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GEOLOGY AND PEGMATITES
OF THE
GILGIT-JAGLOT-HANUCHAL AREA
GILGIT DISTRICT
NORTHERN AREAS
PAKISTAN

By

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GOVERNMENT OF PAKISTAN
GEOLOGICAL SURVEY OF PAKISTAN

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ABSTRACT

A large number of pegmatites were checked physically in the field. In most cases, grab samples were taken, but channel samples of some zoned pegmatites were also collected.

The pegmatites are generally scattered but there is a large concentration of them from Parri upto Shuta along the Skardu road. In the investigated area about 1200 pegmatites have been observed, which range in dimensions from mere one centimetre stringers and veinlets to about 9 metres in thickness and from a few metres to about 175 metres in length. Pegmatites run both along and across host rocks but they mostly occur as dykes. Their general trend is east-west. The host rocks for the pegmatites are meta tuff, diorite, granodiorite, para-amphibolite, ortho-amphibolite and the meta-sedimentary schistose rocks.

Most of the pegmatites are simple but some are zoned. The zoned pegmatites mostly consist of wall zone, intermediate zone and core. In some pegmatites, intermediate zone can be further subdivided into two subzones. The zones are not essentially symmetrical with each other. Some heterogenous pegmatites were also found, viz. hornblende pegmatites in Shuta area.

Most of the pegmatites are intrusive in nature whereas around Parri the recrystallized pegmatites are also developed from the acidic intrusive rocks mostly from granodiorite and aplite under the action of volatiles.

Most of the pegmatites are barren, except a few in which some economically important minerals are noted, viz. microcline, biotite, beryl,

radioactive mineral and amazonite. Beryl has been found in the biotite-bearing pegmatites only. Such economically important minerals are found only as surface traces in pegmatites which seem to be uneconomical except the beryl-bearing pegmatites at Konadas, Station (Sn. 13), Jalalabad (Sn.37) and amazonite-bearing pegmatites at Jaglot (Sh. 46) which are worth further exploration.

Low radioactivity in some samples from Parri, Skardu road, and Jaglot area was noted which measures from 434 to 2,774 counts per hour.

INTRODUCTION

Purpose and Scope

Pegmatite investigations from Gilgit to Jaglot area and from Farhad bridge to Darchan Gah along the Skardu road were carried out from last week of August to first week of December 1982 covering toposheet Nos. 43-I/5, 43-I/9 and 43-I/10. Numerous pegmatites were physically checked along and across the strike and grab samples for analyses were collected. Efforts were made to locate minerals of economic interest in the pegmatites and in the host rock. Apart from the investigation of pegmatites, regional geological mapping on the scale of 1:25,000 was also carried out. Later on, the scale of the map had been reduced to 1:50,000. However, the present report mainly covers the description of the pegmatites found at different localities.

Location and Accessibility

The area under study which starts from Gilgit to Jaglot along the Karakoram Highway, is about 50 km and along Skardu road from Farhad bridge to Darchan Gah is about 15 km. The investigated area lies between latitude $35^{\circ}40'$ - $36^{\circ}00'$, and longitudes $74^{\circ}18'$ - $74^{\circ}45'$. Gilgit is approachable from Rawalpindi by daily PIA Service which is subject to weather conditions and by Karakoram Highway through Mansehra and Chilas. Approach to the pegmatites located at higher level (near peaks) was tremendously difficult, specially along the Skardu road. Along the Skardu road, crossing of the Indus River is impossible because of non-availability of crossing media in the investigated area.

Physiography

Topographically, the area is very rough due to high peaks and steep slopes. Deep gorges are present in the area specially along the Indus River. The major tributaries are Sai Nala, Bagrot Gah, Jutial Gah, Batkor Gah, Shuta Gah, Darchan Gah etc. The moraines present at the high levels indicate the past glaciation period followed by speedy erosion by the rejuvenated rivers. The Gilgit River flows in NW-SE direction, while the Indus makes a large meander from Burumdoir (out of map) to Bunji.

Climate and Habitation

The climate is almost arid because of low rainfall. Weather is of extreme type and the winter is especially very cold. The precipitation is generally in the form of snow at mountain peaks. The peaks of the mountains

are almost barren while vegetation lies along the valleys. Due to rough terrain and high peaks, the population is sparsely distributed in the valleys. The principal populated areas are Gilgit, Jaglot, Parri, Chhamungarh, Aushkandas and Danyor. Malbury, apricot and walnut are common and sold in Gilgit town. People are mostly involved in agriculture profession. Wheat and maize are the major crops of the area

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Previous Work

Misch in 1949 mapped the Nanga Parbat area south of Gilgit at a scale of 1:250,000. Abu Bakr (1965) traversed through the area and summarized the geology of Gilgit Agency at a scale of 1:250,000. Desio

and Zenettin (1956) published a geological sketch map of western Karakoram Mountains at a scale of 1:253,440. W.P.I.D.C. reports give some information about the mineral showings of Gilgit and Baltistan Districts. Riaz Ahmed (1967, unpublished) carried out pegmatite investigations of parts of Haramosh range between Alampul and Shuta Nala, Gilgit Agency at a scale of 1:250,000.

Saleem et al. (1975, unpublished) carried out pegmatite investigations, between Shuta nala and Shengus, Gilgit Agency, at a scale of 1:250,000. Geological mapping of Gilgit quadrangle (43-I/5), was done by M.S. Zafar et al. at 1:50,000 scale, in which pegmatite locations were marked. Geological and mineral investigations of the Parri quadrangle (43 I/9) was carried out by Sajid Hussain et al. (1984) in which pegmatites were briefly described.

Jan et al. (1981) and Tahirkehl (1982) of Peshawar University, contributed in the geology of the Gilgit, Baltistan area and described the intrusive rocks of the Kohistan island arc. They also described the major structural events of the area.

Present Investigation

The object of the present investigations was to check physically the pegmatites of the area from Gilgit to Jaglot and from Farhad bridge to Darchan Gah in search of minerals of economic importance. Sampling of all pegmatites for the purpose of their petrographic and chemical analyses was done.

Although mapping was also carried out but the stress was not given on detailed regional geological mapping as the project mainly aimed at the physical checking of the pegmatites. The pegmatite samples were ground and sieved to minus 80 mesh for their volatile and metallometric analyses. Thin section studies of some of the pegmatites and the host rocks were done. Radiometric analyses were performed for some pegmatite samples.

GENERAL GEOLOGY

The rock types exposed in the investigated area include meta volcano-sedimentary rocks, orthogneiss, granodiorite, diorite and orthoamphibolite. The meta volcano-sedimentary rocks include the metasedimentary and metavolcanoclastic units belonging to Rakaposhi volcanic complex and Kamila amphibolite. They include the schistose rocks, paraamphibolite, meta tuffaceous beds alongwith bands of marble and quartzites, profusely intersected by pegmatites with different trends and dimensions. For convenience purpose the map showing pegmatites has been divided in two parts viz. Gilgit-Parri-Chhamongarh area and Parri-Jaglot-Hanuchal area. Generalized sequence of Gilgit-Chhamongarh area (Plate-I) is as under:-

Unconsolidated sediments

Alluvium and Terraces	...	Sub-recent
Glacial deposits	...	Pleistocene

Intrusive Rocks

Pegmatites)	
Acidic intrusives)	...
Diorite and diorite mixed with acidic intrusives.)	Late Cretaceous to Pliocene

Meta volcano-sedimentary Group

Rakaposhi Volcanic Complex	...	Lower Cretaceous
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Generalized sequence of Parri-Jaglot-Hanuchal area (Plate-II)

is as under:-

Unconsolidated Sediments		
Alluvium and Terraces	...	Sub-recent
Glacial deposits	...	Pleistocene
Intrusive Rocks		
Pegmatites)	
Granodiorite gneiss)	
Diorite and diorite mixed with acidic intrusives.)	Late Crétaceous to Pliocene.
Mafic intrusive	...	Crétaceous (?)
Meta volcano-sedimentary Group		
Rakaposhi volcanic complex	...	Lower Crétaceous
Kamila amphibolites	...	Jurassic to Early Crétaceous.

GEOLOGY

Meta volcano-sedimentary Group

Kamila amphibolite:

Jan (1977, in Tahirkheli, 1979) introduced the "Name Kamila amphibolite as the subdivision of the Upper Swat Hornblende Group of Martin et al. (1962) which extends westward in Dir, while towards east of Nanga Parbat after looping around the Nanga Parbat-Haramosh massif it extends southwards toward Astore. Previous workers (Wadia, 1932, pp. 212-234 and Gansser, 1964, p.62) described these metasediments as the extension of the Precambrian Salkhalas which are highly metamorphosed and gradually granitized to granite gneiss in the neighbouring Nanga Parbat area.

The Salkhala are part of the Archean rocks of the Indian Shield which subducted under the oceanic rock sequence of the Kohistan island arc along the Magashear - the main Mantle Thrust (MMT). As the investigated area lies towards north of the MMT, with the meta volcano-sediments consisting of the pronounced light coloured amphibolite, intercalated with the schistose rocks, quartzite and banded meta tuff, the name Kamila amphibolite seems to be the most suitable instead of the Salkhalas.

Among the three types of the Kamila amphibolites, as given by Tahirkheli (1982, p. 27) the banded variety is exposed in the investigated area, towards east of Hanuchal, around Hosi village and at confluence of Sai Nala with the Indus. The Kamila amphibolite in the investigated area, comprises of predominantly banded amphibolite, intermixed sporadically with minor quartzite, marble and the schistose rocks - quartz mica schist, hornblende schists, calcareous schist, biotite schist, and phyllites. These rocks are well-foliated, well-banded and mostly thinly laminated. The marble bands are quite common towards south east of Darchan-Indus confluence, and extend as thin bands between Bunji and Hosi. Near the confluence of Sai Nala with the Indus River, greenish grey coloured phyllite, hornblende schist, meta tuff and para amphibolite with some diorite intrusions have been observed.

The Kamila amphibolite show sporadic intermediate and acidic intrusives viz. diorite, granodiorite, aplite, pegmatite.

It's contact with the diorite and granodiorite is of intrusive type while at the confluence of Sai Nala with the Indus, the contact is concealed under the alluvium.

The Kamila amphibolite has been assigned Jurassic to Early Cretaceous age (Tahirkheli, 1982, in map).

Rakaposhi Volcanic Complex:

A thick sequence of meta tuffaceous beds interlayered with the metasedimentary rocks and mixed with abundant volcanic flows is widely exposed in Gilgit - Jaglot area. Formerly this rock sequence was included in the Greenstone Complex, - the term introduced by Ivanac et al. (1956 p.9), to the heterogenous and multi-lithological assemblage of rocks with predominant greenish colouration in metasedimentary rocks mixed with large group of volcanic rocks, extending from Hindu Kush in the west to Baltistan in the east. Later on, Tahirkheli (1982, p.26) assigned it the new terminology as "Rakaposhi Volcanic Complex", which originated as a thick oceanic crust formed in the Tethys, between the converging Indo-Pakistan and Eurasian plates. It is developed mostly on the northern periphery of the Kohistan island arc.

In the mapped area, the rock assemblage of the Rakaposhi volcanic Complex include the meta tuffaceous beds and meta volcanoclastics - biotite schists, hornblende schist, amphibolite, hornblende gneiss, agglomerate, minor metasedimentary incorporates - slate, phyllite, phyllitic schist, quartzite, chert, crystalline limestone, marble; mixed with sporadic volcanic flows-basalt, andesite, rhyolite and intruded by diorite and hornblendite.

The major rocks of the meta volcano-sediments are the meta tuffs exposed from Gilgit to Parri and onwards upto Jaglot in the mapped area. However, a thin band of it crops out near Shuta along

the Skardu road.

Around Gilgit, the meta volcano-sedimentary rock units are mostly phyllite, banded quartzite, the schistose rocks, coarse grained crystalline limestone, and banded gneiss, which have been intruded by epidotized volcanic rocks such as andesite, dolerite and basalt. The alterations such as epidotization, serpentization and chloritization are common among the intrusive rock units. Between Aushkandas and Parri, the major units exposed are epidotized hornblende gneiss, gneissic tuff, amphibolite and hornblende schist which have been intruded by thin dykes of dolerite, basalt, andesite and hornblende. The gneissic tuff is Psammitic in appearance, grey to dark grey, fine to medium grained, well foliated and banded. The dark bands consist of biotite and hornblende, while the light bands consist of quartz, feldspar and minor muscovite. Garnet and epidote are occasionally present. Near Jalalabad (Sn. 37), finely banded gneissic tuff has thin pegmatitic stringers showing pygmatic folding. Along the KKH (Sn. 17), the gneissic tuff is spotted. The spots are composed of quartz which are ellipsoidal in nature. At Sn.16 the intercalated white, foliated quartzite has inclusion of light grey calcite crystals with rhombic cleavage. Between Parri and Jaglot, the meta tuff is associated with amphibolite and orthogneiss bands. Younger intrusions of diorite, aplite and pegmatite are common. Along the KKH, near Minawar, a brecciated sheared zone has been noted at the contact of meta tuff with consolidated moraine.

On the basis of fossils discovery from the Shigar (Baltistan) and Ghizar valleys, the Rakaposhi volcanic Complex has been placed in the Lower Cretaceous (Tahirkheli, 1982, p.26).

Intrusive Rocks

Ladakh Granodiorite of Ivanac et al: (1956 p.12), and Kailas Granodiorite of Bakr (1965 p.10) had been named as "Ladakh-Kohistan granitic belt" (Jan et al. 1981, p. 172) which extend from Dir in the west to the Ladakh range in the east. These intrusive rocks occupy the Kohistan island arc, situated between two suture zones - Main Mantle Thrust (MMT) in the south and the Main Karakoram Thrust (MKT) in the north. The intrusions are of composite nature with general variation from basic to acidic rock types. Later on, Tahirkheli (1982, p.28) renamed all these intrusive rocks ranging from felsic to mafic in composition, as the Ladakh intrusives, belonging to multicycle magmatic phases.

Jan et al. (1981, p. 172) assigned Late Cretaceous to Miocene age to all the Si-saturated intrusive rocks "Ladakh-Kohistan granitic belt". The earlier phases became foliated and gneissose. These composite rocks include mafic intrusions, diorite and acidic intrusions along with orthogneiss.

Mafic intrusion;

A boss of basic volcanic rock, (now metamorphosed to ortho-amphibolite) has been found along the Skardu road, about 2 kilometer west of Shuta Nala. The ortho-amphibolite is low to medium grade metamorphic rock. It is dark green, mega-crystalline and is mainly composed of actinolitic hornblende with minor amounts of sphene and epidote. Epidotization of amphiboles is wide spread. This rock type in this locality is exposed, on both banks of the river Indus.

At Station 62, a thin intrusive pegmatite within this ortho-amphibolite exhibit the following mineralogy :- quartz, feldspar (potash & sodic), biotite (at places augmented), pistacite (epidote), garnet, calcite (secondary), hematite with pyrite and hornblende. The orthoamphibolite boss has been described under the "Metamorphic ophiolites (Desio, 1974, p. 122-124) which he defined as basic volcanic and plutonic rock complex. These ophiolites were emplaced during Cretaceous and Eocene times (Tectonic Map of Pakistan, 1982).

Diorite:

Small bodies of diorite composition are scattered almost throughout the investigated area.

Diorite is mostly grey, medium to coarse grained and somewhat weakly foliated and at places they are associated with the dolerite and andesite dykes. Diorite is meso-cratic but in area opposite and downstream Parri is mela-type (melano cratic) with abundant hornblende and biotite. Diorite between Sn.60 & Sn. 61 (Aftab Camp) shows gradational transition to hornblendite which indicates that hornblendite is formed after recrystallization of diorite. This is perhaps on the marginal facies of the Ladakh granodiorite batholith, because the marginal facies of intrusions is a dark coloured hornblende diorite which changes gradationally into normal grey granodiorite (Ivanac et al, 1956, p.12). Bakr (1965, p.10) described the dominant rock type of Gilgit-Parri-Haramosh area as Greenstone Complex with epidiorite, dolerite, andesite and hornblende gneiss. The mineralogy of diorite is hornblende, feldspar with minor pyroxene, biotite, and epidote. In Jutial area, quartz diorite is dominant.

The diorite zone in contact with moraine near Parri, is highly sheared and associated pegmatites are also sheared and kaolinized, due to great burden of glacier and action of water at the glacier floor.

Acidic Intrusives and Orthogneiss:

The acidic intrusives comprise of granodiorite and granite, cut profusely by aplite and pegmatites. The granodiorite is exposed around Gilgit and opposite Chhamongarh village. Around the Indus-Gilgit Rivers confluence, the granodiorite is not a separate mappable unit and therefore, show mixed with diorite. These intrusive bodies have been cut by the swarms of aplite, younger granites, pegmatite veins, which are profuse around the Indus-Gilgit River confluence. Along the Skardu road between Aftab camp and Hanuchal, the lit-part-lit injections of pegmatites and aplite veins predominate in almost horizontal position. The ratio of granodiorite as compared with the granite is much more. The granite is mostly leuco-type, but around Indus-Gilgit Rivers confluence it is in the form of hornblende granite. Granodiorite in the investigated area is light grey, medium to coarse grained, occasionally foliated. Its mineralogy being quartz, feldspar (sodic plagioclase and potash feldspar), biotites, muscovite with minor hornblende, zircon, epidote and little garnet. Exfoliation is visible at places. At Sn.25, the granodiorite is pink, having light brown aureoles of limonite.

Aplite veins are fine grained, allotriomorphic and at places difficult to be distinguished from the wallzones of pegmatites which are idiomorphic in texture. Aplite are light coloured composed of quartz, microcline, orthoclase, albite, muscovite and garnet. In hand specimen, it appears "sugary" in contrast with the pegmatites. They show a maximum thickness of upto 2 metres. They are associated with pegmatites.

The intrusion of granodiorite in the area is of multiphase type; both younger and older than the pegmatites. Along the Skardu road at Aftab camp, a big boulder of granodiorite show sharply cut small xenolith (10 cms, in length) of pegmatite which proves that at least some of the pegmatites are older than the associated granodiorite.

Ortho-gneiss, which is a metamorphosed granodiorite, has intersected the pre-existing meta tuff and amphibolite in Hanuchal (along roadside) and opposite Parri and as unmappable small bodies exposed along the KKH, at stations 20, 43 and 46. The ortho-gneiss of Hanuchal has small xenolith of amphibolite and has interfingered with the metasedimentary rocks to such an extent that this zone may be termed as a migmatite.

Ortho-gneiss is light grey, medium to coarse grained, well-foliated and thinly banded, with the general mineral composition of granodiorite viz. quartz, feldspar, biotite and epidote. The orthogneiss has been intersected by thick dykes of granodiorite, pegmatite and aplite. At Sn.46 orthogneiss has developed beautiful green and pink colour due to abundant epidote and pink potash-feldspar respectively.

③ All the felsic to mafic intrusions of the Ladakh Intrusives on the basis of radiometric data have been assigned Late Cretaceous to Miocene age (Jan et al, 1981, p. 172) while orthogneiss being the oldest rock unit of these intrusives may be given Late Cretaceous(?) age. However, Tahirkheli (1982, p.28) assigned Early Eocene to Pliocene age to these multiphase magmatic intrusives, representing the later age to mainly pegmatites and felsic and mafic dykes.

Pegmatites:

Pegmatites are scattered in almost throughout the investigated

area but are clustered around the Indus-Gilgit Rivers confluence. They are much profuse in Parri-Shuta-Jaglot area.

For description purpose, the pegmatites bearing areas are designated as (a) Jutial area (b) Konadas area (c) Danyor-Jalalabad area (d) Minawar-Parri area (e) Indus-Gilgit Rivers confluence area (f) Parri-Hanuchal area (g) Jaglot-Hosi area.

(a) Jutial area:-

The host rock is grey, thinly bedded, finely foliated meta tuff which has been profusely intersected by diorite, granodiorite and aplite. Pegmatites in this area are thin, small, intrusive and sparsely distributed.

Pegmatites range in thickness from 15 cm to 50 cm have different trends and cut across each other (Plate-I). Zoning is also developed in some pegmatites, which show grey, medium grained wall zone and very coarse grained intermediate zones. The intermediate zone has biotite flakes of about 5 cm. in size. At Sn.25, the older, smaller and comparatively vertical pegmatites are simple, while the younger which are larger and comparatively horizontal pegmatites are zoned. These zoned pegmatites bear vugs and cavities filled with limonite and biotite. The intermediate zone is generally 5 cm. in thickness and occupy the central part of zoned pegmatites. At places, the simple pegmatites border the aplite dykes on their both sides. Pegmatites have both muscovite and biotite. The general mineralogy being quartz, feldspar biotite, muscovite, epidote and hematite.

(b) Konadas area:

The host rocks in this area are amphibolite and hornblende-biotite gneiss (unmappable units), which have been profusely intersected by thick granodiorite and diorite intrusions, and have been metamorphosed at places to granodiorite-gneiss. At Sn.15, porphyritic granodiorite with feldspar phenocrysts is also present. Thin hornblende and dolerite dykes have also been found mostly along the Gilgit River. Aplite dykes are associated with the pegmatites.

Pegmatites are intrusive type and range in thickness from mere two centimetres to a maximum of about half metre, in the form of thin stringers, dykes, lenses and small pods within the host rocks and aplite. At Sn.12 xenoliths of granodiorite are present in pegmatite. Here at one locality, the aplite shows recrystallization and thus changing partially into pegmatite. Here, a small, white saccharoidal marble vein show minute, transparent, green crystals of diopside.

Generally, these pegmatites are composed of quartz, feldspar and biotite with minor epidote and garnet. Almost all the pegmatites are biotite bearing, except the pegmatite at Sn.9 where both muscovite and biotite are present. At Sn.13, light bluish green beryl has been found in pegmatite intruded within amphibolite. These pegmatites cut across the aplite, and hence are younger in age. At Sn.12 smoky quartz has been observed in central portion of a pegmatite.

Generally, the pegmatites have no definite trend, but those along the Hunza River have east-west strike and dip towards north.

(c) Danyor-Jalalabad area:

In this area, the host rocks for pegmatite are diorite, the schistose group and the meta tuff (Plate-I) . Diorite (Sn. 27 to Sn.33) is medium to coarse grained, grey to dark grey, occasionally epidote bearing, at places gneissic, having some lenses and small bodies of hornblendite; and apophyses of granodiorite. The schistose group (Sn.34 - Sn.36) consists of epidote and pyrite bearing hornblende schist, mica schist, garnetiferous talc schist, phyllite, amphibolite, with occasional andesite porphyry.

Pegmatites are both simple and zoned. They are of intrusive nature, with varying thickness from 2 centimetres to a maximum of 9 metres but commonly they range from 30 centimetres to 1.5 metres. Their general trend being northeast with gentle dip towards west, but at Sn.37 the trend being southeast, 55° northeast. At Sn.27, 35 a pegmatite show pinch and swell type of structure. At Sn.34, at one locality, within pegmatite the recrystallization has developed from comparatively fine grain to coarse grain size.

Zoning has developed in a few pegmatites at Sn.28,29,35 & 36. At Sn. 28 intermediate zone lies in the centre and bordered by wall zones. Here the thickness of wall and intermediate zone vary from place to place. The chemical analysis reveals the traces of chloro-apatite within the intermediate zone. At Sn. 29, zoning is irregular with thick wall and thin intermediate zone. Here topaz lies only in the intermediate zone. At Sn.35, three different pegmatites have been noted. (a) The eastern pegmatite (b) the western pegmatite and (c) central pegmatite. (a) The eastern pegmatite ranging in thickness from 30 cm to 1 metre,

is simple and medium grained. Its grain size is equal to the grain size of the wall zones of the other two pegmatites. (b) The western pegmatite (9 metre thick) has a wall zone and two intermediate zones. The intermediate zone has been further divided in two sub-zones (Intermediate-I and Intermediate-II) on the basis of their grain size (Fig. 1). The coarse grained (Intermediate-I) has quartz, feldspar, biotite - (upto 15 cms flakes), garnet, magnetite (in thin veinlets upto 1 cm thickness). Quartz and spessartite garnet are present in radiating shapes chondrules. This zone is half metre to one metre thick in lensoid and vein shape. The chemical analysis reveals that the intermediate sub-zone I bear some mineralization of Cu (431 P.P.M.) and Mn (473 P.P.M.). Intermediate sub-zone II is very coarse grained coarser than zone I and has quartz and biotite. Quartz is more, while biotite is same as at zone I. The chemical analyses show the presence of 200-300 ppm of P in wall zones, while both the intermediate zones are devoid of it. (c) The central pegmatite is 3 metres thick and has mostly wall zone with lenses and thin layering of intermediate zone. The grain size of its intermediate zone is similar with the intermediate zone I of western pegmatite. A quartz lens having 15 centimetres thickness is developed along a crack between wall and intermediate zone. At Sn.36 the pegmatites, which are dispersed in a 300 sq. metres area are mostly simple but zoning in two pegmatites of southern portion is present. In one pegmatite, wall and intermediate zone are intermixed with each other with parallel layering of different thicknesses.

Mineralogically the pegmatites have both muscovite and biotite except at Sn.31 to Sn.37 which are devoid of muscovite and most of them are beryl bearing. At Sn.27 & 31 black minute, elongated tourmaline

area but are clustered around the Indus-Gilgit Rivers confluence. They are much profuse in Parri-Shuta-Jaglot area.

For description purpose, the pegmatites bearing areas are designated as (a) Jutial area (b) Konadas area (c) Danyor-Jalalabad area (d) Minawar-Parri area (e) Indus-Gilgit Rivers confluence area (f) Parri-Hanuchal area (g) Jaglot-Hosi area.

(a) Jutial area:-

The host rock is grey, thinly bedded, finely foliated meta tuff which has been profusely intersected by diorite, granodiorite and aplite. Pegmatites in this area are thin, small, intrusive and sparsely distributed.

Pegmatites range in thickness from 15 cm to 50 cm have different trends and cut across each other (Plate-I). Zoning is also developed in some pegmatites, which show grey, medium grained wall zone and very coarse grained intermediate zones. The intermediate zone has biotite flakes of about 5 cm. in size. At Sn.25, the older, smaller and comparatively vertical pegmatites are simple, while the younger which are larger and comparatively horizontal pegmatites are zoned. These zoned pegmatites bear vugs and cavities filled with limonite and biotite. The intermediate zone is generally 5 cm. in thickness and occupy the central part of zoned pegmatites. At places, the simple pegmatites border the aplite dykes on their both sides. Pegmatites have both muscovite and biotite. The general mineralogy being quartz, feldspar biotite, muscovite, epidote and hematite.

(b) Konadas area:

The host rocks in this area are amphibolite and hornblende-biotite gneiss (unmappable units), which have been profusely intersected by thick granodiorite and diorite intrusions, and have been metamorphosed at places to granodiorite-gneiss. At Sn.15, porphyritic granodiorite with feldspar phenocrysts is also present. Thin hornblende and dolerite dykes have also been found mostly along the Gilgit River. Aplite dykes are associated with the pegmatites.

Pegmatites are intrusive type and range in thickness from mere two centimetres to a maximum of about half metre, in the form of thin stringers, dykes, lenses and small pods within the host rocks and aplite. At Sn.12 xenoliths of granodiorite are present in pegmatite. Here at one locality, the aplite shows recrystallization and thus changing partially into pegmatite. Here, a small, white saccharoidal marble vein show minute, transparent, green crystals of diopside.

Generally, these pegmatites are composed of quartz, feldspar and biotite with minor epidote and garnet. Almost all the pegmatites are biotite bearing, except the pegmatite at Sn.9 where both muscovite and biotite are present. At Sn.13, light bluish green beryl has been found in pegmatite intruded within amphibolite. These pegmatites cut across the aplite, and hence are younger in age. At Sn.12 smoky quartz has been observed in central portion of a pegmatite.

Generally, the pegmatites have no definite trend, but those along the Hunza River have east-west strike and dip towards north.

(c) Danyor-Jalalabad area:

In this area, the host rocks for pegmatite are diorite, the schistose group and the meta tuff (Plate-I) . Diorite (Sn. 27 to Sn.33) is medium to coarse grained, grey to dark grey, occasionally epidote bearing, at places gneissic, having some lenses and small bodies of hornblendite; and apophyses of granodiorite. The schistose group (Sn.34 - Sn.36) consists of epidote and pyrite bearing hornblende schist, mica schist, garnetiferous talc schist, phyllite, amphibolite, with occasional andesite porphyry.

Pegmatites are both simple and zoned. They are of intrusive nature, with varying thickness from 2 centimetres to a maximum of 9 metres but commonly they range from 30 centimetres to 1.5 metres. Their general trend being northeast with gentle dip towards west, but at Sn.37 the trend being southeast, 55° northeast. At Sn.27, 35 a pegmatite show pinch and swell type of structure. At Sn.34, at one locality, within pegmatite the recrystallization has developed from comparatively fine grain to coarse grain size.

Zoning has developed in a few pegmatites at Sn.28,29,35 & 36. At Sn. 28 intermediate zone lies in the centre and bordered by wall zones. Here the thickness of wall and intermediate zone vary from place to place. The chemical analysis reveals the traces of chloro-apatite within the intermediate zone. At Sn. 29, zoning is irregular with thick wall and thin intermediate zone. Here topaz lies only in the intermediate zone. At Sn.35, three different pegmatites have been noted. (a) The eastern pegmatite (b) the western pegmatite and (c) central pegmatite. (a) The eastern pegmatite ranging in thickness from 30 cm to 1 metre,

is simple and medium grained. Its grain size is equal to the grain size of the wall zones of the other two pegmatites. (b) The western pegmatite (9 metre thick) has a wall zone and two intermediate zones. The intermediate zone has been further divided in two sub-zones (Intermediate-I and Intermediate-II) on the basis of their grain size (Fig. 1). The coarse grained (Intermediate-I) has quartz, feldspar, biotite - (upto 15 cms flakes), garnet, magnetite (in thin veinlets upto 1 cm thickness). Quartz and spessartite garnet are present in radiating shapes chondrules. This zone is half metre to one metre thick in lensoid and vein shape. The chemical analysis reveals that the intermediate sub-zone I bear some mineralization of Cu (431 P.P.M.) and Mn (473 P.P.M.). Intermediate sub-zone II is very coarse grained coarser than zone I and has quartz and biotite. Quartz is more, while biotite is same as at zone I. The chemical analyses show the presence of 200-300 ppm of P in wall zones, while both the intermediate zones are devoid of it. (c) The central pegmatite is 3 metres thick and has mostly wall zone with lenses and thin layering of intermediate zone. The grain size of its intermediate zone is similar with the intermediate zone I of western pegmatite. A quartz lens having 15 centimetres thickness is developed along a crack between wall and intermediate zone. At Sn.36 the pegmatites, which are dispersed in a 300 sq. metres area are mostly simple but zoning in two pegmatites of southern portion is present. In one pegmatite, wall and intermediate zone are intermixed with each other with parallel layering of different thicknesses.

Mineralogically the pegmatites have both muscovite and biotite except at Sn.31 to Sn.37 which are devoid of muscovite and most of them are beryl bearing. At Sn.27 & 31 black minute, elongated tourmaline

crystals possibly, schorlite variety have been observed. Generally, the pegmatites are composed of quartz, feldspar (orthoclase, microcline, Na-plagioclase), biotite, muscovite (only in some pegmatites), garnet, spodumene (in few pegmatites at Sn.31, 32, 35 & 36), epidote (in few pegmatite at Sn.29, 30 & 36), chlorite (in few pegmatites at Sn.32, 33, 34 & 36), beryl (in few pegmatites at Sn.27, 28, 31, 32, 36 & 37 (but commonly at Sn.27 and 37), secondary calcite (in few pegmatites at Sn.36), hematite (in few pegmatites at Sn.36), magnetite (in few pegmatites at all localities), and Chalcopyrite (in few pegmatites near Danyor). Beryl at Sn.37 is comparatively well-concentrated than at other stations. Here, it is present upto more than 20% in a 15 cms thick pegmatite lying in the lowest horizon, as small dispersed grains, as well as, small pods and stringers; while in the upper horizon in a one metre thick pegmatite, beryl is present both as grains and linings.

At Sn.36 two types of pegmatites are present; chlorite bearing and biotite bearing; however, in a few chlorite pegmatites minor amount of biotite is also present. The chemical analyses show little variation in their composition. Here, at base of a 100 metres long inclined pegmatite, secondary epidote and calcite are present.

Thin aplitic veins are present at Sn.34, 36, 37. At Sn.36, aplite is both older and younger than pegmatites. At Sn.37, a 30 cms thick aplite in the central area, has on both sides 2 cms thick beryl bearing pegmatites.

(d) Minawar-Parri area:

The host rocks in this area are meta tuff, granodiorite, amphibolite and diorite bodies of various dimensions (Plate-I).

The gneissic tuff is finely laminated, mostly thinly banded, fine to medium grained, garnetiferous, varved and spotted. At contact with granodiorite (Sn.21) it is recrystallized while with pegmatite has no effect. At Sn.4 & 5, xenoliths of amphibolite are common. Granodiorite intrusions are present throughout the area but are common in the recrystallized pegmatite area (Sn. 1-8 & Sn. 22-23). Near the Chhamungarh Bridge, granodiorite and aplite show common feature of recrystallization and segregation of coarse minerals either as stringer, veinlet, pods, lenses and linings, in which there is gradual increase in the grain size of minerals from fine to very coarse grained with all variations and without sharp boundary (Fig. 2). At Sn.18 & 37 small pegmatitic pods and lenses are present within meta tuff which are due to either injection of pegmatitic fluids or concentration of silicon, aluminum and alkalis formed by ionic diffusion of the host rock (Turner & Verhoogen, p. 425).

Pegmatites in this area are of two types according to their mode of origin. (a) recrystallized pegmatite after granodiorite and aplite; (b) intrusive pegmatite.

Recrystallized pegmatites are formed after recrystallization of granite, aplite and other intrusive rocks under action of volatiles evolving from cooling magmatic chamber and penetrating along zone of fractured rocks into upper horizons of intrusive masses that had congealed earlier. Under action of these volatiles, the granite, aplite and other intrusive rocks are decomposed and feldspar and other rock forming minerals are replaced by albite, muscovite etc. (Zavaritsky, in Dorokhin et al. 1969, p.36).

The recrystallized pegmatites are localized at Sn.1-8 and Sn. 22,23. Here the field evidence show that thin pegmatitic differentiations have accompanied the lateral pegmatitic intrusion also. The recrystallized pegmatites in this area have no definite pattern but cut across randomly the host rock. Thickness of these pegmatites vary from mere 2 cms to a maximum of 10 metres.

At Sn.2, pegmatitic veinlets are repeated successively from 2 to at least 5 times in a single intrusion of aplite and granodiorite of varying dimension.

The intrusive pegmatites are present mostly along the KKH, opposite Jalalabad. However, they also accompany the recrystallized pegmatites. They range in thickness from mere thin stringers of 2 cm to a maximum of 5 metres (but commonly 30 cm. to one metre) with length upto 600 metres. General trend of pegmatites is E-W and NW-SE and dip southward and westward respectively.

Zoning in intrusive pegmatites is visible only at Sn.1, 17,18 &20. At Sn.1 intermediate zone is present both within wall zone and between wall zone and host rock. At Sn.18,20 there are two intermediate sub-zones. The intermediate sub-zone-I has quartz, feldspar, biotite (minor), muscovite, garnet; while intermediate sub-zone-II which is very coarse-grained has only quartz and garnet. At Sn.18, some medium grained pegmatites have books of muscovite. At Sn.21 the simple intrusive pegmatite has pink feldspar and quartz which give pegmatite a beautiful pink ornamental colour. At Sn.16 & 17 within some thin pegmatite, rosy quartz and secondary calcite are also present. At Sn.5 &6 big garnet clusters are present both within pegmatite and the host rock. The

biotite bearing pegmatite^s are devoid of calcite. At Sn.3, the mineralogy of pegmatite is microcline, quartz, muscovite, biotite (minor), orthoclase (5 cm long), spodumene[?](2 cm long). Aplites are both older and younger than the pegmatites.

(e) Indus-Gilgit Rivers confluence area:-

It comprises of a small area around the Indus-Gilgit Rivers confluence and extends upto Station No.60 along the Indus and upto Station No.42 along the Gilgit River (Plate-II).

The host rocks are mostly grey to light grey, coarse grained diorite and granodiorite, which are unmappable as separate units, while at Sn.43, orthogneiss and meta tuff serve as host rock. At Sn.60, diorite is darkgrey in colour, with colour index 60-90 (Mela-diorite), and displays changing process to amphibolite with indefinite margins. At contact with the acidic intrusions, mineral changes appeared in diorite viz. abundance and augmentation of biotite flakes and hornblende alongwith appearance of epidote. At Sn.43, fine grained foliated meta tuff is associated with light grey, coarse grained, foliated ortho-gneiss and both these host rocks have been cut across by pegmatites and granodiorite so profusely, that the host rocks seem to be as big xenoliths. Granodiorite dykes along with thin aplite and pegmatites have cut the host rocks at randomly with indefinite trends, so profusely, that in appearance, the Indus-Gilgit Rivers confluence area looks like a network. Granodiorite is mostly older than the pegmatites, but a big boulder at road side (Sn.60) show sharply cut small xenolith about 10 cms. long of pegmatite within granodiorite which indicates that pegmatite is also older than granodiorite. Aplites in this area are both younger and older than the pegmatites.

Pegmatites range in thickness from mere stringers of one cm. to a maximum of 3 metres (but commonly 1 metre to 1.5 metre). They are mostly simple, intrusive, but at places show zoning and recrystallization features. Some pegmatites have wall zone, with two sub-zones of the intermediate zone (Sn. 67, 44). Here the wall zone is generally smaller in thickness than the intermediate zone, with the same mineral composition. At Sn.44, the intermediate zone, at certain spots has rosy quartz and pink feldspar. Here the intermediate inner sub-zone has biotite flakes upto 10 cms long. Certain pegmatites (Sn. 43,60) have two sub-zones of intermediate zone and a core. In the intermediate sub-zones, the comparatively coarser, thinner, inner sub-zone has upto 7 cms long laths of feldspar and upto 15 x 7 cms biotite flakes; while the outer sub-zone has upto 2 cms long feldspar grains. The core in a pegmatite (Sn.43) is 10 cms. thick with quartz and feldspar; while in a pegmatite (Sn.60) it is in the form of elongated small pods and lenses, with 1.5 metre average thickness and lie within the intermediate zone and has quartz, feldspar and spodumene. In this core feldspar is greater than quartz and measure upto 15 cms in length.

A few pegmatites (Sn. 42,44,60) appear to be formed due to gradual recrystallization of granodiorite by the augmentation and segregation of quartz, feldspar and biotite in irregular and random pattern with indefinite margins.

The minerals of pegmatites in this area are quartz, feldspar, biotite, garnet, with minor showings of bornite (Sn. 60), hematite, spodumene (Sn. 57,60), magnetite (Sn. 57, 59,60), copper mineralization in the form of chalcopyrite (Sn. 57,59,60), brown calcite (Sn.44,57 &60), rutile

(Sn. 59), beryl (Sn. 44). The minerals listed above from bornite to beryl are usually very minor and found only in certain pegmatites. At Sn.57, small spodumene crystals are embedded within biotite. In a few pegmatites, at Sn.59 abundant magnetite is present with as long crystals as upto 2 centimetres.

In the whole of this area, feldspar is mostly microcline which is very coarse grained and usually greater in amount than quartz.

At Sn.56, red spessartite garnet, quartz and magnetite with radiating crystals are present in form of chondrules.

(f) Parri-Hanuchal area:-

It comprises the areas around Parri, Shuta and Hanuchal along both banks of the Gilgit and Indus Rivers respectively (Plate-II). This area is separated from the Indus-Gilgit Rivers confluence area, because of almost regular and harmonized pattern of these pegmatites, with the exception of a few irregular ones also. The left bank of the Indus River could not be studied due to inaccessibility, but the pegmatite pattern has been marked.

The major and the oldest rock units in this zone are ortho-amphibolite, meta tuff, amphibolites, quartzite and schistose rocks of both volcanic complex and Kamila amphibolite. These rocks are associated with orthogneiss, at Hanuchal and opposite Parri, while they are intruded by diorite, granodiorite and ortho amphibolite masses of different dimensions. However, a little upstream from Hanuchal, along the Skardu road, a small zone of migmatite has also been found.

In this area, the pegmatites ranging in thickness from mere stringers

of 2 cms. to about 6 metres (but commonly upto 1.5 metre) are present. At Sn.40, 69 pegmatites are in the form of small pods and lenses within meta volcano - sedimentary rocks. The general trend of pegmatites is NE with dip 10° - 50° NW. However, at Sn. 52,63 the trend is almost E-W dipping 35° N. The pegmatites are mostly simple, but at certain localities viz. Sn. 39, 41,49 &52 zoning is present with core and intermediate zones; while at Sn. 50, 51,53,54,61 & 63 zoning is present in the form of wall zones and intermediate zones. However, at Sn.40, all the three zones are present and their chemical analyses, reveal the presence of manganese in wall and intermediate zones only. The intermediate zones are mostly surrounded by the wall zones of 5 to 15 cms. thick, but at places they are asymmetrical. At Sn.61 the intermediate zone in a pegmatite has two sub-zones with coarser zone having 10 cms. long microcline crystals. Some 3-6 metres thick pegmatites at Sn.50&51 &54 show asymmetrical zoning, with the wall and intermediate zones being repeatedly intermixed with each other, with the general proportion as intermediate zone (60 - 80%) and wall zone (20-40%). The core commonly ranging in thickness from 5 to 15 cms, in the form of small pods and lenticular bodies lie both within and outside the intermediate zones with gradational contacts. It has big crystals of quartz, feldspar upto 7 cms. in length, and occasionally flesh coloured spodumene. However, within a 5 metres thick pegmatite at Sn.49, feldspar laths upto 15 cms are located within the core. Here, about 15 to 30 cms. thick upper portion of this pegmatite has a second phase pegmatite with sharp contact, and is characterized by abundant and big flakes measuring 2 to 7 cms. in length of green mica (biotite), which is in much smaller quantity and size in the remaining pegmatite portion. Some thin heterogenous pegmatites at Sn.62 &63

show upto 5 cms. long crystals of hornblende. These hornblende pegmatites are older than the other pegmatites. Black coloured hornblende-feldspar bearing basic pegmatites are common in Shatui Gah with general trend NE-SW, alongwith the parallel acidic pegmatites. Both pegmatites are intrusive in nature. Heterogenous pegmatites develop when a pegmatitic melt intrude the rocks which are sharply different in composition from granite. In that case it melts the wall rocks and reacts with them assimilating those constituents in which it is poor; thus changing the pegmatites composition abruptly (Dorokhin et al. 1969, p. 37).

Mineralogically, the pegmatites in this area have quartz, feldspar, biotite (as green mica also), garnet, muscovite (Sn. 38, 52, 65, 69), hornblende (Sn. 62,63) calcite (Sn. 54,62), black radioactive mineral (Sn. 50,51,52,62,69 &64), hematite and limonite (Sn. 38, 55,61 &64), magnetite (Sn. 50,62) spodumene (Sn.49), tourmaline as bunches of minute crystals (Sn. 69), chalcopyrite (Sn. 61), epidote (Sn. 62), amazonite (Sn. 64) and smoky quartz (Sn.50). All the minerals listed above from muscovite to smoky quartz are minor. Limonite at Sn.38 show peculiar coloured spots, which are reddish brown in centre and surrounded by light brown and yellow colours respectively. Microcline feldspar as big laths is present at Sn.48,49,54,63, measuring in length from 7 to 15 cms., while biotite flakes measure 5 cms. at Sn.50.

Some black radioactive mineral is present at Sn.50, in both wall and intermediate zones; at Sn.51 in intermediate zone only; at Sn.52 probably due to monazite (?) in 2-30 cms. thick pegmatites; at Sn.62, as 1-2 cm thin linings in pegmatites; at Sn.64 in a one metre thick pegmatite in upper reaches of a ravine; at Sn.69 as one to 10 cms.

thick veinlets and stringers in one metre thick lensoid pegmatite.

Radiactivity measurement of the above mentioned crushed samples shows low radiation, which is most likely due to the daughter products of uranium.

In a thin heterogeneous pegmatite within orthoamphibolite, at Sn.62, the mineralogy is quite varied, in being quartz, feldspar, biotite (augmented at places), epidote with minor amount of garnet, calcite, hematite with pyrite, beryl and hornblende (taken from the host rock).

Quartz veins with wine yellow colouration, ranging in thickness from 15-30 cms. are present within pegmatites at Sn.61, 63 & 64.

Thin aplite dykes run along the border and within pegmatites mostly in parallel manner.

At Sn.51, chondrules with radiating crystals of red spessartite garnet, magnetite and quartz are abundantly present in a simple pegmatite. At Sn.40, xenoliths of pegmatites are present in granodiorite, which show that some granodiorite dykes are also younger than the pegmatites.

(g) Jaglot-Hosi area:-

It comprises the Jaglot area, and Hosi village area lying on both banks of the Indus River (Plate-II).

The oldest host rocks in this area are the garnetiferous meta tuff, paraamphibolite, and metasedimentary phyllite and metachert of Kamila amphibolite and the volcanic complex. Diorite and granodiorite intrusions of various dimensions have

intruded in the area which at certain localities changed into orthogneiss. The orthogneiss at Sn.46 give beautiful colouration of green and pink shades due to abundant epidote and potash feldspar. At Sn.47, the diorite, granodiorite and hornblendite have intruded so profusely that the host rocks remained only as big xenoliths. Between Hosi and Bunji, thin saccharoidal marble bands have been found alongwith the thin pegmatites within the meta volcano-sedimentary rocks.

Pegmatites varying in thickness from mere stringers upto 6 metres (but commonly 0.5 to 1.5 metre) are present. Around Sn.68, pegmatite veins occur in parallel "horizons" with very low dips. The pegmatites are mostly simple and intrusive except at Sn.45, 46 where recrystallization processes prevailed in granodiorite giving rise to the pegmatites with indefinite boundaries. The pegmatites generally trend NE with medium dip towards west, except at Sn.68 where the trend is NW with very low dip towards SW. At Sn.46, muscovite bearing intrusive pegmatites are also present, in which abundant flakes of muscovite measuring 2 cms. in length, lie in central portion of pegmatites. Here a few pegmatites show zoning with the intermediate zone surrounded by the wall zones.

Pegmatites are composed of quartz, feldspar, biotite, muscovite (minor), garnet, green mica (Sn.47), hematite, epidote (Sn. 46,47), beryl (Sn.66), radioactive mineral (Sn. 47,68) and tourmaline (Sn.46). All the minerals listed from muscovite to tourmaline are minor. Biotite flakes in pegmatites measure upto 15 cm (Sn. 68) in length. At Sn.45, there lie plenty of aureoles around brown hematite with brown, light brown and yellow colours from centre towards boundary respectively. At Sn.46, big phenocrysts, about 5 cms. wide, of light greenish amazonite are

embedded within comparatively fine grained portion of the pegmatites and is present only in the recrystallized pegmatites having both muscovite and biotite. At Sn.68, a thin pegmatite having thickness upto 7 cms. trending SE with high dip show low radioactivity due to the presence of grey radioactive mineral. Similarly at Sn.47, a coarse grained biotite pegmatite boulder has 0.5 cms. thick veinlet of some radioactive mineral of dark grey colour with submetallic lusture and low radioactivity.

ECONOMIC SIGNIFICANCE

Most of the pegmatites are devoid of the minerals of economic importance, except a few having little mineralization of beryl, amazonite, potash feldspar, biotite and radioactive mineral.

Beryl

Beryl, which is a silicate of beryllium and aluminium belonging to the hexagonal crystallographic system occur at Konadas (Sn.13); Jalalabad (Sn.37); between Danyor and Aushkandas (Sn. 27,28,31&32); Aushkandas (Sn.36); between Parri and Jaglot (Sn.44); Hosi (Sn.66) and along Skrou road (Sn.62) within the biotite bearing pegmatites of intrusive and recrystallized nature. At Konadas, light green variety occur in the central and border portions of the pegmatites in the form of compact masses and thin stringers within thin, elongated and lensoid pegmatites, which have intruded the para-amphibolite.

At Jalalabad(Sn.37) beryl has been found in some of the intrusive and lensoid pegmatites, within the gneissic tuff. The beryl-bearing pegmatites range in thickness from 2 cms. to one metre. Beryl within

pegmatites is distributed as small grains and small discontinuous linings and small pods. In a 15 cms. thick small pegmatite just above the debris, beryl constitute about more than 20%. Beryl at Jalalabad (Sn. 37) is comparatively well concentrated than that of Konadas (Sn,13). However, both these areas need further exploratory work to know the behaviour of beryl in depth.

Between Danyor and Aushkandas (Sn. 27,28,31 & 32) the intrusive, simple pegmatites which are parallel with each other, and having thickness upto 60 cms, and length upto 15 metres, have some beryl as small grains. A simple pegmatite about 30 cms to 2.5 metres thick and about 30 metres in length, located at northern side of Sn.27 is comparatively rich in beryl. This pegmatite is also recommended for detailed exploratory work.

Moreover, very few grains and linings of beryl have been seen in intrusive pegmatites at Sn. 36, 44, 62 & 66.

Amazonite

The occurrences of a greenish variety of microcline have been noted at Jaglot (Sn. 46) and Hanuchal (Sn.64).

At Jaglot (Sn.46), light bluish-green variety of amazonite occurring as big phenocrysts of about 5 cms in width, have been embedded within comparatively fine grained recrystallized pegmatites having both muscovite and biotite.

At Hanuchal (Sn.64), a small crystal of bluish-green amazonite has also been encountered within the pegmatite. However, this area seems to be less promising for detailed investigations.

Feldspar

Potash feldspar mostly in the form of microcline, is well - dispersed in the pegmatites, of the area from Parri to Hanuchal, and most common in the net-work zone. Large laths of feldspar are present in the intermediate zones and core, of the pegmatites and are far abundant than quartz. Near Aftab Camp along Skardu road (Sn. 60), pegmatites have a core and two subzones of the intermediate zone. Here in the core, the feldspar laths are upto 15 cms in length; while in the intermediate inner and outer subzones their length ranges upto 7 cms and 2 cms respectively. The core in the form of small pods and lenses with 1.5 metre thickness have feldspar more than quartz in quantity. In the neighbouring pegmatites at Sn.61, the microcline crystals measure upto 10 cms in length in inner sub-zone of the intermediate zone.

The pegmatites in the area opposite Parri (Sn.49-51,52) have feldspar laths measuring upto 15 cms in length, within the core.

As Potash feldspar is present in reasonably quantity within the pegmatites of the area opposite Parri, and their extension along Skardu road, it is worthwhile to check in detail for establishing the quartz-feldspar ratio. This ratio has been roughly marked as 2:3. If this ratio proves to be suitable, then feldspar may be used for ceramic, glass and paint-filler purposes.

Biotite

Biotite flakes of various dimensions have been found in the pegmatites of Jutial, Aushkandas, Parri and Jaglot area.

In Jutial area (Sn. 25,26) biotite flakes of about 5cms in length are

present in the intermediate zone of pegmatite; however, in Aushkandas area (Sn. 35) they measure upto 15 cms. in length in the intermediate inner and outer subzones, in a 9 metres thick western-side pegmatite. In Parri area, biotite flakes measure upto 10 cms, in intermediate inner subzone of pegmatite (Sn. 44). Abundant biotite flakes (green mica) in booklet form measuring 2 to 7 cms in length are present in a 15 to 30 cms thick portion of a pegmatite, showing two phases of intrusion (Sn. 49). Near Partab bridge (Sn. 45) biotite flakes measure upto 7 cms. in length, while towards south of Jaglot (Sn.68) they are upto 15 cms in length. Big quantity of biotite flakes measuring upto 15 cms. have been found in lensoid pegmatites measuring from 30 cms to 15 metres in thickness, at Skardu road, near Darchan Gah confluence with the Indus.

Radioactive minerals

The pegmatites located opposite Parri, Shuta to Indus-Darchan Gah confluence, and near Jaglot have some grey to black, earthy radioactive mineral. This radioactive mineral is present either in the wall zones or intermediate zones or both and occur as thin linings and stringers, in very localized areas of the pegmatites.

The samples with radioactive minerals were crushed to minus 80-mesh and exposed before the 3"x3" NaI(Tl) detector, at PINSTECH, Rawalpindi. Their low radioactivity as measured from 434 to 2774 counts per hour (Table-2) is probably due to the daughter products of Uranium - with possible contamination from thorium products. Two of the samples containing radioactive minerals were chemically analysed, which show 5 & 7 p.p.m. of U_3O_8 content.

A detailed survey with geiger-counter is recommended in the above mentioned area.

CONCLUSION AND RECOMMENDATIONS

The pegmatites could only be visually examined at such preliminary investigation stage.

Most of the pegmatites of the investigated area seem to be economically insignificant, except a few ones having the showings of beryl at Konadas (Sn. 13) and Jalalabad (Sn. 37); amazonite at Jaglot (Sn.46).

The pegmatites of Jalalabad as a whole show quite high percentage of beryl, which makes more than 20% in one thin pegmatite. The beryl is present in the form of small grains and small discontinuous linings. The presence of beryl underneath may be further explored.

The amazonite a bright, light green coloured semi precious gem variety measures upto 5 cms in width at Station 46. The amazonite may be further explored for its prospects.

The pegmatites of the Skardu road and Jaglot area, and specially of the network zone, can prove to be of economic significance for the ceramic purpose, if the ratio of quartz-feldspar is established to be suitable, by later detailed investigations. The ratio of quartz-feldspar during the present visual examination has been roughly marked as 2:3.

The low radioactivity from 434 to 2,774 counts per hour, in the samples of the area opposite Parri, Skardu road and near Jaglot was traced at PINSTECH, Rawalpindi. Further prospecting for the radioactive elements is recommended during the field work in future.

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Table-1: Chemical analyses of certain pegmatites.

Sample No.	Rock/zones	Cu PPM	Zn PPM	Mn PPM	Fe 10%	Volatiles	
						Chloride 10%	phosphorus(F) (PPM)
1(b)	Wallzone	19	35	205	0.46	-	-
3(b)		18	35	179	0.53	0.035	71
7(a)		-	50	153	0.42	-	-
8(a)	Aplite	23	46	128	0.50	0.017	-
8(b)		-	27	256	0.37	0.035	-
9(f)		139	32	179	0.40	-	45
12(a)		130	25	205	0.42	-	37
13(b)		769	27	179	0.49	-	-
18(C)-I	Wall	19	27	102	0.37	-	41
18(C)-II	Intermediate	19	27	230	0.46	-	-
19(b)		19	39	128	0.66	-	-
25(e)-I		23	47	125	0.40	-	-
27(c)		37	18	128	1.42	-	-
28(c)-I		19	43	153	0.34	-	-
28(d)-II		19	23	103	0.70	0.04	50
30		305	35	128	0.53	-	30
31(a)		12	4	3788	0.47	0.053	200
32(a)		12	14	-	0.66	0.018	400
32(b)		12	11	-	0.44	0.035	150
35(a)	Host+pegmatite	-	-	-	1.22	-	100
35(b)	Wallzone	-	18	-	0.32	-	200
35(c)	Intermediate-I	-	-	-	0.80	0.035	-
35(d)	Intermediate-II	-	14	-	0.61	0.071	-
35(e)		-	13	-	0.55	0.035	300
35(g)		431	13	473	0.73	0.009	-
36(b)	Chl. pegmatite	50	6	-	0.45	0.035	296
36(c)	Bt. Pegmatite	226	5	124	0.40	-	496
37(b)		76	13	145	0.51	-	329
40(b)	Wall	12	51	332	0.68	0.018	214
40(c)		5	10	-	0.20	0.018	164
40(d)	Intermediate	5	1	352	0.20	-	329
40(e)	Core	4	4	-	0.25	0.035	131

Table-I (contd.)

44(c)	Intermediate	13	8	145	0.36	-	181
44(d)	Recrystallized	-	67	300	0.55	0.018	82
46(a)		11	74	100	0.75	0.018	49
47		13	23	198	0.98	-	-
49(b)		-	32	170	0.43	0.01	-
50(a)		-	10	395	0.40	0.04	-
50(b)			5	-	0.22	0.04	-
51(b)		-	-	-	0.27	0.02	-
51(c)		-	5	198	0.20	0.04	-
52		-	10	150	0.57	0.04	147
59(d)		40	27	198	0.39	0.04	
62(b)		-	27	295	0.40	-	-
63(a)		46	9	200	0.60	0.11	-
64		-	21	196	0.29	0.035	42
64(b)		15	5	396	1.05	0.053	71
66		465	10	201	0.40	0.035	-
68		18	6	100	0.53	0.017	-
69		-	4	298	0.30	0.035	-

Table - 2: Radiometric analyses of certain pegmatites.

<u>Sample</u>	<u>Counts(per hour)</u>	<u>U₃O₈ content(in p.p.m.)</u>
3 C	barren	-
66	"	-
68	434	-
64	1070	-
51-B	1098	-
62-B	1062	-
52	1048	-
47	1520	5
69	2112	-
50-B	2774	7

Measured with a 3"x3" Na I (Tl) detector. Radioactivity is most likely due to the products of Uranium (with possible contamination from thorium products). The U₃O₈ contents, for only two sample, were checked by their chemical analyses for radioactive elements.

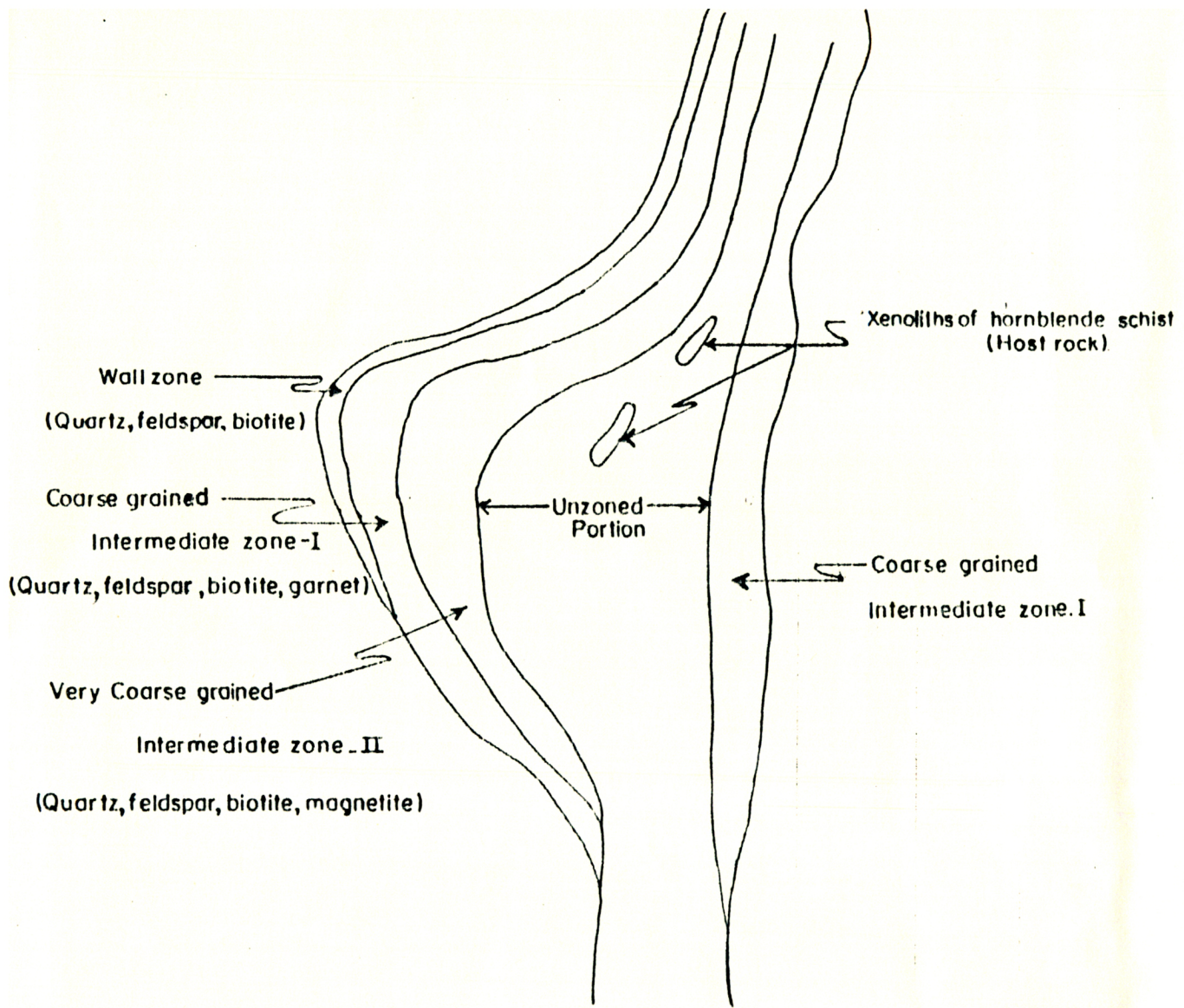


FIG. 1:- ZONED PEGMATITE AT AUSHKANDAS (Sn . 35)

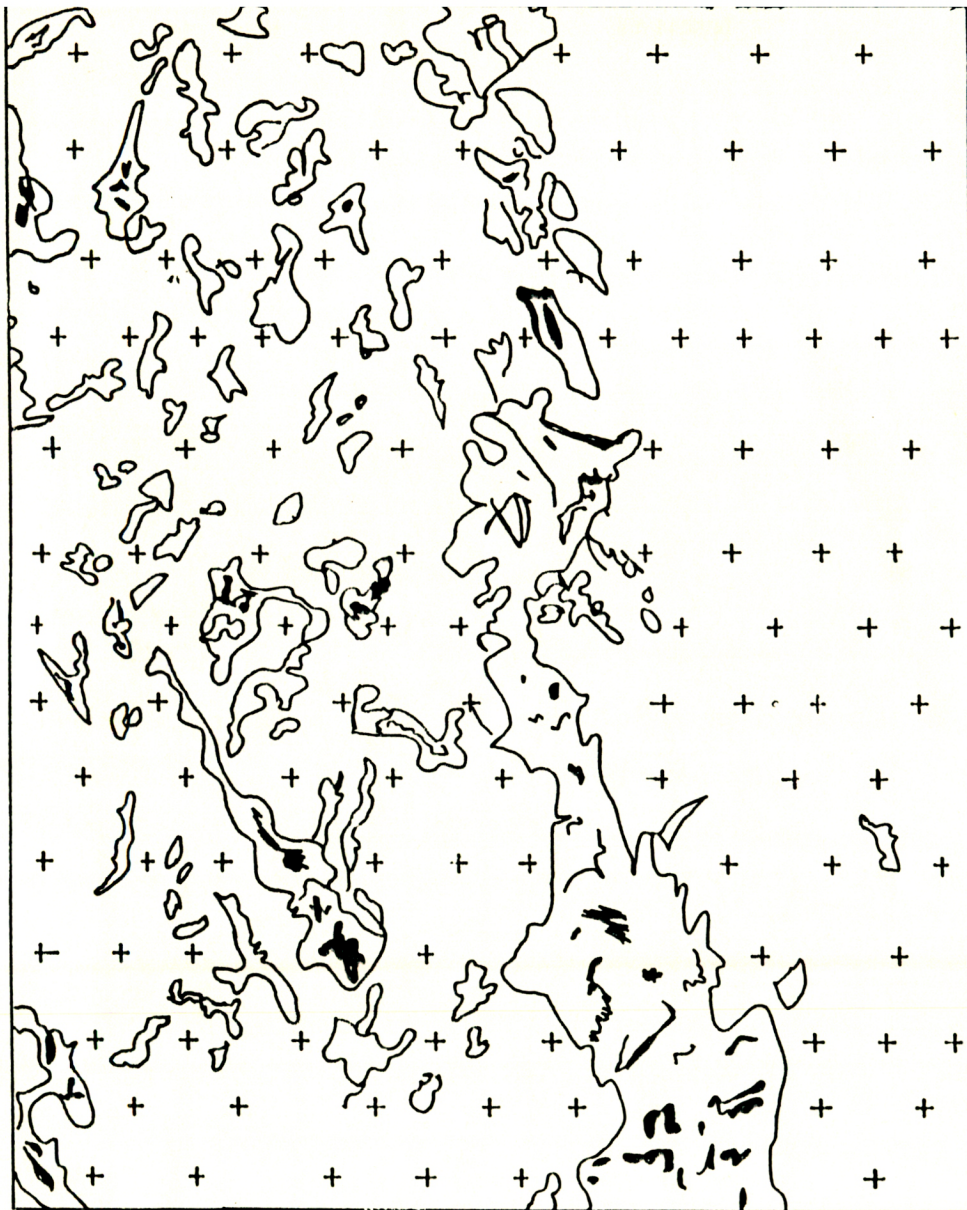
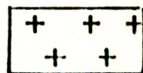
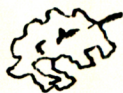


FIG. 2: RECRYSTALLIZED PEGMATITE AT CHHAMONGARH BRIDGE (Sn.8)



Granodiorite (Parent rock)



Recrystallized pegmatite (without sharp boundary and indefinite pattern)

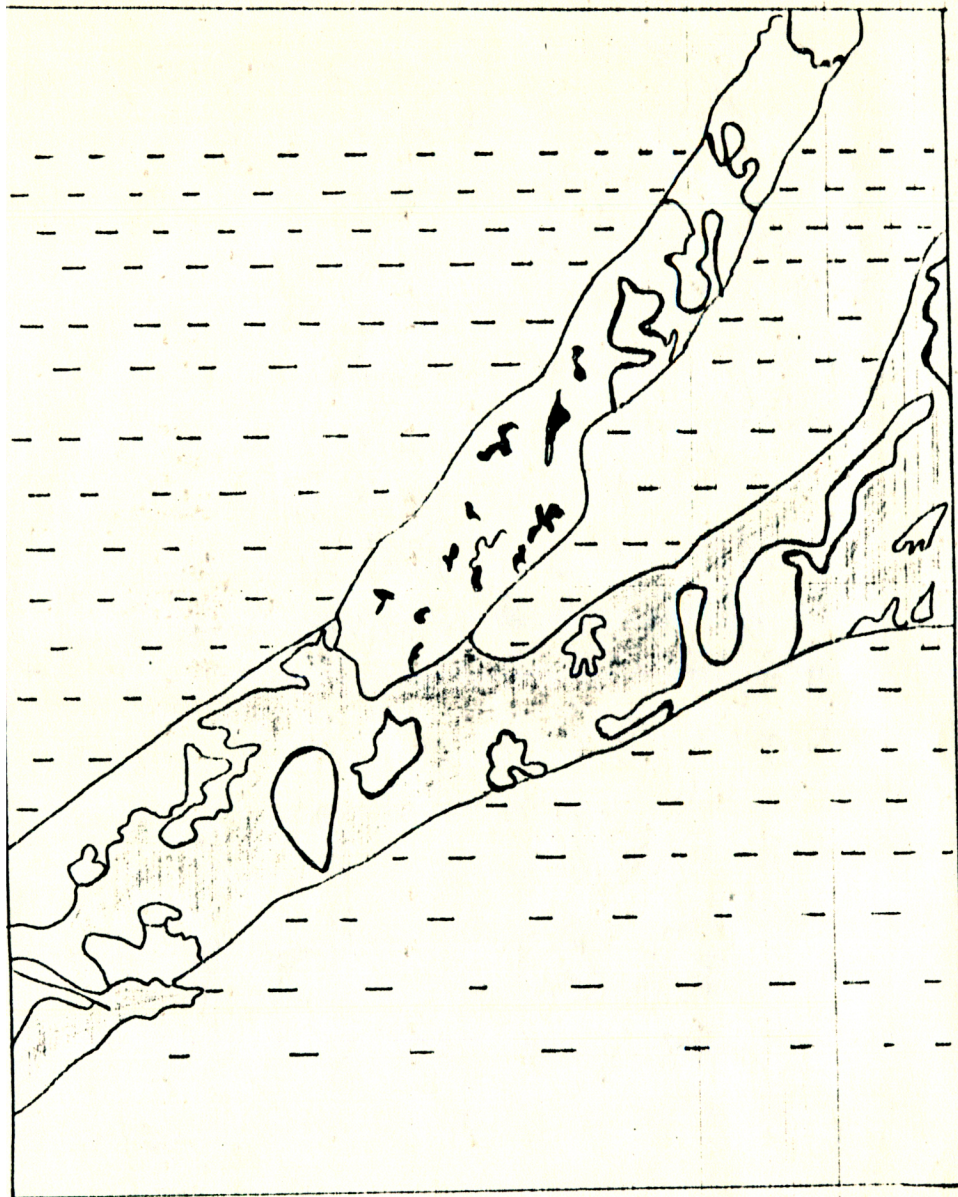
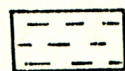


FIG. 3:-INTRUSIVE PEGMATITE NEAR JAGLOT (Sn. 68)



Meta volcano sediments & amphibolite (Host rock)

Shaded portion of pegmatite showing radioactive mineralization.