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HUNZA SPINAL (RUBY SPINAL) DEPOSITS, HUNZA STATE, GILGIT AGENCY, PAKISTAN

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ILLUSTRATIONS

ABSTRACT

Gem quality spinel deposits are located in Baltit area of Hunza Valley, Gilgit Agency. The Spinel occurrences are scattered over a 12 miles long arcuate belt between latitudes 36° 17' N and 36°19' N and longitudes 74°32' E and 74°47' E, at an elevation ranging from 7500 feet to 10,000 feet A.S.L. The Spinel showings are located at five places, i.e. Saeed Kutsbull, Bajoring, Aliabad, Murang & Dagan Das and Muhammadabad.

Spinel in various shades of red and blue occurs as one of the accessory minerals of white and light grey metamorphosed crystalline limestone, associated with honey coloured mica (phlogopite), pyrite, micaceous haematite and actinolite. The spinel occurs along foliation planes and as disseminated grains with other accessory minerals in crystalline limestone having the general strike of N80W and dips ranging from 20° to 37° NE.

INTRODUCTION

Purpose and Scope

Study of the spinel (ruby) deposits of Hunza*, Gilgit Agency was undertaken during October, 1972 on the request of Resident, Gilgit and Baltistan Agencies, under Project P-3(4) of the Geological Survey of Pakistan, Punjab Circle, Lahore. The request was based on the recommendations of WPIDC (1971), according to which "these occurrences warrant special attention as a potential source for a possible gem field in Pakistan".

During the current investigations, the 'spinel ruby' occurrences reported by WPIDC (1971) were studied and their locations were plotted on 1:250,000 scale. It was followed by laboratory mineralogical study. The present report incorporates results of these investigations.

Location and accessibility

The spinel (ruby) deposits are located on steep slopes of the Great Karakoram, north of Baltit (8000' A.S.L.), about 65 miles north-east of Gilgit Town (4500' A.S.L.) and fall in "1:250,000 scale toposheet 42 L, third Edition" of Survey of Pakistan. The name 'Baltit' is being gradually replaced by the name 'Hunza' which also defines Hunza State. The Baltit or Hunza is the seat of Mir of Hunza State and is connected with Gilgit through Karakoram Highway (K.K.H.) which is un-metalled, all weather, truckable and runs along Hunza River.

The spinel occurrences are scattered over a 12 miles long arcuate strip extending to the east and west of the Hunza (Baltit) Town between latitudes $36^{\circ}17'$N and $36^{\circ}19'$N. and longitudes $74^{\circ}32'$E. and $74^{\circ}47'$E. The occurrences studied are located at five places, i.e. Saeed Kutsbull Bajoring, Aliabad, Murang & Dagan Das and Muhammadabad (Fig.1) ranging in altitudes from 7500 feet to 10,000 feet, between Hasanabad Nala in the west and Mohammadabad village in the east, on the right bank of the Hunza River. These locations are approachable through trails and mule tracks from the Highway (K.K.H.).

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* Coordinates are given in the end.

A PWD Rest House at Karimabad (recently adopted name for the locality around the Mir Sahib's Palace) is ideally situated in the middle of the spinel bearing area. Reservation of the Rest House is granted by the Executive Engineer, PWD, stationed at Gilgit.

Previous investigations

Various workers have been working in the Hunza River Valley area since the beginning of 20th century. Notable of these are Hayden (1914), Clark (1948-52), Kazmi (1951, Ivanac et al (1956), Bakr (1965), Messrs Geological & Mining Consultants (1965), Stauffer (1968) and WPIDC (1971).

Hayden (1914) and Clark (1948-52) made reconnaissance traverses along the Hunza River Valley. Clark described the metamorphics, exposed in the upper Hunza River valley as "Khaiber Series" of Late Carboniferous to Early Permian age. Kazmi (1951) described the geology and mineral occurrences of lower Hunza River valley. Ivanac, Traves & King (1956) and Bakr (1965) mapped parts of the Gilgit and Baltistan Agencies, including the Hunza State. The metamorphics around Hunza Town were described as "Darkot group" of Permo-Carbonferous age by them. Middle part of their Darkot group was later nameddBaltit group by Stauffer (1968) while mapping the area on 1:250,000 scale.

None of the above mentioned workers has recorded the presence of spinel (ruby) deposits of Hunza. Their observations were later compiled by Messrs Geological & Mining Consultants (G.M.C.), Quetta (1965) for the Ministry of Home and Kashmir Affairs, Government of Pakistan. They supplemented the data with their field observations and recorded various mineral occurrences of the Gilgit and Baltistan Agencies, with suggestions for further work.

Following the recommendations of the G.M.C. (1965), the Ministry of Home & Kashmir Affairs commissioned WPIDC to investigate the mineral wealth of the Gilgit and Baltistan Agencies. WPIDC (1971) has described the "Spinel and Sapphire" occurrences of Hunza, within the crystalline limestone of the Darkot group, 3 localities of spinel and 2 of "Sapphire" have been recorded by them, all of which are, however, considered spinel by the present workers. According to WPIDC (1971) "the proportion of the gemstone in the host rock is very low

and the quality also appears to be very poor". WPIDC (1971) could not recover any good crystal in their 10 feet drift, driven in the limestone exposures to the east of Mohammadabad. Further work was recommended by them.

Acknowledgements

Cooperation extended by the Mir of Hunza is thankfully appreciated. The authors are indebted to the authorities of the Gilgit and Baltistan Agencies especially Mr. Mohammad Akhtar, Mining Engineer who accompanied the party to Hunza for introduction with the Mir of Hunza. Valuable assistance of Mr. Iqbal Hussain, Field Assistant of the Geological Survey of Pakistan in field work is gratefully acknowledged.

REGIONAL GEOLOGY

The following stratigraphic sequence is quoted from Bakr (1965):-

"Quaternary system	Unconsolidated deposits	Glacial morains, Terrace deposits and recent stream gravel deposits.
Tertiary system	Granodiorite & Hornblende granite.	Biotite granodiorite, biotite granite, hornblende granite, hornblende gneiss and hornblendite.
Cretaceous system	Yasin Group	Limestone, tuff, quartzitic limestone. + 200 feet.
Trias - Jurassic system	Greenstone complex.	Epidiorite, dolomite, basalt, andesite, hornblende gneiss. Several thousand feet.
Permo-Carboniferous system	Darkot Group	Slate, quartzite, limestone, micaceous gneiss and schist + 1400 feet".

In the middle Hunza River valley (Chalt-Baltit - Sarat area), the Darkot group is the only unit exposed. Darkot group has a faulted western contact with the Greenstone complex near Chalt and an intrusive gradational contact with the Tertiary batholith (Karakoram granodiorite of Ivanac et al, 1956), near Sarat. In the Chalt-Baltit-Sarat area, the Darkot group

comprises high grade metamorphic rocks, as compared to the low grade metamorphic rocks of this group studied by the authors in the Yasin Valley. In the western half of the middle Hunza River valley, the group comprises phyllite, spotted slate, silicous schist, slaty quartzite, garnet quartzite, crystalline limestone and garnet-mica schist. In the eastern half, garnet-mica schist, garnet-staurolite-mica schist, garnet-amphibole schist, micaceous gneisses and coarse crystalline limestone to micaceous marble constitute the Darkot group. The coarse crystalline limestone to micaceous marble is the host rock of the spinel.

ECONOMIC GEOLOGY

The gemstones of Baltit are mineralogically spinel and occur in various shades of red and blue. The red variety has been described as 'Spinel ruby' and the blue one as 'Sapphire' by WPIDC (1971). In strict sense, 'Ruby' and 'Sapphire' connote the red and blue gem varieties of Corundum (Al_2O_3) respectively, although the term 'Ruby' has been used adjectively to define certain red varieties of Spinel ($Mg\ Al_2\ O_4$), as well. The present workers not only consider both the varieties as spinel, but also maintain that the red variety may not be described as 'Spinel ruby' since this name has been used for only deep red variety of spinel (Deer, Howie, Zussman, 1962). Other variety names of spinel as described in literature on the basis of shade of red colour, are 'ruby spinel' for clear red variety, 'rubicelle' for red and 'almandine spinel' for purple ones. The authors are, therefore, inclined to describe the Baltit gemstone deposits merely as spinel.

It is not precisely known as to when these deposits were discovered. The apprehension is that the first discovery of the spinel was made in sixtees of the 20th century in a nalla bed about ½ a mile east of the village Mohammadabad, by local inhabitants. The locals were attracted by red colour of the spinel against white background of the crystalline limestone. This discovery was communicated to Mir of Hunza, who reportedly followed the find which resulted into location of a number of other occurrences of the gemstone in the limestone exposures along the escarpment north of Hunza town. The area was subsequently leased out to the Hunza Mining Corporation, a subsidiary of Industrial Promotion Services Ltd., which is owned by his Royal Highness Prince Karim Agha Khan, Mir of Hunza and others. The Hunza Mining Corporation carried out prospecting in the lease area at Muhammadabad, Altit, Aliabad, Bajoring and Saeed Kutsbull. Unfortunately, no record

of any production of the spinel (gem variety) is available with the office of the Mining Engineer, Gilgit and Baltistan Residency. The Hunza Mining Corporation also engaged foreign experts to prepare a report on the mining feasibility of the spinel deposits. Although their report was not available for reference; it was learnt (verbal communication of the Mir of Hunza,1972) that the foreign experts recommended Bajoring and Altit occurrences as suitable deposits for production of "gem-quality spinel". The lease area is kept under watch by a number of security guards employed by the Corporation. Some locals are still secretly engaged in collecting spinel from the loose scree and from the outcrops present in their lands by blasting and breaking the rock with hammers. But the quantity of spinel thus collected is very small.

Geology of the deposits

All known locations of spinel deposits were studied during the present field investigations by the authors. These are described below from west to east.

a) Saeed Kutsbull

It is the westernmost occurrence studied. It is located ½ a mile north of village Kuchichul on the western side of the Hassanabad halla at an elevation of about 8000 feet A.S.L., where thick beds of coarse grained crystalline limestone are exposed on a steep slope. Some exploratory trenching has been done by the Hunza Mining Corporation in about 15 feet thick white to light grey crystalline limestone which is the host rock for spinel. Small grains (1 to 2 mm) of light pink spinel were seen on the broken surfaces of the limestone at 3 points over a total strike distance of about 50 yards. On breaking rock pieces from the mine dump, few small grains (2-3 mm.) of spinel were found associated with other accessory minerals (amber coloured mica and pyrite). The spinel is light pink in colour and semi-transparent.

b) Bajoring

This place is located roughly opposite to Saeed Kutsbull, on the eastern side of the Hassanabad nalla at an elevation of about 8500 feet A.S.L. Spinel is present in the crystalline limestone beds which seem to be the continuation of those exposed at Saeed Kutsbull. The approach to this deposit is by means of a foot path from the village Aliabad. The path is quite difficult and involves steep

climbing. The crystalline limestone beds are present on a westfacing steep slopes of a gorge cut by the Hassanabad nalla. Some prospecting has been done by the Hunza Mining Corporation. White and light grey beds of crystalline limestone, which at places grade into marble, are the host rock for spinel. The general strike of the beds is N.70 W with a dip of 15°N. Dark red spinel crystals (2 to 5 m.m.) of the spinel are present on the blasted face of the host rock. The spinel is present in streak along the foliation as well as in the form of irregularly dispersed grains in the host rock.

c) Aliabad

This deposit is located north of the village Aliabad at an elevation of about 9500 feet A.S.L., and can be approached by a foot path from the Karakoram Highway. The limestone beds are similar to those exposed at Bajoring and seem to be their lateral continuation. The spinel found here is similar to that at Bajoring and occurs as accessory mineral of the limestone.

d) Murang and Dagan Das

Murang and Dagan Das prospects are located in village Altit, at an elevation of about 9000 feet A.S.L. The Murang prospect is located in the land owned by one Mr. Naukar Ali, while Dagan occurrence is present to the south east of Murang in the land owned by Hawaldar Habib Ullah Jan. At Murang, more than 50 feet thick sequence of crystalline limestone is present, out of which only 10'-15' thick zone in the middle of the sequence contains spinel crystals where exploration mining has been carried by the Hunza Mining Corporation. The limestone is white to light grey, coarsely crystalline and composed almost entirely of calcite/ dolomite. Two small grains of red spinel were seen along the foliation with other accessory minerals (muscovite and pyrite). At Dagan Das, about 30 feet long and 3 feet thick outcrop of the crystalline limestone is exposed within alluvium and seems to be a continuation of the limestone beds exposed at Murang. No spinel could be seen on the outcrop, but on breaking blocks of limestone from the dump, one small grain of light pink spinel was found. Strike of the beds is N 70 W and dip is 30°N.W.

e) Muhammadabad

It is the easternmost exposure, located in a nalla locally called Deyitas Bar, about 1 mile north east of Muhammadabad village, which

is also known as Hammadabad and is about 5 miles east of Karimabad. Muhammadabad is connected with Karimabad by a mule track running on the right hand slopes of the Hunza River and the deposit is approached from Muhammadabad village by a foot path. Thick beds of white and light grey coarsely crystalline limestone are exposed at this location. Spinel is present as an accessory mineral in a 20 feet thick zone of the crystalline limestone. The spinel occurs along the foliation, with other accessory minerals (white mica, pyrite and actinotite) and is dull red and bluish grey in colour. Its size ranges from 1 mm. to 3 mm. No spinel of gem variety was seen on the outcrop. The strike of beds is N 88 W and dip is 37°NW.

As described above, the so far known spinel deposits occur in coarse crystalline limestone beds within Darkot group of Permo-Carboniferous age in the area between Muhammadabad nalla in the east and Hassanabad nalla in the west. The general strike of rocks in the area approaches east-west. The foliation trend is parallet to strike. The crystalline limestone is white to light grey, coarse grained and mostly thick bedded. At places, the limestone has been metamorphosed to greater extent and has changed to marble where it is compact and hard. The light grey crystalline limestone, at places, gives sulphurous smell on breaking.

Spinel occurs as one of the accessory minerals of the crystalline limestone in two distinct modes (Fig.2) :-

(i) Crystals along the foliation plane with other accessory minerals (mica, pyrite and actinolite).

(ii) Crystals disseminated in the host rock with complete disregard to foliation. Other accessory minerals may or may not be associated with it.

Mineralogy

The crystalline limestone containing spinel may be called ore. The ore is composed of calcite/dolomite, amber to honey coloured mica (phlogopite) pyrite, micaceous haematite, actinolite and spinel. Calcite is the dominent mineral and comprises more than 90 percent of the rock while the accessory minerals do not exceed 10 percent.

The spinel occurs in various shades of red and blue and the different colours seen are pink, purple, dark red, bluish red, bluish grey and light grey. The colour is light and uneven in most of the grains. The smaller grains are comparatively brighter in colour than large ones. In general, the spinel is translucent to semi-transparent, but transparent crystals are also present. The spinel crystalizes in cubic system. Generally, the mineral is in the form of octahedral crystals, but anhedral grains are also common. The size of the spinel varies from 1 mm. to 1.cm. The smaller grains are more common. Rarely bigger crystals (even upto 5 cm.) have been found. Hardness of the spinel is 8 according to Mohr scale.

Fractures are common in the spinel grains. The bigger crystals have prominent parallel partings at right angle to the 'C' axis. Partings and fractures are more common in bigger grains than in smaller ones. The fractures become prominent in the process of blasting the hard crystalline limestone and breaking its pieces while extracting the spinel.

Genesis

Spinel is a common high temperature mineral of metamorphic rocks. It has been commonly found in regionally metamorphosed limestone, in association with calcite and phlogopite (mica). It is a common mineral of the spinel group which forms continuous replacement series from Spinel ($Mg\ Al_2O_4$) to Hercynite ($Fe\ Al_2O_4$). The spinel can be formed in the laboratory by fusing MgO and Al_2O_3 and the action may be repressed by the following equation:-

$$MgO + Al_2O_3 = Mg\ Al_2O_4 \quad \text{(spinel)}$$

The Hunza spinel occursin crystalline limestone as one of the accessory minerals in association with mica (phlogopite), actinolite and pyrite. Both magnesia (MgO) and alumina (Al_2O_3) are usually available in limestone, in amount sufficient to form metamorphic minerals like spinel and mica. It can be concluded from the observed assemblage of accessory minerals of the crystalline limestone that the spinel has been developed in limestone as a result of metamorphism. This view is in conformity with the views of the earlier workers like Ivanac et al (1956) and Bakr (1961) who have inferred that the Darkot group with its interbeds of coarse crystalline limestone to marble has undergone thermo-dynamic regional metamorphism to a greater degree in Hunza area as compared with its exposure to westwards where no spinel is found to occur. It is, however, pointed out that some small bodies and dykes of acidic rocks are present around the spinel bearing area, but no genetic relationship of these bodies with the spinel occurrences

was observed.

Plan for further work

Prospecting may be carried out at already known spihel bearing localities to determine the amount and quality of various varieties of spinel. Rough estimates of all categories of spinel may be made from the volume of rock blasted and the quantity of the spinel thus recovered.

Initially 5 to 10 feet long drifts may be made along the dip at Saeed Kutsbull, Bajoring and Murang and Dagan Das deposits. This prospecting work may be carried out by personnel of the Gilgit and Baltistan Agencies or any other development agency like WPIDC.

Since the metamorphosed limestone of the Darkot group containing spinel as one of its accessory minerals is laterally very extensive, possibility of locating more occurrences of spinel is very likely. It is, therefore, recommended that the limestone beds of the group may be extensively checked, by pitting and trenching, in the entire middle and upper Hunza River valley and Nagar area.

The geological map of the area is available only on 1" to 4 mile scale (Ivanac et al 1956; Bakr, 1961), while large scale mapping is not possible without large scale base maps, which are, unfortunately, not available at present. At the same time, it will be rather expensive to prepare large scale base maps by surveying techniques. It is, therefore, proposed that large scale geological maps may be prepared only of the areas selected for mining after thorough exploration. These maps can also be used for planning and development of the mine.

It is recommended to the authorities of the Gilgit & Baltistan Agencies to persuade the Survey of Pakistan to prepare 1:50,000 toposheets of their entire territory for systematic geological exploration.

COORDINATES OF LOCALITIES MENTIONED IN THE TEXT

S. No.	Name of place	Latitude	Longitude
1.	Aliabad	36° 18' N.	74° 37' E.
2.	Bajoring	36° 19' N.	74° 35' E.
3.	Baltit (Hunza)	36° 20' N.	74° 40' E.
4.	Chalt	36° 16' N.	74° 20' E.
5.	Gilgit	36° 55' N.	74° 20' E.
6.	Karimabad	36° 19' N.	74° 40' E.
7.	Muhammadabad	39° 19' N.	74° 45' E.
8.	Murang & Dagan Das	36° 20' N.	74° 41' E.
9.	Nagar	36° 16' N.	74° 43' E.
10.	Naz Bar	36° 22' N.	73° 51' E.
11.	Saeed Kutsbull	36° 18' N.	74° 34' E.
12.	Sarat	36° 19' N.	74° 50' E.
13.	Yasin	36° 23' N.	73° 20' E.

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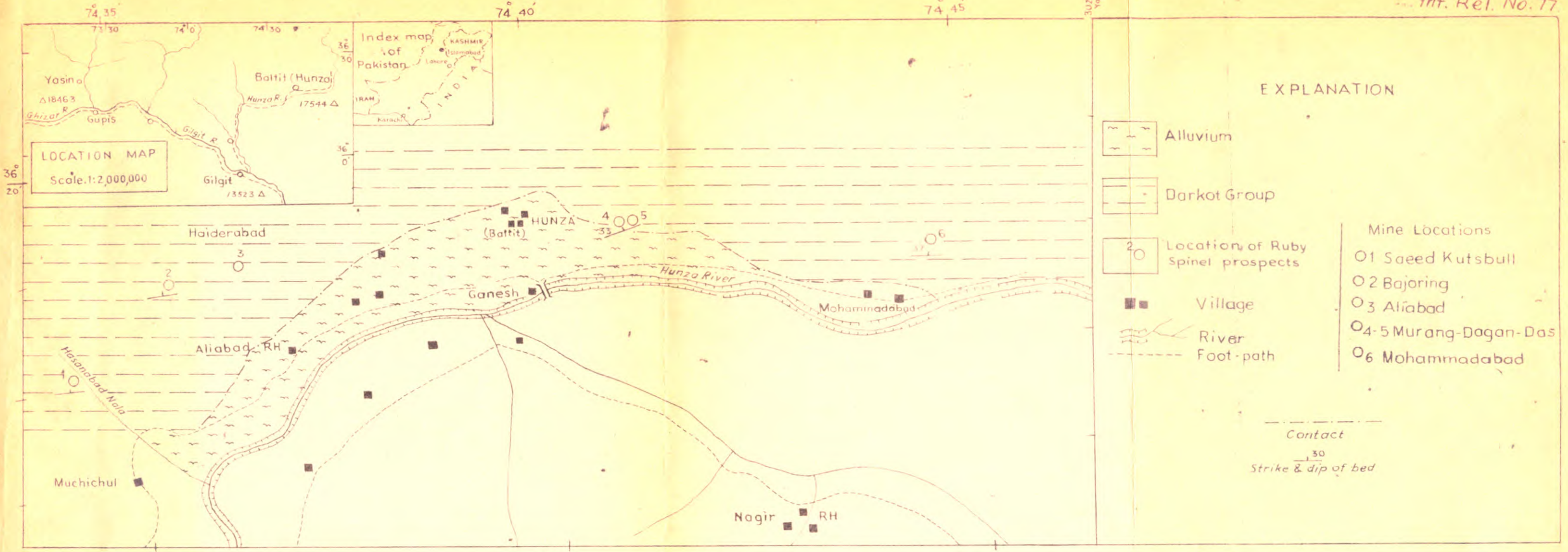

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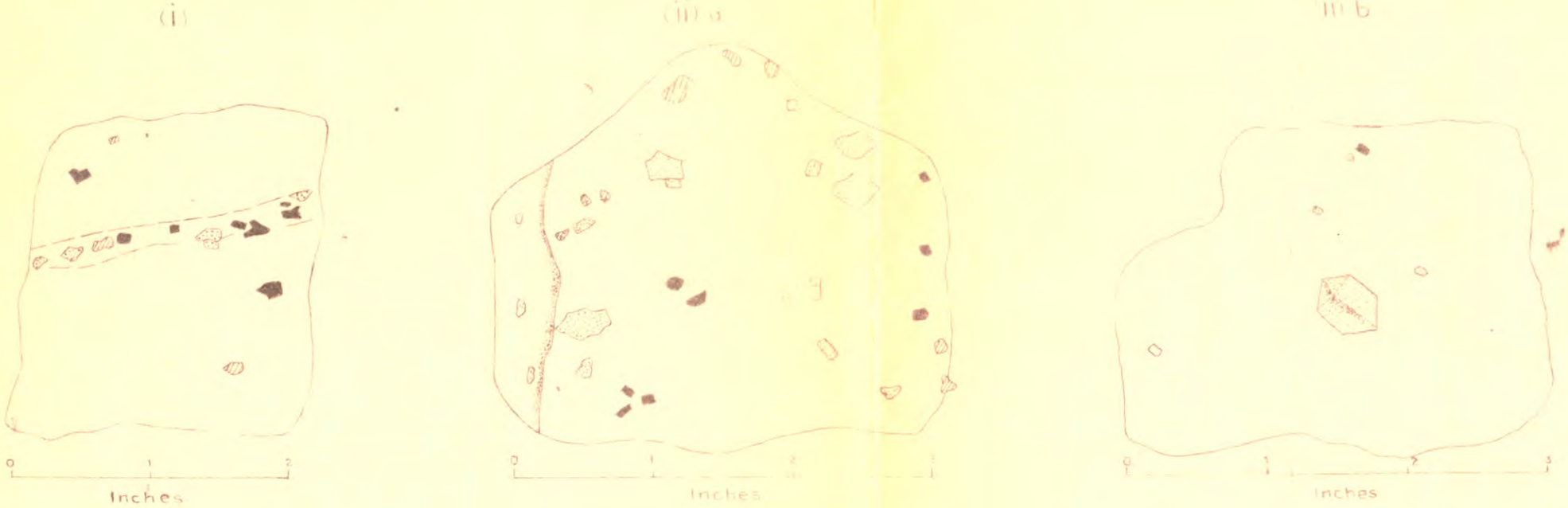
FIG. 1. GEOLOGICAL MAP OF RUBY SPINEL, HUNZA AREA, GILGIT AGENCY.

Fig. 2 Sketches showing mode of occurrence of spinel in crystalline limestone of Bajoring area, Hunza.



(i) Occurrence of spinel along foliation with other accessory minerals.

(ii) Occurrence of spinel in disregard to foliation:
(a) with abundant other accessory minerals.
(b) with few other accessory minerals.

EPLANATION
- Spinel
- Pyrite
- Mica
- Calcite/dolomite

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