADING

LEVELS OF PROTECTION

Fig. 38
Planning principles
Laureano

5.2. THE ZONES

The lack of aerial photographs, satellite imagery and/or suitable maps, prevents us from providing the Management Plan with a detailed land use map, on which could be based the zoning.

The map, **Fig. 39**, is therefore a tentative map, designed according to our limited investigations through the site. It should be completed and corrected as soon as the implementation phase of the Management Plan starts.

7 types of zones can be distinguished within the proposed boundaries:

Zone I - **Archaeological and Natural Sanctuaries**: Petra, Siq al-Barid/Beidha
Zone II - **Botanical & Wildlife Reserves**: Ba'ja, Siq Um-al-Aldah, Jebel Hisha, upper Beidha, Qurnat-Bin-Sa'd, Jebel Harun, Ras-Sliman, Wadi-Siyagh, Wadi-Sabra
Zone III - **Silvo-Pastoral Zone**: Hisha Forest
Zone IV - **Agro-pastoral Zone**: Petra North, Petra South, Beidha, SW Wadi-Musa
Zone V - **Afforestation Zone**: Um-Sayhun, Taiyibe North
Zone VI - **Village Zone**: Um-Sayhun, Beidha
Zone VII - **Transit Zone**: track through the Sanctuary, linking Um-Sayhun village to "Petra South" Bdul tribeland.

The rest of the Park should remain temporarily **"Undetermined"**, until more complete information is available.

A **Buffer zone** should be established as a **Zone VIII**, with regulations adapted to every specific condition. A Buffer zone is needed:

- ***in the north,***

as a "wildlife corridor" to facilitate movements of large wild animals between Dana Wildlife Refuge and PANP;

- ***in the west,***

1) to preserve scattered archaeological remains: caravanserais, roman terraces, coppermines, paleolithic and neolithic sites, Nabataean sites,... (protection of major antiquities being enforced through a more strict statute as "Sanctuary"),
2) and for more efficient actions related to extensive grazing management improvement: the Park and its buffer zone would include the seasonal movements of the main nomadic tribal groups of the area;

- ***in the east,***

to control Wadi-Musa city and Taiyibe rapid development. A buffer zone including the whole of the historic Great Petra with strict planning control over building development is proposed. The aim is to avoid an uncontrolled growth of a single agglomeration and promote the harmonious and coordinated development of the Great Petra region. The Archaeological and Natural Park will have authority over planning and management decisions.

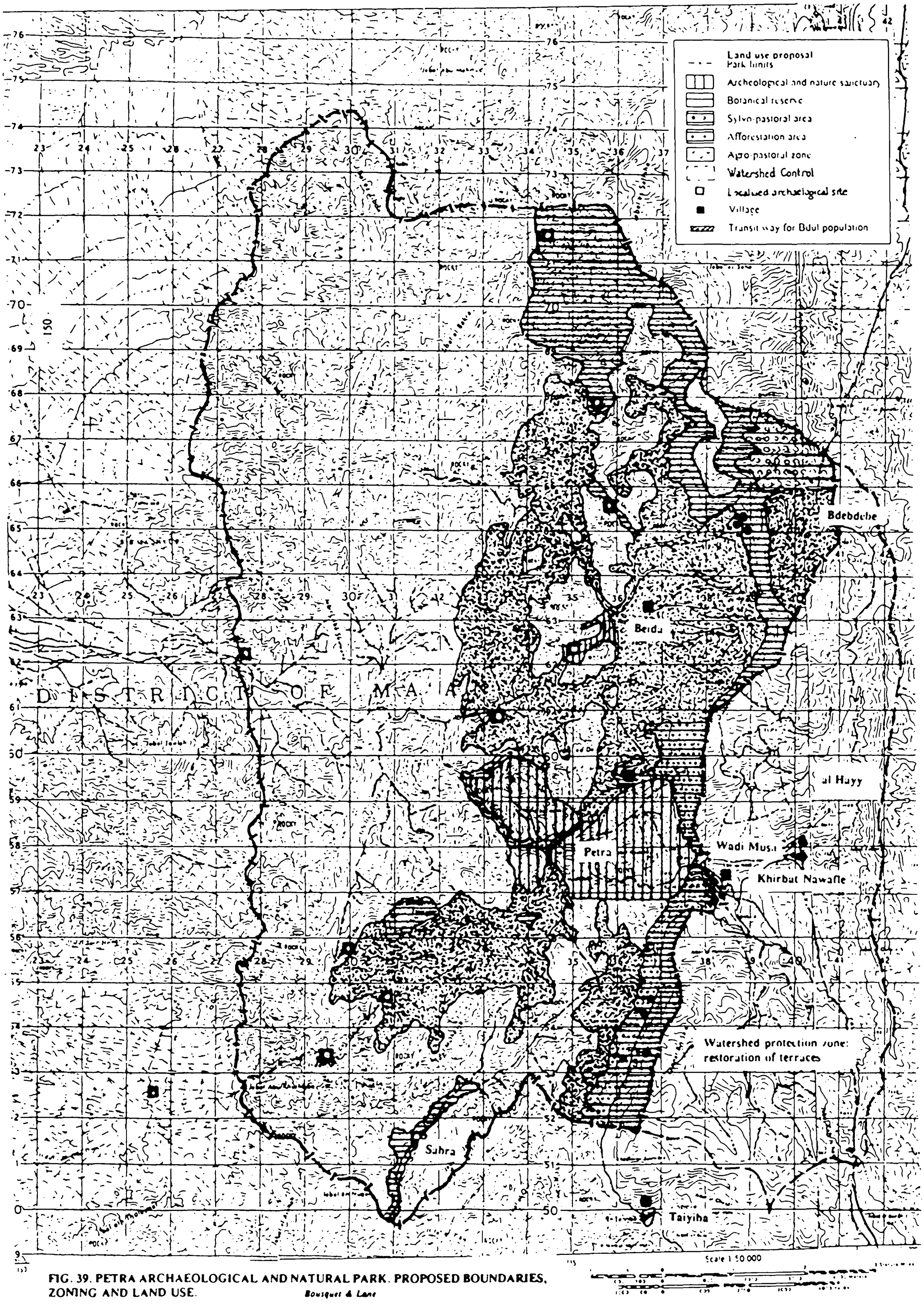


FIG. 39. PETRA ARCHAEOLOGICAL AND NATURAL PARK. PROPOSED BOUNDARIES, ZONING AND LAND USE.

Bousquet & Lane

5.3. OBJECTIVES AND REGULATIONS OF EACH ZONE

Zone I:

Main objectives:
- the long-term conservation of the World Heritage Site of Petra - conservation of bio-diversity and the natural environment of the monuments
- restoration of a perennial vegetation cover
- reduction of the erosion process
- restoration and/or maintenance of antiquities
- maintenance of the whole Sanctuary (cleaning,...)
- restriction of any new open air excavations
- tourism control improvement (mapped circuits, law enforcement)
- diversification of tourism activities and quality improvement

Restrictions:
- no mining (or mining exploration)
- no new road/track development
- no new building (except Park facilities)
- no camping and housing (except authorized researchers and Park staff)
- no shopping and trading of any kind (except on designated plots)
- no waste disposal (except on designated plots)
- no hunting
- no agriculture
- no grazing
- no plant removal
- no plantation of exotic species
- no walking off demarcated trails

Zone II:

Main objectives
- conservation of biological diversity
- restoration of original plant communities
- centres of dissemination (plants, animals)
- soil conservation
- eco-tourism development

Restrictions:
- no mining (or mining exploration)
- no new road/track development
- no building (except Park's facilities, and existing inhabited caves)
- no camping and housing (except authorized researchers and Park staff)
- no hunting
- no agriculture (except existing terraced orchards in Wadi-Siyagh)
- no grazing (consider the case of Wadi-Sabra)
- no plant removal
- no plantation of exotic species
- no fires

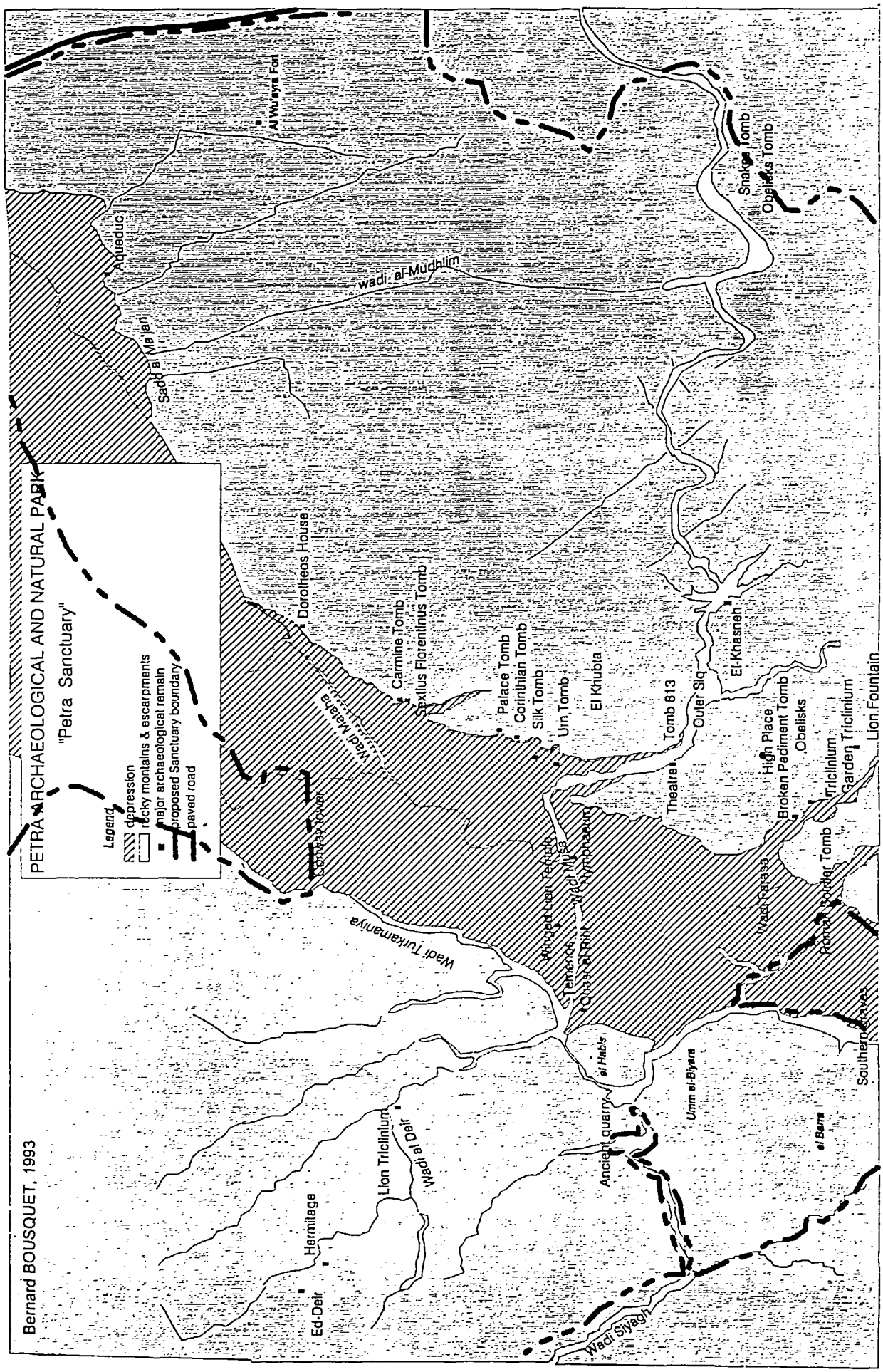

PETRA ARCHAEOLOGICAL AND NATURAL PARK
"Petra Sanctuary"
Legend
depression
rocky montains & escarpments
major archaeological remain
proposed Sanctuary boundary
paved road
Bernard BOUSQUET, 1993
Al Wu'eyra Fort
Aqueduc
Sadd al Ma'jan
wadi al-Mudhlim
Snake Tomb
Obelisks Tomb
Dorotheos House
Carmine Tomb
Sextius Florentinus Tomb
Wadi Mataha
Palace Tomb
Corinthian Tomb
Silk Tomb
Urn Tomb
El Khubta
Tomb 813
Outer Siq
El-Khasneh
Theatre
High Place
Broken Pediment Tomb
Obelisks
Triclinium
Garden Triclinium
Lion Fountain
Roman Soldier Tomb
Wadi Farasa
Southern Graves
Wadi Turkamaniya
Winged Lion Temple
Wadi Musa
Nymphaeum
Qasr al Bint
Temenos
el Habis
Ancient quarry
Umm el-Biyara
el Barra
Lion Triclinium
Wadi al Deir
Hermitage
Ed-Deir
Wadi Siyagh

Fig. 40

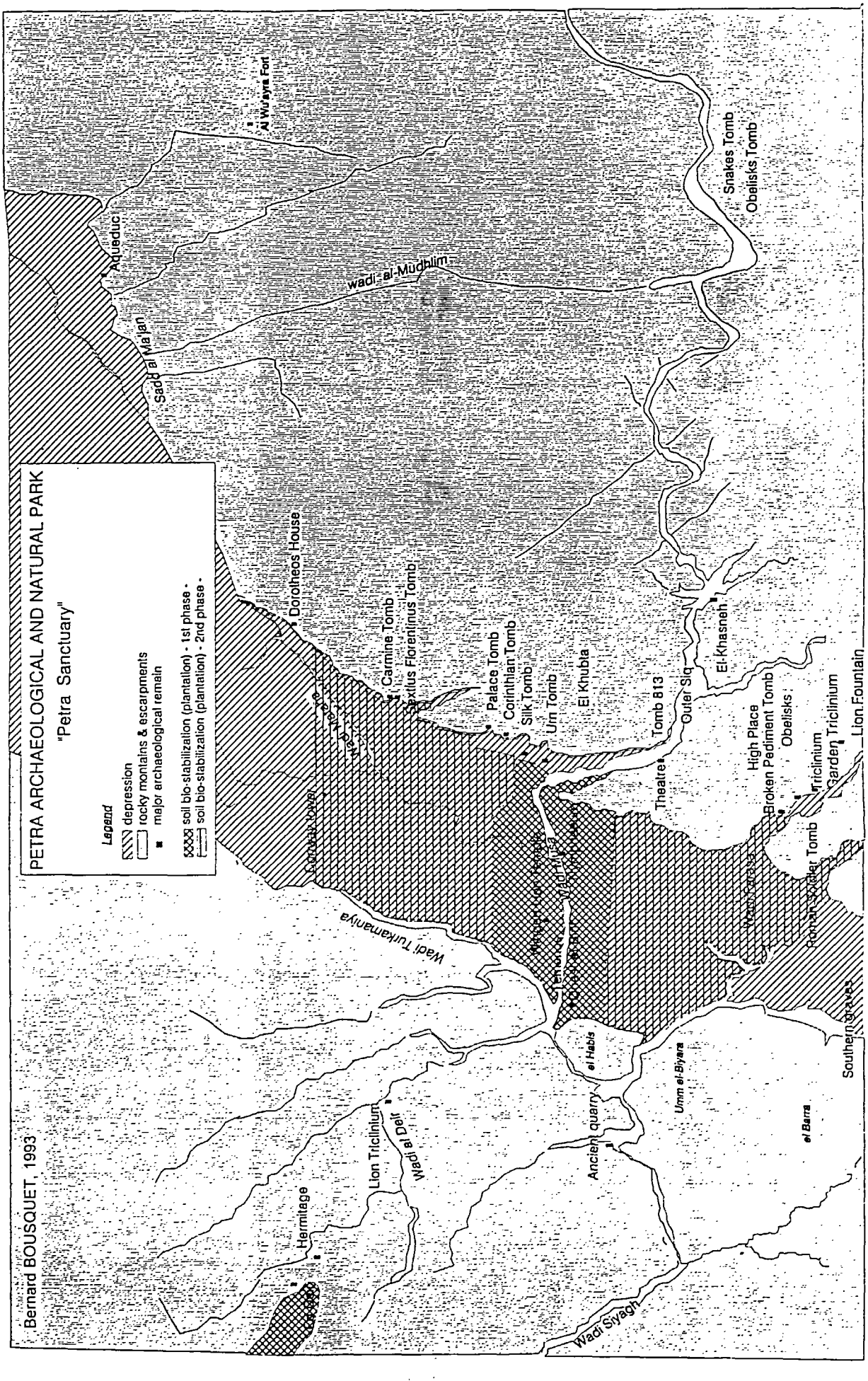
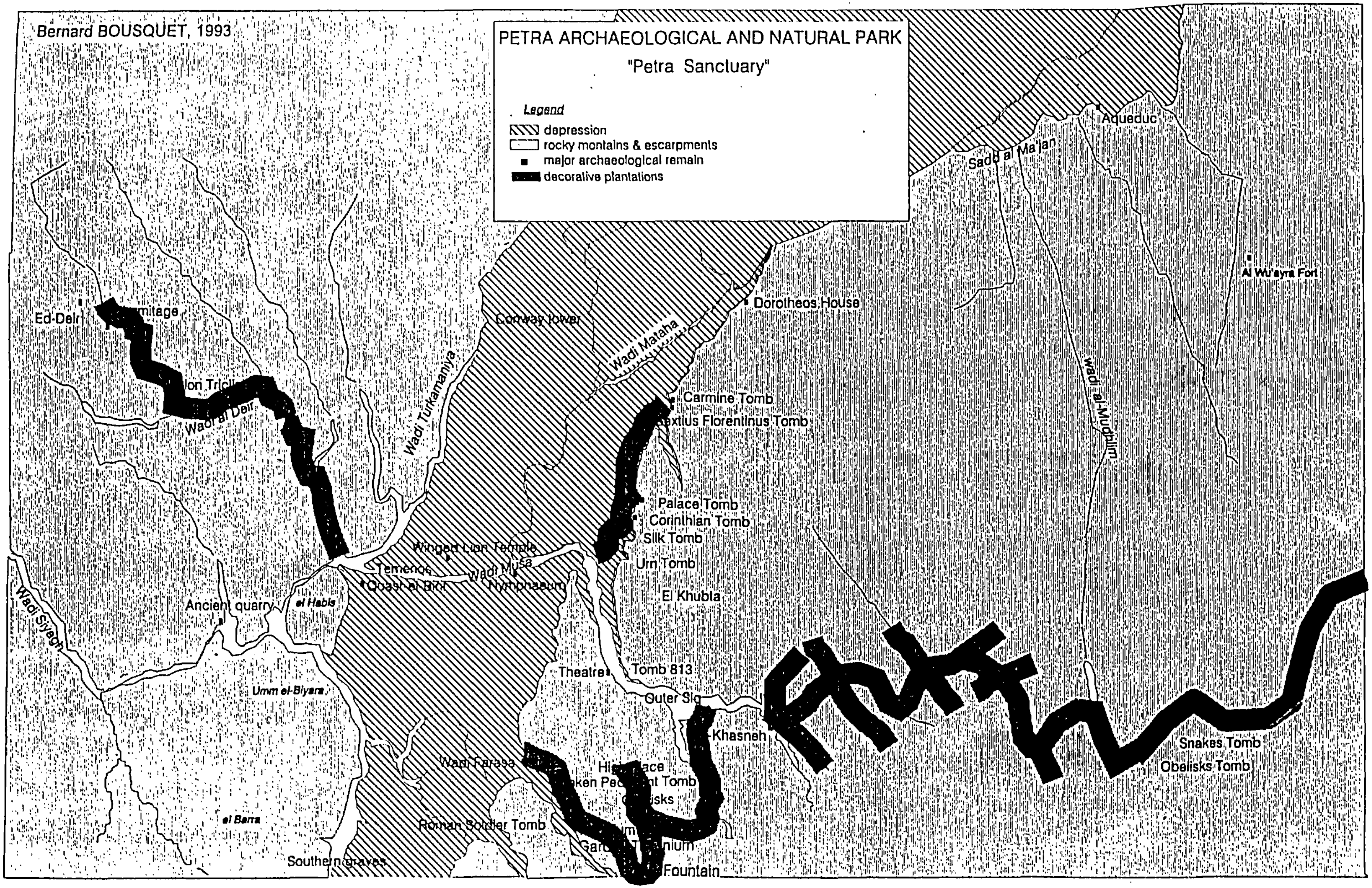

PETRA ARCHAEOLOGICAL AND NATURAL PARK
"Petra Sanctuary"
Legend
depression
rocky montains & escarpments
major archaeological remain
soil bio-stabilization (plantation) - 1st phase -
soil bio-stabilization (plantation) - 2nd phase -
Bernard BOUSQUET, 1993
Aqueduc
Al Wu'ayra Fort
wadi al-Mudhlim
Sadd al Ma'jan
Snakes Tomb
Obelisks Tomb
Dorotheos House
Corinthian Tower
Carmine Tomb
Sextius Florentinus Tomb
Palace Tomb
Corinthian Tomb
Silk Tomb
Urn Tomb
El Khubta
Tomb 813
Outer Siq
El-Khasneh
Theatre
High Place
Broken Pediment Tomb
Obelisks
Triclinium
Garden Triclinium
Lion Fountain
Roman Soldier Tomb
Wadi Farasa
Wadi Turkamaniya
Hermitage
Lion Triclinium
Wadi al Deir
Ancient quarry
el Habis
Umm el-Biyara
el Barra
Wadi Siyagh
Southern graves

Fig. 41

Fig. 42


Bernard BOUSQUET, 1993
PETRA ARCHAEOLOGICAL AND NATURAL PARK
"Petra Sanctuary"
Legend
depression
rocky montains & escarpments
major archaeological remain
decorative plantations
Aqueduc
Sadd al Ma'jan
Al Wu'ayra Fort
Dorotheos House
Ed-Deir
Conway tower
Wadi Mataha
Wadi Turkamaniya
Wadi ad Deir
Carmine Tomb
Sextius Florentinus Tomb
Wadi al-Mudhlim
Palace Tomb
Corinthian Tomb
Silk Tomb
Urn Tomb
El Khubta
Winged Lion Temple
Temenos
Wadi Musa
Qasr al Bint
Nymphaeum
Wadi Siyagh
Ancient quarry
el Habis
Theatre
Tomb 813
Outer Siq
Umm el-Biyara
Khasneh
Snakes Tomb
Obelisks Tomb
Wadi Farasa
Roman Soldier Tomb
el Barra
Southern graves
Fountain

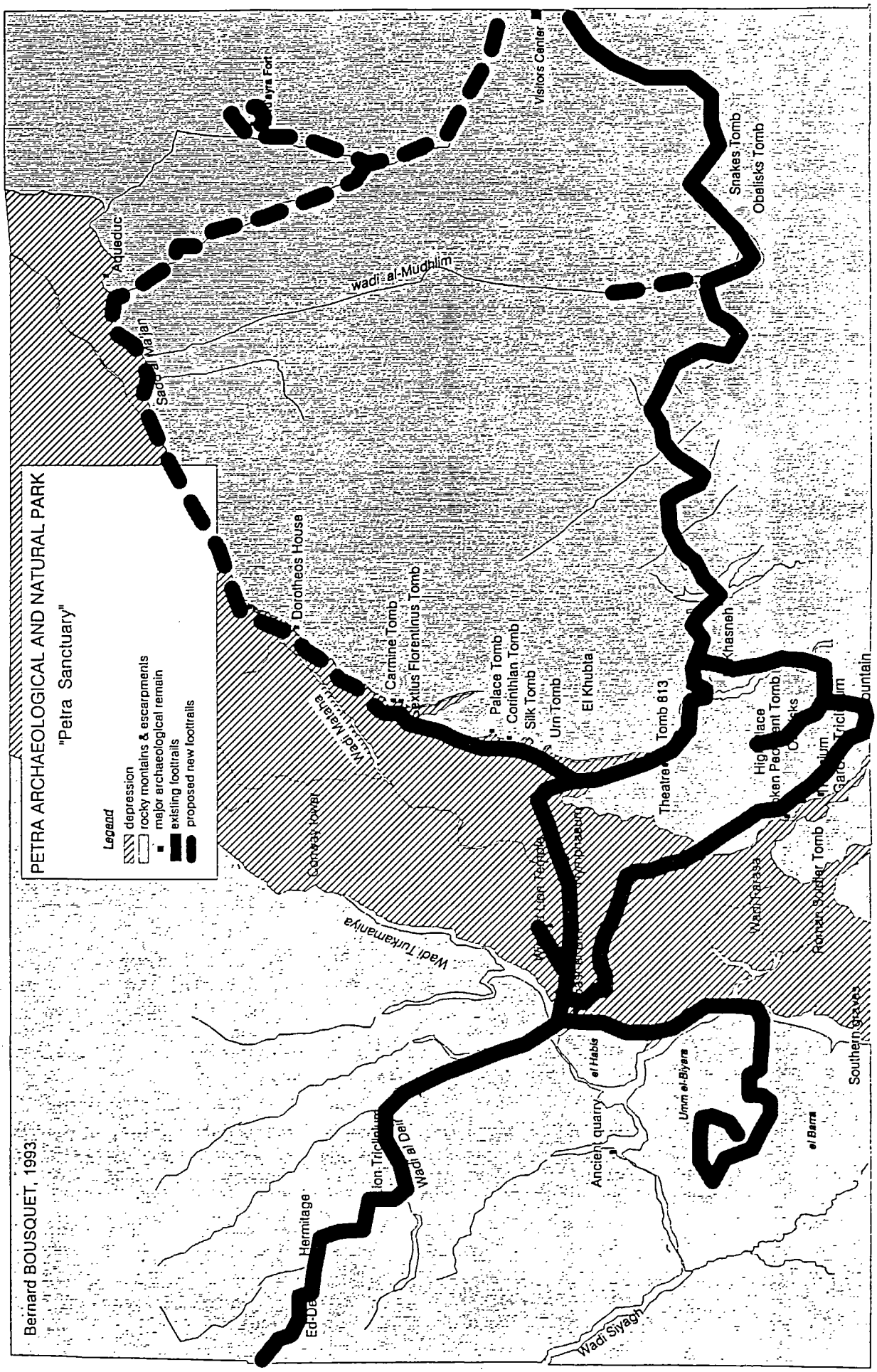

PETRA ARCHAEOLOGICAL AND NATURAL PARK
"Petra Sanctuary"
Legend
depression
rocky montains & escarpments
major archaeological remain
existing foottrails
proposed new foottrails
Bernard BOUSQUET, 1993
Aqueduc
wadi al-Mudhlim
Visitors Center
Snakes Tomb
Obelisks Tomb
Dorotheos House
Carmine Tomb
Sextius Florentinus Tomb
Palace Tomb
Corinthian Tomb
Silk Tomb
Urn Tomb
El Khubta
Tomb 813
Khasneh
Theatre
Wadi Mataha
Wadi Turkamaniya
Wadi Farasa
Roman Soldier Tomb
Southern Graves
Ancient quarry
Umm el-Biyara
el Habis
el Barra
Wadi al Dair
Hermitage
Wadi Siyagh

Fig. 43

Zone III:

Main objectives:
- sylvo-pastoral management of the oak forest (rotative pasture, regenerative growth preservation,...)

Restrictions:
- no mining (or mining exploration)
- no new road/track development
- no building (except Park facilities)
- no agriculture
- no plantation of exotic species
- no hunting

Zone IV:

Main objectives:
- implementation of sustainable agro-pastoral techniques
    . restriction of rainfed cereal culture development
    . fruit tree plantations development
    . water supply facilities
        * ancient cisterns restoration and cleaning
        * restoration/construction of limited waterworks (small dams, small canals,...)
- preservation of remaining steppe areas
- soil protection

Restrictions:
- no mining (or mining exploration)
- no hunting
- no urban (incl. new villages) development
- control of rural infrastructures development

Zone V:

Main objective:
- reduction of erosion process (runoff and wind)
- reduction of flood violence
- reducing sediment load of wadis
- preservation of downstream Petra Sanctuary (Um Sayhun Affor. Zone)
- stop Um-Sayhun village development towards Petra Sanctuary (Um Sayhun Afforestation Zone)
- reduce visual impact of village from Petra Sanctuary (Um-Sayhun Afforestation Zone)

Restrictions:
- no mining (or mining exploration)
- no hunting
- no agriculture
- no grazing
- no building (without Park Authority authorization)
- no camping and housing (except for authorized researchers and Park staff)

Zone VI:

Main objectives:
- establish and put into effect a village masterplan
- encourage plantations (fruit trees,...) in the village area

Restrictions:
- restrict any village development threatening the PANP integrity (visual impact, garbage & waste materials, fencing, public infrastructures,...)

Zone VII:

Main objectives:
- allow Bdul people living in Um-Sayhun village, to reach their southern tribeland, south of Petra

Restrictions:
- no circulation of people, animals or vehicles outside the transit zone

6. PROPOSED ADMINISTRATIVE STRUCTURE

6.1. IMPLEMENTATION OF THE MANAGEMENT PLAN

Implementation of the multi-sectorial, interlinked activities needed for the implementation of the Management Plan requires a single structure acting with enlarged responsibilities and autonomy within the Park's boundaries.

A "Project", acting on behalf of the national authorities, appears as the best type of structure capable of federating the various interests and interlocutors involved in the Petra region.

The Project should be led by a National Director, assisted by an International Technical Adviser. The Director should ideally have ministerial rank, and be responsible directly to the Cabinet or to the Royal Palace. The International Technical Adviser would ensure a kind of neutrality between contradictory interests, as well as implementing planning techniques. The National Director should have a good appreciation of the inter-relationships existing between the various issues. A preparatory training is foreseen (3 months).

A **Management Committee** should approve and supervise the implementation of the Project's activities.

The Management Committee will include one representative of each entity involved in or concerned with PANP conservation and development. The following list is indicative:

- Park Director	1
- Department of Antiquities (MTA)	1
- Department of Tourism (MTA)	1
- Dpt. of Environment/Land Protection Spec. (MMRA&E)	1
- Rangeland & Forest Dpt. (MOA)	1
- Agriculture Dpt. (MOA)	1
- Environment Sector (High Council for Science & Technology)	1
- Petra National Trust	2
- Royal Society for Conservation of Nature	1
- Scientist for culture & archaeology	1
- Scientist for natural resources (University,...)	1
- Representative of UNESCO	1
- Representative of each donor agency	..
- Representative of each local population group	3

6.2. ORGANIGRAMME

		Prime Minister or Royal Diwan		
	Management Committee	Director Petra Park	Technical Adviser	Admin. & Secr. Mapping technician
Assistant Conservation Cultural values	Assistant Conservation Natural values	Assistant Tourism	Assistant Rural Ecodevelopment	Assistant Urban Planning
Field Force 1 warden (2x2 patrolling rangers) 2 fixed rangers Antiquities Museum	Field Force 1 warden (2x3 patrolling rangers) 1 fixed ranger Natural History Museum	Ticketing Police 4 Entrance Gates (4x2 "guardians")	Extension workers (4)	
Ethnographic Museum				
1 Research Attaché	1 Research Attaché			1 Research Attaché
consultancy services	consultancy services	consultancy services	consultancy services	

The difficulty of providing some senior staff, such as the 4 assistants to the Director, can be overcome by a certain amount of technical assistance, as long as the Government has not affected suitable personnel. The proposed Technical adviser to the PANP's Director can also be provisory to one of the Assistants.

7. MANAGEMENT PROGRAMMES

7.1. PROGRAMME 1: "ARCHAEOLOGICAL CONSERVATION"

7.1.1. SUB-PROGRAMME CONSERVATION OF ROCK MONUMENTS (ROCK)

*** Action: Consolidation of the floor of the Siq**
The aim of this action will be to determine the best method for reducing dust pollution in the Siq and improve the comfort of visitors, while safeguarding the integrity of the site and displaying to the best advantage the fragments of original paving. Tests would be made with cleaning a section of the Siq down to bedrock, backfilling holes and consolidating the surface with a traditional lime mortar with a ground stone aggregate.

Implementation:
For this extremely sensitive operation, the DOA will need technical assistance in the form of consultancy services for the preparation of detailed drawings and specifications, and to provide the necessary close supervision.

Cost estimate:
survey, design and specifications (0.75 mm):

*** Action: International symposium on stone conservation**

Towards the beginning of the Project, an international symposium on stone conservation would be organized at Petra, with a view to bringing together international and national experts and institutions such as UNESCO, ICOMOS, the Higher Council For Science and Technology, Yarmouk University, Getty Conservation Institute, ACOR, GTZ, IFAPO, etc.

Implementation:
HCST, DOA, UNESCO and other international organizations and NGOs.

Cost Estimate:

$ 50,000

*** Action: Experimental treatment with EDF patented stone waterproofing process.**

This action has been proposed as a possible project for technical patronage by the EDF. Preliminary tests should be carried out on a monument of lesser importance until the possible long-term effects are known.

Budget:
Private sector finance. To be determined

*** Action: Halting erosion of monuments through planting**
see sub-programme (FLOR)

*** Action: Restoration of the Palace Tomb**

The Palace Tomb, crossed by several natural joints, shows many of the typical forms of weathering and failure mechanisms seen at Petra. The erosion caused by rainwater run-off is most severe where the protective cornices and gutters have been breached by the action of water infiltrating into the joints. The monument has been a potential danger to visitors since 1988, when several blocks of stone fell down from its masonry superstructure. A large triangular block of masonry has become detached along the slip-plane of a natural joint, and is in danger of falling. Some repairs have been carried out, but the consolidation of the masonry and clearing of the roof are far from complete.

A new pilot programme of restoration is needed, preceded by careful studies of the structural stability of the monument. The major issues to be dealt in the restoration project are:

- consolidation of loose masonry blocks in the upper part of the façade.
- experimentation with suitable means of securing the rock fragments, such as dowels and bolts.
- clearing the roof terrace and provision of adequate drainage to prevent rainwater infiltrations.
- prevention of damage from rainwater run-off by simple, reversible repairs to gutters and cornices.
- removal of vegetation growing in fissures.
- reduction of erosion by planting ground cover. (See sub-programme (FLOR)).

This action should be a model restoration project using simple, reversible means wherever possible. For the time being, however, the area immediately in front of the tomb should probably be roped off and closed to the public until it has been possible to carry out remedial work. A crane will be needed to hoist the building materials up 46 metres to its roof terrace.

Implementation:
The project must be preceded by a structural survey by a geotechnical engineer. Conservation work must be carried out under the supervision of a highly experienced architect/conservator, who would be attached to the project for its duration.

Cost estimate:

- geotechnical engineer (0.75 mm):	$ 15,000
- supervision, international expert:	project budget
- labour (30 x $135 x 4m):	$ 16,200
- 3 masons (3 x $225 x 4m):	$ 2,700
- equipment:	$ 6,800
- materials:	DOA
- publications:	$ 1,000
Subtotal:	**$ 40,700**

7.1.2. SUB-PROGRAMME CONSERVATION OF FREE-STANDING MONUMENTS (MON)

*** Action: Consolidation of Qasr al-Bint**

The immediate purpose of this action is to consolidate the structure and stabilize those elements which are in a precarious state of equilibrium. The project will also serve as a model project for on-site training in conservation.

The methods to be used should be, as much as possible, reversible, although it may be necessary to resort to some sophisticated techniques. If, for example, it is decided to fix the stones displaced in antiquity in-situ, it may be necessary to anchor them with stainless steel or glass-fibre rods.

In view of the outstanding importance of this monument and its structural instability, it is essential that any future restoration works be preceded by a thorough static examination by a structural engineer, in order to determine the resistance of the masonry, taking into account the possibility of an earthquake. The conservation work must be carried out under the direction of a highly qualified and experienced architect/conservator.

Implementation
The DOA will require technical assistance from an institution such as IFAPO, which has already carried out architectural and archaeological studies of the monument in the past, and could provide the necessary technical expertise. Laboratory testing can be done by the University of Yarmouk.

Estimated Cost:

- international experts (2 x 0.5 m/m):	$ 20,000
- supervision (foreign institution)	o/a project budget
- in-country experts (10mm x $2,500):	$ 25,000
- labour (15 x 10m x $135/m):	$ 20,250
- skilled workers (60mm x $225):	$ 13,500
- equipment:	$ 6,750
- materials:	DOA/running costs of project
- publications:	$ 1,000
Subtotal:	**$ 82,500**

*** Action: Consolidation of the Winged Lion Temple**

This action will be a model project for the conservation and presentation of a free-standing monument, the fragile remains of which have been exposed to the action of wind, rain and sand since their excavation. This project is urgent, as the ruins are rapidly deteriorating to the point where it may soon be too late to save them. The conservation problems to be addressed are:

- layout of site and protection against erosion by planting the surrounding area with suitable ground-cover plants (see sub-programme Flora and Vegetation).
- protection of the site against flooding by proper drainage.
- protection of the ruins against rain.
- protection of walls and column drums against rising damp, either by insertion of a damp-proof course, or by electro-magnetic process.
- leaching out salts in the stonework.
- consolidation *in situ* of the existing stones and stucco decoration.

Although a complete reconstruction should be ruled out, because too many of the original elements have disappeared, a partial anastylosis, using original elements, could be envisaged, provided that the proper evidence is available, in order to restore to the monument its vanished vertical dimension and increase its legibility.

The original appearance and function of the monument should be explained by suitable graphic and information panels on site and a scale model exhibited in the visitors' centre.

Implementation:
The design of the restoration project and the execution of the conservation work will need a high level of international expertise which could be provided by a foreign institution such as ACOR or IFAPO within the framework of an overall project. On-going projects will also be monitored by the UNESCO associate expert attached to the DOA.

Estimated Cost:

- Restoration study	$ 15,000
- Supervision (foreign institution)	Bilateral aid
- laboratory testing	$ 2,500
- labour	$ 17,000
- materials	DOA/project running costs
- publications	$ 1,000
Subtotal	**$ 35,500**

*** Action: Consolidation of Beida Neolithic Village**

The exposed remains need to be consolidated and protected by adequate fencing.

Implementation
PANP with the assistance of a skilled conservator from one of the foreign archaeological missions working in Petra (preferably the British Institute, who excavated the site).

Cost estimate:

- supervision:	o/a project budget
- consolidation:	$ 10,000
- fencing repairs:	$ 5,000
Subtotal:	**$ 15,000**

*** Action: Restoration of old stone villages**
see programme (TOUR)

*** Action: Upgrading sign posting**
see programme (INTER)

*** Action: Training** for conservators
see sub-programme (TRAIN)

7.1.3 SUB-PROGRAMME RESTORATION OF MURAL PAINTINGS (PAINT)

*** Action: Cleaning and restoration of Mural paintings at Beida**

The frescoes of the painted cave at Siq al-Barid, Beida, are the finest and most extensive of the very rare fragments of Nabataean mural painting of the Alexandrian/Pompeian style which have survived to the present day. Dimly visible through the thick coat of soot deposited on them through years of open fires having being lit underneath, they depict tree branches with cupids and singing birds. Cleaning, consolidation and reintegration of the paint layer are needed.

Implementation:
International expert or bilateral cooperation.

Cost estimate:

international expert (3 months)	$ 60,000 (or bilateral aid)
materials and equipment	$ 1,000
Publications:	$ 1,000
Subtotal:	**$ 62,000**

7.2. PROGRAMME 2: "CONSERVATION OF BIODIVERSITY & HABITAT"

7.2.1. SUB-PROGRAMME FLORA & VEGETATION (FLOR)

*** Action: Decorative plantation of local trees & shrubs within Sanctuaries**

Special effort should be made within the Petra Sanctuary to realize two objectives: to reduce dust and soil erosion, and to improve the aesthetic quality of the monuments' environment. There is evidence that the natural vegetation was much more lush before tourism development (e.g., David Roberts drawings), especially within the Siq. In restricted areas, beautiful small wild gardens could be established, as for example "hanging gardens", to benefit from and emphasize the natural rocky forms and topography. Several local species can be used, depending on the micro-ecological conditions (moisture, soil and exposure), but oleander will be the backbone to planting in the bottom of wadis and narrow canyons. The major touristic foot-trails should be treated first: the Siq (including the space in front of the 'Khazne'), the Outer Siq, to ed-Deir, up to the High Place, and Wadi Farasa (including the "Lion Fountain").

Obviously, such an action should not be implemented until regulations can be enforced.

Implementation:
Such an operation should be confided to a well-known landscape architect, selected through international bid.

Cost estimate:

- design study:	$ 15,000
- plantations:	$ 20,000
- *running costs (3 years)*	$ 3,000
Subtotal	**$ 38,000**

*** Action: Vegetation reconstitution in the vicinity of the monuments**

see: "Soil stabilization within Zones I (Sanctuaries)" of Sub-Progr. "EROS".

*** Action: Afforestation using local tree species**

see: "Afforestation programme for Zones V" of Sub-Progr. "EROS".

*** Action: Protection and Management of Hisha oak forest**

This oak forest is a community resource and should be protected by regulations and laws, and through awareness campaigns. Therefore, this activity aims particularly at improving sustainable use of the Hisha Oak Forest.

A management plan should be elaborated, with special emphasis on important issues such as: overgrazing control, early grazing prohibition, cutting and ploughing prohibition, natural breeding facilitation (enclosures), oak plantation, and awareness among local residents. It will help to protect the forest against abusive exploitation and/or powerful vested interests.

Implementation:
The study would be under the responsibility of the MOA.

Cost estimate:

- in-country expertise		
(2 man-months: agropastoralism & forestry)	$ 5,000	
- elaboration of Management Plan		
(1 man-month in-country expertise)	$ 2,500	
- putting into effect the MP (enclosures,		
awareness campaign, alternatives implementation)	$ 9,000	
Subtotal:	**$ 16,500**	**$ 54,000**

7.2.2. SUB-PROGRAMME WILDLIFE (WILD)

*** Action: Reduce poaching**

see: Programme "LAW ENFORCEMENT".

*** Action: Improvement of knowledge on wildlife**

see Sub-Progr. "INVEN".

7.3. PROGRAMME 3: "SUSTAINABLE RURAL DEVELOPMENT"

One of the main objectives of the PANP is to reconcile human development needs and cultural + natural resources conservation requirements, through the cooperation of all concerned, but the importance and the status of this protected area justifies that the conservation institutions should take the leading role to achieve this objective.

Alternative solutions for environment-friendly rural practices should be introduced within the PANP, with the basic support of a land use plan.

7.3.1. SUB-PROGRAMME LAND TENURE (LAND)

In this area, and more particularly inside the limits of the Park, land is government-owned and "Mirri", which means that individuals or groups have the usufruct. The uses of these lands, for agricultural purposes, depend on customary laws, and are divided among the tribal populations of the area. From an administrative point of view, as long as the name of the land-holder is not registered in a cadastre, this usufruct has no legal validity.

The three tribes dealt with in this study cultivate the "Mirri" land of Petra:

- **The 'Amarine**, established in the northern part, cultivate the area north of Wadi Beidha.
- **The Lyathne** of Wadi Musa have their fields to the south of Wadi Beidha and to the east.
- **The Bdul** cultivate the land in the south of the site, on the Stouh of Jebel Harun, and also on a part of the Beidha stretch.

The fact of not owning land, *Mulk*, is a main issue. Since it is not private property, the user has no incentive to have a long-term approach towards the land he cultivates. No preparation is done, and no long-term cultivation may be expected. Because it can be taken away, or any agriculture forbidden at any time, land is considered as a short-term resource, to be exploited until it dies out. This is the reason for the extension of cultivated land over the steppe, and for its intensive use, with little or no fallow.

*** Action: mapping at 1/10 000* scale**

A land tenure map to 1/10,000 scale is needed to delimit individual plots for agriculture. A second map, to be used in conjunction with the first, will show soil potential (see sub-programme Agriculture).

Cost estimate:

- expert (1mm):	$ 20,000
- in-country expert:	$ 2,500
- student team (lump-sum):	$ 8,000
- mapping:	$ 10,000
Subtotal:	**$ 40,500**

Action: preparation of contractual agreements between people and PANP

The object of this action is to develop and negotiate a form of land tenure agreement applicable to the populations living in and around the PANP, to permit the sustainable exploitation of agricultural land within the Park limits in such a way as to balance the exigencies of a National Park, the economic welfare of the local populations, and the national legislative system. The human factor is the main issue. Since these lands depend on those who use them, it is necessary to give the latter a certain security of tenure, through a system of long-term (say 20 years) lease.

The contract signed between the usufructuary and the Park Authority will provide the necessary technical advice on suitable plots and choice of species and protection of the natural cover, and will specify restrictions on ploughing and the use of tractors. It will form the basis of negotiations, propositions for exchanges, etc. between the different tribal groups. As a result, the populations living in the park will be able to participate actively in the management and protection of its resources.

Implementation:
The field study should be carried out by an international expert in applied judicial anthropology with thorough prior knowledge and understanding of the local populations, in close collaboration with the PANP, the MOA, the Dana Project, and the PNT, whose negotiating abilities have been proved in the past.

Cost estimate:

International expert (2 mm):	$ 40,000
In-country expert (agriculture, 1 mm):	$ 2,500
Subtotal:	**$ 42,500**

7.3.2. SUB-PROGRAMME AGRICULTURE (AGRI)

The extension of the cultivated areas with the use of tractors, little or no use of soil fertilizers, rain fed agriculture, no protection of the soil, and the planting of unsuitable crops, result in progressive desertification. The farmers are well aware of these issues. In the Stouh Jebel Harun, for example, the Bdul reap 50 kg of wheat from one dunum in a good season, diminishing to 10 kg with little rain. Five years ago, the Lyathne obtained 150 kg per dunum with plentiful rain, and 100 kg in a bad season.

Some fields on the verge of desertification or on steep slopes exposed to severe wind and rain erosion will have to be abandoned. The farmers questioned during the mission said they would be willing to abandon such fields in exchange for technical assistance to improve the yield of other more suitable land. Since cereal farming and fruit-tree planting are the main possibilities, it will be necessary to regulate both: the plain areas being more suitable for cereals and the slopes for fruit trees. Olive and apricot trees, vines and pomegranates are already cultivated within the three tribal areas, together with wheat and barley. The persons concerned are ready to shift from one crop to another.

Several steps, technical and administrative, have to be taken urgently. The objectives are double: firstly, to improve the quality and quantity of the produce; secondly, to apply appropriate techniques for arid zones in order to help reduce erosion by wind and water and the threat of desertification.

The improvement of the available water systems will be dealt with under sub-programme Water Resources.

*** Action: Soil survey and preparation of land capability maps**

It is essential to carry out a reconnaissance soil survey, using aerial photograph interpretation (satellite imagery ?), backed up by the necessary field work, in order to define those areas which are unsuitable for arable cropping because of excessive slope, rockiness, etc. Based on the soil survey, it will be possible to assess the capacity of the soils to sustain long-term dry land cropping, including their susceptibility to erosion, and inherent fertility.

Implementation:

As no standard land capability classification has so far been developed for use in Jordan, international consultantcy services would be provided to assist the Park's ADED and MOA (Dpt. of Agriculture) in formulating a system of classification adapted to the Petra region. It is assumed that a first consultancy would be required prior to the commencement of field work, in order to define the information to be collected during the survey. A later input would be needed to assist with the application of the land capability criteria and with the reporting of the survey.

Cost estimate:

Soil surveyor/land classification specialist 1 mm	$ 20,000
- Jordanian staffing (semi-detailed survey) 2 mm	$ 5,000
- reporting 1 mm	$ 17,000
- mapping	$ 5,000
- equipment	$ 300
Subtotal	**$ 44,300**

*** Action: Promotion of orchard plantation**

The Park Authority will promote fruit tree plantations. It will help the usufructuary by preparing terraces for fruit-trees and rehabilitate ancient Nabataean terraces.

Implementation:
PANP and MOA.

Cost estimate:
To be determined

*** Action: Improvement of cereal cultivation**

Other terraces can be prepared for cereal farming, particularly in low sloping areas, with olive or fruit trees planted on the edge of each terrace.

Cost Estimate:
to be determined

*** Action: Integrated restoration of Wadi Mataha**

The Wadi Mataha project is a pilot example of the possibilities of achieving an archaeological and environmental type of integrated rehabilitation with strong social values through the presence of the local population as employees and managers.

The aim of the project is to restore the system of water conduits in the terraces and gardens and make an inhabited environment of ancient Petra worth visiting. The diverting dams and cisterns and cultivation of Wadi Mataha will be reactivated. The area will be managed by the Bdul groups of Um Sayhun who will be responsible for maintaining and cultivating it and who will exploit it economically for tourism and agriculture. The highly prestigious project will provide an added attraction for a visit to Petra, and will enable the effects of the environmental restoration to be tested on the protection of the monuments and the possibility of involving the local population in the managing and maintenance of the territory, the only guarantee of long-term protection (**Fig. 14**). It is obvious that this project can not start until regulations can be enforced and land tenure agreements finalized.

Implementation:
PANP, MOA, universities, foreign institutions...

Cost estimate:

- preliminary survey, technical and landscape studies (lump sum):	$ 50,000
- repair of terrace retaining walls:	$ 20,000
- repair of dams:	sub-programme water
- cleaning, repair of cisterns	$ 5,000
- repair of water conduits, aqueducts	$ 17,000
- equipment	$ 8,000
Subtotal	**$100,000**

*** Action: Integrated restoration of Wadi Farasa**

See sub-programmes (FLOR) and (CIRC)

7.3.3. SUB-PROGRAMME LIVESTOCK & PASTURE (PAST)

Together with agriculture, animal husbandry is one of the main "traditional" activities, although the number of herds and their size has diminished considerably during the last decades. The 'Amareen, the Bdul and the Lyathneh all have herds, and some move with them in search of pastures, the general movement being north-west in winter, towards the hotter areas of Wadi 'Araba. Starting from springtime and all through summer, this movement is towards the south-east on the Shara heights.

It is necessary to exercise a degree of control over the rangelands if the flora of the steppes and the tree cover, particularly the ancient Hisha forest, are to be conserved, and in order to prevent rapid erosion. For this it is important to regulate pasture movements. The persons interviewed were prepared to accept a certain amount of control, but a full explanation will be needed of the procedures to be followed, and a "grazing agreement" drawn up.

*** Action: Livestock survey**

It is clear that obtaining relevant data on the present herds living in and/or moving through the area, represents a starting point for any livestock and range management plan.

The scope of work is:
1) to carry out a sample survey of the domestic livestock of the Park's area over the period of at least 1 year, recording births, deaths and disposals, in order to define the population dynamics of the goats and sheep. The sample shall be so selected as to allow statistical analysis of the data to permit extrapolation to the total livestock population of the area;
2) to collect data on management practices presently used by the herd owners, to identify potential methods of improving management;
3) to report the findings of the survey, including recommendations for improvements in management together with the economic implications for the livestock owners of such changes, like better adequation between carrying capacity and stocks, range improvement (exclusion zones, forage plantation, prohibition of early grazing,...).

Implementation:
Design of methodology and recording techniques, and data processing as well, could be the same as for DWR.

1 month of consultancy services is required to address this issue, in close collaboration with ADED and MOA (Forestry & Rangeland Dpt.).

Cost estimate:

International expert (1 mm):	$ 20,000
in-country expert (1 mm):	$ 2,500
Subtotal:	**$ 22,500**

*** Action: Establishment of "Grazing agreement"**

This action consists of drawing up of regulations concerning the rangelands (as defined in the agreed land use plan) inside the limits of the park and the buffer zone. These regulations will form the basis of a signed contract between the Park authority and the individual herder. The contract will contain the following stipulations:

- Control of the grazing areas and distances covered, following the regulations.
- A rotational system whereby areas will be protected for a period of five years and where high quality foraging plants will be grown.
- Breeding regulations: breeds, medical and hygienic control, etc.
- Dairy products (dried yoghurt, milk and butter): control and assistance for commercialization.

Implementation:
The preliminary study will be carried out under the authority of the MOA.

Cost estimate:

- agro-pastoralist expert (0.75 mm):	$ 15,000
- in-country expertise (1 mm):	$ 2,500
Subtotal:	**$ 17,500**

7.3.4. SUB-PROGRAMME RURAL INFRASTRUCTURES (RINF)

The uncontrolled growth of the urban areas leads to ever-increasing infrastructure costs. The drinking water supply system and the water disposal system are inadequate or nonexistent. The risk of violent floods on the abandoned slopes is more and more serious and the whole environmental system is in danger of total collapse (**Fig. 34**).

The present trend is to create a large agglomeration that, following the line of the springs, embraces the whole archaeological site of Petra. Thus instead of being a unique place in the world for its monuments that are totally immersed in history and nature, this site runs the risk of becoming, like the Pyramids at Cairo, the theatre of Amman and the vestiges of Gerasa, an archaeological centre, incorporated into and suffocated by uncontrolled development. This process is all the more dangerous for the monuments of Petra because the area in question is that of the upper basin of wadi Musa, overlooking the ancient city. The area is of archaeological interest because the Nabataean hydraulic works started from here, and it is of vital ecological and environmental interest for the city: everything that is discharged at the level of the springs from Beida, Wadi Musa and Taiyibe will end up in Petra, and everything that is done in this area will have repercussions on the protection of the Nabataean city.

A protection and planning area including the Great Petra needs to be defined. The aim is to avoid an uncontrolled growth of a single agglomeration and promote the harmonious and coordinated development of the Great Petra region, including archaeological areas, natural sites, urban areas, land for farming and production, tourist and residential areas. The identity of the individual villages will be maintained by a plan that will take the possible interactions and synergies into consideration, avoiding the creation of a continuous fabric and instead organizing huge buffer areas and woodland protection areas. The Archaeological and Natural Park will have authority over planning and management).

*** Action: Drawing up design codes and planning regulations for the villages**

Enforceable planning and building regulations adapted to the local circumstances are badly needed. The most urgent problems to be addressed are: expansion plans for Wadi Musa and Um Sayhun, a redevelopment plan and land use map of Wadi Musa, and strict regulations on height restrictions, design standards and permissible building materials. A good start has been made by the University of Jordan. The plan will also have to take into account prospective archaeological sites.

Implementation:
International bidding open to Jordanian practices. The University of Jordan should be associated with the study.

Cost estimate:

Town planner:	30,000
Architect:	20,000
University team:	5,000
Mapping:	5,000
Subtotal:	**60,000**

*** Action: Soil Waste Disposal**

There is no disposal system for used water. At Wadi Musa the two alternatives suggested I) to convey all the water down to the entrance to the archaeological area near the Rest house and II) pump it to a higher level and treat it near Um Sayhun, are both unadvisable. The first, because it would require a huge depuration plant right at the entrance to Petra's monuments. On the one hand this plant would have a heavy environmental impact in an area crossed by tourist flows, and on the other it uses a type of technology that is unreliable in arid zones, and hazardous because it lies on the wadi course. In the event of breakdowns or floods, everything would be carried down to the Petra site. The second solution, with the need to raise and pump the water, would increase the risks of obstructions and breakdowns, without entirely removing the dangers from Petra.

A correct system for disposing of used waters should be organized by means of a non-centralized water disposal system, divided into sectors using the morphology of the site itself created by descending terraces like large sloping basins (Fig. 35). The purification of used waters utilizes these same terraces as a system of dispersion tanks in the soil itself, filtering the water and using it to irrigate green areas. These become areas where building is not allowed, to check urban expansion.

Implementation:
PANP, Ministry of Municipalities, Governorate of Ma'an. Design study by civil engineering consultant. This study could be incorporated in the planning regulations study.

Cost estimate:

Design study:	30,000

7.3.5. SUB-PROGRAMME WATER (WATER)

*** Action: Water requirements study**

A study of water supply needs is important. The local population should have priority over the water resources, whereas the needs of tourism are likely to grow, and even exceed, the carrying capacity of the region. Already, with new hotel projects being planned in the area, worries about the adequacy of the water resources were expressed to the team by the Municipality of Wadi Musa.

On the other hand, Petra is an immense water well. The Nabataeans developed an exceptional hydrological system for stocking and distributing rain water. In order to promote agriculture, it will be necessary to rehabilitate as many as possible of the ancient cisterns and dams.

*** Action: Cleaning of Nabataean cisterns**

Some important Nabataean cisterns have been marked on the map. The bedouin have already cleaned and restored some. According to them, the cleaning of a cistern 4 m deep and 6 m wide costs almost 600 JD.

*** Action: Restoration of ancient small dams, construction of new ones**

Old dams can also be restored, and new ones built in small valleys. Construction costs will not exceed 2000 JD for a small dam.

*** Action: urgent small-scale hydraulic measures at territorial level**

A torrential flood like the one in 1963 when 1 million m3 of water poured into the Siq in Petra in a quarter of an hour, or the one in April 1991, is always possible in the region's catastrophic type of climatic regime. However there is no point in building huge protective structures designed for catastrophic events which are generally useless for most of the time and which then turn out to be insufficient when an exceptional flood does occur. It would be more appropriate to introduce a policy of small-scale hydraulic works, repairing banks and barrages, protecting the soil: preventing the formation of big floods by separately controlling the numerous tributaries and by holding back the water on the slopes.

The most important measures of this far-reaching programme involve the repair of the wadi Musa course and of its tributaries within Petra; the creation of stone diverting dams and of flooding zones above the site; the cleaning and protection of the banks of the wadi Mudhlim; the repair of the dam on the wadi Abu Uliayqa above the Turkmania to be carried out at the same time as the organization of the vehicle-park in this area.

*** Action: the integrated Wadi el Mataha project**

7.3.6. SUB-PROGRAMME EROSION CONTROL (EROS)

*** Action: Afforestation programme for Zones V**

There will be rain-fed tree plantations, with support of additional watering if required (earliest years). In some cases, fruit trees should be planted, for better population acceptance and maintenance, but local

tree species like juniper, pistachio, carob, oak, even slow-growing species, should be given priority, especially when compensatory planting is the main goal (e.g., scattered juniper stands growing on the steep slope of the limestone plateau between Wadi-Musa and Um-Sayhun). Exotic species like *Acacia cyclops, A. cyanophylla*, eucalypts, should be avoided within the Park area, except on very degraded lands where, in a second phase, they could facilitate climax vegetation recovery.

A quota of, say 50 ha/year, could be planted.
The establishment of a nursery is needed within or close to the Park. 1/2 ha of relatively flat land appears to be sufficient, if possible located on fertile soil and with suitable water supply.

Implementation:
This action would have to be implemented by the Forestry Dpt. (MOA), through the Ma'an Provincial Service; but the local Forestry Service is extremely weak.

Cost estimate:

- nursery establishment (1/4 to 1/2 ha)	$ 10,000
- *running costs ($ 1,500 + staff)*	$ 1,500
- plantations (50 ha/yr x 3 yrs = 150 ha)	$170,000
(30 labourers x 1.5 m/m)	$ 30,000
- *running costs (3 years)*	$ 5,000
Subtotal:	**$ 21,500**

*** Action: soil stabilization within Zones I (Sanctuaries)**

This action aims at reducing the effects of wind and water erosion within the Petra and the Beida/Siq-el-Berid Sanctuaries.

In the immediate vicinity of monuments, the most eroded and fragile areas are shown on map Fig. 9. They will be planted with indigenous grasses, herbs, shrubs or trees, adapted to the prevailing ecological conditions of each site. They will become **controlled areas**, where trespassing and plant removal should be sanctioned by fines. Non palatable species (goats) are preferable (Retam, Oleander, *Daphne linearifolia,...*). Visitors could be incited to use stone ways (1 m wide). For reasons of cost and aesthetics, fences are to be avoided.

The Park's nursery will provide this programme with cuttings and seedlings. Watering could be needed at the beginning. Donkeys loading water tanks will be rented from local people.

Implementation:
This action has to be linked with "Decorative Plantation of local trees and shrubs within the sanctuaries", especially by using the services of the landscape architect (same tender). The protection of the monuments will be of paramount importance during the contracting phase.

Cost estimate:

- design study:	$ 10,000
- nursery:	PM
- plantations (contracting)	$ 10,000
- stone ways (3 km)	$ 9,000
- *running costs (3 yrs)*	*$ 6,000*
Subtotal	**$ 30,000**

7.3.7. SUB-PROGRAMME FOREST MANAGEMENT (FORES)

The management actions included in this SP. aims particularly at improving the sustainable use of the Hisha oak Forest.

*** Action: establishment & implementation of the Hisha Forest Management Plan**

7.4. PROGRAMME 4: "TOURISM"

7.4.1 SUB-PROGRAMME TOURISM INFRASTRUCTURE (TOUR)

At Petra, the problem of tourist accommodation is difficult to resolve owing to the overriding need to protect and preserve the archaeological, natural and scenic values of the site.

At present, there is a considerable lack of tourist facilities in Petra. Requests for visits already exceed the facilities provided and they will increase with time. However it is not a matter of limiting the flow of tourists, but of managing tourism more efficiently. Tourism can be negative for a site, but it can also be a factor of conservation and an economic opportunity that should certainly be preferred to harmful and destructive industries. The figure of 1,000 visitors per day recorded for Petra seems enormous only in comparison with the present shortcomings, but it is still low in comparison with other international tourist venues and to the attraction of the site of Petra.

A different management model is needed. The organization of the Great Petra park will provide new itineraries and opportunities for longer and more detailed visits. The tourist model of the big hotel in a panoramic and dominant setting, away from the town, demands a short and expensive stay, cut off from the town centres, and with no benefit for the latter. A different model could meet the requirements of the local population to benefit more adequately from tourism and could integrate the needs of tourism with the aim of protecting the architecture and landscape.

Thematical and geographical diversification of touristical activities should be the backbone of this Management Programme. To this end we propose three different systems of tourist facilities: **a**) agricultural tourism; **b**) the great itineraries of nomadic tourism; **c**) a high standard of hotel tourism.

Agricultural tourism

Agricultural tourism is a synthesis between the aims of architectural rehabilitation, environmental protection and tourist development. Today those who work in tourism abandon the old villages and the cultivated land that provided the only protection against erosion and environmental degradation. By giving the inhabitants who manage their farms correctly the possibility of organizing tourist facilities, an incentive will be provided for them to return to their old villages and crops. For the visitor, accommodation in a traditional village with its rhythms and way of living, food, festivities, the opportunity to learn and to meet the people would provide a further attraction. By offering living styles that differ from those of the type of tourism which conforms to international standards, and is also more economical, visitors are encouraged to prolong their stay, making use of the possibility of following extended itineraries organized on foot, on horseback or by camel with the guides, means and experience provided by the same agricultural tourism company. Bdebdebe, Beida, El Hai, Newafle and other scattered agglomerations can thus be recovered. In this context the Taiyibe project is already an example of architectural restoration work. The organizational model consists of providing the owners, the families themselves, with an incentive to practice tourism and agriculture. The first activity

supports the second which remains a safe economic basis in case of variations or a fall in the number of tourists. International funds and aid can be organized for these projects, whose aim is to develop the local economy and guarantee protection and management of the environment at the same time.

Nomadic tourism

The area of the PANP and its surroundings is so vast and offers such a variety of landscapes that an exhaustive visit can only be afforded by an itinerant tourism. The trip with guides, on foot, on horseback or by camel, with donkeys could be made using temporary accommodation and in tents. If properly organized for small groups on a strictly limited scale, this type of traditional accommodation and hospitality would appeal to discerning visitors, and manage tourist flows with respect for the cultural and natural heritage.

Evidently, sufficient preparation of the itineraries, a thorough assessment of the impact on the natural environment, and guides with a thorough knowledge of the terrain would be necessary, and no initiative outside the appointed plans should be allowed.

Hotel tourism

Hotel tourism is at present the main type of tourism offered in Petra. It is inadequate as far as high quality service and the possibility of providing more economical accommodation are concerned. The average length of a stay in Petra is so limited nowadays that even the visit to the monumental part is reduced to the minimum of its possibilities. This is due both to the lack of a centre for the direction and organization of new itineraries, and to the tourist structure of the large hotels, which gives preference to a short, expensive sojourn with an abundant rotation of visitors. The need for new spaces for hotels cannot be denied, but this must not be achieved to the detriment of the site, in areas where their visual impact and effect on the landscape would be negative, or in environmentally important areas. It is of no consequence for the tourist after a day spent visiting Petra, to be able to look over it from above, while the construction of hotels in this position will certainly damage the incomparable harmony and unity of the landscape which can still be observed from the monumental area and from the high places in Petra.

A total of 772 additional beds is planned in the Petra region. This extension must be perfectly controlled, in order to preserve the environment, and conserve the image of quality and high level tourism at Petra. The Jordanian Ministry of Tourism being very sensitive to this problem, legislation has been instituted to limit the height of constructions to two storeys, and their maximum capacity to 200 beds. Notwithstanding, the Ministry of Tourism has approved the construction of four hotels on the hillside overlooking Petra between Wadi Musa and Taiyibe, in a position visible from the site, above the line of natural springs. This project raises a double problem:

- damage to the view from the site
- evacuation of drainage

It seems advisable to build only one hotel in this area, for several reasons:

- The Petra Forum has already foreseen an extension of its capacity of accommodation.
- Too strong a concentration of hotels does not necessarily meet the demand of the clientele wishing to "appropriate" the site.
- The rare and precious character of water in Jordan imposes the respect and the limitation of its utilization.

For all these reasons, it is important to ensure that these hotels are not concentrated in one place where the most important water sources of the basin are concentrated, and to exercise the utmost caution in the treatment of sewerage and waste water for any hotels in the Petra area.

The area privileged for the construction of new hotels is Wadi Musa, to be qualified as a superior tourist centre. The area is already built-up and is subject to rapid saturation. It would be appropriate, rather than occupying new land, to situate hotel structures in this area which has already suffered from the point of view of the landscape, and to use the new buildings as part of the planning and enhancement of the urban space and buildings.

Such a development in Wadi Musa, however, should not be permitted until such time as a coherent Urban Plan, including a land use plan and a careful planning of infrastructures have been drawn up. The Municipality should have the power of pre-emption of land in order to improve its capacity for managing land resources. The aim should be to ensure that each intervention, whether on the monuments, the buildings, roads and trails, sign posting or sales outlets, contributes to the overall aim of quality (respect of the environment and protection of cultural heritage) and efficiency (maximum exploitation of local possibilities of development).

*** Action: Impact and feasibility study for tourism projects**

The aim will be to assess the economic viability and environmental impact of new hotel, agro-tourism and nomadic tourism projects, particularly in terms of water resources, and prepare an architect's brief to form the basis of an international bidding exercise.

Implementation
PANP, MOTA, MOA. The feasibility study should be carried out by an international consultancy selected by competitive bidding. Until a new administrative structure is set up to manage the Park, the Petra National Trust should be consulted concerning all projects for the construction of hotels in the Petra region.

*** Action: Upgrading sanitary facilities**

Without any further comment, it is sufficient to follow any group of tourists, as was done during the mission, particularly groups of elderly people, in order to realize that the lack of sanitary facilities does not incite people to prolong the duration of their stay. In particular, there are no facilities between the entrance of the site and the restaurant.

The archaeological zone of Petra needs an adequate number of lavatories organized in specially planned spaces, with water supply systems and dispersion tanks. With the already existing points and those yet to be built, the number of lavatories reaches 12 in the central Petra area. The lavatory sites are also those where there will be small cafés, places of refreshment and sales points, where the managers will be responsible for maintaining the sanitary facilities.

The sanitary facilities to be provided will be located: in the area between Qasr el Bint, the Museum and the restaurant: (1) the lavatory in the archaeological centre that already exists will enable a functional facility to be provided for visitors; (2) in the museum, existing facilities; (3) in the restaurant, existing facilities; (4) in the café "Nabataean Shop" garden; (5) at the ancient monuments, already existing. Between the theatre and the Urn Tomb: (6) large sanitary facility at the foot of the Urn Tomb. On the slope descending from the high place: (7) facility to be built in the horse stopping place towards Wadi el Farasa. At the Deir: (8) dispersion facility behind the present refreshment building. At Snake Monument: (9) dispersion facility. Along wadi el Mataha: (10) facility to be built in the horse park

between Doroteus House and Sextius Florentinus. At the entrance to the Siq: (11) partially existing facilities. At the Turkmania: (12) facility to be built together with the reorganization of the vehicle-park.

*** Action: Design and implementation of prototype sanitary facilities**

Detailed studies will be necessary in order to economize precious water resources, and integrate the design of the new facilities into their surroundings in such a way that they are not visible from the monuments and do not disturb the harmony of the site.

*** Action: Reorganization of shops and cafes**

The abundance of unorganized trade and the disorganization of refreshment facilities along the itineraries are prejudicial to the aesthetic unity of the site. Only about twenty merchants have licenses to trade inside Petra, although many more have set up ugly metal stalls in places frequented by tourists. The wooden shelters erected by the Department of Tourism in an attempt to impose some order on the stalls are in fact more damaging to the character of the site than either traditional bedouin tents or those shops and cafes discretely tucked away inside caves. Better solutions must be found, without depriving the visitors of their purchases or the merchants of their livelihood.

A distinction should be made between the newcomers and those tradesmen and cafe owners with licenses who have been established for many years in their present locations, and who have become institutions in their own right and are well liked and appreciated by tourists. Their premises are often well maintained and well integrated into the site. They provide many valuable services to visitors such as first aid, and should, wherever possible, be allowed to stay in their present positions.

The sale of souvenirs should be avoided outside specific areas destined for traditional markets, or set up in specially prepared caves. Places of emotional and aesthetic value such as the façade of the Treasury, the Deir, the high places etc., must absolutely be safeguarded against the invasion of market stalls.

As is the case for all of the management programmes suggested in this draft Management Plan, it should be emphasized that any new development be coordinated by the Park Authority and its management and advisory committees, within the framework of an overall detailed development plan, taking into account its environmental and socio-economic implications. As an indication, to be followed by further study, the following ideas are proposed.

- Construction of permanent traditional "suqs": at the entrance to the site (in place of the public lavatories which double those in the visitors' centre) selling guide books, films, postcards and national handicrafts, to replace the existing temporary structures; and at Um Sayhun, which would benefit from the flow of tourists for the new carriage traffic.
- Along wadi al-Mataha, where the Nabataean cave dwellings could be presented to great advantage.
- Two or three "teashops" inside some of the less important caves would make the visit more comfortable and facilitate contacts with the bedouins.
- A souvenir shop at the end of the principal itinerary, in the restaurant building (in the small space actually reserved for, but too small for, a site museum). This shop would sell certified copies of archaeological objects in the museum's collections.
- In the centre of the site, just after the theatre, a group of shops inside the series of less important caves below the royal tombs.

*** Action: Electricity supply**

The electricity generator behind the restaurant is particularly noisy and disturbing; its presence does not encourage the visitor to continue the visit as far as Al Deir. The clouds of dust raised by the horses are a nuisance for visitors, who are obliged to cover their faces. This dust is also tarnishing and damaging the walls of the Siq. The generator could be buried underground. A better, long-term solution would be to provide an electricity supply line to the site.

7.4.2. SUB-PROGRAMME VISITOR CIRCULATION (CIRC)

The various propositions set out below present the advantage of avoiding too great a concentration of visitors inside Petra, thus helping to preserve the natural heritage of the region.

From a sacred and monumental road, the Siq has become a place where dust and bad odours are unbearable. The dirt raised by the wind attacks the sandstone walls and the monuments, threatening the safety of Petra. Horse transport is of no use to tourists. In fact for people who are unaccustomed, it is certainly more dangerous and fatiguing to travel on horseback than on foot. The visitors choose to use horses because this is proposed as a custom that cannot be refused. On the other hand those who are experienced riders and love horses, certainly do not appreciate the appalling conditions in which they are used in the Siq in Petra. In any case it is certainly more agreeable to go to the Siq on foot to appreciate the many points of interest; these visits are disturbed today by the continual coming and going of too many horses, by the dust and bad odours.

The solution to be adopted should be the result of detailed studies within the framework of the site development and management plan taking into account the economic well-being of the local communities as well as a careful study of possible negative impact on the environment. The suggestions which follow are therefore indicative only, and are subject to modification as more data becomes available.

In the long term, it would be desirable to limit, or even prohibit, animals throughout the Siq and within the city walls of Petra, which would become a pedestrian area. Two other possible means of access to the archaeological zone could be envisaged. One is along the asphalt road through Um Sayhun, and the other on horseback along Wadi al Mataha. Road access could be from the panoramic road from Wadi Musa to Um Sayhun by small buses or open vehicles specially equipped for Petra.

The asphalt road must of necessity stop at Turkmania where there is space to organize a car-park. From this point the visit will continue by carriage or on foot towards the restaurant or museum. A possibility of access on horseback will be provided by the track that leaves the panoramic Um Sayhun road and descends towards Mughuran Nasara and enters Wadi al Mataha. The horses would have to stop and go no further than the tomb of Sextius Florentinus. Another place where horses and camels can be left is on the slope coming down from the High Place towards wadi el Farasa where at the end of the itinerary on foot, tourists can be taken back towards Zibb el Faraon. This same place could be the starting point for long-range itineraries towards Snake monument, Djebel Harun, Sabra and Wadi Araba.

It is clear that horses, completely banned from the Siq and from the site within the walls of Petra because of the need to safeguard the site, remain one of the characteristics of the Nabataean city and must become one of its positive features. The idea of Petra linked to horseback rides should be maintained and strengthened, improving the quality and care of the horses, preparing tracks beside the asphalt roads and organizing horse-races and tournaments. Those who work at present in this field will

find compensation for renouncing their activity in the Siq from the increase in the number of long-range itineraries and a better overall organization of the sector. On the tourist farms, a week can be spent practicing riding to enable tourists to visit the great Petra park on horseback or on camels.

With this traffic organization, the project of paving the Siq will become unnecessary, because when it is no longer used by horses, it will regain an ecological balance by means of light repair work.

The tourist, informed and oriented as to the various possibilities, may choose to enter Petra on foot, following a route that is no more fatiguing than a visit to any other historical town centre and is of international monumental interest. Completing the circuit as far as the museum and the restaurant, the tourist may decide to return on the bus which he will take at the Turkmaniya. Elderly people, or those who are unable to walk, can reach the bus-park at the Turkmaniya by carriage or decide to reach Petra directly by this means. This route will also be used by those who have already visited the Siq and intend to visit other parts of the town. Those who are fond of riding on horseback may choose the third possible entry, through wadi Mataha, which with its wide, ample banks does not have the same problems as the Siq, and being part of a project for environmental restoration, would be an added attraction.

Implementation:

Programme to be developed. All of the above studies could be carried out by one multi-disciplinary consultancy, selected by competitive bid.

Cost estimate

8 mm	**$ 160,000**

*** Action: Impact assessment study related to creation of new visiting itineraries**

One should carefully examine the creation of new itineraries before actions are taken. Indeed, in the worst cases, negative impacts on antiquities and vegetation could be extended to other sites. For example, regular camel riding to Wadi-Sabra could increase browsing pressure on fragile wadi vegetation, with biological and ecological consequences.

A careful impact assessment should be carried out for any proposal. Therefore, a detailed plan of visitor trails can not be designed here. A preliminary study is needed.

Implementation:

Ecologist/parks management specialist.

Cost estimate

1.5 mm	$ 30,000

*** Action: Development of new touristic itineraries**

This action should be developed taking into account the preliminary studies required ("Impact assessment study related to the creation of new visiting itineraries" and "design of signalization"). One 3-4 day circuit (e.g. horse riding) could be designed to link Petra with the Dana Wildlife Refuge in the North and through the "corridor". This circuit, constantly over 1,200 m altitude, would be particularly appreciated during summer.

The approximate needs of the Park and the region in various materials and equipment are summarized below:

- *trekking:*

. foot trails: 100 km
. horse trails: 200 km
. camel trails: 100 km

Most of these itineraries are existing infrastructures, requiring only punctual improvement (especially regarding security standards), and marking out.

- *sign posting*

The main points of access to the park (roads entering the park) should be clearly and pleasantly indicated (adequate panelling).

Cost estimate

- trails development:	$ 14,000
- panels:	$ 8,000
- *running costs (3 years):*	*$ 3,000*
Subtotal:	**$ 25,000**

*** Action: Consolidation of the floor of the Siq**

See sub-programme (ROCK)

*** Action: Creation of a minibus service**

The feasibility of creating, within the Park service, a small company, which could be run by the Bdul from Um Sayhun, to organize a minibus service with a small fleet of 5 to 6 vehicles holding from 15 to 17 passengers to take passengers back to their hotels at the end of their visit should be studied. The quantity of vehicles allowed into the site should be strictly limited, and a preliminary environmental impact assessment study is needed in order to ensure that the integrity of the site will not suffer. In order to limit possible pollution from exhaust gases, the possibility of using electric vehicles should be seriously considered. A vehicle maintenance workshop would also need to be set up at Um Sayhun.

Estimated Cost:

6 minibuses	$180,000
Vehicle repair workshop	$ 30,000
Subtotal	**$210,000**

*** Action: Feasibility study for redeployment of horses**

This study would determine the feasibility of redeploying the 350 horses in Petra for other purposes. For example:

- in return for permission to set up the taxi service, the Bdul would withdraw a certain number of horses.

- Others could be used by the park rangers and guides.
- A certain number would be used for horse trails to Beida, etc.
- The Petra and Wadi Musa region has more horses than any other part of Jordan. In the past it would have been well-known for its thoroughbred arab horses. Another interesting line of investigation would be to study the feasibility of reintroducing arab horses into the region.

If a cooperative body were to be set up by the horse owners, some of the horses could be sold in exchange for thoroughbred race-horses, at a rate of, say, three to one. A regular horse-race on the Beida plain, similar to that held recently on the occasion of the HM the King's birthday could be a considerable attraction to visitors and locals alike, and provide yet another incentive to visit Beida by horse. It could also bring a welcome income from tourism to the Amarine.

Implementation:
PANP, PNT.

Cost estimate:

- horse breeding expert (0.75mm)	$ 15,000
Subtotal	**$ 15,000**

7.4.3. SUB-PROGRAMME HANDICRAFT DEVELOPMENT (CRAFT)

It is regrettable that most of the articles sold in Jordan are not the products of a national handicraft industry, but come from Syria, Egypt, Yemen or Iraq.

*** Action: Establishment of Pilot Workshops**

Local handcrafts should be encouraged by the creation of pilot workshops. A feasibility study followed by detailed studies will be necessary, taking into account the potential of each of the tribal groups around Petra. Indicative ideas are:

- pottery workshop: utilization of clay from Wadi Musa area to make copies of Nabataean art objects.
- weaving workshop: Fabrication of carpets, bags, kefiehs...
- stone and wood carving workshop: possibility of sending a sculptor to train local craftsmen.
- jewelry workshop: Fabrication of jewelry in silver and gold after Hellenistic models.
- moulding workshop: Casting of reproductions of antique objects for sale in the museum shop.
- food related crafts: pickles, dried tomatoes and figs, etc.

Pilot workshops would train up to 15 local craftsmen at a time. Some of the workshops could be located in the old stone suq located behind the main shopping street, after restoration. The crafts suq would also contain exhibition spaces and retail outlets, as well as a small traditional tea house/restaurant. It might also be possible to accommodate, for example, weaving workshops as a tourist attraction inside caves in Wadi Mataha, as part of the integrated restoration project, or in Wadi Farasa, as part of a living ethnological museum.

Implementation:
The PNT, and Jordanian NGOs such as the Queen Alia Fund with on-going crafts projects in Jordan should be involved in the development of the project.

Cost estimate:		
feasibility study		
international handicrafts consultant (1.5 mm):	$ 25,500	
detailed study, specifications		
6 in-country handicrafts consultants (6 x 1 mm):	$ 22,500	
training		
6 in-country instructors for 1 year (72 mm):	$ 144,000	
equipment:	$ 90,000	
restoration of premises:		$ 50,000
promotional activities:		$ 10,000
running costs (3 yrs):		*$ 8,000*
Subtotal:		**$ 350,000**

7.5. PROGRAMME 5: "TRAINING AND COMMUNICATION"

7.5.1. SUB-PROGRAMME TRAINING (TRAIN)

Training is, of course, one of the key elements for the success of the project and the Park's activities. International cooperation could be mobilized to this effect, as well as bilateral cooperation.

*** Action: Training for senior staff**

A 3 months' training should be organized for the Park's National Director, before the start of Project implementation (or during the first phase). The purpose of this training is to prepare the Director to deal with the Park's multiple issues, i.e. management constraints, planning methodology, etc., and to enable him to gain complementary knowledge in fields of competence other than his own.

A lump-sum of 1 year training is foreseen for other senior staff (Assistants).

Implementation
The training courses are expected to be attended abroad for the Park's Director, and in-situ for the assistants. Several short training periods could be organized in other National Parks in Jordan and abroad.

Cost estimate:

- 20 days international expert:	$ 15,000
- 20 days in-country expert:	$ 1,700
- training courses abroad (lump sum for 5)	$ 10,000
Subtotal:	**$ 26,700**

*** Action: Training for junior staff**

Rangers and scouts are the foundation of any protected areas. It is therefore of paramount importance to develop in-service training programmes.

A questionnaire should be prepared to test the level of knowledge of the rangers. After being trained, the rangers should be able to collect data on illegal human activities, such as poaching, tree cutting, livestock grazing in unauthorized areas, encroachment, and, for some of them, ecological data relating to wildlife, rare species, etc. The following subjects will be taught: ecology and natural re sources,(flora, fauna, water, soils), conservation of antiquities, initiation in management techniques, law enforcement, monitoring and control, Park regulations and administration, map and compass work, etc. Rangers also have to know how to improve relations with local people. Fieldwork should be implemented as soon as possible.

Implementation:
In Jordan, to be determined.

cost estimate

- lump-sum	$ 12,000
Subtotal:	**$ 12,000**

*** Action: Training for guides**

A specialized expert in eco-tourism could carry out a mission to Petra in order to develop and commercialize products for rambling, as well as horse, donkey and camel trekking (for example, an expert from the "Grande Traversée des Alpes". The specialist will identify training needs for guides, syllabus, adequate national structures and trainers, means, constraints and costs.

Cost estimate:

international expert (1 month):	$ 20,000
expenditure for training guides (lump sum)	$ 8,000
Subtotal	**$ 28,000**

*** Action: Training for forest nursery technicians**

The training course should be divided into three sessions: one at the first stage of planting (2 weeks) and two after (1 week each).

cost estimate:

- in-country nursery specialist (1 month)	$ 2,500
Subtotal	**$ 2,500**

*** Action: Training in radio-communication maintenance**

The aim of this training course is to provide operators with minimum skills to ensure appropriate maintenance of the radio-communications network.

Cost estimate:
Under Park's after-sales service provided by the company having put in the network.

7.5.2. SUB-PROGRAMME EDUCATION & PEOPLE AWARENESS (AWARE)

*** Action: Organization of yearly field works for some students from the Shaubak Agricultural School**

*** Action: School pupils and students awareness**

Entrance to Petra will be restricted to supervised groups of students and school children. Free entrance of scholars during weekly leaves should be prohibited.

*** Action: workshops for farmers**

7.5.3. SUB-PROGRAMME INTERPRETATION (INTER)

*** Action: Development of Thematic circuits**

The geological and natural diversity of the site and the extent of its archaeological remains should be exploited by the development of thematic visitor trails, either archaeological (neolithic, chalcolithic, Nabataean, Roman, Byzantine, crusaders...), natural (flora and fauna, wild birds...), or ethnographic (visit and overnight stop in a bedouin camp). In addition, one or more purely geological circuits would be proposed inside the limits of the park; one of these would include the descent to Wadi 'Araba and the Rift Valley. The development of such thematic circuits should be preceded by an environmental impact study. Information on them would be available in the visitors' orientation centre and in video films diffused in the hotels.

*** Action: Upgrading the Visitors' Centre**

The poor legibility of the antique city is a fact which must be remedied as it leads to misinterpretation. The future role of the Visitors' centre should be as an Orientation Centre which will give the visitor the essential keys to understand and interpret the archaeological and natural site. The most important themes which should be explained in this centre in order to acquire a frame of reference for understanding the site are:

The mountain mass of Petra: the history of its geological formation
The history and extent of the Nabataean empire and the history of the capital
The principles of its ecological equilibrium
The ancient city and its water supply network
The characteristics of its monumental architecture
The gods of the Nabataeans and ritual practices
Itineraries for archaeological discovery
Itineraries for discovery of the natural site (birds, plants, the rift valley, scenic routes)

The interest of the landscape and geology of the Petra region is such that it merits a special museographic presentation in the visitors' centre, in order to explain, through models and drawings:

the geological history of the region
petrography/identification of different types of rock
phenomena of erosion

The possibilities for hiring a guide, visiting an archaeological dig, reserving for a horse or camel trek, etc., will be indicated precisely. Reservations would be made at the tourism office's counter in the Visitors' Centre.

The major themes would be developed in the form of relief models, maps, graphic panels and showcases housing selected objects from each historic period.

The existing lecture theatre would be equipped with a permanent audiovisual show using multi-slide projectors to give a lively, panoramic presentation of the site in all its aspects.

The treatment of the tall, top-lit central space would suggest a garden court containing a large-scale replica of the lion fountain, emblematic of Petra and its Nabataean water supply system, with the recorded sound of water and of birdsong. The central feature would be a relief model of the site explaining the functioning of the reconstructed hydrological network.

Implementation
The scientific programme should be established by an international expert in museography, preferably nominated by ICOM, in close consultation with a scientific committee appointed by the management of the PANP. The detailed design work should be carried out by an architectural or design office specializing in museum and exhibition design, selected by a process of international bidding based on a detailed architectural brief.

Cost estimate

museologist (2 mm):	$ 40,000
fitting out, exhibits:	$ 300,000
equipment:	$ 25,000
design, supervision:	$ 50,000
Subtotal:	**$ 415,000**

*** Action: Design of coherent signposts and information panels**

The almost total absence of sign posting makes the site difficult to "read" and understand. The design and manufacture of those information panels which do exist is of poor quality and lacks coherence. Qualified guides are few and far between, and in any case it is essential, for individual tourists as well as groups, to provide some information on the history of the tombs, temples, sanctuaries, theatre, etc.

In order to respect the harmony of the site, conventional signboards should be excluded. There is a need for a specially designed and well-coordinated signalization system, specially designed for Petra.

*** Action: Reorganization of site Museum**

The existing small museum is far too small to hold the collections. It will be necessary to separate the existing collections of the museum into two themes, and enrich them with some objects lent by the National Museum at Amman.

The existing Museum in a Nabataean cave on al-Habis would house domestic and ritual objects associated with everyday life: Nabataean pottery, coins, statuettes, betyls, oil lamps, etc., in a suitably scaled setting. Information would be available on copies of objects from the collections certified by the Department of Antiquities. These copies will be on sale in the first instance in the exhibition space adjoining the restaurant situated below the museum.

*** Action: Creation of a monumental sculpture museum in the Urn Tomb**

The Urn Tomb, the biggest of the tombs of Petra, suitably fitted out, would present the most remarkable of the architectural fragments of the site, (sculptured figures, column capitals, friezes, painted stucco decoration, mosaics) simply displayed on marble plinths, protected by a rope barrier and lit by a discrete installation of low-voltage spots. A specially designed, classically proportioned bronze grille, the creation of a contemporary designer, would protect the window and door openings.

An orientation table would be installed on the edge of the raised terrace in front of the tomb overlooking the historic centre of Petra, engraved with a panoramic view of the ancient city as it used to be, and identifying the principal Nabataean, Roman and Byzantine monuments.

It is in fact essential to recall to the visual memory that Petra was first and foremost a city and not just a collection of troglodític tombs; a living city as explained in the orientation centre, particularly through the presentation of the hydrological system. An official sales area under the vaults below the

raised terrace half way up the monumental access stairs would sell guide books, of which one could present reconstructions of the principal monuments through the VISION process, patented in Italy.

*** Action: creation of a living ethnographic museum for the Bdul, wadi Farasa**

Petra is not only a natural and archaeological site with magnificent monuments and landscapes; its human and cultural environments are also important elements of the Management Plan which should be given a certain value.

The mission was informed of a private initiative by a citizen of Wadi Musa to restore a historic house belonging to his family and convert it into a museum of traditional way of life. This excellent initiative is one that should be encouraged, and will, if well done, undoubtedly add to the tourist attractions of the area. The same principle could well be promoted and applied to other local communities, and would help disperse tourists around the Park:

Wadi Farasa is one of the wadis which does not communicate directly with the main Wadi Musa. It lies behind Qasr al Bint and Jebel Madhbah, and faces Um al Biyara. Tourists who climb up to the high place can go down through Wadi Farasa, passing in front of the Lion Tomb and the Garden Triclinium.

This wadi, like all the secondary wadis which were not related directly to Petra, was inhabited, until 1985 by the Bdul. They lived in its caves, cultivated the fields of Stouh Jebel Harun, moved through the pasture lands available within the limits of the Park, served tea and served as tourist guides. They had, in fact, over the years, evolved a whole way of life inside Petra.

Several caves at a time were used by each family, grouped around huge terraces where everyday life was spent. There were caves for living, for storing food and wood, granaries, sheepfolds and stables. There were also winter and summer caves, for there was also seasonal migrations inside Petra. In spring time, the *Beit Sha'ar* was set up on the terrace or on the surrounding hilltops. The fields were in the Stouh of Jebel Harun, where the cemetery of Um Khrerib was situated.

A group of caves of Wadi Farasa with its terrace can be a suitable place to tell this story, to explain how Petra was rediscovered by Burkhardt, who were the main travellers and notable bedouin personalities at that time, how the Bdul used the space within the wadi, and how, little by little, they started to live in Petra and inhabit its caves.

In order to present this story in the liveliest possible way, it would be animated by Bdul women preparing and offering tea and *Saj* and *Tabun* bread to the visitors on a terrace opening on to a breathtaking view of the valley.

This idea is important as a means of ensuring a degree of social recognition for the Bdul, and give value to their way of life.

*** Action: Creation of a living museum of the 'Amarine**

A similar setting can be created for the 'Amarine in Beidha. One of the tiny rooms now used as a store can be decorated with everyday objects and implements, accompanied by explanatory panels with photographs and information about their lives in the past and the present. This will give the visitors an idea of the changes which have occurred in the region and among the local populations.

*** Action: Irrigation and re-planting of Wadi Farasa**

This would be one of the most important new attractions of Petra. It would occupy a central place in the Visitors' Centre, for the reason underlying all of the reflections of this report: the dyad water/desert can be exhibited life size, opening out like a vine leaf or an olive branch, following the image of the admirable frescoes of the painted cave at Beida; the distribution of water in order to transform these lands into an oasis of beauty, an art of equilibrium with the environment.

The exemplary value of this interpretation of life in Petra for modern times would be to give a striking example of the victory of harmony with a particularly difficult natural environment. The irrigation would also involve the replanting of the terraces and orchards as they must have appeared in antiquity.

Action: Presentation of Archaeological Digs

An archaeological site as important as Petra, still under excavation, should be able to propose to visitors, particularly schoolchildren, commentated visits to explain the progress of the digs, the stratigraphy, important finds, techniques of dating, conservation problems, etc. This type of visit could be a "cultural tourism product" which would be particularly appreciated by a small foreign clientele, and answer a real, if expressed, need for a deeper understanding of the site.

*** Action: Presentation of Beida**

The presentation of the "Little Petra" is absolutely indispensable. Excavations should be carried out rapidly in order to uncover the partly visible remains of the paving of the Siq. This site possesses an undeniable charm, and presents the economic advantage of becoming a destination for horse or camel rides: a "product" to be proposed for a second day's stay in Petra.

*** Action: Landscaping the area in front of the Khazne**

Here the stage would be set for a recreation of the first "image" of the nineteenth century voyagers who rediscovered the monument. This image is that which is sold throughout Jordan through postcards and posters, and corresponds to a real desire for reverie on the part of the new voyagers: present day tourists. The idea would therefore be to give back to this sublime space its character at the time of its rediscovery by recreating, as much as possible, the landscape engraved by David Roberts.

7.5.4. SUB-PROGRAMME COMMUNICATION (COMM)

*** Action: Publication of maps and guides**

Publication of individual guide books, and the realization of a guide book with reconstructions of the principal monuments (e.g. the winged lion temple, the cardo, the triumphal arch) using the procedure developed by VISION editions in Italy.

*** Action: Production of video documentaries**

Edition of video documentaries on the principal themes, proposing the various "products" offered by the Park. These films could be broadcast by the internal video channels of hotels in Petra on the one hand, as well as being commercialized and sold, to adherents of the Petra National Trust, for example.

7.6. PROGRAMME 6: "RESEARCH & MONITORING"

7.6.1. SUB-PROGRAMME ADDITIONAL INVENTORIES, MONITORING (INVEN)

A partnership could be developed simultaneously with the Park, the RSCN and the HCST (+ eventual foreign institutions). This "research force" could be capable of monitoring wildlife, flora and vegetation on a zone encompassing DWR, PANP and in-between corridor (where ibex populations are expected to live).

In strengthening such an association (through specific agreements), the Park could also elaborate joint research projects.

*** Action: Carry out survey of wild large mammals**

This action aims at providing the Park Authority with better knowledge of wildlife. It would cost a great deal of effort (and money) to carry out a detailed census of large mammal populations (densities, numbers), even restricted to ungulates (ibex, gazelle ?), owing to the extreme difficulty of access to several areas. Therefore, the objective will be to assess the distribution and relative abundance of large mammals within the Park.

The method will consist in carrying out surveys of indirect signs of the presence of animals: faeces, footprints, etc., with the assistance of keen local guides. All sectors of the Park will be investigated, with particular emphasis on the wadis, waterpoints surroundings and pastures. Should they occur, direct observations will bring more information on the movement of populations of large mammals (males, females, juveniles). The distribution mapping will be compared with those of human activities, such as grazing areas.

At the same time, rangers will make seasonal field surveys during the course of their field patrols. The Park's Division for Natural Resources Conservation will draw up survey forms and provide rangers with suitable preliminary on the spot training. Records will be processed (by computer) at the Park's HQs or (better) in close collaboration with the DWR/RSCN Project (see below).

Implementation:
PANP/DNRC (Scientifical Attaché, rangers), RSCN, University. A GPS would be very useful to locate records in detail. In the case that no national expertise were available, an international expert would be needed at the beginning of this activity, to assess the methodology and provide adequate training to participants, and, at the end, for data processing and interpretation.

Cost estimate:

- materials and facilities	PM	
- in-country expert (2 months):		$ 2,500
- international expert (specialist in wild-life census) (1 month):		$ 20,000
Subtotal:		**$ 22,500**

*** Action: Carry out reconnaissance survey of a "corridor" between Dana Wildlife Refuge and PANP**

This action aims at assessing potential wildlife use of this area, for further natural recolonization of PANP by large wildlife animals. Land use identification will help in further development.

Implementation:

PANP, RSCN/Dana WR, University. In particular, in-country specialists (e.g. from RSCN), trained during the previous activity, will lead this survey, with the support of the pack of rangers from DWR as well as PANP.

Cost estimate:

- in-country expert (1 month)	$ 2,500
Subtotal	**$ 2,500**

*** Action: Inventory of other zoological groups**

The inventory of other zoological groups such as small mammals, birds, reptiles and amphibians, should be carried out by specialized institutions (Universities, Museums,...) or researchers, through agreements with the Park. Some records are already available (e.g. for birds), but should be mapped for eventual management implications (e.g., establishment of new conservation areas within the Park, development of bird-watching itineraries,...).

Implementation:

Universities, RSCN,....

Cost estimate:

lump sum:	$ 8 000
Subtotal:	**$ 8,000**

*** Action: Collect & process information & data related to species & habitats**

This action should be developed in close collaboration with the DWR (managed by the RSCN), where a GIS will be established to store all pertinent data and information related to the Dana Reserve. In particular, methodology for inventorying and monitoring fauna & flora, should be identical, and data storage and processing alike. Specifically, this collaboration should ensure a better geographical coverage of the movement of large mammals.

Implementation:

ANRC, Park's rangers, Post-graduate students (Yarmouk & Jordan Univ.), RSCN (DWR).

Cost estimate:

lump-sum (students facilities):	$ 10,000
equipment:	under Park's.
Subtotal	**$ 10,000**

7.6.2. SUB-PROGRAMME ADDITIONAL STUDIES (STUD)

*** Action: Study of erosion process on one water catchment**

Three major wadis drain the entirety of the proposed Petra Park: Wadi Musa in the central part, Wadi Sabra in the southern part, and the Wadi Mataha in the north. Wadi Musa would be chosen as it is the major one in size, and also because it directly concerns Petra Sanctuary.

In order to ensure the durability of a harmonious development of the Petra region it is necessary to take into account the erosion processes affecting the water catchments of these three wadis, as well as their ecological and socio-economical impacts.

However, erosion processes are complex and varied, depending on the scale of the approach: "micro" or "macro". As a preliminary to any restoration works (civil works and bio-engineering: afforestation, agroforestry,...), it will be necessary to study in detail the erosion processes simultaneously at the global scale (water catchment), and at the local scale (douar, field plot, pasture land, wadi, archaeological sites).

Water catchment management (from the point of view of the struggle against erosion), needs both detailed physical and ecological analysis (with use of mapping: land use, soil potentialities, thematic, cross-sectorial), as well as efficient involvement of local people (socio-economic study). A 10,000' scale land use and field surveys are required.

Implementation:
This activity needs interdisciplinary team work. It could be sub-contracted to a specialized consulting firm.

Cost estimate:

appx. $ 3/ha x approx. 15,000 ha	$ 45,000
Subtotal:	**$ 45,000**

*** Action: Plant associations typology**

It would be necessary to map the various plant communities of the Park. This document (the vegetation map) will facilitate the monitoring of vegetation. Also, available data (e.g. from the Nurenberg national History Museum) should be mapped. Management implications of the result include possible new opportunities to establish botanical and wildlife reserves within the PANP.

Implementation:
The University in collaboration with the German team. The results should be incorporated into the GIS.

Cost Estimate:

- in-country botanist expert (1 month):	$ 2,500
- student team (lump sum):	$ 10,000
- mapping and editing:	$ 8,000
Subtotal	**$ 20,500**

*** Action: Mapping of antiquities**

In 1974, aerial photographs to 1/10,000 scale of the Petra area were taken by IGN. At that time, the surface of the Park was estimated at 17 sq. kms., compared with the 260 sq. kms. proposed today. In fact, the aerial photographs cover 256 sq. kms, just a little short of the area proposed by the DTA.

With the help of these photographs, a photoplan was produced in 1977 by IGN, and later a 1/5,000 map of the central area of Petra was prepared by Mr. René Saupin, cartographer formerly attached to IGN, with the assistance of F. Zayadine, and printed by the Royal Geographic Centre in Amman. This map, available to tourists, is one of eight sheets covering the Park area; the seven other sheets are awaiting completion. The DOA is urging the RJGC to complete the maps, but technical assistance is needed.

Implementation
RJGC, DOA. In order to avoid duplication of effort, it would be highly desirable for the Jordanian authorities to collaborate on this project with the CNRS/Centre d'Art et Archéologie Orientale, who are presently working on completing the remaining maps and constituting a geographical data base of the antiquities.

Cost estimate

*** Action: Photogrammetric survey and plotting of remaining monuments**

In 1969, a UNESCO mission of three experts from IGN carried out a two-week programme of photogrammetric surveys. A similar mission was carried out by the British Institute. Altogether, 56 metric couples were registered, corresponding to 20 monuments, in addition to two panoramic views of al-Kubtha mountain. Only twelve of the monuments, however, have been plotted by IGN, owing to the high cost of the operation.

Implementation

IGN, RJGC, DTA

7.6.3. SUB-PROGRAMME ARCHAEOLOGICAL RESEARCH (ARCH)

*** Action: Study of Petra City Centre**

Archaeological research at Petra has, until very recently, concentrated on the rock-carved tombs and stone built monuments. Very little excavation or archaeological investigation has been carried out in the ancient city centre area, and much research needs to be done on the urban structure of the ancient city, and its relationship with the outlying centres in antiquity.

*** Action: Archaeological Survey of Wadi Musa and neighbouring villages**

The village of Wadi Musa, ancient Gaia or el-Dji ('the valley in Aramaean') was excavated in 1978, before the building of a school. Nabataean and Roman strata were identified near the mosque, and an

eight-line Nabataean inscription was discovered by chance in an old house[1]. A medallion representing a god discovered in the foundation trench of the school suggests the presence of an important temple. A future campaign of excavation in the area may provide decisive evidence of early occupation of el-Dji/Gaia.

In Khirbat al-Nawafle, there is a water reservoir which needs to be excavated if this area is to become a tourism project.

There are several antiquities sites at al-Hayy and Bdebdebe.

*** Action: Survey of Wadi Sabra**

To date, little investigation of this major site has been possible, owing to the difficulty of access.

[1]Khairy, Milik, 1981

7.7. PROGRAMME 7: "LAW ENFORCEMENT"

7.7.1. SUB-PROGRAMME BOUNDARY DEVELOPMENT (BOUND)

*** Action: survey and mark the boundaries**

This action presupposes that the boundaries of the Park (see Chapter 1) have been fixed, through official procedure, after the goals of the PNP and the choice of boundaries have been explained to the local populations living within the park and in its buffer zone.

Once the Park is officially settled and gazetted, boundaries are needed to provide it with a permanent visible demarcation and to facilitate regular patrolling. Clear physical (crests, gorges, escarpments, outcrops, wadis...) or artificial lines (roads...), should be chosen wherever possible; this will also reduce the cost of maintenance. Markers (beacons) must be established at more or less regular intervals, according to the gazetted description of the Park. In some places, these markers will be the unique visible demarcation of the Park boundary. Remote beacons should be built in such a way as to be maintenance free. Toughness and durability could be achieved by using stone masonry pillars.

Cost estimate:

- establishment of approx. 300 beacons (contracting)	$ 38,000
Subtotal:	**$ 38,000**

*** Action: explain the goals of the PANP and the choice of boundaries to local populations**

7.7.2. SUB-PROGRAMME FIELD FORCE (FORCE)

Mobile Field Force

The Park will create two groups of specific mobile surveillance units, one group patrolling on behalf of the Archaeological Conservation Assistant-Director, the other one on behalf of the Natural Resources Conservation Assistant-Director (see: organigramme p. 159). Both groups should be assigned the same tasks, but the patrolled geographical areas may be different. The latter unit will have to move through more remote sectors of the Park, and therefore adequately equipped for several successive days of field patrolling. Each group should be trained (see Progr. "Training").

Archaeological Conservation:

1 warden should be responsible for 2 mobile units composed of 2 guards/unit.

Equipment:

- 5 camels
- 3 walkie-talkies
- 5 binoculars
- uniforms, signs
- field equipment

Natural Resources Conservation:

1 warden should be responsible for 2 mobile units composed of 3 guards/unit

Equipment:

- 7 camels
- 3 walkie-talkies
- 7 binoculars
- uniforms, signs
- field equipment

Cost estimate:		
- equipment		$ 12,000
- *running costs (3 yrs):*	*$ 4,000*	
Subtotal:		**$ 16,000**

Natural resources conservation:

1 warden should be responsible for 2 mobile units composed of 2 guards/unit.

Equipment:

- 5 camels
- 3 walkie-talkies
- 5 binoculars
- uniforms, signs
- field equipment

Cost estimate:		
- equipment:		$ 17,000
- *running costs (3 yrs):*	*$ 6,000*	
Subtotal:		**$ 23,000**

Fixed Posts

1 Surveillance Ranger Post is needed within the Petra Sanctuary. It will shelter 3 rangers: 2 for the Archaeological Conservation, 1 for the Natural Resources Conservation. It should be also sized for possible stay of the Tourist Police. In addition to their daily controlling duties, they will provide assistance to visitors and ensure their safety. They should be easily recognized and carry Park's uniform & signs.

Entrance Gates

4 Entrance Gates are needed, at:

- Wadi-Musa (existing Main Petra Entrance),
- Um-Sayhun village (existing entrance on the road to Petra Sanctuary),
- Beida village (road to Shaubak),
- North of the Park (to be determined, on the road to Wadi-Araba).

The ticketing procedure will be concentrated at the Visitors Centre (Wadi-Musa).
2 ticket collectors, able to provide itineraries and advice to entering visitors, should be assigned at each Gate.

Cost estimate:

- constructions:	$ 32,000
- restoration:	$ 20,000
- equipment (lump sum):	$ 10,000
- radiocom. equipment (see tab):	$ 3,000
- *running costs (3 yrs):*	*$ 12,000*
Subtotal:	**$ 77,000**

7.8. PROGRAMME 8: "PROJECT IMPLEMENTATION"

7.8.1. SUB-PROGRAMME HEADQUARTERS (HEAD)

Buildings

It is strongly recommended to establish the Park's Headquarters in Wadi-Musa city.
The HQs (the Project) could be housed (offices, technical rooms, "bed-sit" accommodation, equipment stores, etc.), in a group of traditional old houses in Wadi-Musa. Two abandoned groups of historic stone buildings have been identified by the PNT, who have already commissioned preliminary studies, and are trying to raise funds to save them. The PANP headquarters would thus provide a good example to the local community of a model project for the restoration of a historic group of buildings and its reinsertion into the life of the community for a prestigious international project.

Building space requirements:

- 9 rooms (Director, assistants, administration and secretary, technical adviser, others)
- 2 technical rooms (drawing and mapping, computer)
- 1 meeting room (training, extension programme)
- 2 "studios"
- storage space
- reception/exhibition space
- services, circulation

Total estimated space requirements: approx. 350 M2.

Implementation:
The project could be commissioned by the PNT and executed by a local architect experienced in the restoration of vernacular building traditions and techniques. A preliminary feasibility study will be needed by an international expert.

Cost estimate:

- construction:	$ 70,000
- furniture and equipment:	$ 35,000
- design and supervision:	$ 15,000
running costs (3 yrs):	*$ 45,000*
Subtotal:	**$165,000**

Equipment

- 3 PU 4x4 (Land-Rover type)
- 2 PU (or R4 Renault type)
- 3 motos (125 cc)
- 1 VHF equipment

Cost estimate:

- equipment:	**$**
- radiocom. equip. (see tab 1):	$ 900
- running costs (3 years):	**$**
Subtotal:	

Additional radio-communication equipment

Cost estimate:

- 2 repeaters (see tab 1):	$ 11,200
Subtotal:	**$ 11,200**

ANNEX 1

Chief Technical Adviser: Terms of Reference

Tasks:

The TA will work in close collaboration with the Park's Director and other senior staff, to undertake the following:

1. assist with the implementation of the Management Plan, planning , coordination and contracts specifications procedures (staff recruitment, studies, equipment, constructions, agreements,...)

2. assist each Park's section to prepare annual workplans, establishing the ways in which resources will be deployed to meet the objectives determined by the Management Plan, and tangible criteria by which progress can be monitored.

3. launch the top priority additional studies to improve knowledge and consequent management actions.

4. assist the Park's Director with leading of first Management Committee sessions.

5. on-site training of his counterpart, and other staff of the Park.

Qualifications:

Relevant qualifications (10 years experience) in Park's management, planning, & budget's administration, plus one other speciality (e.g., sustainable rural development, urban planning,...).
Strong ability to communicate with all tribal groups, officials and private sector.
Ability to train.

ANNEX 2

Radio-communication equipment specifications and costs

Type of equipment	Quant.	Unit Cost	Total	Locations
Fixed VHF Station				
1 kit is composed of:				
a) Radio				
- 1 VHF transceiver 50W, 12V				
- 1 speaker				
- 1 antenna 6 dB				
b) Generator				
- 4 solar panels				
- 1 (4 modules/frame)				
- 1 regulator (30A+30A)				
- 2 "no maintenance" batt. 6V/390AH				
Subtotal:	3	1000 $	3000 $	HQs, North Gate, undetermined (Wadi Araba ?
Mobile VHF Station (vehicle)				
Radio				
1 kit is composed of:				
- 1 VHF Transceiver 50W, 12V				
- 1 speaker, 1 mobile support				
- 1 antenna 3.5 dB				
- cable+connector				
Subtotal:	1	900 $	900 $	vehicle 4x4
Talkie-walkie (Handheld)				
1 Handheld is composed of:				
- 1 VHF handy-portable				
- 1 battery pack 7.2V				
- 1 charger-adapter				
Subtotal:	6	800 $	4800 $	Rangers
Repeater				to be determined (Jbel Harun ? Jbel el-H
1 kit is composed of:				
- 1 repeater 10W, 12V				
- 1 VHF cavity duplexer 60 dB				
- 1 antenna				
- 1 amplifier 50W, 12V				
Subtotal:	2	5600 $	11200 $	
Total:			19900 $	

SELECTED BIBLIOGRAPHY

Ahmad A.A. Jordan Environmental Profile Status and Abatement. 1989.

Al-Eisawi M.D. Vegetation in Jordan.

Bartlett, 1990. From Edomites to Nabataeans: the Problem of Continuity. ARAM First International Conference, University of Oxford, 1990

Bennet, C.M.A. Graeco-Nabataean Sanctuary on Um el Biyara. ADAJ* 24 1980.

Browning I. Petra. 1989

Jaser & Bargous. Geotechnical Studies and Geological Mapping of Ancient Petra City. Ministry of Energy and Natural Resources, Geological Directorate, Bulletin 1. 1992.

Khayri, N., Milik, J.A. New Dedicatory Nabataean Inscription from Wadi Musa. PEQ**, 113, 1981, pp 19-26

Kirkbride, D. The Environment of the Petra Region During the Pre-Pottery Neolithic. Studies in History and Archaeology of Jordan, II 1985

Kohl, H. Kasr Bint Firaun. Leipzig, 1910.

Künne I, Wanke M. Petra: Landschaft und Pflanzenwelt, 1989.

Hammond, Ph. The Crusader Fort on el-Habis at Petra. Utah, S.L.C., 1970.

Lindner, M. An Archaeological Survey of the Theatre Mount and Catch-water Regulation System at Sabra, South of Petra, 1980. ADAJ, 26. 1982.

McKenzie, J. The Architecture of Petra. Oxford, 1990.

MMRA&E. National Environment Strategy for Jordan. 1991.

Parr, P.J. Sixty years of Excavation at Petra. Oxford, 1990.

RJGC. The Tourist Map of Petra.

*RSCN. The Dana Project.

UNDP/FAO Strengthening Forest and Range Management. 1992.

UNDP/FAO Workplan, Project JOR/92/004. 1992.

USAID Master Plan for the Protection & Use of Petra National Park. 1968. Zayadine, F.Caravan Roads Between Egypt and Nabataea and the Voyage of Sultan Baibars to Petra in 1276. Studies..II, 1985

---

* Annual of the Department of Antiquities of Jordan

**Palestine Exploration Quarterly