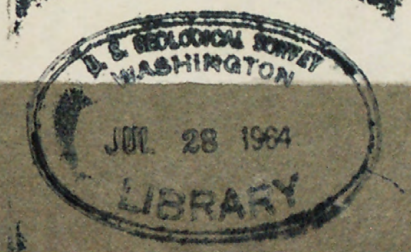
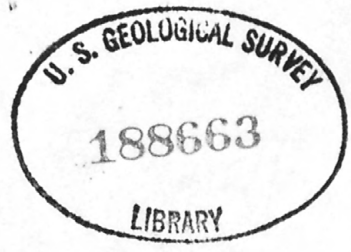


EXPLORATION OF THE JEFREN GYPSUM-ANHYDRITE DEPOSIT TRIPOLITANIA, LIBYA

by
J. L. GUALTIERI
United States Geological Survey

July 1959



MINERALS INVESTIGATION PROGRAM

EXPLORATION OF THE JEFREN GYPSUM-ANHYDRITE DEPOSIT, LIBYA

By

J. L. GUALTIERI, 1924-

U. S. GEOLOGICAL SURVEY

U. S. Operation Mission
In behalf of the Ministry of National Economy
UNITED KINGDOM OF LIBYA

JULY, 1959

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
Washington, D. C.

For release AUGUST 8, 1962

The Geological Survey is releasing in open files the following reports. Copies are available for consultation in the Geological Survey Library, 1033 GSA Bldg., Washington, D. C.:

1. Geology of the Wilson Peak stock, San Miguel Mountains, Colorado, by C. S. Bromfield. 154 p., 1 pl., 37 figs., 8 tables.

2. Exploration of the Jefren gypsum-anhydrite deposit, Tripolitania, Libya, by J. L. Gualtieri. 65 p., 11 pl., 3 figs.

3. A geologic report on the iron deposit of the Shatti Valley area of the Fezzan Province, Libya, by G. H. Goudarzi. 77 p., 38 pl., 10 figs., 3 tables.

4. Report on Marada, Pisida, Idri and Tauorga salt deposits in Libya, by G. H. Goudarzi. 31 p., 11 pl.

5. Idri salt deposits, Fezzan Province, Libya, by G. H. Goudarzi. 36 p., 5 pl., 7 figs., 19 tables.

Copies of the following report are available for consultation in the Geological Survey Library, 345 Middlefield Rd., Menlo Park, California:

6. Preliminary geologic map of the Strawberry Mine area, Madera County, California, by Dallas L. Peck. 1 map.

Copies of the following reports are available for consultation at the Geological Survey Libraries, 1033 GSA Bldg., Washington, D. C.; Bldg. 25, Federal Center, Denver, Colo.; and 345 Middlefield Rd., Menlo Park, Calif.:

7. Description, composition, and tenor of unconsolidated sediments in monazite-bearing tributaries to the Catawba River in the western Piedmont of North Carolina, by Amos M. White. 17 p., 2 figs., 9 tables. A copy from which reproductions can be made at private expense is available in the Library, 1033 GSA Bldg., Washington, D.C.

8. Description, composition, and tenor of unconsolidated sediments in monazite-bearing tributaries to the Broad River in the western Piedmont of South Carolina and North Carolina, by P. K. Theobald, Jr. A copy from which reproductions can be made at private expense is available in the Library, 1033 GSA Bldg., Washington, D. C.

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10. TEI-809. Geology of the Williston basin, North Dakota, Montana, and South Dakota, with reference to subsurface disposal of radioactive wastes, by Charles A. Sandberg. 148 p., 28 figs. Also on file at 468 New Custom House, Denver, Colo.; 437 Federal Bldg., Salt Lake City, Utah; Water Resources Div., USGS, Room 201, 1 North 7th St. West, Billings, Mont.; North Dakota Geological Survey, University Station, Grand Forks, No. Dak.; South Dakota Geological Survey, Vermillion, So. Dak.

11. Bouguer gravity map of the Twin Buttes area, Pima and Santa Cruz Counties, Arizona, by Donald Plouff. 1 map. Also on file at 437 Federal Bldg., Salt Lake City, Utah; 602 Thomas Bldg., Dallas, Texas; Arizona Bureau of Mines, University of Arizona, Tucson, Ariz.; 1031 Bartlett Bldg., Los Angeles, Calif.; 232 Appraisers Bldg., San Francisco, Calif.; 468 New Custom House, Denver, Colo. Copy from which reproductions can be made at private expense are available in the Library, Bldg. 25, Federal Center, Denver, Colo.

Additional depositories are hereby announced for the following report, placed on open file on May 10, 1962:

Aeromagnetic maps of the Twin Buttes area, Pima and Santa Cruz Counties, Arizona, flown at 500 feet above ground and flown at 4,000 feet barometric elevation, by G. E. Andreasen and J. A. Pitkin. 2 maps. Now also on file at 468 New Custom House, Denver, Colo.; 1031 Bartlett Bldg., Los Angeles, Calif.; and 232 Appraisers Bldg., San Francisco, Calif.

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CONTENTS

Illustrations

EXPLORATION OF THE JEFREN GYPSUM-ANHYDRITE DEPOSIT, LIBYA

By

J. L. Gualtieri

Location and extent

A deposit of gypsum and anhydrite occurs in the Jefren-Garian area of Tripolitania and is exposed almost continuously along the gebel escarpment from about 4 kilometers west of Garian to about 14 kilometers west of Jefren, a distance of about 60 kilometers (fig. 1). The maximum exposed width of the deposit is about 25 kilometers. Access to the deposit is over 94 kilometers of the Tripoli-Azizia-Jefren highway, a narrow, hard-surfaced road.

Previous work

The deposit was undoubtedly known to the Italian geologists who mapped the beds as part of the Jurassic system. A. L. Brichant (1/)

(1/) Written communication, dated March 15, 1952.

made a general survey of the mineral resources of Libya and reported gypsum present in practically unlimited quantities, although no specific mention of the Jefren deposit was made. A. M. Christie (2/) who described

(2/) Christie, A.M., Geology of the Garian Area: United Nations, New York, pp. 14-15, 45, 1955.

and mapped the area around Garian, noted the presence of the deposit and mapped it as a separate stratigraphic unit which he called the Bir el Ghnem group.

Figure 1. View of the deposit looking northwestward from Caf el Bahri toward Bir el Ghnem.

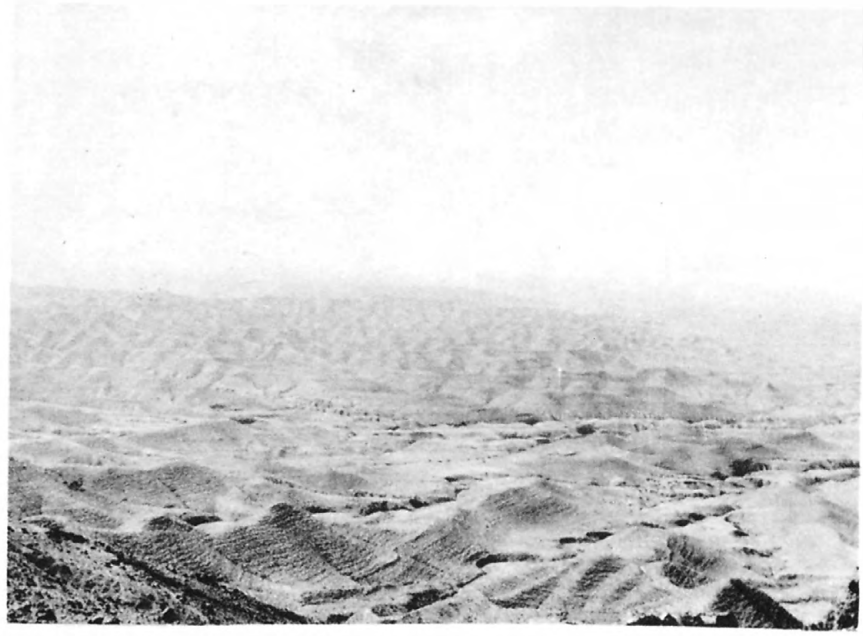

Fig. 1 - View of the deposit looking Northwestward from Caf el Bahri toward Bir el Ghnem.

Fig. 2 - Drilling operations underway near Bir el Ghnem.

Mr. Gus Goudarzi, U. S. Operation Mission economic-geologist, made a study of the deposit in 1954 and recommended that the Ministry of National Economy make an effort to encourage the exploitation of the gypsum as a building material and for use in arts and crafts. Later, in 1956, the Minerals Investigation Program proposals to the Libyan-American Reconstruction Commission included the allocation of LL 1,000 to subsidize a local contractor to undertake quarrying, transport, and the operation of a pilot plant to determine the economic feasibility of working the deposit. No contractor could be found and the matter was left standing.

Present work

In 1957 because of interest shown by a housing expert of the United Nations Mission in using gypsum building blocks for low-cost housing in Libya, studies were resumed. A brief examination was made of the gypsum beds in the Bir el Ghnem area and some samples were collected for chemical analysis. The results were encouraging and work was expanded to include the whole deposit. The exposed area of the deposit was mapped on a scale of 1:100,000 (Plate 1) and four geologic sections were measured (pp. 38-65).

Drilling operations began in September 1958 and were completed in May 1959 (fig. 2). Altogether nine successful holes were drilled for a total of 360.45 meters. Nine additional holes were abandoned because of difficulties encountered when unstable rock was penetrated.

Figure 2. Drilling operations underway near Bir el Ghnem.

Three holes were drilled in the Bir el Ghnem area near Km 95 of the Azizia-Jefren highway providing a composite section, with minor breaks, of about 85 meters. Single holes were drilled in the areas of Km 101 and 105 to depths of 41.95 and 37 meters respectively. One hole was drilled near Km 109 to a depth of 95 meters. A second hole was located in the same general area so as to provide a more complete section, but due to drilling difficulties it reached only 59 meters. Two holes were drilled in the area of Km 120 to furnish a composite section of about 35 meters.

The location of the drill holes and geologic sections is shown on the outline map of the deposit and the core logs are included in the report (pp. 13-37).

The present work has been under the direction of Mr. Gus Goudarzi, Chief of the U. S. Geological Survey field party in Libya.

Geology

The Jefren gypsum-anhydrite deposit is in the Bir el Ghnem group which is considered to be of Jurassic age (1/). It is thought

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(1/) Christie, A.M., Geology of the Garian area: United Nations, New York, pp. 14-15, 1955.

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to have formed under lagoonal conditions which may at times have given way to a shallow-water marine environment. In exposures the deposit appears to be composed of gypsum interbedded with dolomitic limestone and some claystone but considerable thicknesses of anhydrite were discovered in the drill holes.

In the Jefren area, the deposit exceeds 400 meters in thickness, but 40 kilometers eastward, in the area of Caf el Caldia, it measures only 32 meters and about 2 kilometers farther east it pinches away to nothing. The individual beds are lenticular and only a few may be traced for more than a kilometer.

The deposit is flat-lying to low-dipping for the most part. Only at its eastern extremity where the beds have been disturbed by intrusive igneous rocks is the structure pronounced.

The nature of the occurrence of gypsum and anhydrite revealed in some of the drill holes strongly indicates that possibly much of the gypsum has been formed by the hydration of anhydrite. The anhydrite is found containing sparse selenite crystals. These crystals are rounded or roughly tabular and have a smooth outline, and are usually dark-brown or brownish-gray. They range from less than a millimeter to over 2 centimeters in diameter, and in places they are found zoned or containing traces of claystone laminae. Less abundantly, selenite occurs in the anhydrite as irregular seams or very thin undulating stringers which roughly parallel the bedding and in places transect it. These features are thought to represent an incipient stage of the conversion of anhydrite to gypsum. Where abundant crystalline selenite occurs in the gypsum, it is believed that the host beds were originally anhydrite. As these crystals occur in many of the gypsum beds it is concluded that the deposit has undergone large-scale conversion.

Contorted bedding, evident in the gypsum units and affecting the thin claystone seams and dolomitic limestone laminae, is believed to have resulted from the increase in volume of the rock upon the hydration of anhydrite (fig. 3). Small quantities of anhydrite indicated by chemical analyses to be present in the gypsum are thought to be residual, representing the last stage of the conversion process. The presence of anhydrite at depth in the deeper drill holes is considered to represent the unconverted parts of the deposit. It is therefore concluded that conversion has taken place only within a limited vertical zone that extends some distance beneath the present surface. This view is further substantiated where the fortuitous circumstances of structure and topography reveal surface exposures of gypsum units which, where intersected at depth in a drill hole, are found to be anhydrite.

Conversion is believed to have affected the beds to a greater depth in the areas more distant from the main escarpment than those areas nearer. It is reasoned that the conversion process, resulting from the penetration of the beds by meteoric water, has been in effect longest in those places where the overlying beds were first removed. Based mainly on drill hole information and taking into account the topography of the area, a round estimate of 30 meters is given as the overall average thickness of the affected zone.

Figure 3. Contorted gypsum beds near Km. 95 Azizia, Jefren highway.

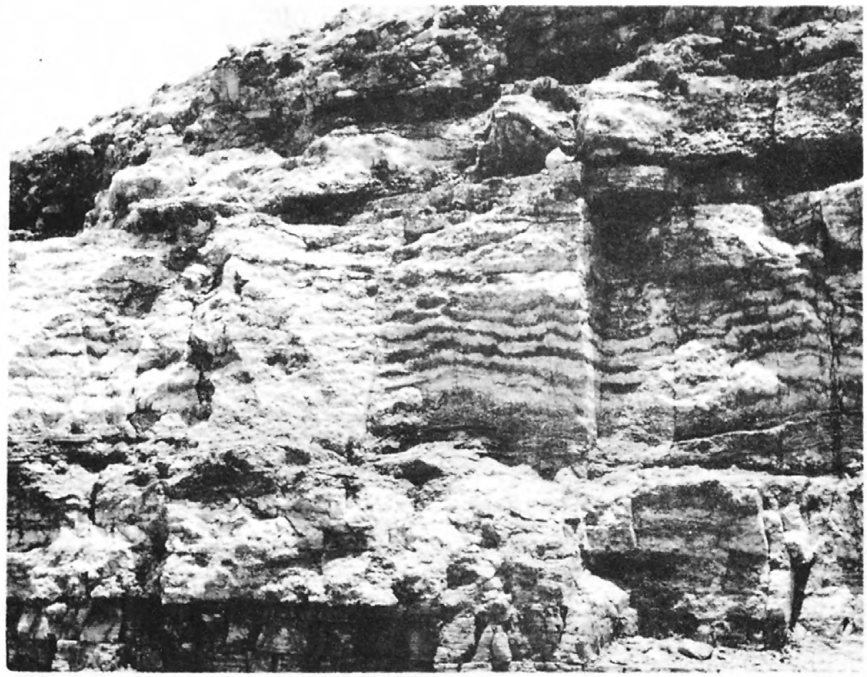

Fig. 3 - Contorted gypsum beds near km 95, Azizia-Jefren highway.

Analyses

Because of their chemical similarity, the methods of quantitative determination of gypsum and anhydrite are much the same. The amount of sulfate as a weight-percent of the sample is determined and from this figure the weight-percent of gypsum or anhydrite calculated. Since both minerals were thought to be present in the samples, calculations were made to ascertain the theoretical maximum percent of each; the difference represented the theoretical weight-percent of water of crystallization. A comparison of the theoretical weight-percent of water to that found by analysis served as a check. If the theoretical figure did not exceed the determined figure by more than 1.50, the original figure calculated for gypsum was retained but if the difference came to more than 1.50, the weight-percent of gypsum was recalculated on the basis of water of crystallization determined by analysis. The margin of 1.50 was used in the calculations to allow for the water of crystallization that might remain in the samples. It is thought that some water still remained in the gypsum even when heated to 180°C.

The samples that did not exceed the permissible limit were considered either free of anhydrite or to contain it in only minute quantities. The samples that showed a more than marginal discrepancy were considered to contain the mineral in considerable quantities. In such samples the weight-percent of anhydrite was calculated from the difference between computed weight-percent of sulfate in gypsum and the total weight-percent of the sulfate determined by analysis.

In following this procedure it was assumed that the samples in question contained no sulfate minerals other than gypsum or anhydrite and no hydrous minerals other than gypsum. In some samples the amount of water determined was anomalously high so as to definitely indicate the presence of at least one other hydrous mineral not to be classed as gypsum. The analyses are shown on plates 3 through 11.

The samples submitted for analysis were obtained by "splitting" the core, cutting it lengthwise. One of the halves was crushed and used in the analysis and the other saved for future reference. Each analysis corresponds to a lithologic unit, except in the case of relatively thick units which were subdivided and analyzed in two or more parts.

Reserves

Two classes of reserves have been computed for the purposes of this report, indicated and inferred. A map showing the location and extent of the reserve blocks is included with the report (plate 2). The indicated reserves were computed from drill hole data that were projected on 500 meter radii from the respective drill holes. Where two or more holes were drilled in an area to obtain a more complete section, the radius was projected from a point central to the holes. The computations were based on area, thickness, and specific gravity and the results given in metric tons (1000 kgs.). Topography of the areas included in the reserve blocks was taken into account in calculating the tonnage. The grades of the respective blocks were computed by combining and averaging the anlyzed units. Only material averaging 64.5 percent or more $CaSO_4.2H_2O$ is considered economically exploitable.

The indicated reserves are shown by blocks. The quantity is given to the nearest million tons and the grade to the nearest percent.

It is to be noted that no reserves were calculated around drill holes 7, 8, and 9. The quantities of gypsum indicated to be present in these holes is considered too small to make the blocks or selected parts of them economically exploitable.

The inferred reserves are based on knowledge gained from examining and mapping the deposit and especially from the information obtained from the measured sections and drill holes. The reserves are estimated only for the exposed areas of the deposit and the adjoining alluvium-covered areas. The alluvium-covered areas include the broad valley of Wadi Zaret, the fringe area along the line of hills that trend northwest from Wadi Zaret to a point beyond Bir el Ghnem, and the large area west of the Azizia-Jefren highway from about Km 90 to KM 120. The extension of the deposit west of the highway to the limits shown on the reserve map is assumed because just east of the highway in the area of Ras el Tamellel and D.D.H. 6 it measures over 400 meters in thickness.

The indication that anhydrite predominates at depth, at least in the areas immediately in front of the gebel escarpment, has serious implications for it necessarily limits the volume of rock that can be assumed to be gypsum. Where the deposit is overlain by Cretaceous claystone beds, it must be assumed that no or very little conversion has taken place and that the sulfate rock beds are predominantly anhydrite. Consequently this area is not considered as part of the deposit. As already indicated in the section on geology the zone of conversion is estimated to be no more than 30 meters thick, as an overall average.

The area of the inferred reserves was found by using a planimeter on a 1:100,000 scale map. The grade of the inferred reserve is considered to be equal to the weighed average of the three blocks of indicated reserves. This consideration is based on the field observation that generally the quality of the beds appears to vary but little from place to place.

On the basis of the concepts and procedures outlined above the inferred reserves are calculated to total 79,700,000,000 metric tons of material that is 80 percent $CaSO_4.2H_2O$. The figure for tonnage is given to the nearest 100 million tons and that of grade to the nearest 10 percent as being more significant of the accuracy of the estimate.

Recommendations for future work

Economic and time factors forced a cessation of the drilling operations but only after enough information was obtained to form a basis for this preliminary report. When and if private parties explore the deposit, additional drilling will be required to provide a sounder basis for estimating the reserves of the deposit and to more thoroughly explore the gypsum-anhydrite relationship. Drilling should be done both in the area west of the ~~Amisia~~ Jefren highway and the area between the highway and Wadi Zaret. Access to the western area poses no problem but access to the eastern area will require the construction of a road, a difficult task in view of the relief. The drill holes can be spaced as much as 10 kilometers apart provided they penetrate a key unit that can be used for correlation purposes. This would probably necessitate drilling the beds through the base of the deposit.

DIAMOND DRILL HOLE No. - 1

Depth: 24.00 meters Collar Elevation: 253.12 meters

From (m)	To (m)	Thickness (m)	Recovery (m)	Description
0.00	0.08	0.08	-	Surficial cover-alluvium.
0.08	6.00	5.92	5.72	Gypsum, white and yellowish-gray; contains very abundant selenite crystals as much as 5 mm in diameter, vuggy in one place, bedding vague and contorted in places.
6.00	6.33	0.33	0.28	Dolomitic limestone, very light-gray and light-olive-gray, argillaceous, bedding contorted; satin-spar veinlets occur in fractures.
6.33	7.85	1.52	1.30	Gypsum, light-gray, yellowish-gray and white; contains abundant selenite crystals; bedding contorted.
7.85	8.00	0.15	0.05	Dolomitic limestone, very pale-orange, argillaceous.
8.00	12.85	4.85	4.07	Gypsum, gray, yellowish-gray and white; vuggy and fractured in places; abundant selenite crystals occur in rock and fractures.

Continued

(NOTE: Page 12 deleted from report)

From (m)	To (m)	Thickness (m)	Recovery (m)	Description
12.85	14.58	1.73	1.43	Dolomitic limestone, light-gray and yellowish-gray, argillaceous.
14.58	19.55	4.97	4.21	Gypsum, light-gray, white and yellowish-gray; contains abundant selenite crystals and sparse limonite-coated fractures that in places are filled with silt-sized quartz grains.
19.55	21.20	1.65	0.45	Dolomitic limestone, grayish-orange-pink and light-gray, highly fractured; limonite on fracture surfaces; rock vuggy adjacent to fracture surfaces.
21.20	22.70	1.50	1.25	Gypsum, light-gray; contains abundant selenite crystals.
22.70	23.39	0.69	0.40	Dolomitic limestone, very pale-orange and grayish-orange, granular appearing, very vuggy near top.
23.39	23.74	0.35	0.35	Gypsum, light-gray; contains abundant selenite crystals.
23.74	23.81	0.07	0.07	Dolomitic limestone, gray.
23.81	24.00	0.19	0.05	Gypsum, light-gray, massive.

DIAMOND DRILL HOLE No. - 2

Depth: 10.00 meters Collar Elevation: 263.45 meters

From (m)	To (m)	Thickness (m)	Recovery (m)	Description
0.00	0.07	0.07	-	Surficial cover-alluvium.
0.07	9.55	9.48	9.40	Gypsum, light-gray and very dark-gray, yellowish-gray and white, vuggy; contains abundant selenite crystals as much as 10 mm in diameter, satin-spar veinlets in one place; bedding contorted.
9.55	9.84	0.29	0.29	Gypsum, light-gray, dolomitic; bedding contorted; contact with overlying unit gradational.
9.84	10.00	0.16	0.16	Gypsum, yellowish-gray, argillaceous; contact with overlying unit gradational.

DIAMOND DRILL HOLE No. - 3

Depth: 40.00 meters Collar Elevation: 222.20 meters

From (m)	To (m)	Thickness (m)	Recovery (m)	Description
0.00	0.10	0.10	-	Surficial cover,-weathered gypsum mixed with alluvium.
0.10	0.70	0.60	0.60	Gypsum, white, light-gray and yellowish-gray; contains sparse selenite crystals as much as 10 mm in diameter.
0.70	1.55	0.85	0.28	Dolomitic limestone, light-gray, granular, gypsiferous; contact with overlying unit gradational.
1.55	4.35	2.80	2.71	Gypsum, light-gray and white; contains sparse to abundant selenite crystal masses, some only sand-sized.
4.35	5.09	0.74	0.62	Dolomitic limestone, light-gray.
5.09	6.55	1.46	1.46	Gypsum, light-gray and dark-gray, argillaceous; contains sparse selenite crystals as much as 15 mm in diameter, some are zoned.
6.55	7.00	0.45	0.38	Dolomitic limestone, light-gray, fractured; satinspar in fractures.
7.00	7.60	0.60	0.54	Gypsum, white, light and dark-gray, argillaceous; interbedded with minor thicknesses of dolomitic limestone.

Continued

From (m)	To (m)	Thickness (m)	Recovery (m)	Description
7.60	9.00	1.40	1.13	Dolomitic limestone, yellowish-gray, vuggy in one place.
9.00	12.64	3.64	3.64	Gypsum, light and dark-gray, argillaceous; contains sparse selenite crystals, satinspar veinlets and dolomitic limestone laminae.
12.64	13.56	0.92	0.92	Dolomitic limestone, light and dark-gray, oolitic.
13.56	15.90	2.34	2.04	Claystone, dolomitic, dark-gray.
15.90	17.15	1.25	1.08	Gypsum, yellowish-gray; contains contorted laminae of dolomitic limestone and sparse selenite crystals.
17.15	17.91	0.76	0.73	Dolomitic limestone, dark-gray, argillaceous at base; contains sparse satinspar lenses and selenite crystals.
17.91	20.13	2.22	2.01	Gypsum, yellowish-gray; contains sparse to abundant selenite crystals as much as 15 mm in diameter.
20.13	21.72	1.59	1.47	Dolomitic limestone, light-gray, gypsiferous; interbedded with minor thicknesses of dark-gray claystone; contains sparse thin satinspar lenses.
21.72	23.96	2.24	2.02	Gypsum, yellowish-gray, massive; contains sparse to abundant selenite crystals.

Continued

From (m)	To (m)	Thickness (m)	Recovery (m)	Description
23.96	24.47	0.51	0.51	Anhydrite, light-gray.
24.47	28.10	3.63	3.38	Dolomitic limestone, light-gray; interbedded with yellowish-gray gypsum.
28.10	29.18	1.08	1.08	Dolomitic limestone and claystone, light and dark-gray, gypsiferous.
29.18	31.06	1.88	1.78	Gypsum and anhydrite, yellowish-gray; contains sparse selenite crystals, very abundant veinlets of white gypsum.
31.06	31.45	0.39	0.30	Dolomitic limestone and claystone, dark-gray, gypsiferous; contains sparse satinspar veinlets.
31.45	31.72	0.27	0.27	Gypsum, yellowish-gray; interbedded with minor thicknesses of claystone; contains very sparse selenite crystals bedding contorted.
31.72	32.67	0.95	0.95	Claystone and gypsum, grayish-green, dark-gray and black; contains satinspar veinlets.
32.67	33.14	0.47	0.39	Gypsum, yellowish-gray; contains sparse selenite crystals as much as 20 mm in diameter.
33.14	33.85	0.71	0.69	Claystone and dolomitic claystone, light-gray, bedding contorted, brecciated in places.

Continued

From (m)	To (m)	Thickness (m)	Recovery (m)	Description
33.85	34.84	0.99	0.99	Anhydrite and gypsum, light-gray; contains sparse to abundant selenite crystals as much as 10 mm in diameter, some are zoned.
34.84	36.00	1.16	1.14	Claystone, dolomitic, and argillaceous dolomitic limestone, dark-gray.
36.00	37.50	1.50	1.25	Anhydrite, light-gray, gypsiferous; contains sparse to abundant selenite crystals and sparse claystone bodies.
37.50	38.00	0.50	0.32	Gypsum, yellowish-gray; contains very sparse selenite crystals.
38.00	40.00	2.00	1.64	Gypsum and anhydrite, dark-gray and grayish-green, grades into almost pure claystone at base; sparse satinspar veinlets in claystone.

DIAMOND DRILL HOLE No. - 4

Depth: 30.00 meters Collar Elevation: 280.98 meters

From (m)	To (m)	Thickness (m)	Recovery (m)	Description
0.00	0.33	0.33	-	Surficial cover-weathered gypsum mixed with alluvium.
0.33	2.00	1.67	1.61	Gypsum, white, light-gray and brownish-gray; contains abundant irregular bodies of gray claystone.
2.00	2.18	0.18	0.18	Dolomitic limestone, light-gray, argillaceous.
2.18	3.60	1.42	1.36	Gypsum, brownish-gray; contains irregular films of gray claystone.
3.60	3.70	0.10	0.08	Dolomitic limestone, light-gray.
3.70	7.10	3.40	3.09	Gypsum, white, light and dark-gray, and light-brownish-gray; contains sparce to abundant claystone films and seams especially near base.
7.10	7.17	0.07	0.07	Dolomitic limestone, light-brownish-gray, argillaceous.
7.17	8.38	1.21	1.14	Gypsum, white and light-brownish-gray; contains abundant selenite crystals 2-3 mm in diameter and claystone seams and films near base.
8.38	8.77	0.39	0.35	Claystone, light-gray, dolomitic.

Continued

From (m)	To (m)	Thickness (m)	Recovery (m)	Description
8.77	9.40	0.63	0.55	Gypsum, white and light-gray contains abundant gray claystone films.
9.40	9.56	0.16	0.13	Gypsum, light-gray, dolomitic; contains sparse contorted satinspar seams.
9.56	12.43	2.87	2.65	Gypsum, light-brownish-gray.
1 .43	12.68	0.25	0.21	Dolomitic limestone, light-yellowish-brown, argillaceous.
12.68	13.00	0.32	2.29	Gypsum, light-gray and yellowish-gray; contains appreciable amounts of dolomitic limestone and claystone in irregular bodies.
13.00	13.32	0.32	0.26	Claystone, light-yellowish-gray, dolomitic near base.
13.32	21.70	8.38	7.45	Gypsum, white and light-gray, argillaceous near base; minor amounts of claystone and dolomitic limestone occur as irregular bodies and seams.
21.70	25.50	3.80	0.78	Claystone and siltstone, light-grayish-red.
25.50	27.50	2.00	0.36	Dolomitic limestone, light-brown and gray, granular and vuggy to dense.
27.50	30.00	2.50	0.92	Gypsum, white to light-brownish-gray; contains sparse selenite crystals.

DIAMOND DRILL HOLE No. - 5

Depth: 24.00 meters Collar Elevation: 286.59 meters

From (m)	To (m)	Thickness (m)	Recovery (m)	Description
0.00	1.00	1.00	-	Surficial cover-weathered gypsum mixed with alluvium.
1.00	1.70	0.70	0.53	Gypsum, white; contains abundant irregular grayish-green claystone bodies.
1.70	2.30	0.60	0.30	Gypsum, white and light-brownish-gray; contains dolomitic limestone chaotically intermixed.
2.30	6.35	4.05	3.49	Gypsum, white and light-gray; contains sparce irregular bodies of grayish-brown dolomitic limestone and abundant dark-gray claystone films and selenite crystals.
6.35	7.58	1.23	0.83	Dolomitic limestone and argillaceous dolomitic limestone, brownish-gray and dark-gray.
7.58	10.32	2.74	2.24	Gypsum, white, light-brownish-gray and medium-gray; argillaceous near top; sparse dolomitic limestone bodies occur through-out unit; abundant selenite crystals as much as 3 mm in diameter in places.
10.32	10.76	0.44	0.44	Dolomitic limestone, light-brownish-gray, argillaceous; gypsum in fractures.
10.76	11.83	1.07	1.07	Gypsum, white and light-brownish-gray; contains abundant dark-gray claystone films through-out and abundant selenite crystals 2-3 mm in diameter in places.

Continued

From (m)	To (m)	Thickness (m)	Recovery (m)	Description
11.83	12.27	0.44	0.39	Claystone, light-gray, dolomitic.
12.27	13.82	1.55	1.50	Gypsum, light and medium-gray, argillaceous; contains abundant selenite crystals.
13.82	13.89	0.07	0.05	Dolomitic limestone, light-brownish-gray, argillaceous.
13.89	15.70	1 81	1.69	Gypsum, medium and dark-gray, argillaceous; contains abundant selenite crystals as much as 5 mm in diameter.
15.70	17.27	1.57	1.47	Gypsum, white and very light-gray; contains abundant selenite crystals in places.
17.27	17.59	0.32	0.30	Dolomitic limestone, light-brownish-gray, argillaceous.
17.59	21.10	3.51	3.23	Gypsum, white and medium-gray, argillaceous; contains abundant dark-gray claystone films and sparse selenite crystals in places.
21.10	21.42	0.32	0.30	Dolomitic limestone, brownish-gray; interbedded with minor thicknesses of gypsum; bedding contorted.
21.42	21.70	0.28	0.24	Claystone, grayish-green; gypsiferous at top.
21.70	22.30	0.60	0.42	Gypsum, white and light-gray, contains abundant grayish-green claystone films.

Continued

From (m)	To (m)	Thickness (m)	Recovery (m)	Description
22.30	22.36	0.06	0.02	Claystone, grayish-green, gypsiferous.
22.36	22.45	0.09	0.07	Dolomitic limestone, light-brownish-gray, gypsiferous.
22.45	24.00	1.55	1.39	Gypsum, white and light-gray; contains sparse dark-gray claystone films.

DIAMOND DRILL HOLE No. - 6

Depth: 95.00 meters Collar Elevation: 240.25 meters

From (m)	To (m)	Thickness (m)	Recovery (m)	Description
0.00	0.55	0.55	-	Surficial cover-weathered gypsum mixed with alluvium.
0.55	7.78	7.23	6.63	Gypsum, white to light-grayish-brown; contains abundant disseminated claystone films through-out and abundant selenite crystals in places; bedding contorted.
7.78	8.16	0.38	0.32	Dolomitic limestone, light-brownish-gray, argillaceous.
8.16	10.40	2.24	2.15	Gypsum, gray and light-brownish-gray, contains abundant claystone disseminated as fine particles and as seams and films near top.
10.40	10.50	0.10	0.10	Gypsum, light-greenish-gray, argillaceous.
10.50	20.42	9.92	9.12	Gypsum and anhydrite, white, light-gray and light-brownish-gray contains abundant claystone disseminated as fine particles and as seams and films.
20.42	20.83	0.41	0.39	Gypsum, light-greenish-gray; very light-gray and dark-gray, argillaceous; contains satinspar seams.

Continued

From (m)	To (m)	Thickness (m)	Recovery (m)	Description
20.83	30.05	9.22	8.71	Gypsum, white, light-gray and light-brownish-gray, argillaceous in places.
30.05	35.27	5.22	4.41	Gypsum white, gray and grayish-brown, argillaceous; contains interbedded gray claystone.
35.27	25.50	0.23	0.15	Claystone, gray.
35.50	37.84	2.34	2.25	Gypsum, light-gray and light-brownish-gray; contains sparse dolomitic claystone laminae.
37.84	41.55	3.71	3.42	Anhydrite, brownish-gray and dark-gray; interbedded with minor amounts of gypsum and claystone.
41.55	44.10	2.55	2.40	Gypsum, white, light and dark-gray; contains sparse dolomitic claystone seams.
44.10	44.19	0.09	0.08	Claystone, medium-gray.
44.19	45.27	1.08	1.04	Gypsum, light-gray and light-brownish-gray, argillaceous in places; contains anhydrite.
45.27	45.48	0.21	0.21	Claystone, dolomitic medium-gray.
45.48	48.58	3.10	2.93	Gypsum, light-gray and light-brownish-gray, argillaceous in places; contains anhydrite.
48.58	48.63	0.05	0.05	Claystone, dark-gray.
48.63	50.85	2.22	2.13	Gypsum light-brownish-gray.

Continued

From (m)	To (m)	Thickness (m)	Recovery (m)	Description
50.85	52.21	1.36	1.25	Anhydrite, medium-gray, massive.
52.21	54.36	2.15	2.05	Anhydrite, medium-gray, argillaceous; contains abundant claystone seams and gypsum.
54.36	74.52	20.16	19.58	Anhydrite, medium-gray, massive; contains irregular claystone bodies and seams in places.
74.52	74.66	0.14	0.13	Dolomitic limestone, light-brownish-gray.
74.66	78.10	3.44	3.24	Anhydrite, medium-gray, massive.
78.10	79.65	1.55	1.50	Dolomitic limestone, light-brown and light-gray; granular appearing in upper part; contains anhydrite in irregular bodies near base.
79.65	83.76	4.11	3.83	Anhydrite, light-gray; contains sparse selenite crystals as much as 5 mm in diameter.
83.76	84.12	0.36	0.32	Dolomitic limestone, light-brown, contains abundant sand-sized selenite crystals; bedding contorted.
84.12	85.51	1.39	1.25	Anhydrite, light-gray, contains abundant selenite crystals as much as 5 mm in diameter.
85.51	87.27	1.76	1.61	Dolomitic limestone, light-brown and light-gray; bedding contorted.

Continued

From (m)	To (m)	Thickness (m)	Recovery (m)	Description
87.27	88.00	0.73	0.65	Anhydrite, light-gray, massive; contains sparse large masses of black selenite crystals near top.
88.00	88.26	0.26	0.26	Dolomitic limestone, light-brown.
88.26	89.00	0.74	0.70	Anhydrite, light and medium-gray; contains sparse selenite crystals as much as 10 mm in diameter; bedding laminae discernable in crystals.
89.00	90.24	1.24	1.19	Dolomitic limestone, dark-gray, argillaceous at base.
90.24	93.16	2.92	2.62	Anhydrite, light-gray; contains sparse to abundant selenite crystals as much as 5 mm in diameter and irregular black claystone bodies.
93.16	93.59	0.43	0.42	Dolomitic limestone, medium-gray; contains sparse black claystone bodies; chaotic slump structure noted at base.
93.59	93.74	0.15	0.24	Anhydrite, light-gray; contains irregular dolomitic limestone and claystone bodies.
93.74	94.76	1.02	0.95	Dolomitic limestone and argillaceous dolomitic limestone, moderate-gray and dark-gray; contains irregular anhydrite bodies and satinspar veinlets.

Continued

From (m)	To (m)	Thickness (m)	Recovery (m)	Description
94.76	95.00	0.24	0.19	Anhydrite, light-gray; contains sparse selenite crystals as much as 10 mm in diameter.

DIAMOND DRILL HOLE No. - 7

Depth: 59.00 meters Collar Elevation: 273.31 meters

From (m)	To (m)	Thickness (m)	Recovery (m)	Description
0.00	4.79	4.79	-	Surficial cover-alluvium.
4.79	6.00	1.21	1.21	Dolomitic limestone and gypsiferous claystone, light-yellowish-brown and greenish-yellow; thin satinspar veinlets and selenite crystals permeate the claystone.
6.00	8.83	2.83	2.83	Claystone, yellowish-gray and yellowish-brown; contains abundant satinspar veinlets.
8.83	9.00	0.17	0.17	Dolomitic limestone, brownish-gray andlight-green, argillaceous.
9.00	21.90	12.90	12.90	Claystone, medium-bluish-gray and grayish-red, marly in places.
21.90	22.82	0.92	0.92	Dolomitic limestone, medium-gray, bedding laminae are undulatory.
22.82	24.38	1.56	1.56	Gypsum, medium-gray, contains irregular bodies of dolomitic limestone in places.
24.38	26.53	2.15	2.15	Dolomitic limestone, light-gray; contains minor irregular bodies of gypsum.
26.53	27.00	0.47	0.47	Claystone and gypsum, dark-gray; contains abundant satinspar veinlets.

Continued

From (m)	To (m)	Thickness (m)	Recovery (m)	Description
27.00	29.06	2.06	2.06	Gypsum, light-gray; contains sparse to abundant claystone seams in places.
29.06	29.50	0.44	0.44	Dolomitic limestone, light-gray; contains abundant dark-gray and brownish-gray gypsum seams with selenite crystals as much as 10 mm in diameter.
29.50	30.43	0.93	0.45	Gypsum and claystone, dark-gray; contains abundant satinspar veinlets.
30.43	31.15	0.72	0.72	Dolomitic limestone, gypsum, and claystone, light and dark-gray, interbedded.
31.15	34.75	3.60	2.87	Claystone, dark-gray and grayish-red; contains abundant satinspar veinlets.
34.75	45.30	10.55	9.93	Anhydrite, very light-gray and light-brownish-gray, gypsiferous at very top; contains sparse to abundant irregular bodies and seams of dolomitic limestone and claystone and sparse dark-gray selenite crystals as much as 15 mm in diameter.
45.30	46.30	1.00	0.95	Dolomitic limestone, dark-gray, argillaceous.
46.30	48.62	2.32	2.11	Gypsum, white, light, medium and dark-gray, argillaceous; contains claystone, disseminated as fine particles and as irregular bodies.

Continued

From (m)	To (m)	Thickness (m)	Recovery (m)	Description
48.62	49.10	0.48	0.44	Dolomitic limestone, medium and dark-gray, argillaceous; contains one thin gypsum bed.
49.10	51.37	2.27	2.13	Gypsum, white, light, medium and dark-gray, argillaceous; contains irregular bodies and seams of claystone and sparse selenite crystals at base.
51.37	59.00	7.63	4.44	Anhydrite, medium and dark-gray, argillaceous and dolomitic; sparse gypsum seams occur in the argillaceous beds and sparse selenite crystals occur near top.

DIAMOND DRILL HOLE No. - 8

Depth: 37.00 meters Collar Elevation: 266.98 meters

From (m)	To (m)	Thickness (m)	Recovery (m)	Description
0.00	7.78	7.78	-	Surficial cover-alluvium.
7.78	9.52	1.74	1.54	Dolomitic limestone, gray and light-gray, argillaceous.
9.52	11.40	1.88	1.65	Gypsum, white and light-brownish-gray; contains abundant selenite crystals as much as 5 mm in diameter.
11.40	16.46	5.06	0.78	Dolomitic limestone, light-brownish-gray, oolitic; one megafossil noted.
16.46	19.93	3.47	3.21	Gypsum, white and light-brownish-gray; contains abundant argillaceous material through-out and selenite crystals in upper part.
19.93	21.00	1.07	0.26	Dolomitic limestone, light-gray, argillaceous, vuggy.
21.00	24.50	3.50	2.77	Gypsum, white, light-gray and light-brownish-gray; contains abundant selenite crystals and small irregular bodies of argillaceous material.
24.50	28.80	4.30	1.76	Dolomitic limestone, light-gray and light-brownish-gray, both dense and granular; contains disseminated argillaceous material and claystone and gypsum seams near base.

Continued

From (m)	To (m)	Thickness (m)	Recovery (m)	Description
28.80	31.32	2.52	2.12	Gypsum, white, light and dark-brownish-gray; contains abundant selenite crystals and some seams and irregular bodies of dolomitic limestone.
31.32	37.00	5.68	2.80	Dolomitic limestone, medium-brownish-gray, argillaceous.

DIAMOND DRILL HOLE No. - 9

Depth: 41.45 meters Collar Elevation: 253.46 meters

From (m)	To (m)	Thickness (m)	Recovery (m)	Description
0.00	0.17	0.17	-	Surficial cover-alluvium.
0.17	0.28	0.11	0.11	Dolomitic limestone, reddish-brown.
0.28	2.30	2.02	-	No core
2.30	9.00	6.70	1.69	Dolomitic limestone, light and medium-gray, granular; sparse fractures in places.
9.00	10.85	1.85	0.72	Gypsum, white, mottled very light-gray in places; contains abundant selenite crystals.
10.85	11 62	0.77	0.62	Dolomitic limestone, light-gray, oolitic in part contains a thin claystone seam
11.62	12.00	0.38	0.29	Gypsum, light-gray and light-brownish-gray; contains abundant contorted dolomitic limestone laminae.
12.00	12.65	0.65	0.52	Dolomitic limestone, gray, argillaceous in part, oolitic near base.
12.65	14.83	2.18	1.91	Gypsum, white, light-gray and light-brownish-gray; contains abundant selenite crystals as much as 5 mm in diameter and abundant dolomitic limestone laminae near the base.

Continued

From (m)	To (m)	Thickness (m)	Recovery (m)	Description
14.83	15.00	0.17	0.07	Gypsum, claystone and dolomitic limestone, gray.
15.00	17.58	2.58	1.73	Gypsum, light-brownish-gray; contains abundant selenite crystals as much as 5 mm in diameter and abundant dolomitic limestone laminae near base.
17.58	20.45	2.87	0.17	Dolomitic limestone, gray.
20.45	21.07	0.62	0.20	Gypsum, light-brownish-gray; contains abundant films of argillaceous material near base.
21.07	21.21	0.14	0.14	Dolomitic limestone, light-gray and light-organish-brown; contains satinspar seams near base.
21.21	21.47	0.26	0.26	Gypsum and dolomitic limestone, gray; contains abundant satinspar seams.
21.47	21.80	0.33	0.33	Dolomitic limestone, light-gray; contains a thin gypsum bed.
21.80	23.13	1.33	1.12	Gypsum, light-brownish-gray; contains abundant selenite crystals and a thin gray dolomitic limestone bed.
23.13	23.48	0.35	0.27	Dolomitic limestone, gray, dense and granular; contains sparse to abundant satinspar laminae and veinlets.

Continued

From (m)	To (m)	Thickness (m)	Recovery (m)	Description
23.48	24.75	1.27	1.17	Gypsum, light-brownish-gray contains abundant films of argillaceous material and abundant dolomitic limestone laminae in places.
24.74	34.50	9.75	0.90	Dolomitic limestone, gray, dense and granular; sparse fractures in places.
34.50	40.61	6.11	5.22	Gypsum, white and light-brownish-gray; contains selenite crystals as much as 10 mm in diameter and abundant dolomitic limestone laminae; friable silty material found in one place.
40.61	41.45	0.84	0.71	Dolomitic limestone, gray, granular; bedding contorted; contains satinspar seams.

SECTION 3/4 KM EAST OF KM 95, AZIZIA - JEFREN HIGHWAY

Jurassic	Meters
Bir el Ghnem group Slumped strata almost in place, estimated to be about 25 percent dolomitic limestone and 75 percent gypsum	25.00
Dolomitic limestone, gray, massive and thin-bedded	0.30
Alluvium-covered interval with sparce, small outcrops of gypsum.	7.00
Dolomitic limestone, gray, massive and thin-bedded, ledge forming	2.00
Alluvium-covered interval with sparse, small outcrops of gypsum.	5.10
Dolomitic limestone, gray, dense, ledge forming.	1.70
Alluvium-covered interval with sparse outcrops of white and gray gypsum containing sparse selenite crystals and sparse dolomitic limestone laminae.	5.60
Gypsum, gray, argillaceous; interbedded with gray, thin-bedded and laminar dolomitic limestone	1.10
Alluvium-covered interval with sparse outcrops of massive, white and gray gypsum.	7.60

Continued

	Meters
Dolomitic limestone, gray, thin-bedded, oolitic.	0.50
Alluvium-covered interval with sparse outcrops of gypsum.	5.50
Dolomitic limestone, gray, vuggy, thin-bedded; contains interbedded gypsum.	1.50
Alluvium-covered interval with sparse outcrops of gray and white gypsum containing sparse to abundant selenite crystals.	8.50
Dolomitic limestone, gray, thin-bedded.	0.50
Alluvium-covered interval with outcrops of gray and white gypsum.	0.35
Dolomitic limestone, gray, argillaceous, thin-bedded, platy.	0.15
Dolomitic limestone, gray, thin-bedded, platy.	0.30
Gypsum, white and gray; contains disseminated claystone films.	2.55
Dolomitic limestone, gray, oolitic.	0.10
Gypsum, white and dark-gray; contains undulatory dolomitic limestone laminae.	0.75

*Continued

	Meters
Dolomitic limestone, gray, dense, thin-bedded, platy.	0.40
Gypsum, light and dark-gray; contains abundant claystone laminae and sparse selenite crystals in places.	3.10
Siltstone, light-gray, dolomitic, thin-bedded and laminar.	1.10
Gypsum, white, massive; contains sparse selenite crystals.	0.15
Claystone, grayish-green; contains thin satinspar veins replacing claystone along fractures.	0.10
Gypsum, gray contains sparse selenite crystal masses and claystone laminae.	2.20
Claystone and siltstone, greenish-gray, gypsiferous at base, dolomitic at top.	0.55
Gypsum, white and gray; contains sparse thin claystone lenses.	0.35
Claystone, light-green; contains abundant satinspar veinlets.	0.70
Claystone, light-green and black.	0.60

Continued

	Meters
Gypsum, white and gray; contains abundant selenite crystals; base of unit not visible.	0.20
Total	85.55

Quaternary

Wadi fill:
Alluvium, pebbles, cobbles and boulders of local origin.

SECTION AT RAS TAMELLEL

Cretaceous

Chicla formation:

Jurassic	Meters
Bir el Ghnem group	
Dolomitic limestone, brown, granular, ledge forming.	10.00
Alluvium-covered interval with exposures of gypsum and some claystone.	22.25
Dolomitic limestone, gray, fossiliferous.	1.10
Alluvium-covered interval with exposures of gypsum and some claystone and dolomitic limestone.	14.10
Claystone, grayish-green.	0.60
Alluvium-covered interval with exposures of gypsum.	2.00
Alluvium-covered interval with exposures of dolomitic limestone and claystone.	2.20
Alluvium-covered interval with exposures of gypsum.	5.75
Claystone, grayish-green; contains undulating, coarsely fibrous satin-spar seams.	0.55
Gypsum, white, massive.	1.00

Continued

	Meters
Dolomitic limestone, gray.	0.30
Alluvium-covered interval with exposures of gypsum.	6.35
Dolomitic limestone, gray, argillaceous.	0.60
Gypsum, white, massive.	2.00
Dolomitic limestone, gray.	0.35
Gypsum, white and gray, massive contains two thin dolomitic limestone beds.	9.45
Dolomitic limestone, gray; interbedded with grayish-green claystone	2.00
Alluvium-covered interval with exposures of massive, gray and white gypsum.	6.10
Claystone and dolomitic limestone, gray.	0.40
Gypsum, white and gray, massive.	1.45
Dolomitic limestone, gray, argillaceous; grades laterally into claystone.	0.35
Gypsum, white and gray, massive.	3.30
Dolomitic limestone, gray, argillaceous.	0.25
Alluvium-covered interval with exposures of white and dark-gray gypsum; banded where dark-gray.	11.10

Continued

	Meters
Dolomitic limestone, gray.	0.25
Gypsum, white, gray and dark-gray, massive.	1.60
Claystone, grayish-green interbedded with gray dolomitic limestone and minor thicknesses of gray, argillaceous gypsum.	1.50
Gypsum, gray and white, impure in places.	8.10
Dolomitic limestone, gray.	0.10
Gypsum, white and gray, massive.	0.25
Dolomitic limestone, gray, and gray argillaceous gypsum; limestone is of uneven thickness.	0.10-0.15
Gypsum, white and gray, massive.	0.50
Claystone and gypsiferous claystone, grayish-green; contains abundant satin-spar lenses.	0.60
Alluvium-covered interval with exposures of gypsum.	7.05
Claystone, grayish-green and green, gypsiferous and carbonaceous at the very top; bedding con-torted.	0.80
Gypsum, white and gray, massive.	5.30

Continued

	Meters
Dolomitic limestone, gray, thin-bedded to massive.	0.25
Gypsum, white and gray, massive.	2.85
Claystone, grayish-green, gypsiferous; contains contorted satinspar lenses.	0.45
Alluvium-covered interval, believed to be gypsum.	2.20
Dolomitic limestone, gray, thin-bedded, lenticular.	0.35
Alluvium-covered interval with exposures of gypsum; one thin claystone seam noted.	10.90
Claystone, grayish-green, gypsiferous.	0.65
Claystone, gypsiferous and argillaceous gypsum, gray and dark-gray, laminar and thin-bedded.	0.90
Gypsum, gray, dark-gray and white, massive.	1.45
Claystone, grayish-green, gypsiferous; contains satinspar and dolomitic limestone lenses.	1.00
Alluvium-covered interval with exposures of gypsum.	8.80
Dolomitic limestone, gray, thin-bedded.	0.25

Continued

	Meters
Alluvium-covered interval with exposures of gypsum.	2.70
Dolomitic limestone, gray, thin-bedded and massive.	1.15
Gypsum, gray and white, massive.	0.90
Dolomitic limestone, gray, thin-bedded and finely laminar, undulatory in places.	0.60
Alluvium-covered interval with exposures of massive bedded, gray and white gypsum.	6.25
Claystone and argillaceous gypsum, grayish-green and gray dolomitic limestone.	4.15
Gypsum, white and gray, massive.	4.80
Claystone, grayish-green.	0.35
Gypsum, white and gray, massive.	0.60
Claystone, siltstone, and dolomitic limestone, gray; contains thin interbedded satinspar units.	1.40
Alluvium-covered interval with exposures of gypsum.	5.70
Dolomitic limestone, gray.	0.50
Alluvium-covered interval with exposures of grayish-green claystone and siltstone.	1.05

Continued

	Meters
Alluvium-covered interval, believed to be gypsum.	1.20
Dolomitic limestone, gray.	0.15
Alluvium-covered interval, believed to be gypsum.	3.75
Dolomitic limestone, gray.	0.10
Gypsum, white and gray, massive.	1.70
Gypsum, argillaceous, and claystone, grayish-green; in places unit is composed of almost pure claystone interbedded with satin-spar; selenite crystals noted in some of thicker gypsum units.	3.30
Alluvium-covered interval with exposures of massive gray and white gypsum.	1.60
Claystone and dolomitic limestone, grayish-green and gray, interbedded, lenticular.	1.05
Alluvium-covered interval with exposures of gypsum.	10.25
Claystone, red and gray; contains very abundant satinspar lenses.	2.70
Partially covered interval with exposures of massive gray and white gypsum; one thin dolomitic lime-stone lens noted.	17.00
Claystone, red, permeated by gypsum.	0.70

Continued

	Meters
Alluvium-covered interval with exposures of gypsum containing thin claystone lenses.	9.35
Alluvium-covered interval with exposures of red and grayish-green siltstone and claystone permeated in places by lenticular beds of satinspar or masses of selenite crystals.	21.00
Alluvium-covered interval believed to be gypsum and claystone.	1.35
Dolomitic limestone, light-brown, granular.	2.50
Alluvium-covered interval with sparse exposures of white and gray gypsum.	4.00
Claystone, red and gray; contains abundant small selenite crystals on the bedding planes.	2.10
Gypsum, white and gray; interbedded with undulating seams of gray claystone.	0.20
Claystone, red, gypsiferous; contains small selenite crystals.	1.00
Gypsum, gray and white, massive.	2.65
Dolomitic limestone, gray, finely laminar and thin-bedded.	0.15

Continued

	Meters
Gypsum, gray, light-gray and white, massive.	1.15
Dolomitic limestone, light-gray, massive, undulatory.	0.05-0.10
Gypsum, white; contains irregular thin films and seams of gray claystone.	0.30
Dolomitic limestone, light-gray; contains thin claystone seams.	0.25
Gypsum, gray and white, massive.	2.15
Dolomitic limestone, gray, undulatory.	0.10
Gypsum, gray and white, massive.	1.10
Claystone, gray; contains thin beds of satinspar and selenite; base and top of the unit are undulatory.	0.30
Gypsum, white and gray, massive.	0.70
Claystone, gray; contains satinspar veinlets.	0.20
Alluvium-covered interval with exposures of massive white and gray gypsum.	2.40
Claystone and dolomitic limestone, gray, and white gypsum, interbedded and interlensing; contains abundant undulating satinspar veins that appear to have replaced claystone.	1.00

Continued

	Meters
Gypsum, white and gray, massive.	2.80
Dolomitic limestone, gray, massive and thin-bedded.	1.00
Alluvium-covered interval with exposures of gray and white, massive gypsum.	3.50
Dolomitic limestone, gray, thin-bedded and massive.	0.50
Gypsum, gray and white, massive.	3.40
Claystone, gray; contains satinspar veinlets.	0.20
Gypsum, white and light-gray; contains abundant selenite crystals.	0.70
Dolomitic limestone, gray, thin-bedded.	0.20
Gypsum, white and light-gray, massive.	1.00
Gypsum, white and gray; interbedded with gray claystone; satinspar lenses and veinlets abundant in claystone.	0.80
Gypsum, white, massive.	0.40
Dolomitic limestone, gray, massive.	0.20
Gypsum, gray and white, massive.	2.20
Claystone, gray; contains satinspar veinlets.	0.10

Continued

	Meters
Gypsum, white, gray, and dark-gray, massive; contains sparse selenite crystals at the base.	1.15
Dolomitic limestone, gray.	0.15
Gypsum, white, gray and dark-gray, massive.	3.00
Gypsum, brownish-gray; contains abundant dolomitic limestone laminae.	0.60
Siltstone, light-brown, dolomitic.	0.40
Gypsum, white, gray and dark-gray, massive.	1.00
Dolomitic limestone, gray, conglomeratic; contains angular and rounded fragments of dolomitic limestone.	0.60
Gypsum, white and gray; contains abundant dolomitic limestone laminae at the base; upper part of unit obscured.	26.75
Dolomitic limestone, light-brown, silty.	0.30
Gypsum, white, gray and dark-gray, argillaceous; base of unit not visible.	3.70
	Total 344.15

Quaternary

Wadi fill:
Alluvium, pebbles, cobbles, and boulders of local origin

SECTION AT CAF EL BAHRI

Cretaceous

Chicla formation:

Jurassic	Meters
Bir el Ghnem group	
Alluvium and talus-covered interval, with exposures of gypsum, claystone and dolomitic limestone, believed to be predominantly claystone.	32.50
Claystone, medium and dark-gray; contains thin satinspar lenses on bedding partings.	2.50
Alluvium-covered interval with exposures of white and gray gypsum; contains at least one thin dolomitic limestone bed.	5.40
Claystone, green and gray dolomitic limestone; contains minor thicknesses of impure gypsum and satinspar.	1.20
Alluvium-covered interval with exposures of white and gray gypsum; contains at least two thin dolomitic limestone beds.	8.70
Dolomitic limestone, gray, massive.	0.20
Alluvium-covered interval with exposures of gypsum; contains at least two thin dolomitic limestone beds.	22.40

Continued

	Meters
Dolomitic limestone, gray.	0.90
Gypsum, white.	0.90
Dolomitic limestone, gray, finely laminar.	0.40
Gypsum, white and gray.	0.90
Dolomitic limestone, gray.	0.40
Alluvium-covered interval with exposures of white gypsum.	1.00
Dolomitic limestone, gray.	0.15
Alluvium-covered interval with exposures of white and gray gypsum.	4.95
Dolomitic limestone, light-grayish-brown, fossiliferous.	1.00
Alluvium-covered interval with exposures of light and dark-gray gypsum.	11.95
Alluvium-covered interval with exposures of grayish-green claystone and silty dolomitic limestone.	2.50
Gypsum, gray and dark-gray; contains disseminated claystone.	2.00
Dolomitic limestone, gray; interbedded with gray carbonaceous claystone.	0.30
Gypsum, white, massive.	0.65

Continued

	Meters
Gypsum, white, finely laminated; contains satinspar lenses and seams and minor thicknesses of interbedded green claystone.	1.60
Claystone, green; contains minor thicknesses of interbedded gypsum and ovoid bodies of gypsum up to 15 cm. long.	7.90
Gypsum, white, massive.	2.45
Claystone, red mottled green; contains satinspar lenses.	0.45
Gypsum, white, light-gray and pale-red; contains disseminated claystone.	1.65
Alluvium-covered interval with exposures of red and green claystone containing satinspar seams and lenses.	15.30
Dolomitic limestone, brownish-gray, granular.	1.90
Alluvium-covered interval with numerous exposures of white and very dark-gray, massive gypsum; contains two thin dolomitic limestone beds.	111.15
Dolomitic limestone, gray, finely laminar, granular in places.	1.70

Continued

	Meters
Alluvium-covered interval believed to be gypsum.	5.80
Dolomitic limestone, gray, massive to finely laminar.	0.80
Alluvium-covered interval with exposures of white and gray gypsum.	11.90
Dolomitic limestone, gray.	0.45
Alluvium-covered interval with exposures of white and gray gypsum.	2.65
Dolomitic limestone, gray, massive and thin-bedded.	2.60
Alluvium-covered interval believed to be gypsum.	6.80
Dolomitic limestone, gray, massive and thin-bedded.	1.25
Alluvium-covered interval with exposures of gypsum; contains two thin dolomitic limestone units.	15.40
Dolomitic limestone, gray, massive and thin-bedded.	0.15
Alluvium-covered interval believed to be gypsum.	4.05
Dolomitic limestone, gray, thin-bedded.	1.90
Gypsum, white, massive.	1.35
Dolomitic limestone, gray, massive.	0.60
Gypsum, white, massive.	1.80

Continued

	Meters
Dolomitic limestone, gray, silty, thin-bedded, platy.	0.10
Gypsum, white and gray, massive.	6.30
Selenite, transparent to translucent, imbedded in green claystone, possibly replacing claystone.	0.15
Gypsum, light-gray, massive.	1.00
Alluvium-covered interval with exposures of gray, massive and oolitic dolomitic limestone.	0.60
Alluvium-covered interval with exposures of gray and white gypsum.	8.50
Dolomitic limestone, gray, massive.	0.80
Gypsum, white, massive.	0.90
Dolomitic limestone, brown, massive.	0.20
Gypsum, white, gray and dark-gray, massive and finely laminar.	2.45
Dolomitic limestone, gray, massive.	0.20
Gypsum, light and dark-gray, massive.	5.10
Dolomitic limestone, gray, massive.	0.25

Continued

	Meters
Gypsum, white, gray and dark-gray, massive to finely laminar; contains sparse dolomitic limestone laminae.	7.50
Dolomitic limestone, gray.	0.30
Gypsum, white, gray and dark-gray, massive.	3.40
Alluvium-covered interval believed to be gypsum.	3.40
Dolomitic limestone, gray and white, massive to laminar.	3.00
Gypsum, gray, white and dark-gray, massive.	3.40
Dolomitic limestone, gray, massive.	1.20
Gypsum, gray, massive to finely laminar; contains sparse dolomitic limestone laminae near base.	9.80
Dolomitic limestone, gray, massive.	0.55
Alluvium-covered interval with exposures of white, gray and dark-gray gypsum.	8.00
Dolomitic limestone, gray, massive.	0.40
Gypsum, white and gray, massive.	1.70
Dolomitic limestone, gray, massive.	0.35

Continued

	Meters
Gypsum, white and gray, massive; contains selenite crystals near top of unit.	1.20
Dolomitic limestone, gray, massive; interlenses with gypsum.	0.45
Gypsum, gray and white, massive.	4.30
Dolomitic limestone, gray, silty, thin-bedded and finely laminar.	0.40
Siltstone, gray, dolomitic.	0.40
Partially covered interval with exposures of white and gray gypsum.	4.00
Siltstone and claystone, grayish-green; contains some thin, gray, dolomitic limestone lenses.	2.70
Gypsum, white and gray; contains sparse dolomitic limestone laminae; argillaceous near top.	0.25
Dolomitic limestone, gray; contains some clastic material near top of unit.	0.55
Gypsum, white, gray and dark-gray, massive; contains sparse dolomitic limestone laminae; argillaceous at top.	15.15
Dolomitic limestone, gray.	0.20

Continued

	Meters
Claystone, green, contains undulating lenses of gypsum.	0.55
Gypsum, white and gray, massive.	0.25
Claystone, gray, gypsiferous.	0.35
Total	402.80

Quaternary

Wadi fill:
Alluvium, pebbles, cobbles, and boulders of local origin.

SECTION AT GARAAT ED DABA

Cretaceous

Chicla formation

Jurassic	Meters
Bir el Ghnem group Alluvium-covered interval; predominantly gypsum in the lower half, upper half unknown.	90.60
Gypsum, white and gray, massive; contains one thin dolomitic limestone bed.	10.60
Claystone, gray and brown; contains thin satinspar lenses.	0.30
Alluvium-covered interval; some outcrops of white and gray gypsum.	5.10
Dolomitic limestone, grayish-green, dense and granular.	0.25
Gypsum, white, massive; contains sparse selenite crystal masses.	1.90
Dolomitic limestone, gray, argillaceous, highly fractured.	0.80
Gypsum, white and gray, massive.	1.05
Dolomitic limestone, gray, dense; contains sparse, thick lenses of white gypsum.	1.70

Continued

	Meters
Gypsum, white; contains selenite crystal masses and thin irregular claystone beds.	0.35
Dolomitic limestone, gray, thin-bedded and laminar, undulatory; contains some white gypsum lenses.	0.40
Dolomitic limestone, gray, thin bedded.	1.15
Gypsum, white; contains abundant selenite crystals.	1.00
Claystone, dolomitic, and argillaceous limestone, gray.	0.45
Gypsum, white; contains abundant selenite crystals.	0.60
Gypsum, gray and white, argillaceous; interbedded with dense, gray dolomitic limestone; contains abundant selenite crystals in places.	1.20
Gypsum, white and gray, argillaceous, massive.	0.25
Claystone, gray; contains abundant satinspar veins and a thin limestone bed at top.	0.30
Gypsum, white and dark-gray; contains sparse selenite crystals.	1.85

Continued

	Meters
Dolomitic limestone, gray, dense; interbedded with minor thicknesses of gray claystone	1.20
Gypsum, white; contains abundant selenite crystals.	1.80
Dolomitic limestone, gray, dense.	0.10
Gypsum, white; contains abundant selenite crystals.	0.30
Dolomitic limestone, light-brownish-gray, dense, thin-bedded and massive; contains gypsum bed near top of unit.	2.80
Gypsum, white; contains abundant selenite crystals.	2.35
Dolomitic limestone, gray, granular.	0.10
Gypsum, gray and white, massive; contains selenite crystals in places.	1.55
Dolomitic limestone, grayish-brown, very finely vuggy.	0.40
Gypsum, white, massive; contains sparse dolomitic limestone laminae.	1.00
Dolomitic limestone, gray, argillaceous, massive and thin-bedded	0.65
Gypsum, white, massive.	1.85

Continued

	Meters
Dolomitic limestone, gray, granular.	0.10
Gypsum, white; contains sparse dolomitic limestone laminae.	0.45
Dolomitic limestone, grayish-brown, dense.	0.30
Gypsum, white; contains disseminated claystone films.	1.40
Gypsum, white; contains irregular bodies of gray claystone and rounded bodies of gray dolomitic limestone.	0.25
Dolomitic limestone, gray, argillaceous; interbedded with minor thicknesses of greyish-green claystone.	0.45
Gypsum, white; contains irregular claystone bodies in upper part.	2.25
Dolomitic limestone, gray, dense, thin-bedded.	2.40
Gypsum, white, massive; contains claystone films.	0.35
Dolomitic limestone, gray, dense.	0.40
Gypsum, white, massive with disseminated claystone films.	2.25

Continued

	Meters
Dolomitic limestone, gray, very finely vuggy, massive and thin-bedded.	1.10
Gypsum, white, massive; contains disseminated claystone films.	0.70
Dolomitic limestone, gray, dense.	2.70
Gypsum, white, massive; contains disseminated claystone films.	0.75
Dolomitic limestone, gray.	0.20
Gypsum, white, massive; contains disseminated claystone films.	1.05
Dolomitic limestone, gray, thin-bedded and finely laminar.	0.30
Claystone, green.	0.05
Gypsum, white, massive, argillaceous in places.	0.75
Claystone, green, and gray dolomitic limestone, irregularly interbedded; contains minor thicknesses of gypsum that appear to replace the claystone.	0.75
Gypsum, white, massive, argillaceous in places.	1.20
Alluvium-covered interval, probably gypsum containing minor thicknesses of dolomitic limestone.	6.35

Continued

	Meters
Dolomitic limestone, gray, oolitic.	2.00
Dolomitic limestone, gray, thin-bedded and finely laminar.	1.90
Gypsum, white and gray; contains dolomitic limestone laminae at base.	2.90
Dolomitic limestone, gray, massive and thin-bedded.	1.00
Gypsum, white and gray; contains a thin limestone bed.	3.40
Total	171.65

Quaternary

Wadi fill:
Alluvium, pebbles, cobbles, and boulders of local origin.

POCKET CONTAINS
11 ITEMS.