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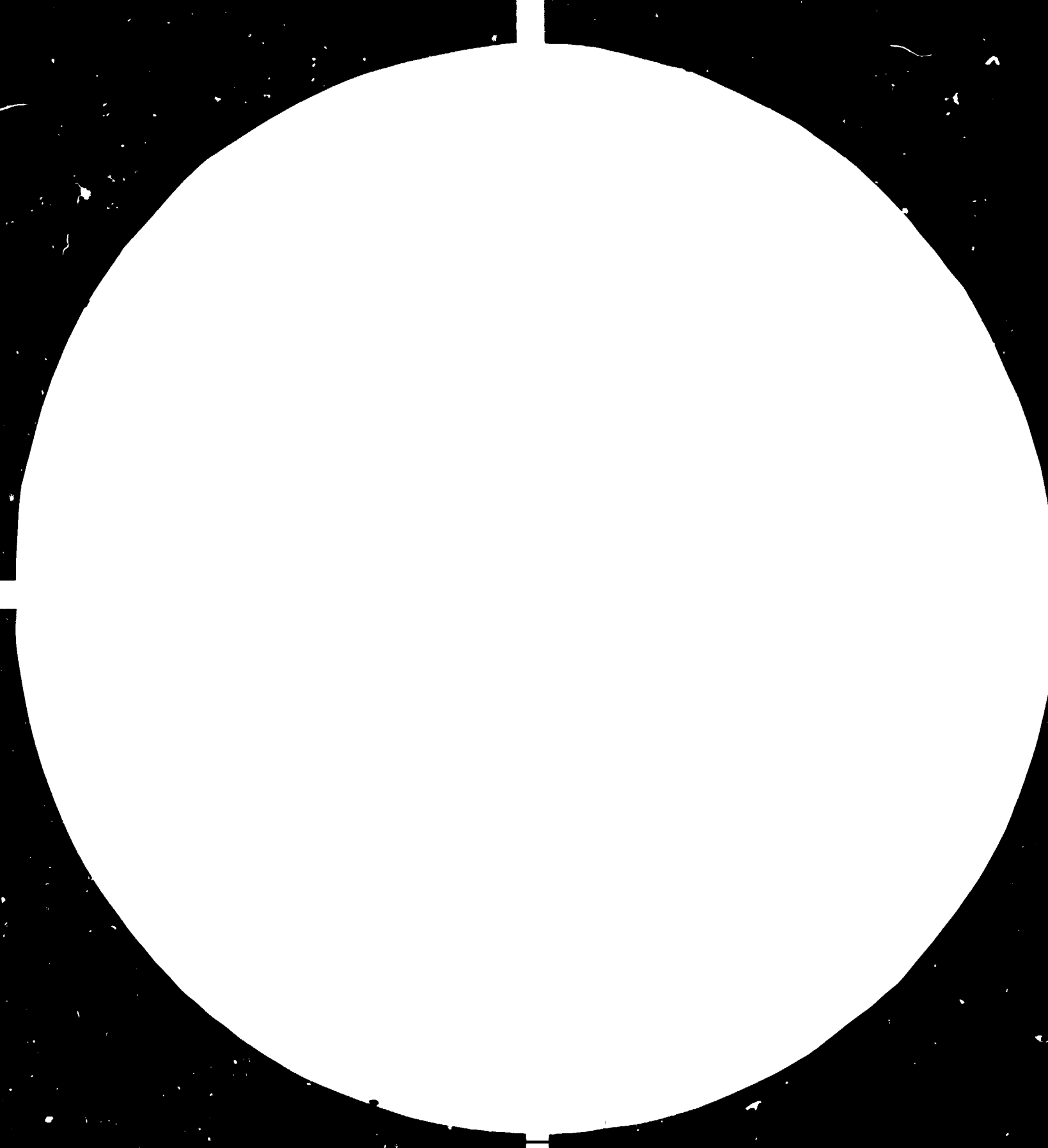

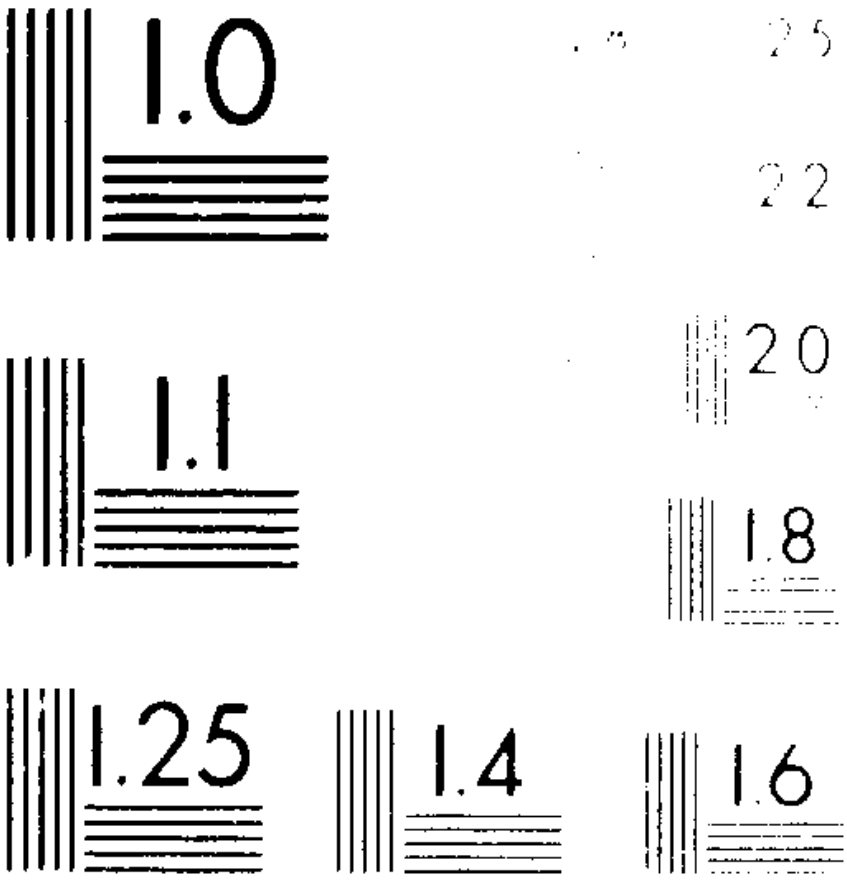
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ASSISTANCE TO EL-FATAYEH CEMENT COMPANY
TF/LIB/81/008
LIBYAN ARAB JAMAHIRIYA

Technical report: Appraisal of the gypsum deposits located in the Sidi Mabruk area

Prepared for the authorities of the Libyan Arab Jamahiriya
by the United Nations Industrial Development Organization

Based on the work of R. Rabajczyk, project co-ordinator

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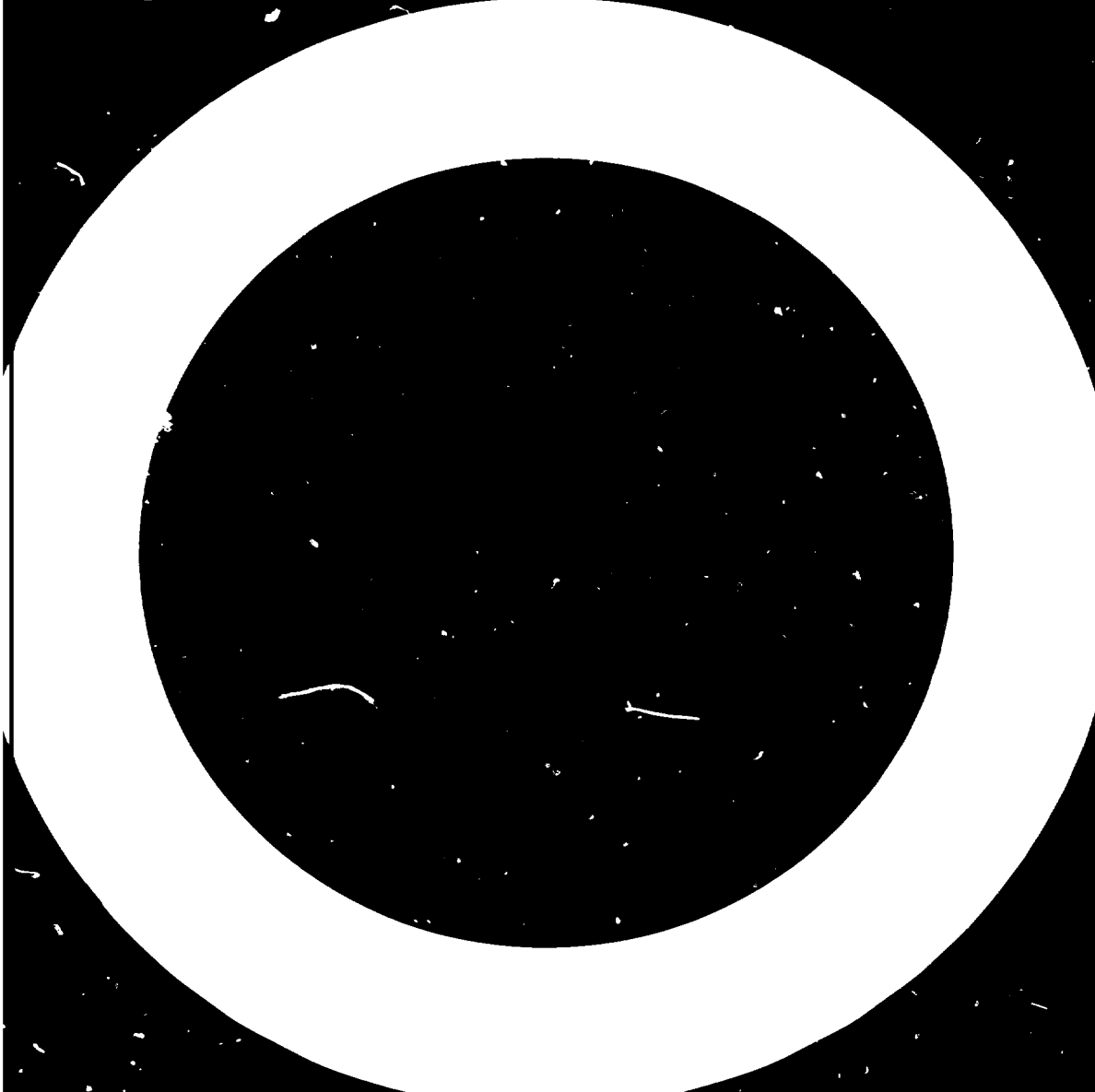
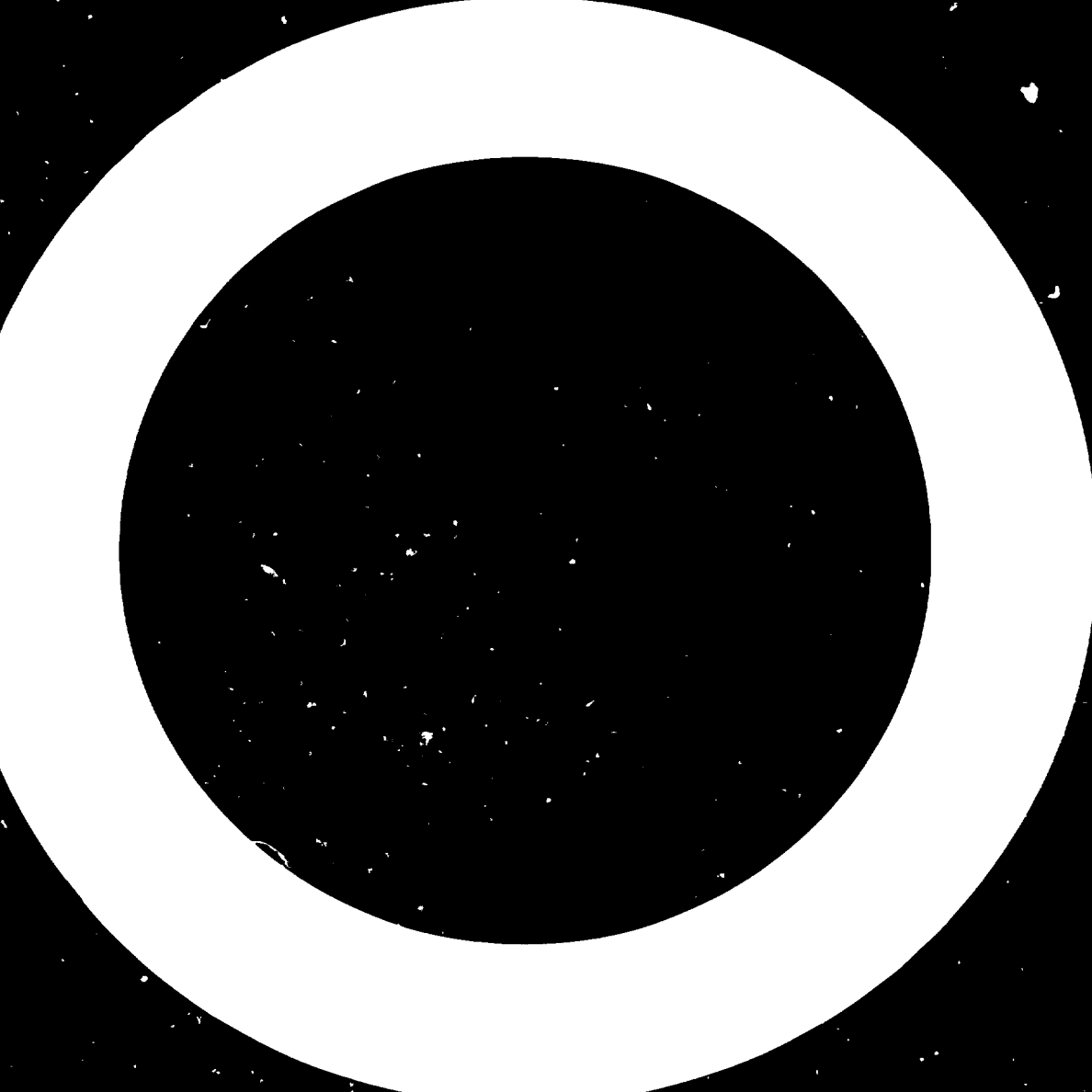


ABSTRACT

As part of the on-going project "Assistance to El-Fatayeh Cement Company" (TF/LIB/81/008) which was launched in September 1981 and for which the United Nations Industrial Development Organization (UNIDO) is the executing agency, the project co-ordinator made an appraisal of the gypsum deposits located in the Sidi Mabruk area.

In the present report, which is a summary of a more elaborate survey prepared by the expert, he compares the results of a geological study carried out by the Industrial Research Centre (IRC) with his own findings and concludes that the gypsum deposits are larger than calculated by IRC, while their status of geological recognition is only probable or possible and not proven, as suggested by IRC.

He gives detailed recommendations concerning further gypsum exploitation in the area of hill BH-12 and recommends additional geological investigations.



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INTRODUCTION

As a part of the on-going project "Assistance to El-Fatayeh Cement Company" (TF/LIB/81/008) which was launched in September 1981 and for which the United Nations Industrial Development Organization (UNIDO) is the executing agency, the project co-ordinator made an appraisal of the gypsum deposits located in the Sidi Mabruk area.

The present report is a summary of a more elaborate survey prepared by the expert, and comprises only the northern sub-area which is being exploited.

FINDINGS

A. Findings of the Industrial Research Centre

The gypsum reserves indicated in the report prepared by the Industrial Research Centre (IRC) cannot be considered either proved with regard to the upper gypsum layer, or probable with regard to the lower gypsum layer. Moreover, some boreholes which have been drilled in this area have a very low core recovery which diminishes the geological recognition of the deposit. The location of the gypsum deposit is shown in figure I.

According to the IRC report, the calculated reserves in the northern sub-area are as follow.

(a) Upper gypsum layer

Area of hill, borehole BH-12: 159,040 m^3 at 1.9t/m^3 302,176 t
(The multiplyer of 1.9t/m^3 is extremely low considering the specific gravity of gypsum; it should be at least 2.1t/m^3.)

Area of hill, boreholes BH-15 and BH-16: 148,759 m^3 at 1.9t/m^3 282,625 t

Total gypsum reserves 584,801 t

They are considered proven reserves.

(b) Lower gypsum layer

The reserves which have been calculated only in the area of the hill, borehole BH-12, are 1,112,640 t. These reserves are considered as probable.

(c) Stripping ratio

For the upper gypsum layer the ratio is 0.71 and for the lower one it is 1.95.

B. The expert's opinion on the deposit

The upper gypsum layer

Area of hill, borehole BH-12

According to the IRC report, the gypsum layer occurs in two small, separated areas, the first around BH-12, and the second around BH-15 and BH-16. The surface of the gypsum occurrence is reported to be 40,000 m^2 and 43,000 m^2 respectively, and the layer described as occurring between 305.7 and 309.7 m above sea level, slightly dipping towards north, and the dip not exceeding 1°.

It was found that after the intersection of the roof plane of the upper gypsum with the terrain, the size of the gypsum occurrence differs considerably as compared to the delimitation of the deposit defined in the IRC report. There is no interruption of the occurrence between the hills (boreholes BH-12 and boreholes BH-15 and BH-16). If the two deposits are considered separately, as in the IRC report, the surface of the first area (BH-12) would amount to 34,816 m^2 and that of the second area (BH-15, BH-16) to 90,880 m^2. The thickness of the upper gypsum layer in the hill of borehole BH-12 is 5.4 m.

The thickness of the upper gypsum layer given in the IRC report is based on the assumption that the layer has a lenticular shape; however, in the expert's opinion the present gypsum forms are the result of erosion.

Therefore the reserves of upper gypsum in the area of BH-12 equal 188,006 m^3. That area seems to be a faulted zone; tectonic movements destroyed the upper gypsum layer and weathering is much progressed. From observation of the quarry face it seems obvious that at least 30 per cent of the gypsum layer should be considered as weathered material. After deduction of 30 per cent, the total reserves of upper gypsum amount to 276,369 t, and the stripping ratio, after addition of useless material, is 1.75.

The above-mentioned quantity is considered as probable reserves, taking into consideration that the layer is under exploitation (one borehole and the quarry face).

Area of hill, boreholes BH-15, BH-16

The surface of the area amounts to 90,880 m^2. The average thickness, calculated from BH-15 and BH-16, is 3.8 m. It has to be emphasized that the core recovery from borehole BH-15 is very low (5 per cent) and the thickness of the bed is not explicitly determined.

The calculated reserves amount to 725,222 t and the stripping ratio is 245,376 : 345,344 = 0.71. According to the stage of geological recognition, these reserves can be considered as possible.

The middle gypsum layer

That gypsum bed has not been included by IRC into their calculation of reserves. The occurrence of this bed seems to be stable. The favourable thickness of the middle bed has been established by BH-13. The mineable thickness equals 2 m and can be easily interpreted and the isopach of 2 m allows for a delimitation of the mineable reserves.

The gypsum bed occurs in the vicinity of borehole BH-13. At this stage of geological recognition its surface has been calculated to amount to 36,552 m^2. With an average thickness of 2.5 m, the reserves amount to 191,898 t. The stripping ratio is 153,518 : 91,380 = 1.7. These reserves are considered as possible.

The lower gypsum layer

Area of hill, borehole BH-12

The delimitation of the occurrence has been established on the basis of boreholes BH-12, BH-13 and BH-14 and the intersection of the roof plane of the bed with terrain surface. The following values were obtained:

Surface of occurrence	232,150 m^2
Average thickness	6.3 m
Reserves	3,071,344 t
Overburden of upper gypsum layer	211,080 m^3
Volume of upper gypsum layer	188,006 m^3
Overburden of middle gypsum layer	153,518 m^3
Volume of middle gypsum layer	91,380 m^3
Stripping ratio 1,582,015 : 1,462,545 = 1.1	

Area of hill, boreholes BH-15 and BH-16

The lower gypsum layer in that area has not been calculated in the IRC report. The thickness of the bed has been proved to be 4.3 m at BH-15 and 1.6 m at BH-16. The core recovery in BH-16 is very low (6 to 15 per cent). Taking into consideration the stable occurrence of gypsum in the lower layer over the whole area, the following reserves have been calculated:

Surface of occurrence	120,320 m^2
Average thickness	3.0 m
Reserves	752,016 t
Stripping ratio after deducting the upper bed	1,618,355 : 360,960 = 4.5

Those reserves could be considered as possible as they are based only on two boreholes, one of which with a very low core recovery. They were calculated only for purposes of further investigation.

Calculated reserves - comparison of results of IRC study and the expert's findings

	IRC study		Expert's study	
	BH-12	BH-15 and 16	BH-12	BH-15 and 16
Upper bed	302 176 t	282 625 t	276 369 t	725 222 t
Stripping ratio	0.72	0.70	1.75	0.71
Geological recognition	proved	proved	probable	possible
Middle bed	-	-	191 898	-
Stripping ratio	-	-	1.70	-
Geological recognition			possible	-
Lower bed	1 112 640 t	-	3 071 344 t	752 016 t
Stripping ratio	1.95	-	1.1	4.5
Geological recognition	probable	-	possible	possible

A map showing the expert's interpretation of the gypsum occurrence is given in figure II.

RECOMMENDATIONS

A. Further geological investigation

For a further investigation of the area, additional holes should be drilled. The boreholes should be evenly spaced, the recommended grid being approximately 100 m. In addition, a certain amount of chemical analysis should be performed as well as ground survey work.

The gypsum deposit is considered a valuable one and can easily guarantee the production of cement in the El-Fatayeh Cement Plant for some decades.

In the area of borehole BH-12, it is recommended to drill 26 boreholes. Their depth should vary from 10 to 29 m, giving a total of about 436 m. In the area of boreholes BH-15 and BH-16 only eight additional boreholes are recommended to be drilled, which will give a total of about 182 m.

It should be pointed out that it is risky to plan the exploitation of deposits which fall under the geologically recognized categories probable and possible. The stage of geological recognition can be improved by progressing the exploitation, however, that method is not recommended by the expert.

B. Further gypsum exploitation in the area of hill BH-12

The gypsum quarry has been opened on the southern slope of the hill (BH-12), in the upper gypsum layer. The bed is tectonically destroyed. The big gypsum blocks occur in weathered material which makes exploitation difficult. The quarry has now been deepened and has reached the middle gypsum layer in a thickness of 1.0 m. It is approaching the roof of the lower gypsum. The extraction of gypsum in that place has become very difficult as it requires the removal of the entire upper gypsum layer to enable progress in the lower gypsum. Huge masses of barren rocks have to be removed which makes the operation very costly.

It is therefore advisable to abandon the present quarry and to transfer the exploitation to an area located in the vicinity of BH-13. In that place, under a 3.5 m thick layer of overburden, the middle gypsum can be easily exploited. As discussed above, the gypsum deposit extends over an area of approximately 15 hectars.

For 1,000,000 t of clinker, the annual requirement of gypsum is 40,000 t, and the daily requirement approximately 125 t. Taking into account exploitation losses, the quantity necessary to guarantee a 25-year production is 1,250,000 t.

The expert recommends to open the first bench at a level 292.8 m, in the vicinity of BH-13. The quarry face should be opened in north-south direction and advanced towards the east (borehole BH-12). When the deposit at the level of 292.8 m - within the boundaries of outcrop of the upper gypsum layer in the western part of the hill - is exhausted, the next bench should be opened at a level of 305 m in the bottom part of the upper gypsum layer. An auxiliary bench for the stripping of the overburden should be opened at a level 308 m in the roof of the upper gypsum layer. A further bench should then be opened at a level 282.6 m, in the vicinity of BH-13, at the botton of the lower gypsum layer.

C. Quarry operation

The quarry operation involves drilling, blasting, excavation (ripping), piling, loading and transportation.

Drilling and blasting

Considering the nature of the deposit, the expert suggests to use rotary-type drilling machines, capable of drilling holes of a diameter of 100-112 mm.

Blasting should be carried out as required for gypsum output and stripping of overburden.

Excavation, ripping, piling and loading

As the gypsum deposit appears to be soft, it can most likely be mined by ripping and piling the ripped-off material with a bulldozer. In some parts drilling and blasting may be required. As far as equipment is concerned, a pull shovel of a capacity of 3 m^3 will be required.

The removal of the overburden will constitute the main problem. The overburden materials such as limestone and marls could be removed by ripping and piling with a bulldozer; part of the overburden may, however, require drilling and blasting.

Transportation

The gypsum deposit being located at a distance of about 280 km from the El-Fatayeh Cement Plant, the only means for the transportation of the output are highway dump trucks with a capacity of 40 t. For the transportation of the overburden at least one heavy-duty truck will be required.

Dump truck calculation

Average total distance one way	280 km
Average distance	360 km
Average travel time at 40 km/h	540 minutes
Average loading time	12 minutes
Average unloading time	10 minutes
Total time cycle 540+12+10	562 minutes
Effective available time/day	420 minutes
Number of trips per one truck/day	0.74
Quantity of material transported per truck/day	29.6 t
Quantity to be transported/day	125.0 t
Number of dump trucks required/day	4.2 = 5

Equipment requirements

1 bulldozer with multi-shank ripper
1 rotary drilling machine
1 mobile compressor for drilling machine
1 pull shovel with 3 m^3 capacity
5 heavy-duty dump trucks
1 dump truck for overburden
1 set of electrical blasting tools
1 electrical cable for firing explosives (2 km long)
1 portable blasting shelter

Drilling equipment for the following benches:

Middle bed at level 292.8 m - 7.5 to 17.2 m
Upper bed at level 304.0 m - 5.4 to 12.0 m
Lower bed at level 282.6 m - 12.0 to 20.0 m

Average burden and spacing 2.5 m x 2.5 m.

Figure I. Extract of geological map of the Libyan Arab Jamahiriya showing the location of the gypsum deposit

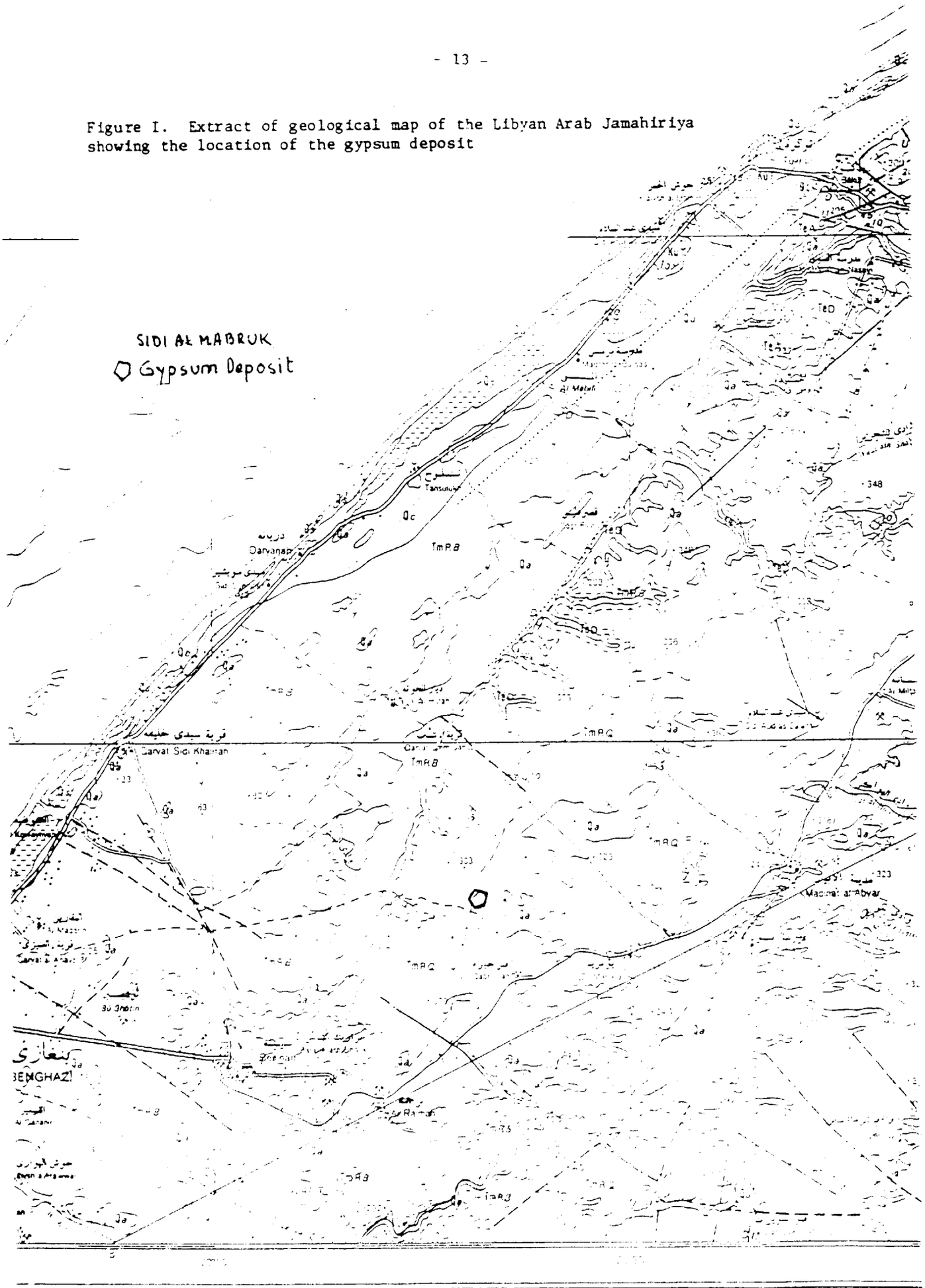
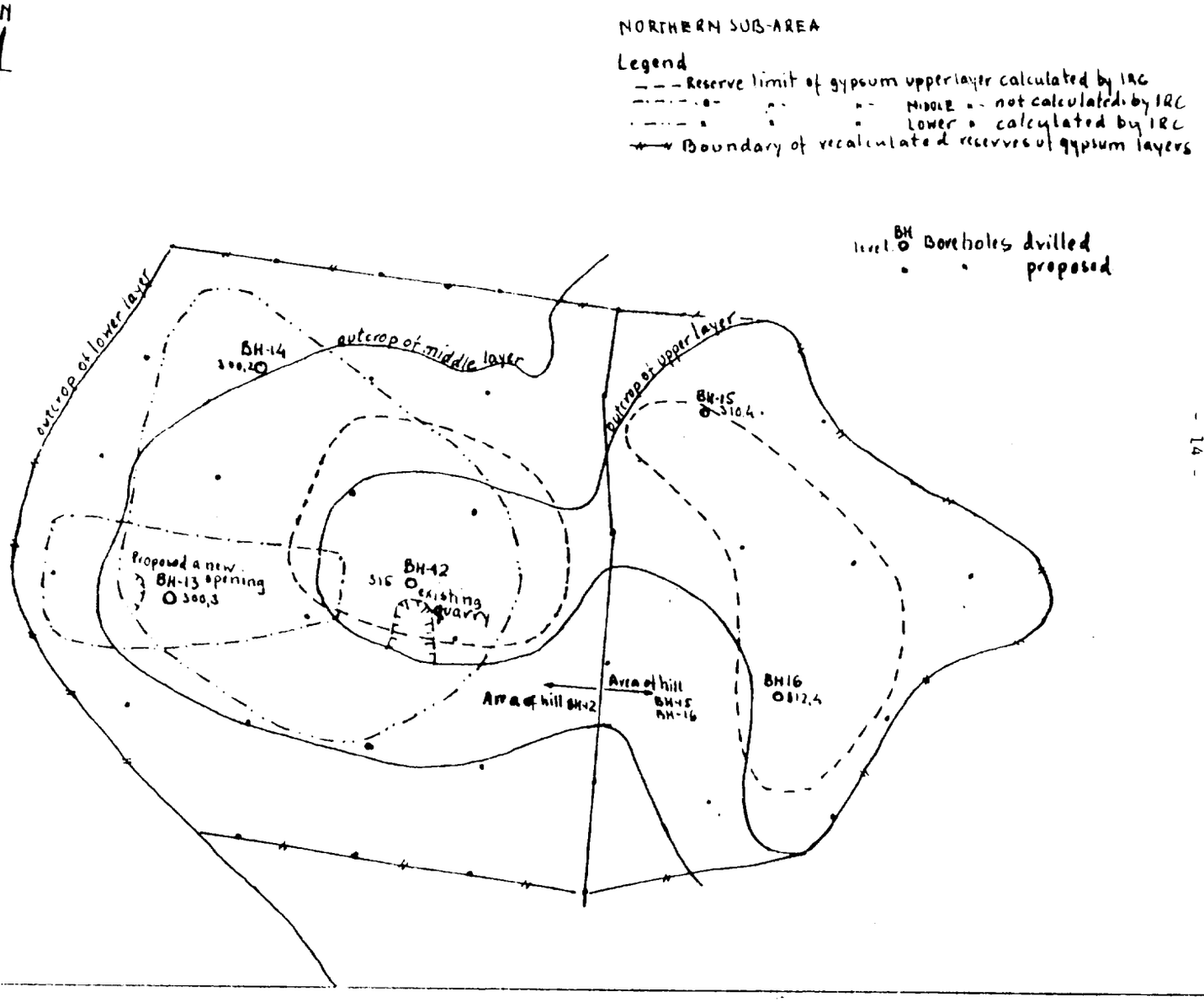


Figure II. Map showing a new interpretation of the gypsum occurrence in the Sidi Al Mabruk area

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