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A GEOLOGICAL TRAVERSE THROUGH MOHMAND AGENCY AND BAJAUR, N.W.F.P. WEST PAKISTAN.

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ABSTRACT

Traverses in Mohmand Agency and Bajaur reveal that the area is underlain by a variety of metamorphic and igneous rocks. Slates, phyllites, schists, amphibolites and interbedded crystalline limestone cover extensive part of the area. Granite, microgranite and diorite are the igneous rocks found in addition to a thick ultramafic body which is closely associated with the carbonate horizon.

Extensive marble reserves of various grades and shades have been encountered. The carbonate horizon mostly yields pure white, greenish and brownish marble, as well as several varieties of limestone. Big economical blocks of marble can be extracted. This part of the metasedimentary terrain may be the northern termination of a large fold having connection with the Mullangori structure.

INTRODUCTION

Extensive marble reserves of various shades and grades have been discovered in the metamorphic terrains of Mohmand Agency and the adjacent area of Bajaur. During recent years, Mohmand Agency has also attracted the attention of geologists due to the occurrence of emerald. The Department of Geology, University of Peshawar, has been in contact with several Maliks of the area to arrange a trip to cover geologically the virgin terrains and to know the extent of mineralization of emarald and other non-metallic and metallic minerals.

Due to a limited time and restricted traverse, a large part of the tract could not be brought into the fold of geological investigation. The observations were confined to the route adopted and the samples were collected systematically. The areas around Pipal (north of Sheikh Ismail Village) and Kaimoor, where the author broke the journey for three days each, were subjected to detailed

investigation. The marble deposits are extensively exposed in these areas and are associated with schists, phyllites and phyllitic-slates etc.

Location and Accessibility.

The area investigated lies between Long. 71° 15'E and 71° 35' E; Lat. 34° 25'N and 84° 45'N on the toposheets Nos. $38\frac{N}{6}$, $38\frac{N}{7}$ and $38\frac{N}{10}$ of the Survey of Pakistan. Approach to the area is from Shabqadar to Yousaf Khel by motorable road and onward by mule-tracks. An other route connecting the area is from Khar (Bajaur) to Nawagai by motorable road and again by mule-tracks to other localities. The traverse-route is shown on the map. Sheikh Ismail, a central locality of the area, is about 16 miles from Yousaf Khel and about 9 miles from Nawagai.

Topography.

Mohmand agency and the adjacent area of Bajaur consist of high- to low-topped mountains, isolated hillocks and some plain areas. The area is more mountainous to the south and east where the elevation culminates to 8120 ft. In the north-western part, the elevation ranges between 2250 and 4838 ft. above the sea level. The height of plains and low areas ranges from 2250 to 3000 ft.

The important plains are those of Nahakhi, Yakh Dand, Pipal, Dag and the surrounding area of Khar, where the broad valleys coalesce to form agricultural lands, parts of which are irregated by perennial streams. Streams are quite broad in the western part of the area but are narrow in eastern and south-eastern parts. The main streams of the area are Barang Nala, Ambahar Roa, Gandao Khwar, Pindiali Rud and Danish Kol Khwar. Running in east and southeast direction, all these streams drain into the Swat River.

Limestone forms higher and steep topographic features as compared to the other rocks like shales, phyllites, slates and schists, etc. At some localities, granitic rocks also produce high and rugged relief. Except small areas around Kaimoor peak, all the mountains are barren.

GENERAL GEOLOGY

The geology of the area is very interesting and complicated. A large variety of rocks occur together in a very disturbed manner. The country rocks are slates, phyllitic slates, phyllites, various types of schists and amphibolites associated with crystalline limestone and marble. Granite, microgranites, pegmatites and diorites have been encountered in the northern and eastern

parts of the area. The rocks are very much disturbed, thusit was not possible to decipher various structural features. On the basis of lithology, it appears that this part of the metasedimentary terrain may be the northern limb of a large eroded fold having connection with the Mullagori structure. A thick ultramafic body is exposed at three different places namely Sheikh Ismail, Kontaro Kandao and Kaimoor. This appears to be the extension of the ultramafic body exposed in the southern foothills of Malakand and Uthmankhel. The various rock types are serpentinites, pyroxenites and peridotites. Dolerite intrusions are prominent in phyllites and slates.

Epidote is frequently distributed in various forms throughout the area. Green and yellowish-green epidote is associated with numerous quartz veins which is mistaken for emerald by the locals. The areas where the author got a chance to work in detail are located in the vicinity of, (1) Pipal (north of Sheikh Ismail), (2) Sarkari Qila, and. (3) Kaimoor. The geology of these areas is described in detail as following.

In Pipal area the rocks exposed are various types of crystalline limestones containing thick beds of marble, phyllites, phyllitic slates and minor slaty-shales. Moreover, amphibolite, amphibolitized diorite, serpentinite and serpentinized peridotite are also common. The limestone is crystalline and varies in colour from yellowish-brown to greenish-white and is associated with thick, massive, pure white marble.

The yellowish brown and greenish-white limestone is thick-bedded to massive and at places contains thin partings of argillaceous material. A substantial part of the limestone is fine to medium-grained, whereas coarse variety is not uncommon. The other types of limestone are dark grey with minute reddish spots, and white to light grey with conspicous dark-gray patches. The former is thin-bedded, fractured, jointed and is only exposed in a hillock near Musafer Sahibzada Baba. Under the microscope, the reddish grains appear to be carbonate while grains of quartz, hematite and chlorite were also seen. The dark-gray limestone is massive and very coarse-grained and is exposed in the vicinity of Saed Mian Village.

The ultramafic body seems to have forcefully intruded the greenish and yellowish crystalline limestone and marble. Serpentinite and peridotite are the common rocks in the ultramafic body. Serpentinite is light green to dark green, hard and compact but, at places, it has become talcosic. Peridotite is of beautiful whitish-green colour, hard and compact, and is mostly serpentinized.

Light to dark green schists are exposed in close association with the

ultramafic body over a larger part of Pipal area. The schists are thin- to thick-bedded, compact and are fractured. Limonite crystals ranging from minute to about one inch cubes are scattered abundantly in the greenschists. Amphibolites and amphibelitized diorites are associated with these schists. Texturally, the amphibolites can be differentiated into fine- and medium-grained varieties. Both are of uniform light to dark green colour. Under microscope, both the varieties show epidote, chlorite, hornblende, altered feldspar and some carbonate. Amphibolitized diorite is also light to dark green and grades from fine- to coarse-grained. Hornblende, plagioclase and epidote are its major minerals.

Light to dark brown phyllites and slates, striking eastwest, are exposed near Tsagai Kandao. Their average thickness is about 100 ft. while they thicken towards west. A thin bed of these phyllites and slates also underlie the dark grey limestone near Musafar Sahibzada Baba. They are jointed and on weathering break into elongated splinters. The rocks resemble the phyllites and slates of Attock and are also intruded by dolerite sills. Maroon slaty shales have also been observed in this part of the area.

Hydrothermal quartz veins are distributed throughout the area. Epidote is found in most of the veins in green crystalline form. Long needle-like epidote crystals of light yellow and green colours are also distributed in calcite veins, marble and limestone.

The general strike in this area is northeast-southwest, locally swinging to east-west. The dip varies between 40° and 70°, but the marble and some crystalline limestene beds are about vertical. Most of the formations are dislodged and torn apart as a result of severe structural disturbances which have made the area more complicated.

The geology around Nawagai is similar to that of Pipal in some respects. White, light grey and yellowish-brown crystalline limestone with pure white marble is exposed on the peaks around Nawagai and along Kamangara Khawar. Associated with the limestone are thick beds of dark brown phyllites, phyllitic-slate, slate and maroon shales striking NW-SE. The ultramafic body is exposed near the northern end of Kamaggara Khawar and extends as far as Saida Shah Village in the east. Serpentinites are most abundantly developed here.

To the north-east of Kamangara Khwar, a granitic body, showing several textural variations, is exposed and covers large area, running eastwards to reach Tangi Village and beyond. Near its margin at Kontaro Kandao and Asghar Village, microgranite of greyish-white colour has been located. Greyish-

white, coarsed-grained granite with dark biotite flakes and equigranular texture is another variety developed towards the middle of the igneous mass. Porphyritic granite, with large feldspar phenocrysts, is also exposed towards the eastren extremity. This granitic mass might be the extension of the Malakand granite. Hornblende and biotite are the common accessories. Some xenoliths of greenish material are embedded in the granite. On the northern side of Kantaro Kandao, dark grey porphyritic diorite is exposed. It contains phenocrysts of plagioclase in dark grey matrix of feldspar, quartz, biotite and hornblende.

In the vicinity of Sarkari Qila, small veins of 3 to 10 ft. thickness of microgranite, diorite and pegmatite have been recorded cutting accross the amphibolites. The pegmatite veins contain well-developed hornblende and plagioclase crystals. Amphibolites are quite common over here and exhibit fine-to coarse-grained texture. A well-exposed branching intrusion of altered dolerite of green colour has been found cutting the amphibolites and diorites. Under microscope, it shows chlorite, epidote, some hornblende, a little feldspar and traces of iron ore. Crystalline limestone is exposed along the skyline of the the ridges.

Thick beds of crystalline limestone, marble, extensive green-schists as well as dark brown phyllites and slates are also encountered in the Kaimoor area. An extensive part of the ultramafic body, mostly consisting of serpentinites is also associated with these rocks. The serpentinites contain chromite mineralization in the form of small lenticular bodies and disseminations. However, no workable deposite could be located. A light brown to dirty red garnet is developed along the fractures in the serpentinites. Samples from the small microgranite veins show epidote, quartz, kaolinized feldspar and some chlorite in thin sections.

Other rocks which cover a major part of this area are chlorite schists, mica-schists and quartz-mica-schist, with minor metapyroxenite containing horn blende, serpentine, epidote and hematite. A thin outcrop of steelgrey, compacted schist is exposed which under microscope revealed chlorite, epidote, quartz, sericite and a lot of ore dust. A yellowish-green, massive epidote body is located close to the crystalline limestone and marble in this part of the area.

GEOLOGY OF MARBLE AND EPIDOTE

A huge quantity of marble is associated with the crystalline limestone through out the Mohamand agency and Bajaur. The most important outcrops are exposed in Pipal area, around Nawagai village, along the Kamangara Khwar

and in Kaimoor area. Though the marble outcrops are quite extensive, yet they do not run continuously but instead are dislodged due to sever structnral disturbances. All the deposits are thick-bedded to massive and large economical blocks can be extracted. Joints and fractures are mostly absent except some widely spaced irregular cracks which can prove helpful in mining. The general strike of the marble beds is NE-SW but along the Kamangara Khwar it locally swings to NW-SE. The dip is nearly vertical everywhere.

The marble deposits show several lithological and textural variations. Pure white marble, which has been located in all the above mentioned areas, is most abundantly distributed. At some places near Nawagai, it has developed light grey shades. Beautiful yellowish-green shades have been developed due to its close association with the ultramafic rocks to the north of Sheikh Ismail and Inzari Villages. The yellowish-green colour is imparted by serpentine and epidote and the marble can be named as verd antique which is commercially called green zebra marble. The distribution of green and white colours makes various patterns such as paralled bands and irregular amalgamation at certain places. The greenish-white marble grades into brownish-white variety when traced towards the west in the same area. It exhibits yellowish-brown to light brown and white colours with some greenish streaks. This variety cantains some thin argillaceous partings along which sericite has been developed.

Serveral textural variations have been noticed in these deposits, ranging from very fine- to very coarse-grained. The pure white marble shows all these gradations at every place, especially in the vicinity of Nawagai. The greenish-white variety is mostly medium-grained while the brownish-white grades from medium- to coarse-grained. All the varieties can take very good polish to become appreciable decorative material.

Throughout the area epidote is frequently found in various forms. Minute grains of epidote are found in almost all the rocks such as shale, crystalline limestone, marble, schist, amphibolite, pyroxenite, granite and diorite, etc. In yellowish-green crystalline form it is associated with the quartz and calcite veins. The most important occurence is in the Kaimoor area where a thick body of epidote is associated with the marble and the ultramafic rocks. It is yellowis-green with irregularly distributed minute black spots. It is hard, compact but fractured and the debris are scattred around. However, blocks of reasonable dimensions can be extracted. It can be used as semigem and decorative stone. Serpentine found in the area can also be used as decorative material.

ECONOMICS OF THE MARBLE DEPOSITS

These deposits can yield an enormous quantity of marble. According to a tentative estimate, reserves of about 2.36 million cubic feet (Sheikh Ismail=.892 million cubic feet; Nawagai=1.388 million cubic feet; Kaimoor=.08 million cubic feet.) has been confirmed and still more reserves can he proved easily. The pure white variety constitutes about two thirds of these reserves while one third is greenish-white and brownish-white varieties.

The marble deposits are not easily accessable for exploitation due to their location in the interior parts of the area. The only deposit which is somewhat close to the road is that of Nawagai. This is about 17 miles from Khar (Bajaur) and from there to Nowshera or Peshawar the distance, is so long that it will prove uneconomical and therefore not recommended.

The only alternative is to improve the other approach to the area which is through Shabqadar. The distance between Shabqadar and Sheikh Ismail is about 37 miles out of which about 20 mile road is motorable which reaches Yousaf Khel; and to connect Sheikh Ismail about 17 mile road will havc to be constructed. To reach Nawagai and Kamagara Khwar deposits, the same road will have to be extended only about 14 miles. This will open all the above-mentioned deposits except that of the Kaimoor area for which another 10 mile road will be needed which will join the proposed Yousaf Khel-Sheikh Ismail road somewhere near Agra.

In the road construction no great problem will be faced. Thc relief along the proposed route in not very high and rough; instead large plains and wide valleys are present. Greater parts of the mule-tracks are even now truckable. The auther came to know during the field-work that the political department of Mohmand Agency has sanctioned a road to connect Yousaf Khel with Nawagai.

Plenty of labour is available to work in quarries on reasonably cheaper rates; still the shortage of skiled labourers will be acute in the brginning. To raise a generation of skilled labourers in the area will need sufficient time.

The cost of transportation from the mine-head to Shabqadar will naturally depend upon the distance. The nearest deposits are those of the Pipal which will be 38 miles away from Shabqadar on the proposed road. The Nawagai deposits will be at a distance of 50 to 55 and those of Kaimoor at about 48 miles from Shabqadar. The average cost of transportation from all these areas to Shabqadar will range between Rs. 3/- to 6/- per cubic foot.

Acute shortage of water is a serious problem because the area is mostly dry

with some perennial streams only. If large scale development is planned, permanent supply of water will have to be ensured. Some wells have proved successful in Pipal area, still the shortage of water is great and most of the people drink pond water during greater part of the year. Intensive efforts will be needed for locating permanent and adequate water sources.

Under present conditions, only small scale mining and quarrying is possible because no electric line passes close to any of the deposits. Power supply is another great hurdle in the way of large scale development. Electrification of the area will also become possible after the construction of the road, provided all the tribes agreed upon it although it will be an expensive and time consuming process.

A political problem during the exploitation of these deposits is sure to arise. Whole of the area where marble deposits are located is private and common property of the people. Severe fighting for property between various tribes and families is a common and well-known feature of their life. Only by taking the local people in confidence, who are the owners of the property, exploitation of these deposits will be possible.

CONCLUSIONS

On the basis of this study the author has drawn the following conclusions.

1. The geological setup of the area is favourable for metallic and non-matallic mineralization and thus needs a detailed geological investigation to locate potentially rich belt for systematic exploration.

2. Economic minerals and the Industrial rocks located in the area include chromite, epidote, marble and serpentinite. The marble reserves which have been tentatively estimated as 2.36 million cubic feet, warrants commercial exploitation. Massive epidote and serpentinite are also found in sufficient reserves and can be used as decorative material, while crystalline epidote can be used as semigems. Chromite has got erratic distribution in the ultramafie body and needs detailed investigation.

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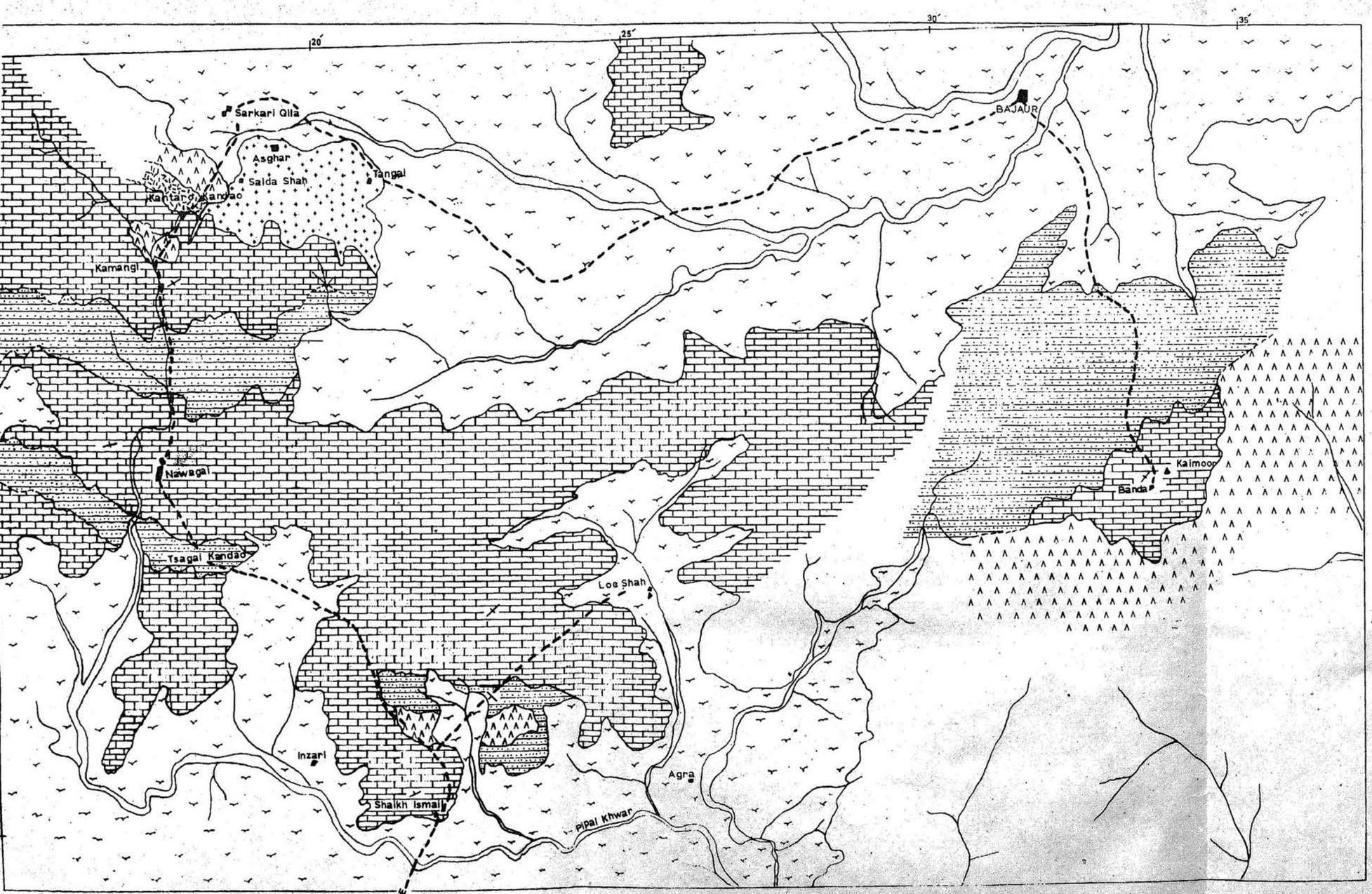

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SCALE

Furlongs 8 6 4 2 0 1 2 3 Miles.

ROUTE GEOLOGICAL MAP OF MOHMAND AGENCY AND ADJACENT PART OF BAJAUR.