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BARITE IN PAKISTAN

by

F.L. Klinger
U.S. Geological Survey

and

R.L. Richards
U.S. Bureau of Mines

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ABSTRACT

Before 1953 almost no barite deposits were known in Pakistan. Discovery of such deposits relatively close to oil fields in northern Pakistan in 1953 led to increased barite production from 1957 to 1961 and to doubling of production in 1962, firmly establishing a new industry for the country.

During 1962 and 1963, most of the known barite deposits in Pakistan were geologically mapped, and minimum reserves were estimated to be 1,423,000 short tons. The largest single deposit, at Gunga, Khuzdar, is estimated to contain more than 1,100,000 short tons of barite.

Barite has been found in Pakistan principally in the Hazara, Khuzdar, and Las Bela districts. Although several vein deposits contain good quality barite, 90 percent of estimated reserves are in replacement deposits concordant to bedding in sedimentary rocks. Host rocks range in age from Precambrian to Pleistocene, but the periods of barite deposition are probably Jurassic or younger. Some barite concentrated in sandstone may be of detrital origin.

In late 1962, demand for barite in Pakistan was estimated at about 8,000 tons annually. Although domestic barite resources far

exceed this figure, less than 40 percent of demand was being supplied by domestic mines in 1963. Transportation costs and limited production facilities are partly responsible for low output, but the lack of quality control is a major obstacle. Producers are not generally familiar with commercial specifications for barite and have not recognized that their products are too impure to be successfully marketed without installing the necessary control procedures of sampling and beneficiation.

INTRODUCTION

Barite is the mineral form of barium sulfate ($BaSO_4$), a relatively soft, heavy, and chemically stable mineral whose properties make it useful in industrial applications.

Most barite produced today is consumed by the petroleum industry as a weighting agent in high-density drilling muds. Barite is also used in the manufacture of paint, rubber, and glass, and it is the principal raw material for the production of barium chemicals. New uses for the mineral or its derivatives are being found in construction materials, electronics, and in ceramics.

Pure barite has a specific gravity of 4.5 and contains 65.7 percent BaO and 34.3 percent SO_3 by weight. Although these values are closely approached in single crystals of the mineral, they are rarely attained in commercial deposits, because other minerals, such as quartz, carbonates (usually calcite), or silicates (clay minerals), are almost always associated and tend to reduce the specific gravity

of the material. In most commercial deposits, mineral impurities are so abundant that they must be mechanically or chemically removed before barite can be successfully marketed.

Barite mining is a relatively new industry in Pakistan, having developed only during the past 6 or 7 years. Until 1961, the average annual production was about 500 tons, mostly obtained from small deposits in the districts of Hazara and Las Bela. Production increased to 1,250 tons in 1961 and 2,800 tons in 1962, largely as a result of the discovery and development of new deposits in the Hazara District. In 1962, geologic investigations revealed large deposits of barite in the Khuzdar District, and the total reserves of barite in Pakistan are now estimated to be 1,423,000 short tons. This quantity is sufficient to supply domestic requirements for many years.

Pakistan is thus potentially self sufficient in this mineral commodity, and barite production appears to be an area of the economy where foreign exchange can be saved. While complete self sufficiency may not be possible for some time, a more rapid advance toward this goal can be made if producers, government, consumers, and private investors are sufficiently informed about the resources available, together with the problems facing the industry and the steps which can be taken to solve them.

Purpose and scope of report

During 1962 and 1963, under the auspices of the Government of Pakistan and the Agency for International Development, U. S. Department

of State, much new information has been gathered on the geology, technology, and economics of barite in Pakistan by personnel of the Geological Survey of Pakistan in cooperation with the U. S. Geological Survey and U. S. Bureau of Mines.

In view of the increasing information on barite resources, and the possibility that self sufficiency might be attainable, it was desirable that all available information be brought together and evaluated in a single report for convenient reference. This report is intended to focus attention on some of the economic problems facing the domestic barite industry as well as those of a technologic or geologic nature. No attempt has been made to formulate detailed exploration or mining plans, or to recommend specific beneficiation equipment, because sufficiently definitive chemical or physical studies have not yet been made. Data in this report are as of 1967.

Acknowledgments

The information in this report is mostly based on field studies of barite deposits and on information gained from correspondence and conversations with barite producers and consumers. The initial investigations were guided by mineral information reports in the files of the Geological Survey of Pakistan and the U. S. Agency for International Development. The writers were assisted by several officers of the Geological Survey of Pakistan, including M. I. Ahmad, S. Tayyab Ali, Mesbahuddin Ahmed, S. H. Abbas, and Afzal Khan. In the fieldwork, the cooperation received from officials of the Zia Mining Corp., the United Mining Corp., Amin Agencies, Ltd., and Jensen and Nicholson of Pakistan, Ltd. was much appreciated.

Several other petroleum and mining companies furnished written information which was of assistance in compiling this report. These include Attock Oil Co., Pakistan Petroleum, Ltd., Pakistan Shell Oil Co., Tidewater Oil Co., Esso Standard Eastern, Inc., and Modern Mining Industrial Syndicate.

Chemical analyses were furnished by the staff of the U. S. Geological Survey and the Lahore laboratory of the Pakistan Council for Scientific and Industrial Research.

BARITE DEPOSITS

Location

The location of the barite deposits of Pakistan is shown on figure 1. The principal deposits are found at Bankhri, Kudni, and Gunga, and at several places in the Hazara District. Small quantities of barite also are found near Koh-i-Sultan and at Mianwali-Katha. The mineral has been reported from Swat State and from the northern Hazara District, but few details are available.

Types of deposits

Based on mode of occurrence, the barite deposits may be classified into three groups: (1) vein deposits; (2) replacement deposits; and (3) sedimentary deposits. Vein and replacement deposits are the most important economically. The sedimentary deposits are found over large areas, but the concentration of barite is low.

The vein deposits are found in the Hazara and Las Bela districts. Most of the veins follow shear-zone faults or tension fractures which cut across the structure of the host rocks; however, the Kohala

TOP

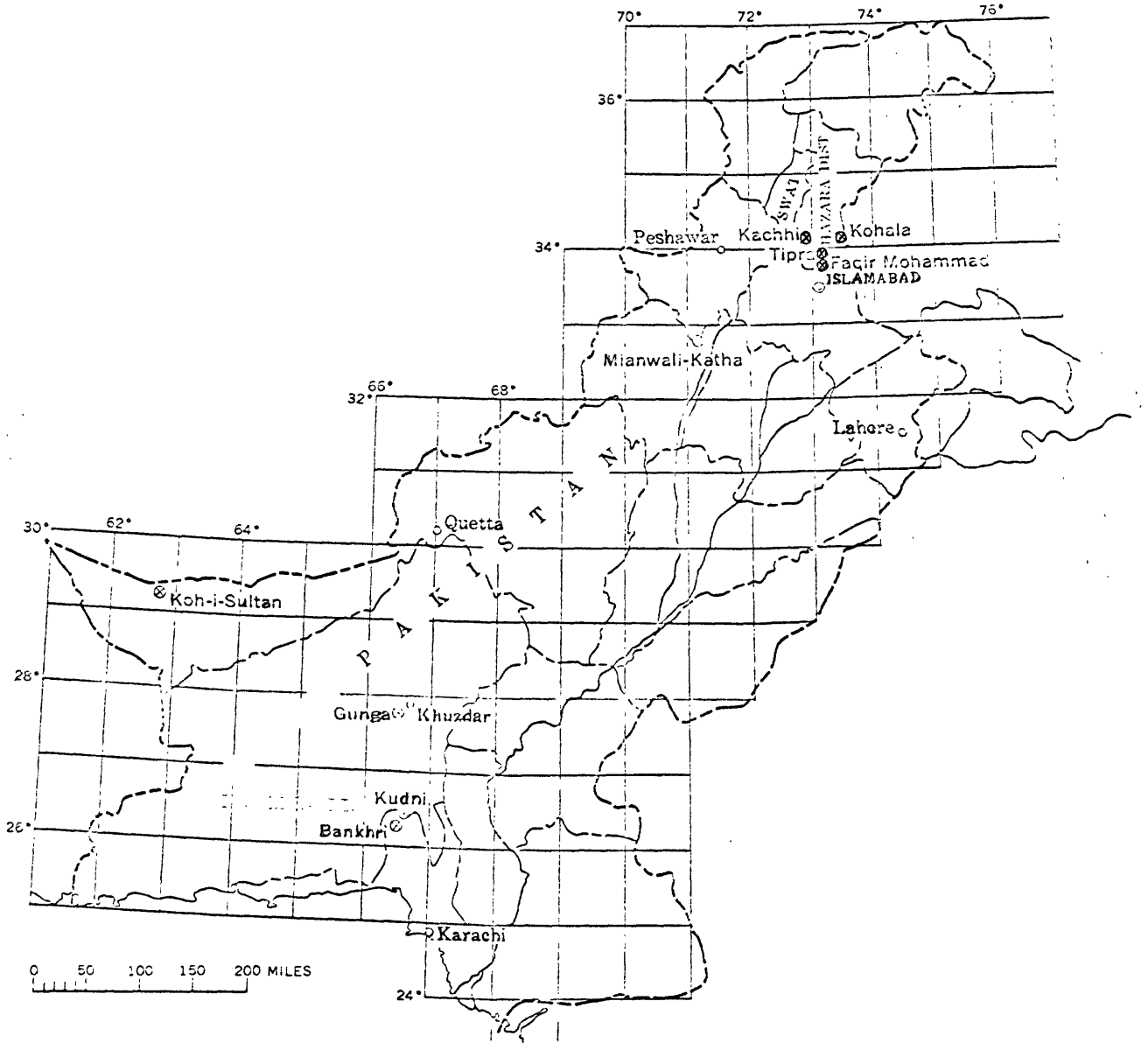


Figure 1 — Index map of Pakistan, showing the locations of barite deposits. ⊗ is barite deposit.

deposits of Hazara are mostly parallel to the sedimentary structures and appear to be concentrated along certain stratigraphic horizons or zones. Minable deposits are podlike and are not often more than a few hundred feet long, although the localizing structures may be traceable for greater distances.

Replacement deposits in the Khuzdar and Las Bela districts follow sedimentary structures and exhibit rather precise stratigraphic controls. These ore bodies are more persistent and regular in width than the vein deposits. The small deposits near Koh-i-Sultan are reportedly found in an igneous dike and are probably of replacement origin.

The sedimentary deposits are represented by nodules, concretions, and disseminated grains of barite in sedimentary rocks. Nodules of barite are found in shales of the Khuzdar and Las Bela districts. In the Salt Range of Mianwali District, barite is a minor constituent of sandstone beds of the "Speckled sandstone" formation and is reported to be found as concretions in the overlying "Lavender clays."

Age of mineralization

The country rocks enclosing the barite deposits include igneous, sedimentary, and low-rank metamorphic rocks which range in age from Precambrian(?) to Pleistocene. With the possible exception of the Salt Range localities, the barite mineralization may be as old as Jurassic, and some is probably Pleistocene.

In the Hazara District, most of the barite deposits are found in the Precambrian(?) Hazara Slate, but they also cut Carboniferous

sandstone as well as limestone of probable Eocene age. The barite-bearing sedimentary rocks of the Salt Range are of Carboniferous and Permian age; the barite may have been part of the original sediment, or it may have been deposited later. The replacement, vein, and sedimentary deposits of Khuzdar and Las Bela are found in Jurassic and Cretaceous sedimentary rocks. The barite-bearing dike near Koh-i-Sultan cuts andesitic volcanic rocks which are probably of Pleistocene age.

Mineral composition

The barite deposits generally contain significant amounts of mineral impurities. Although high-grade barite of economic interest is found in several of the deposits, the quality of the ore is variable, and it is unlikely that any one deposit can produce appreciable quantities of high-purity barite without beneficiation.

The principal mineral impurities are quartz and calcite. Iron oxide is a common but minor impurity in the replacement deposits of Khuzdar and Las Bela. Most of the barite deposits contain traces of galena and copper-iron sulfides such as chalcopyrite and bornite. Barite is found as an accessory mineral in narrow veins of quartz and galena which cut the Hazara slate 3 miles northeast of Abbottabad.

Hazara District

Kohala deposits

Location and access -The Kohala deposits (fig. 2) are near the eastern boundary of the Hazara District, 3 miles southwest of the town of Kohala (lat. 34°06' N. long. 73°27' E.; Survey of Pakistan

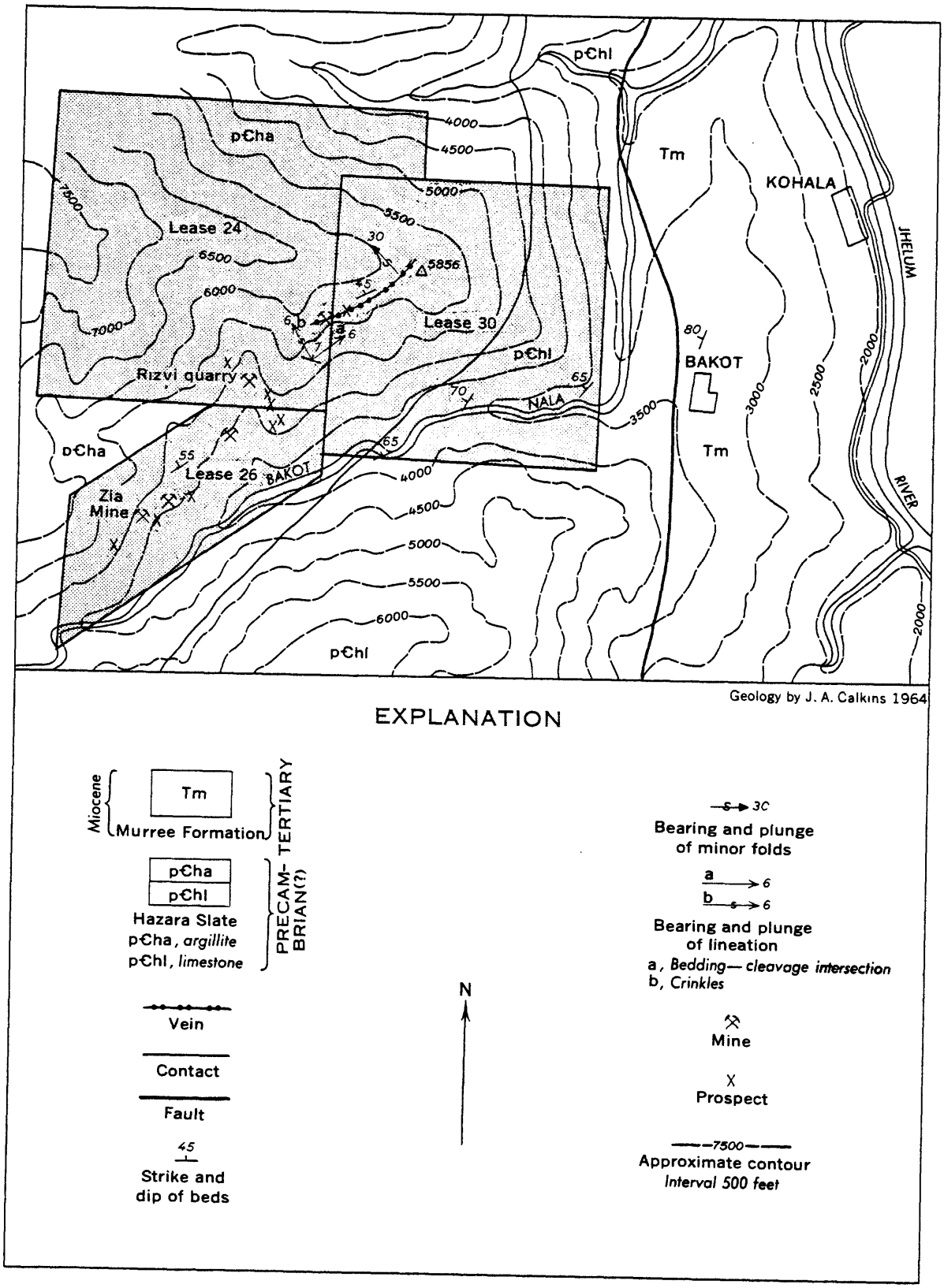


Figure 2 —Geologic sketch map showing the location of the Kohala barite deposits.

topographic map 43/F/8). The deposits are reached from Kohala by a 5-mile footpath which passes through Bakot village and up Bakot Nala.[1/] The deposits are on steep slopes on the north side of the nala, at elevations ranging from 4,500 to 5,500 feet. The deposits can also be reached by footpath from Nathia Gali, which lies 4 miles to the southwest. The government is reportedly considering construction of a road from Nathia Gali to Kohala that would pass close to the barite deposits and greatly improve their accessibility.

Leaseholders.—Two mining companies held leases in the area. The only operating mine is in Lease 26, held by the Zia Mining Corp. of Rawalpindi. Leases 24 and 30, covering about 2 square miles north and east of the Zia concession, are held by Messrs. Rizvi and Sons of Abbottabad. The Rizvi quarry (now idle) is near the south boundary of Lease 24. The lease locations and reference numbers are shown in figure 2.

General geology.—The barite is found in the argillite unit of the Hazara Slate of probable Precambrian age. In this area the Hazara Slate consists mostly of black and gray argillite and quartzitic argillite, together with layers and lenses of gray argillaceous limestone. Also distinguished in this area is a lower unit of the

---

1/"Nala": a small stream or stream course, whether water is present or not. Equivalent English terms would be "stream," "creek," "brook"; also "gulch," "dry wash," etc. Maps of other regions in the country may show "dhera," "jhal," "nadi," etc., in place of "nala."

Hazara Slate composed of gray, thick- and thin-bedded limestone, in places deformed internally by small-scale folds. The eastern boundary of the limestone unit is faulted against the Murree Formation of Miocene age (fig. 2).

In the lease area the rocks strike northeast and dip northwest. This attitude persists for a considerable distance to the west. In the northern part of the lease area the regional strike swings northward and maintains this trend for 30 miles or more. The lease area lies toward the southern limits of regional metamorphism; the rocks very seldom exhibit slaty cleavage or small-scale folds; bedding is by far the most prominent planar structure.

The barite deposits are distributed as lenses along a narrow northeast-trending zone which follows the strike of the beds. This zone extends from the Zia mine northeastward to hill 5856, a known distance of 1.5 miles. Most of the lenses lie parallel to the bedding of the argillite.

The lenslike character of the barite deposits in the Zia lease and the relationship of the deposits to the argillite, are shown in Figure 3. The larger lenses of barite at localities 1, 2, and 4 lie parallel to the bedding; crosscutting bodies are found at localities 3 and 6. Small lenses of barite at other stratigraphic horizons are present at locality 5 and immediately southeast of the Zia mine. The larger lenses of barite are 75 to 140 feet long and have maximum thicknesses of 20 to 22 feet. Although the lenses are generally conformable to the bedding of the argillite, the hanging wall is commonly irregular near the extremities of a lens, and the

barite appears to cut across the bedded structure. The shape and structural relationships of a typical lens are illustrated by the inset sketch of figure 3.

The Rizvi quarry is a complex lens 110 feet long and 25 feet wide which follows a system of plunging folds in the argillite (fig. 4). The lens plunges 30° S., 70° W., parallel to the minor folds in the argillite.

Half a mile northeast of the Rizvi quarry, a lens of barite 90 feet long and 5 feet thick has been opened up recently. This locality lies at the western termination of a vein that extends to hill 5856, half a mile to the northeast. The vein is parallel to the strike of the argillite and consists of rusty-brown quartz-carbonate material and a few small pods of barite. The newly opened lens at the western end of the vein and another smaller lens a few hundred feet to the east are the only ones large enough to exploit.

Grade.—The ore is a massive, fairly coarse grained aggregate of interlocking barite crystals up to half an inch in diameter. It is light gray to brown and has a somewhat glassy appearance.

The ore contains small amounts of calcite and quartz and traces of iron oxide. Ali (1962) reports variable but sometimes high percentages of quartz in some deposits in the eastern part of the area. In the deposits shown in figures 3 and 4, argillite inclusions are the principal impurity. The inclusions make up 10 to 30 percent of a 3- to 6-feet thickness of ore along the hanging wall and footwall

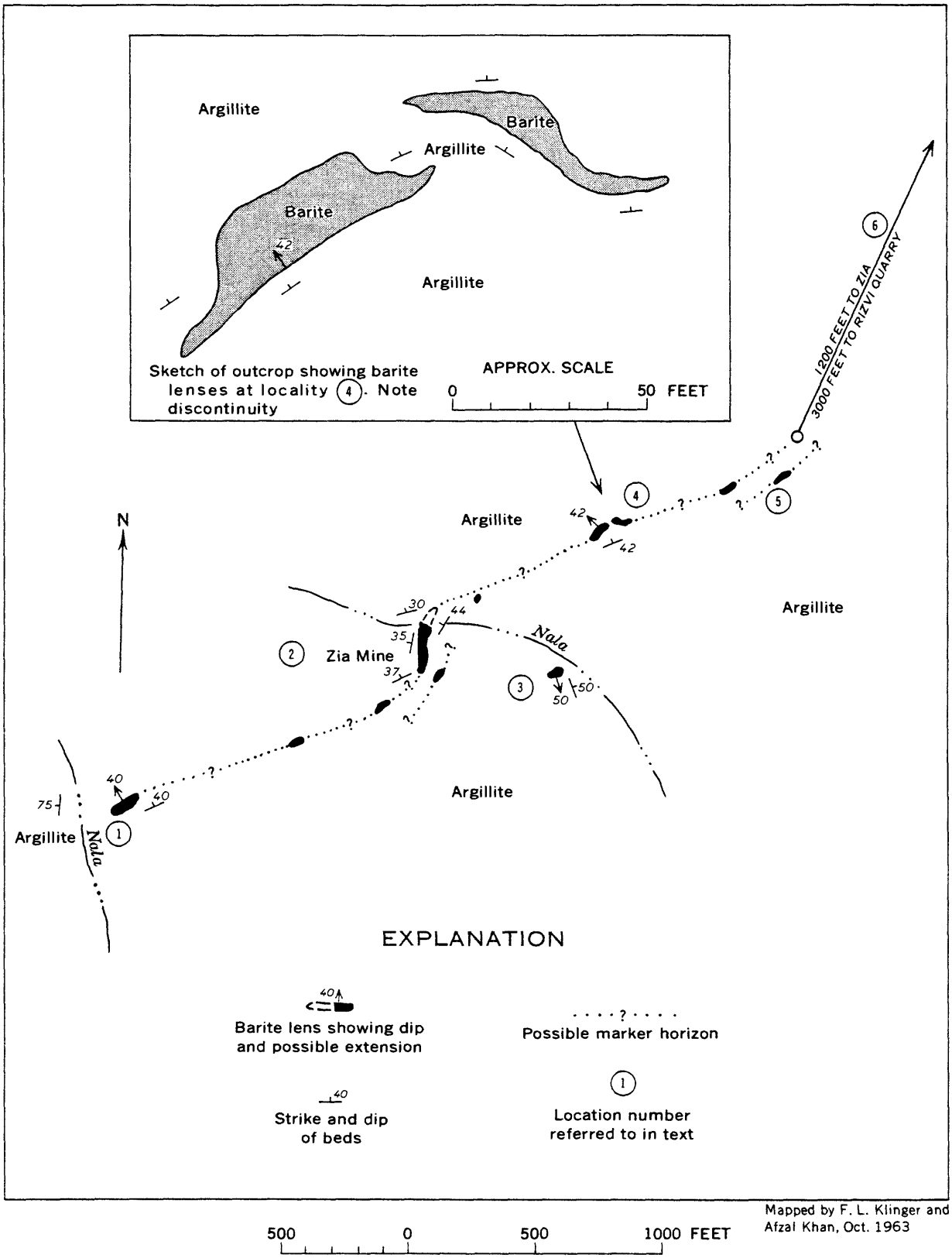
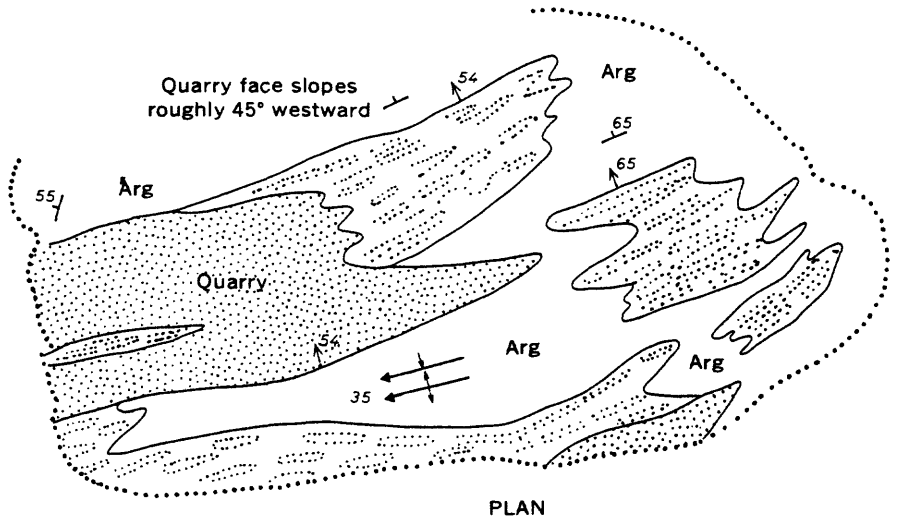


Figure 3 —Sketch map showing distribution of barite lenses in concession area of Zia Mining Corporation near Kohala.



PLAN

EXPLANATION

N

Arg

Argillite

Mixed argillite and barite

Barite

Limit of outcrop

54

Contact, showing dip

65

Strike and dip of beds

Bearing and plunge of folds

Mapped by F. L. Klinger, Oct. 1963

20 0 20 40 60 FEET

Figure 4 —Geologic sketch map of barite deposits quarried in M/S Rizvi and Sons concession area near Kohala, Hazara District, Pakistan.

of the lenses. The central parts of the lenses are usually free from inclusions and contain the best quality ore.

Some analyses of ore from the Zia and Rizvi deposits are shown in Table 1. The analyses indicate a barite content of 88 to 93 percent in the crude material, and about 94 percent in the milled product. The grade of the crude at the mine is more variable than these analyses would indicate, and the mill samples (RR-53, 54) represent handpicked material. Careful sorting at the mine is necessary to produce high-quality barite.

Reserves.—Barite reserves in the larger deposits shown in figures 3 and 4 are estimated to be 25,000 to 30,000 short tons. This assumes a specific gravity of 4.2, and that a given lens of barite will persist downdip for a distance of one-half its strike length. Perhaps half this tonnage may be mined without recourse to underground methods. Additional exploration and development work can probably increase the present estimate, but a major increase in reserves should not be expected.

Ore reserves were previously estimated (Klinger and Abbas, 1963) to be 150,000 tons. This was based on reports that the various ore showings were intermittent exposures of a single continuous vein. Subsequent examinations showed that the ore is not continuous.

Mining and production.—Mining at the Kohala deposits is done by the Zia Mining Corp. This company has produced about 4,000 tons of barite from their own lease and about 600 tons from the Rizvi lease under a contract with the latter company. The current rate of

Table 1.—Analyses of barite samples from Kohala deposits, Hazara District

Sample	Specific gravity	$BaSO_4$	SiO_2	$CaCO_3$	Fe_2O_3	H_2O-sol. salts	Sol. in HCl	Remarks
RR-44*	4.18	90.80	4.20	3.75	0.2	1.9	ND	Zia lease
RR-44**	4.22	92.22	3.34	2.66	0.1	0.19	ND	Zia lease
RR-45**	4.14	88.42	2.55	5.78	0.15	0.11	ND	Rizvi lease
RR-46**	4.21	92.52	1.78	3.27	0.09	0.15	ND	Rizvi lease
RR-47**	4.24	92.76	1.91	2.64	0.09	0.12	ND	Rizvi lease
"A"	4.35	98.9	-	-	-	-	-	Zia, picked
"B"	4.22	-	-	4.00	-	0.45	4.80	Zia, mill
RR-53	4.28	93.48	1.85	1.39	0.13	0.27	-	Zia, mill 1½"
RR-54	4.26	93.44	2.17	2.00	0.13	0.14	-	Zia, mill ¼"

*Analysis by Pakistan Council for Scientific and Industrial Research, Lahore laboratories.
**Analyses by U.S. Geological Survey, Washington, D.C.

RR-44 Chip sample across 12' barite, Zia Mining Corp. opencut.
-45 Chip sample across 5-1/2' barite, hanging wall of vein.
-46 Chip sample across 8-1/2' barite, central part of vein.
-47 Chip sample across 8' barite, footwall of vein.

Note: Samples 45-46-47 are consecutive, along one traverse.

RR-53 Mill feed at Zia Mining Corp. plant.
RR-54 Crushed barite, product of jaw-crusher, Zia Mining Corp. plant.

"A" Sample picked by Zia Mining Corp.; location and type unknown.
Analysis by Jenson and Nicholson of Pakistan, Ltd., Karachi
Source: Zia Mining Corp., letter to Geol. Survey of Pakistan dated 16 September, 1962.

"B" Run-of-mill sample from Zia Mining Corp. plant, Rawalpindi.
Analysis by P.P.L.-Burmah Oil Co., Ltd.

production at the Zia mine is 3 to 10 tons per day; the Rizvi quarry is idle.

Mining is done in opencuts. The ore is broken by drilling holes 6 to 12 inches deep, then blasting with black powder and fuse. Ore slabs and chunks are barred loose, then are further broken and sorted by hand.

Lump barite is transported by donkeys 5 miles to the road head at Kohala. From Kohala the ore is trucked 60 miles to the company's mill at Rawalpindi, where it is precrushed, ground to 300-mesh in a 3-roll Raymond mill, and bagged. The product is sold for 200 rupees per ton to oil companies and local paint manufacturers. Company officials state that another 3-roll Raymond mill and a small ball mill have been ordered for their Rawalpindi plant. This should increase the grinding capacity of the plant to 3 or 4 tons per hour. If market conditions are favorable the company may also install bleaching facilities, using a sulfuric acid process.

An improved system of quality control would help to stabilize the company's present markets and to increase sales. This will require better sampling procedures and methods of beneficiation.

Kachhi deposits

Location and access.—The Kachhi, or "Chathi," barite deposits (fig. 5) are 1.5 miles east of Kachhi and 13 miles northwest of Haripur (lat 34°07'30" N. long 72°58' E., Survey of Pakistan topographic map 43 B/16). The deposits are accessible by a short trail from the road head at Kachhi.

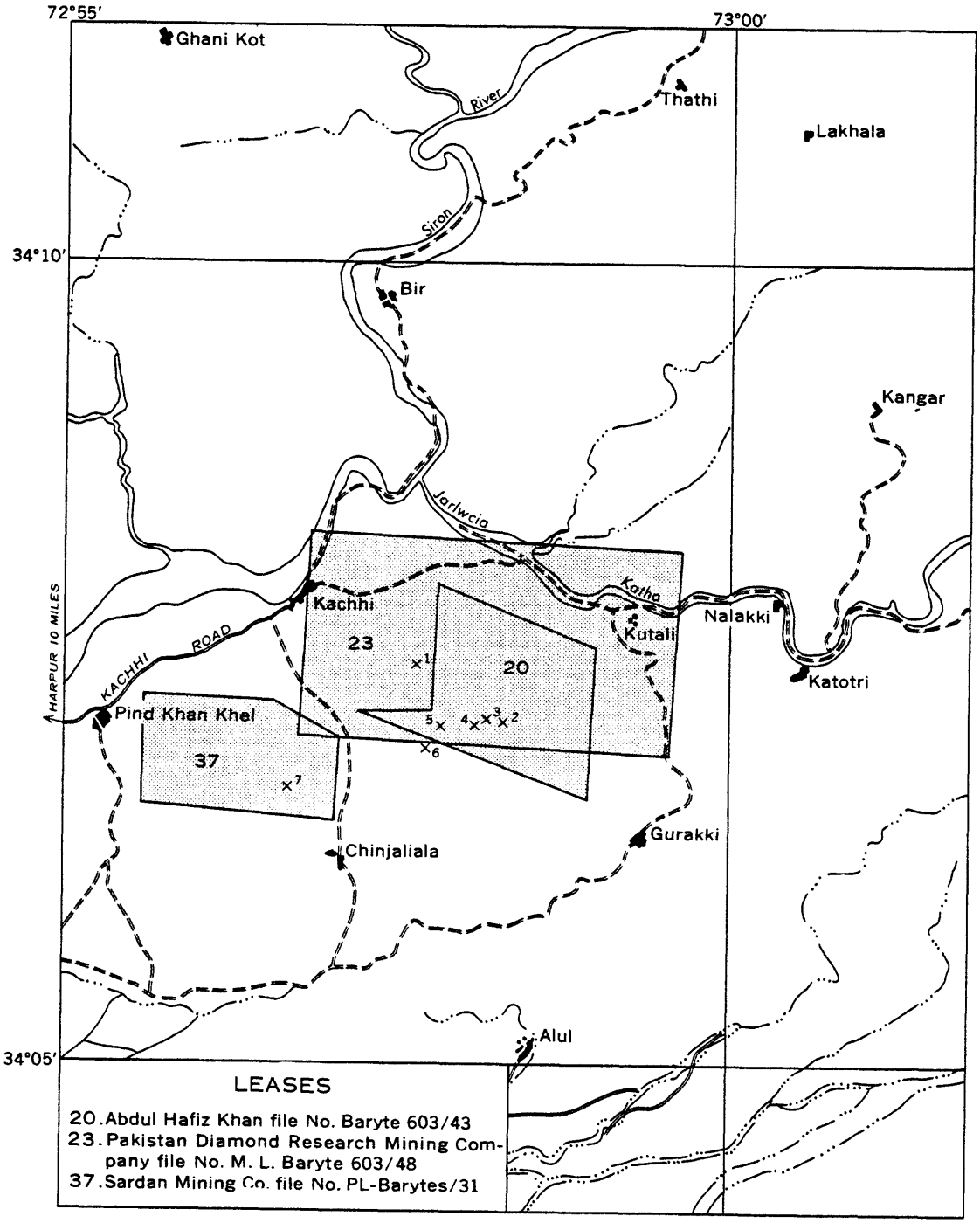


Figure 5 —Sketch map showing the location of the Kachhi barite deposits and leases. x and number indicate prospects mentioned in text.

Leaseholders.—Barite leases are held by Mr. Abdul Hafiz Khan of Abbottabad, and the Pakistan Diamond Research Mining Co. of Haripur. The lease locations and reference numbers are shown in figure 5.

General geology.—Barite is found in narrow veins within quartzitic sandstone of the Tanawal Formation of early or middle Paleozoic age. The veins are localized in shear zones which cut across bedding at many different angles and have steep to vertical dips. Six prospect pits and trenches (fig. 5) expose veins that pinch and swell but that generally are not more than 1 foot thick and typically range from 4 to 8 inches. The greatest width exposed, 4 or 5 feet of impure barite, is at the base of the cut face in prospect 3. Prospects 2, 3, and 4 are on a single zone in which two or three thin barite veins probably have intermittent strike extent of as much as 300 feet. This zone is the only observed site that might be favorable for further digging; the size of veins and quality of barite are generally unfavorable factors. Prospect 7 was opened on a vein of white banded calcite, mistaken as "first-quality barite."

Grade.—The ore consists of bluish-white, massive barite containing subordinate amounts of quartz. Although the quality of the barite is relatively high, most of the ore is so closely intergrown with quartz that it is difficult to upgrade the material by hand.

Some analyses of the ore are shown in Table 2. The difficulty in upgrading the ore by hand may be illustrated by comparing the

Table 2.—Analyses of barite from Kachhi deposits, Hazara District

[Analyses by U.S. Geological Survey, Washington, D.C.]

Sample	Specific Gravity	$BaSO_4$	SiO_2	$CaCO_3$	Fe_2O_3	Water-soluble salts @ 25°C.
62-RR-50*	3.83	76.13	20.39	0.04	0.07	0.04
62-RR-51**	3.92	80.07	16.62	0.04	0.19	0.11
62-RR-52***	4.09	87.06	4.58	0.00	0.08	0.04

* Crude ore; chip-channel sample across 4' barite vein.
** Handpicked ore; grab sample from ore pile No. 1.
*** Handpicked ore; grab sample from ore pile No. 2.

crude-ore analysis with the analyses of handpicked ore. The absence of calcium carbonate in these samples is noteworthy and distinguishes the Kachhi ore from other deposits in the Hazara District.

Reserves.—Minable reserves are estimated to be 1,000 tons, contained in three deposits. Reserves above this estimate are doubtful unless the worked veins widen markedly at depth. The small size of the Kachhi deposits and the difficulty in obtaining a high-grade product by handpicking limit the importance of the deposits as a source of barite. Barite veins have been reported near Haripur, but these have not been investigated.

Mining and production.—The Khan Mining Corp. of Abbottabad intermittently worked the deposits, starting in 1958, and reportedly produced about 400 tons of barite which did not prove salable. An unknown but small amount was also produced by Mr. Anwar Beg of Haripur. The highest rate of production in the area was 3 tons per day. The deposits were last worked in 1963. Mining was done by opencut trenching methods, and the ore was broken and sorted by hand. Underground mining methods will be necessary if production is to continue.

Faqir Mohammad deposits

Location and access.—The Faqir Mohammad deposits (fig. 6) are 17 miles east of Haripur by road and half a mile southwest of the village of Faqir Mohammad (lat. 33°56'30" N., long. 73°09'30" E.; Survey of Pakistan topographic map 43 G/1). Close approach to the deposits can be made by motor vehicle via the Lora road which leaves

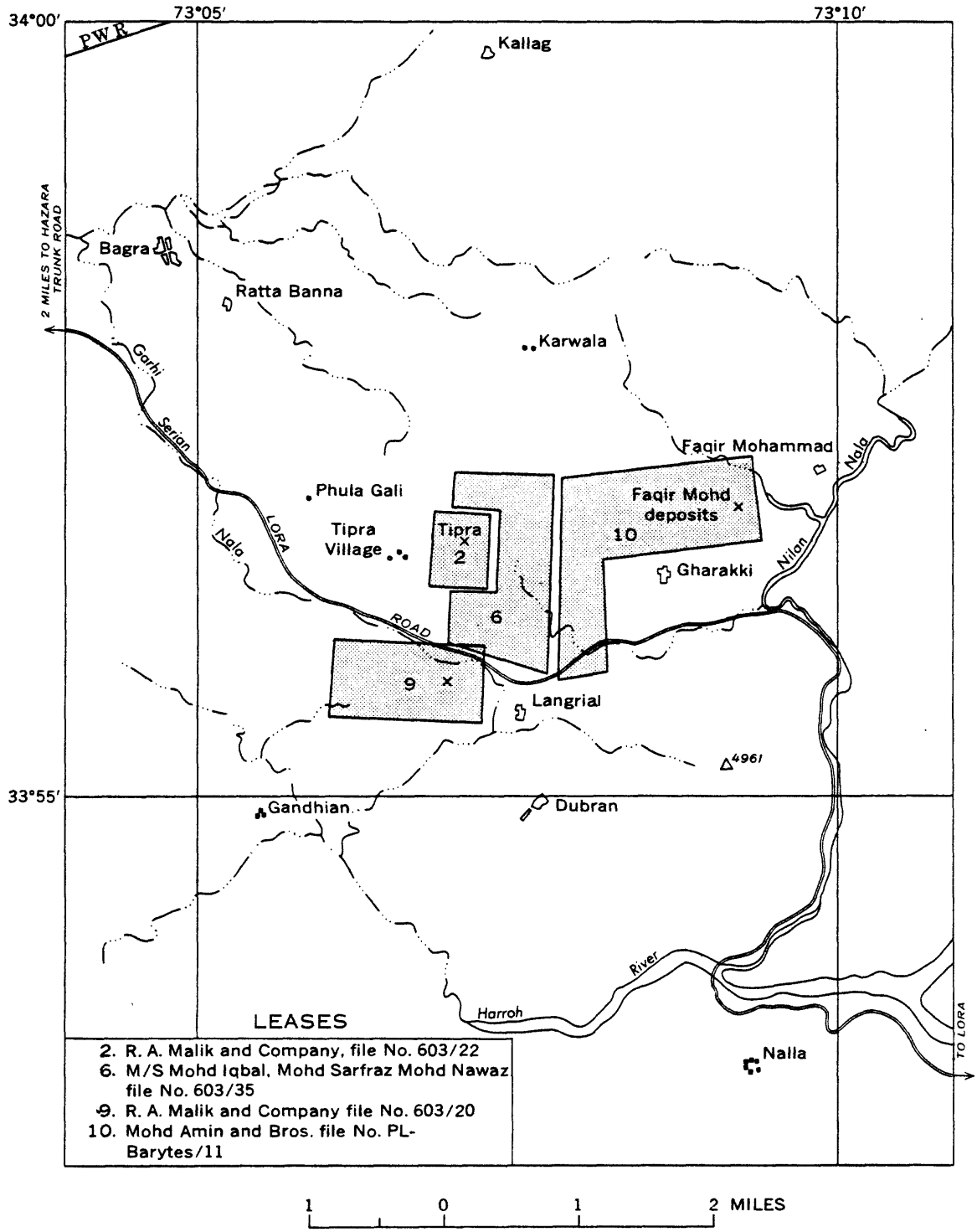


Figure 6 —Sketch map showing the location of the Tipra and Faqir Mohammad barite deposits and leases. × barite prospect.

the Hazara truck road 6 miles east of Haripur. The deposits are 1 mile by footpath north of the Lora road.

Leaseholder.—The deposits are being explored by Amin Agencies, Ltd., under a prospecting license in the name of Mohd. Amin and Bros., Karachi. The location and reference number of the lease are shown in figure 6.

General geology.—Three quartz-barite veins are found in nodular, fossiliferous limestone of probable Eocene age. The veins strike east, dip steeply north, and are approximately parallel to the bedding of the limestone. The veins range from 6 inches to 3 feet in thickness and from 40 to 200 feet in length.

Two of the veins lie 20 feet apart at the crest of the hill. The southern vein consists of milky quartz, barite, and traces of galena, and is 2 to 3 feet thick over an exposed length of 40 feet. The adjacent vein is of similar thickness and contains an estimated 30 percent coarse white barite over a distance of 200 feet. The third vein is about 300 feet to the north and consists mostly of quartz with minor amounts of barite. Calcite is locally abundant in the ore, and traces of copper minerals are also found.

Grade.—Analyses of the ore are shown in Table 3. The differences in the composition of the ore are shown by that between samples 41 and 42. This was also indicated by specific gravity measurements, which ranged from 3.3 to 4.4, on miscellaneous ore samples. The coarse grain size of the mineral constituents, however, suggests that

Table 3.—Analyses of barite ore, Faqir Mohammad deposits, Hazara District

[Analyses by U.S. Geological Survey, Washington, D.C.]

Sample	Specific Gravity	$BaSO_4$	$CaCO_3$	Fe_2O_3	Water-soluble salts, @ 25°C.	SiO_2
62-RR-41*	4.00	82.41	13.96	0.13	0.19	0.81
62-RR-42**	3.45	57.52	8.82	0.20	0.12	32.55
62-RR-43***	4.21	92.16	6.39	0.12	0.17	0.45

* Chip-channel sample across 10" barite vein.
** Chip-channel sample across 12" barite vein.
*** Grab sample from barite stockpile.

most of the impurities can be removed by careful hand sorting.

Reserves.—The deposits are relatively small and irregular. At the time they were examined (September 1962), minable reserves were estimated to be only 100 tons.

Mining and production.—Mining of the deposits is largely incidental to exploratory and development work, which was started by Amin Agencies Ltd. in January 1962. About 60 tons of ore was shipped during the year, including 15 tons of "float" barite picked up from the hillsides.

The narrow veins are mined by opencuts, in which the waste-to-ore ratio is about 10 to 1. Short holes are drilled and blasted using black powder and fuse. Secondary breaking and sorting of the ore are then done by hand. The ore is hauled by donkey to the road, then by truck to the railroad south of Havelian. The small production was reportedly sold to paint manufacturers in Karachi.

The Faqir Mohammad deposits are not of significant economic importance because of the small reserves and high costs of mining and transportation.

Tipra deposits

Location and access.—The Tipra deposits (fig. 6) are half a mile east of Tipra village and 2 miles west of the Faqir Mohammad veins (lat 33°54'30" N., long 73°06'30"). Other small showings are reported just south of the Lora road. Access is by the Lora road and thence half a mile by footpath to the prospects.

Leaseholders.—Leases north and south of the road are held by Mr. R.A. Malik of Lahore. A second lease is held by M/s Mohd. Iqbal,

Mohd. Sarfraz, and Mohd. Nawaz. The locations and reference numbers of these leases are shown in figure 6.

General geology.—The Tipra deposits consist of very small veins and pockets of barite and quartz found in fractures or joints in nodular limestone of possible Eocene age and in the Hazara Slate. None of the several small showings of barite in the area are more than a few feet long or more than a foot or so wide. Reserves are negligible, and the deposits have no economic importance.

A grab sample of the barite from one of the showings had a specific gravity of about 4.2. Chemical analysis (Pakistan Council for Scientific and Industrial Research (PCSIR) laboratory, Lahore) showed 86.8 percent $BaSO_4$, 5.1 percent SiO_2, 4.46 percent $CaCO_3$, 0.36 percent Fe_2O_3, and 0.4 percent water-soluble material.

Khuzdar District

Gunga deposits

The Gunga deposits contain the largest known reserve of barite in Pakistan. At present (1963) they are incompletely developed because of the relatively remote location and the lack of accurate information regarding the quality of the deposits or the requirements for beneficiation.

Location and access.—The deposits are 6 miles southwest of Khuzdar in Kalat Division (lat. 27°44'30" N., long. 66°32' E.; Survey of Pakistan topographic map 35 I/NE). The deposits are reached by a 10-mile jeepable road from Khuzdar (fig. 7). The deposits are 260 miles by road north of Karachi and 165 miles south of Mastung, the nearest railhead. The railway distance from Mastung to Karachi is about 575 miles.

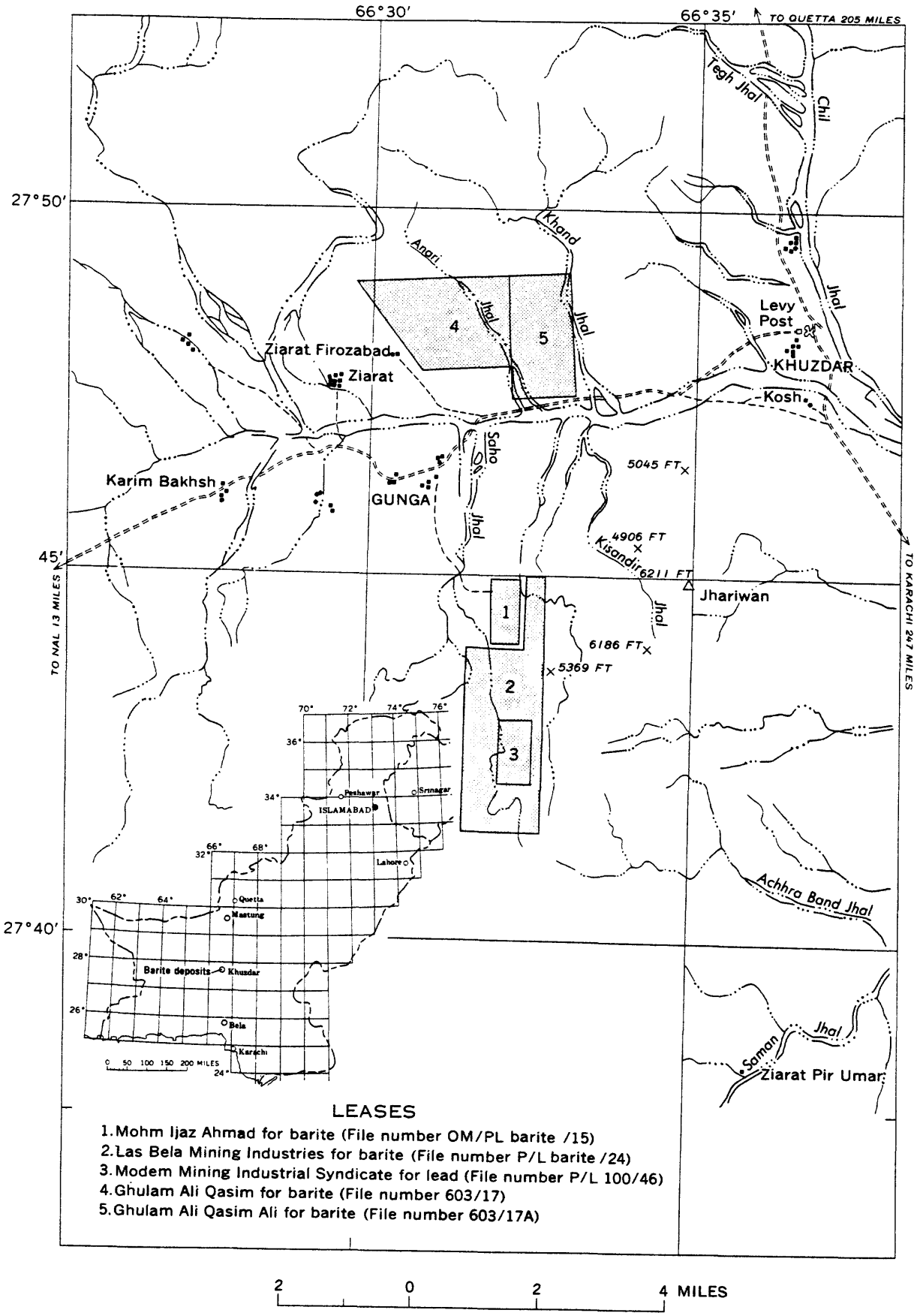


Figure 7—Sketch map of area west of Khuzdar, Kalat Division, showing location of barite leases.

Leaseholders.—The area containing the deposits is covered by a prospecting license held by Mr. Mohd. Ijaz Ahmad of Karachi. Mining operations are being considered by M/s Modern Mining Industrial Syndicate. A prospecting license held by M/s Las Bela Mining Industries adjoins this concession on the east. The locations and reference numbers of these licenses are shown in figure 7.

General geology.—Host rocks of the barite deposits are interbedded limestone and shale belonging to the Zidi Formation of Jurassic age. Most sediments strike north and dip west at steep to moderate angles. Barite is found as a series of elongate lenses, parallel to bedding and distributed along a narrow stratigraphic zone several hundred feet below the Jurassic–Cretaceous boundary.

Barite is associated with a conspicuous alteration zone in which beds of limestone and shale have been leached, silicified, and discolored by red and yellow oxides of iron. The altered rocks, as much as 100 feet thick, are found mostly along the footwalls of barite lenses. It is tentatively concluded that the barite deposits are of hydrothermal origin.

The mineralized zone is 4,600 feet long and contains four principal lenses of barite (fig. 8). The largest lens is 1,200 feet long and 30 to 80 feet thick (fig. 9). Other lenses along the strike of the main deposit are 270 to 450 feet long and 5 to 40 feet thick. The two northern lenses, which include the main deposit, form relatively extensive dipslopes and are well suited to opencut mining. The southern lenses could be mined by opencut for a short distance

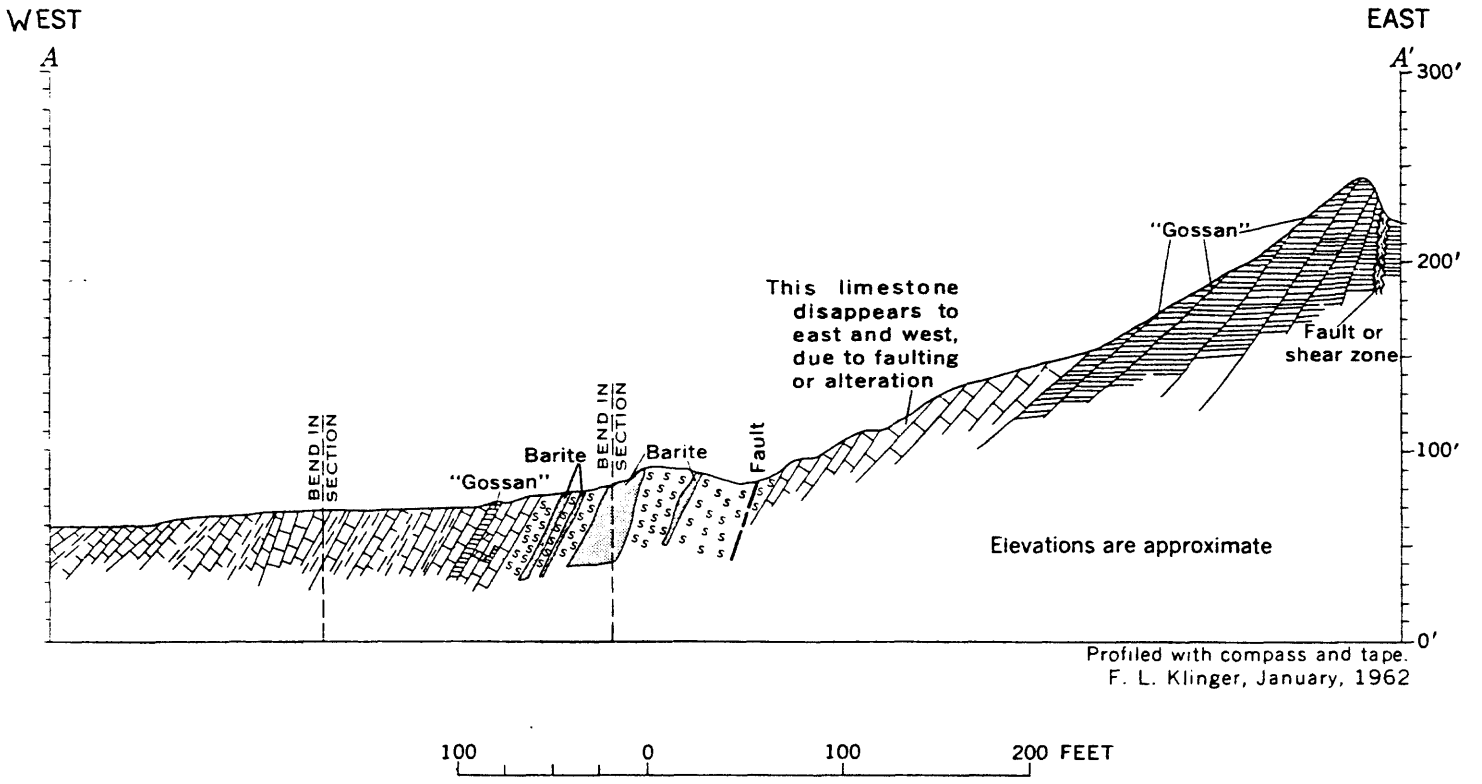


Figure 8 —Geologic section A-A' through mineralized zone, Gunga barite deposits. (Section is 500 feet south of area shown in figure 9).

downdip, but undergound methods would then be necessary. A generalized cross section of the barite deposits is shown in figure 8.

Grade.—The average barite content of the deposits, calculated from specific gravity measurements,[2/] is approximately 80 percent. Specific gravities of 5- to 15-pound representative samples ranged from 3.96 to 4.35. The average specific gravity of samples from the two northern lenses (including the main deposit) is 4.05; this is equivalent to a (calculated) barite content of 75 percent. Specific gravity of samples from the two southern lenses averaged about 4.2, equivalent to a barite content of 85 percent. These figures are approximate and need confirmation by chemical analysis.

2/ As no chemical analyses were available for the samples used to estimate tonnage and average grade, specific-gravity measurements were made as a means of estimating barite content. Information available from fieldwork and previous partial analyses suggest that the material consists essentially of barite in a gangue of quartz and Ca-Mg carbonate. In making the estimates, the material was considered to consist of two components: 1) barite (sp. gr. 4.50); and 2) gangue (sp. gr. 2.70) composed of equal proportions of quartz (sp. gr. 2.65) and Ca-Mg carbonate (sp. gr. 2.75).

Bulk specific gravity was measured by obtaining sample weight in grams, and volume in cubic centimeters by immersion in water in a large graduated cylinder. Errors caused by internal porosity of the material were estimated at 1 percent or less.

For a detailed discussion, refer to Klinger and Ahmad (in press).

A few chemical analyses of the ore are available and are shown in Table 4. Except for sample RGS-1, the samples listed are random specimens and do not represent average ore composition. Sample RGS-1 was collected from the southernmost lens of barite, which composes about 3 percent of the estimated reserves.

The principal mineral impurities are quartz and calcite. Both are very fine grained and difficult to recognize in hand specimens. Acid testing shows that all specimens of the ore are calcitic, and the few chemical analyses show that silica ranges from 1.8 to 4 percent. Iron oxide is found as a minor impurity mostly along the walls of ore bodies and in fault zones. Small amounts of galena are present in the footwall of the main deposit, and traces of cinnabar, cerussite, and plumbojarosite have been found.

If the required chemical analyses indicate the presence of substantial amounts of calcite and/or quartz, selective mining or concentration of the ore may be necessary to obtain a salable product. Because of the fine-grained nature of ore and gangue minerals and the difficulty in recognizing impurities, upgrading of ore by hand will probably be difficult, and mechanical methods may be necessary.

Reserves.—The four lenses are estimated to contain a total reserve of 1,700,000 short tons of crude ore, or 1,280,000 short tons of barite. Approximately 1,100,000 tons of barite, or 85 percent of the total estimated reserve now known in Pakistan, are contained in one deposit.

Table 4.—Chemical analyses of barite from deposits near Khuzdar, Kalat Division (in percent)

Sample	$BaSO_4$	Al_2O_3	SO_3	SiO_2	CaO	MgO	Ign. loss	F	Fe_2O_3
RGS-1 1/	96.0*	N.D.	33.0	4.0	N.D.	N.D.	N.D.	0.06	0.8
Ba-1 2/	91.86	0.73	-	2.48	0.98	1.91	1.63	N.D.	0.02
Ba-2 2/	95.92	0.26	-	1.84	0.49	0.76	0.67	N.D.	0.03
1172-1 3/) 1172-2 3/)	87.0**	-	-	-	-	-	-	Neg.	-

1/ Chip sample, every 1 foot, across a 20-foot thickness of ore, southernmost lens. Analysis by D.L. Skinner and L.F. Rader, U.S. Geological Survey, Washington, D. C.

2/ Loose pieces of barite ore: 1 from hillside, 1 from streambed, collected by M.I. Ahmad. Analysis by PCSIR laboratory, Lahore. Lab ref. No. G. & C/RM/3018.

3/ Grab samples by M.I. Ahmad from northern lens of the two southern deposits. Analysis of BaO by GSP laboratory, Quetta.

* Calculated from percentage of SO_3 given in analysis, assuming that all SO_3 was derived from barium sulfate.

** Calculated from percentage of BaO given in analysis (57.13 in sample 1; 56. 18 in sample 2).

Note:- The calculated percentage of $BaSO_4$ in sample RGS-1 (96) may be compared with 85 percent $BaSO_4$ calculated from the specific gravity of a second sample taken at approximately the same location. The difference could be due to porosity in the specific-gravity sample, or to the presence of sulfate minerals other than barite in the analyzed sample.

Estimated reserves for individual deposits listed below are believed to be conservative.

	Crude ore (short tons)	Est. barite	Contained barite (short tons)
North deposit	116,470	75	87,352
Main deposit	1,514,118	75	1,135,588
N. lens, S. deposits	22,066	85	18,756
S. lens, S. deposits	46,000	85	39,100
	1,698,654		1,280,796

Mining and production.—The Gunga deposits are not being mined at present, although an access road has been built and a small tonnage of "float" barite has been stockpiled. Probably the ore can best be mined in an opencut by means of portable compressors, jackhammers, and random blasting. Secondary breakage can be done with sledgehammers.

Special problems.—To estimate the commercial potential of these deposits requires more accurate information concerning chemical and physical characteristics of the ore. Analytical data are necessary to determine whether the ore is commercially acceptable in its natural state, whether concentration will be required, or what type(s) of beneficiation might be practicable.

Specific gravity tests on a series of controlled samples indicate that some concentration will probably be necessary. With the costs of transportation and milling expected to be high, the additional cost of concentration may render the deposits uneconomic. For this reason the cheapest method of separating commercially acceptable barite

from crude ore may be desirable, even though a high degree of efficiency is not attained. It may be feasible to concentrate the ore by handsorting at the mine, or by handjigging or heavy-media separation at Khuzdar where a supply of water is available. These possibilities should be investigated.

Las Bela District

Bankhri deposits

Location and access.—The Bankhri deposits (fig. 10) are 10 miles east of Bela (lat. 26°14' N., long. 66°27' E.; Survey of Pakistan topographic map 35 J/SW). The deposits are reached by a 20-mile jeepable road from Bela to Khinar Dhora, and then 4 miles by trail.

Ownership.—The area is leased by the United Mining Corp. of Karachi. The company has applied for an extension of their lease, toward the northeast, but the status of this application is not known. The location and reference number of the lease is shown in figure 10.

General geology.—Barite is found as scattered stockworks and fissure veins in quartzitic sandstone of Jurassic age. The sandstone is gray, thinbedded, and contains shaly beds in some places. The rocks strike north to N. 20° W. and dip west 10° to 40° as part of a system of broad folds. In Khinar Dhora, slaty cleavage was observed; it strikes north and dips west at 80°.

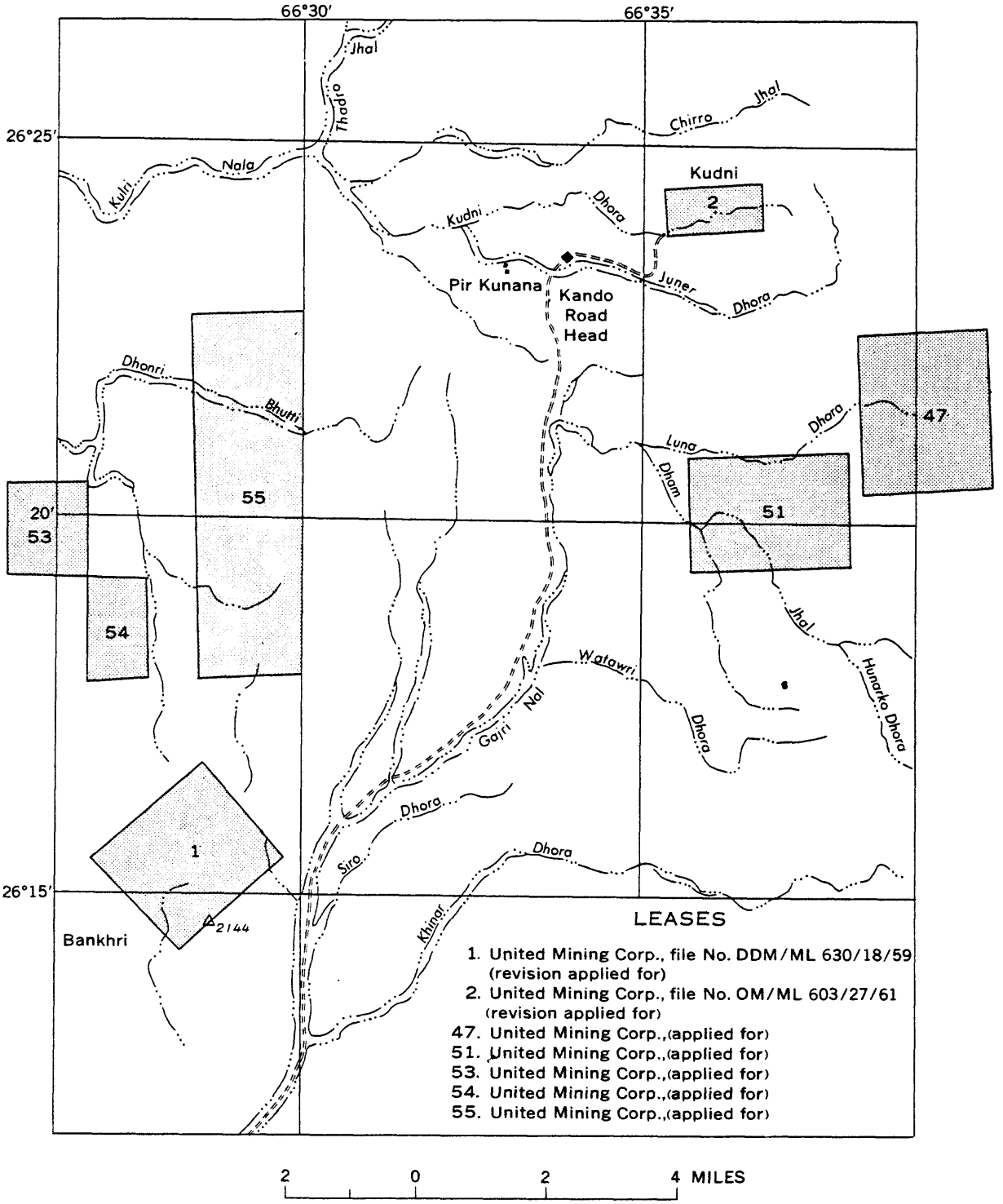
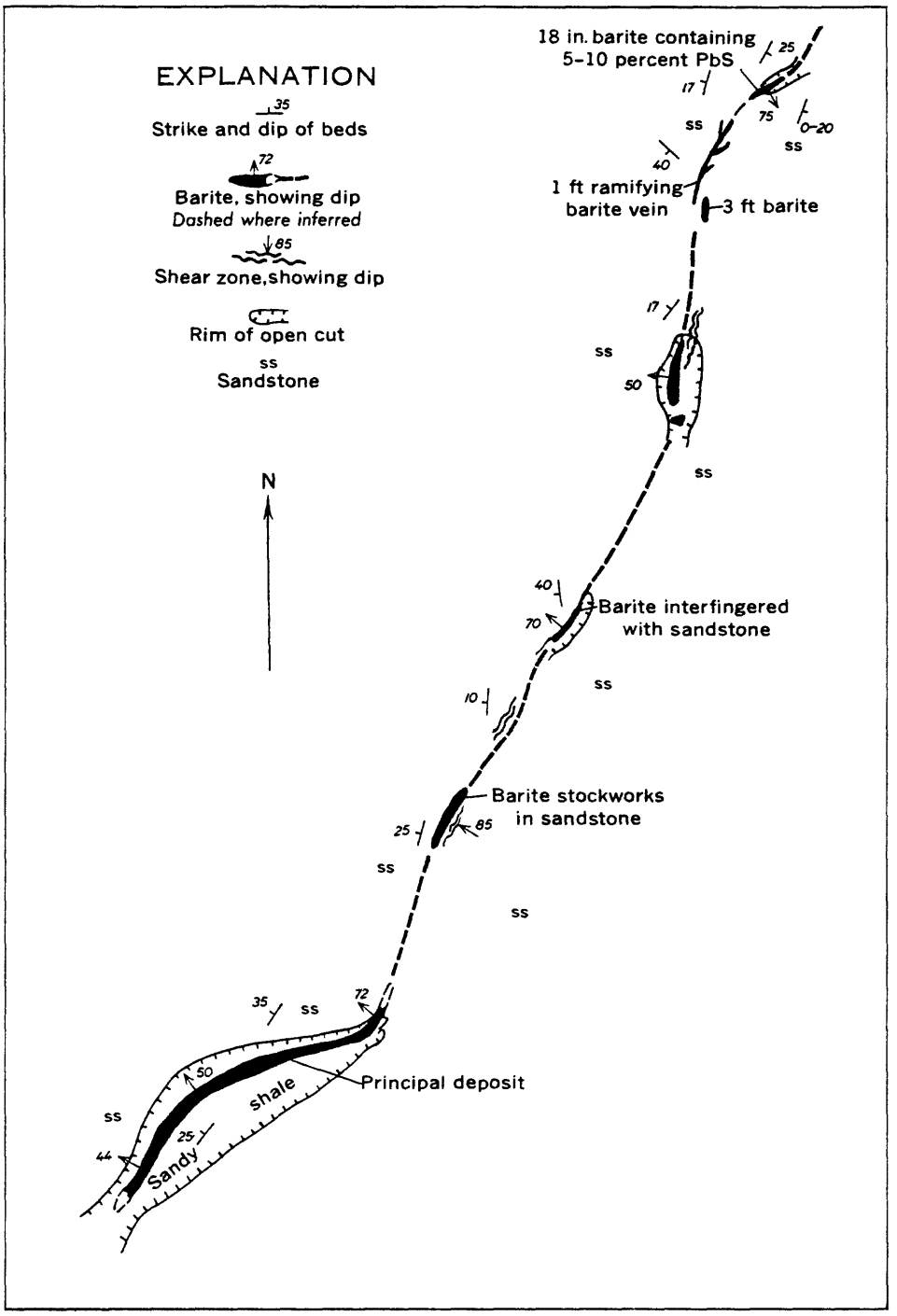


Figure 10—Sketch map showing the location of the Bankhri and Kudni barite leases.

The principal barite deposit is a vein which follows a shear zone or fault (fig. 11). The vein strikes N. 20° E., dips 40°-70° NW., and is exposed on a steep slope for a distance of about 600 feet. Along strike the vein ranges in thickness from a few inches to several feet, and in several places it becomes merely stockworks of veinlets in sandstone. The southern part of the vein maintains a thickness of 4 to 7 feet for a distance of about 125 feet, and is being mined here in a shallow opencut. At its northern end the vein is exposed in a small adit; at this point it is 18 inches thick and contains as much as 10 percent galena and trace amounts of chalcopyrite. Spectrographic tests indicate that the galena contains minor amounts of silver.

About 1/4 mile west of the mining locality small amounts of barite are found in a ferruginous zone in sandstone. The ferruginous rock, essentially quartzite impregnated with fine-grained hematite and goethite, forms a zone some 4,000 feet long and as much as 300 feet wide, parallel to the regional structure. The barite is coarsely crystalline and is found as veinlets, "pockets," or stockworks, none of which measures more than a few feet in length or diameter. The presence of barite in this rock suggests that ferruginous zones may be a guide to prospecting in the area, but it should be noted that the sandstone wallrock of the vein described above is not impregnated with ferruginous matter and shows no visible alteration.



Compass and tape survey by F. L. Klinger and S. H. Abbas, June 1962

50 0 50 FEET

Figure 11—Map of the Bankhri barite deposits.

Grade.—Barite exposed in the opencut appears to be of high quality, although chemical analyses are not available. The mineral is medium grained, dense, and light gray to white. No sandstone inclusions were observed, and the walls of the vein seem to break cleanly from the country rock. The only impurities seen were small amounts of quartz and traces of iron oxide. A chip sample taken across a 5-foot thickness of the vein showed a specific gravity of 4.25, which suggests a barite content of more than 90 percent.

Reserves.—Minable barite reserves in the part of the vein now being mined are estimated to be 2,000 tons. As a dangerous overhang has developed, pillar or timber support will be necessary to extract this tonnage. This estimate is based on the assumption that the vein will maintain an average thickness of 5 feet for a slope distance of 25 feet below the present mining level. Because of the differences in thickness observed over the length of the vein, reserve estimates are risky without supporting data obtainable from undergound exploration. Additional deposits of barite probably can be found in the area. A limonitic vein of barite, 1 foot thick, was found 2 miles south of the mining locality, and another vein, 2 feet thick, is reportedly exposed 1 mile to the east.

Mining and production.—Since 1957, approximately 600 tons of barite have been mined from this deposit by the United Mining Corp. Production is intermittent because of accessibility problems and suspension of work during the hot summer months.

Mining is done by hand-drilling short holes and blasting with black powder. The ore is sorted by hand, transported by donkey or camel 4 miles to the roadhead, then trucked 113 miles to Karachi, where it is ground and bagged by an independent firm. The product is reportedly sold in Karachi to paint manufacturers and petroleum concerns.

The mining company has recently purchased a 5-roll Raymond mill for grinding the barite, but it is not yet in operation. The good quality of the ore and its relative proximity to Karachi would suggest that if transportation and milling costs can be minimized, a small but steady production of marketable barite may be possible from these deposits. However, higher costs can be expected as underground mining methods become necessary.

Kudni deposits

Location and access.—The Kudni deposits (fig. 10) are 15 miles northeast of Bankhri and 40 miles north of Bela (lat. 26°25' N.; long. 66°31' E.; Survey of Pakistan topographic map 35 J/SE).

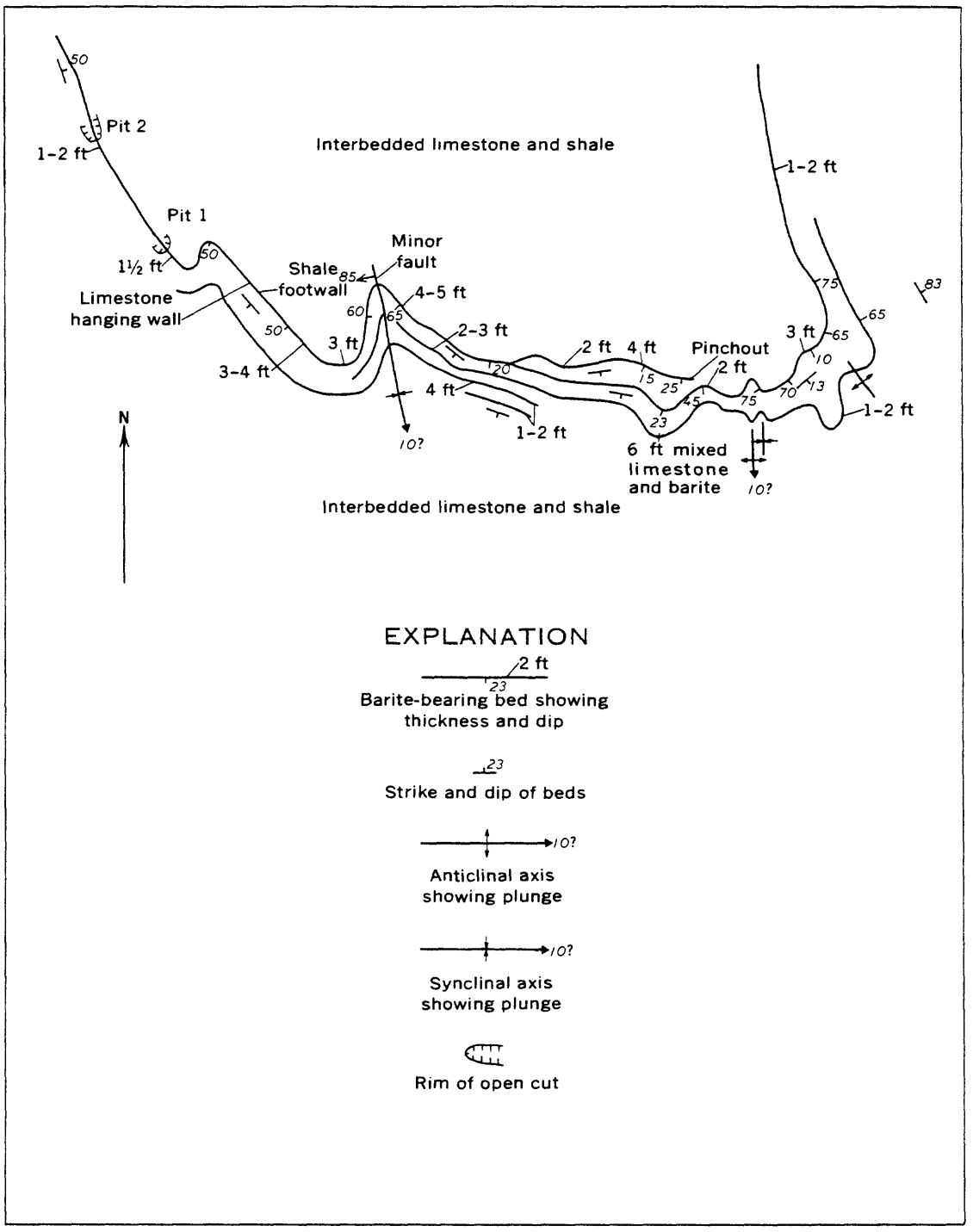
The deposits are reached from the barite dump at Khinar Dhora by following a jeep track up Gajri Nal for 20 miles to Kando, and then by footpath 4 miles eastward via Juner Dhora and Kudni Dhora to a small mining camp. The deposits are half a mile east of the camp, on both sides of Kudni Nala and as much as 500 feet above it.

Ownership.—The mineralized area is leased by the United Mining Corp., which is also mining the Bankhri deposits. The location and reference number of the lease are shown in figure 10.

General geology.—The barite is found as replacement deposits in limestone in a sequence of interbedded limestone and shale. The rocks have been mapped (by Hunting Survey Corp., Ltd. (1960) as the Windar Group of Jurassic age. They are similar in age and lithology to rocks of the Zidi Formation in the Khuzdar region, some 100 miles north.

The rocks are strongly folded and have a regional strike of N. 20° W. The beds dip at steep to moderate angles, and in some places are overturned. The barite-bearing beds of the Kudni deposits are in a complex anticline. The western flank of the anticline is overturned, and the crest of the structure is corrugated by several minor folds which strike parallel to the major structure and pitch gently southeastward. The structure has a width of about 600 feet and an amplitude of about 500 feet. The zone of barite-bearing beds is exposed for a total length of approximately 1,800 feet. Although the barite-bearing zone is continuous across the anticline, deposits of good-quality ore seem to be restricted to the western one-third of the structure. A sketch map of the deposits is shown in figure 12.

In the mineralized zone, as many as five beds of limestone, 1 to 5 feet thick, are partially replaced by barite. These beds are separated by 1 to 4 feet of dark-gray fissile shale, and the alternating series occupies a stratigraphic interval of about 25 feet. Mineralization in the upper three beds is only spotty, and most of the barite is found in the two lower beds. The average thickness of baritic material is probably not more than 2 feet, although thicknesses of as much as 5 feet were observed.



Pace and compass survey by F. L. Klinger and S. H. Abbas, June 1962

100 0 100 200 FEET

Figure 12—Sketch map of Kudni barite deposits.

The mineralization is discontinuous along the strike and probably down the dip. Within a given bed the mineralized rock may terminate abruptly against barren limestone, or the transition may be gradational over several feet or tens of feet. In places the mineralization "jumps" from one limestone bed to the one above or below it. Of the two largest baritic layers, one is 1 to 3 feet thick and persists for a distance of about 250 feet; the other is 3 to 4 feet thick and extends for about 120 feet. Other layers are either very small or of very low grade.

Grade.—The barite content of the mineralized rock is estimated to range from 30 to 98 percent. No chemical analyses are yet available.

Along the crest and eastern flank of the antioline, the mineralized beds are only partially replaced by barite; most of the rock here is of low grade, containing an estimated 30 to 70 percent barite. A chip sample taken across one of the mineralized beds showed a specific gravity of 3.22; this is equivalent to a composition of about 30 percent barite and 70 percent limestone. One small body probably contains 95 percent barite. The barite in this area is relatively coarse grained, and the only observed impurities are calcite (unreplaced limestone) and small amounts of goethitic iron oxide.

The best material is found in a narrow, steeply dipping bed on the western flank of the structure. Compared with the deposits on the crest and eastern flank, the ore here is cleaner, more compact, and is not noticeably discolored by iron oxide. It contains trace amounts of lead and copper minerals such as galena, chalcopyrite, bornite, and malachite.

Reserves.—About 14,000 tons of barite may be available if the mineralized beds are mined for a distance of 25 feet from present exposures. Of this total, 3,000 tons of barite may be recoverable in lump form. The remainder would probably be recoverable only by crushing the material to at least 20-mesh, and subsequent separation of gangue.

Additional deposits can probably be found in the area. The restriction of barite to limestone beds suggests that larger deposits might be found where limestone beds are thicker. In addition, barite may tend to occur along one or more stratigraphic horizons. Both possibilities should be investigated.

Mining and production.—Mining activity has been concentrated on the western flank of the anticline. The steeply dipping, veinlike bed of barite is exposed in a shallow trench for several hundred feet up the dip slope on the south side of a nala and to a maximum depth in the trench of about 10 feet. The excavated area suggests that several hundred tons of barite has been mined from the deposit.

Some mining is also done on the north side of the nala, in an extension of the anticlinal structure. The deposits here are not well exposed; they appear to be irregular and pockety but contain good quality ore.

The ore is either barred or blasted loose, then further broken and sorted by hand. It is hauled 4 miles by camel to the roadhead at Kandc, then 130 miles by truck to Karachi. Most of the first 20

miles of the truck route follows the dry river bed of Gajri Nal, which in places is made nearly impassable by boulder concentrations. Such roadway as exists is always subject to washout. At present, transportation problems can be expected to seriously hinder development of the Kudni deposits.

Chagai District

Koh-i-Sultan deposits

Location and access.—The Koh-i-Sultan deposits (fig. 1) are located near Dabbar, 5 miles northwest of Lower Miri Camp (lat. 29°10' N., long. 62°45'30" E.; Survey of Pakistan topographic map 30/K).

The deposit is accessible by a 40-mile jeep road from Nok Kundi and thence by a 2½-mile trail up Begari nala.

Leaseholders.—No recorded leases are known at present.

General geology.—Barite is found as irregular lenses in a siliceous, vesicular dike which cuts andesitic rocks. The dike strikes north, dips vertically, and is 30 to 50 feet thick. Most barite lenses are only 1 to 2 feet thick, but one lens is 10 feet thick and 100 feet long. Contacts with the igneous rock are gradational, and the barite appears to have formed by replacement. The age of both the dike and the barite is thought to be Pleistocene.

Grade.—The material consists essentially of barite with minor quartz. Near the borders of the lenses barite becomes contaminated with feldspar and other host-rock minerals.

The grade of the handpicked barite is reported to be high, and it is said to have a specific gravity of 4.3. These statements would seem to be supported by the chemical analyses in table 5. The deposits were sampled in 1943 by E.R. Gee and S. Tayyab Ali, then of the Geological Survey of India. The average BaO content of the two samples is 62.2 percent, equivalent to a barite content of about 95 percent.

Reserves, mining, and production.—The deposit is estimated to contain 500 tons of barite, to a depth of 6 feet. Concentration would be necessary to recover this tonnage. The deposit is of doubtful economic importance because of the remote location, small reserves, and scarcity of water.

No mining is now being done. The only known production was three truck loads of barite that were shipped to Lahore in 1959 by a Mr. A. Rahim Khan.

Miscellaneous occurrences

Nodules in shale

Concretions of barite, associated with pyrite, were reported by Tipper (1909) to be widely distributed through the Cretaceous ("Belemnite") shales of Kalat and Las Bela, especially near the Sarmowli River between Chad and Anjira, and on the lower scarps of the Pab Range near Pabni. No estimate of the quantity was given.

Barite nodules were reported by W.N. Khan (1952) from Cretaceous shales west of the Pab Range, near Naka Pabni in Las Bela District.

Table 5.—Analyses of barite ore from Koh-i-Sultan, Chagai District (in percent)

/Analyses by Geological Survey of India/

Sample	BaO	SO_3	Insol	CaO	K_2O	Na_2O	SrO	Loss	Total
1	63.18	34.13	0.64	Tr.	1.08	0.24	0.18	0.34	99.79
2	61.22	34.59	1.30	0.88	1.10	Tr.	0.63	0.43	100.15

The nodules were at lat 27°46' N., long 66°31' E. (Survey of Pakistan topographic map 35 K/SE); they weather out of the shale and may be picked up on the surface. The nodules might constitute 1 percent of the volume of the shale. No analyses are available.

Nodules of barite have been found in the Khuzdar region; they range up to 2 inches in diameter but are relatively scarce. The nodules are found in shale beds of the Jurassic Zidi Formation, along the strike of the Khuzdar barite deposits and about half a mile south.

In the Salt Range, Mianwali District, Kleiber (1958) reports barite as nodules or concretions in the "Lavender clays" of Carboniferous and Permian age. This report is unconfirmed.

Detrital(?) grains in sandstone

Barite is found as an accessory mineral in the "Speckled sandstone" of Carboniferous and Permian age, in the western and central Salt Range, Sargodha Division. The barite may be of detrital origin, or it may have been precipitated in the sandstone during deposition of (hydrothermal?) copper sulfide. The presence of barite in the sandstone was detected by J.J. Matzko and S.H. Abbas while making laboratory investigations of copper deposits in these rocks. Heavy-mineral concentrates from several sandstone beds over a wide area were found to contain as much as 30 percent barite. The concentration of barite in sandstone as a whole, however, is less than 1 percent and is only of academic interest at present. If workable copper deposits are found in this region, barite might be recoverable as a byproduct in a milling operation.

Other occurrences

S. Tayyab Ali (1959) reports a deposit of barite near Pawa in the Hazara District, at lat 34°12' N., long 73°10'30" E. (Survey of Pakistan topographic map 43 F/4). Pawa is 4 miles northeast of Abbottabad and 6 miles east of Sherwan. Although no details are available on this particular locality, Shams (1963) reports barite in galena-bearing veins about 1 mile south of Pawa, and the report may be based on these localities.

Another deposit of barite is reported near Gerai Banda in Swat State, at lat 34°57' N., long 72°47' E. (Survey of Pakistan topographic map 43 B/13). The barite is said to be found as pockets in crystalline limestone. No further details are known.

Conclusions

Several of the barite deposits described above are being worked on a small scale and thus contribute to the overall national production, but current production comes largely from Kohala, and the majority of reserves are near Khuzdar. These areas are therefore of principal economic interest. A small but steady production of high-quality barite can probably be expected from Kohala during the next few years, but sustained barite production and future expansion of the industry probably depend to a large extent upon successful exploitation of the Khuzdar deposits.

Geological mapping of the Kohala area should be done as soon as possible in order to locate additional deposits and to define reserves more accurately. The relatively advantageous location of these deposits

and the high quality of barite that can be produced from them are factors which should be exploited as much as possible.

Some degree of beneficiation is necessary for all deposits in order to produce high-quality barite. Each deposit contains local concentrations of mineral impurities such as calcite, quartz, iron oxide, or metallic sulfides. To some extent the quantity of impurities can be reduced by careful hand sorting, but in some cases more selective methods involving gravity separation or flotation may be necessary. Special facilities for fine-grinding and elimination of impurities by mechanical and/or chemical methods, will be necessary to produce the "snow-white" grade of barite which is not now produced in Pakistan.

Additional deposits of barite can probably be found in the Hazara, Khuzdar, and Las Bela Districts. In Hazara, the deposits of Kohala, Kachhi, Faqir Mohammad, and Tipra are similar in composition and mode of occurrence, and they seem to represent a regional type of mineralization that could be present in many other parts of this district. The Khuzdar deposits lie along a mineralized belt at least 15 miles long which contains several small deposits of galena with barite as an accessory mineral; further prospecting of this belt, and others like it, may result in discovery of additional deposits of barite or other minerals. In Las Bela, barite veins are known over an area of several square miles around Bankhri. Both the Bankhri and Kudni deposits are found in folded Jurassic rocks, and it seems likely that additional deposits may be found in this region. The Khuzdar and Las Bela localities may represent a second regional type of

mineralization possibly related to mafic igneous rocks that are common to both districts, in which case a very large area may be favorable for prospecting.

A summary of the reserves and other details of the barite deposits of Pakistan is presented in Table 6.

UTILIZATION OF DOMESTIC BARITE RESOURCES*

Annual requirements of industry

During the latter part of 1962, hearings were held by the Pakistan Tariff Commission to investigate the problems of barite supply and demand in the country. At these hearings the annual requirements of industry were stated to be 8,700 short tons of barite, 6,000 tons of which were needed for the oil industry and 2,700 tons for the paint industry (Qureshi, 1963). Paint requirements include 1,200 tons of "snow-white" barite, and 1,700 tons of "off-white" grade. Both the oil and paint industries require barite to be ground to a fineness of about 325 mesh. Some paint companies will accept crude barite in lump form and grind it to specifications in their own mills. An unknown but very small quantity of barite and barium products may be required for use in the manufacture of synthetic materials and chemicals.

Requirements of individual consumers in the oil and paint industries are variable. All of them, however, require supplies of relatively high quality barite. Specifications from several consumers in Pakistan are summarized in Table 7.

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* As noted earlier, data in this report are as of 1967.

(page 43b follows)

Table 7.--Domestic consumers' specifications for barite

/Date as received from answers to questionnaires prepared by the Geological Survey of Pakistan/

	Jenson & Nicholson Paint Co.	Attock Oil Co.	Pakistan Shell Oil Co.	Esso Standard Co.	Pakistan Petroleum Co.	Tidewater Oil Co.
Min. $BaSO_4$ (percent).....	90	95	NS	NS	NS	NS
Min. spec. gravity.....	4.0	4.25	4.2	4.1	4.15	4.15
Max. $CaCO_3$ (percent).....	NS	0.1	NS	0.1	NS	2.0
Max. water-soluble salts (percent).....	0.5	0.01	0.1	0.1	0.2	NS
Max SiO_2 (percent).....	NS	NS	NS	"Negligible"	NS	0.5
Max. Fe_2O_3 (percent).....	Very little	NS	NS	NS	NS	5.0
Allowable lead content.....	None	None	NS	None	NS	NS
Allowable clay content (percent).....	NS	1	NS	NS	NS	NS
Free sand or other abrasive material.....	NS	None	NS	NS	NS	NS
Max. other impurities.....	NS	NS	NS	NS	Salinity 300 ppm; 1% sol. in HCl	0.5% H_2O 0.1% other
Color.....	NS	NS	NS	NS	NS	NS
Sizing.....	99.9%-240 mesh	98%-300 mesh	97%-200 mesh	100%-200 mesh	100%-200 mesh	100%-200 mesh
Packaging.....	NS	Double jute bags	6-ply paper bags with polyethylene or bitumenized layer	Paper bags	Double jute or 6-ply paper bags	Paper bags
Specifications standard.....	NS	NS	O.C.M.A.1/	A.P.I.2/	A.P.I.; O.C.M.A.	A.P.I.
Est. consumption 1963 (tons)..	Off-white 1,500 3/ Snow-white 1,000	2,000	1,000	None	2,500	None

1/ O.C.M.A.: Oil Companies Materials Association (performance tests). NS-Not specified
2/ A.P.I.: American Petroleum Institute
3/ Estimated consumption 1963 in Jenson & Nicholson column refers to all paint companies in Pakistan, not J. & N alone.

Table 8.--Firms engaged in mining or exploration of barite deposits in Pakistan.

/Source: 1. Natural Resources, various issues, Nov. 1961-June 1963. 2. Concession maps filed with Bureau of Mineral Resources, Lahore./

Name of firm	Type of activity
1. M/s Zia Mining Corporation Metropole Hotel, Karachi, or 78 Dalhousie Rd., Rawalpindi	Mining
2. M/s United Mining Corporation S. E. Lotitia Chambers Bunder & Kutchery Roads Karachi	Mining
3. Khan Mining Corporation (Mr. Abdul Hafiz Khan) Abbottabad	Mining
4. M/s Amin Agencies, Ltd. 425 Link Road Abbottabad	Mining
5. M/s Rizvi and Sons Abbottabad	Property mined by Zia Corp.
6. M/s Modern Mining Industrial Syndicate Karachi?	Development of Khuzdar deposits
7. M/s A. R. Malik & Co. Jhodkamal Bldg., Ratan Chand Rd. Lahore	Prospecting concession
8. M/s Kohistan Diamond Research Mineral Co. Haripur	Prospecting concession
9. M/s Buxly Paints Ltd. Karachi	Prospecting concession
10. M/s Las Bela Mining Industries Karachi	Prospecting concession

Table 8.--Firms engaged in mining or exploration of barite deposits in Pakistan (continued).

11. M/s Crown Mining Corporation 300/2 Alfred Street, Garden West Karachi	Prospecting concession
12. M/s Pakistan Industrial Mining Syndicate, Ltd. Quetta	Prospecting concession
13. M/s Ahmed and Company, Jodhamal Bldg., Thornton Road Lahore	Prospecting concession
14. M/s Century Mines and Forests 4, Mandiwala, Yusuf Bldg. Grant Road, Karachi	Prospecting concession
15. M/s Bella Mineral Corporation 18, E/2, P.E.C.H.S. Karachi	Prospecting concession

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Table 6. Summary of barite resources in Pakistan

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Division	District	Deposit	Est. reserves (short tons)	Est. grade of ore (% $BaSO_4$)	Main gangue minerals	Type of deposit	Country rock	Remarks
Peshawar	Hazara	Kohala	25,000 +	80-95	Quartz, calcite, slate inclusions	Vein and replacement?	Argillite	Small deposits. Active mining; opencuts, later underground. Further exploration needed, especially in Khan Kalan area.
Do.	do.	Kachhi	1,000 +	60-90	Quartz	Vein	Quartzite	Small deposits. Underground mining necessary.
Do	do.	Faqir Mohammad	500 +	30-95	Quartz, calcite	Vein	Limestone	Very small deposits. Exploration and development continuing.
Do.	do.	Tipra	--	50-90	Quartz, calcite	Vein	Slate	Very small, pockety. Uneconomic.
Kalat	Khuzdar	Gunga	1,280,000	60-95	Calcite, quartz, iron oxide	Replacement	Limestone and shale	Low-cost mining possible, open-pit. Transportation problem, possible beneficiation problem.
Karachi	Las Bela	Bankhri	2,000 +	80-95	Small amounts of calcite, quartz galena	Vein	Sandstone	Small deposit, good ore. Underground mining necessary. More deposits likely in area.
Do.	do.	Kudni	14,000 +	40-95	Calcite, iron oxide	Replacement	Limestone and shale	25% of reserves high grade; remainder requires beneficiation. Transportation problem, underground mining necessary. More deposits likely in area.
Quetta	Chagai	Koh-i-Sultan	500 +	30-95	Quartz, feldspar	Replacement	Felsic igneous rock	Beneficiation needed. Transportation problem, also water. Uneconomic.
Kalat-Karachi	Khuzdar Las Bela	--	Less than 2% of host rock	80?	Shale 98% +	Sedimentary	Shale	Nodules in Cretaceous shale. Uneconomic.
Sargodha	Mianwali	Salt Range	Less than 1% of host rock	?	Feldspathic sandstone 99%	Sedimentary?	Sandstone	Accessory mineral in sandstone. Uneconomic.
		Total	1,423,000 tons					