ADVANCING EGYPTIAN GEOLOGY

Efforts and Achievements of the Egyptian Geological Survey

by

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Staff at the Egyptian Geological Survey and Mining Authority - some of whom are third generation employees - have reason to be proud of the Survey's scientific accomplishments. As the Survey prepares to host (under the auspices of the Geological Society of Africa) the 5th Conference on African Geology October 6-15, 1979 in Cairo, Conference Secretary Dr. Bahay Issawi outlines the Survey's objectives and some of its current mineral exploration and research programs.

Introduction

For historians, Egypt has meant in essence the famous Nile Valley - scene of human activity through so many centuries. For geologists however, the Egypt of greatest significance is the vast desert area of almost one million km² lying on both sides of the Nile Valley. Stretching from the Mediterranean in the north to the desolate regions of northern Sudan in the south, and from the Great Sand Sea near the Libyan borders to the Levant on the northeast and the Red Sea on the east, the Egyptian Deserts form an integral part of the great African Sahara.

Historical evidence has shown that the desert was occupied in prehistoric times by nomadic hunters and temporary settlers. In Pharaonic times Egyptians roved the desert looking for gold, copper, and precious stones. More recently their descendents have continued this search, organized largely by the Egyptian Geological Survey and Mining Authority.

Established in 1896 as a small section in the Ministry of Public Works, the Survey had a humble budget of 730 Egyptian pounds a year and less than 2500 pounds for field operations. By 1898, it was annexed to the Topographic Survey Department, and later joined the newly established Mines and Quarries Department. In 1914 the Survey became fully integrated with the Mines and Quarries Department, where it remained until 1945 when the Department merged with the Ministry of Commerce and Industry. "Independence" came in 1956 when the Survey, under the name of "Geological and Mineral Research Department", emerged as part of the newly established Ministry of Industry.

For a period of five years (1965-1970), the Survey was amalgamated with the General Egyptian Organization for Mining and Geological Researches, founded in 1961 to

supervise the nationalized mining industry. By the end of 1970 however, the Geological Survey became a separate body under the name of Geological Survey and Mining Authority (EGSMA), with an annual budget of more than 4 million Egyptian pounds.

Irrespective of the different titles and affiliations, the Survey has had from the beginning a specific role to play in exploring and mapping the desert and in discovering and evaluating Egypt's mineral resources. Keeping abreast of the progress made in industry, housing, and city planning, the Survey has launched varied research programs, systematically employing complex methods of mineral exploration, modern techniques of mapping, new and sophisticated geophysical and laboratory equipment. At the same time, service and support administrative activities were expanded and reorganized to meet the demands of new geological enterprise; library holdings were increased and laboratories improved.

Professional scientific staff now include geologists, geophysicists, chemists and engineers totalling some 370 - almost ten times the number of those employed before 1952. Some of these are second and third generation Survey employees, imbued with a clear sense of the Survey's main purpose: to produce geological maps of the country, and to explore and evaluate the rocks and minerals found in Egypt.

Geological Mapping

With Egypt lying at the crossroads connecting Europe with the Old World, the importance of building up a cartographic section in the Survey was recognized right from the beginning. Shortly after the turn of the century, several eminent geologists collaborated to produce a geological map at a scale of 1:6 000 000 (Hume, 1911). The first coloured geological map of Egypt (1:1 000 000) was published in 1928 in an Atlas of Egypt put out by the Survey.

A field party from the Egyptian Survey camps near the Gilf Kebir in SW Egypt. Many in the party are second and third generation Survey employees. The author, Dr. Issawi, is in the back row, eighth from the left. (Photo courtesy R. Giegengack)

During the late thirties and early forties, an extensive program for oil exploration in the northern part of the country led to the publication of a regional geological map (1:500 000) for the area north of latitude 27°30'. Working on the Red Sea Hills, Central Eastern Desert, and the Aswan area, the Survey also published geological maps for these areas at a scale of 1:100 000 (Amin, et al., 1952, 1953, 1954; El Shazly and Hamada, 1954; Mansour and Bassiouny, 1954; Moustafa, et al., 1954a, b, Attia, 1955, El Ramly and Al Far, 1955 and many others).

The Survey's mapping program was particularly active in the late fifties and early sixties when many parts in the Western Desert were covered, as well as the Bahariya Oasis (El Akkad and Issawi, 1963). Here, in the south and in the western Nubia area important iron ore deposits were discovered and evaluated (Issawi, 1968, 1971). Geological mapping of the Sinai included Maghara (Al Far, 1966), Beda, Thora and Ayun Musa. During this phase, assembled maps were published at scales of 1:250 000 and 1:100 000. All of these areas were investigated for possible coal deposits as well.

The last decade has witnessed the Survey's most energetic mapping program. The area mapped, totalling some 300 000 km², includes

- the northern Red Sea Hills;

- the Red Sea coastal strip between Safaga and Brenice (El Akkad and Dardir, 1966 a, b and Issawi, et al., 1968, 1971);
- the northern part of the Western Desert (north of 30°N);
- the Western Desert from 24° to 26°N, and between 29°E and the Nile (El Hinnawai, et al., *in press*, and El Deftar, et al., *in press*); and
- the Nile Valley area between Qena and Idfu where economic phosphate beds are exposed (Ghanem, et al., 1970 and El Bassiouni, et al., 1970),

Much of the above compilations were assembled on a new geological map at a scale of 1:2 000 000 in 1971, accompanied by an explanatory note (Said, 1971), while two geological maps for the igneous and metamorphic rocks in the Eastern and Western Deserts (1:1 000 000) appeared in 1972 (El Ramly, 1972). By the end of this year (1979) the Geological Survey will publish International Sheet No. NG-36 (scale 1:1 000 000).

Figure 1 summarizes the current status of geological mapping in Egypt.

Important Recent Mineral Discoveries

During the last two decades, mineral exploration activities by the Survey have led to several important discoveries in the

Figure 1. Status of geological maps for Egypt as of 1979.

Bahariya: Iron Ore

Some 325 km southwest of Cairo in the Bahariya Oasis, iron ore was found in the form of beds diagenetically replacing Middle Eocene carbonate strata. The thickness varies from 2 m to 25 m and averages 9 m. The ore has been found in four localities: Ghorabi (Fig. 2), El Harra, Nasser and El Gedida (Fig. 3). Production started in 1972 at almost half a million tons, but by 1976 it was estimated to be at 1 242 000 tons per year. Work is restricted now to the El Gedida area where the reserves are estimated to be over 120 million tons.

Figure 2. Aerial view of pits (100m apart) in Middle Eocene iron-ore at East Gebel Ghorabi, Bahariya Oasis, looking north.

The ore is composed mainly of goethite, hematite and manganese oxide minerals. Fe varies from 45% to 58% with an average of 51%. Trains loaded with goethite and hematite cross the Nile to the smelters at Helwan. Mining is carried out by the open cast system because there is so little overburden.

Kalabsha: Kaolin

Kaolin deposits were discovered in 1964 at the foot of Gebel (which in Arabic means "mountain") Kalabsha, 85 km southwest of Aswan. The kaolin is interbedded in the famous Nubia Sandstone section which covers a great tract of southern Egypt, north of Sudan. (The Nubia Sandstone is a Mesozoic formation perhaps in large part of Cretaceous age.) The ore is non pisolitic, plastic with quartz sand intercalations at the top, and pisolitic and concretionary at the base. The upper part of the deposit forms lenticular bands in the sandstone section, while the lower units form well developed extensive beds.

Figure 3. Iron-ore beds (approximately 10m thick) in Middle Eocene carbonates at El Gedid area, Bahariya Oasis, looking east.

The following table shows the range of ore components:

Al_2O_3	SiO_2	TiO_2	Fe_2O_3
(%)	(%)	(%)	(%)
15-34	44-49	ca.2.4	ca.0.5

Reserves amount to 2.16 million tons in an area of approximately 25 km^2 . The average thickness of the exploited bed is about 4.0 m, with less than a meter overburden.

Abu Tartu: Phosphates

This deposit is located in the heart of the Western Desert some 50 km west of Kharga Oasis. Phosphorites occur in terrigenous-carbonate sediments of Maestrichtian age represented by almost horizontal beds. The economic bed averages 3 to 9 m in thickness, while its P_2O_5 content averages 25.56%. In a huge cliff bounding the Kharga depression oasis (Fig. 4), phosphorites are overlain by clay and limestone beds which are approximately 200 m thick, and underlain by clay and sandstone about 130 m thick. The estimated geological reserves, in 1972, amounted to 987.8 million tons (Wassef, 1977).

In all of its exploration programs, the Egyptian Geological Survey acts not only as a "herald" for mining companies, but follows up on the mining programs through inspectors stationed in the mining areas. When technical problems are encountered in exploiting the ore (in tracing an ore bearing horizon to establish reserves, or in getting rid of unwanted materials in the ore dressing), the Survey provides the staff and equipment which companies may lack.

Figure 4. Cliff bounding the Kharga oasis in the Abu Tartur area: main phosphate bed (approximately 9m thick) with carbonate intercalations of Maestrichtian age underlain by Nubian continental sandstone and overlain by marls of Dakhla Formation.

In the Quseir-Safaga stretch of the Red Sea coast, for example, a company mining phosphate asked for a reevaluation of the deposit. For a period of three years (1966-1969) the Survey conducted detailed mapping and drilling, and was able to advise the company as to which areas were economically feasible for further development (Issawi, et al., 1969, 1971).

Significance of Specific Quaternary Research Programs

Systematic mapping of Egypt's deserts and the Nile Valley led to important discoveries in Quaternary geology. Deposits belonging to this period were once considered of minor significance, except for the pioneering work of Sandford and Arkell (1933) on the Nile basin, and of Caton-Thompson (1952) in the Kharga Oasis. In the last two decades, however,

and with the construction of the Aswan High Dam, an active program dedicated to the anthropology and archaeology of the area covered by water south of Aswan has been launched.

It has also entailed a detailed study of Quaternary geology which has led scholars from many different parts of the world to establish a tentative chronological sequence of events. The encouraging results to the north of the High Dam have stimulated the study of Quaternary geology in southern Egypt as well (Wendorf, 1965, 1968, and Wendorf and Schild, 1976, and Butzer and Hansen 1968).

Areas on both sides of the Nile Valley (previously mapped as a vague unit called "Quaternary deposits") have become a focus of study for these workers. Three main results stem from their research:

1. *Mud pans, whether of the ancestral Nile (Nilotic) or deposits of other river systems, have been delineated.* A long and very complex history of how many channels once flowed and wandered over the present Valley and its adjacent deserts has now been revealed. Furthermore, the channels of these old rivers and their fans have provided potential for newly reclaimed land and sites for new cities. Information on the types of soil, the thickness of solums, their elevations and extensions has increased enormously in the last few years.

West of Kom Ombo, new findings of very black Nilotic soils extending 50 km west of the present Nile, constitute important additions to the country's needed agricultural land. The recently discovered silt deposits which finger the Eastern Desert hills and plateaux through many entrants and wadis (as, for example east Kom Ombo and Wadi Abad) are now sites of green cultivation as well.

Quaternary research has included many parts of the Western Desert, where huge silt and fine sediments were located for the first time. During the course of field investigations carried out west of Darb El Arbain (approximately 300 km west of the Nile at Aswan), a Survey party located an extensive lacustrine deposit at the Bir Sahara area (Schild and Wendorf, 1975 and Issawi, in press). The deposits (Fig. 5) point to an old lake (approximately equal in size to Lake Victoria in central Africa) as having been in existence during Acheulean and Mousterian times, some 200 000 to 50 000 years ago, when the area was inhabited.

2. *A chronological sequence of events based on studies of sediments has been established.* The chronology established so far sheds new light on anthropological, archaeological and climatological interpretations. The longstanding question regarding the origin of underground water in the Western Desert, whether fossil or renewable, has probably been satisfactorily answered. In 1977, samples of Bir Sahara water indicated a very recent origin - 230 years (Vance Haynes,

personal communication), probably due to heavy and extensive showers over the area at that time. Fluctuations in wet and dry climates during the last 20 000 years, and also the eustatic changes in the underground water levels can be traced by studying the types of sediments deposited.

3. *Quaternary deposits have furnished good source materials for the construction industry.* Different types of quartz sands, gravels of various sizes and constituents, clay and silt, tufa and travertine, diatomite - all these have been found and mapped recently along many parts of the Nile Valley and in the Western Desert. Lack of access to Nile silt after the building of the Aswan High Dam affected the brick industry. A substitute has now been found in the old river deposits on both sides of the present Nile Valley, and in the huge quartz sand Quaternary deposits recently located in Upper Egypt - Kom Ombo, Qena and the western stretch of the Nile between Minia and Beni-Suef. The tufa and travertine found in west Assiut, east Beni-Suef and in the south of Egypt (Kurkur Oasis) are used in part for making stairs, facades for buildings and even in artificial mosaic tiles.

The study of Quaternary deposits has also encouraged research that is of universal appeal, as, for example, the study of glacial and interglacial phases and their extensions in temperate, semi-arid and arid zones. Inasmuch as the past is a key to the present, the present in turn is proving to be a key to the future. Past climatic fluctuations are well echoed in the Quaternary sediments in many parts of the world; when assembled together, along with other scientific findings in the fields of paleomagnetism, anthropology, and the like, they should give a clearer picture of past climates and a basis for predicting future climatic changes.

Conclusion

The Egyptian Survey's activities and research work are providing the country with new insights not only of scientific but also of economic and social value. In organizing and hosting the 5th Conference on African Geology this October, the Survey is recognizing the importance of studies being conducted by scientists from other African countries. The Conference program will emphasize the age and characteristics of the Precambrian in the Nubian Shield and in Pan-Africa in general, the geology of mineral deposits (especially phosphorites) in Egypt and the uranium potential of Africa, the nature of ophiolites and their relation to regional tectonics, and the nature of alkaline complexes in relation to the Red Sea rift. Also included will be a report on the inferred paleogeography of the region (based on recent paleomagnetic data) which should indicate even more clearly the key location of Egypt in the previous bonding of Africa, Asia and Europe.

Figure 5. Quaternary lacustrine deposits at Bir Sahara, believed to have accumulated in a lake the size of Lake Victoria (Africa) between 200 000 and 50 000 years ago. (Photo courtesy R. Giegengack)

EDITORS' NOTE: Arrangements have been made to publish the papers presented at the 5th Conference on African Geology (October 6-15, 1979) in a special issue of the *Annals of the Geological Survey of Egypt*. Further information may be obtained from the Conference Secretary:

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