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(R) ASSISTANCE IN ROCK SALT EXPLOITATION AND PROCESSING[a]

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SYRIAN ARAB REPUBLIC

Terminal report

Prepared for the Government of the Syrian Arab Republic
by the United Nations Industrial Development Organization,
executing agency for the United Nations Development Programme

Based on the work of Pablo Hadzerima, expert in the exploitation and processing of rock salt

United Nations Industrial Development Organization
Vienna

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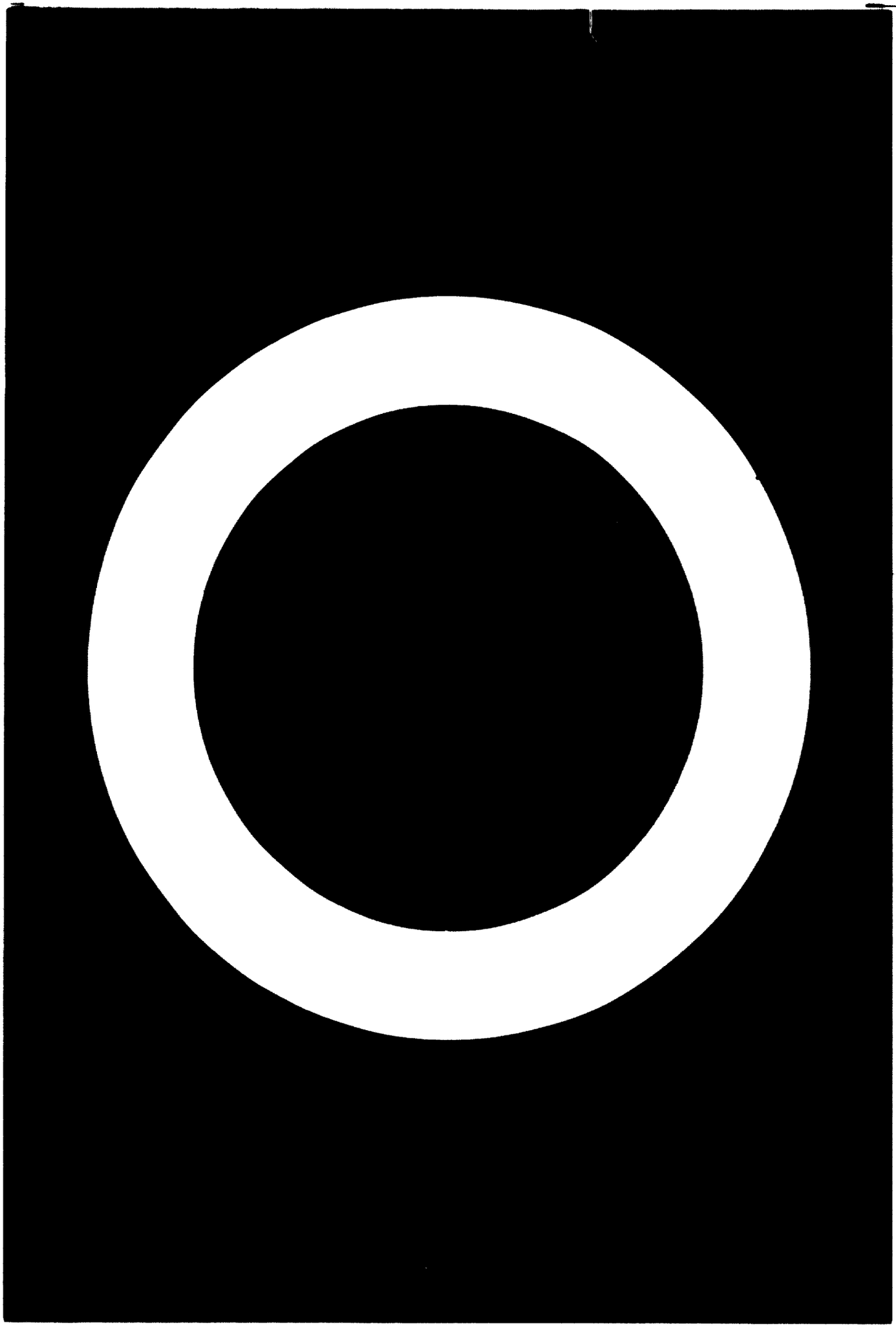
SUMMARY

As a result of drilling and geological studies carried out to the present, the proven reserves of common salt occurrence in the Northeast of the Syrian Arab Republic, are large enough to justify additional studies for its utilization in the country.

It is obvious that the development of this natural resources will have a substantial benefit for the economy of the Republic.

It is also obvious that improvement of present operations producing common salt will result in an increase of recovery and purity. Therefore, a brief study was made of the TIBNI mining operation and the efforts and future planning to improve the efficiency of this mine and the quality of its product.

The reserves of rock-salt in the northeast of the Republic amount to several hundred million tons and are considered of high economical value since the production of common salt is a vital product for the development of other basic industries.



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INTRODUCTION

Since the late thirties of the present century, considerable drilling and exploration was performed in the northeast section of the Syrian Arab Republic. This work aimed fundamentally for the search of gas and oil. During these drillings, unvariably, layers of of halite of different thickness and depths were intercepted in the area. This area covers some 40,000 km^2 and extends itself from the Syrian Arab Republic to its neighbouring countries of Turkey and Iraq, most of it laying northeast, northwest and southeast of the town of Deir-Ez-Sor on the Euphrates River valley. The present proven reserves amount to several hundred million tons of rock salt.

Although Syria produces some 40 to 60 thousand tons of salt for its internal consumption per year, notably in Tibni and the area of Jabboul, for the last several years interest has been developed to exploit the extended deposit described above but in a much larger scale. One of the major reasons in generating this interest, is the intention for producing sodium carbonate using the Solvay process method and taking advantage of the several limestone deposits available in the area.

The operation of Tibni, one of the largest in the country (produced about 40,000 tons of salt in 1977) appears to be mining a section of the deposit which contains large quantities of impurities, especially clay and anhydrite. As a result, the salt produced is of low quality. During this brief study the operation at Tibni was reviewed with the intention of giving recommendations about the immediate and future steps to be taken in an attempt to improve it.

CONCLUSIONS

The conclusions are based on reports issued in English, verbal translations of reports issued in Arabic and general and detailed conversations with officials and technical personnel at different Syrian Government Departments.

1. The proven reserves of rock salt in the northeast of the Syrian Arab Republic are large enough to justify additional studies from the geological standpoint. Some identified deposits are deeper than others but most of them amenable for exploitation.

2. The proven reserves are of sufficient high grade that relatively simple beneficiation methods can be used to increase its grade to the point that the salt will meet specification of the different industrial clients as well as for human consumption.

3. The geological work performed up to the present appear to indicate that conventional mining by the room and pilar method or by solution mining are a matter of economical and technical considerations to be taken in the future rather than to be inclined toward one or another method by mere thought. Although solution mining may be favored as a consequence of relative small thickness of some of the deposits, conventional mining should not be discarded because the possibility of selective mining when necessary. Definitively solution mining should be selected for the deeper deposits.

4. The research work performed at the Damascus University (written in Arabic and verbally translated in part) to purify the rock salt mined at Tibni is considered incomplete and to some extent inadequate for the technical improvement of the operation.

5. The operation at Tibni is one of high cost because either excess of man power or inadequate or outdated machinery. The short length of the mission did not permit a visit to the operation, but conversations held in the Ministry of Petroleum

and Mines in Damascus, lead to believe that this is the case.

6. The price of common salt in Syria, and also apparently in neighbouring countries, is exceptionally high compared with prevailing international prices.

RECOMMENDATIONS

As for the conclusions, the following recommendations are based on reports written in English, verbal translations from Arabic and personal conversations held with technical personnel from different Syrian government organizations.

1. Based on the already available geological information of the northeast of the Syrian Arab Republic and the known deposits of limestone, review the feasibility study made by the General Establishment for the Chemical Industry for the production of sodium carbonate using the Solvary process. This review should be made with the special task of selecting the site for the plant according to the deposits - of rock salt and limestone - and the infrastructure available in the zone.

2. If the results of the above recommendation are encouraging, perform additional drillings to establish definitively the rock salt horizons in order to determine the most economical mining method.

3. Once the mining method has been selected, conduct a prefeasibility study to determine the optimum tonnage of salt to be mined and the purification process to be used at the surface (if any). To attain this, representative samples (from the drilling cores) should be used for laboratory studies for:

   a. beneficiation methods to obtain a salt product which will meet specifications in case that conventional mining is selected;
   b. obtain solutions which will be of similar composition to the ones that could be produced by solution mining of the deposit and carry out the necessary tests for the purification of said solution (if necessary) to produce a solution suitable to yield a pure sodium chloride product by crystallization.

4. Conduct the necessary feasibility studies, marketing and engineering to bring the project to a reality.

5. As for the Tibni mine, presently operated by the Ministry of Petroleum and Mines, engaged a consulting mining engineer (expert in salt mining or otherwise in potash or coal mining) to correct, if possible, the defects mentioned in conclusion 5.

6. Conduct additional laboratory testing (and pilot plant, if necessary) for the purification of the Tibni mined ore using the most practical view of the problem. That is, conduct, using representative samples from the Tibni mine, conventional purification processes testing (precipitation of impurities and crystallization). Follow up the build up of impurities upon recycle of mother liquors and determine complete material balances of the circuit tested. This study should include the measurement of such physical variables as settling and solid liquid separation rates and physico-chemical influences of impurities in the crystallization habits of the sodium chloride crystals.

7. Conduct laboratory testing to investigate the possibilities of dry purification of the Tibni rock salt using the best representative samples that can be obtained. These studies should be based on mineralogical examinations of the different types of rock salt samples available at the mine.

8. Before making a decision of erecting a purification plant for the Tibni's salt, study by drilling the "pure salt" section of the deposit to verify its actual purity and reserves. It has been verbally indicated, that at the present rate of mining, the "pure salt" horizon should be reached in one or two years. If this proves to be the case, no purification plant should be needed.

9. Before installation of an ore purification plant at Tibni, consideration should be given to the possibility of solution mining of the deposit and treat the brine pumped to the surface

10. Because the arid conditions in the northeast of Syria, in case of exploitation of any of the deposits found in the area, consideration should be given to the use of solar evaporation of salt solutions made artificially of mined salt or obtained by solution mining.
11. Solar drying of salt product obtained by crystallization should also be considered.

ROCK SALT IN NORTHEAST OF SYRIA

There are several deposits which have been identified in the northeast of the Republic as a consequence of numerous drillings made in the search for gas and oil. These deposits were found as far back as the late thirties. The following reports described some of them.

1. Djibissa Area Drillings (three reports issued in 1940, 1941 and 1951) by the Geological Department of the Syrian Petroleum Company (in English).
2. "Report on prospecting and exploration in the rock salt deposit area of Harmoshiya with the calculation of reserves by August 1, 1962", Volumes I and II, Aleppo, 1962, by V.P. Telegin, K.I. Prasolov and Y.M. Kazak from the V/O "TECHNOEXPORT", USSR (contract No. 326) (in English).
3. "Report on Preliminary Studies pertaining to the salt resources in the Syrian Arab Republic and the possibilities of their exploitation" Volume I, March, 1964, by K. Scheer, P. Matthiass, H. Welser, R. Küttner, B. Hornemann and A. Brecklinghaus from the BPG Bergbau-Planung GmbH, P.O. Box 139, Essen, Federal Republic of Germany (in English).
4. "Rock Salt in Tibni" prepared by the Phosphate and Mines Co. and others. (in Arabic).
5. Several other reports (in Arabic and English) found at the General Organization for Cement and the Syrian Petroleum Company in Damascus.

The Djibissa area, about 45 km south of the town of Hassetche, close to the river Khabour and on the railroad connecting that town and the city of Deir-Ez-Zor, salt beds were intercepted by drilling throughout the area. The salt beds are found at different depths and are of different thickness. Typical examples of some of the perforated holes and the thickness of salt beds intercepted are presented in the following table.

Salt beds in the Djibissa Region

Hole No.	Salt thickness (m)	Depth (m)	Depth under sea level (m)
5	88	697	365
201	8	693	359
202	162	986	688
203	176	742	384
205	115	595	218
207	112	785	500

The drilling performed during the years 1961 and 1962 showed extensive salt deposits in the area of Tibni and Harmoushiya, located about 45 km northwest of the city of Deir-Ez-Zor and at the banks of the Euphrates river. These drilling indicated a reserve of several hundred million tons of halite with variable amounts of anhydrite and clays. Subseqnently, a mine was opened at Tibni using the room and pilar method. The operation has a crushing-grinding-screening plant at the surface. The capacity has been reported between 50,000 and 60,000 tons per year.

Many other underground rock salt deposits have been reported in other sections of northeast of Syria. Detailed description of them can be found in the above mentioned reports. However, it can be said here that the inferred reserves in the country are almost unlimited of this important raw material.

SOME ADDITIONAL TECHNICAL COMMENTS AND SOME ECONOMICAL ASPECTS

The very brief length of the mission did not allow enough time to review the available reports in detail from the technical and economical points of view. Nevertheless, is it possible to make some general comments on both points of view.

RECOMMENDATION 2

About the additional drilling recommended, it will be up to the Syrian officials in charge of the project, if there is enough information already available to warrant the investment for a new mine.

RECOMMENDATION 9

This was based in the fact that one potash mine located in Utah, USA. after operating for several years using conventional mining methods (room and pilar) was recently converted to a solution mining operation. This switch was performed for technical and economical reasons. This operation is now performing successfully from the technical and economical standpoint.

RECOMMENDATION 10

Even though fuel is available at cheap prices in Syria, the recommendation was given because by solar evaporation of brines there will be a saving in production cost which in turn will help to reduce the selling price of salt to the consumers. The quality of the soil is very important in the installation of a solar pond. But, it is possible to overcome difficulties in this aspect, by proper lining of the selected area with different methods (one commonly used is polyvynil chloride sheets).

RECOMMENDATION 11

The concept of solar drying of an ore or product is applied in Australia, United States of America, Chile and probably at other places in the world. As the comment of recommdnation 10 this will yield a cheaper product.

In respect to the general economics of rock salt production in Syria it can be said that every attempt should be made to reduce its cost.

For instance, it was verbally stated that the rock salt from the Tibni mine, which is of poor quality, sells to the industry at 25 piastres per kilogram or 250 S£ per metric ton or (at 4 S£ = US $ 1.00) US $ 62.50 whereas exported Mixican or Australian sea water solar salt, of much better quality, cost about US $ 7.00 per metric ton. However, it is also true that Tibni mine production is very small compared with operations in Mexico or Australia. But still the disproportion of the two prices is very large and it should, sooner or later, be reduced by increase capacity, by reducing man power and by improving mining operation.

To increase the capacity of an operation, larger internal market should be developed (this would be the case if the soda ash plant becomes a reality) and make all possible efforts to conquer an exportation market (in which case the Syrian salt should meet the international prices).

The reduction of man power is always possible by an increase of efficiency and maintaining the same production. However, in the case of the Tibni operation it has been verbally stated, that for the same production, man power has been increased by about 300% between 1973 and the present.

Improvement in mining operation can be accomplished by increasing the efficiency of the miners, by using better mining machinery and by improving the mining method (recommendation 5).

All three factors of above are fully related to each other and all of them should be taken into consideration when planning the opening a new mine or improving presently operating mines.

The writer has been told that the quality of table salt for human consumption is very bad even though commanding a high price.

The University of Damascus' report on salt purification by crystallization from a brine made using the Tibni rock salt, calculated a total cost for purification of 7 piastres per kilogram (including packing). This calculation was based on a production of 15.5 metric tons per hour or at the predicted days per year of operation, will result in a capacity of 100,000 tons per year. Syrian human consumption is less than this production at the present but the growth rate of population (2.7% yearly) may absorb this amount in the future.

In case that the soda ash plant becomes a reality and it is economically close to the limestone deposit, the purification steps ahead of crystallization should be increased accordingly, because the purified brine will be split. A part going to the crystallization section and another to the soda ash plant. A combination of this kind may result in a lower cost of crystallizing salt per unit weight.

The calculated cost (by the University of Damascus) of 7 piastres per kilogram for purification and crystallization is equivalent to US $ 17.50 per metric ton for the above mentioned capacity. This relative low cost (perhaps because the low cost of fueld in Syria) is favorable comparing it with the cost in other parts of the world of similar capacity. The capital cost calculated (US $ 7.5 million) is about what should be at the present.

The other economical alternative is to build a smaller purification plant just to produce purified salt for human consumption. In the United States of America, a small purification-crystallization plant with a capacity of around 12,500 tons per year will require an investment of approximately one million U.S. dollars. The capital cost will be distributed

about as following:

	US $
Salt evaporator and accessories	200,000
Rotary filter and accessories	20,000
Salt dryer	120,000
Pumps	10,000
Settling tanks	20,000
Storage bins	30,000
Piping, compressor, sheet metal work and miscellaneous items	60,000
Total equipment	460,000
Engineering and contingencies	65,000
Erection, building and site preparation at 100% of equipment	460,000
Total cost	985,000

For this small capacity, the purification cost per ton of salt would range from US $ 24 to US $ 34 plus the cost of the feed brine.

For a production of purified salt by precipitation of impurities with chemicals and crystallization of the salt, ten times larges (125,000 tons per year), the approximate capital cost will be as calculated by the work of the University of Damascus, roughly about US $ 7.5 million and the cost per unit weight will probably be reduced by about US $ 9 per ton or US $ 15 to US $ 25.

It is generally agreed that in most cases for similar deposits (in depth and thickness of the salt bed) solution mining is cheaper than conventional mining (room and pilar method). However, the cost of solution mining may vary to a great extent. This great variation in cost is a result of several factors:

1. Depths of the deposit,
2. Thickness of the bed salt,
3. Life of the wells and cost per unit,
4. Method of operation,
5. Solution lifting cost,

To the above, it will be necessary to add the expected variations from one country to another, of equipment cost and operating cost (direct and indirect cost). The length of this mission did not permit to go into these details. Pertinent articles are given in the bibliography.

However, it can be said of the present status of the project or projects of the Syrian Arab Republic to produce salt from the very vast reserves, that all indications are that they should be persued further with more detailed investigations (technical and economical) with the necessary government technical personnel and consultants from the country and abroad.

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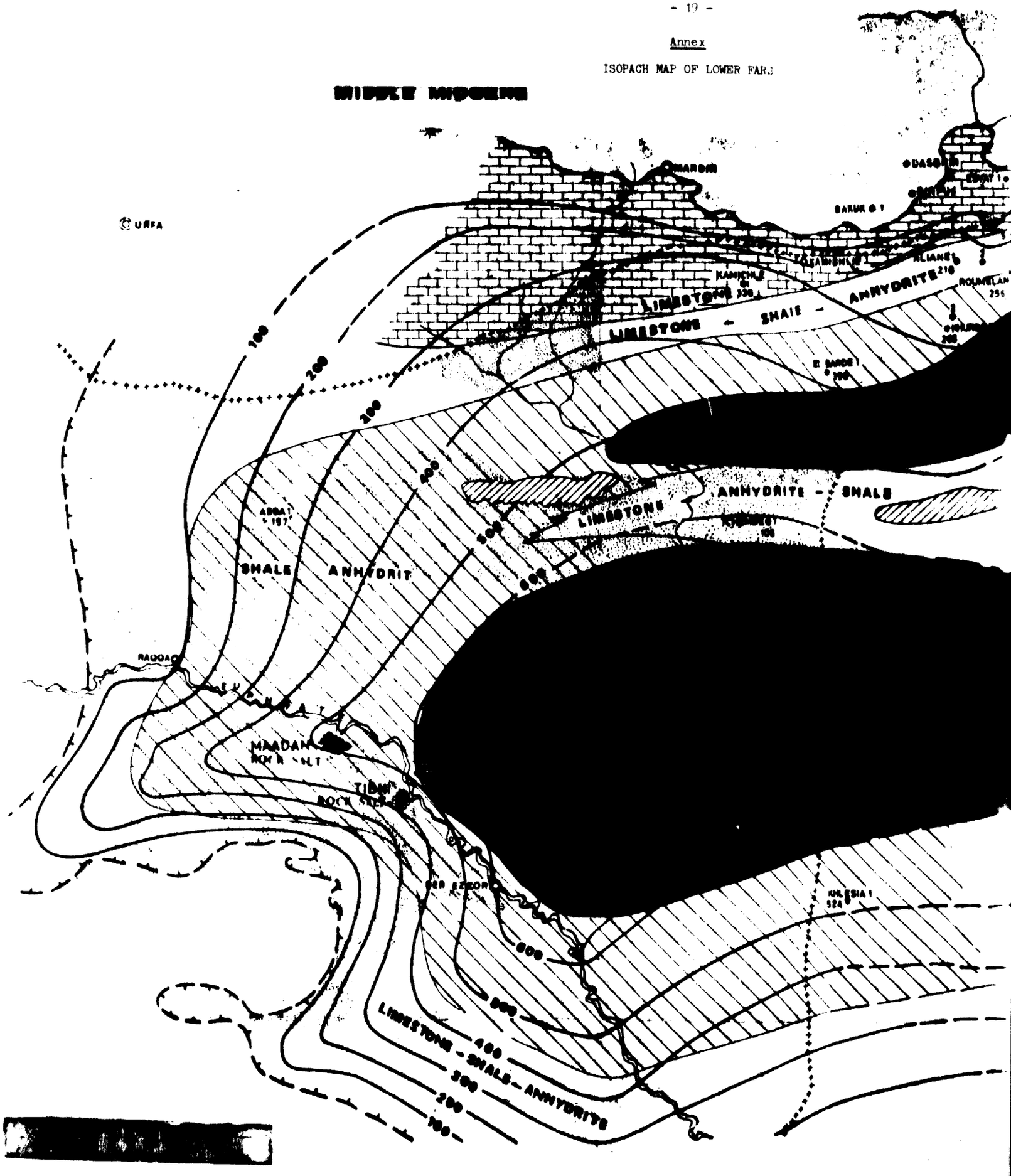
Annex

ISOPACH MAP OF LOWER FARS



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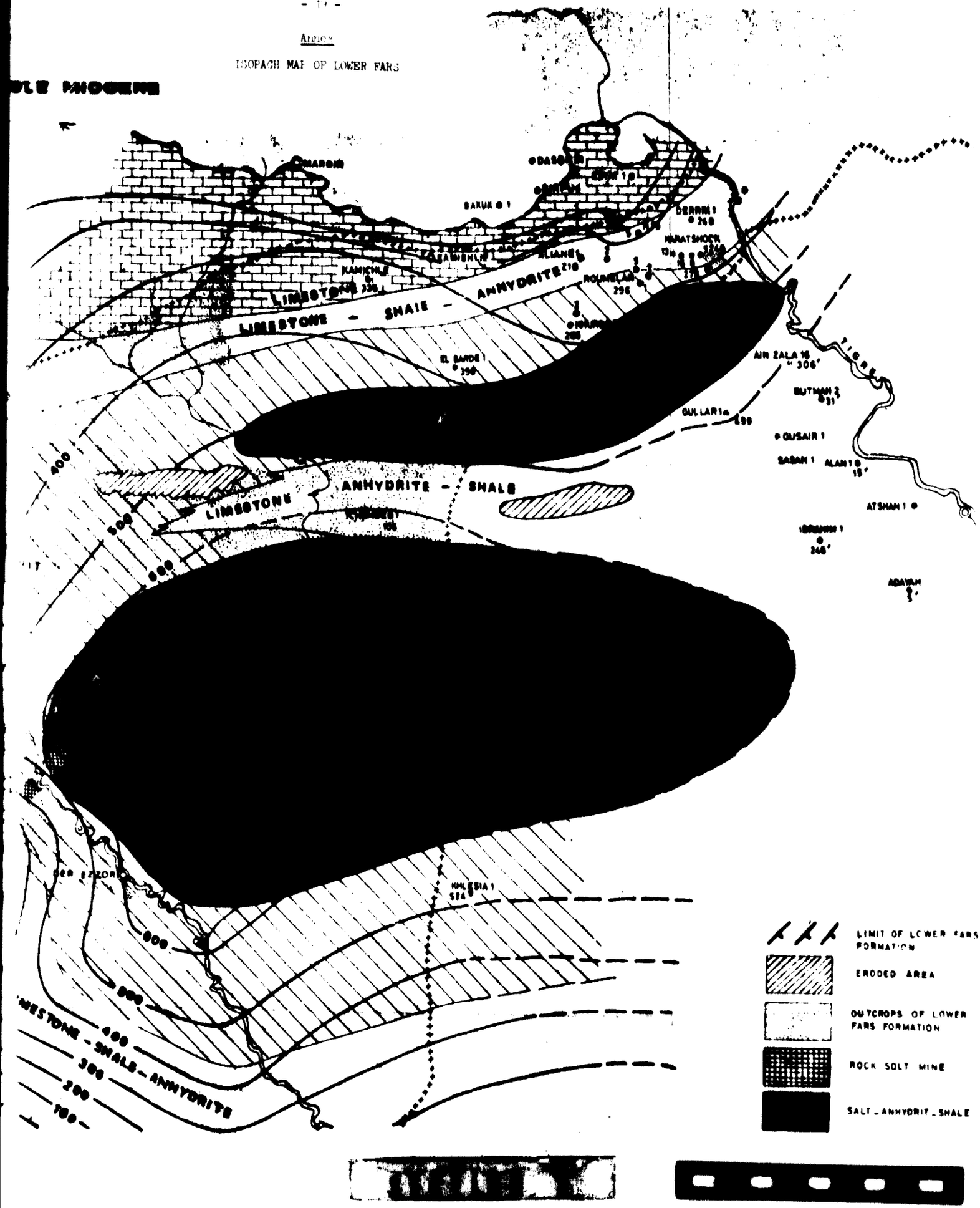

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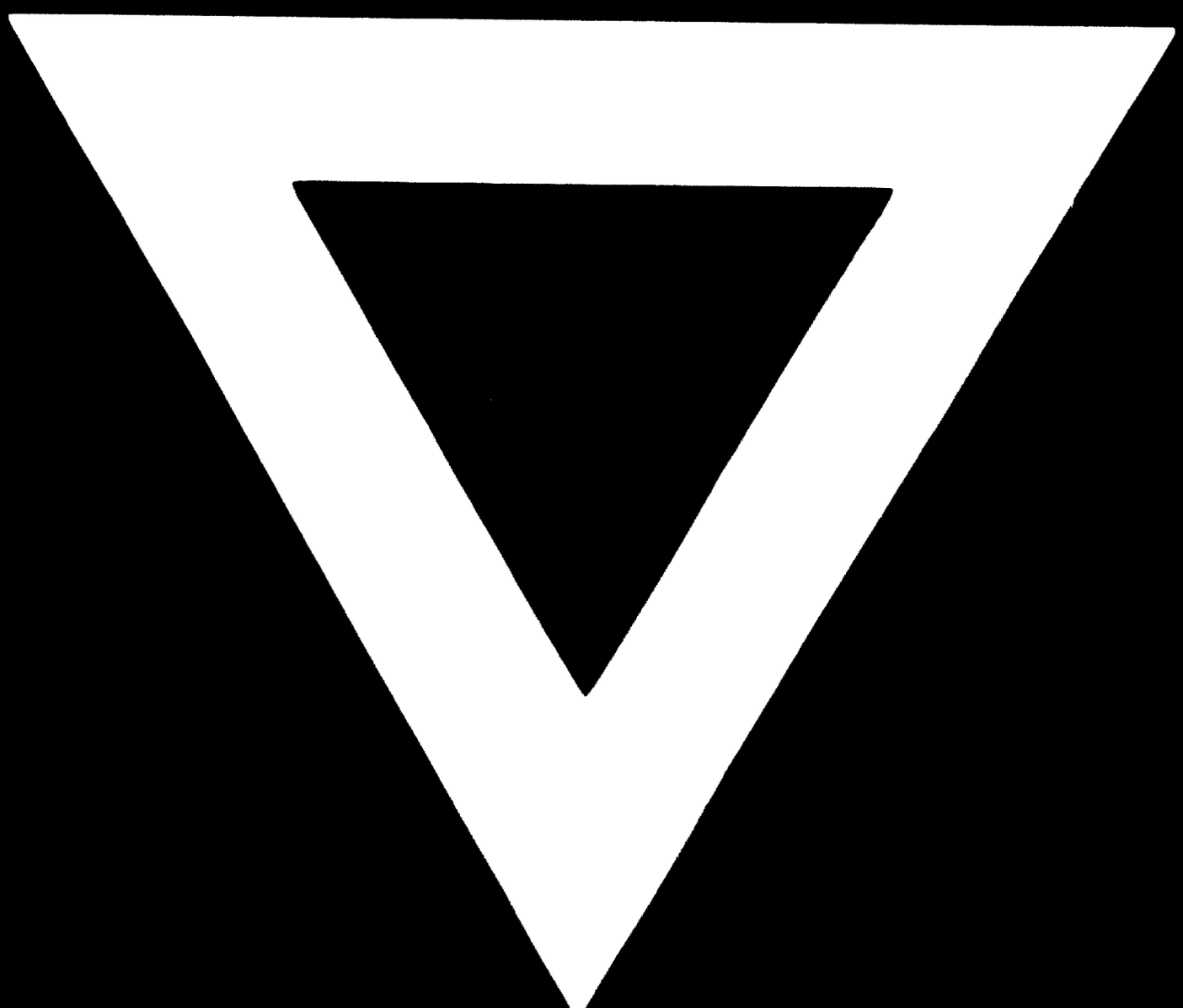

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