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SECOND QUARTERLY PROGRESS REPORT

NASA-"27930", GEOLOGICAL AND ENVIRONMENTAL RESOURCES INVESTIGATIONS IN EGYPT USING LANDSAT IMAGES

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Academy of Scientific Research
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(E77-10039) GEOLOGICAL AND ENVIRONMENTAL RESOURCES INVESTIGATIONS IN EGYPT USING LANDSAT IMAGES Quarterly Progress Report (Academy of Scientific Research and Technology) 21 p HC A02/MF A01

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 progress 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 km^2 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. Khawasik, 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 km^2 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 km^2 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.

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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 singnificant results of this study is the differentiation on the LANDSAT images of sand dunes and following their migration and encroachment. This study revealed a genèral eastward movement of the main sand dune belts in the area, with an average of about 10^{o} 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, Ocotober 1973.

(NASA)

(Final Report Published)

LANDSAT satellite images of an area covering about 34,000 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

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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 strcutural 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 km^2 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.

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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 km^2 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 singificant 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 km^2 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 km^2 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.

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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.

(NAS)

(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 km^2 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 singificant 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.

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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 km^2 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.

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,

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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:

- 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.

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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

SECHEDULE OF ACTIVITY CHART FOR THE

JONGLEI CANAL PROJECT AREA INVESTIGATION (Upper Nile Basin)

	1. Acquiring satellite images, producing colour composite images	2. Submission of interpretive maps without field checking 1:250000	3. Submission of final maps 1:250,000	4. Submission of thematic extraction maps	5. Submission of technical report	6. Submission of 1:500,000 colour photomosaics and infrared (band 6) Black and white mosaics from satellite images in two seasons
	(1)	(2)	(3)	(4)	(5)	(6)
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1- 1/9/76						
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PRESS RELEASE - FOR IMMEDIATE RELEASE

Egypt Remote Sensing Center Using NASA-LANDSAT Satellite to Study Water Conservation Projects at Upper Nile for the Benefit of Egypt and Sudan.

A Scientific and technical cooperative agreement has been signed between the Remote Sensing Center at the Egyptian Academy of Scientific Research and the Joint (Egyptian-Sudanese) Technical Commission for Nile Waters, for the use of advanced satellite images and aircraft remote sensing equipment in the study of water resources, geology, and vegetation cover over a vast area (165000 km^2) in the Upper Nile Basin around the proposed Jonglei Canal Project.

The Remote Sensing Center in Cairo has started as a joint venture between the U.S. National Science Foundation, Oklahoma State University and the Egyptian Academy of Scientific Research. Since its initiation four years ago, the center has developed to be one of the most sophisticated centers of Remote Sensing in the Near East and Africa, using NASA-ERTS and LANDSAT Satellite images and advanced airborne remote sensors. Presently, this Center, under the direction of Dr. Mohamed Abdel-Hady, Professor at Oklahoma State University and who has been on extended resident research leave in Cairo for the past 4 years to organize and establish the Center, employs a core of 65 highly qualified scientists and resource specialists, covering the areas of geology hydrology, mineral resources, agriculture, soils, geophysics, engineering and physics. Also, a specialized airborne geophysical exploration team.

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The Remote Sensing Center, also has a large inventory of the most modern remote sensing facilities and equipment available in the world, including ground, laboratory and airborne equipment.

A $ 1,000,000 Multispectral Data Analysis System, aquired by U.S. AID loan funding to the Remote Sensing Center in Cairo, has just been installed, for analyzing and categorizing digital data from specialized resources survey LANDSAT satellites receiving stations. This system is unique and was originally developed by Bendix Corp. for the U.S.-NASA space program. Also, the RSP Center in Cairo will be using in the investigation two aircrafts equipped with the most modern airborne remote sensing equipment, including multispectral aerial digital scanners, infrared thermal mappers, and aerial multispectral cameras.

The governments of Sudan and Egypt in particular, both countries of limited water resources, are pursuing every avenue to achieve additional storage and conservation of water to make available additional water for irrigation, human consumption, which would channelize the flood waters of Bahr El Jebel (Upper Nile) to eliminate much of the flooding in El Sudd region of Southern Sudan. The objective is to save about 13 billion cubic meters of water for beneficial use that is otherwise wasted through evaporation from vast water surfaces and through transpiration from plants of potentially limited benefit. Also, much grassland used for grazing animals would be improved through the introduction of other varieties of

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species, which is now periodically inundated. Water thus saved and controlled could be used for irrigation and other beneficial uses in Sudan and Egypt.

Various proposals for reclaiming extensive areas of El Sudd region include irrigation, introduction of new crops or new better adapted plant varieties improving transportation and others, all of which must take into account the living habits of the Nylites and others. Design of the Jonglei Canal, and planning of the future for the modified terrain and environment of the southern clay plain requires an inventory of present and potential land use, soil and vegetation resources, and the extent and duration of flooding over the region.

This reconnaissance and resource survey of the region will be implemented in two phases. In the initial phase, photomosaics of LANDSAT imagery will provide base maps of the area at 1:500,000 and 1:250,000 (and 1:100,000 where greatest detail is needed) depending on detail required. This phase will include field characterization of soil mapping units including geology, soils, vegetation, hydrology, drainage patterns, occurrence of water areas, and present land use. Resource overlays will be developed over LANDSAT imagery by photo and machine interpretation. Resource data will be put into a spatial data base which will be available for planning purposes. The data base may have cellular elements of any convenient size and will be incorporated into a sub-division of latitude and longitude.

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The second phase of the project will include integration of resource data stored in the computer into comprehensive information schemes. Data from the data bank would be used to make interpretive thematic extractions for various purposes (irrigability, potential land use, soil drainage, natural grazing transportation, etc.) These maps would be constructed based on interpretation of the initial resource maps and other available data.

The project will be conducted under the leadership of Prof Dr. M. Abdel-Hady, who will direct the American and Egyptian scientific teams. The following Egyptian scientists will lead study groups in this area: Prof. Dr. El-Shazly the Director of the Geological Studies Group of the RSP and the Deputy Director of the Egyptian Atomic Energy Establishment, who is also one of the World's leading geological scientists; Soils and Agricultural scientist Prof. Dr. G. Abdel-Samie the Vice President of the Egyptian Academy of Sciences. An american scientific team under the direction of Prof. V. Myers, the Director of the Remote Sensing Institute at South Dakota State University, will be also participating in the investigation.

The U.S.-NASA Has already programmed a coverage of this area with LANDSAT-2 satellite which was launched by NASA in 1975. Already several digital tapes and multispectral images at various seasons are recorded by the satellite over the area, and coverage will continue through the next year.

The study will cost about $ 200,000 which will be paid for by Egypt and Sudan and will be completed in 18 months.

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