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Part 7

SECOND QUARTERLY PROGRESS REPORT

NASA-"27930", GEOLOGICAL AND ENVIRONMENTAL RESOURCES

INVESTIGATIONS IN EGYPT USING LANDSAT IMAGES

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Director, Remote Sensing Project
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and Technology, Cairo- Egypt.

I. Significant Geological and Resource Studies; Nubian Sandstone
(Groundwater Aquifer) Studies; and Structural Maps of Egypt

A large area of the Western and Eastern Deserts of Egypt, as
designated on the map enclosed with our first quarterly pro-
gress reports, has been, or is now being mapped using ERTS-1
and LANDSAT-2 satellite images. All studies are oriented to
solving major problems in connection with significant national
and regional projects in Egypt. General outline and status
of all studies conducted and those in progress are briefly
described in this report.

1. Regional prospecting for Iron Ores in Bahariya Oasis -
El Faiyum Area, Egypt, using LANDSAT Satellite Images.
Part I.

By: E.M. El Shazly, M.A. Abdel Hady, M.A. El Ghawaby, and
S.M. Khawasik.

Remote Sensing Project, Academy of Scientific Research
and Technology, Cairo. February 1976.

(NASA)

(Preliminary Report Published - Final Report and Maps
in Print).

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LANDSAT satellite images have been interpreted for the Bahariya Oasis - El Faiyum area covering about 100,000 km² in north Western Desert of Egypt, where new geological, drainage and structural maps have been constructed. Quantitative structural analysis for the major linear elements of folds, long fractures and faults as interpreted from LANDSAT images has been carried out as a modern technique of regional prospecting for iron ores under the prevailing conditions in the studied area. Among the significant results of this study is the discovery of some new iron ore occurrences. Furthermore, the conditions of the already known iron ore deposits and occurrences are regionally connected and verified.

2. Geologic Interpretation of LANDSAT Satellite Images for West Nile Delta Area, Egypt.

By: E.M. El Shazly, M.A. Abdel Hady, M.A. El Ghawaby, I.A. El Kassas, S.M. Khawabik, M.M. El Shazly, and S. Sanad.
Remote Sensing Research Project, Academy of Scientific Research and Technology, Cairo 1975.

(NASA)

(Final Report Published).

This study is based mainly on the interpretation of LANDSAT satellite images for an area covering about 85,000 km² including the west of the Nile Delta and the adjacent north Western Desert of Egypt, where new geological, structural lineations and drainage maps have been constructed on scales of 1:500,000

and 1:1,000,000. Furthermore, the groundwater hydrological characteristics and potentials of the same area have been compiled and evaluated in the light of the new investigation. Of special interest is the contribution of the major structural lineations, as interpreted from LANDSAT images, to the development of major features in the area including the Nile Delta, Wadi El Natrun, and Siwa Oases.

3. Geology and Groundwater Potential of Kharga-Dakhla Oases Area, Western Desert, Egypt, From NASA LANDSAT Satellite Images.

By: E.M. El Shazly, M.A. Abdel Hady, I.A. El Kassas, A.B. Salman
M.M. El Shazly, H. El Amin, and A.A. Abdel Megid.

Remote Sensing Research Project, Academy of Scientific
Research and Technology, Cairo, April 1976.

(NASA)

(Preliminary Report Published - Final Report with Maps in
Print).

In this study, interpretation of LANDSAT satellite images has been carried out for the Kharga-Dakhla Oases area covering some 100,000 km² mostly in the Central Western Desert of Egypt. Accordingly new geological, structural lineation and drainage maps have been constructed on a scale of 1:500,000. Many drainage lines and linear structures have been delineated for the first time from the investigation of LANDSAT images.

The roughly NE-SW drainage in the Nubian Sandstone plain is mostly related to some fold axes of the same trend. On the LANDSAT satellite images, the Nubian Sandstone in this area could be differentiated into three main stratigraphic members apart from the overlying shale formation. Among the significant results of this study is the differentiation on the LANDSAT images of sand dunes and following their migration and encroachment. This study revealed a general eastward movement of the main sand dune belts in the area, with an average of about 10° difference over more than 45 years.

4. Geologic Interpretation of ERTS-1 Satellite Images for West Aswan Area Egypt.

By: E.M. El Shazly, M.A. Abdel Hady, M.A. El Ghawaby, and I.A. El Kassas.

Remote Sensing Research Project, Academy of Scientific Research and Technology, Cairo, October 1973.

(NASA)

(Final Report Published)

LANDSAT satellite images of an area covering about $34,000 \text{ km}^2$ to the west of Aswan in Southern Egypt have been interpreted in terms of geology, drainage and structure. Apart from cultivation and vegetation, twenty two geological units are distinguished on the ERTS-1 images of the area covering various geological formations ranging from Precambrian to Quaternary ages. Of special interest from the economic geology point of

view is the delineation of ERTS-1 images of the regional extension of the Nubian Sandstone iron ore-bearing member and the phosphate-bearing formation. Moreover, the Nubian Sandstone exposures in the area have been subdivided into four different geological units. The tracing on ERTS-1 images of main drainage lines and major fractures and faults showed some significant results. The drainage pattern of the River Nile is mainly controlled by some structural elements of N-S, NNW-SSE, NNE-SSW trends and the slope towards the Mediterranean Sea. The branches of Lake Nasser (Aswan High Dam Reservoir) in its northern part occupy the wadis and fracture systems.

5. Geological and Groundwater Potential Studies of El Ismailiya Master Plan Study Area, Egypt.

By: E.M. El Shazly, M.A. Abdel Hady, M.M. El Shazly, M.A.

El Ghawaby, I.A. El Kassas, A.B. Salman, and M.A. Morsi.

Remote Sensing Research Project, Academy of Scientific Research and Technology, Cairo, 1975.

(NASA)

(Final Report Published).

In this study new geological, structural and drainage maps have been constructed from LANDSAT satellite images for El Ismailiya Master Plan Study Area covering about 10,000 km² almost on the western side of Suez Canal. The groundwater, hydrogeological characteristics and potentials of the area have been compiled and evaluated in the light of LANDSAT images.

By examination of successive coverages of LANDSAT images and by reference to previously published maps, some features are found have been changed such as the disappearance of some islets in the Lake Manzala and the submergence of some structures in it. The area is dissected by many structural lineaments which are delineated for the first time from the interpretation of satellite images. Of significant importance is the distribution of the sandy or shelly bars and islands inside Lake Manzala and the southern marshes which may be structurally controlled by folding and faulting. Furthermore, LANDSAT images have been found to be greatly helpful in the distinction of various Quaternary sediments having a great practical value to reclamation projects in such area.

6. Geology of Sinai Peninsula from LANDSAT Satellite Images.

By: E.M. El Shazly, M.A. Abdel Hady, M.A. El Ghawaby, I.A. El Kassas, and M.M. El Shazly.

Remote Sensing Research Project, Academy of Scientific Research and Technology, Cairo, Sept. 1974.

(NASA)

(Final Report Published).

In this study new geological, structural lineation and drainage maps have been constructed for Sinai Peninsula covering about 64,000 km² on 1:500,000 and 1:1,000,000 scales using LANDSAT satellite images. Furthermore, two interpretation maps have been prepared for the petroleum, mineral and construction material potential as well as the groundwater potential of the

Peninsula. These maps are more elaborate, precise and showing greater details as compared to the previous maps made by the conventional techniques. Among the significant results of this study is the elaboration of a new theory on the formation of the proper Delta basin in the Miocene and later times mainly by the interaction and intersection of the Mediterranean fault systems (ENE-WSW) and the Red Sea and Gulf of Suez fault systems (NW-SE). Accordingly, the Delta basin could be considered as an extension of the Red Sea rift though greatly modified by Mediterranean tectonics

7. Geologic Interpretation of ERTS-1 Satellite Images for East Aswan Area, Egypt.

By: E.M. El Shazly, M.A. Abdel Hady, M.A. El Ghawaby, and I.A. El Kassas.

Remote Sensing Research Project, Academy of Scientific Research and Technology, Cairo, May 1973.

(NASA)

(Final Report Published).

This study was the first in Egypt carried out on ERTS-1 satellite images for geological and structural mapping of an area covering some 34,000 km² in southeastern Egypt. It has been possible to construct on the images the main geological units of the area apart from the distinction of some small units which could be only revealed by detailed mapping. This is well exemplified by the distinction between the various granitic plutons and the subdivisions of the Nubian Sandstone into six main units.

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Of paramount importance is the tracing of the Nubian Sandstone iron ore bearing member on ERTS-1 images being characterized by specific features of color, tone, texture and drainage pattern. The study of images proved to be particular significance in the elucidation of major structures such as folding and continuous long fractures and faults. A particular important result of this study is the observation that the River Nile along its some 160 km course in the area is controlled even in detail by linear elements.

8. Soil Characteristics and Groundwater Potential of the Bahariya Farafra Oases Area, Western Desert, Egypt. Using LANDSAT Satellite Images.

By: E.M. El Shazly, M.A. Abdel Hady, M.M. El Shazly, S. Sanad, and R. Misak.

Remote Sensing Research Project, Academy of Scientific Research and Technology. Cairo, 1976.

(NASA)

(Study completed and report being prepared).

In this study, LANDSAT images have been used for soil mapping of the area between Bahariya and Farafra Oases covering some 80,000 km² in the North Western Desert. On compiling the delineated drainage lines with the structural lineations in each soil type, it is found to be useful to evaluate the hydrogeological characteristics and the groundwater potential of the studied area, in addition to ground truth, and isotope and chemical analysis of samples collected.

9. Geologic Interpretation of LANDSAT Satellite Images for
Qattara Depression, Western Desert, Egypt.

By: E.M. El Shazly, M.A. Abdel Hady, M.A. El Ghawaby, and
S.M. Khawasik.

Remote Sensing Research Project, Academy of Scientific
Research and Technology, Cairo, 1976.

(NASA)

(Study completed and report being published).

This study is based mainly on the interpretation of LANDSAT satellite images for an area of about 94,000 km² around Qattara Depression in the North Western Desert, where new geological, drainage and structural lineation maps have been constructed on scales of 1:500,000 and 1:1,000,000. The new investigation helped in elucidating the tectonic history and development of the Qattara Depression where its present configuration is structurally controlled by some major folds and faults mapped for the first time from LANDSAT images. Careful mapping of surface drainage lines in such flat and level areas using satellite images are of significant value in the study of the potential groundwater situation in the area. The new geological map includes twenty five different lithologic units of which not more than 30% were previously mapped. Regional mapping of some geological units is important in following the movement and seepage directions of the groundwater in the low areas of the depression.

10. Geologic Interpretation of LANDSAT Satellite Images for Tushka Basin Area, Southern Egypt.

By: E.M. El Shazly, M.A. Abdel Hady, I.A. El Kassas, H. El Amin, and S.I. Mansour.

Remote Sensing Research Project, Academy of Scientific Research and Technology, Cairo 1976.

(NASA)

(Study completed and Report being prepared).

Interpretation of LANDSAT satellite images in terms of geology, drainage and structural lineations was carried out for an area covering about 77,000 km² in southern Egypt. The images are greatly valuable in delineating the sequential changes in the Lake Nasser Water reservoir and in mapping the long fractures and faults intersecting it which may be used as channel ways for surface seepage. Many geological formations were identified for the first time in the studied area from LANDSAT images, especially the igneous and metamorphic rocks of the uplifted Basement Complex surrounded by a country of Late Cretaceous to Early Tertiary sediments.

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II. Jongli Canal Project

The proposed study has finally been approved for implementation by both the governments of Egypt and Sudan, and agreement was signed by both governments early this month.

A work plan and schedule has been formulated to carry out the implementation of this project - a copy of this plan is enclosed. Also, a copy of the press release related to this activity is enclosed.

III. Feasibility Study of a Proposed Transnational Project for Using LANDSAT Satellite Images for the Survey and Management of the Major Regional Aquifers in North East Africa and the Arabian Peninsula.

The present feasibility study covers thirteen countries, four of which are in the subregion of North East Africa and nine in the subregion of the Arabian Peninsula. Both subregions are divided geologically and geographically by the Red Sea.

The countries in North East Africa namely Egypt, Chad, Libya and Sudan are all large in area coverage which ranges from one million to more than two and half million square kilometres. On the other hand the countries in the Arabian Peninsula which include Bahrain, Kuwait, Oman, Qatar, Saudi Arabia,

United Arab Emirates, Yemen Arab Republic and the People's Democratic Republic of Yemen are greatly variable in their area coverage from less than one thousand square kilometres to more than two million square kilometres.

Two major regional aquifers are distinguished in the region of study, the older is the sandstone aquifer of Paleozoic and Mesozoic age and the younger is the limestone-detritus aquifer of Cenozoic age. Each of these aquifers is further subdivided into major regional subsidiary aquifers or sub-aquifers. Due to the common geological history of the studied region and the prevalence of essentially arid conditions in modern times, a unique groundwater regime has been imposed on the region which justifies treating it as one major unit regarding aquifer management.

The status and analysis of the sandstone and limestone-detritus aquifers in North East Africa and the Arabian Peninsula is given. The sandstone aquifer is distributed in extensive areas in all the investigated countries in North East Africa, namely Egypt, Chad, Libya and Sudan. The Nubian Sandstone sub-aquifer is represented in all these countries, however, older Paleozoic sandstone sub-aquifers are present northwards.

The termination of the sandstone aquifer at about latitude 30° N is reasonably demonstrated. The limestone-detritus aquifer is well illustrated in Egypt by the limestone sub-aquifers in the northern Mediterranean coastal zone, and by the detritus sub-aquifer in the Nile Delta and the Nile Valley. The influence of sea water intrusion is manifested by the Mediterranean Sea and the Suez Canal Zone.

The sandstone aquifer in Saudi Arabia is represented by several sub-aquifers. The Cretaceous sandstone sub-aquifer, which corresponds to the Nubian Sandstone sub-aquifer, extends southwards into the Yemen Arab Republic and the People's Democratic Republic of Yemen and probably into Oman. The limestone-detritus aquifer is well established in Saudi Arabia, which include limestone sub-aquifers. These extend eastwards into Kuwait, Bahrain, Qatar, United Arab Emirates and Oman. Towards the Arab Gulf the limestone sub-aquifers are partly affected by sea water intrusion, while the deeper sandstone aquifer does not bear anymore fresh water.

The gaps and problems related to the management of major regional aquifers in North East Africa and the Arabian Peninsula are treated. Regarding the available data there exist no data

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in some areas, while there are unused or unsynthesized data, whereas hydrogeological maps are not usually constructed. Assessment of groundwater resources stored in the aquifers is overoptimistic in several cases. Accordingly, the management of aquifers is threatened by insufficient determination of water needs and water costs, as well as, by the insufficient education of water users. Problems in management arise especially from overpumping; starting several projects without assigning priorities to some of them; lack of proper water allocation, taxation and legislation; and salt water intrusion and salinization.

A transnational project is suggested and elaborated to overcome the problems and to fill the gaps in the management of the major regional aquifers in North East Africa and the Arabian Peninsula with the ultimate aim to combat and eventually reverse the desertification processes. taking into consideration the human factor as the cornerstone in achieving this noble endeavour.

There are great advantages of applying the LANDSAT satellite mapping techniques for the concerned region, which include the following:

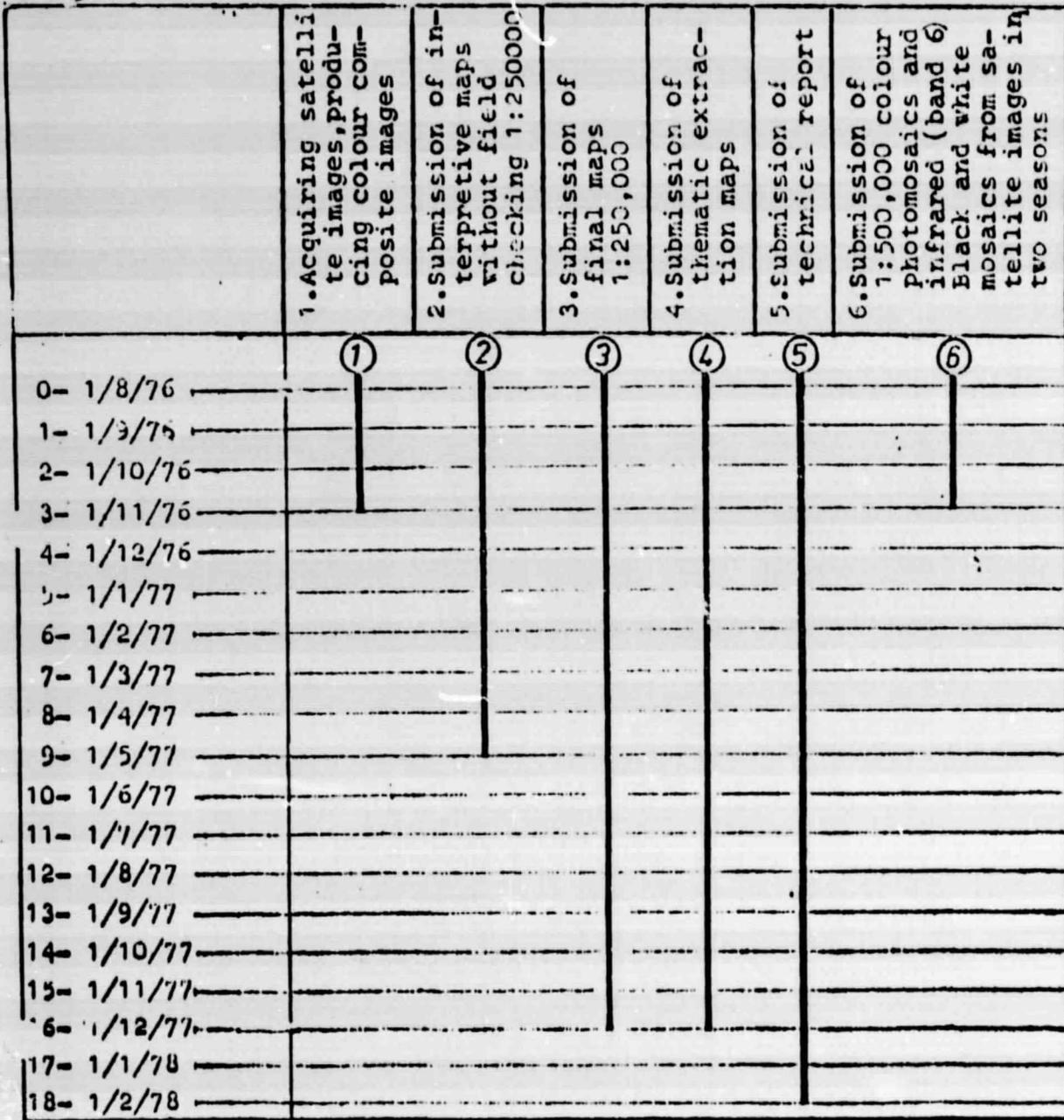
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- Most of the area coverage of the region is not covered by accurate maps and the new maps may be done in a short time and with a high degree of accuracy consistent with the speedy pace of development required.
- It is of particular importance to connect the small areas in an advanced state of study from the hydrological point of view with the large areas which are not so well known, and to interconnect the various dispersed known aquifers with each other, which was hitherto impossible to undertake applying the classical mapping.
- The standardization of the aquifers' geological characteristics and accordingly most of their hydrological parameters is related to the observations of these geological units over large areas which is only guaranteed through the application of satellite imagery.
- The possibility of mapping and investigating a multitude of natural resources with the same imagery opens the door for an integrated approach to develop deserts which is the only feasible way in most cases, for example the availability of water and certain minerals, or of water and energy resources, etc.

To define a plan of action and to initiate pilot projects for implementation, a preliminary meeting of a panel of experts representing the countries of the region was held in Cairo last May. Also, the feasibility study was discussed in the meeting of Senior consultants to the UNEP in Geneva September 13-15. The second draft report of this feasibility study will be discussed in another panel meeting of experts in Kuwait next month, after which a final feasibility study report will be prepared as a part of the report of the Secretary General of the U.N. to the International Conference on Desertification to be held in Nairobi in 1977. It is hoped that the implementation of the pilot project areas, utilizing Remote Sensing and Satellite image interpretations, will be initiated before the conference convenes in mid 1977.

Sep. 1976

**SCHEDULE OF ACTIVITY CHART FOR THE
JONGLEI CANAL PROJECT AREA INVESTIGATION (Upper Nile Basin)**



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Mr. L.H.