RECONNAISSANCE INVESTIGATION OF EVAPORITES IN THE AL QASAB AND RAYDA AREAS, KINGDOM OF SAUDI ARABIA

by

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OPEN-FILE REPORT USGS-OF-[redacted] 82-218

Ministry of Petroleum and Mineral Resources
Deputy Ministry for Mineral Resources
Jiddah, Kingdom of Saudi Arabia
1402 AH 1981 AD

An Interagency Report prepared by the
U.S. Geological Survey
Saudi Arabian Mission
for the
Ministry of Petroleum and Mineral Resources
Kingdom of Saudi Arabia

The work on which this report was based was performed in accordance with a cooperative agreement between the U.S. Geological Survey and the Ministry of Petroleum and Mineral Resources.

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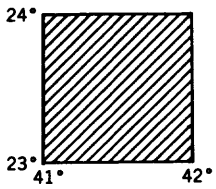
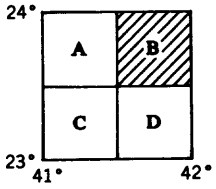


23/41

1-degree quadrangle



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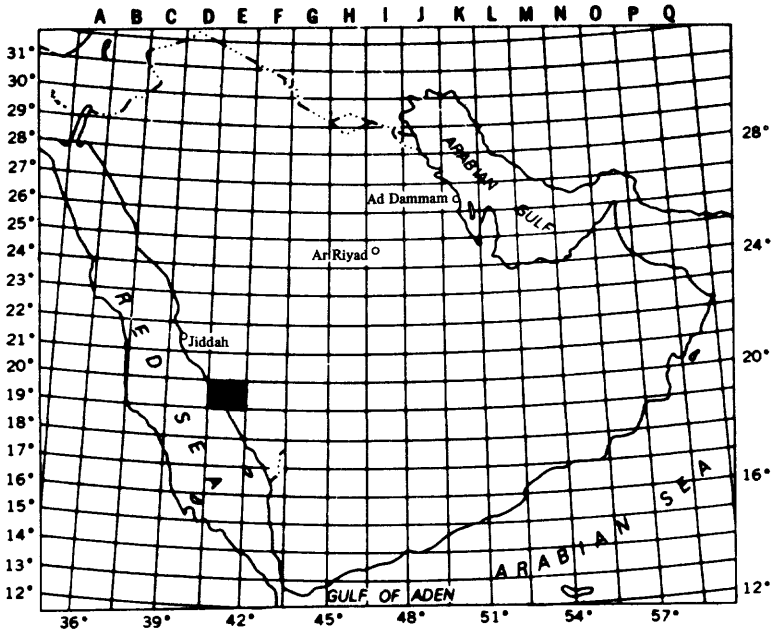
30-minute quadrangle



19E

1x1½-degree
quadrangle

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RECONNAISSANCE INVESTIGATION OF EVAPORITES IN THE AL QASAB AND RAYDA AREAS, KINGDOM OF SAUDI ARABIA

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ABSTRACT

Salt is being produced by the evaporation of brine in shallow pits at Sabkhah al Milh (lat 25°15' N., long 45°35' E.), near Al Qasab. In the Rayda area (lat 20°28' N., long 47°40' E.), extensive, discontinuous beds of gypsum are exposed, but bedded halite is absent. No other evaporites with any potential for commercial exploitation were observed in these areas, and it is not recommended that further studies be undertaken at this time.

INTRODUCTION

From December 20, 1980, to January 4, 1981, reconnaissance studies were made of a salt-producing brine at Sabkhah al Milh (lat 25°15' N., long 45°35' E.) near Al Qasab and of exposed gypsum beds west of Rayda (lat 20°28' N., long 47°40' E.) (fig. 1). The areas were studied to determine whether the evaporite mineral resources in these areas are sufficient and suitable for commercial exploitation and to search for other potentially exploitable evaporite mineral resources.

This study was done in accordance with a work agreement between the U.S. Geological Survey and the Ministry of Petroleum and Mineral Resources, Kingdom of Saudi Arabia.

SABKHAH AL MILH, AL QASAB AREA

A reconnaissance investigation of Sabkhah al Milh, a playa northwest of Ar Riyad near Al Qasab (figs. 1, 2), was conducted in December 1980. The playa occupies a topographic low in a valley bounded on the southwest by rocks of the Marrat Formation (Lower Jurassic) and on the northeast by rocks of the Tuwayq Mountain Limestone (Upper Jurassic). Because the ground-water table is shallow, evaporation through the overlying sediments, aided by capillary draw, produces a brine at the vadose-phreatic zone interface. Such formation of brine is common in playas or sabkhas where the water table is within 1.5 m of the surface.

1/U.S. Geological Survey, Denver, Colorado

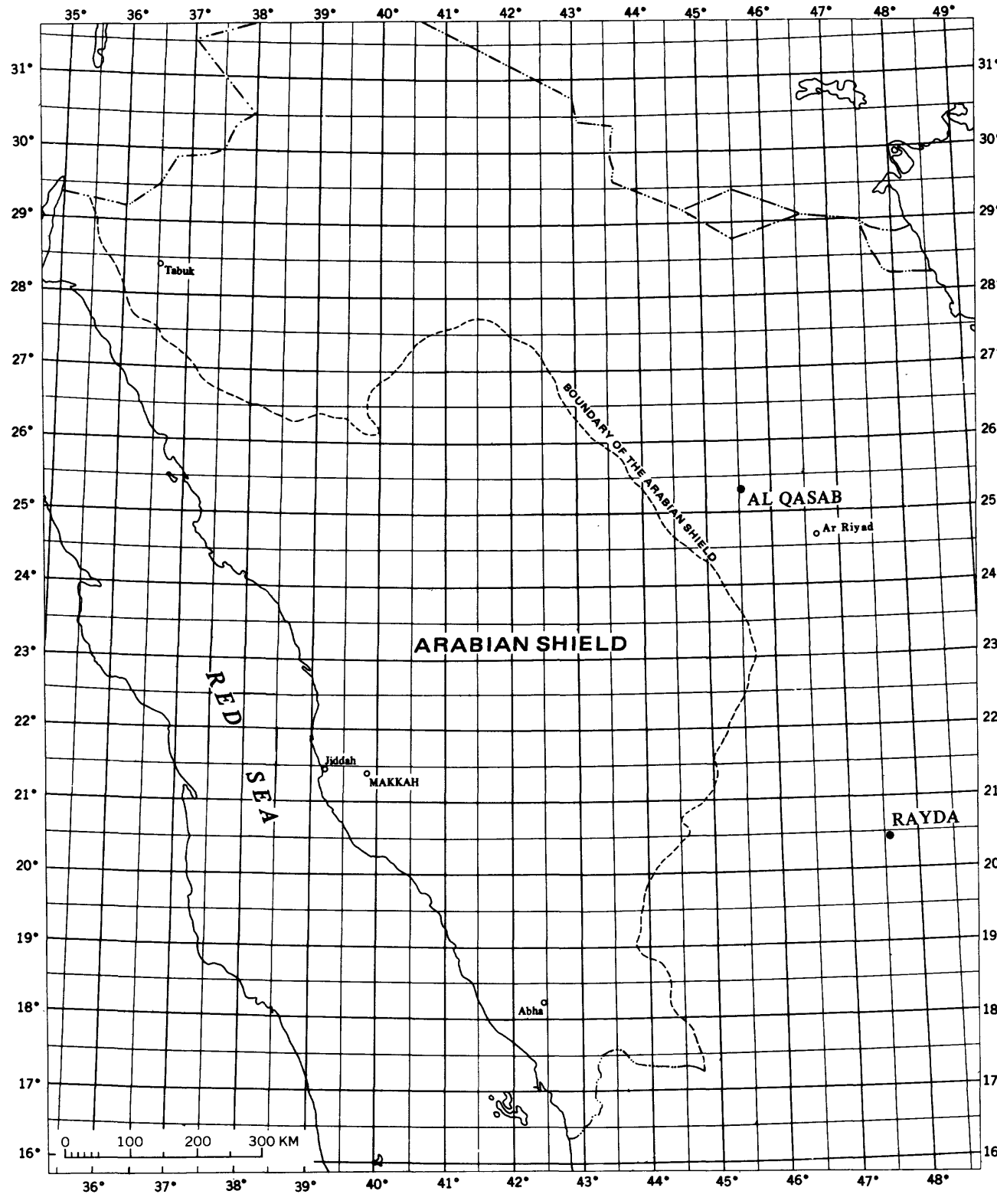

Figure 1.–Index map of western Saudi Arabia showing the location of the Al Qasab and Rayda areas.

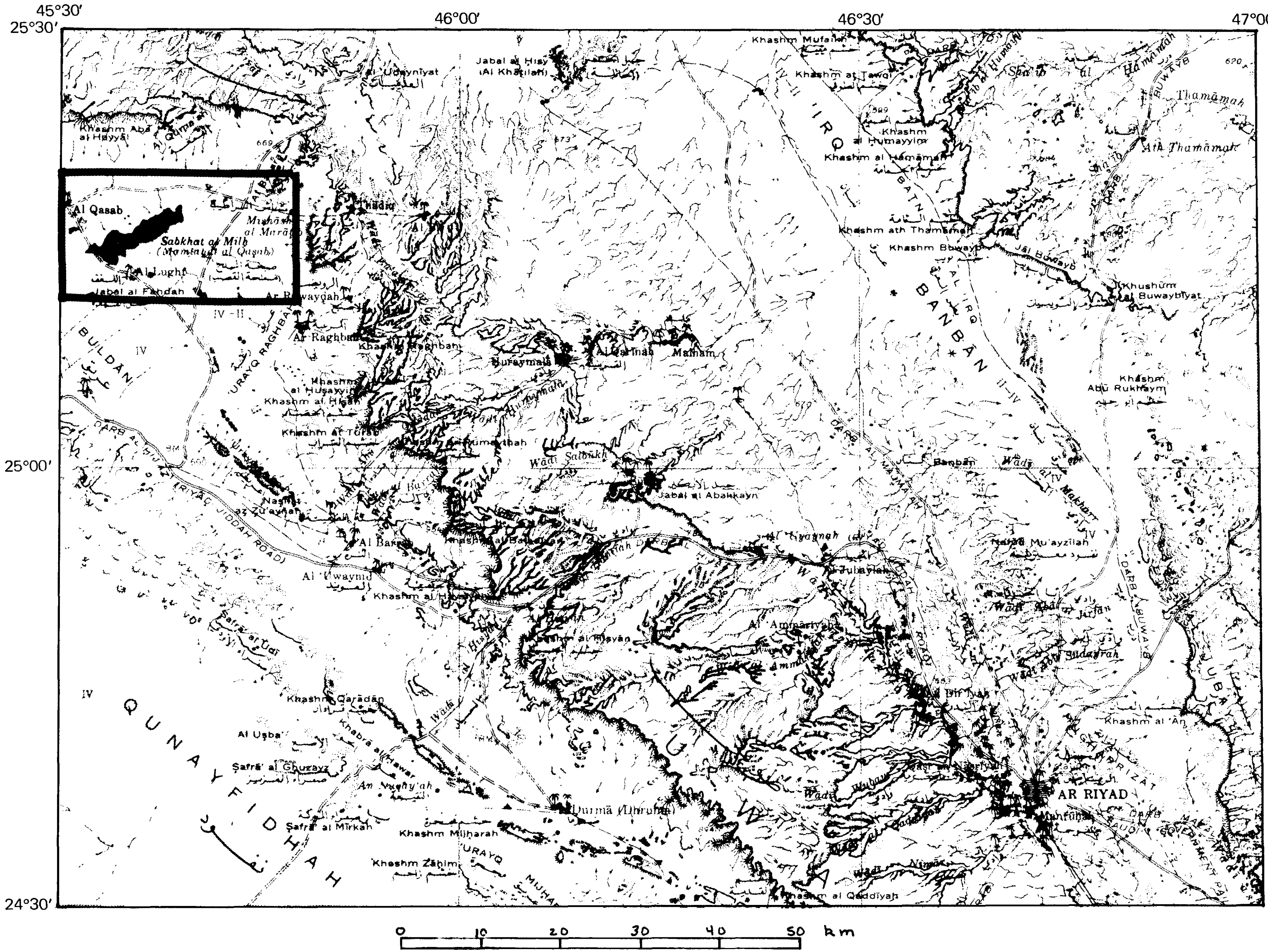

Figure 2.–Location map for Sabkhah al Milh, Al Qasab area. Area delineated by box; playa in solid black.

At the time of the investigation much of the playa was impassable to vehicles because of recent rains, and only one salt-producing site on the playa was visited. At this locality salt has been produced from shallow, bulldozed pits approximately 1 m deep and 8 by 30 m in area. These pits were periodically flooded with brine from a deeper hole at one end of the pit in which ground water collected. After evaporation of brine in the shallow pits and precipitation of halite and less soluble minerals, the salt was harvested by means of rubber buckets and steel wheelbarrows. Holes in the bottoms of the buckets and wheelbarrows allowed the brine to drain from the collected salt and some silt to be washed from salt surfaces. The salt was then piled on the side of the pit for subsequent transport from the producing site. This method of salt production appeared similar to that used near the towns of Ithera and Kaf in northern Saudi Arabia (Smith, 1980), except that the pits near Ithera and Kaf were dug by hand.

Most salt produced in the manner described above contains some eolian silt and sand as well as gypsum that precipitated both before and during halite precipitation. As examined under a hand lens, the salt at Sabkhah al Milh appears to contain less than 95 percent sodium chloride. In the United States, salt produced by evaporation of sea water contains about 95 percent sodium chloride and is considered to be of industrial grade. Most salt produced in the United States for human consumption contains at least 99 percent sodium chloride.

Outside the area containing the pits, no economically significant quantities of evaporites were observed. The relatively high concentration of sulfate in the brine, as indicated by the small gypsum fragments in the area, suggest that trona and other evaporite minerals that contain carbonate are unlikely to form. Much more extensive studies in this area would be required to determine if halite and gypsum beds might be present in the subsurface.

RAYDA AREA

Gypsum has been deposited and is being deposited near and on the coasts of the Kingdom of Saudi Arabia in continental and marine sabkhahs (Shearman, 1976, Al Habshi and Roger, 1979; Boardman, 1980). Beds of gypsum as much as 13 m thick are exposed near Ayn Ibn Fahayd (lat 26°47' N., long 44°13' E.) in the continental Jilh Formation (Middle Triassic) (Powers and others, 1963). Gypsum also is precipitated from near-surface ground waters in playa sediments near Al Isawiyah in northwestern Saudi Arabia (Smith, 1980). At least some gypsiferous lake beds in the Rub al Khali desert were deposited in lakes perched above the local ground-water

table (McClure, 1978). Extensive gypsum lake deposits, which are less than 5 m thick and possibly associated with a high ground-water table, are found along the base of the Tuwayq escarpment. Powers and others (1963) described a band of gypsum 60 km in length of late Quaternary age (McClure, 1976) that extends south of Wadi al Faw along the base of the Tuwayq (Al Arid) escarpment about 400 km northwest of Ar Riyad. Arabian American Oil Company (1955) described extensive gypsum deposits northwest of Al Kharj that have also been deposited at the base of the Tuwayq (Hith) escarpment.

Discontinuous, horizontal beds of gypsum less than 1 m thick are exposed east of As Sulayyil (fig. 3) in the Rayda area, where a reconnaissance investigation was undertaken from December 22, 1980, to January 4, 1981. The gypsum beds are on the edge of the Rub al Khali basin where eolian sands are in contact with Tertiary marly sandstones and late Tertiary to early Quaternary reg gravels (Bramkamp and others, 1956). Both reg gravel plains and eolian sands of the Rub al Khali desert probably formed by deflation of a late Pliocene alluvial plain in the Rub al Khali basin (McClure, 1978).

The gypsum beds are exposed in much of the Rayda area (fig. 3) but are most extensive in areas labeled A, B, and C. Some gypsum appears to have been eroded from topographically higher beds and redeposited in deflation hollows. The gypsum outcrops range in thickness from less than 25 cm to greater than 150 cm. Fossil reeds and algal material in area A suggest that water from which gypsum was subsequently deposited was at least periodically fresh. Gypsum-cemented sand crystals in area B indicate that a considerable amount of water had evaporated from a shallow ground-water table because at least 900 m of gypsum-saturated water must be evaporated to produce 1 m of gypsum. These observations suggest that the lake or lakes in which the bedded gypsum was deposited were probably more permanent than the perched, carbonate-producing lake beds formed in deflation hollows and depressions between seif dunes in the Rub al Khali desert (McClure, 1978). The lake beds in the Rayda area are probably similar in origin to the gypsum-bearing lake beds at the base of the Tuwayq escarpment.

At least 2 million metric tons of gypsum are estimated to be in the Rayda area. Hand-lens examination of samples of gypsum suggests that the gypsum is fairly pure. One of the major difficulties of utilizing gypsum from this deposit is the transportation to a manufacturing site. Between 60 and 75 km of eolian sand must be crossed before the gravel plain is reached, and it is necessary to travel another 100 km to reach As Sulayyil, the nearest population center.

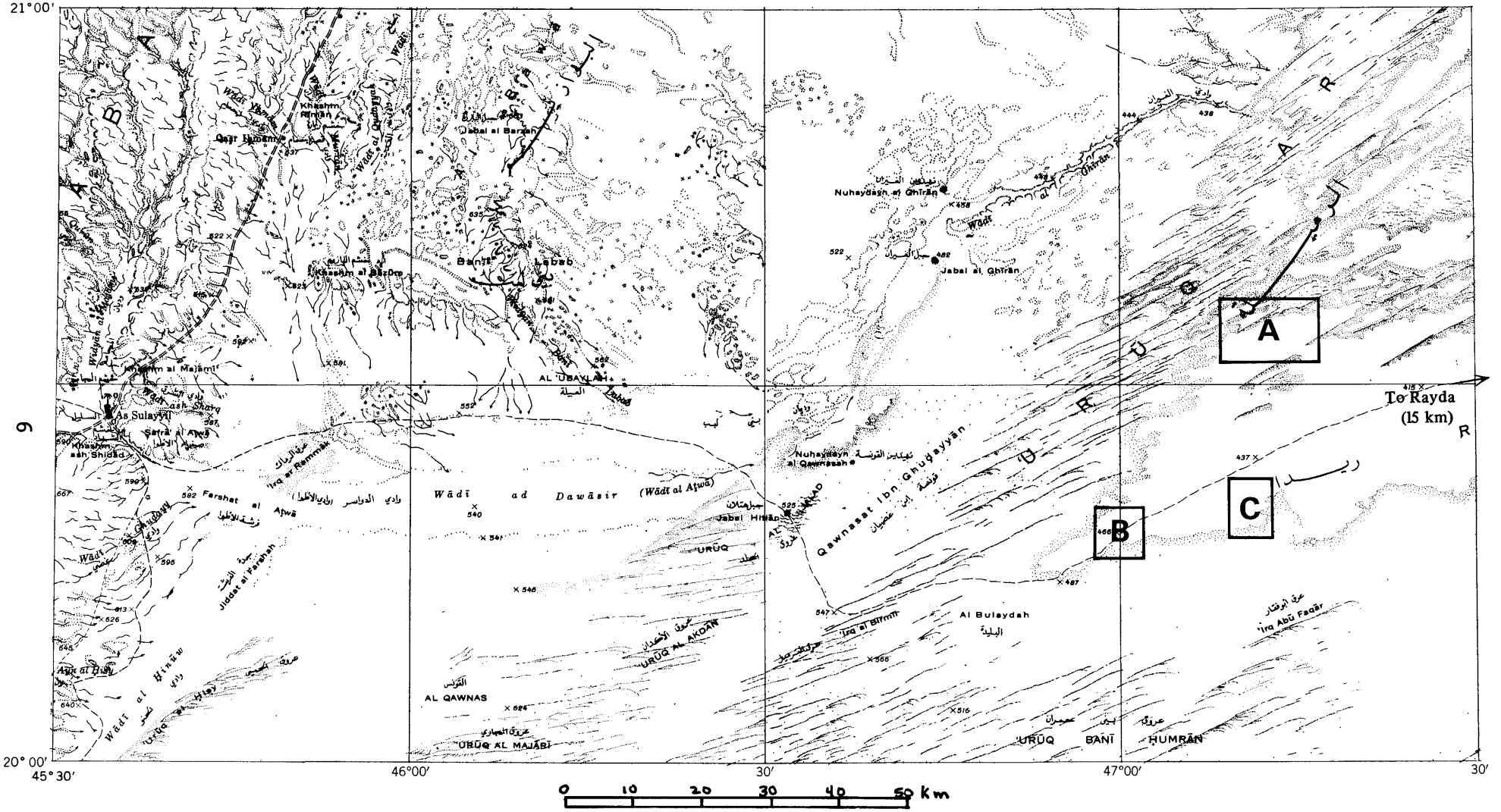

Figure 3.–Location map for the Rayda area. Labeled areas (A, B, C) indicate extensive gypsum beds.

No other evaporites of economic importance were found in the Rayda area. A minor amount of halite is locally disseminated in some of the clay and silt of the lake beds and in overlying gypsum (area A, fig. 3), but there is no indication of bedded halite.

CONCLUSIONS

Evaporites are primarily utilized as industrial raw materials. The cost of installing processing equipment for evaporites is high; therefore, a processing facility must produce large volumes of material at relatively low cost to make a profit. In most cases, a plant must be situated near the source of its raw material and close to transportation facilities. Because of the large capital investment required, the plant must also have enough raw material to continue operations for several years.

Neither the Rayda gypsum deposit nor the Sabkhah al Milh brine deposit merit a high priority for further investigation. The Rayda gypsum deposit has large reserves, but transportation is difficult, and other gypsum deposits are closer to centers of population.

The Sabkhah al Milh brine is fairly close to Ar Riyad, which might provide marketable outlets, and modern production methods can remove many of the impurities from the salt. However, the present methods of salt production cannot provide sufficient sodium chloride to meet industrial needs, and normally this type of brine deposit is not used for the industrial production of sodium chloride. Extensive studies, including drilling, would have to be undertaken before it could be determined if salt reserves are adequate to support the production of salt on an industrial scale. Salt can probably be produced on an industrial scale by solar evaporation of seawater brine on the coasts of Saudi Arabia and by the mining of salt deposits at Jizan, in the Farasan Islands, and in the Eastern Province of the Kingdom. Under these circumstances, further investigation of the potential for salt production in Sabkhah al Milh area seems unwarranted.

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