General Disclaimer

One or more of the Following Statements may affect this Document

- This document has been reproduced from the best copy furnished by the organizational source. It is being released in the interest of making available as much information as possible.

- This document may contain data, which exceeds the sheet parameters. It was furnished in this condition by the organizational source and is the best copy available.

- This document may contain tone-on-tone or color graphs, charts and/or pictures, which have been reproduced in black and white.

- This document is paginated as submitted by the original source.

- Portions of this document are not fully legible due to the historical nature of some of the material. However, it is the best reproduction available from the original submission.

Produced by the NASA Center for Aerospace Information (CASI)
Regional Prospecting for Iron Ores in Bahariya Oasis-El Faiyum area, Egypt, Using Landsat Satellite Images

NASA Landsat G-27930

By:
Professor Dr. E.M. El Shazly
Professor Dr. M.A. Abdel Mady
Dr. M.A. El Ghawaby
Dr. S.M. Khawasik

Published by:
Remote Sensing Center
Academy of Scientific Research & Technology,
Cairo, Egypt

Feb. 1976
Regional Prospecting for Iron Ores in Bahariya Oasis-El Faiyum area, Egypt, Using Landsat-1 Satellite Images

Published by Remote Sensing Center
Academy of Scientific Research and Technology
101, Kasr El Aini Street, Cairo, Egypt
February 1976
<table>
<thead>
<tr>
<th>Abstract</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chapter 1. Structural elements of iron deposition</td>
<td>7</td>
</tr>
<tr>
<td>Chapter 2. Geological criteria of iron deposition</td>
<td>15</td>
</tr>
<tr>
<td>Chapter 3. Recommendations</td>
<td>21</td>
</tr>
<tr>
<td>References</td>
<td>22</td>
</tr>
<tr>
<td>List of plates: I - XXV</td>
<td>23</td>
</tr>
</tbody>
</table>
Based on deep theoretical and practical considerations of iron deposition in the northern and central Western Desert of Egypt, an area exceeding 10,100 km² is chosen for regional iron ore prospecting. This area has been called Bahariya Oasis-El Fayum area and it extends from the west of Bahariya and Farafra Oases eastwards to the Nile Valley. The most modern techniques of regional prospecting for iron deposition have been applied under the prevailing conditions in this area, especially the interpretation of LANDSAT satellite images and quantitative structural analysis. The geological, structural and drainage maps constructed have thrown a new light on the investigated Bahariya Oasis-El Fayum area, and their manifold scientific and applied aspects, other than their use in iron ore prospecting, will be discussed in another publication to follow.

New discoveries of iron occurrences have been registered as a result of the present prospecting work, and the conditions of the already known iron ore deposits and occurrences are regionally connected and verified. Several localities are recommended for more detailed prospecting and exploration for iron ore deposits, which are arranged according to their priorities.
Chapter 1

Structural elements of iron deposition

The construction of geological, structural and drainage maps for Bahariya Oasis-El Faiyum area from LANDSAT satellite images had led to the deciphering of the regional geological picture of this area. The interpretation of the satellite images has been directed mainly towards the deciphering of the regional conditions of iron deposition, and their application towards the discovery of new iron occurrences or the understanding of the status of the already known iron ore deposits and occurrences.

Two major structural elements are found in the investigated area, namely, folding and fracturing including faulting. It has been found that the iron ore deposition is not primarily controlled by fracturing. Accordingly, although the fracture systems are drawn on the enclosed structural maps, they are not analyzed in this work which is devoted primarily to the positive elements of iron prospecting, and will be given in a subsequent work. Iron ore deposition, however, was found to be related to folding and unconformity surfaces. Of special importance in this respect is the Laramide diastrophism which was initiated in the Late Cretaceous and continued into the Paleogene which played a special role in the deposition of iron ores in combination with the climatic conditions prevailing during the Late Cretaceous and which has been proved to be tropical to subtropical (El Shazly and Krs 1973).

The known iron ore deposits in Northern Bahariya Oasis locality, enclosing El Gedida, Gebel Chorabi and El Harra, have been found, on
LANDSAT images, to be mostly located on crenulations representing hinge areas of relatively meso or macro folds with axial trace of nearly NE-SW trend.

In addition, the already known iron occurrence of El Heiz in the Central Bahariya Oasis locality are, in the same manner, located on crenulations representing hinge areas of relatively meso or macro folds. However, the final traces of these folds possess variable trends ranging from NW-SE to NNW-SSE directions. At least two generations of deformation have acted on the rocks of the previously mentioned localities, as well as, the mapped Bahariya Oasis-El Faiyum area.

In addition to the two known localities of iron deposition, three more localities of comparable tectonic setting, namely Gebel Qalamun Locality, Qaret Had El Bahr locality and Southern Bahariya Oasis locality, have been given particular attention in the field work and they show the presence of iron occurrences in the exposed rocks.

The registration of favorable structures on the satellite images in the following localities, namely, the extension of Northern Bahariya Oasis locality, Ghard Ghorabi locality, West El Faiyum locality and West Giza locality, leads to the recommendation of these localities for subsurface prospecting of iron ore deposits, although surface exposures of iron occurrences have not been noted during the field work carried out so far in the investigated Bahariya Oasis-El Faiyum area. In the mentioned localities the rocks belonging to the Late Cretaceous and the lower formation of the Middle Eocene rocks are not normally outcropping in the surface and they are usually covered with later Middle Eocene, Late Eocene and Oligocene rocks.

Introduction

Two systems of minor folds are associated with the already known and the newly discovered iron occurrences in the investigated Bahariya Oasis-El Faiyum area. These occurrences are Northern Bahariya Oasis, Central Bahariya Oasis, Southern Bahariya Oasis, Qaret Had El Bahr and Gebel Qalamun. The structural field data are tested if two of minor fold systems or one of them indicate corresponding major folds, or they are just local inhomogeneties.

A new technique is applied for treating the field data to determine the major structures which could not be fully investigated in outcrops, as well as their geometrical elements. This technique is based on viewing the linear structures and the normals of the planar structures as vectors of a unit magnitude each (Ramsay 1967 & Koch and Link 1971). The vectors are expressed in terms of direction cosines p, q and r related to the coordinate axes x, y and z which are coinciding with the E-W and NS geogrphic directions, and the vertical, respectively. This method is more accurate than the current graphical methods, as the former avoids the drawing errors, and gives results which cannot be elucidated on the same detailed level in the diagrams.
Regional Prospecting for Iron Ores in Bahariya Oasis - El Fanum Area, Egypt

Structural Test of Field Data in Northern Bahariya Oasis Locality

To carry out the test, the orientation data are assumed to be disposed on a surface of a cone; then it is proceeded to determine the orientation of the cone axis and the amount of its vertex angle. The determined angle should approximate 0° if the area is not folded on the regional scale. If it is cylindrically folded by a single simple phase it should be 180°, while if the two phases have affected the outcropping rocks the angle will be moderate.

The field data are expressed in terms of direction cosines and arranged in such determinants.

\[
D = \begin{vmatrix}
\Sigma p^2 & \Sigma pq & \Sigma p \\
\Sigma pq & \Sigma q^2 & \Sigma q \\
\Sigma p & \Sigma q & N
\end{vmatrix} \quad \text{and} \quad D_i = \begin{vmatrix}
\Sigma pr & \Sigma pq & \Sigma p \\
\Sigma qr & \Sigma q^2 & \Sigma q \\
\Sigma r & \Sigma q & N
\end{vmatrix}
\]

Three parameters are then determined by the following equation:

\[D_i = D \quad \text{and} \quad V = \begin{vmatrix}
D_i & 1 \\
D & 1
\end{vmatrix}
\]

The angles \(\gamma\), \(\alpha\) and \(\beta\) which the cone axis make with the cartesian coordinates are then determined by the following equations:

\[
\cos \gamma = \frac{1+I^2+J^2}{2} \\
\cos \alpha = \frac{I(1+I^2+J^2)}{2} \\
\cos \beta = \frac{J(1+I^2+J^2)}{2}
\]

The vertex angle is determined by the following equation:

\[
\cos K = -V(1+I+J) \times 2
\]

Where \(K\) is half the apical angle of the cone.

The values of \(\Sigma p\), \(\Sigma q\), \(\Sigma r\), \(\Sigma p^2\), \(\Sigma q^2\), \(\Sigma pq\), \(\Sigma qr\) and \(\Sigma r\) are calculated to be: 0.7993, 1.7088, 26.8609, 4.1247, 6.1435, -4.2493, 1.7283, and -1.0076, respectively.

From equation 1, \(D\), \(D_i\), \(D_j\) and \(D_k\) are determined.
From equation 2, the three following parameters are determined:

\[ I = \frac{117.9343}{220.0636} = 0.5359 \]
\[ J = \frac{169.1585}{220.0636} = 0.7687 \]
\[ V = -\frac{185.1305}{220.0636} = -0.8413 \]

From equation 3 to equation 6, \( \cos \gamma \), \( \cos \alpha \), \( \cos \beta \) and \( \cos \kappa \) are determined:

\[ \cos \gamma = (1 + 0.5359^2 + 0.7687^2)^{-\frac{1}{2}} = 0.7297 \]
\[ \cos \alpha = 0.7297 \times 0.5359 = 0.3910 \]
\[ \cos \beta = 0.7297 \times 0.687 = 0.5609 \]
\[ \cos \kappa = 0.7297 \times 0.841 = 0.6139 \]

The above results show that the bedding and contacts are affected by the two fold phases on a major scale.

**Structural Analysis of Localities of Iron Deposition**

Iron deposition has been discovered in several localities in Bahariya Oasis-El Faiyum area. The deposition of iron in these localities, as well as in the already known occurrences is structurally controlled.

The localities of iron deposition so far proved in the investigated area are:

1. Northern Bahariya Oasis locality.
2. Central Bahariya Oasis locality.
4. Qaret Had El Buhr locality.
5. Gebel Qalamun locality.

Structural analysis is carried out in each of these localities to elucidate the major structures. Attention is given to those structures which control the iron deposition or influence the mineralized localities.

1. Northern Bahariya Oasis Locality

Three main iron ore occurrences are outcropping in this locality namely those of Gebel Ghorabi, El Harra, and El Gedida.
The iron ore deposits at Gebel Ghorabi are located on a nearly horizontal fold with a vertical or steeply inclined axial plane; its inclination is either SE or NW. The average plunge of the axis is 4°N25°E and the mean strike of the axial plane in N22°E which is dipping 78°SE (Plate VII and Table 1).

Another probable anticline is found east of Gebel Ghorabi anticline, both are nearly parallel to each other. The former incorporates the two iron ore deposits of El Gedida and El Harra (Plate VI).

These two folds are affected by another younger folding phase which is represented by Gebel Ghorabi second fold (Plate VIII). The latter's axial trace makes an obtuse angle with the axial traces of the folds belonging to the first generation. The younger fold should, therefore, affect the iron ore bodies which are controlled geometrically by the shape and attitudes of the first folds. Gebel Ghorabi second fold is also upright of nearly horizontal plunge, its mean axis is plunging on the average 4°N58°W (Plate VIII and Table 1).

2. Central Bahariya Oasis Locality

This locality incorporates El Heiz known occurrence and other adjacent occurrences encountered during the present field work. The iron deposition here is believed to be located on the axes of first folds which have been deformed by the later second fold generation. The Central Bahariya Oasis locality represents, structurally, the top of the culmination resulting from the effect of the second folds on the first, while the northern and the southern localities represent the two reversely plunging tails of the culmination.

In two lithostratigraphic sections (XXX and XLI) measured northwest of Ain El Gharbia and at Gebel Radwan respectively, it has been found out that the iron content increases upwards as the lower stratigraphic horizons are of lower grade. It is considered, therefore, that higher grade iron ores may have been eroded, since this part of this section represents the structural top of the anticline.

The second fold which affected the Central Bahariya Oasis locality is parallel to what is called here, El Hafhuf second fold (Plate VI). The geometry of this fold is shown in Table 1 and Plate IX.

3. Southern Bahariya Oasis Locality

Iron occurrences encountered at this locality are represented in Sections LXII (Sample 260), XLII (Samples 257 and 258), and LI (Sample 267). The iron deposition is located on Ain Khoman first fold (Plate VI), which is an open upright anticline, its axis is statistically plunging 3°S36°W, and its mean axial plane is striking S 35°W and dipping 79°SE (Plate X). This fold and its associated iron occurrences are affected by another younger fold, namely Ain Khoman fold 2. The latter's axis is plunging 30°S39°E on an axial plane striking N 37°W with a mean dip of 51°SW.
The locality under consideration has a special interest, if it is assumed that the iron deposition in the subsurface has not been extremely reduced for any stratigraphic or other reason, especially by lateral variation. The Southern Bahariya Oasis locality is structurally, though not stratigraphically, corresponding to the Northern Bahariya Oasis locality. At the northern locality, the three known iron occurrences at Gebel Ghorabi, El Gedida, and El Harra are found on the axes of the first folds which are slightly plunging NE, whereas at the southern locality the iron deposition is found at the corresponding folds slightly plunging SW.

4. Qaret Had El Bahr Locality

An iron occurrence is outcropping at this locality (Section V, Sample 34) on an unconformity surface between Gebel Qalamun Formation of the Middle Eocene and the overlying Early Miocene rocks. The iron deposition in this locality is thought to be located on the extension of the fold axes controlling El Gedida or Gebel Ghorabi anticlines.

5. Gebel Qalamun Locality

This locality extends from Gebel Qalamun southeastwards to the boundary of the cultivated land of Maghagha, then southwestwards to Qaret Abu Roh due west of El Bahnasa and Samalut, and may even extend southwards outside the mapped area. The iron deposition at this locality is outcropping along a curve of some 70 km length (Plate VI).

The bedding planes and contacts in the discussed locality are approximately horizontal. When they are projected, their poles are distributed in a partial great circle expressing a weak regional folding. Two fracture systems are encountered, each of them has a strike concomitant with the two main directions of the axial trace of this major fold.

The mean vector of the bedding planes and contacts, and accordingly their plane of best fit, are determined. The value of this plane will be used in the structural computations or the detailed exploration at this locality since it represents the statistical mean value. The mean vector is the normal to the plane of best fit, which in projection (Plate XV) is the locus of limb maxima of the two sides of the fold. The two planes containing the mean value of fractures represent two girdles of the two sides of the fold. It is obvious in Plate XV that the fold axis is either horizontal and trending NE, in the southern part of the locality, or plunging 2°NW, in its northern part.
<table>
<thead>
<tr>
<th>Fold</th>
<th>Axis</th>
<th>Axial plane</th>
<th>Accompanied fractures</th>
<th>Unaccompanied fractures</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Trend</td>
<td>Plunge</td>
<td>Strike</td>
<td>Mean dip</td>
</tr>
<tr>
<td>Gebel Ghorabi anticline</td>
<td>N25°E</td>
<td>4°</td>
<td>N22°E</td>
<td>78°SE</td>
</tr>
<tr>
<td>Ain Khoman anticline</td>
<td>S36°W</td>
<td>6°</td>
<td>S35°W</td>
<td>79°E</td>
</tr>
<tr>
<td>Naqab El Sellim</td>
<td>N13°W</td>
<td>19°</td>
<td>N13°W</td>
<td>79°E</td>
</tr>
<tr>
<td>Farafra Oasis</td>
<td>S42°W</td>
<td>8°</td>
<td>N47°E</td>
<td>72°SE</td>
</tr>
<tr>
<td></td>
<td>N58°W</td>
<td>4°</td>
<td>N62°W</td>
<td>78°NE</td>
</tr>
<tr>
<td>El Hafhuf</td>
<td>N72°W</td>
<td>10°</td>
<td>E-W</td>
<td>30°N</td>
</tr>
<tr>
<td>Ain Khoman</td>
<td>S39°E</td>
<td>3°</td>
<td>S37°W</td>
<td>81°SW</td>
</tr>
<tr>
<td>Farafra Oasis</td>
<td>N54°W</td>
<td>1°</td>
<td>N54°W</td>
<td>78°SW</td>
</tr>
</tbody>
</table>
Chapter 2

Geological criteria of iron deposition

Deposition of iron started in the Late Cretaceous and continued in the Middle Eocene, especially Gebel Qalamun Formation. It has been proved during the present work that the iron occurrence at El Heiz in the central part of Bahariya Oasis is actually belonging to the Late Cretaceous and not to the Oligocene. It is considered here that the Oligocene and Miocene may be periods of ferrugination particularly enhanced by volcanic activity but not periods of iron deposition leading to the formation of ore deposits. Accordingly, iron ore deposits of economic potential in the Bahariya Oasis-El Faiyum area are believed to be restricted only to the Cretaceous-Eocene geological units. Hence, exploration activities should be directed towards these units, especially in the top parts of the Cretaceous and the bottom parts of the Middle Eocene within the sphere of influence of the previously mentioned structures.

The main geological conditions of the known and newly discovered iron occurrences in the regionally investigated area are as follows:

1. Northern Bahariya Oasis Locality

The iron ore deposits of El Gedida, Gebel Ghorabi and El Harra are occurring in this locality. The iron ores are normally encountered in Gebel Qalamun Formation of the Middle Eocene (El Shazly 1962a, El Akkad and Issawi 1963, and Mahgoub and Amer 1964). In addition, it has been stated by El Bassyouni (1970) that the lower economic iron ore beds
in El Harra represent a member of the Late Cretaceous Bahariya Oasis Formation.

The aim of the present work in this locality is to connect regionally the known iron ore deposits from the geological and structural point of view. These deposits have been found to be actually dominated by Laramide folding acting on the Late Cretaceous-Middle Eocene geological units. The same structural conditions have been noted in the northern extension of this locality towards the north of the already known deposits.

Apart from the well established iron ore deposits in the Middle Eocene rocks, occurrences have been encountered during the present work in the Late Cretaceous rock units in the Northern Bahariya Oasis locality which are illustrated in Table 2. Both samples analyzed from these occurrences are high in salts especially sample No. 208.

2. Central Bahariya Oasis Locality

The iron occurrence of El Heiz outcropping in this locality is stated by Ball and Beadnell (1903) to be of Oligocene age based on the lithologic similarity with the Oligocene rocks in northern Egypt. Later, authors followed the same age assignment given by Ball and Beadnell. However, in the present work the iron occurrence under discussion is assigned to the Late Cretaceous. El Shazly (1962b) considers the dark

<table>
<thead>
<tr>
<th>Sample No.</th>
<th>Location</th>
<th>Th. m.</th>
<th>5 Km</th>
<th>NNW El Harra</th>
<th>Gebel Gherobi</th>
</tr>
</thead>
<tbody>
<tr>
<td>200</td>
<td>NNW El Harra</td>
<td>0.1</td>
<td>15</td>
<td></td>
<td></td>
</tr>
<tr>
<td>208</td>
<td>NNW El Harra</td>
<td>15</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 2. Analysis of Samples from Late Cretaceous Rocks in Northern Bahariya Oasis Locality*

<table>
<thead>
<tr>
<th>Sample No.</th>
<th>Location</th>
<th>Th. m.</th>
<th>5 Km</th>
<th>NNW El Harra</th>
<th>Gebel Gherobi</th>
</tr>
</thead>
<tbody>
<tr>
<td>200</td>
<td>NNW El Harra</td>
<td>0.1</td>
<td>15</td>
<td></td>
<td></td>
</tr>
<tr>
<td>208</td>
<td>NNW El Harra</td>
<td>15</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Chemical analyses by Dr. M.M. Ali, Atomic Energy Establishment.
Regional Prospecting for Iron Ores in Bahariya Oasis-El Fayum Area, Egypt

brown low grade iron ore encountered at El Heiz as constituted of goethite replacing quartz grains along their boundaries, associated with small amounts of manganese oxide, lime and clay.

Two new sections have been measured in the Central Bahariya Oasis locality showing the presence of iron, namely XXX and XXXI at NW Ain El Gharbia (Plate XXII) and Qaret El Sheikh (Plate XXIII respectively (for description of the lithostratigraphic sections, reference is made to the mentioned plates). However, the analyzed iron samples are collected from two horizons of Late Cretaceous sandstones in the case of the section at Qaret El Sheikh.

Chemical analyses of the samples collected from the Central Bahariya Oasis locality are given in Table 3. It may be noted that there is a high silica trend in the analyzed samples except sample 181 which is very high in iron. The chloride content is low in sample No. 188 and 183, high in sample No. 181 and very conspicuous in sample No. 18b.

Table 3. Analysis of Samples from Late Cretaceous Rocks in Central Bahariya Oasis Locality.

<table>
<thead>
<tr>
<th>Sample No.</th>
<th>181</th>
<th>183</th>
<th>185</th>
<th>188</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location</td>
<td>E Ain El Gharbia</td>
<td>NW Ain El Gharbia</td>
<td>Qaret El Sheikh</td>
<td></td>
</tr>
<tr>
<td>Section No.</td>
<td>XXX</td>
<td>XXX</td>
<td>XXXI</td>
<td></td>
</tr>
<tr>
<td>Horizon No.</td>
<td>2</td>
<td>4</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Thickness (m)</td>
<td>Unknown</td>
<td>Patchy</td>
<td>Not regular</td>
<td>Unknown</td>
</tr>
<tr>
<td>TiO₂ wt%</td>
<td>0.03</td>
<td>53.50</td>
<td>16.05</td>
<td>56.03</td>
</tr>
<tr>
<td>SiO₂ wt%</td>
<td>3.55</td>
<td>2.55</td>
<td>1.79</td>
<td>0.89</td>
</tr>
<tr>
<td>Al₂O₃ wt%</td>
<td>2.04</td>
<td>34.97</td>
<td>63.23</td>
<td>30.18</td>
</tr>
<tr>
<td>Fe₂O₃ wt%</td>
<td>80.43</td>
<td>Tr.</td>
<td>Tr.</td>
<td>Tr.</td>
</tr>
<tr>
<td>FeO wt%</td>
<td>Tr.</td>
<td>0.67</td>
<td>1.01</td>
<td>1.01</td>
</tr>
<tr>
<td>CaO wt%</td>
<td>0.67</td>
<td>1.93</td>
<td>2.42</td>
<td>1.93</td>
</tr>
<tr>
<td>MgO wt%</td>
<td>1.93</td>
<td>0.43</td>
<td>6.04</td>
<td>0.32</td>
</tr>
<tr>
<td>Na₂O wt%</td>
<td>1.29</td>
<td>0.63</td>
<td>0.48</td>
<td>0.19</td>
</tr>
<tr>
<td>K₂O wt%</td>
<td>0.24</td>
<td>0.56</td>
<td>0.40</td>
<td>0.10</td>
</tr>
<tr>
<td>H₂O wt%</td>
<td>1.64</td>
<td>3.00</td>
<td>2.80</td>
<td>7.20</td>
</tr>
<tr>
<td>L.O.I. wt%</td>
<td>5.76</td>
<td>0.50</td>
<td>7.24</td>
<td>0.14</td>
</tr>
<tr>
<td>Cl wt%</td>
<td>1.21</td>
<td>0.68</td>
<td>0.52</td>
<td>0.81</td>
</tr>
<tr>
<td>SO₃ wt%</td>
<td>0.70</td>
<td>0.18</td>
<td>0.85</td>
<td>0.42</td>
</tr>
<tr>
<td>P₂O₅ wt%</td>
<td>0.37</td>
<td>0.21</td>
<td>0.04</td>
<td>0.05</td>
</tr>
</tbody>
</table>

Here the iron occurrences have been found in the exposed Late Cretaceous rocks. The structural features of this locality as explained earlier are comparable to those of the Northern Bahariya Oasis locality. Two lithostratigraphic sections showing the presence of iron have been

3. Southern Bahariya Oasis Locality
measured in the discussed locality; these are XLII at Ain Khoman and XLIII at Naub El Sellim. These sections are illustrated and described in Plates XXIV and XXV, respectively. The iron in these sections is associated with Late Cretaceous clay and sandstone.

Chemical analyses of samples collected from sections XLII and XLIII are given in Table 4. These samples show high silica content, while the salts are high in sample No. 260 and, especially so, in sample No. 267 and sample No. 258.

Table 4. Analysis of Samples from Late Cretaceous Rocks in Southern Bahariya Oasis Locality.

<table>
<thead>
<tr>
<th>Sample No.</th>
<th>Location</th>
<th>250</th>
<th>257</th>
<th>258</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Ain Khoman</td>
<td>Naub El Sellim</td>
<td></td>
</tr>
<tr>
<td>Section No.</td>
<td>XLII</td>
<td>XLIII</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Horizon No.</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Thickness (m)</td>
<td>2</td>
<td>0.3</td>
<td>Patchy</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>SiO₂ (wt%)</th>
<th>Al₂O₃ (wt%)</th>
<th>Fe₂O₃ (wt%)</th>
<th>FeO (wt%)</th>
<th>CaO (wt%)</th>
<th>MgO (wt%)</th>
<th>Na₂O (wt%)</th>
<th>K₂O (wt%)</th>
<th>P₂O₅ (wt%)</th>
<th>TiO₂ (wt%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>250</td>
<td>9.50</td>
<td>3.83</td>
<td>58.83</td>
<td>Tr</td>
<td>1.68</td>
<td>4.80</td>
<td>0.63</td>
<td>4.86</td>
<td>11.60</td>
<td>0.20</td>
</tr>
<tr>
<td>257</td>
<td>13.42</td>
<td>4.59</td>
<td>43.51</td>
<td>Tr</td>
<td>4.37</td>
<td>5.56</td>
<td>1.21</td>
<td>3.80</td>
<td>9.80</td>
<td>0.92</td>
</tr>
<tr>
<td>258</td>
<td>25.85</td>
<td>4.59</td>
<td>28.74</td>
<td>Tr</td>
<td>2.35</td>
<td>5.56</td>
<td>1.16</td>
<td>4.70</td>
<td>8.10</td>
<td>0.83</td>
</tr>
</tbody>
</table>

This locality is found towards the NE of Bahariya Oasis and it shows the same structural features encountered in the Northern Bahariya Oasis locality. The geological succession at Qarret El Bahr is constituted of Gebel Qalaunun Formation of the Middle Eocene overlain unconformably by the Early Miocene Gebel El Khassab Formation (Section V, Plate XVIII). The iron bearing horizon in this section is dark brown sandstone passing into conglomerate towards the top, and it is localized at the unconformity between the Middle Eocene and the Early Miocene.

The chemical analysis of a sample from Qarret Had El Bahr is shown in Table 5. The sample is characterized by a high silica content though it is low in salts.
Iron deposition has been found to be widely spread in Gebel Qalaman locality in the eastern part of the investigated Bahariya Oasis-El Faiyum area. The structural conditions have been proved to be comparable to those of Bahariya Oasis and the geological unit enclosing the iron deposition is equivalent to the lower formation of the Middle Eocene where the iron-ore deposits of El Gedida, Gebel Ghorabi and El Barra are present.

Four lithostratigraphic sections have been measured in the discussed locality namely No. II, VIII, XIV and XV (Plates XVII, XIX, XX and XXI). The iron-bearing samples are encountered in the shaly horizons of Gebel Qalaman Formation. The samples tend to be high in silica or carbonates or both, and they may contain a wide range of chloride and sulphate content from low to high.

5. Gebel Qalaman Locality
Table 6. Analysis of Samples from Middle Eocene Rocks at Gebel Qolamun Locality.

<table>
<thead>
<tr>
<th>Sample No.</th>
<th>Location</th>
<th>Section No.</th>
<th>Horizon No.</th>
<th>Thickness (m)</th>
<th>SiO₂ wt%</th>
<th>Al₂O₃ wt%</th>
<th>Fe₂O₃ wt%</th>
<th>FeO wt%</th>
<th>CaO wt%</th>
<th>MgO wt%</th>
<th>Na₂O wt%</th>
<th>K₂O wt%</th>
<th>H₂O wt%</th>
<th>L.O.I. wt%</th>
<th>Cl wt%</th>
<th>SO₃ wt%</th>
<th>P₂O₅ wt%</th>
<th>TiO₂ wt%</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>Deir Samuel Gebel</td>
<td>II</td>
<td>4</td>
<td>0.6-1.2 7 Shale bed</td>
<td>4.80</td>
<td>3.05</td>
<td>49.82</td>
<td>0.04</td>
<td>19.49</td>
<td>14.75</td>
<td>2.29</td>
<td>0.24</td>
<td>0.64</td>
<td>23.96</td>
<td>0.39</td>
<td>6.54</td>
<td>0.23</td>
<td>0.08</td>
</tr>
<tr>
<td>48</td>
<td>Qalamoun</td>
<td>VIII</td>
<td>1</td>
<td>Unknown</td>
<td>23.40</td>
<td>3.05</td>
<td>26.83</td>
<td>0.04</td>
<td>11.09</td>
<td>2.18</td>
<td>2.83</td>
<td>0.42</td>
<td>2.16</td>
<td>12.00</td>
<td>0.78</td>
<td>1.75</td>
<td>0.31</td>
<td>0.25</td>
</tr>
<tr>
<td>53</td>
<td>2 Km NW Deir</td>
<td>XIV</td>
<td>2</td>
<td>Unknown</td>
<td>23.40</td>
<td>3.05</td>
<td>49.82</td>
<td>0.04</td>
<td>5.04</td>
<td>8.76</td>
<td>2.76</td>
<td>1.69</td>
<td>1.80</td>
<td>10.54</td>
<td>2.02</td>
<td>2.92</td>
<td>0.36</td>
<td>0.21</td>
</tr>
<tr>
<td>93</td>
<td>6 Km SE Deir</td>
<td></td>
<td></td>
<td>0.2</td>
<td>7.20</td>
<td>3.05</td>
<td>33.09</td>
<td>0.14</td>
<td>7.06</td>
<td>7.02</td>
<td>0.81</td>
<td>0.30</td>
<td>3.20</td>
<td>12.00</td>
<td>0.56</td>
<td>3.63</td>
<td>1.86</td>
<td>0.21</td>
</tr>
<tr>
<td>95</td>
<td>5 Km SE Deir</td>
<td></td>
<td></td>
<td>Unknown</td>
<td>8.50</td>
<td>3.05</td>
<td>33.09</td>
<td>0.14</td>
<td>1.93</td>
<td>1.93</td>
<td>0.81</td>
<td>0.30</td>
<td>3.20</td>
<td>10.50</td>
<td>0.56</td>
<td>3.63</td>
<td>1.86</td>
<td>0.21</td>
</tr>
<tr>
<td>97</td>
<td>8 Km SE Deir</td>
<td></td>
<td></td>
<td>0.25</td>
<td>5.14</td>
<td>3.05</td>
<td>33.55</td>
<td>0.14</td>
<td>1.03</td>
<td>1.03</td>
<td>0.81</td>
<td>0.30</td>
<td>5.20</td>
<td>21.00</td>
<td>0.24</td>
<td>7.33</td>
<td>1.86</td>
<td>0.21</td>
</tr>
<tr>
<td>99</td>
<td>SE Deir Samuel</td>
<td></td>
<td></td>
<td>Unknown</td>
<td>24.80</td>
<td>3.05</td>
<td>29.50</td>
<td>0.14</td>
<td>20.16</td>
<td>20.16</td>
<td>0.54</td>
<td>0.60</td>
<td>2.00</td>
<td>10.30</td>
<td>0.24</td>
<td>7.33</td>
<td>2.00</td>
<td>0.21</td>
</tr>
<tr>
<td>101</td>
<td>E Deir Samuel</td>
<td></td>
<td></td>
<td>Unknown</td>
<td>13.40</td>
<td>3.05</td>
<td>29.50</td>
<td>0.14</td>
<td>8.10</td>
<td>8.10</td>
<td>0.54</td>
<td>0.60</td>
<td>2.00</td>
<td>6.30</td>
<td>0.24</td>
<td>7.33</td>
<td>2.00</td>
<td>0.21</td>
</tr>
<tr>
<td>133</td>
<td>NW El Bahana</td>
<td></td>
<td></td>
<td>0.25</td>
<td>8.00</td>
<td>3.05</td>
<td>40.17</td>
<td>0.14</td>
<td>9.15</td>
<td>9.15</td>
<td>0.54</td>
<td>0.60</td>
<td>2.00</td>
<td>6.00</td>
<td>0.24</td>
<td>7.33</td>
<td>2.00</td>
<td>0.21</td>
</tr>
<tr>
<td>176</td>
<td>El El Bahana</td>
<td></td>
<td></td>
<td>Unknown</td>
<td>13.01</td>
<td>3.05</td>
<td>43.01</td>
<td>0.14</td>
<td>10.25</td>
<td>10.25</td>
<td>0.54</td>
<td>0.60</td>
<td>2.00</td>
<td>8.06</td>
<td>0.24</td>
<td>7.33</td>
<td>2.00</td>
<td>0.21</td>
</tr>
</tbody>
</table>
Chapter 2

Recommendations

As a result of analysis presented in previous discussions and after careful consideration of all factors involved, the localities selected for further prospecting and exploration are shown on the map of Bahariya Oasis-Hal Faiyum area (Plate X). These localities are arranged into three categories of priorities:

Localities selected for immediate prospecting and exploration

These include Northern Bahariya Oasis locality (1) and Gebel Qalamun locality (2). Two pieces covering 1600 km² are chosen in the two localities for second phase prospecting and exploration during 1976. The choice is based on the favorable geological and structural conditions, the presence of iron deposition in exposures or under shallow depths, and the simplicity of the infrastructure.

Localities selected for medium term prospecting and exploration

These include Qaret Had El Bahr locality (3) and Ghard Ghorabi locality (4) in the vicinity of Northern Bahariya Oasis locality, and West El Faiyum locality (5) to the West of Gebel Qalamun area. The progress of work in the medium term stage will depend on the results achieved in localities (1) and (2). The choice of localities of Priority No. 2 is based on favorable structural conditions and the possible link in infrastructure with the development of either Northern Bahariya Oasis locality or Gebel Qalamun locality. The thickness of the overburden and its nature will play an important role in the prospecting and exploration costs to be incurred in the second priority localities.
Priority No. 3

Localities selected for long term prospecting and exploration

These include Central Bahariya locality (6) and Southern Bahariya Oasis locality (7), as well as West Giza locality (8).

These areas, although favorable from the structural point of view, yet they require separate infrastructure. Furthermore, in localities (6) and (7) only Late Cretaceous rocks are present while in locality (8) the favorable rocks for iron deposition are expected to be encountered at a depth of about 600 m or more.

References

Ball, J. and Brandall, H.J.L. (1903) Bahariya Oasis, its topography and geology, Survey Dept., Cairo.


# List of Plates

<table>
<thead>
<tr>
<th>Plate</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plate I</td>
<td>Location map of Bahariya Oasis-El Faiyum area</td>
</tr>
<tr>
<td>Plate II</td>
<td>Peniinge map of Bahariya Oasis-El Faiyum area, Scale 1:500,000</td>
</tr>
<tr>
<td>Plate III</td>
<td>Structural map of Bahariya Oasis-El Faiyum area, Scale 1:500,000</td>
</tr>
<tr>
<td>Plate IV</td>
<td>Geological map of Bahariya Oasis-El Faiyum area, Scale 1:500,000</td>
</tr>
<tr>
<td>Plate V</td>
<td>Map showing the location of lithostratigraphic sections and samples of Bahariya Oasis-El Faiyum area, Scale 1:500,000</td>
</tr>
<tr>
<td>Plate VI</td>
<td>Map showing the localites selected for iron ore prospecting and exploration in Bahariya Oasis-El Faiyum area</td>
</tr>
<tr>
<td>Plate VII</td>
<td>Stereogram showing the geometry of Gebel Ghorabi first fold</td>
</tr>
<tr>
<td>Plate VIII</td>
<td>Stereogram showing the geometry of Gebel Ghorabi second fold</td>
</tr>
<tr>
<td>Plate IX</td>
<td>Stereogram showing the geometry of El Haffuf second fold</td>
</tr>
<tr>
<td>Plate X</td>
<td>Stereogram showing the geometry of Ain Khoman first fold</td>
</tr>
</tbody>
</table>
PLATE XI: Stereogram showing the geometry of Ain Khoman second fold.

PLATE XII: Stereogram showing the geometry of Naqib El Sellim first fold.

PLATE XIII: Stereogram showing the geometry of Farafra Oasis first fold.

PLATE XIV: Stereogram showing the geometry of Farafra Oasis second fold.

PLATE XV: Stereogram showing the mean vector of the normals to the bedding plane, the cone of confidence, and the geometrical elements of Gebel Qalarnun fold.

PLATE XVI: Synoptic diagram of the major folds.

PLATE XVII: Lithostratigraphic Section II, Deir Samuel.

PLATE XVIII: Lithostratigraphic Section V, Qaret Had El Bahr.

PLATE XIX: Lithostratigraphic Section VIII, Gebel Qalarnun.

PLATE XX: Lithostratigraphic Section XIV, SE Deir Samuel.

PLATE XXI: Lithostratigraphic Section XV, SE Deir Samuel.

PLATE XXII: Lithostratigraphic Section XXX, NW Ain El Gharbia.

PLATE XXIII: Lithostratigraphic Section XXXI, Qaret El Sheikh.

PLATE XXIV: Lithostratigraphic Section XLII, Ain Khoman.

PLATE XXV: Lithostratigraphic Section XLIII, Naqib El Sellim.
تم اختيار منطقة شاسعة بشمال ووسط الصحراوة النزيفية تبلغ مساحتها ما يزيد على مئة ألف كيلومتر مربع لإجراء عمليات الكشف الإقليمي عن خامات الحديد، وقد جرى هذا الاختيار بناءً على تقييم نظري عميق وعملي لظروف ترشيب الحديد وإمكانات تجهيزه في شكل رواسب.

وتمتد المنطقة المختارة من غربي الواحات البحرية والوادي الرافر إلى وادي النيل شرقاً وقد اطلق عليها منطقة الواحة البحرية - النيوم، وقد استخدمت في عمليات الكشف عن الحديد أحدث الوسائل العلبية للحالة لهذا الغرض والمتمثلة في الظروف المطلوبة، وعلى الأخص صور التمر النباتي لانداسات وتحليل الترسب. وقد استميت خواصة جيولوجية وتركيبية ورصفية جديدة لمنطقة الواحة البحرية - النيوم، ذات نواة تطبيقية وعلمية مميزة، بالإضافة إلى استخدامها في الكشف عن خامات الحديد.

وقد سجلت اكتشافات جديدة لمواقع الحديد نتيجة لأعمال الكشف الحالية، كما جرى ربط المناطق المسورة سابقًا لخامات الحديد، وبناءً على البحث الحالي حدثت ثنائية مواقع لإجراء عمليات الكشف والتقييم التفصيلي عن خامات الحديد، بما وردت هذه المواقع حسب أهميتها إلى ثلاث أسباب.

ORIGINAL PAGE IS OF POOR QUALITY
الكشف الإقليمي عن خيامات الحديث من منطقة الواجهة البحرية - الفيوم - جمهورية مصر العربية

باستخدام صور القمر الصناعي لا يد سات 1

استاذ الدكتور الشاذلي محمد الشاذلي
نائب مدير هيئة الطاقة الذرية ورئيس فص الجيولوجيا والخامات الذرية ومدير المجموعة الجيولوجية مركز الاستشعار من البعد - القاهرة

دكتور محمد عبد الرؤف النواوى
و دكتور سمير محمد خواصان
جيولوجيين يقظ/articles والخامات الذرية - ومختصان بمراكز
الاستشعار من البعد - القاهرة

الناشر
مركز الاستشعار من البعد,
جمهوريةمصر العلمية والتكنولوجيا،
101 شارع قصر العابد، القاهرة,
جمهورية مصر العربية

فبراير سنة 1976
LOCATION MAP OF DAHARIVA
OASIS - EL FAYUM AREA MAPPED
ON SCALE 1:500,000, AND
DAHARIVA OASIS - FARAFRA
OASIS AREA MAPPED ON SCALE,
1:250,000. EGYPT

ORIGINAL PAGE IS
OF POOR QUALITY
NSF - REMOTE SENSING RESEARCH PROJECT
ACADEMY OF SCIENTIFIC RESEARCH AND TECHNOLOGY

DRAINAGE MAP OF BAHARIYA OASIS EL FAIYUM AREA
(FROM LANDSAT-1 SATELLITE IMAGES, 1973)
LEGEND

↑↑ CULTIVATED LAND

YY NATURAL VEGETATION

WIDE PLAIN COVERED BY QUATERNARY DEPOSITS AND SAND DUNES

SAND DUNE BELT

NILE COURSE

VALLEY (WADI)

GEBEL: MOUNTAIN
LEGEND

FOLDS
FRACTURES INCLUDING FAULTS
OTHER LINEAMENTS
BEDDING
CROSS BEDDING
FOLIATION
JOINTING
GYPSOUS VEINLET

FOLD AXIS (SYNCLINE - ANTICLINE)
AXIS OF SYNCLINE
AXIS OF ANTICLINE
SHEAR ZONE ON HINGE PLANE OF FOLD
ATTITUDE OF FOLD AXIS TO AXIAL PLANE
GEOLOGICAL MAP OF BAHARIYA OASIS-EL FAIYUM AREA

( FROM LANDSAT -1 SATELLITE IMAGES, 1973 )
MAP SHOWING THE LOCATION OF LITHOSTRATIGRAPHIC SECTIONS AND SAMPLES OF BAHARIYA OASIS-EL FAIYUM AREA (FROM LANDSAT-1 SATELLITE IMAGES, 1973)
NSF - REMOTE SENSING RESEARCH PROJECT
ACADEMY OF SCIENTIFIC RESEARCH AND TECHNOLOGY
MAP SHOWING THE LOCALITIES SELECTED FOR IRON ORE PROSPECTING
AND EXPLORATION IN BAHARIYA OASIS-EL FAIYUM AREA
(from Landsat 1 Satellite Images, 1973)
LEGEND

FOLDING
FIRST FOLD AXIS
SECOND FOLD AXIS
PROBABLE FOLD AXIS
KNOWN IRON OCCURRENCE
NEWLY INVESTIGATED IRON OCCURRENCE
SAMPLE NUMBER
LOCALITIES SELECTED FOR PROSPECTING AND EXPLORATION
PARTS OF LOCALITIES CHOSEN FOR IMMEDIATE PROSPECTING AND EXPLORATION
GEOMETRY OF GEBEL GHORABI FIRST FOLD

TT - GIRDLE OF BEST FIT
P - DETERMINED AXIAL PLANE
b - STATISTICAL FOLD AXIS
Z - MEAN POLE TO THE AXIAL PLANE

ORIGINAL PAGE IS OF POOR QUALITY
GEOMETRY OF GEBEL GHORABI SECOND FOLD

TT GIRDLE OF BEST FIT
P DETERMINED AXIAL PLANE
b • STATISTICAL FOLD AXIS
z • MEAN POLE TO THE AXIAL PLANE
GEOMETRY OF EL HAFHUF SECOND FOLD

TT GIRDLE OF BEST FIT
P DETERMINED AXIAL PLANE
b • STATISTICAL FOLD AXIS
η • MEAN POLE TO THE AXIAL PLANE
GEOMETRY OF AIN KHOMAN FIRST FOLD

TT GIRDLE OF BEST FIT
P DETERMINED AXIAL PLANE
b ♦ STATISTICAL FOLD AXIS
嗥 ♦ MEAN POLE TO THE AXIAL PLANE

ORIGINAL PAGE IN
OF POOR QUALITY
GEOMETRY OF AIN KHOMAN SECOND FOLD

TT - GIROLLE OF BEST FIT
P - DETERMINED AXIAL PLANE
b - STATISTICAL FOLD AXIS
? - MEAN POLE TO THE AXIAL PLANE
GEOMETRY OF NAQB EL SELLM FIRST FOLD

TT: GIRDLE OF BEST FIT
P: DETERMINED AXIAL PLANE
\textbullet: STATISTICAL FOLD AXIS
\gamma: MEAN POLE TO THE AXIAL PLANE
GEOMETRY OF FARAFRA OASIS FIRST FOLD

TT GIRDLE OF BEST FIT
P DETERMINED AXIAL PLANE
b • STATISTICAL FOLD AXIS
• MEAN POLE TO THE AXIAL PLANE
GEOMETRY OF FARAFRA OASIS SECOND FOLD

TT GIRDLE OF BEST FIT
P DETERMINED AXIAL PLANE
b • STATISTICAL FOLD AXIS
γ • MEAN POLE TO THE AXIAL PLANE
GEOMETRY OF GEBEL QALAMUN FOLD

π  GIRDLE OF BEST FIT
b  STATISTICAL FOLD AXIS
φ  MEAN POLE TO AB FRACTURE
SYNOPTIC DIAGRAM OF THE MAJOR FOLDS

- **/statistical axis of a first fold**
- ○ **statistical axis of a second fold**
- X **mean axial plane of a first fold**
- Δ **mean axial plane of a second fold**

*Original page is of poor quality.*
LITHOSTRATIGRAPHIC SECTION II

- 10: Sandy marl limonitic in parts, containing gypsum
- 20: Hard buff limestone
- 40: Brown and black shale containing ferruginous beds
- 60: Grey and green clay
- 80: Shale
- 100: Shale, hematitic in parts
- 120: Chalky limestone with a clayey base

DEIR SAMWEIL
LITHOSTRATIGRAPHIC SECTION V

Geological unit

Horizon

1
2
3
4
5
6

Brown quartzite

Fine to medium grained buff sandstone, containing occasional bands of conglomerate

Dark brown hematitic sandstone, partly limonitic, the top of the bed is conglomeratic

Fossiliferous limonitic limestone

Coarse grained, weakly cemented pale yellow sandstone

White fossiliferous limestone

QARET HAD EL BAHAR

ORIGINAL PAGE IS OF POOR QUALITY
<table>
<thead>
<tr>
<th>Horizon</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>Chalky limestone</td>
</tr>
<tr>
<td>10</td>
<td>Sandy clay</td>
</tr>
<tr>
<td>9</td>
<td>Alternation of gypsum and clay</td>
</tr>
<tr>
<td>8</td>
<td>Hematitic clay with gypsum</td>
</tr>
<tr>
<td>7</td>
<td>Gypseous shale with limonitic alteration</td>
</tr>
<tr>
<td>6</td>
<td>Liny clay</td>
</tr>
<tr>
<td>5</td>
<td>Sandy clay</td>
</tr>
<tr>
<td>4</td>
<td>Fossiliferous limestone</td>
</tr>
<tr>
<td>3</td>
<td>Gypseous grey clay</td>
</tr>
<tr>
<td>2</td>
<td>Conglomerite</td>
</tr>
<tr>
<td>1</td>
<td>Ferruginous grey shale</td>
</tr>
</tbody>
</table>

**Gebel Qalamun**

*Original page of poor quality*
LITHOSTRATIGRAPHIC SECTION XIV

Chalky limestone, limonitic in part.

Grey greenish calcareous clay, containing ferruginous patches

Soft clayey limestone

SE DEIR SAMUEL
LITHOSTRATIGRAPHIC SECTION XV

<table>
<thead>
<tr>
<th>Horizon</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Ferruginous calcareous shale</td>
</tr>
<tr>
<td>2</td>
<td>Ferruginous clay</td>
</tr>
<tr>
<td>3</td>
<td>Chalky limestone containing limonitic spots</td>
</tr>
</tbody>
</table>

SE DEIR SAMUEL
Ferruginous fine grained sandstone, the nonferruginous rock is buff, patches of gypsum are found on the surface planes, ferrugination increases upwards.

Dark yellow ferruginous sandstone with dark brown patches of iron oxides and white knobs of gypsum.

Crossbedded fine grained sandstone, creamy with red iron patches.

Pale yellow fine grained sandstone, with thin laminae of iron and manganese oxides.

NW Ain El Gharbia
LITHOSTRATIGRAPHIC SECTION XXXI

<table>
<thead>
<tr>
<th>Geological unit</th>
<th>Horizon</th>
</tr>
</thead>
</table>
| m
| 1  | $K_1$ | 1  | $K_2$ |
| 10 |         | 2  | Brown terrigenous clay - exposed - Grey and greenish shale |
|     |         | 3  | White to grey sandy clay |

OARET EL SHEIKH
LITHOSTRATIGRAPHIC SECTION XLII

<table>
<thead>
<tr>
<th>Geological unit</th>
<th>Horizon</th>
</tr>
</thead>
<tbody>
<tr>
<td>m</td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>K2, K1^2</td>
</tr>
<tr>
<td>20</td>
<td>K1</td>
</tr>
<tr>
<td>10</td>
<td>K1</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Hard yellow dolomitic limestone containing calcite druses
- Dark greenish clay
- Reddish ferruginous sandy clay

Grey greenish shale, enclosing beds of creamy fine grained sandstone each, 1 meter in thickness

Fine grained creamy, bedded sandstone

Ferruginous clay

Ain Khoman
LITHOSTRATIGRAPHIC SECTION XLIII

Geological unit

m

Horizon

1 2 3 4 5

30

20

10

K1

K2

K1

K3

Soft creamy to dark yellowish limestone
Grey clay containing patches of gypsum
Yellowish limestone containing crystals of calcite
Ferruginous creamy fine to medium grained cross bedded sandstone
Ferruginous dark grey clay, with patches of kaolin and gypsum

NAQB EL SELLIM

ORIGINAL PAGE IS OF POOR QUALITY