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SULFUR, FLUORSPAR, MAGNESITE, AND ALUMINOUS CHROMITE IN PAKISTAN

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SULFUR, FLUORSPAR, MAGNESITE, AND ALUMINOUS CHROMITE IN PAKISTAN

by

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CONTENTS

	Page
ABSTRACT	1
INTRODUCTION	3
Purpose and scope	3
SULFUR	4
Solfataric deposits	5
Koh-i-Sultan	5
Deposits associated with oil seeps and tar accumulations	7
Sanni deposit	7
Khattan deposit	9
Jacobabad deposit	9
Jaba deposit	9
Deposits associated with springs	10
Khan Berar deposits	10
Laki deposits	10
Muzhigram deposit	10
Pimpishka deposit	10
Deposits associated with gypsum	11
Chhappar deposit	11
Sangarh Pass deposit	11
Deposits in Kohat District	12
Deposits associated with pyrite	12
Domunda deposit	12
Deposits in Rawalpindi Division	13
Rampur	13

CONTENTS (Cont.)

SULFUR (Cont.) Page

Deposits of uncertain association 13

Gokurth deposit 13

Gandahari Hill deposit 14

Jiwani deposits 14

Karghari deposit 15

Ghizri Bunder deposit 15

FLUORSPAR DEPOSITS 16

Koh-i-Maran 16

Dobranzel deposit 18

Khojakzai Kalai deposit 18

Bichcha Khurd deposit 18

MAGNESITE DEPOSITS 19

Spin Kan deposit 19

Shabi Ghundi deposit 21

Tlerai Mohammed Jan deposit 22

Sra Salawat deposit 23

Zizha deposit 23

Sakhakot deposit 23

Karku deposit 24

Loya Na Pani deposit 24

Baran Lak deposit 24

Sinchi Bent deposit 25

ALUMINOUS CHROMITE 25

CONTENTS (Cont.)

	Page
RECOMMENDATIONS	25
REFERENCES	27
Sulfur	27
Fluorspar	30
Magnesite	31
Aluminous chromite	32

ILLUSTRATIONS

		Page
Figure 1.	Map of Pakistan, showing locations of sulfur, fluorspar, and magnesite deposits	In pocket
2.	Sketch map showing the location of sulfur deposits at Koh-i-Sultan	6a
3.	Diagrammatic sketch map and section of the Sanni sulfur deposit, Pakistan	8a
4.	Sketch map of the Koh-i-Maran fluorspar deposits, Pakistan	16a
5.	Geological sketch map of the Spin Kan magnesite deposit, Pakistan	20a
6.	Cross section of the Spin Kan magnesite deposit, Pakistan	20b
7.	Geological sketch map of the northern part of the Shabi Ghundi deposit, Pakistan	21a
8.	Cross section of the Shabi Ghundi deposit	21b

SULFUR, FLUORSPAR, MAGNESITE, AND ALUMINOUS CHROMITE DEPOSITS IN PAKISTAN

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ABSTRACT

Reports and analyses on elemental sulfur, fluorspar, magnesite, and aluminous chromite were reviewed for the purpose of identifying and categorizing the known deposits, and to indicate those which seem to merit further study on the basis of available information. General conclusions drawn from the study are: (1) Although aluminous chromite deposits exist, no minable deposits of refractory-grade material have been made found to date; (2) small but minable reserves of elemental sulfur, fluorspar, and magnesite are available; (3) detailed mapping, prospecting, and sampling are required to fully assess the ore reserves in known deposits, and (4) field examination of some of the other deposits described herein may call for additional exploration which may eliminate them from further consideration as minable deposits.

The sulfur deposits at Koh-i-Sultan volcano in the Chagai District of Quetta Division are the only assured source of elemental sulfur in Pakistan. Indicated reserves are 85,000 tons of less than 50 percent sulfur ore of solfataric origin. The deposits are currently being mined.

The old Sanni mine in the Kalat District of Kalat Division has been inactive for more than 80 years. Attempts in 1917 and 1941 to reopen the mine were unsuccessful. Reserve estimates range from 18,000 to 195,000 tons of ore containing less than 50 percent elemental sulfur.

Eighteen other sulfur deposits are identified, but available information indicates that they contain no minable ore reserves.

More than 25 fluorspar-calcite veins containing as much as 81 percent fluorspar crop out on the east side of Koh-i-Maran mountain in Kalat Division. Total tonnage estimate on 10 of the veins is 1,500 long tons of acid-grade fluorspar. Additional mapping and measurement of the veins will increase fluorspar reserves at Koh-i-Maran.

Available information on other fluorspar deposits in Pakistan suggests that they are too small or the fluorspar is too sparsely disseminated to constitute minable deposits.

The Spin Kan mine, in the Hindubagh chromite mining district of Quetta Division, is the only producer of magnesite in Pakistan. Estimated reserves are 14,000 tons of high-grade cryptocrystalline magnesite ore. Reserves of low-quality magnesite in the Shabi Ghundi deposit, near the Spin Kan mine, are estimated at 6,000 tons. The Sra Salawat deposit, also in the Hindubagh chromite mining district, is reported to contain 16,000 tons of magnesite. No assays of the magnesite at Sra Salawat are available; the material does not appear to be of high quality. The few available analyses from other magnesite deposits in Pakistan show high CaO and FeO content.

Assays of chromite reveal that no crude ore of aluminous refractory grade is present in Pakistan. One small deposit contains chromite minerals approaching aluminous refractory grade after clean separation of the serpentine gangue.

INTRODUCTION

Purpose and scope

This report was prepared as part of the cooperative Mineral Exploration and Development Program undertaken by the Geological Survey of Pakistan and the U. S. Geological Survey, under the sponsorship of the Government of Pakistan and the U. S. Agency for International Development, U. S. Department of State.

All available reports in the files of the Geological Survey of Pakistan and other Government agencies, as well as published reports on deposits of elemental sulfur, fluorspar, magnesite, and aluminous chromite, were reviewed and summarized for the purpose of accumulating pertinent information on the geology and ore reserve potential of those commodities. Although geologic maps adequate to locate and identify the deposits are available for some of the localities, maps in sufficient detail for determining mineral potential are not available, and only very brief descriptions exist for many of them. Descriptions of some deposits include an evaluation of the potential; in other descriptions, it is possible to deduce that there are no minable reserves.

Recommendations for mapping, prospecting, and measurement of ore bodies are made for the most promising deposits. All known mineral localities as of 1964 of sulfur, fluorspar, and magnesite are listed in this report. The author briefly visited the Koh-i-Maran fluorspar deposits in 1963, the Koh-i-Sultan sulfur deposits in 1964, and mapped the Spin Kan and Shabi Ghundi magnesite deposits in 1963 in conjunciton with a Geological Survey of Pakistan diamond-drilling program.

All deposits described in this report, except the Spin Kan magnesite deposit, are named after the nearest town, village, or locality. (Spin Kan is a descriptive name meaning "white mine" in Urdu). Persons desiring to visit these mineral localities may find the given geographic coordinates a guide to the nearest town. The precise location and mode of access to the deposits must be determined by local inquiry. Figure 1 shows the locations of sulfur, fluorspar, and magnesite deposits.

SULFUR

Many of the 20 elemental sulfur deposits described below yielded sulfur for local gun-powder manufacture during the 19th Century. Two of the deposits, the Koh-i-Sultan and the Sanni, merit geological mapping and prospecting. The Koh-i-Sultan is the only producing sulfur mine in Pakistan today; production from the Sanni mine was started prior to 1843 and continued until 1880 when the mine burned and caved.

The deposits are listed below according to their apparent genetic association with other minerals or with springs. The Koh-i-Sultan deposit is unique in its solfataric origin in the ash and tuff of the recently extinct Koh-i-Sultan volcano. Four sulfur deposits are associated with oil seeps or tar accumulations; four are associated with springs; three are associated with gypsiferous layers; three are associated with pyritic shale; and five are of uncertain genetic association. The classification is somewhat aribtrary in that the deposits associated with pyritic shale also occur near gypsiferous horizons.

All the deposits are probably of Holocene age. The Koh-i-Sultan deposits still emit hydrogen sulfide gas. Deposits associated with gypsum and pyrite apparently formed as a result of weathering of those minerals. No deep-seated deposits of elemental sulfur are known in Pakistan, although sulfur associated with oil seeps indicates that deep deposits may exist.

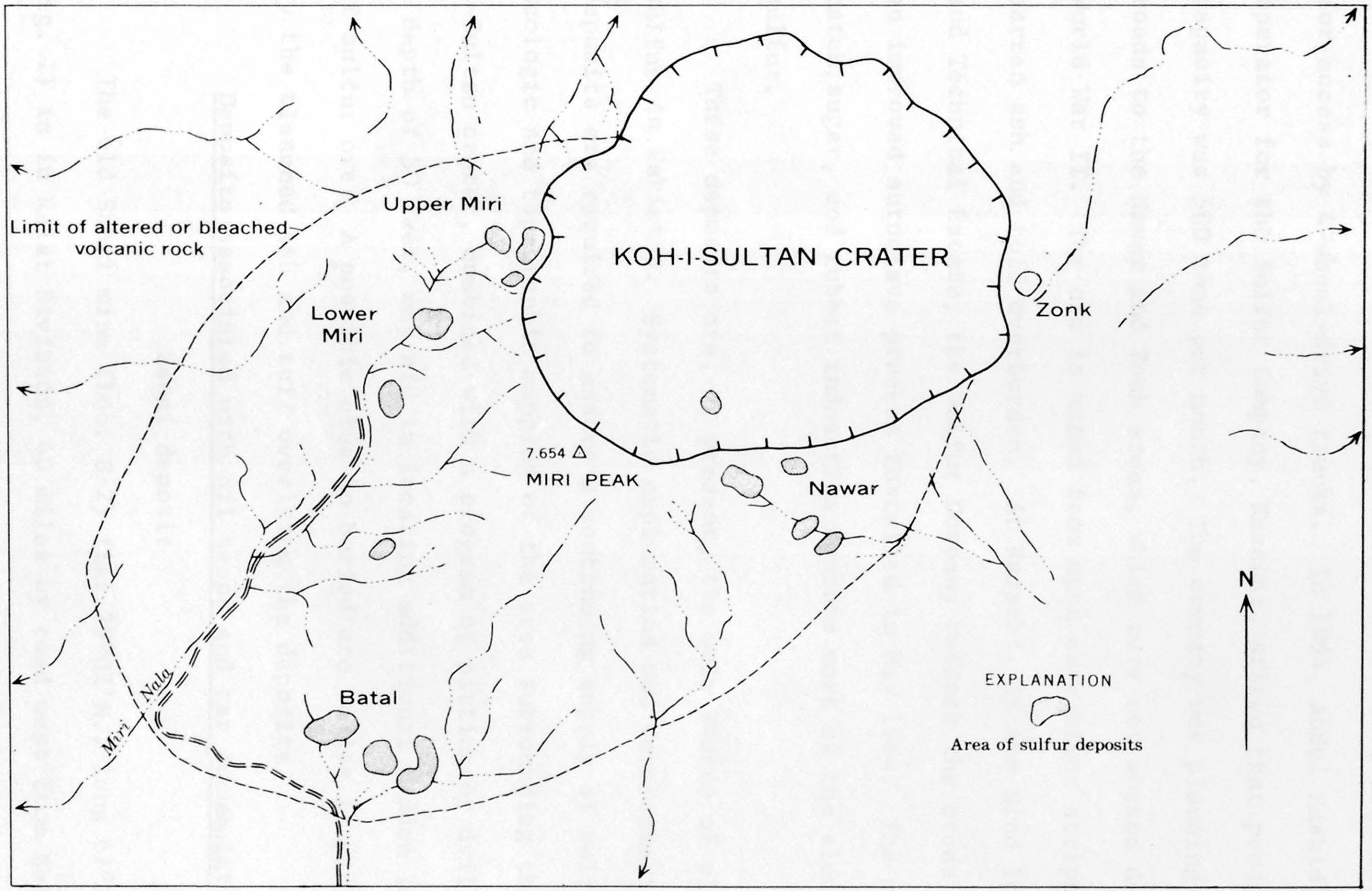
Solfataric deposits

Koh-i-Sultan

The Koh-i-Sultan (Loc. S-1) sulfur deposits (lat 29°07'N., long 62°47'E., fig. 1) are in the arid Chagai District of Quetta Division. They are accessible 25 miles by road northeast from Nok Kundi, a rail station and customs post on the highway through Pakistan to Iran.

Approximately 40 lenslike impregnations and vug fillings of sulfur in tuff and ash are clustered on the steep and deeply dissected southern slopes of the recently extinct Koh-i-Sultan volcano. The deposits are grouped into four areas named the Batal, Miri, Nawar, and Zonk (fig. 2), and all lie within an area of about 7 square miles. The sulfur ore bodies form impregnations containing as much as 60 percent sulfur in the tuffs. They vary considerably in size, averaging about 20,000 cubic feet. Red and yellow argillitic layers underlie the sulfur, and bleached white altered tuff and ash lie above it. Quartz, gypsum, and alum are associated with the sulfur. Hydrogen sulfide gas still emanates from some of the deposits and has deterred attempts at underground mining.

During World War II, the Geological Survey of India (G.S.I.) worked the deposits under the supervision of E. R. Gee. The geology of the mine area has been described by M. I. Ahmad (1944). When mining ceased in 1945, 51,700 tons of high-grade ore (containing more than 50 percent sulfur) and 14,000 tons of low-grade ore (containing between 25 and 50 percent sulfur) had been mined from the Batal and the Miri deposits (Gee, 1946). A stock pile of 10,000 tons of high-grade ore was left at the Nok Kundi rail station. Gee (1946) lists remaining reserves at 47,000 tons of high-grade ore in the Miri and Nawar deposits and 38,000 tons of low-grade ore in the Batal, Miri, and Nawar deposits. The Zonk deposits had not been prospected.



After Hunting Survey Corporation
(1960, figure 324)

1 0 1 MILE

Figure 2.—Sketch map showing the location of sulfur deposits at Koh-i Sultan, Pakistan.

In 1961, the road from Nok Kundi to the Miri area was rebuilt for access by 4-wheel-drive trucks. In 1964, Abdul Rashid, mine operator for the Sulfur Company, Karachi, stated that production capacity was 500 tons per month. The company was planning access roads to the Nawar and Zonk areas, which were not worked during World War II. The ore is mined from open cuts after stripping barren ash and tuff overburden. At Karachi, in the Sind Industrial and Technical Estate, the Sulfur Company refines the crude ore in an improved autoclave process installed in May 1964. The munitions, match, sugar, and rubber industries consume most of the elemental sulfur.

These deposits are, at present, the only source of elemental sulfur in Pakistan. Systematic exploration and development of the deposits are required to assure a continuing supply of sulfur. Geologic and topographic mapping of the area surrounding the Koh-i-Sultan crater, combined with a program of pitting or drilling to a depth of 50 feet, may aid in locating additional hidden lenses of sulfur ore. A possible clue to buried ore bodies is provided by the bleached ash and tuff overlying the deposits.

<u>Deposits associated with oil seeps and tar accumulations</u>

Sanni deposit

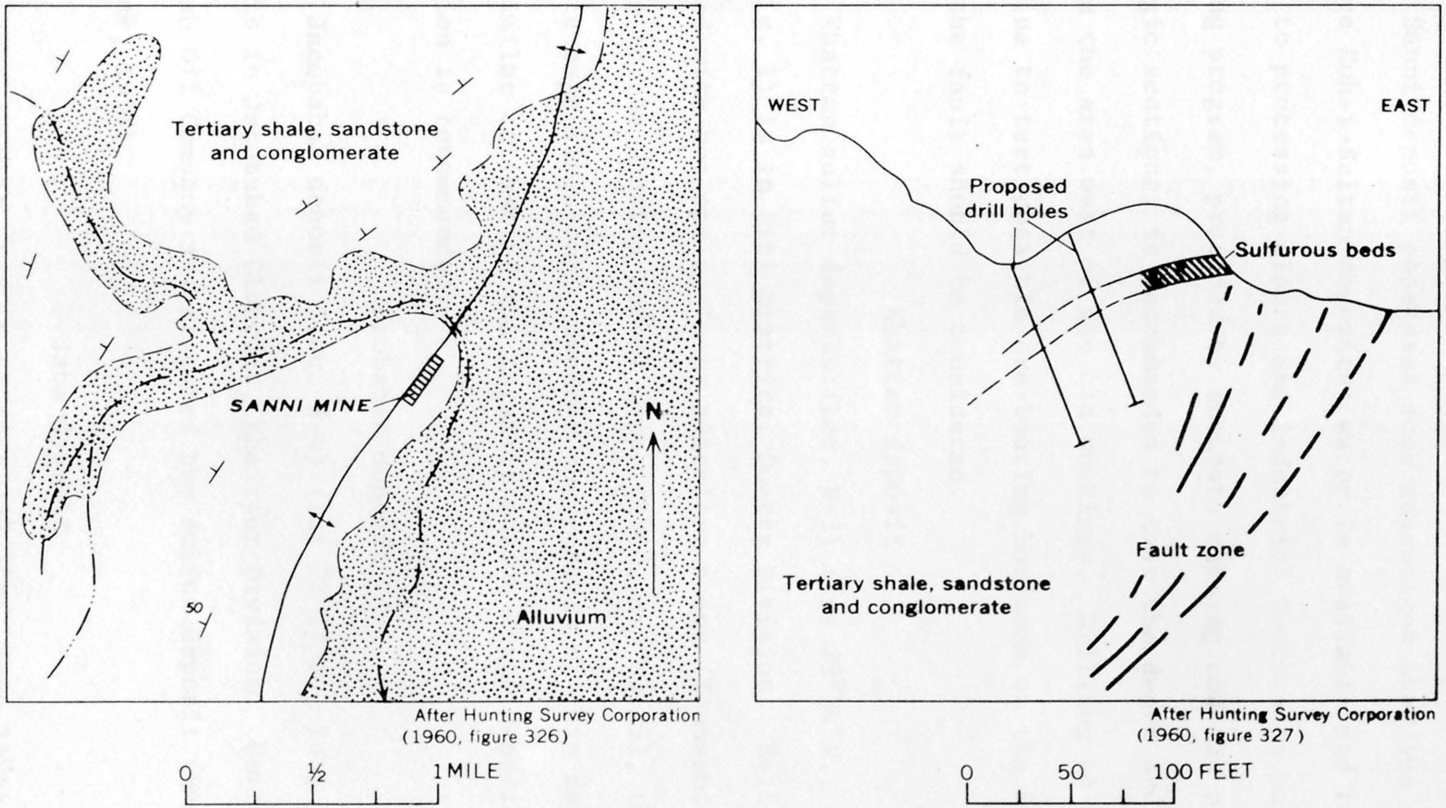
The old Sanni mine (Loc. S-2) (lat 29°02'N., long 67°27'E., fig. 1) is in Kalat Division, 40 miles by road west from Belpat rail station.

The sulfur is interbedded with west-dipping Tertiary shale and sandstone (fig. 3) which form the west limb of an anticline. East of the mine, a north-striking fault zone parallels the anticlinal axis (fig. 3). Sandstone beds east of the fault moved down relative to those on the west side. Tar or "maltha" (Cotter, 1919) lies below the sulfur in the lower part of the old mine workings.

Mining was carried on prior to 1843 until 1880, when the mine caught fire and collapsed. Cotter (1919) succeeded in reopening part of the mine and found a large stope and the tar mentioned above. During World War II, the shortage of sulfur required for munitions prompted an effort by the G.S.I. (Sulfur Operations) to reopen the mine. Seven adits were started, but the effort was abandoned in 1942 because of poor ventilation and caving.

Estimates of the thickness and extent of ore remaining vary widely. Cotter (1919) estimated that the ore bed was 11 feet thick and 170,000 square feet in area. He calculated reserves of 36,000 tons, allowing 25 percent mining loss. Krishnaswamy (1941) reported three ore beds totaling 20 feet in thickness. He estimated the size of the ore body at 1,525 by 150 feet and calculated 195,274 long tons of 45 percent sulfur ore. The most recent estimate is 18,000 tons in an ore body 200 feet wide by 10 feet thick (Hunting Survey Corp., 1960).

Little information is available regarding the extent of old workings and the continuation of the ore beds. Eight diamond drill holes were drilled by G.S.I. in 1943 (Lawton, 1943), but only two reached sulfur-bearing horizons. The locations and depths of the holes are not specified in the reports available.



After Hunting Survey Corporation (1960, figure 326)

After Hunting Survey Corporation (1960, figure 327)

Figure 3.—Diagrammatic sketch map and section of the Sanni sulfur deposits, Pakistan. Proposed locations of drill holes are shown on the section.

The Sanni deposit possesses some advantages over the currently productive Koh-i-Sultan deposits; water is available and the haulage distance to processing plants and industrial centers is much less. A drilling program, preceded by accurate mapping and the preparation of geologic sections, is recommended to test the depth and extent of ore in the area west of the old workings. Drilling to the east of the mine to test possible ore-bearing horizons on the downthrown side of the fault should be considered.

Khattan deposit

The Khattan sulfur deposit (Loc. S-3) (lat 29°34'N., long 68° 31'E., fig. 1) is in Sibi District, Quetta Division. Sulfur is associated with hot springs near petroleum seeps (Townsend, 1886). According to the Hunting Survey Corp. (1960, map no 25), the deposit is in Paleocene limestone. Because the genesis of this deposit may be similar to that of the formerly active Sanni deposit, a field examination is recommended.

Jacobabad deposit

The Jacobabad deposit (Loc. S-4) (lat 28°17'N., long 68°28'E., fig. 1) is in Jacobabad District, Khairpur Division. Geologists of the Burmah Oil Company investigated the sulfur deposit (Heron and Crookshank, 1954).

Jaba deposit

The Jaba deposit (Loc. S-5) (lat 32°52'N., long 71°44'E., fig. 1) is in Mianwali District, Sargodha Division. Small quantities of sulfur, associated with gypsum near oil seeps, occur along a linear distance of 2 miles (Bowring, 1850; Fleming, 1852; and La Touche, 1918).

Deposits associated with springs

Khan Berar deposits

Sulfur deposits are reported near Khan Berar (Loc. S-6) (lat 25° 29'N., long 66°03'E., fig. 1), Las Bela District, Karachi Division, at the southern end of the Haro Range, about 3 miles from the seacoast near the Pohr River. Sulfur and salt, associated with saline springs, are found in rocks of Miocene and Pliocene age. The minerals are pure and well crystallized, but the amount is said to be too small to be of economic value (Vredenburg, 1909).

Laki deposits

The Laki sulfur deposits (Loc. S-7) (lat 26°16'N., long 67° 57'E., fig. 1) is in Dadu District, Hyderabad Division. Vicary (1847) mentions that sulfur was collected from the vicinity of a hot spring near the town of Laki.

Muzhigram deposit

This sulfur deposit (Loc. S-8) in Chitral State (lat 36°06'N., long 71°37'E., fig. 1) is associated with a sulfurous spring located near the village of Muzhigram, about 20 miles north of the town of Chitral. The sulfur is used by local inhabitants for the manufacture of gunpowder (U. S. Bureau of Mines, 1957).

Pimpishka deposit

The Pimpishka sulfur deposit (Loc. S-9) (lat 26°45'N., long 63°43'E., fig. 1), Makran District, Kalat Division, is on the north side of a salt playa, about 30 miles southwest of Panjgar, and about 3 miles southwest of a small peak named Pimpishka. Oligocene sandstone has been intensely leached in an area of 50 square feet, leaving quartz grains in a matrix of sulfur and gypsum. Sulfur comprises less than 20 percent of the rock and also fills fractures in the rocks at a nearby spring. Hunting Survey Corp. (1960) states that the origin of the Pimpishka deposit is similar to that of the Sanni deposits. In this report, the Pimpishka deposit is grouped with deposits associated with springs. Although gypsum is present at Pimpishka, it is not in the form of a gypsiferous bed with which sulfur is associated elsewhere in Pakistan. Moreover, the absence of any known petroleum or tar in this area suggests an origin unlike that of the Sanni deposit.

Deposits associated with gypsum

Chhappar deposit

The Chhappar sulfur deposit (Loc. S-10) (lat 29°06'N., long 66°21'E., fig. 1), Kalat District, Kalat Division, is about 15 miles west-northwest of Kalat near Manguchar. Gee (1941) describes small quantities of sulfur, associated with gypsum, filling fractures in a 6-foot-thick bed of Eocene nummulitic limestone. The deposit had been prospected by trenches dug by local inhabitants.

Sangarh Pass deposit

The Sangarh Pass deposit (Loc. S-11) (lat 30°42'N., long 70° 32'E., fig. 1), Dera Ghazi Khan District, Multan Division, is described by Ball (1874), and by Blanford (1883). Blanford named the deposit after Sangarh Pass and believed it to be the same as that described by Ball. Both men reported that sulfur was produced from stringers and veins in amorphous gypsum contained in rocks of Eocene age.

Deposits in Kohat District

Sulfur in the Kohat District (Loc. S-12) (fig. 1), Peshawar Division, has been mined on a small scale near Panoba (lat 33° 37'N., long 71°59'E.), Jatta (lat 33°19'N., long 71°17'E.), and Dandi (lat 33°36'N., long 71°59'E.). The sulfur apparently formed as an oxidation product of pyrite contained in highly carbonaceous shales (Lyman, 1870, and Wynne, 1875). C. R. Meissner, U. S. Geological Survey, (written commun., 1963) reports that the amount of sulfur is very small, and that it perhaps formed through the weathering of gypsum.

The Kushalgar and Gunjali sulfur deposits (lat 33°27'N., long 71°53'E.) are in the same general area as Panoba. The sulfur was extracted from pyritic shale below a limestone scarp on the west bank of the Indus River (La Touche, 1918; and Wynne, 1875); gypsum beds underlie the shale. According to Meissner, (written commun., 1963), no sulfur is visible there now.

Deposits associated with pyrite

Domunda deposit

The Domunda sulfur deposit (Loc. S-13) (lat 31°36'N., long 70° 14'E., fig. 1) Dera Ismail Khan District, Dera Ismail Khan Division, is found in nummulitic limestone of Paleocene age where sulfur apparently formed through the decomposition of pyrite.

Deposits in Rawalpindi Division

Vicary (1847) reported that sulfur mines had been worked in the hills (Loc. S-14) east of Margala Pass (lat 33°42'N., long 72°53'E., fig. 1), Rawalpindi District, Rawalpindi Division. Some pyritic shale is found in this area.

Lyman (1870) reported the production of sulfur at Luni-ki-Kassi (lat 33°36'N., long 72°01'E.), Campbellpore District, from carbonaceous pyrite-bearing shale.

Rampur

Chalcopyrite and pyrite are reported by S. T. Ali, Geological Survey of Pakistan (written commun., 1962) in a quartz vein 250 feet long and 25 feet wide, between Rampur (Loc. S-15) and Ziapur in Azad Kashmir (lat 35°14'N., long 74°46'E., fig. 1). The vein cuts shale and phyllite of unknown age. The quantity of pyrite has not been determined; a field examination is recommended to ascertain the sulfur and base-metal potential. Elemental sulfur has not been reported in this deposit.

Deposits of uncertain association

Gokurth deposit

Tipper (1909) reported that sulfur deposits were found at Gokurth (Loc. S-16) (lat 29°33'N., long 67°28'E., fig. 1), Kalat District, Kalat Division, in the Bolan Pass, in massive limestone of Late Cretaceous age. The Hunting Survey Corp. (1960, map no. 24) considered the deposits to be in limestone of Eocene age. The outcrops are reported to be partly obscured by sinter deposits.

Gandahari Hill deposit

The Gandahari Hill (Loc. S-17) sulfur deposit, Sibi District, Quetta Division, (lat 29°06'N., long 69°46'E., fig. 1) is in white beds of Eocene age on the south side of Gandahari Hill (Blanford, 1883). Eocene limestone in the general area may be the formation mentioned by Blanford. The origin of this deposit is unknown; hot springs are in the general vicinity. The deposit is in the same stratigraphic sequence as the Gokurth deposit to the east.

Jiwani deposits

The Jiwani sulfur deposits (Loc. S-18) (lat 25°05'N., long 61°47'E., fig. 1) are 12 miles N. 40°W. from the coastal town of Jiwani on the Arabian Sea. These deposits are described by M. I. Ahmad (1962) as forming in a discontinuous dark-gray clay layer 9 inches thick near an active mud volcano (several mud volcanos are found along the coast). The layer containing the sulfur is within a few feet of the surface, and some crystals of pure yellow sulfur are contained in the overlying alluvial sand. The sand is cemented by gypsum, limonite, and sulfur (Hunting Survey Corp., 1960). Analyses of the sulfur content range from 43 to 56 percent. The deposit measures only a few hundred square feet in area and, according to M. I. Ahmad, the deposit and reserves are small. Another small area containing sulfur deposits is about 1.5 miles southeast of the mud volcano.

M. I. Ahmad (1962) commented that only a very small amount of exploratory work has been done. He suggests that further exploration by pitting or hand-auger holes located on 100-foot centers may find more deposits within the general area.

Half a mile west of Ganz, a fishing village about 9 miles east of Jiwani, is another small sulfur deposit similar in mode of occurrence to the other deposits at Jiwani (Hunting Survey Corp., 1960). Numerous gypsum veins cut marly mudstone of Pliocene age. Sulfur associated with gypsum is found at two places several hundred feet apart; each deposit is no more than 12 square yards in area. Samples containing as much as 40 percent sulfur have been collected, but the total amount of sulfur is reported to be negligible.

Karghari deposit

The Karghari sulfur deposit (Loc. S-19) (lat 25°27'N., long 64°09'E., fig. 1) Las Bela District, Karachi Division, is near Golkurt. Sulfur in significant quantities was reported to be procurable in 1861, according to Goldsmid (1863), as reported by Heron and Crookshank (1954).

Ghizri Bunder deposit

The Ghizri Bunder deposit (Loc. S-20) is in Karachi District, Karchi Division. According to Preedy (1843), quoted by Heron and Crookshank (1954), extensive deposits containing 30 percent sulfur were found there (lat 24°48'N., long 67°08'E., fig. 1). No recent, verified reference to these deposits has been found.

FLUORSPAR DEPOSITS

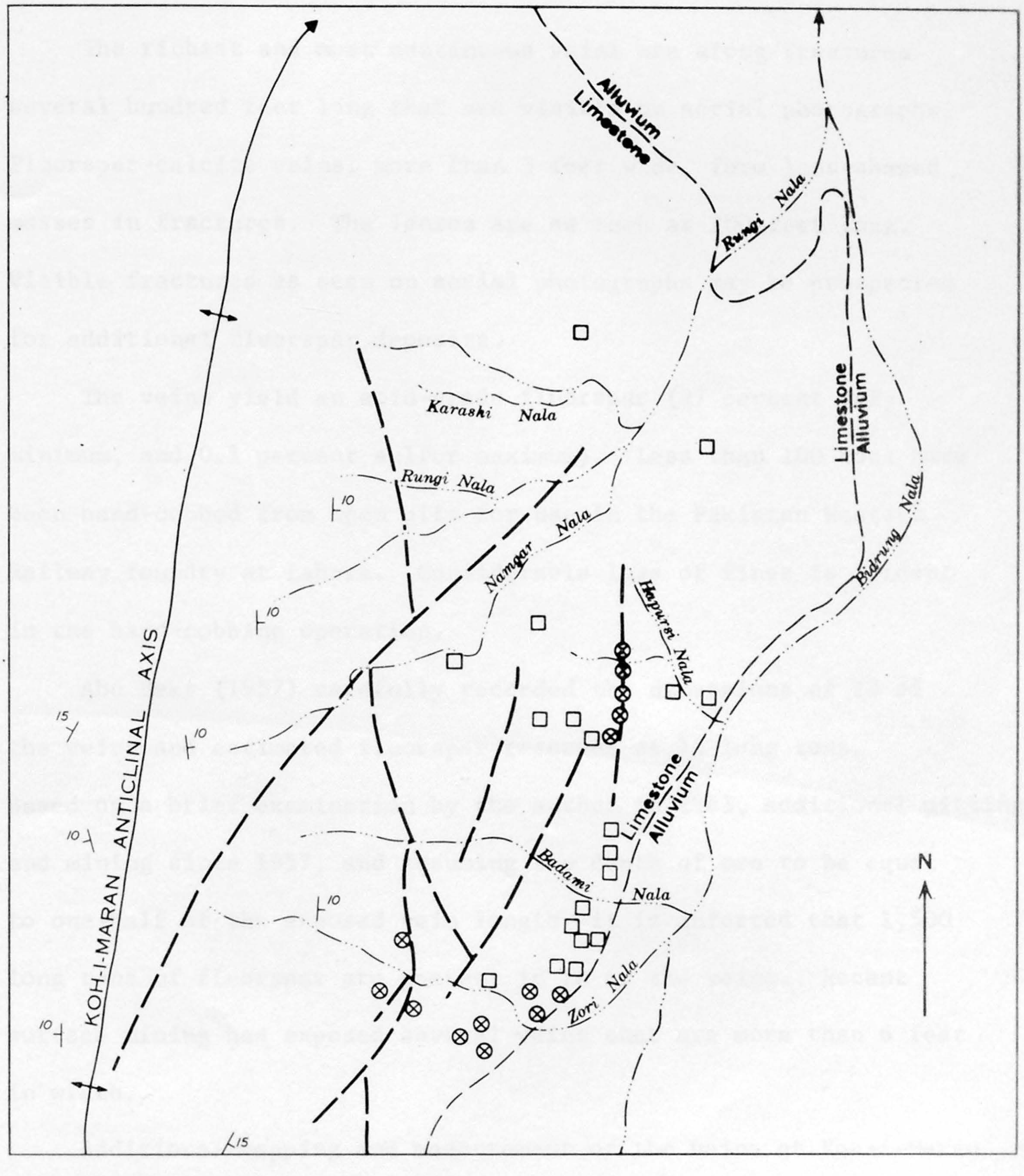
Of the four fluorspar-bearing areas described in West Pakistan, only the Koh-i-Maran deposits have been mined and have potential for future production of acid-grade fluorspar. The other three deposits are too small, or the fluorspar is too sparsely disseminated to be considered as minable.

Mining World (1959) lists fluorspar deposits in the Mirgasht and Yarkhan areas of Chitral, and in Gilgit, Hunza, and South Waziristan (fig. 1). No information on the exact location, form, or grade of these deposits is available.

Koh-i-Maran deposit

The Koh-i-Maran fluorspar deposits (Loc. F-1), Kalat District, Kalat Division (lat 29°35'N., long 66°30'E., fig. 1) are 40 miles by road south from Kolpur rail station.

More than 25 fluorspar-calcite veins in Jurassic limestone crop out within an area of 4 square miles. The deposits lie on the east slope of Koh-i-Maran mountain, the crest of which approximates the axial trace of a major north-striking anticlinal fold (fig. 4). The veins range from a few inches to more than 6 feet in width and formed as hydrothermal open-space fillings and replacements in the limestone. A few fragments of limestone wallrock are included in the vein. Most of the fluorspar is milky white; some crystals contain tiny inclusions of amber-colored oily liquid. Three channel samples, analyzed by heavy-liquid separation of the fluorspar, show 24 to 81 percent fluorspar. No sulfide minerals are present.



EXPLANATION

□ Deposits from map by Abu Bakr (1957)

⊗ Deposits shown by A. Ali and deposits mined prior to 1963

Fracture, visible on aerial photographs

Strike and dip of beds

Figure 4.—Sketch map of the Koh-i-Maran fluorspar deposits, Pakistan.

The richest and most continuous veins are along fractures several hundred feet long that are visible on aerial photographs. Fluorspar-calcite veins, more than 3 feet wide, form lens-shaped masses in fractures. The lenses are as much as 200 feet long. Visible fractures as seen on aerial photographs may be prospected for additional fluorspar deposits.

The veins yield an acid-grade fluorspar (97 percent CaF_2 minimum, and 0.1 percent sulfur maximum). Less than 100 tons have been hand-cobbed from open pits for use in the Pakistan Western Railway foundry at Lahore. Considerable loss of fines is evident in the hand-cobbing operation.

Abu Bakr (1957) carefully recorded the dimensions of 23 of the veins and estimated fluorspar reserves at 72 long tons. Based on a brief examination by the author in 1963, additional pitting and mining since 1957, and assuming the depth of ore to be equal to one-half of the exposed vein length, it is inferred that 1,500 long tons of fluorspar are present in 10 of the veins. Recent surface mining has exposed several veins that are more than 6 feet in width.

Additional mapping and measurement of the veins at Koh-i-Maran are recommended for more complete evaluation of the ore potential in this district. If more extensive utilization of fluorspar in the metallurgical, ceramic, and chemical industries of Pakistan is foreseen, then underground mining methods and a small beneficiation plant are recommended for efficient utilization of these deposits.

Dobranzel deposit

The Dobranzel deposit (Loc. F-2) (fig. 1) is 13 miles by road south-southeast of Isplinji village and near Dobranzel Nala. The deposit is about 9 miles east of the Koh-i-Maran area. Purple-zoned fluorspar crystals are found in the soil overlying Jurassic limestone. Small veins of calcite fluorspar are nearby. No prospecting has been done in this area; a field examination is recommended to determine the extent of the fluorspar deposit.

Khojakzai Kalai deposit

Fluorspar has been reported north of Fort Sandeman, Zhob District, Quetta Division. Crookshank (Heron and Crookshank, 1954) noted deposits near Brunj Kili at a place called Khojakzai Kalai (Loc. F-3) (lat 31°33'N., long 69°31'E., fig. 1). Calcite veins reported to contain 5 percent fluorite are in a belt several miles wide; the veins range in length from 10 to 150 feet, and in width from 2 to 18 inches.

Efforts to locate these deposits by the Hunting Survey Corp. (1960, p. 440) were unsuccessful. Re-examination of the area is recommended to determine the existence and the extent of the fluorspar veins.

Bichcha Khurd deposit

Fluorspar has been reported by M. I. Ahmad (1954) at Bichcha Khurd (Loc. F-4) (lat 34°11'N., long 73°03'E., fig. 1) 3 miles southwest of Sherwan. This area is in the Hazara District of Peshawar Division.

Schists of possible Precambrian age and overlying Paleozoic limestone are cut by silicic dikes in which fluorspar is reported to be disseminated. The fluorspar content is not known; this prospect seems to have little promise.

MAGNESITE DEPOSITS

Ten magnesite deposits have been found in serpentinized ultramafic rock in Pakistan. The Spin Kan deposit, in the Hindubagh chromite mining district, contains an indicated 14,000 tons of high-quality magnesite ore. A few tons of ore have been mined from this deposit. The Shabi Ghundi deposit, near the Spin Kan deposit, may contain as much as 6,000 tons of low-quality ore. The Sra Salawat deposit has been described as containing 16,000 tons of crystalline magnesite (van Vloten, 1963); assays of the ore are not available. Assays of samples from other deposits in Pakistan indicate ferruginous dolomitic material rather than magnesite.

A sampling program is recommended to test the quality of magnesite at Sra Salawat.

Spin Kan deposit

The Spin Kan magnesite deposit (Loc. Mg1) (lat 30°47'N., long 68°06'E., fig. 1) as in the Zhob District of Quetta Division, 3 miles east of the Nasai railway station.

The deposit lies on the northern edge of a large, chromite-bearing serpentinized ultramafic complex and forms a steeply dipping, lenslike mass that is 240 feet long and has an average width of 15 feet. Two feet of high-grade magnesite was present in a drill core at a depth of 100 feet below the outcrop (hole Mag C, figs. 5 and 6). Serpentined dunite, containing sparsely disseminated grains of chromite, encloses the magnesite. A steeply south-dipping fault, exhibiting horizontal slickensides, bounds the ore body on the south. The fault branches at the western end of the deposit and the northern branch limits the western extension of the ore. To the east, the magnesite narrows to a width of 8 feet in the face of the mine pit and pinches out beneath a talus cover of serpentine and dolerite. The ore is pure white, fine-grained, massive, cryptocrystalline material that exhibits conchoidal fracture. The average of 12 assays of samples taken by Bari and Haque (1962) is as follows (in percent):

MgO	SiO_2	CaO	FeO_3	Ignition loss
43.38	0.38	1.72	1.04	51.15

The assays and the physical appearance of the ore indicate a deposit of exceptionally high purity. Testing by the Norris Metallurgy Research Laboratory, 1962, shows that the magnesite converts to 95 percent periclase (MgO) after firing at 1600° to 1640° C. Cones made from the dead burned magnesite and fired to P.C.E. cone 40 (1,885°C) showed no sign of softening.

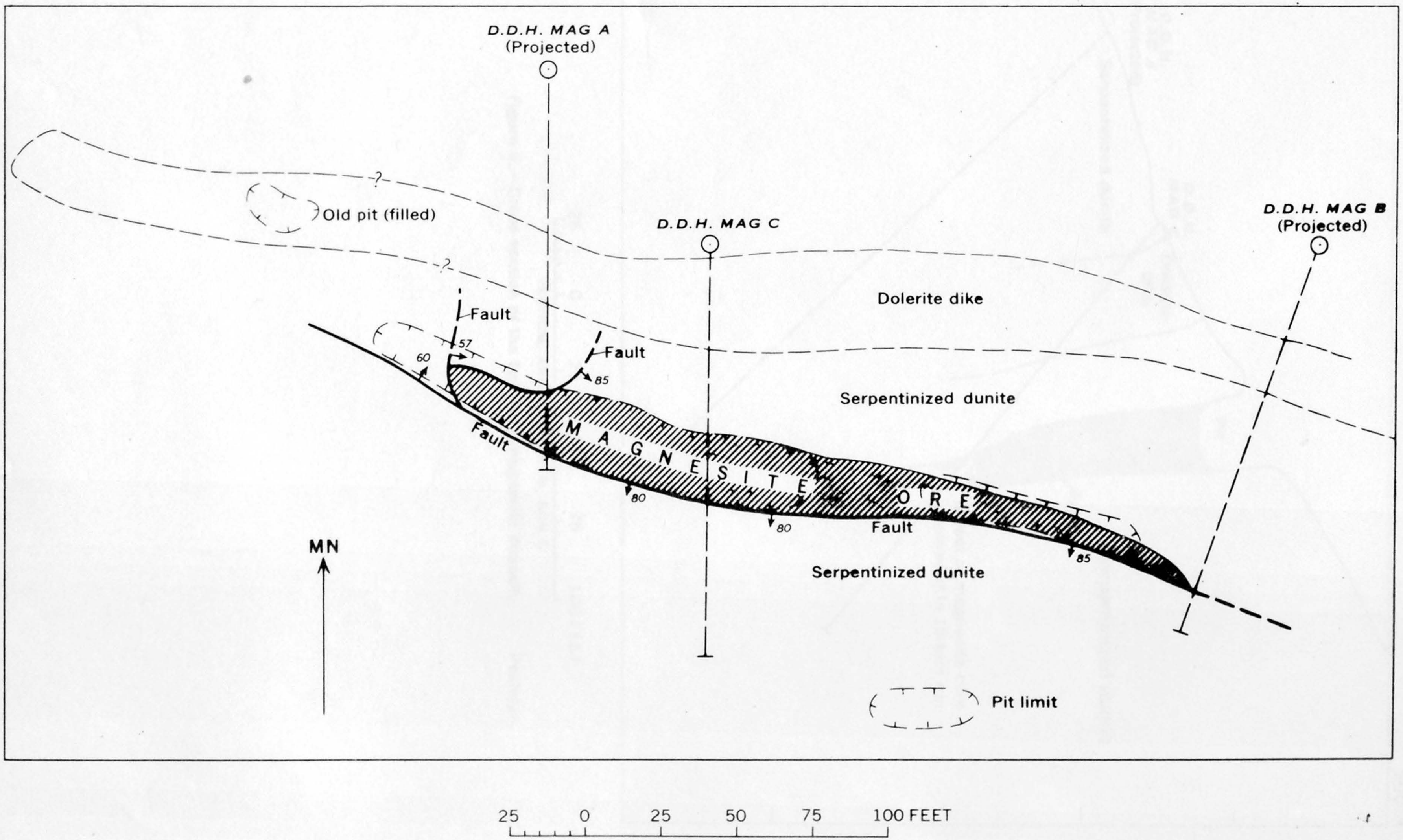


Figure 5.—Geological sketch map of the Spin Kan magnesite deposit, Pakistan.

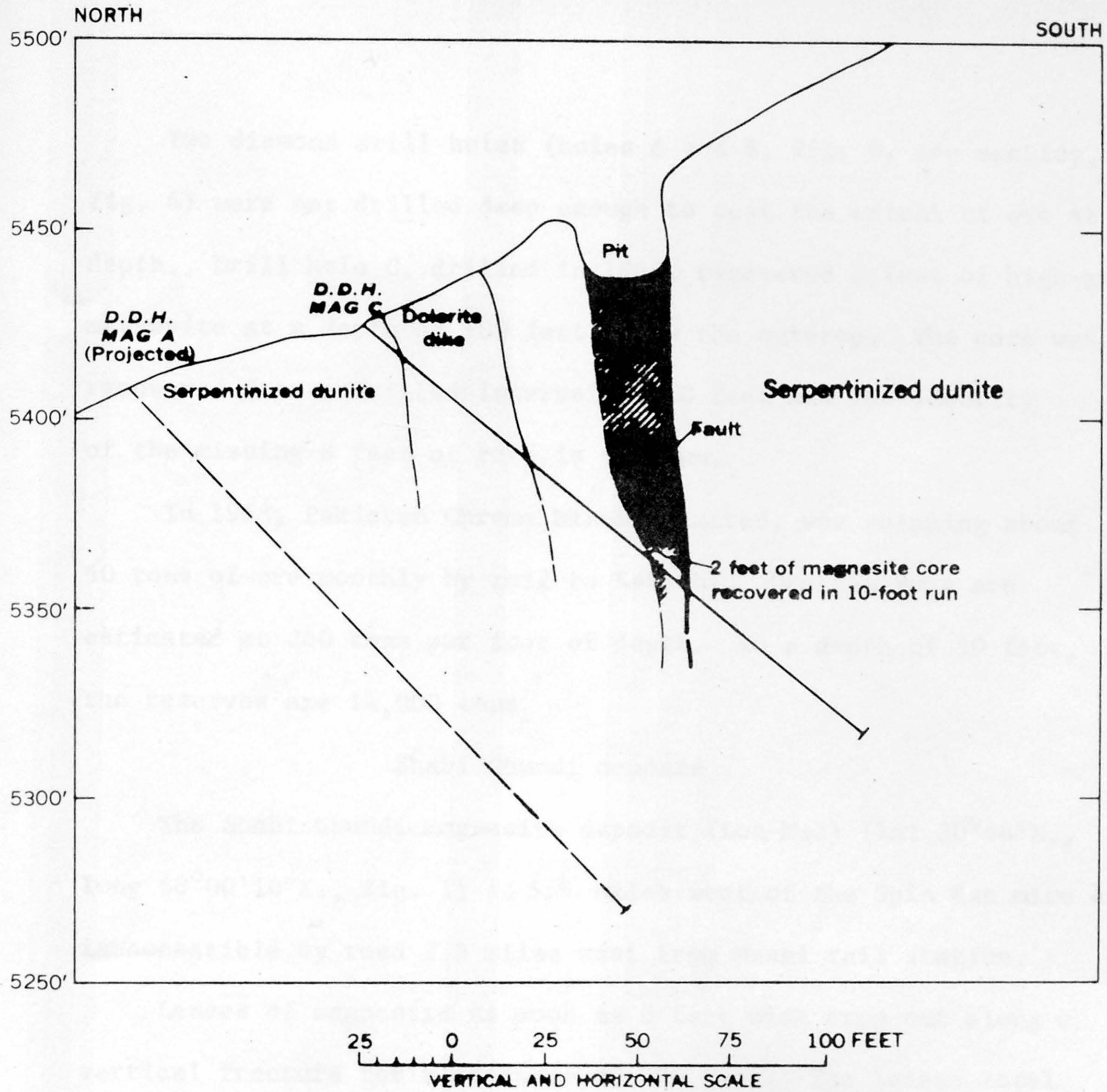


Figure 6.—Cross section of the Spin Kan magnesite deposit, Pakistan.

Two diamond drill holes (holes A and B, fig. 6, see section, fig. 6) were not drilled deep enough to test the extent of ore at depth. Drill hole C, drilled in 1963, recovered 2 feet of high-grade magnesite at a depth of 100 feet below the outcrop. The core was recovered from a drilled interval of 10 feet and the identity of the missing 8 feet of core is unknown.

In 1963, Pakistan Chrome Mines, Limited, was shipping about 50 tons of ore monthly by rail to Karachi. Ore reserves are estimated at 280 tons per foot of depth. To a depth of 50 feet, the reserves are 14,000 tons.

Shabi Ghundi deposit

The Shabi Ghundi magnesite deposit (Loc. Mg2) (lat 30°48'N., long 68°00'10"E., fig. 1) is 5.5 miles west of the Spin Kan mine and is accessible by road 2.5 miles west from Nasai rail station.

Lenses of magnesite as much as 8 feet wide crop out along a vertical fracture for a distance of 820 feet. The lenses total 147 feet in length; individual lenses are separated by barren zones along the fracture. Two of the larger magnesite lenses at the northern end of the fracture are 45 and 30 feet long and are each about 8 feet wide (fig. 7). To the south, the lenses are less than 4 feet wide. A small patch of impure magnesite (23.47 percent MgO) lies along the northern projection of the fracture. Because of its isolated position several hundred feet north of the main magnesite area and its low grade, it is not shown on figure 8.

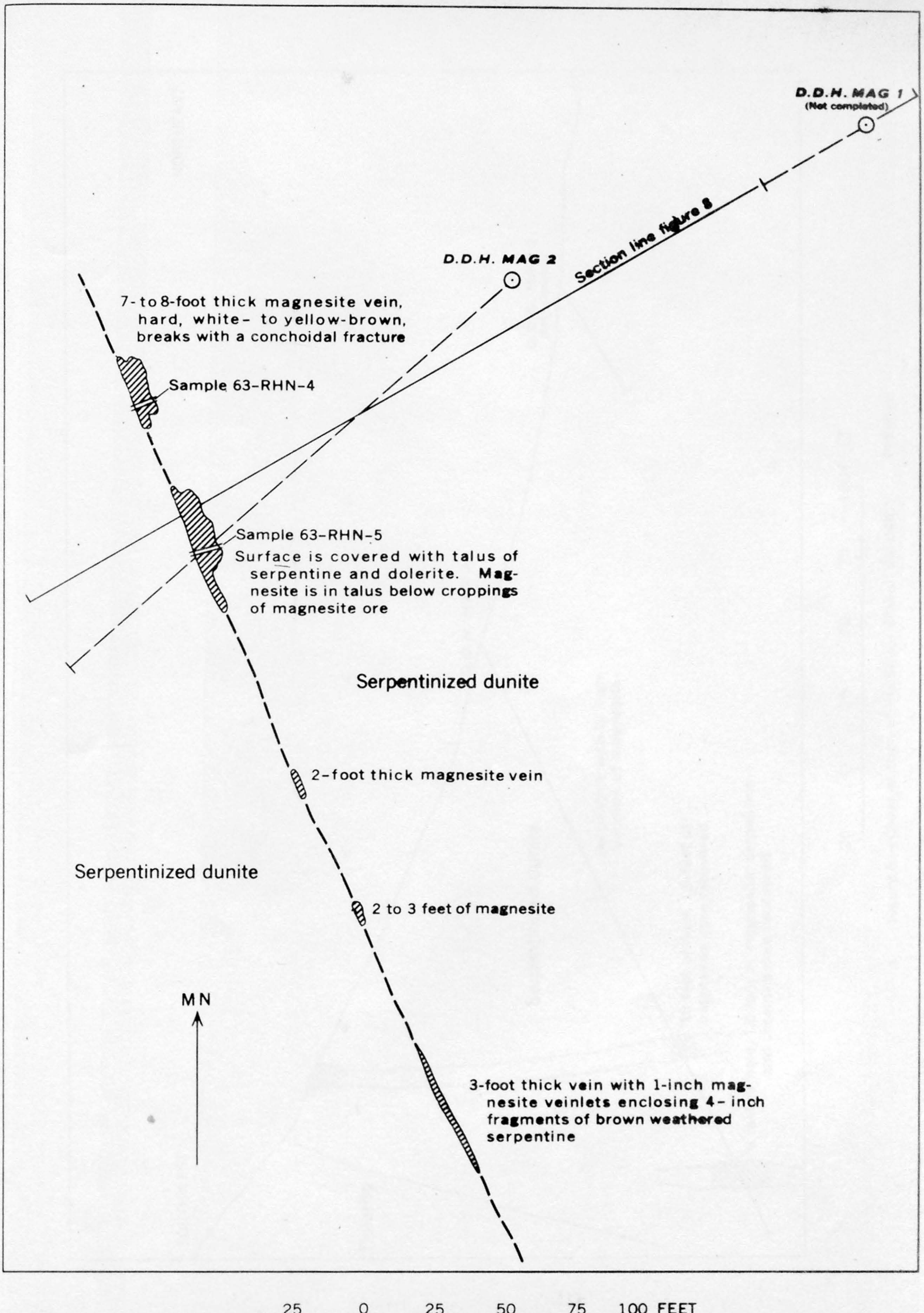


Figure 7.—Geological sketch map of the northern part of the Shabi Ghundi deposit, Pakistan.

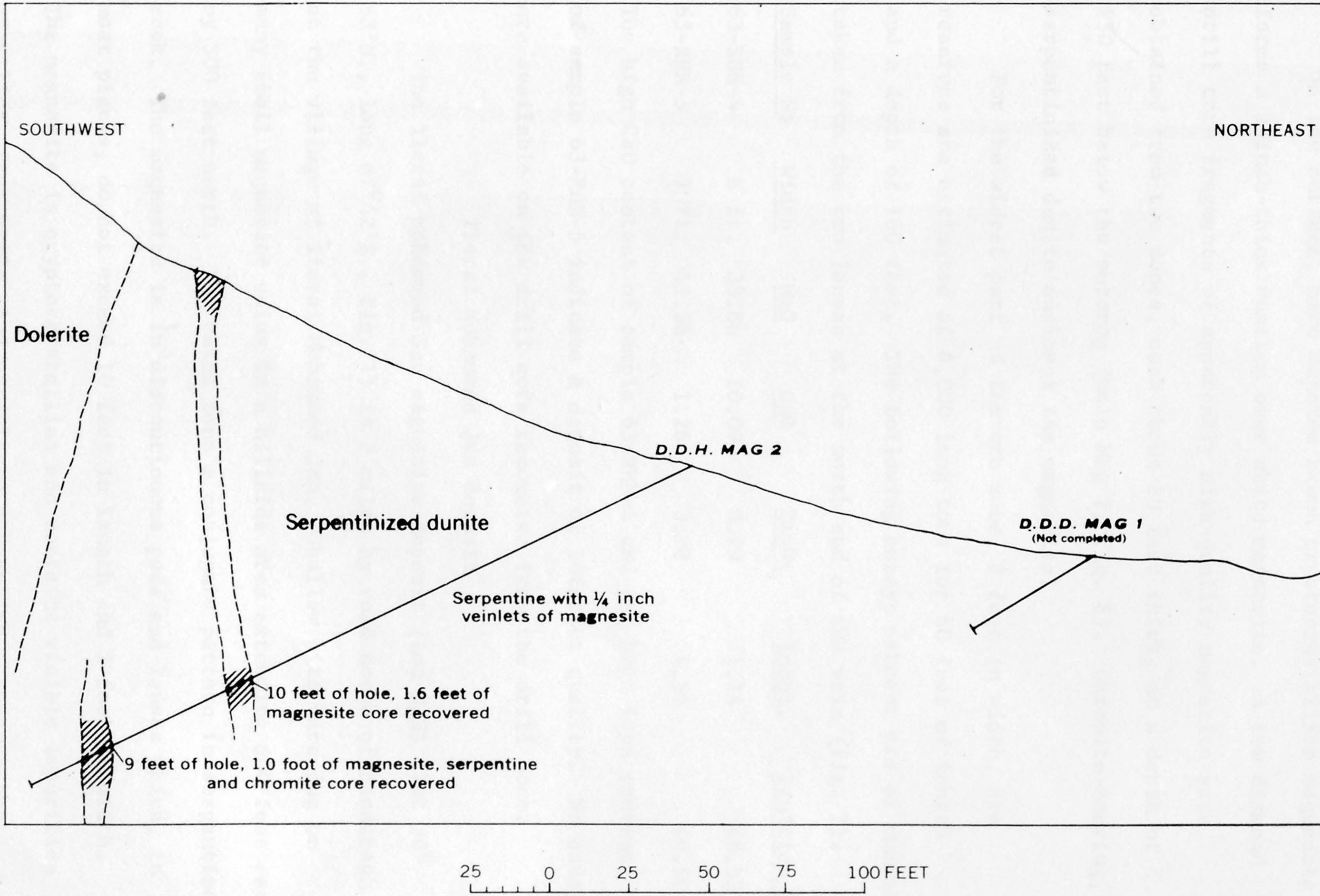


Figure 8.—Cross section of the Shabi Ghundi deposit, Pakistan

On the surface, hard massive brown cryptocrystalline magnesite forms a 2-inch-thick coating over white magnesite. A few diamond drill core fragments of apparently high-quality magnesite were obtained from two zones, each about 10 feet thick, at a depth of 130 feet below the outcrop (hole Mag 2, fig. 8). Chromite-bearing, serpentinized dunite encloses the magnesite.

For the widest part of the ore zone, 8 feet in width, ore reserves are estimated at 6,000 long tons for 60 feet of length and a depth of 160 feet. The following assays percent are of channel samples taken from the two lenses at the north end of the vein (fig. 7):

Sample No	Width	MgO	CaO	Fe_2O_3	Insol.	Ignition loss
63-RHN-4	8 ft.	38.04	10.09	0.79	1.74	48.55
63-RHN-5	7 ft.	42.36	1.26	3.98	1,56	49.54

The high CaO content of sample 63-RHN-4 and the high iron content of sample 63-RHN-5 indicate a deposit of inferior quality. No assays are available on the drill core recovered from the drill core.

Tlerai Mohammed Jan deposit

The Tlerai Mohammed Jan magnesite deposit (Loc. Mg3) (lat 30° 53'N., long 67°42'E., fig. 1) is 7 miles by road north of Hindubagh at the village of Tlerai Mohammed Jan. Shallow pits were dug on many small magnesite veins in a hillside area extending 600 feet east by 300 feet north. The veins form a conjugate pattern in serpentine rock. The magnesite is in discontinuous pods and lenses which, in most places, do not exceed 10 feet in length and 2 feet in width. The magnesite is cryptocrystalline and contains visible impurities of silica, iron oxide, and unreplaced serpentine. Because the individual masses of magnesite are small and of inferior quality, no reserves are estimated.

Sra Salawat deposit

The Sra Salawat magnesite deposit (Loc. Mg4) (fig. 1) is about 20 miles by road south Hindubagh in the Zhob District of Quetta Division. This deposit is more centrally located within the Hindubagh ultramafic complex than the three deposits described above. Asrarullah (Geological Survey of Pakistan, oral commun., 1964) found deposits of crystalline magnesite grading into dolomite of Eocene age. The dolomite unconformably overlies the ultramafic rocks of the Hindubagh intrusive complex, and the magnesite is found as gently folded erosional remnants on hills. Some of the magnesite appears to be of high quality, but analyses are not available. Estimated ore reserves of one of the deposits is 16,000 tons (van Vloten, 1963). Further geologic investigations and sampling should be undertaken.

Zizha deposit

The Zizha mangesite deposit (Loc. Mg5) (lat 31°30'N., long 69° 37'E., fig. 1) is in the Zhob District, Quetta Division, about 10 miles north of Fort Sandeman on the road to Shingar. Ali (1949) reported small quantities of mangesite in ultramafic rock.

Sakhakot deposit

The Sakhakot deposit (Loc. Mg6) (lat 34°27'N., 71°56'E., fig. 1) is in Peshawar Division. Ahmad (1953) mentions that several small veins of magnesite were found in serpentinized ultramafic rock. The tonnage and quality of the magnesite have not been determined.

Karku deposit

The Karku deposit (Loc. Mg7) (lat 27°43'N., long 66°09'E., fig. 1) is in Kalat District, Kalat Division, about 36 miles west-southwest of Khuzdar. Waheeduddin Ahmad (1950) reported a short vein of magnesite 1.5 feet wide in ultramafic rock.

Loya Na Pani deposit

The Loya Na Pani deposit (Loc. Mg8) (lat 27°15'N., long 66° 20'E., fig. 1) is in Kalat District, Kalat Division, about 7 miles south of the village of Wad. Vredenburg (1909) reported a dense network of magnesite veins in the area; Crookshank (1949) also reported extensive areas of ultramafic rocks with magnesite veins. A sample from this area, collected by M. I. Ahmad, Geological Survey of Pakistan, assayed as follows:

MgO	CaO	SiO_2	Fe_2O_3	Al_2O_3	TiO_2	Ignition Loss
32.84	12.75	3.00	2.39	0.11	Trace	47.98

This assay is more indicative of dolomite than magnesite.

Baran Lak deposit

The Baran Lak deposit (Loc. Mg9) (lat 26°59'N., long 66°18'E., fig. 1) is in Kalat District, Kalat Division. A large number of small veins ranging in width from 2 inches to more than 3 feet are in joints in ultramafic rocks (van Vloten, 1963). A sample taken by F. L. Klinger, U. S. Geological Survey, from a place 2 miles south of Baran Lak and 2 miles east of the Bela-Khuzdar road, assayed as follows:

MgO	CaO	SiO_2	Fe_2O_3	Al_2O_3	Ignition Loss
18.08	26.58	1.08	3.19	1.21	49.09

This assay is more indicative of dolomite than magnesite.

Sinchi Bent deposit

The Sinchi Bent deposit (Loc. Mg10) (lat 26°30'N., long 66°21'E., fig. 1) north of Gidri Nala in Karachi Division includes several narrow magnesite veins in ultramatic rocks in an area measuring 50 by 300 feet (van Vloten, 1963). The total quantity of magnesite is small.

ALUMINOUS CHROMITE

Analyses of chromite from the Hindubagh, Ras Koh, Fort Sandeman, and Hari Chand (fig. 1) areas reveal that aluminous chromite (containing more than 20 percent Al_2O_3) is not found in significant quantities in Pakistan. Two analyses of chromite concentrated by exacting laboratory methods indicate that the Sara Grungh deposit near Brunj Kili (fig. 2) north of Fort Sandeman contains aluminous chromite, but the deposit is small, and the iron content of the concentrated chromite mineral exceeds 12 percent. This deposit could not contribute significantly to the manufacture of aluminous chromite refactory materials.

Metallurgical grade chromite is mined in the Hindubagh chromite mining district.

RECOMMENDATIONS

1. The Koh-i-Sultan sulfur deposit should be mapped topographically and geologically on a scale sufficiently large to depict the outlines of bleached rock or other guides to buried sulfur ore bodies. This work should be followed by drilling or pitting to depths of at least 50 feet in the areas most favorable for prospecting. An estimate of ore reserves should be prepared.

2. The Sanni mine area should be mapped. Holes drilled to a depth of approximately 400 feet are required to test the extent of sulfur-bearing horizons west of the old workings and possible ore east of the fault zone.

3. The Koh-i-Maran fluorspar area should be mapped and veins located, using aerial photographs as a guide and ore reserves calculated according to accepted procedures. The Dobranzel deposit near Koh-i-Maran should be examined.

4. Reported fluorspar deposits near Yarkhan and Mirgasht in Chitral and in Gilgit and Hunza should be examined and evaluated.

5. Magnesite deposits, other than the Spin Kan deposit, should be sampled to determine their quality and economic potential. Assay data now available indicate that much material called magensite is dolomitic and ferruginous.

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Figure 1.—Map of West Pakistan, showing locations of sulfur (S), magnesite (Mg), and fluorspar (F) deposits.