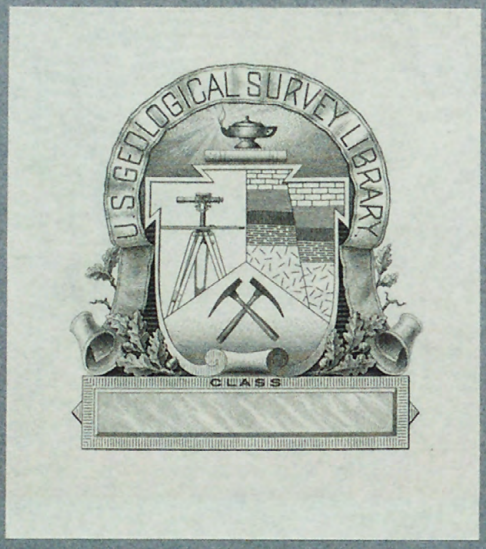
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SOAPSTONE DEPOSITS OF THE SHERWAN AREA

HAZARA DISTRICT, PAKISTAN

by

James A. Calkins and Terry W. Offield
U. S. Geological Survey

and

S. Tayyab Ali
Geological Survey of Pakistan

OPEN FILE REPORT

This report is preliminary and has not been edited or reviewed for conformity with Geological Survey standards or nomenclature

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2. Reconnaissance geology of the Balakot and Mahandri quadrangles, Hazara district, Pakistan, by Terry W. Offield and S. K. M. Abdullah. 41 p., 2 pl. (scale 1:50,000), 1 fig.

3. Reconnaissance geology of the Mansehra quadrangle, Hazara district, Pakistan, by Terry W. Offield, S.K.M. Abdullah, and M. S. Zafar. 31 p., 1 pl. (scale 1:50,000).

4. Soapstone deposits of the Sherwan area, Hazara district, Pakistan, by James A. Calkins, Terry W. Offield, and S. Tayyab Ali. 13 p., 6 figs.

5. Aeromagnetic map of Yellowstone National Park and vicinity, Wyoming-Montana-Idaho, by the U.S. Geological Survey. 1 map (4 sheets), scale 1:125,000. 1012 Federal Bldg., Denver, Colo. 80202; 8102 Federal Office Bldg., Salt Lake City, Utah 84111; 678 U.S. Court House Bldg., Spokane, Wash. 99201; Geological Survey of Wyoming, University of Wyoming (P.O. Box 3008, Univ. Sta.), Laramie, Wyo. 82070; Montana Bureau of Mines and Geology, Montana College of Mineral Sci. and Technology, Butte, Mont. 59701; Idaho Bureau of Mines and Geology, University of Idaho, Moscow, Ida. 83843. [Material from which copy can be made at private expense is available in Moscow, Ida.; Butte, Mont.; and at the USGS office, 1012 Federal Bldg., Denver.] [This report supersedes the open-file of May 17, 1971, entitled "Aeromagnetic map of the Stillwater complex and vicinity, south-central Montana," by USGS.]

6. Geologic map of the Rudolph Hill quadrangle, Gunnison, Hinsdale, and Saguache Counties, Colorado, by J. C. Olson. 1 sheet, scale 1:24,000. 1012 Federal Bldg., Denver, Colo. 80202; 8102 Federal Office Bldg., Salt Lake City, Utah 84111. [Material from which copy can be made at private expense is available at 1012 Federal Bldg., Denver.]

7. Geologic map of the Powderhorn quadrangle, Gunnison and Saguache Counties, Colorado, by D. C. Hedlund and J. C. Olson. 18 p., 1 sheet (scale 1:20,000). [See info. following No. 6, above.]

8. Preliminary geologic map of the unincorporated part of the Topanga quadrangle, Los Angeles County, California, by R. F. Yerkes, R. H. Campbell, J. E. Schoellhamer, and P. W. Birkeland. 1 pl. (scale 1:12,000). 504 Custom House. San Francisco, Calif. 94111; 7638 Federal Bldg., Los Angeles, Calif. 90012. California Div. Mines and Geology, 1416 9th St., Sacramento, Calif. 95814; Ferry Bldg., San Francisco, Calif. 94111; and 107 So. Broadway, Los Angeles, Calif. 90012. [Material from which copy can be made at private expense is available in the San Francisco and Los Angeles offices of the USGS.]

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ABSTRACT

The soapstone deposits in the Sherwan area, Hazara District, are mostly in a narrow 10 mile zone in the dolomite unit of the Abbottabad Formation of probable Carboniferous age. Most of the deposits are at the eastern end on the northern flank of a syncline.

Soapstone forms irregular replacement bodies as much as 100 feet thick along bedding shears, and also along a set of fracture zones which trend N. 80° W. Alteration zones, characterized by secondary microcrystalline and coarsely crystalline dolomite, commonly are associated with the soapstone.

Mining in this area, which commenced in 1952, was done originally by surface cuts; now all the operations are underground. Most production comes from five mines: the Khanda Khu, Chelethar, Bandi, Panjkuian, and Kharan mines. Total production is uncertain; but based on the 2,285 feet of tunnel length and on the size of the surface cuts, it is estimated to be about 20,000 tons. Indicated reserves are slightly more than 200,000 tons.

INTRODUCTION

The largest known deposits of soapstone in Pakistan are in the Sherwan area, Hazara District (Fig. 1), in a belt about 10 miles long and 1½ miles wide extending from Hariala westward through Hal, Khanda Khu, and Bandi to Kharan on the west side of the Siran River.

An investigation of these deposits was undertaken jointly by members of the U.S. Geological Survey and the Geological Survey of Pakistan as an activity of the Mineral Exploration and Development Programme sponsored by the Government of Pakistan and the Agency for International Development, U.S. Department of State. Two visits were made to the Sherwan soapstone area: a two-day reconnaissance trip in late 1961 by Ali, Calkins, and Offield, and a second trip in June 1964 by Calkins and Offield. The results of the first reconnaissance trip were incorporated into a general report by Ali, Calkins, and Offield (1965) on the mineral deposits of the southern part of the Hazara District. The second trip was prompted by the availability of large-scale (1:12,000) topographic base maps prepared by the Geological Survey of Pakistan, which made it possible to survey the deposits and the surrounding area in considerable detail. Regional geological mapping has

Figure 1.—Index map showing the location of the Sherwan area (shaded), Pakistan.

been completed for the Abbottabad quadrangle (S.T. Ali, unpublished data) and for the Tarbela quadrangle (T.W. Offield, J.A. Calkins, and Afaf Ali, unpublished data); some of the data from these unpublished maps have been used in this report, which reflects conditions as of 1967.

Soapstone is the main mineral commodity currently being mined in the Hazara District. Mining of soapstone began in 1952 by Zafaruddin Khan, Abbottabad; at the present time, Zafarudding Khan, his son, Abdul Hafiz Khan, and other relatives own all the soapstone mines under a family partnership called Khans Mining Corp. Mining originally was in open cuts, but now all operations are underground. Production comes mostly from five mines; the Bandi, Chelethar, Khanda Khu, Panjkuian, and Kharan mines. The ore from the first four mines is carried by donkeys to Hal village, and then by truck 25 miles to Abbottabad via the Sherwan-Abbottabad road. Ore from the Kharan mine is carried by donkey to Kachhi and then by truck to Abbottabad. All mining is done with hand tools. In Abbottabad, the soapstone is ground to -80 and -200 mesh in two plants of the Khans Mining Corp. The ground product is sold for Rs.150 per ton ($30.00) for use mainly as a filler in soap and as an important constituent in "Magnesium-Ware" pottery. Because the ore from all the mines is sheared and fractured, it is unsuitable for use as block soapstone.

Other soapstone deposits in Pakistan and a detailed account of uses, current prices, and world production, are given in the commodity report "Soapstone in Pakistan" by Ali and Calkins (1965).

The cooperation and assistance given by Mr. Zafaruddin Khan and other members of the Khans Mining Corp. are gratefully acknowledged.

GENERAL GEOLOGIC SETTING

The rocks in the Sherwan area (Fig. 2) include phyllite, dolomite, and quartzite of the Abbottabad Formation*of probable Carboniferous age, underlain by a thick sequence of quartzose rocks of the Tanawal Formation*of probable Devonian and Silurian age.

The Tanawal Formation*is composed mainly of white and gray quartzite containing thin layers and partings of phyllite. The quartzite is thin to medium-bedded, markedly crossbedded, slightly metamorphosed sandstone and contains lesser amounts of laminated quartzose siltstone and pebble conglomerate layers.

The Abbottabad Formation*unconformably overlies the Tanawal Formation*and occupies most of the mapped area. This formation forms the trough of a large syncline, called the Sherwan syncline. Abrupt facies changes occur in the formation; in order to reveal these lithologic variations and to bring out the synclinal structure of the area, the Abbottabad Formation*is divided into three main units and three members within the units, as follows:

* Published name not formally accepted by Stratigraphic Commission of Palistan.

Figure 2.—Geologic map of the Sherwan soapstone area, Pakistan.

Quartzite unit.
Dolomite unit, containing a phyllite member and a quartzite member.
Phyllite unit, containing a dolomite member.

Because of small-scale folds within the rock units, the thicknesses of the units and members are uncertain, and where stated, should be considered as estimates only.

The phyllite unit, the lowest part of the formation, forms a narrow belt on the limbs and around the nose of the Sherwan syncline. The unit is estimated to range in thickness from 200 to 1000 feet. The unit consists of green, black, and brown phyllite, quartzose phyllite, and calcareous phyllite. Some beds are unmetamorphosed shale and siltstone, but most show the effects of low-grade metamorphism. Lenses of pebble and boulder conglomerate found in places at the base of the phyllite unit indicate an unconformity between this unit and the underlying Tanawal Formation*. An elongate lens of dolomite in the southeast part of the area is mapped as a separate member of the phyllite unit.

The dolomite unit consist mainly of dolomite in most of the mapped area, but on the south flank and east end of the Sherwan syncline a phyllite member and a quartzite member have been mapped separately. The thickness of the dolomite unit is estimated to be about 2500 feet on the flanks of the Sherwan syncline. This figure may be too large, however, because of repetition by folding.

The dolomite is gray to black, thick and thin bedded, and microcrystalline. Most of it is cherty and in places contains rounded sand-size quartz grains scattered throughout the rock. Intercalations of black phyllite, quartzite, and partly dolomitized gray limestone are common. The presence of dolomitized limestone shows that at least some of the dolomite is secondary, but whether all the dolomite rocks are of secondary origin is not known.

The phyllite member of the dolomite unit is similar in lithology to the main phyllite unit of the Abbottabad Formation*. It forms an elongate lens which wraps around the east end of the Sherwan syncline. The phyllite member is underlain by quartzite on the south flank of the Sherwan syncline, dolomite on the north flank, and is overlain in most places by the upper quartzite unit.

The quartzite member of the dolomite unit occupies a thick interval along the south flank of the Sherwan syncline, grading eastward and westward into dolomite. At one point this member makes up the entire thickness of the main dolomite unit. The quartzite is tan, gray and red, medium-to coarse-grained, commonly crossbedded quartzose sandstone containing a few beds of phyllite and dolomite.

The quartzite unit, the uppermost unit of the Abbottabad Formation*, occupies the trough of the Sherwan syncline, and is estimated to be about 1000 feet thick in the mapped area. It is medium to coarse-grained, crossbedded quartzose sandstone similar to that in the dolomite unit.

Structure

The main structural feature in the area is the Sherwan syncline which trends east and is doubly plunging. In the western part of the mapped area the north limb of the syncline is partly truncated by a thrust fault of small displacement along which Tanawal rocks have moved southward over rocks of the Abbottabad Formation*. Numerous smaller folds are present within the syncline, a few of which are shown on the map.

SOAPSTONE DEPOSITS

All the soapstone deposits but one are in the dolomite unit of the Abbottabad Formation. They are distributed around the eastern end and northern limb of the Sherwan syncline (Fig. 2). The Kharan mine, west of the Siran River, is the westernmost deposit in the area. The only soapstone not in dolomite is a small showing in quartzose rocks of the Tanawal Formation* 4 miles east of the mapped area at Hariala.

Soapstone forms irregular bedding-replacement bodies along bedding shears, as well as veins along a set of nearly vertical shear zones. The bedding-replacement bodies are oriented in various directions depending upon the local strike and dip of the bedding. The nearly vertical shear zones trend N 70° to 90°W, parallel to the axial traces of the large and small folds. The two sets of shears are particularly noticeable at the Khanda Khu mine where soapstone veins trend both N 80° W along the steeply dipping shear zones and N 10° E parallel to the bedding. On the north flank of the Sherwan syncline both the bedding and nearly vertical shear zones trend N 70° to 80° W, and the two sets of shears are parallel and indistinguishable.

Unreplaced dolomite in the form of lumps and stringers is the main impurity in the soapstone, and makes up from 10 percent to more than 50 percent of the material mined. Probably an average of 20 percent of the mined material is dolomite; it is removed easily by hand sorting at the mine portal.

Alteration zones from a few feet to as much as 400 feet wide along the outcrop generally are associated with the soapstone deposits. Two of the most prominent alteration zones, however, show no traces of soapstone at the surface. The alteration zones are characterized by small shears filled with pink carbonate minerals and quartz, red and brown-stained siderite and ankerite, and recrystallized dolomite either in rhombic crystals as much as 5 inches long or bleached creamy-white and microcrystalline. Vuggy gray, coarsely crystalline calcite also is present in places.

The soapstone seems to be the result of low-temperature mineralizing solutions that ascended along fracture zones. Because magnesium is a main component of both dolomite and soapstone, dolomite is a natural host rock in the formation of soapstone. Hot water containing silica would provide all that was needed to convert dolomite into soapstone. Some of the silica may have been provided

locally from adjacent beds of quartzose sandstone. The age of mineralization is not known, but it is considered to be associated with the low-grade metamorphism that affected the Tanawal*, the Abbottabad*, and other formations in the Sherwan area, presumably a phase of late Tertiary Himalayan moutain-building activity. The Mansehra Granite is 5 miles from the soapstone deposits and therefore is not directly related to the formation of the soapstone. It may have contributed indirectly, however, by raising the temperature of the region during its intrusion. Post-mineralization structural movements are evident in the shearing of the soapstone.

Description of mines

Khanda Khu mines

The Khanda Khu mines (fig. 2) are three separate workings a short distance west and southwest of Khanda Khu village. Two leases of 12.4 acres each were acquired in 1956 by Abdul Hafiz Khan, a partner in the Khans Mining Corp., Abbottabad.

Khanda Khu No. 1.-- Workings at Khanda Khu No. 1. (fig. 3) located 1,000 feet west of Khanda Khu, consist of a westerly-trending open cut 20 to 40 feet wide, 20 to 30 feet deep, and 250 feet long, together with some underground workings at its western end. The underground workings include a 30-foot steeply inclined shaft providing access to an underground drift, and an inclined adit 40 feet long which joins the underground drift. The open cut was abandoned in 1961 because of wall collapse and is now partly filled in. The underground workings were being operated in 1961, but are now caved. A new pit 25 feet from the western end of the cut, is presently being opened.

The open cut was started on a nearly vertical vein of good quality creamy-white soapstone as much as 14 feet thick, which was localized along a fault of shear striking N. 80° W. in dolomite. The vein pinches eastward against sheared talcose sandstone and is 4 feet thick at the western end of the cut. The two parallel underground tunnels follow splits of the vein for 70 feet, at which point the vein system pinched to 6 inches in thickness, and mining was abandoned. Over this distance, the veins were 2 to 3 feet thick but were split into stringers around dolomite.

The new digging is a small pit sunk 6 feet into the floor of the open cut. Short tunnels to the north and south have exposed the soapstone vein, which is 10 feet thick and dips 50° N.

Fracture cleavage parallel to the vein is common in the dolomite. The fault or shear which localized the vein shows no significant displacement at the surface; in the dolomite west of the open cut, the fault is marked only by a 6-inch zone of dolomite breccia with a rusty-weathering siliceous matrix.

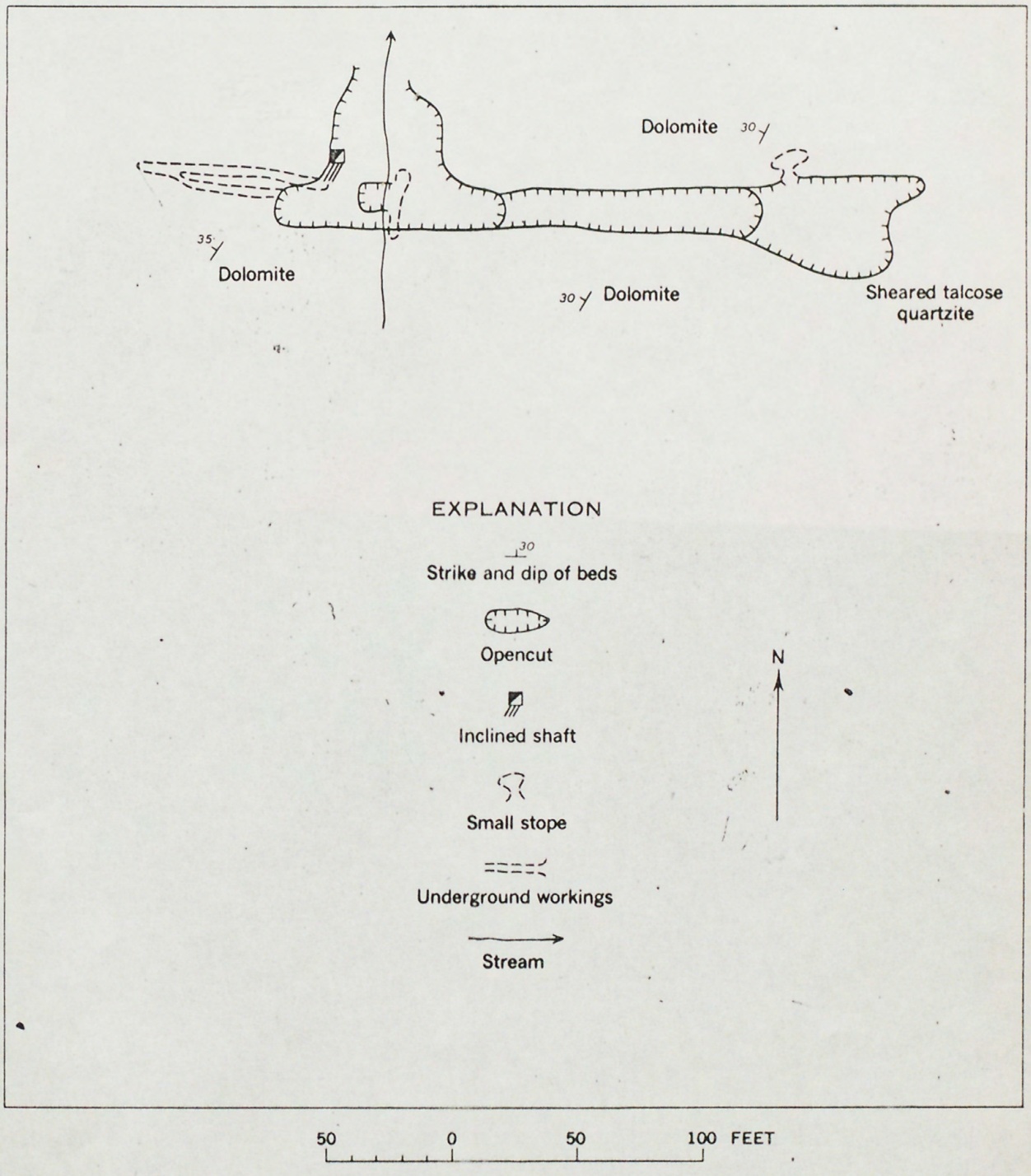

Figure 3.—Sketch map of the Khanda Khu soapstone mine workings number 1, Pakistan.

Replacement of dolomite along bedding shears is not common at this mine area as most of the soapstone was formed along west-trending fracture zones. Such replacement along bedding was observed at one spot on the north wall of the open cut, where a small stope was dug downdip on two small veins. The soapstone in these small veins is associated with white, very coarsely crystalline vein dolomite which forms vertical fracture fillings.

Khanda Khu No. 2.-- Workings at Khanda Khu No. 2 are 700 feet southwest of No. 1, and include three adits, an open trench, and a lateral drift driven southward from the open cut. The bedrock is dolomite containing lenticular beds of quartzose sandstone (fig. 4). In 1964 the open trench was completely filled and converted back to terraced farm land. In 1961, however, when only partly filled, it was 8 feet wide, 30 feet deep, 170 feet long and oriented N. 80° W. along a fault. The open trench was the original working, and it was mined in an eastward direction to the point where the vein pinched to 3 inches. The tunnel driven southward from the open tench had caved prior to the 1961 visit, but the tunnel was reported to have followed a vein of soapstone for 65 feet. The adit 100 feet north of the open trench was driven southeastward in barren dolomite in order to intersect the main vein at depth; however, the tunnel caved and was abandoned. A new exploratory adit starting 36 feet north of the open cut is now being driven to intersect the westward continuation of the main vein. It defines a nearly complete circle dropping in spiral fashion from 4,360 feet elevation at the entrance to 4,300 feet at the working face. Only a few stringers of soapstone have been intersected thus far, indicating that the main vein does not continue west of the creek. The tunnel is being continued northeastward to intersect the old tunnel, where it will be possible to exploit the main vein at depth.

One hundred feet south is another inclined adit driven southwest, and it is presently being worked. Soapstone was intersected 90 feet from the entrance, and two lateral tunnels or crosscuts, 45 and 50 feet long, follow an irregular vein of soapstone, 3 to 5 feet thick, down the dip of a bedding shear. Both laterals are being worked presently.

Khanda Khu No. 3.--Workings at Khanda Khu No. 3 are 900 feet south of No. 2 and are in the same stratigraphic interval (fig. 4). Soapstone is distributed irregularly along west-trending shear zones and as replacement deposits along bedding in dolomite. Work was started originally by opening a quarry or glory hole, which was abandoned long ago and is now largely filled. Workings in 1961, now abandoned, included a 25-foot adit, a caved trench 8 feet wide and 40 feet long, and a sinuous inclined adit about 200 feet long. In the inclined adit the soapstone, 3 to 5 feet thick, is localized in dolomite just below quartzite. The inclined adit follows the 20° dip of the beds, the roof being quartzite the full length of the adit. The quartzite probably served as a caprock to localize the ore in this deposit.

Workings currently being mined include the two adits shown on the south edge of the map (fig. 4). The long adit starting at 4,600 feet elevation and the main lateral drift follow soapstone of unknown thickness the entire length of the workings. The short drift driven south from the main adit ends in quartzite which strikes N.20°W.

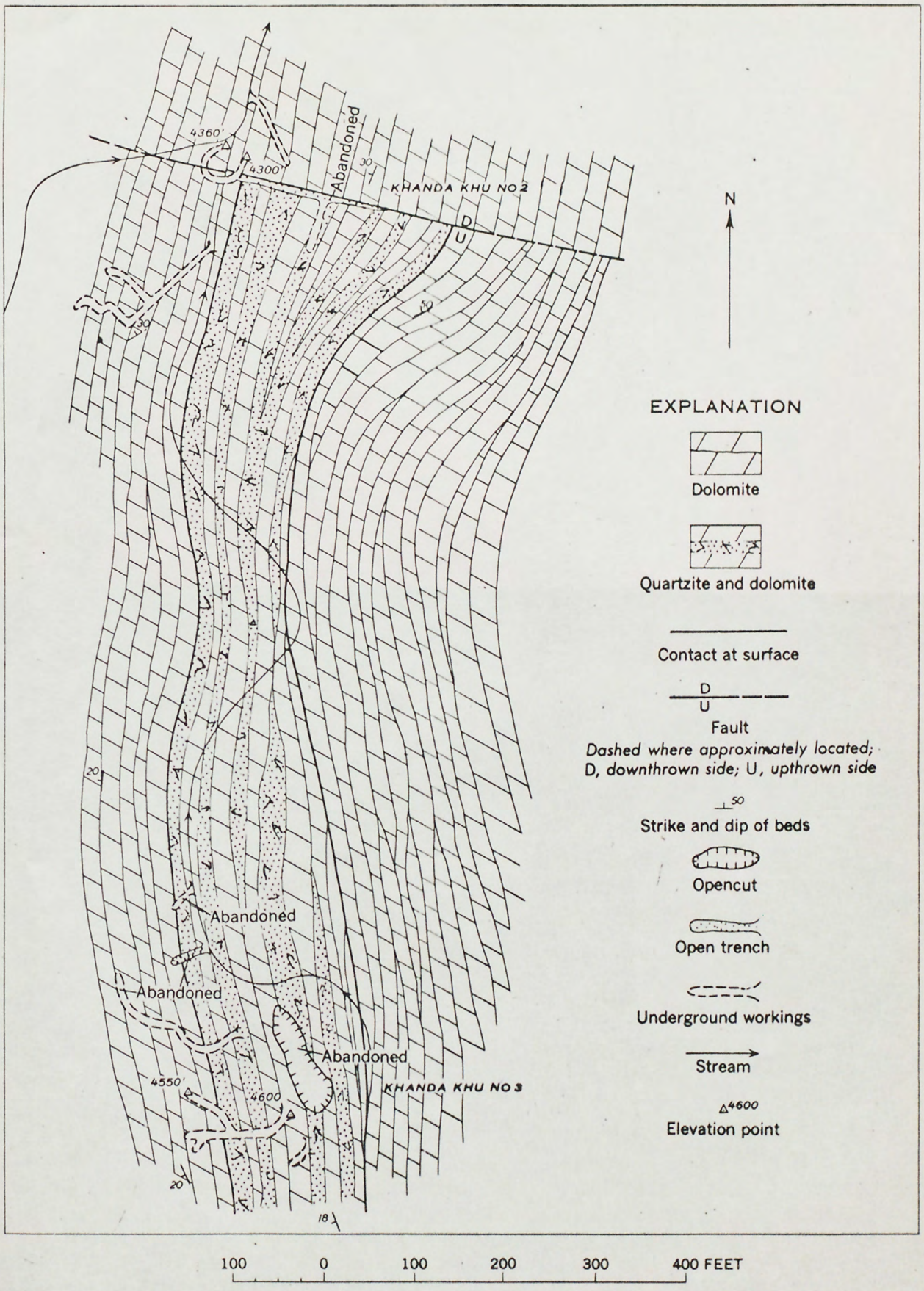

Figure 4.—Sketch map of the Khanda Khu soapstone mine workings number 2 and 3, Pakistan.

and dips 20° SW. The two remaining faces are presently being worked. The short adit 50 feet south of the long adit was started recently. It was opened on a nearly vertical shear zone striking S. 60° W. in quartzite and occupied by a 1-foot vein of soapstone. In the 20-foot interval from the portal to the present working face, the soapstone widens to 4 feet and appears to be of substantial size. This last soapstone vein is of interest because it is one of the rare cases in which soapstone is not directly in or adjacent to dolomite; it also illustrates that a showing of soapstone at the surface is as likely to widen downward as it is to pinch out.

Bagla mine

The Bagla mine (fig. 2) is three-fourths of a mile northwest of Khanda Khu, 50 feet below the crest of a steep east-facing slope. This mine was referred to as "Khand Khu North" by Ali, Calkins, and Offield (1965). No lease is recorded, but the mine is reported to be owned by Mohd. Ferozudding Khan. Workings consist of a small tunnel, 10 feet long in soapstone, and a small pit in quartzite near the tunnel. The mine has been closed for several years. Operations were abandoned because the soapstone contained silica too fine to be removed by hand sorting. Shattered soapstone, 8 feet thick, is exposed in thick-bedded calcareous dolomite. The breccia zone trends west through the saddle south of Hill 3761 (fig. 2) and extends at least 300 feet westward across the saddle, as indicated by chips of soapstone and rusty breccia in the soil. Fractures in the shattered soapstone are filled with orange-stained, silica-carbonate material. If these materials could be separated, this soapstone zone would be a likely place for exploratory digging.

Chelethar mine

The Chelethar mine (fig. 2) is half a mile east of Chelethar village, and 2 miles by trail from Hal. A lease of about 200 acres is held by Mohd. Ferozuddin Khan. The mine is at an elevation of 3,000 feet on a steep north-facing slope along the main trail to Hal. Mining was first done in a large open pit, which eventually caved and is now almost obliterated. The present workings, situated 100 feet downslope from the former open pit, consist of two adits with numerous lateral drifts (fig. 5). A total of 438 feet of underground workings have been driven to date (1964). Fifty feet downslope from the main adits is an old adit, used several years ago, but now caved; its length is unknown. Production from the Chelethar mine is reported to be about 5 tons per day.

The two main adits are approximately at the contact between light-gray, aphanitic dolomite, and soapstone. The strike of the dolomite is N. 70° W. and the dip 35° SW. A large replacement body of sheared and nearly pure soapstone overlies the dolomite in a position approximately parallel to the bedding of the dolomite. The available data from the underground workings, which are entirely in soapstone, indicate that the soapstone body is about 100 feet thick. Its depth and strike length are not known. Sixty feet above the adits at approximately the upper margin of the former open pit is a replacement zone of coarsely

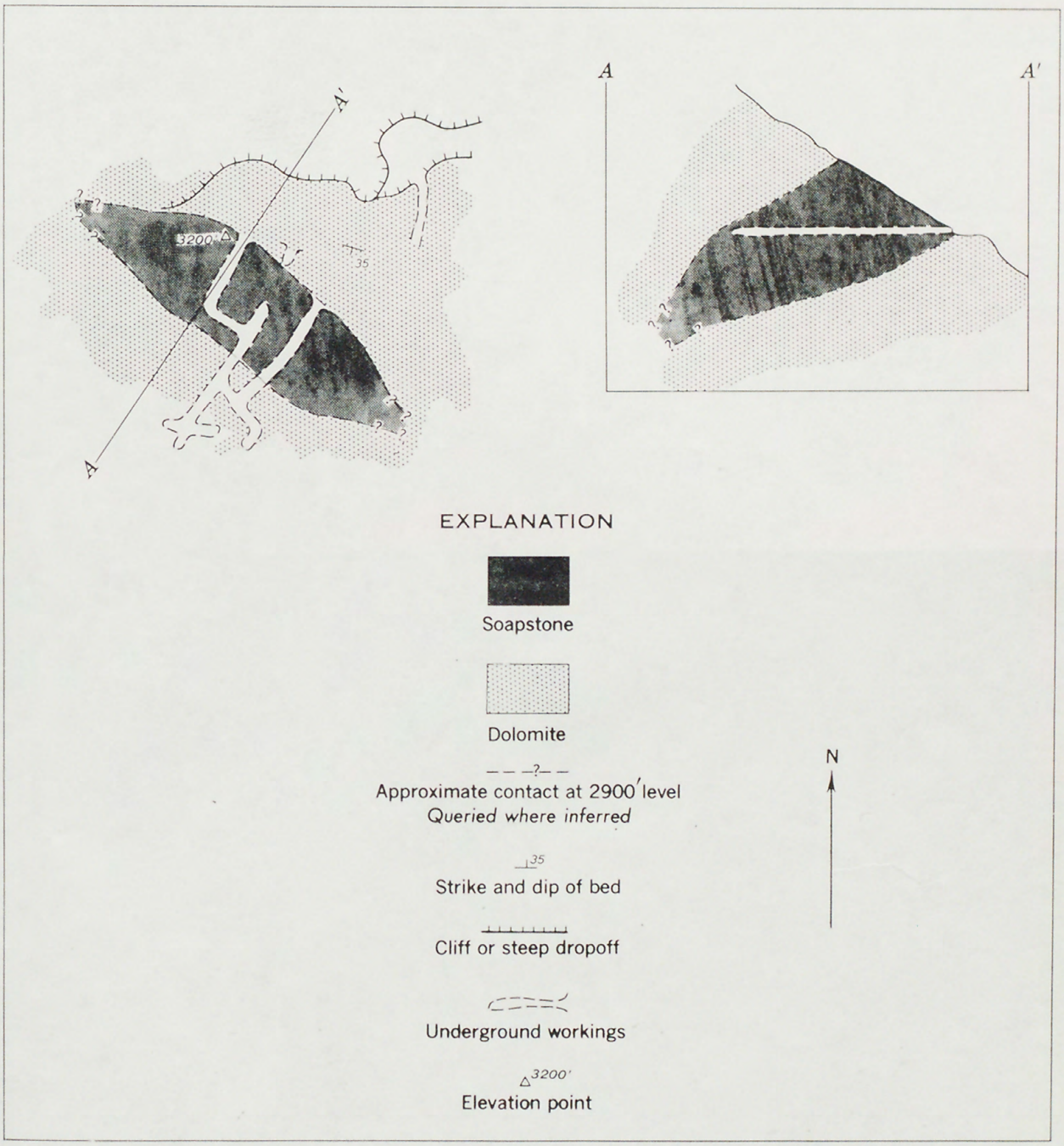

Figure 5.—Sketch map and diagrammatic cross section of the Chelethar soapstone mine, Pakistan.

crystalline dolomite 50 feet thick and at least 300 feet long. Soapstone probably occupies the underlying covered strip for a comparable strike length. A new tunnel, midway between and 20 feet below the two main adits, is being driven through the underlying dolomite in order to intersect the soapstone at a lower level.

Another adit 250 feet west of the main mine is also being worked, but was not accessible. It probably intersects the same soapstone vein. Two more adits are located a quarter of a mile west of the main mine, but these were also inaccessible.

Six hundred feet east of the Chelethar mine along the eastward projection of the same mineralized zone are the remains of an old underground stope of considerable size, now completely caved. This property also is owned by Mohd. Ferozuddin Khan. The size of the workings indicates that about 500 tons of soapstone has been removed.

One thousand feet south of the Chelethar mine is another inactive mine owned by Mohd. Ferozuddin Khan. An adit trends westward from the creek bed on a vertical vein of soapstone which widens to 20 feet. The soapstone was mined out, leaving a stope 100 feet long, 20 feet wide, and 30 feet high, pinching westward and upward. Very little soapstone remains in this lens, but further exploratory tunneling westward might reveal more ore.

Bandi mine

The Bandi Mine (fig. 2) is half a mile west of Chelethar village and 3 miles by trail from Hal. A lease of 208 acres is held by Mohd. Urfan Khan of Havelian. The workings are at an elevation of 2,900 feet and consist of three main horizontal adits with several lateral drifts (fig. 6). The underground workings total 645 feet. The hillside above the adits is covered, but a large tailings pile 50 feet uphill marks the site of former workings where the soapstone intersects the surface. The western adit is caved 55 feet from the entrance and is not being used at present. The middle adit, located 40 feet below the other two, was started in 1961 to serve as a haulage and water-drainage tunnel. The mine produces about 5 tons of soapstone per day, which is carried 3 miles by donkey to Hal, and then by truck to Abbottabad.

The bedrock in the mine area strikes N. 80° E., dips 70° SE., and consists of gray dolomitized limestone below the workings, then 50 feet of soapstone, followed by 60 feet of quartzite, and finally dolomite.

The eastern adit starts in dolomitized limestone and intersects soapstone at 45 feet. The adit continues in soapstone for the remaining 50 feet of its length and terminates in dolomite. One crosscut is driven in soapstone S. 40° W. for 120 feet, and another one, also in soapstone, is driven N. 80° E., ending in a small stope. Near the end of the main tunnel, another rather sinuous drift extends N. 70-80° E. for about 200 feet in soapstone.

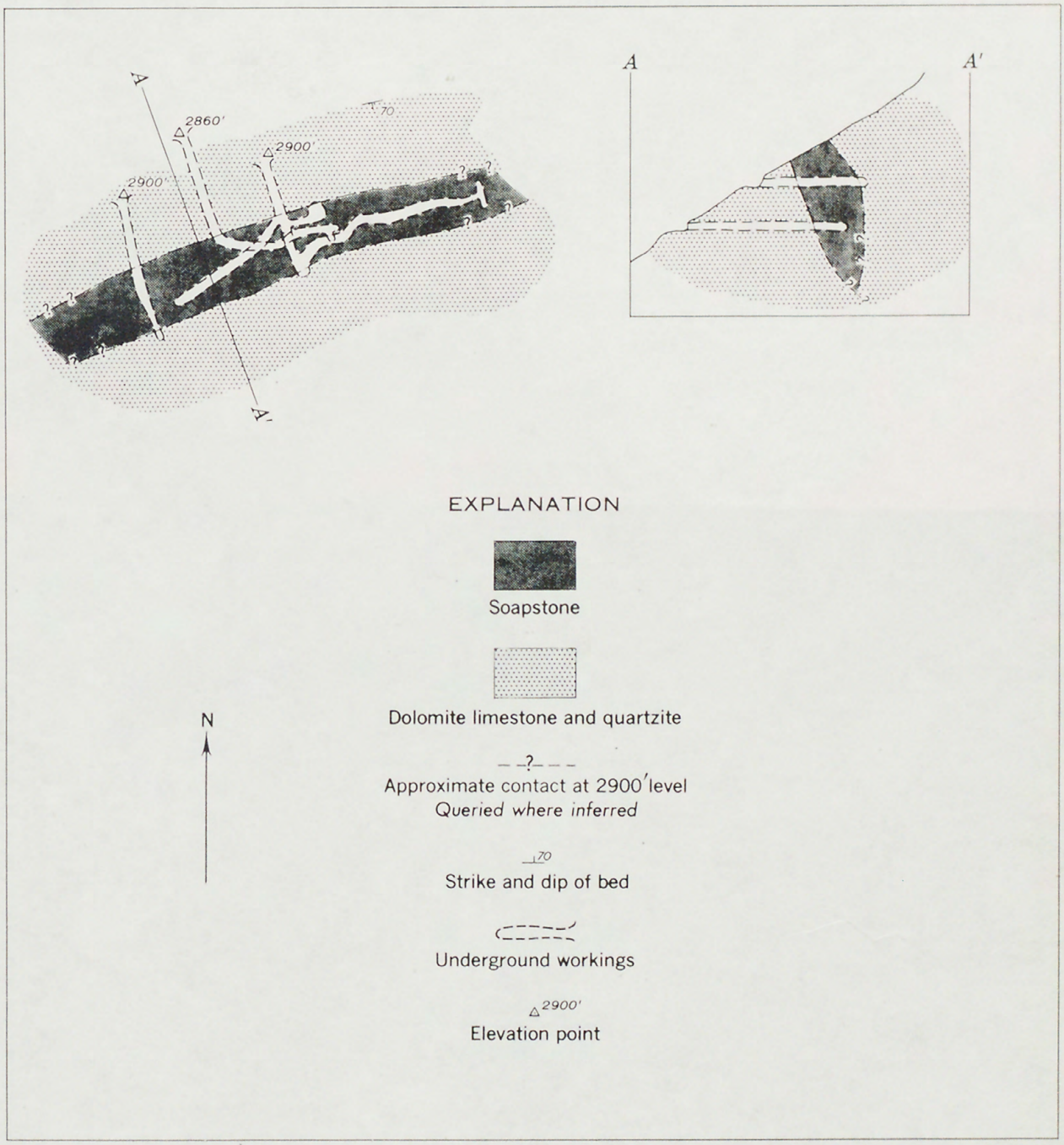

Figure 6.—Sketch map and diagrammatic cross section of the Bandi soapstone mine, Pakistan.

The lower adit, 40 feet below the other two, intersects soapstone 90 feet from the portal. At this point the lower adit turns eastward along the contact to the present working face 182 feet from the portal.

Panjukuian mine

The Panjkuian mine (fig. 2) is located in dolomite 1 mile south of Khanda Khu near the crest of a precipitous southeast-facing ridge. A lease of 70 acres was taken out in 1960 by Major Abdul Jabbar Khan of Hal village. Eight adits at elevations between 4,250 and 4,400 feet are distributed over a distance of 1,500 feet along an altered zone of recrystallized dolimite. The altered zone is 200 to 300 feet thick and swings from south to southwest ot west, parallel to the strike of the bedding. Another adit and an open cut, both in altered zones, are closer to the top of the main ridge just south of Hill 5097 (fig. 2). Mining is done on irregular lenses of soapstone along the replacement zones. The soapstone is localized along bedding shears and along the N. 80° W. set of fractures. In two places, the soapstone bodies have the same direction and plunge as adjacent small-scale folds. The mine was closed temporarily at the time of the visit and the details of the underground workings are not known. The ore is hauled 2 miles by trail to Hal.

The northeasternmost adit, at an elevation of 4,350 feet, was driven N. 55° W. on a 20° incline for 30 feet along a replacement lens of soapstone and recrystallized dolimite. The bedding nearby strikes N. 25° W. and dips 40° SW. The lens is 6 feet thick just inside the adit and thins to 3 feet at the end of the adit. About half the mined material is soapstone, which forms sheared anastamosing stringers around teardrop-shaped pods of recrystallized, mostly microcrystalline, dolimite.

At the mine location shown in figure 2, there are four short, closely spaced adits, inclined 40° to 50° and driven N. 70-80°W. into a replacement zone of intermixed soapstone and microcrystalline dolomite. The longest adit is 40 feet, and the remaining three are each about 20 feet in length.

The adit 300 feet east of the mine location is driven 10 feet due north, then turns N. 40° E. for another 15 feet along a bedding replacement seam of strongly sheared soapstone, 6 inches to 2 feet thick. The adit 250 feet southwest of the mine location was caved and inaccessible. It was driven westward at a steep incline.

The southeasternmost adit was driven horizontally N. 85° W. on a vein of soapstone which follows the bedding in the dolomite. The adit is 55 feet long and slopes downward the last 20 feet. The soapstone is 2 to 6 feet thick in the main body of the vein, but it pinches to thin stringers at the end of the adit. The vein is stoped upward for 12 feet and is 2 feet thick at the top of the stope. The soapstone closely follows the bedding of the dolomite.

The adit just southeast of Hill 5097 was driven along a mineralized shear zone striking N. 70° W. and dipping 45° NE. It is 70 feet long and inclined 30°. The soapstone forms stringers around pods of microcrystalline dolomite and makes up less than 30 percent of the mined material. Mineral streaking, rodding, and drag folds in the adjacent dolomite plunge 22° N. 65° W.

Seven hundred feet west of the adit described in the preceding paragraph is an open cut, 67 feet long, 5 to 10 feet wide, and 10 feet deep along a vertical shear zone. The cut is parallel to the bedding which strikes N. 70° W. and dips vertically. Near the eastern end of the cut, an inclined adit is driven a few feet eastward and opens into a stope, 20 feet high, 8 feet wide, and 20 feet long.

Kharan mine

The Kharan mine (fig. 2) is at an elevation of 2,100 feet, a quarter of a mile west of Kharan on the west side of the Siran River. The property was leased in 1955 by Mohd. Zafaruddin Khan and is now operated by his son, Abdul Hafiz Khan. The ore is hauled by donkey 5 miles by trail down the Siran River to Kachhi, the terminal point on a motorable road, and then by truck to Abbottabad. The mine closed early in 1963, but reoponed in July 1964. Production was reported to be 1½ tons per day.

Workings consist of an adit, 20 feet long, driven N. 65° W., and opening abruptly into a high narrow stope. At the western wall of the stope are three drifts, one below the other, driven N. 80° W. into soapstone. The mine was accessible only to the edge of the stope; the length of the tunnels is not known, although the upper tunnel extends west for about 60 feet. The adit was opened on a bedding shear in dolomite, both the dolomite and the shear striking N. 65° W. and dipping vertically. The shear zone contains coarsely crystalline dolomite, and stringers and pods of soapstone. Inside the adit, the soapstone widens into a lens in which the stope and tunnels are cut. The stope is 30 feet high, 12 feet wide, and 15 feet long. A.Hafiz Khan (personal communication) states that soapstone continues westward and downward. He plans to drive a low-level tunnel that will intersect the lowest workings and make it possible to stope out the entire ore body.

Hariala soapstone showing

The Hariala showing is 4 miles by road east of Hal, 300 feet above and on the north side of the Sherwan-Abbottabad road, east of the eastern border of figure 2. No lease is recorded. Workings consist of a small open cut and short tunnel dug along a sheared schistose talc vein, 2 to 3 feet thick, that strikes N. 25° E. and dips vertically. The host rock is quartzite and schistose conglomeratic quartzite of the Tanawal Formation, which strikes N. 30° E. and dips vertically. The soapstone vein seems to be an offshoot from an adjacent crush zone, 8 feet wide, that strikes N. 20° W. and consists of sheared quartzite intermixed with schistose talc. The amount of material available is small and of poor quality.

PRODUCTION AND RESERVES

Total production of soapstone from the Sherwan area was 14,300 tons through 1963 (Directorate of Mineral Development, Lahore, 1962). Annual production for 1958-1963 has averaged about 2,000 tons. The order of magnitude of total production through 1964 from the individual mines may be calculated from the length of the underground workings and the size of the surface excavations. The average tunnel is taken as 5 feet wide and 7 feet high, and it is assumed that the material mined is 100 percent soapstone, except where the tunnel lengths are known to be barren. Production based on the above assumptions is summarized below:

Mine	Underground workings: Drift length	Underground workings: Short tons mined	Open cuts: Short tons mined	Total (short tons)
Bandi	645 feet	2,000	Production unknown	2,000
Chelethar	438 feet	1,400	" "	1,400
Khanda Khu				
No. 1 Workings	120 feet	370	4,000	4,370
No. 2 Workings	207 feet	600	3,500	4,100
No. 3 Workings	395 feet	1,200	700 from small trench; large open cut of unknown size	1,900
Panjkuian	300 feet	1,300 (includes small stope)	400	1,700
Kharan	180 feet	1,500 (includes large stope)	- - -	1,500
Bagla	unknown	unknown	- - -	- - -
Total	2,285 feet			16,970
Total less 20 percent gangue:				13,576 short tons

Assuming that 20 percent of the mined product is gangue, the resulting total production is about 13,500 tons. This figure does not include production from a few of the adits, which were closed; nor does it include production from the open cuts at the Bandi, Chelthar, and Khanda Khu mines.

These estimates, calculated indirectly for the individual mines, compare reasonably well with the official totals, which, when projected through 1964 at the rate of 2,000 tons per year, will be about 16,000 tons.

Reserves in the Khanda Khu and Panjkuian mines are uncertain because of the patchy distribution and sparse data on the dimensions of the soapstone bodies. The deposits at the Bandi, Chelethar, and Kharan mines are more regular in shape and enough underground data are available to compute the "indicated" reserves.

Underground workings in the Bandi mine outline a soapstone body 50 feet thick, extending a minimum length of 350 feet along the strike, and 70 feet from the lower level to the surface. Assuming a block of this size, the indicated reserves are 107,000 tons. Underground data in the Chelethar mine indicate a body of soapstone 100 feet thick, having a minimum of 100 feet of dip length, and a minimum of 110 feet of strike length. A rectangular block of this size should contain 97,000 tons of indicated ore. Indicated reserves for the Kharan mine are 3,000 tons.

It can be assumed that the soapstone in the Bandi and Chelethar mines extends downward another 100 feet and for a considerable added distance along the strike. This would make the total reserves at the Bandi and Chelethar mines twice the size of the indicated reserves. At the Khanda Khu mine, it can be inferred that the soapstone in the open cut of No. 1 Workings extends downward for 20 feet more, is 10 feet thick and 100 feet long. This would provide 2,000 tons of inferred ore at these workings. At Khanda Khu No. 2, the long adit with two crosscuts partially outlines a body of inferred ore of about 1,000 tons. The two longest inclined adits of Khanda Khu No. 3 partially outline a sheetlike body of soapstone 150 feet long which extends 100 feet downdip, and is 5 feet thick: this would amount to about 6,500 tons of inferred ore. The total inferred reserves at all three workings of the Khanda Khu mine are thus 9,500 tons. Not enough data are available at the Panjkuian mine to compute the reserves.

RECOMMENDATIONS

The Sherwan soapstone area has been prospected fairly well by the local miners, and all the larger surface showings of soapstone and most of the smaller ones have been explored. As soapstone is soft, incompetent, and highly sheared, it is seldom seen at the surface; however, alteration zones commonly associated with soapstone veins provide an indirect means of locating deposits. One such alteration zone, not yet well prospected, extends for several thousand feet east and west of Kangrora (fig. 2). Others are located uphill from the Panjkuian mine near Hill 5020, along the westward extension of the Panjkuian open cut, and west of Khanda Khu. Because of their irregular shape, the soapstone bodies widen underground as often as they pinch out; thus, it commonly happens that a prospect being dug on a thin seam of soapstone at the surface opens into a thick vein a few feet underground.

The rugged terrain of the area creates a difficult transport problem. Donkey transport along rough and steep trails from the mines to Hal village is expensive and inefficient. If the road were extended from Hal to the mines, the cost of transport to Abbottabad would be decreased considerably. Another possibility would be to extend the road 10 miles from Kachhi up the Siran River to the mines and process the soapstone at Haripur instead of Abbottabad.

Because of its sheared and fractured condition, the soapstone is utilized only in ground or powdered form; no block soapstone is produced. It would seem worthwhile to investigate the possibilities of making small shaped items, such as gas nozzles and thread winders, from pressed, ground soapstone, or from small unfractured pieces. The Pakistan Council for Scientific and Industrial Research is equipped to study these possibilities.

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