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UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

PROJECT REPORT
Pakistan Investigations
(IR)-PK-2

[Report - Open file series]

ANTIMONY DEPOSITS OF THE QUETTA-PISHIN DISTRICT,

QUETTA DIVISION, PAKISTAN

by

F. L. Klinger and J. J. Matzko
U. S. Geological Survey

and

S. H. Abbas
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1975

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ABSTRACT

Vein-type deposits of antimony ore, consisting of stibnite and quartz, are found in the hanging wall of faults cutting slate of probable Miocene age 15 miles northeast of Qila Abdullah in the Quetta-Pishin District. The ore is associated with zones of oxidized slate. Although the known deposits are small, the oxidized zones are found over several square miles, and the prospects for additional ore are encouraging.

Deposits of stibnite and oxidized rock are also found in the Qila Viala area, about 25 miles east of the Qila Abdullah deposits. Geologic relationships in the two areas are similar and suggest that deposition of stibnite and quartz, accompanied by alteration of the host rocks, has taken place on a regional scale. This greatly increases the area to be investigated as well as the possibility that deposits of economic value can be found.

A program for further geological investigations is recommended.

INTRODUCTION

Purpose and scope of investigations

A Mineral Exploration and Development Program was started in Pakistan in 1956 under the sponsorship of the International Cooperation Administration, now the U. S. Agency for International Development, U. S. Department of State and the Government of Pakistan. Under this program the U. S. Geological Survey and the Geological Survey of Pakistan cooperated to intensify the exploration and appraisal of Pakistan's mineral, mineral fuel, and water resources. Investigations of an antimony deposit near Qila Abdullah, Quetta-Pishin District, were started in September 1961 as part of the general evaluation of mineral resources of Pakistan. At that time a very small amount of stibnite was exposed in the bottom of a prospect pit, and samples of the ore and adjacent rocks were collected for mineralogical study.

On November 8, 1961, local newspapers reported that a rich deposit of silver had been found 65 miles northwest of Quetta. A vein 5 feet thick and 15 miles long was said to contain 33 percent antimony, 13 percent lead, and 9 percent silver. This report was investigated by M. I. Ahmad and A. Mannan Khan of the Geological Survey of Pakistan and by John Matzko of the U. S. Geological Survey. The deposit reported in the papers was found to be the same deposit near Qila Abdullah on which preliminary geological work was already underway. Although the presence of antimony was confirmed, the investigation did not substantiate the newspaper statements regarding the extent of the deposit or the presence of silver or lead.

Additional investigations were undertaken between November 14, 1961, and January 16, 1962. Six one-day trips were made to the area to study the geology of the deposits and of the surrounding rocks. Samples of the ore and country rock were collected for mineralogical and geochemical study, sketch maps were made using compass and tape, and reconnaissance studies were made over an area of about 1 square mile. On January 16, 1962, the deposits were visited by Arthur Nelson, Senior Mining Consultant, U. S. Agency for International Development, who made several recommendations to the mine owners regarding additional exploratory work.

This report summarizes the Geological Survey of Pakistan-U. S. Geological Survey investigations of the antimony deposits as of 1962.

Acknowledgments

The authors wish to acknowledge the assistance of M. I. Ahmad, A. M. Khan, and A. H. Kidwai, all of the Geological Survey of Pakistan, who visited the Qila Abdullah area to examine and sample the stibnite deposits, and to check the possibility of using aerial photographs to delineate alteration zones.

The authors also wish to acknowledge the cooperation of Mr. Syed Darbar Ali Shah, former Political Agent for Quetta-Pishin District; Mr. Akbar

Jafar, Tehsildar at Pishin; and Mulla Khair Mohammad and Mr. Salauddin of Khair Mohammad and Company, while these investigations were being made. During field work in the Qila Viala area, the industry and general assistance of Mr. Abdul Qayyum, of village Changi Adzezai, was especially helpful.

ANTIMONY DEPOSITS NEAR QILA ABDULLAH

Historical note

The presence of antimony in the vicinity of Qila Abdullah was reported more than 100 years ago by Hutton (1846). Hutton is quoted by La Touche (1918, p. 11) as saying that "stibnite, accompanied by the white oxide of antimony, valentinite, is said to occur in abundance among the hills to the northwestward of Kil'Abdullah." Little is known of any mining activity in the area, although local residents have probably used powdered stibnite as a cosmetic. Recent prospecting and mining activities date from September 1961.

Location

The deposits are 46 miles northwest of Quetta and 14 miles northeast of Qila Abdullah, at lat 30°51'13" N., long 66°51'30" E. (fig. 1). Available base maps of the prospect area include Survey of Pakistan topographic sheet No. 34 J/13 (scale 1:63,360), and a reconnaissance geologic map published by Hunting Survey Corporation, Limited (1960, map no. 26). Aerial photographs at a scale of approximately 1:40,000 are also available.

Access

The prospect area is 72 miles by road from Quetta and may be reached as follows (fig. 1): follow the highway from Quetta toward Chaman, to a point 44.9 miles beyond the Beleli customs post. This point is 1 mile south of the levy post at Qila Abdullah. Turn east onto a dirt road. Follow this road for 4.4 miles to a lone tree, which marks the intersection of a jeep track leading up Arambi Nadi. Turn north and follow the track up Arambi Nadi for 9.6 miles to the village of Silad. Bear left, following the track northward up Ghazlunai Nala for 4.2 miles to the mining camp of Khair Mohammad and Company. The antimony deposits are half a mile northwest of the camp at an elevation of approximately 6,700 feet.

The access road to the prospect area could be improved for use by small trucks. Truck haulage to the railway facilities at Qila Abdullah is about 20 miles.

Ownership

Khair Mohammad and Company of Pishin is prospecting and mining the antimony deposits. Partners in this company include Mr. Khair Mohammad, Mr. Salauddin (General Motors dealer in Quetta), and Messrs. Badruddin and Ghulam Nabi of Quetta. Mr. Mohammad Anwar is the supervisor of the mining camp.

Inquiries regarding the deposits may be made through the office of Mr. Salauddin in Quetta.

Extent of mine workings

Exploratory openings as of January 16, 1962, consisted of 6 prospect pits, 3 irregular inclined shafts, and 2 horizontal adits 8 feet and 30 feet long. The shafts were 20 to 30 feet in length, inclined downward from the surface at angles of about 35°. Approximately 15 tons of stibnite ore had been mined from one pit, and a small showing was being followed in another.

General geology

Rock units and lithology

The rocks of the area are interbedded slate and quartzite sandstone. These are part of the "Kojak shales," named by Griesbach in 1881 and classified by him as Oligocene in age. The same rocks are mapped (Hunting Survey Corporation, Ltd., 1960) as the Shaigalu Sandstone of Oligocene and Miocene age. For a description of the Shaigalu Sandstone the reader is referred to the Hunting Survey Corporation report (1960, p. 270-274).

Slate is the predominant rock type, especially near the antimony deposits, but in places, beds of sandstone constitute 50 percent of the rock sequence. The slate and sandstone have a well-laminated appearance, the beds commonly being less than 2 feet thick. The sandy beds are resistant to weathering and are conspicuous topographic features.

The slate is dark gray, calcareous, and fine grained, and has a compact, massive structure. On weathered exposures it is light to medium gray and splintery. In underground openings (recently excavated) the rock is dark gray and massive. Slaty cleavage is present but not highly developed.

The sandstone is fine grained, gray, and calcareous. It is an indurated rock, massive to thin-bedded, and is abundantly jointed. Under the microscope, anhedral grains of quartz, euhedral crystals of calcite, interstitial iron oxide, and a trace of feldspar are visible; both the quartz and feldspar show secondary overgrowths and undulatory extinction, and calcite has replaced some of the quartz.

The rocks are cut by numerous veins of coarse calcite. These veins, ranging from a few inches to 1 foot thick, are found in en echelon fractures in the slate, in joints in the sandstone beds, and, in places, they form a stockwork of veinlets. Calcite is the only mineral in most of the veins; some of the veins also contain quartz and limonite. Pyrite and chalcopyrite were found near the antimony deposits, but these minerals are rare.

Structure

The rocks are compressed into a series of northeast-trending parallel folds that have vertical or nearly vertical axial planes. Slaty cleavage strikes parallel to the regional structure and has steep to vertical dips. Available maps and aerial photographs indicate that the folded structure is a regional feature and is found over a broad area to the east, north, and south of the prospect area.

Steeply dipping faults strike parallel to the regional structure, or cut across it at angles of 40° to 90°. Individual faults may not be traceable for more than a few hundred feet, but zones in which faulting is common appear to extend for at least half a mile. Displacements along most of the faults are small.

Mineral deposits

The antimony deposits are in zones of oxidized slate. The oxidized zones strike N. 20°-45° E., approximately parallel to the regional structure, and are 50 to 200 feet wide and as much as 2,000 feet long. They are in an area about 4 miles long by half a mile wide. Figure 2 shows the location of the prospect pits and some oxidized zones.

The ore consists essentially of stibnite and quartz, with minor amounts of limonite, hematite, calcite, and secondary oxides of antimony. The ore forms lenses or irregular masses in a friable matrix of quartz and oxidized slate along the hanging walls of faults. Observed ore-bearing rock ranges from 2 inches to 3 feet in width by several inches to 12 feet along the strike or dip of a vein. The mineralization is discontinuous; some faults are mineralized and others are barren. The erratic distribution of ore makes prospecting relatively difficult.

The ore varies in quantity and grade from one prospect pit to another. The distribution of ore in these pits is sketched in Figures 3 and 4, and is briefly described below.

Pit No. 1

Pit No. 1 (fig. 3) is the discovery pit and contains most of the known ore in the area. Approximately 15 tons of ore, containing an estimated 30 percent stibnite by volume, had been mined and stockpiled at this pit at the time of this investigation. Although the stockpile consists of hand-picked material, the ore observed in place is of fairly good grade and probably contains 20 percent stibnite by volume. An estimated 5 tons of ore was in sight in this pit on January 16, 1962. The stibnite lies south of the intersection of faults A, B, and C and may be concentrated into an ore shoot that formed at this intersection along the hanging wall of faults A and C. No ore was found along fault B north of its intersection with A and C although the rock alteration is similar in all places near Pit No. 1. The structures labeled B and C may be local shears rather than faults; they could not be followed for more than 50 feet to the west.

At the small pit southwest of Pit No. 1, a small lens of quartz containing about 1 percent stibnite is along the hanging wall of the fault A-1. The strike and dip of this fault is identical to fault A of Pit No. 1, and it may be a displaced segment of the same structure.

Pit No. 5

Pit No. 5 (figs. 2 and 4) is about 1,200 feet northeast of Pit No. 1. At this pit, two narrow, slightly overlapping lenses of ore are present in siliceous gouge along the hanging wall of a fault. The ore pinches out below the ground surface, and the fault could not be traced for more than 125 feet.

The vein at Pit No. 5 contains 5 to 10 percent stibnite by volume. By January 16, 1962, about 200 pounds of ore had been mined and an estimated 800 pounds of ore was in sight.

Other pits

Other than a small grain of stibnite at Pit No. 4 (fig. 2), no stibnite was found in the other prospect openings of the area.

Mineralogy

Stibnite

The principal ore mineral is stibnite, which has a theoretical composition of 71.7 percent antimony and 28.3 percent sulphur.

Stibnite forms aggregates of prismatic crystals and compact granular masses in a matrix of massive quartz. Individual crystals are as much as several millimeters wide and several centimeters long. They commonly are bent or deformed. The crystals are commonly in parallel or subparallel aggregates; they are less commonly found in random orientation.

Minute aggregates or coatings of fine-grained white, yellow, or reddish-orange material are associated with the stibnite. This material probably consists of various antimony oxides derived from oxidation of stibnite. Stibiconite, a hydrous oxide of antimony, was identified in minute tabular crystals and as pseudomorphs after stibnite crystals. The presence of stibiconite has not been confirmed by X-ray studies.

Quartz

Quartz is the most abundant mineral and is always associated with the stibnite deposits. It forms lenticular masses, veinlets in decomposed rock, and friable to sugary aggregates in altered rock adjacent to ore. It is stained to various shades of brown, yellow, or red by secondary oxides of iron and antimony.

Small euhedral crystals of transparent quartz, some doubly terminated, are present in the ore as a lining in vugs and open fractures.

Accessory minerals

The ore contains small quantities of limonite, hematite, calcite, and pyrite. One small grain of an unidentified copper sulphide, rimmed by a green copper silicate, was also found.

The limonite and hematite are apparently derived from the alteration of sulphides, ferruginous calcite, and from oxidized fragments of slate which are associated with the ore. Calcite is present along fractures as small radiating groups of transparent crystals. Fine-grained pyrite was found in one specimen of ore, and small octahedral pseudomorphs of goethite-hematite after pyrite were found in another.

Near the ore, pyrite and stibnite in very small crystals are disseminated in relatively fresh slate. The pyrite forms cubes and octahedrons, and the stibnite forms acicular crystals. The acicular crystals are found in parallel or random orientation and have an average size of .04 mm by .13 mm. The stibnite is in various stages of alteration to products that have not been identified. A dark-brown to yellowish-brown oxidized material forms replacement shells around some crystals of stibnite and has almost completely replaced others. Mixtures of a yellow to clear, isotropic oxidation material are found with the brown substance and have been tentatively identified as stibiconite. An earthy red coating on stibnite and quartz gives off dense white SO_2 fumes in open-tube test. Other brown and red coatings are a mixture of goethite and hematite.

Chemical analyses

Two representative samples of ore were chipped across the exposed veins at Pits No. 1 and No. 5. Analyses of these samples by the Geological Survey of Pakistan showed 19 percent antimony in the ore from Pit No. 1, and 7 percent antimony in the ore from Pit No. 5. These figures are in general agreement with field estimates.

A grab sample of ore from Pit No. 1 was collected by M. I. Ahmad and A. M. Khan and assayed for silver and gold by the Geological Survey of Pakistan. Only a trace of each metal was found (M. A. Wahid, Geol. Survey of Pakistan, written commun.

A high-grade sample of ore from Pit No. 1 was analyzed (Ref. no. CTL/24/Chem/12/61; file no. CH-7680) for the mine owners by the Central Testing Laboratory, Department of Supply and Development in Karachi. The results were as follows:

	Percent
Antimony	54.29
Barium	10.73
Iron	3.36
Lead	0.3
Arsenic	0.22
Mercury	Trace
Copper	Trace
Zinc	Trace

The quantity of barium shown by this analysis suggests the presence of barite or other barium minerals. Heavy-mineral concentrates of ore samples from this pit were carefully checked, but no barium minerals were found. The presence of lead, arsenic, mercury, or zinc has not been confirmed.

Rock alteration

The association of ore with oxidized zones of the slate has been mentioned above. In general, the long dimension of the oxidized zones is parallel to the regional geologic structure. In detail, the distribution of oxidized rock is also related to crosscutting faults and shears. Oxidation of the slate seems to be indicative of a mineralized area but does not necessarily indicate the presence of ore.

Oxidation of the slate seems to be a weathering effect, not directly related to the process of ore deposition. The slate is commonly oxidized only to a depth of a fraction of an inch, although deeper oxidation is found along faults or shear zones. The fundamental nature of the rock alteration requires further investigation.

Geochemical samples were collected to investigate the distribution of antimony in the oxidized areas, but the chemical analyses are still pending.

The possibility that black-and-white aerial photographs (scale 1:40,000) could be used to detect the rock alteration observed on the ground was investigated in the field by A. H. Kidwai, but the results were negative.

Reserves

The antimony deposits appear to be small. Only one prospect (Pit No. 1) contained appreciable amounts of ore in January 1962.

An estimated 50 tons of ore, containing 20 percent Sb, was present at Pit No. 1 at the time of investigation. This estimate was based on the assumption that the dimensions and grade of exposed ore extended to a depth of 25 feet. Another 15 tons containing an estimated 30 percent Sb were stockpiled. At Pit No. 5, less than 1 ton of ore containing 5 to 10 percent Sb was indicated, and until more development and exploratory work is done, less than 5 tons of ore can be inferred.

These preliminary estimates are summarized as follows:

		Tons	Percent Sb
Pit No. 1	Stockpiled	15	30
	In sight	5	20
	Inferred	45	20
	Total	65 tons containing	22 percent Sb
Pit No. 5	Stockpiled	0.5	5-10
	In sight	0.4	5-10
	Inferred	3.0	5-10
	Total	3.5 tons containing	5-10 percent Sb

The estimated ore reserves are small, but the known deposits had been explored only to shallow depths (about 15 feet at Pit No. 1 and 12 feet at Pit No. 5) at the time of the investigation, and the prospected area is only a small fraction of the area favorable for prospecting. The effects of mineralization, as represented by the oxidized zones, are found over an area of about 3 square miles. Additional exploratory work at the known deposits, geologic mapping, and trenching or pitting in the surrounding area is necessary for a more accurate assessment of the stibnite ore reserves in this area.

DEPOSITS NEAR QILA VIALA

In the Qila Viala region, two areas (fig. 1) have been prospected for antimony. One is located 9 miles northwest of Qila Viala and includes the village of Haji Sardar; the other, Spintangi, is situated about 6 miles southwest of Qila Viala. Antimony has been found only near Haji Sardar.

The geology of both localities is similar to that of the antimony-bearing area near Qila Abdullah. Sandstone and shale of the Shaigalu Sandstone (Hunting Survey Corp., Ltd., 1960, p. 270) are deformed into northeast-trending folds. Linear zones of partly oxidized rocks are found at Haji Sardar and Spintangi, and veinlike deposits of quartz are found within or near the oxidized zones. Stibnite is in the quartz near Haji Sardar, and in mineral composition, texture, and mode of occurrence, this ore closely resembles that near Qila Abdullah. The quartz deposits and oxidized zones at Spintangi seem to be barren of antimony, but the geological similarity of this area to the others suggests that stibnite may eventually be found here.

The following descriptions are based on a few hours reconnaissance work at each locality and are supplemented by analytical results from four samples.

Haji Sardar deposits

Location and access

Two small deposits of stibnite are located 1 mile south of the village of Haji Sardar (fig. 1). The approximate location is lat 30°54' N., long 67°10'25" E. on Survey of Pakistan topographic map No. 34-N/1 (scale, 1:63,360).

The area is about 70 miles by road northeast of Quetta and is reached as follows: drive from Quetta to Pishin; from the petrol station at the turnoff to the Political Rest House in Pishin, drive north on the Qila Viala road for 23.5 miles. Turn north onto a poorly marked fair-weather road (locally called the Bagh road) and continue for 5 miles. Walk 1 mile north to Changi village (locally called Changi Adzezai) and thence about 5 miles north toward Haji Sardar (locally called Shinwam). Mr. Abdul Qayyum, of

Changi village, knows the location of the mineral showings and could be engaged as a guide.

General geology

The rocks are medium-grained quartzitic sandstone and compact, argillitic shale. Although the geology of the area is similar in most respects to the area near Qila Abdullah, the following differences were noted: (1) sandstone is more abundant, forming beds as much as 30 feet thick and constituting the major part of some sections that are as much as 100 feet thick; (2) calcite veins are common in the sandstone but are rarely seen in the shale; (3) slaty cleavage was not observed, although some weathered areas of shale have a splintery appearance; and (4) the regional strike of the beds is approximately N. 60° E. as compared to N. 20°-50° E. near Qila Abdullah.

Several prominent zones of oxidized rock distinguish the Haji Sardar area from the surrounding hills and can be seen from a distance of several miles. The zones are reddish brown, and are as much as 1 mile long and several hundred feet wide. They strike roughly parallel to the regional structure and have probably formed along strike faults or shear zones. Within the zones, oxidation is irregular: some of the rock is completely oxidized and resembles a ferruginous gossan. No oxidation is evident in adjacent areas, although the rock may be softened or bleached.

The stibnite deposits are in quartz and siliceous rock within one of the oxidized zones on the north slopes of the ridge just south of Haji Sardar. The siliceous material seems to form poorly defined zones, or knob-like masses, whose structural relationship to the oxidized areas is not clear. Near the deposits, the beds of sandstone and shale are contorted and seem to be near the crest of an anticline.

Two deposits were found. One is a small pod of massive stibnite ore, several feet long and 2 to 6 inches thick in a small area of siliceous, oxidized rock. The stibnite content ranges from 20 to 90 percent, with accessory pyrite and possibly chalcopyrite in a gangue of fine-grained, iron-stained quartz. This ore weathers black, dark-red, and yellowish-brown and is not readily distinguishable from the altered rock in which it is found. The other deposit consists of a mass of gray to white quartz, about 10 by 12 feet in surface area, which appeared barren but was found by heavy-mineral analysis in the laboratory to contain small amounts of stibnite. The antimony content of this material is probably less than 1 percent.

As only a small part of one oxidized zone was examined, other stibnite deposits may be found in this general area. It is worth noting that the oxidized zones in this area seem to be broader and longer than those in the area near Qila Abdullah. However, the area was insufficiently explored to warrant any estimate of reserves at the time of the examination.

Spintangi area

Location and access

The Spintangi locality (fig. 1) is at lat 30°44' N., long 67°14' E., on Survey of Pakistan topographic map No. 34-N/2 (scale, 1:63,360).

From the petrol station in Pishin (see "Haji Sardar deposits"), drive northeastward on the Qila Viala road for 15.7 miles. Turn south onto a dirt track leading toward two prominent poplar or cypress trees which mark the location of Sardar Skan Khan Qila. Follow track for 1.9 miles to a fort. From the fort, drive eastward along a poorly marked track for 4 miles to the village of Mamanika. The Spintangi area is about 5 miles by footpath south of this village.

General geology

The rocks of the area consist of slaty, argillitic shale with some beds of quartzitic sandstone as much as 10 feet thick. The beds are folded and have a regional strike of about N. 65° E. Slaty cleavage was observed in several places but is not strongly developed.

At least seven large quartz veins are exposed on the north slopes of a hill near Spintangi Nala. They strike northeast, parallel to the bedding of the strata. The veins range from a few inches to 30 feet in thickness, from about 200 feet to 2,000 feet in length, and are found over an area about 4,000 feet long by 500 feet wide. In many places the veins are concordant with the beds, but the dip of the veins is variable and generally is steeper than that of the beds of sandstone or shale.

The veins consist of nearly pure, coarsely crystalline quartz, which on fresh surfaces has a white, milky appearance, but which on weathered surfaces is a light reddish brown. A few well-formed, fairly clear crystals of quartz, as much as 3 inches long and 1 inch in diameter, were found, but none appeared to be suitable for industrial use. A few crystals of pyrite, altered to pseudomorphic aggregates of hematite or goethite, were found in a few places. One grain of sphalerite and several grains of barite were found in heavy-mineral concentrates prepared from the quartz samples in the laboratory. The presence of chromium and manganese was detected by spectrographic tests on the same concentrates, but no antimony was found. Assays for gold have been requested on the field samples, but results are not yet available.

At least six oxidized zones are found in the slate near the quartz veins. The zones are 1 to 10 feet wide and as much as 600 feet long, and they are much smaller and less conspicuous than those observed near Qila Abdullah and Haji Sardar. The oxidized zones at the latter localities are generally parallel to the regional strike, whereas those at Spintangi typically cut across the regional structure at angles of 30° to 40°.

No sulphides or other minerals of possible economic value were found in the oxidized zones. A chip sample taken across one of the oxidized zones was spectrographically scanned for antimony, but no trace of the metal was found.

CONCLUSIONS

The stibnite deposits, rock alteration, and general geology of the mineralized areas near Qila Abdullah closely resemble those near Haji Sardar. Deposition of stibnite and quartz has evidently taken place under similar geologic conditions at these two localities which are about 25 miles apart. This suggests that additional deposits of the same type may be found elsewhere in this region.

The distribution of stibnite and oxidized rock seems to be related to faults, fractures, and shear zones. The principal zones of oxidized rock, in which the ore is found, are oriented parallel to the regional strike and are probably localized along more persistent strike faults or shears. Within the principal zones, the ore deposits, as well as many individual areas of oxidized rock, lie along minor structures which are oriented at angles to the regional strike. The distribution of stibnite seems to be erratic and the deposits are small.

Zones of oxidized rock appear to be indicative of mineralized areas and may serve to guide exploration for antimony and possibly other metals in this region. Although the oxidation is a weathering effect, its distribution suggests that it reflects a rock alteration produced during the period(s) of mineralization. The nature of this alteration is subtle and is not yet understood.

The rocks in the Spintangi area have probably been affected by a similar type of alteration and weathering. Rock alteration in that area is much less extensive than at either Qila Abdullah or Haji Sardar and suggests that mineralization was correspondingly weaker. This may explain the absence (or scarcity) of antimony at that locality.

None of the localities discussed has been adequately prospected or geologically mapped. The three localities described are in a triangular area of about 100 square miles, and the reconnaissance geologic map (Hunting Survey Corp., Ltd., 1960, map No. 26) shows the same rocks exposed in northeast-trending folds over a contiguous area of more than 1,000 square miles. Thus, the total area in which alteration and possible mineral deposits may be found is very large.

RECOMMENDATIONS

The mineralized areas near Qila Abdullah and Haji Sardar should be fully reconnoitered to determine the presence of additional deposits of stibnite or other minerals and to determine the extent and nature of the oxidized zones. The location of all mineral showings and other geologic data should be plotted on appropriate large-scale topographic maps. The mineralized areas should then be geologically mapped on a scale no smaller than 1:6,000, with particular attention given to the relationships between geologic structure, rock alteration, and ore deposition. Supplementary maps on a scale of 1:1,200 (or larger) will be necessary for individual deposits.

The prospect area near Qila Abdullah should be mapped in detail on a scale of 1:1,200. The map should be centered on the main prospect (Pit No. 1) and should cover an area at least 4,000 feet long (in a N. 40° E. direction) and 2,000 feet wide. Larger scale maps and cross sections of individual stibnite deposits should be constructed. Sampling of the ore and wall rocks should be done for chemical, mineralogical, and petrographic analysis. The area recommended for detailed mapping and sampling is shown in Figures 2 and 5.

The quartz veins, oxidized zones, and structure of the Spintangi area should be mapped in detail and the search for antimony continued. An attempt should be made to relate the geology of this area to the areas known to contain stibnite. If no antimony is found, the reasons for its absence may be inferred by comparing geologic details at Spintangi with those from the mineralized areas, and the inferences drawn may prove useful in exploring for and evaluating other antimony deposits in the region.

Geochemical sampling is recommended to investigate the distribution of antimony in the mineralized areas. Both rock and soil samples may be useful, although the soil cover is usually scanty. Sampling of stream sediments will probably be of further assistance in defining mineralized areas.

These investigations will be expedited and will be more effective if the program has the interest and cooperation of mine owners, prospectors, and residents in the area. The reasons for undertaking the investigations, with emphasis on the mutual benefits to be obtained, should be explained to the various groups by the Geological Survey of Pakistan, preferably before field work is started.

Although oxidized areas could not be detected on the aerial photographs available, this does not preclude the possibility that other important features can be delineated that would assist the ground investigations, and these studies should be continued.

In reconnaissance exploration of this region, the possibility that the mineral deposits may be genetically related to the intrusive rock exposed south of Chaman should be recognized. The degree of mineralization may be related to proximity of the intrusive.

Reports, unconfirmed, indicate that other stibnite deposits are in the Gulistan area, southwest of Qila Abdullah. If such deposits are present, geologic relationships similar to those described may be found.

Exploration for antimony deposits northwest of Qila Abdullah is encouraged by the statement of Hutton (1846): "stibnite, accompanied by valentinite, is said to occur in abundance in the hills to the northwest of Kil'Abdullah."

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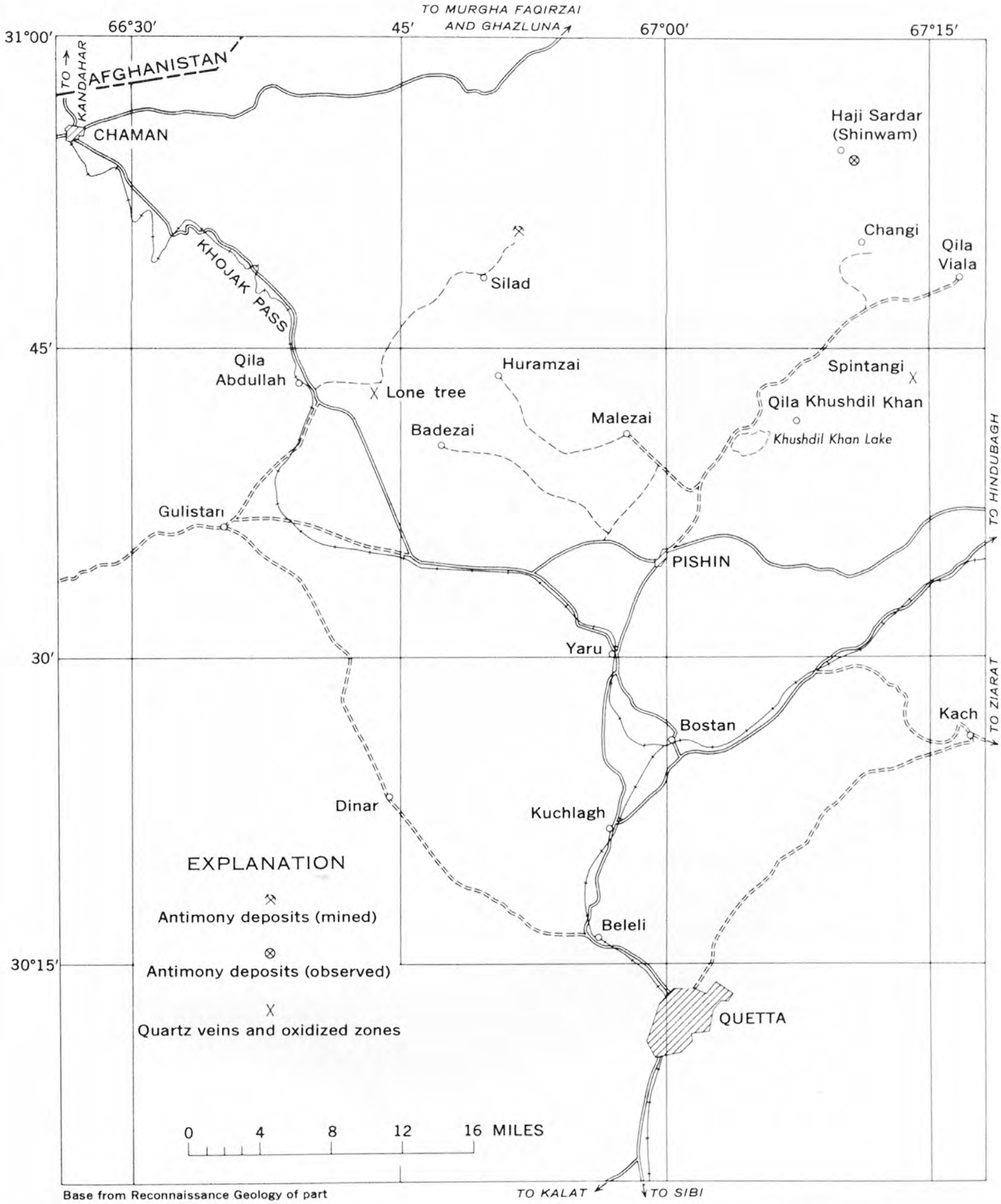

Base from Reconnaissance Geology of part of West Pakistan Geologic map number 26 (Quetta). Compiled by Photographic Survey Corp. Ltd Canada, 1953-56

Figure 1.—Index map showing location of antimony prospects, Quetta-Pishin District, Quetta Division, Pakistan

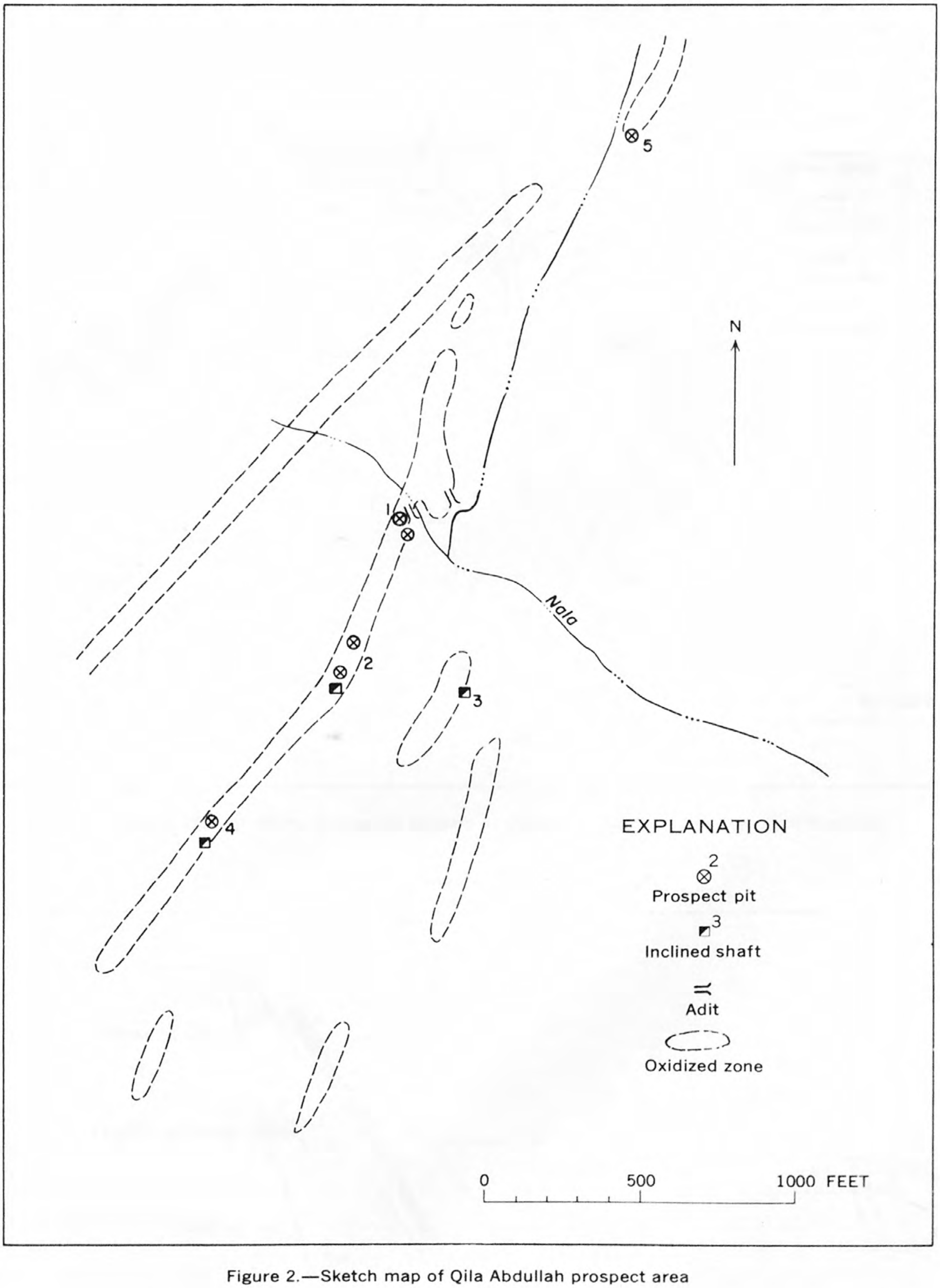

Figure 2.—Sketch map of Qila Abdullah prospect area

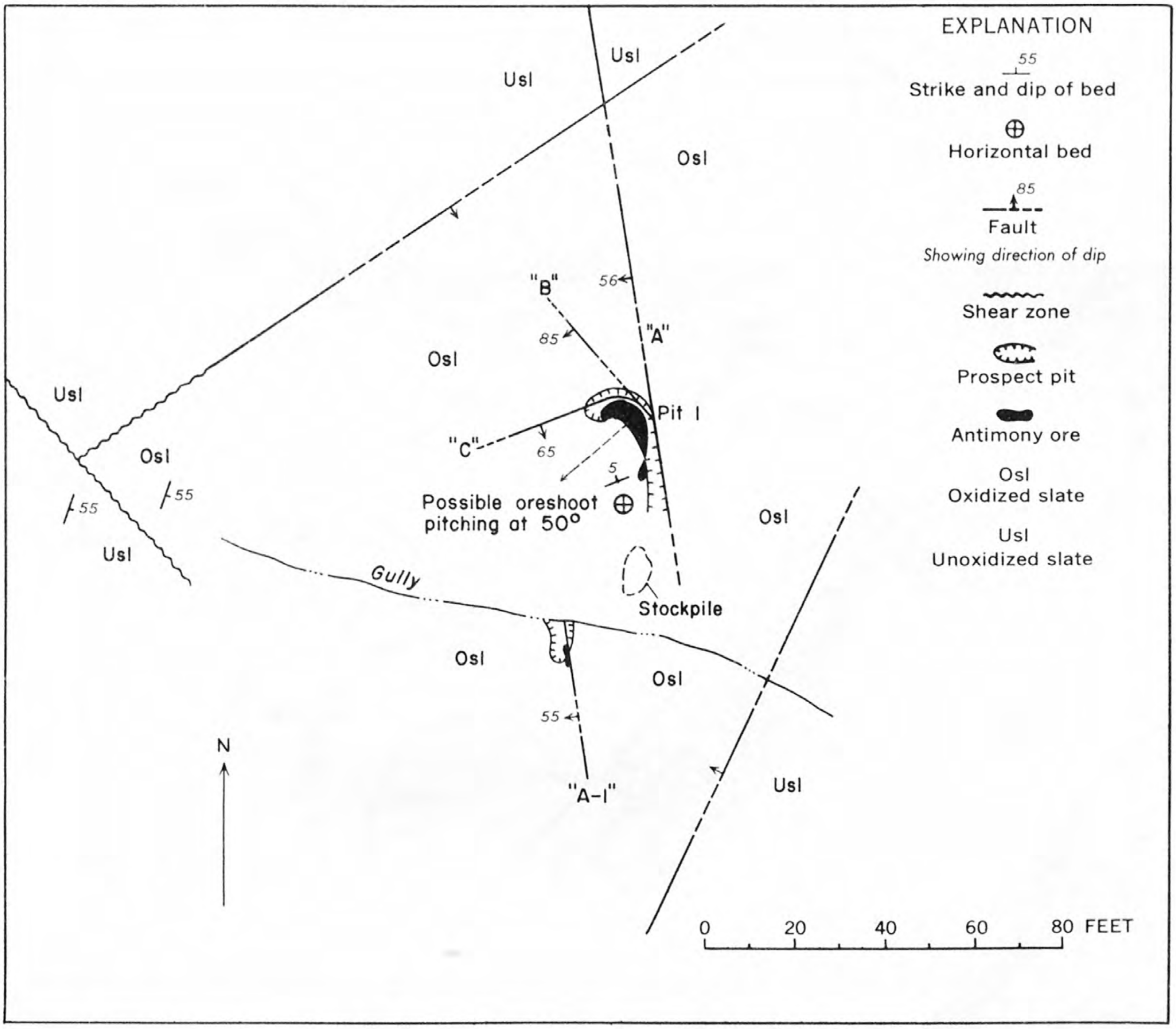

Figure 3.—Sketch map of Pit No. 1 showing relation of ore and oxidized area to structural features

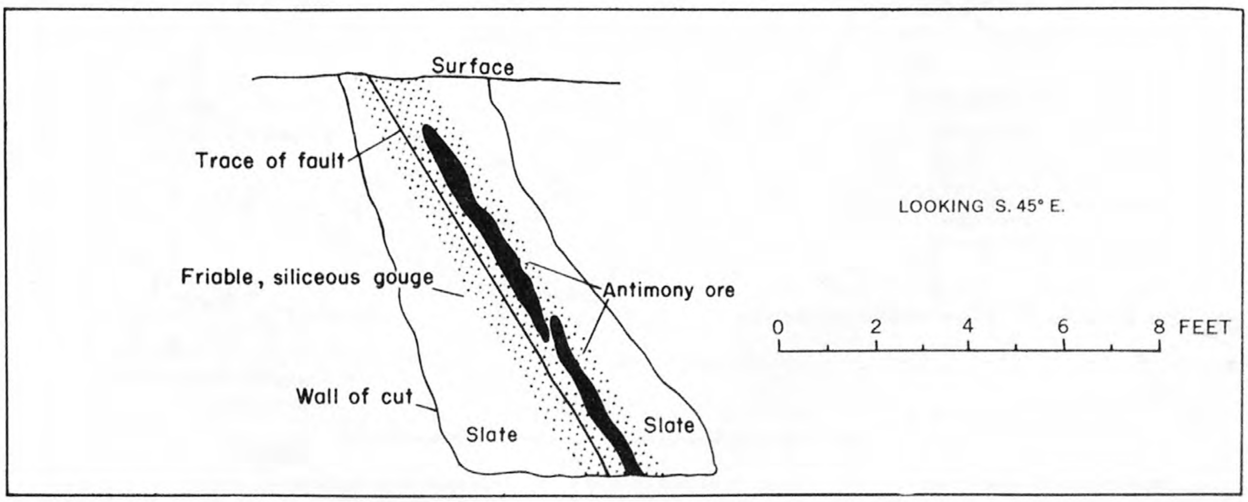

Figure 4.—Diagrammatic cross section through Pit No. 5 showing distribution of ore in hanging wall of fault

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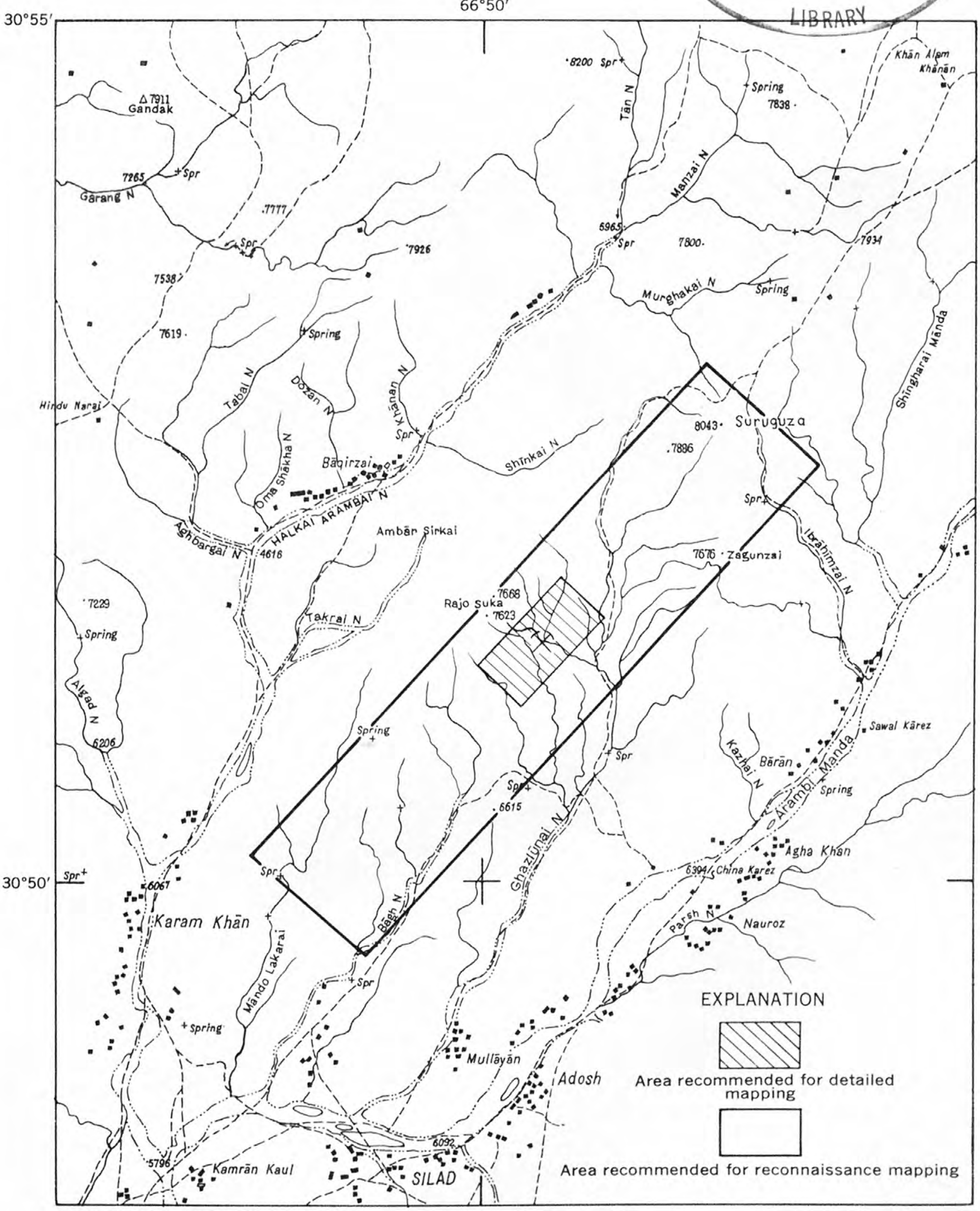

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Figure 5.—Map of Qila Abdullah area showing areas recommended for geological investigation

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