The Volcanic Rocks of Poonch District, Azad Kashmir

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Abstract: The volcanic rocks of the Poonch District are confined to the Pir Panjal Range of Upper Haveli, Poonch District. The volcanic rocks belong to two distinct ages. The Dogra Trap is basaltic and is confined within the Precambrian Dogra Slates. The Panjal Trap alongwith basal agglomeratic slates and Tuffs are Upper Carboniferous. The flows are mainly basaltic to andesitic. The pyroclasts occurring towards the top are intermediate to acidic in composition. The Panjal Trap is overlain by the 'Gondwana Group' of upper part of Upper Carboniferous to Permian.

This paper deals with the geology, petrography, chemistry and geochemistry of the Poonch volcanics. Map of the area on 1:50000 has been prepared. This is the first detailed petrological study of the Poonch Volcanics. A total of thirty nine petrographic analyses, thirty two chemical analyses and fifteen spectrochemical analyses of the volcanics are presented.

INTRODUCTION

The volcanic rocks of Poonch are confined to the Pir Panjal Range. Geographically they fall within the Upper Haveli area of Poonch District. The volcanic rocks belong to two distinct geological ages.

The Dogra trap is confined within the Precambrian Dogra Slates. These volcanics are mainly basaltic rocks.

The Panjal Trap alongwith basal agglomeratic slates and tuffs are Upper Carboniferous. The volcanics of the Panjal trap are basically basaltic to andesitic. The pyroclastic associates are, however, from intermediate to acidic in composition. The Panjal trap is underlain by agglomeratic slates and tuffs while it is overlain by Gondwana Group of upper part of Upper Carboniferous to Permian. In order to understand well the Poonch volcanics, a brief description of general geology and structure of the volcanics and immediately associated rocks is given in the following.

An account of Poonch volcanics has been given earlier by Wadia (1928) describing the above two types of volcanics mainly on the basis of field observations. In the present paper, therefore, their detailed petrography, chemistry and spectrochemistry will be presented.

GENERAL GEOLOGY

In the following table stratigraphy of the area is presented:

Alluvium	Mainly gravels, boulders, sands but also some clays, glacial and glaciofluvial deposits on higher elevations.	Recent to Subrecent.
Siwalik Group	Continental calcareous sandstones, shales, conglomerates and clays. Sandstone is grey to greenish grey (soft and easily scratchable).	Middle Miocene to Late Pleistocene.
Murree	Upper Murree sandstone are light yellowish grey to light brown, soft, medium to coarse grained and mica rich. Lower Murree sandstones are fine grained, micaceous, deep red to purple, sometimes grey. Upper Murree shales are buff, purple red, brown and greyish and may contain plant fossils. The Lower Murree shales are red, green, brown to purple.	Oligocene to Lower Miocene.
	Lower Murrees also contain marl and limestone bands.	

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	Unconformity	
Kuldana Formation	Bright red, purple and green shales with hard sandstone beds.	Eocene
Margala Hill Limestone	Bitumenous black (yellowish grey and flaggy) limestone. Grey, green and khaki shales.	Eocene
Patala Formation	Also coal bearing pyritous shales.	Paleocene
	Unconformity	
Gondwana Group	Basal quartz conglomerate bed overlain by black, green and grey arenaceous, phyllitic and sandy slates succeeded by massive or flaggy quartzites of white and variegated colours.	Permo-Carboniferous.
Panjal Group	Basaltic to andesitic, fine grained, green to greyish green at places merocrystalline, massive as well as amygdaloidal. Ash beds and other pyroclasts are shaly looking, variegated and mottled. Pyroclasts may be intermediate to acidic. Volcanics contain chalcedony and Jaspar. The base is agglomeritic slates, grey to black, slates, conglomeritic and agglomeritic bed, slates with ashes and pyroclasts.	Upper Carboniferous.
	Unconformity	
Abbottabad Group.	White dolomitic limestone and quartzite and quartzitic schists.	Cambrian
Dogra Slates	Grey, dark grey to black slates, phyllitic slates, phyllites, sericite and chlorite schists with carbonaceous/graphitic intercalations. Interbedded Dogra trap is metamorphosed, chloritic schistose or slaty looking, amygdaloidal as well as free of amygdules.	Precambrian

In the following, a detailed description of Dogra Slates including Dogra trap, and Panjal Group (including Panjal trap) will be given.

Dogra Slates and Dogra Trap Volcanics: These rocks are the oldest rocks of the area. They are Precambrian in age. They are well exposed in the areas of Kalamula, Paje-di-Gali, Bedori, Maili, Chappankara and Reji (Fig. 1). These rocks form steep slopes and escarpments. The Dogra trap volcanics occur within the slates. In fact part of the great thickness of slates is a sedimentary/volcanic sequence. The slates themselves are a sequence of black normal or true slates, phyllitic slates, phyllites, sericite and chlorite schists with carbonaceous/graphitic intercalations.

The volcanics (Dogra trap) have undergone metamorphism. They may be amygdaloidal as well as free from amygdules. Due to deformation (metamorphism) the volcanics at places may look schistose.

Marble-Calcareous Schist and Quartzite: They occur as outliers of slates and are from 15 to 60 metres thick marble beds alongwith calcareous schist and quartzite. The authors regard them Cambrian in age. They may be equivalent to the Abbottabad group of Latif (1974). They occur near Maili and Kailer bridge. The marble is thinly bedded brilliant white to cream coloured. At places it is foliated and the foliation planes are marked with chlorite and mica. Where chlorite concentrations increase, green streaks can be observed. The marble at many places appears dolomitic. The group is rather poorly developed and possibly had been deposited under conditions somewhat different from the conditions elsewhere.

Panjal Group Sediments, Volcanics and Pyroclasts: The authors prefer to introduce Panjal group for Panjal system of Lydekker (1876) and would group lower Panjal agglomeratic slates and upper Panjal trap of Middlemiss (1896) into Panjal group. The group starts with a sedimentary volcanic sequence passing into thick volcanic flows and terminating with pyroclasts including ash beds. It is one whole sequence and its splitting by Middlemiss is arbitrary.

The volcanics of the Panjal group are predominantly basaltic to andesitic. The associated pyroclasts may reach acidic composition. The volcanics are mainly green to greyish green and fine grained. At places they may even be merocrystalline. The volcanics are massive to amygdaloidal. The pyroclasts are mottled and variegated. Ash beds may be shaly looking.

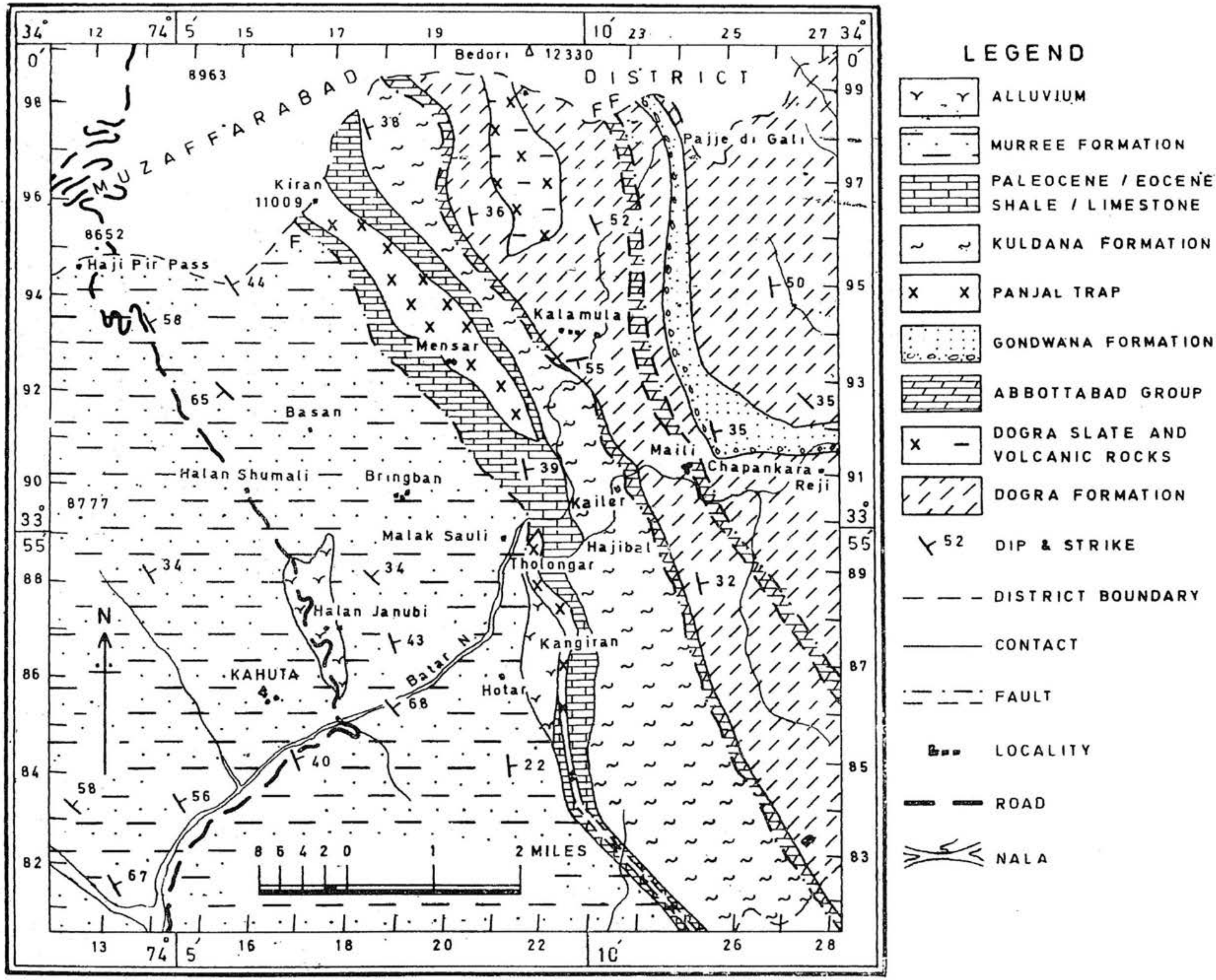

Fig 1 GEOLOGICAL MAP OF UPPER HAVELI, POONCH DISTRICT

Cavities in the volcanics often occur. These are mainly filled by chalcedony, jasper and a dark green to black material which is chlorite and/or epidote.

The volcanics mostly occur as inliers within Paleocene/Eocene rocks, exposed mostly along the foot of Pir Panjal Range in the Upper Haveli area (Fig. 1). Excellent exposures of volcanics can be observed in Kiran, Kangiran and Tholangar areas.

The agglomeratic slates are composed of grey to black slates conglomeritic beds, agglomeritic beds and volcanics. The volcanics are mostly pyroclasts.

STRUCTURE

The Pir Panjal portion of Poonch shows more intense tectonic effects than the rest of the area under discussion. Thrust faulting and isoclinal folding are characteristic in the Pir Panjal Block. General strike is from NW-SE to NNW-SSE. The dip angles range from 30° to 75° and the dip direction generally varies from NNE to NE.

The 'Slate Belt' (NE of 43 K/1) shows fairly tight isoclinal folding. The slates show upto three cleavages. At many places crude schistosity can be seen. Out of the three cleavages in slates, at least two are older than Upper Carboniferous. They are relics of earlier orogenesis. The graphitic/carbonaceous beds within slates are puckered and crumpled.

Gondwanas occur as outliers within the slates. Due to erosion the exposures of Gondwanas now lie in synclinal troughs. Cleavage is developed within harder beds and poor schistosity, or what looks like it, is developed within argillaceous beds. The metaconglomerate has its pebbles and cobbles etc. stretched and its argillaceous groundmass (matrix) is strongly foliated and schistose.

The Panjal trap occurs as inliers within the Paleocene/Eocene rocks. The individual flows are sheet like. The volcanic ashes show moderate to excellent lamination.

There is a major overthrust between Dogra Slates (Precambrian) and Kuldana Formation (Eocene). This is well exposed near Kailer in Batar Valley. Strong stresses have effected the surrounding areas. The Kuldanas in the vicinity have been effected and have developed what looks like crude schistosity. Rocks of the Abbottabad group between Tholangar and Maili (Fig. 1) form a broad isoclinal syncline. The fold units run NNE-SSW.

The Murrees are thrusted against the foot of Pir Panjal. The Lower Murrees are isoclinally folded. They show extensive faulting and fracturing. The shales show flowage, resulting in thickening in pressure shadows and thinning in high pressure areas. These structures are seen in Upper Haveli area.

The Upper Murrees and Lower Siwaliks (outsid the area of Fig. 1) are less disturbed. They are, in ge neral, normally folded. Faulting is less common. Norma folding in Siwaliks is common. The folds are broac and open.

THE DOGRA TRAP

Dogra Trap rocks, the oldest volcanics in the area, occur as a sedimentary volcanic sequence in a part of the Dogra Slates. The volcanics alongwith enclosing and interbedded sediments have undergone low grade regional metamorphism. In the following, petrography of the traps is presented, whereas petrography of slates has been given elsewhere (E.C.L. 1978) which are mainly pelitic materials without volcanic material at many places.

PETROGRAPHY

Six samples of the Dogra trap volcanic flows were selected for petrographic study. All the samples were selected from the Kalamula area of Upper Haveli area. The trap is well exposed here.

The volcanics are fine grained, although medium grained may be present. The rocks are foliated, hollocrystalline and at places amygdaloidal. The amygdules have been almost invariably filled with secondary chlorite of a dark green to dark olive green variety. In vesicules epidote may occur associated with chlorite. Rarely calcite and quartz may occur in the amygdules. Quartz and calcite may also occur as veins, streaks and irregular aggregates. The flows may originally have been merocrystalline but due to recrystallization glassy material is lacking. The Dogra trap has undergone varying degree of epidotization and chloritization.

Epidote ($X = 21.83$, $\rho = 10.82$) and chlorite ($X = 17.83$, $\rho = 11.00$) are the two persistent and main minerals. Epidote has two modes of occurrence. Predominantly it occurs as subhedral prismatic to subprismatic crystals. Secondly, it occurs as granular masses. The prismatic to subprismatic crystals show poor cleavage but better developed cracks. The granular grains hardly show cleavage or fractures. Epidote shows neutral pale green to light green colours. It is almost nonpleochroic. It has low to moderate 2V and normal second to third order interference colours. Ferrian zoisite grains may also be encountered.

Chlorite ($X = 17.83$, $\rho = 11.00$ is medium to dark green and moderately pleochroic. It occurs within the vesicules as well as in the body of the volcanics. Outside vesicules it generally occurs as discrete flakes and irregular to poorly sheaf like aggregates. Within the vesicules it occurs from sheaf like to subradial to radial aggregates. Its growth shows suppression against epidote.

Amphibole (X = 14.50, ρ = 14.80) occurs in four out of six samples and its amount is 6.0%, 20.0%, 25.0% and 36.0% It occurs in the form of subhedral to anhedral grains. The subhedra are subprismatic. It is medium to dark medium green and moderately pleochroic from neutral green to medium green. It is closely associated with epidote outside vesicules.

Plagioclase (X = 8.50, ρ = 8.94) occurs in four out of six samples studied. Its quantity is 3.0%, 10.0%, 18.0% and 20.0%. It mostly occurs as slender fine to medium laths.

Pyroxene has survived in three out of the six samples studied. Its amount in these samples is 6.0%, 8.0% and 19.0%. It mostly occurs as relics. It shows replacement by epidote, amphibole and chlorite. It is colourless and non-pleochroic.

Muscovite/sericite (X = 8.50, ρ = 8.09) are secondary in origin and form as a result of alteration of feldspar. They occur as flakes and needles.

Quartz (X = 5.50, ρ = 6.38) is present in five out of six samples. In four samples quartz is 2.0 to 5.0% while in one sample it is 18.0%. It is fine grained and anhedral. It occurs either interstitial or, at places, as intergrowths with epidote.

K–feldspar occurs in three out of six samples. In these three samples it ranges from 12.0 to 27.0%. It occurs as small anhedra which show alteration to clay and sericite.

Magnetite (X = 3.83, ρ = 2.02) occurs as small subhedra to anhedra and their aggregates. It may show alteration to limonite/hematite.

Hematite/limonite (X = 0.67, ρ = 0.75) occur associated together. Hematite may occur as tiny black grains which show blood red colour in non-incident reflected light. They may occur as small specks, grains and stains.

Pyrite (X = 0.83, ρ = 0.98) occurs as tiny subhedral to eumorphic grains. It may show minor alteration to limonite or goethite. In non-incident reflected light it shows golden yellow colour.

Calcite, clay and biotite are other minor to accessory minerals.

CHEMISTY

Four samples of Dogra trap were analysed chemically. The contents of SiO_2 (X = 45.69, ρ = 2.69) range from 41.82 to 47.42%, that of Al_2O_3 (X = 18.18, ρ = 3.43) range from 15.13 to 19.63, the contents of Fe_2O_3* (X 16.37, ρ = 1.99) range from 13.39 to 17.50%, that of MgO (X = 5.22, ρ = 1.55) range from 2.97 to 6.51%. CaO (X = 7.48, ρ = 1.25) ranges from 6.14 to 8.90%. Na_2O (X = 2.40, ρ=0.82) ranges from 1.90 to 3.59% and K_2O (X=1.00, ρ=0.84) ranges from 0.31 to 2.13%. MnO (X=0.14, ρ=0.04) ranges from 0.09 to 0.18% and TiO_2 (X=0.26, ρ=0.03) ranges from 0.22 to 0.29%.

The chemical composition shows these rocks to be basaltic which are rather high in K_2O and Fe_2O_3*

Trace Elements: Four samples of Dogra trap were analysed by spectro-chemical method. Three samples contain 10 ppm Zr, two samples contain 10 ppm Y and one sample contains 5 ppm Y and three samples contain 5 ppm Mo. The contents of V in all the samples vary from 0.005 to 0.01%, of Cu range from 0.005 to 0.02%, of Cr 0.01%. Co and Ni range from 20 to 50 ppm. Pb is 50 ppm in all the samples and Sc is 10 ppm in two samples and 5 ppm in one sample.

Spectrochemical analysis shows these rocks to be practically barren for the contents studied.

THE PANJAL TRAPS

The rocks of the Panjal traps were collected from NW–SE trending inliers from Kanigran, Tholangar, Mensar and Kiran. They were collected taking into consideration variations in texture/structure, apparent mineral variations, colours etc. These rocks were thereafter analysed petrographically, chemically and spectrochemically.

PETROGRAPHY

A total of twenty nine samples were analysed petrographically. The percentage of constituents alongwith their averages and standard deviations are also given.

The Panjal volcanics are fine to medium grained and from merocrystalline to hollocrystalline. The medium grains are either phenocrysts or porphyroblasts. Hollohayline rocks were not encountered. Some flows or parts of the flows are amygdaloidal. The amygdules are now filled with either epidote or epidote and chlorite or with chalcedony or jasper. Flow structures may rarely be seen. Original structures and textures have been modified due to later reconstitution so that patchy and irregular segregations of epidote are often seen and chalcedonic and jasper patches are also present. The pyroclasts show typical clastic textures. The pyroclasts are often merocrystalline. The rocks are non-porphyritic to subporphyritic.

The plagioclase (X=33.07, ρ =20.56) is labradorite and occurs as fine to medium subhedral to eumorphic laths. The crystals are moderately well twinned. Albite and albite-Carlsbad combination is common. Pericline twinning is relatively rare.. Subparallel alignment of laths is sometimes seen. Alteration to sericite, clay and epidote is quite common. At places subophitic texture is also present.

Pyroxene (X=16.62, ρ =17.21) occurs as fine to medium subhedral grains. Some grains are eumorphic. Pyroxene shows extensive alteration to epidote and chlorite.

Epidote (X=14.07, ρ =17.16) occurs from fine to medium grains. The medium grains show fractures. It is generally from subhedral to anhedral. It occurs either as discrete grains or as irregular to oval shaped (due to filling of vesicules) aggregates. In plane polarized light it is light green to yellowish green and slightly pleochroic. It appears to be mostly zoisite. It is predominantly a secondary mineral. Its amount is highly variable as can be seen by comparing the average and standard deviation. It mostly forms due to the alteration of plagioclase and pyroxene.

Chlorite (X=9.80, ρ =6.08) is mostly fine grained. Although discrete flakes occur, yet aggregates are more common. The aggregates are patchy, sheaf like, elongate as well as radial to subradial (mostly filling vesicules). It is medium to dark leaf green and slightly to moderately pleochroic. It is also generally a secondary mineral which forms after pyroxene or fills vesicules.

Muscovite/sericite (X = 3.91, ρ =4.60) are fine grained and occur as needles and tiny flakes. They are secondary and formed due to the alteration of feldspars.

Quartz (X=6.31, ρ =7.29) is mostly fine grained and anhedral but some medium grains are also present. It may occur as discrete interstitial grains or as vein like to irregular small patchy aggregates. Some grains may show strain twinning and strain extinction.

Clay Minerals (X=2.60, ρ =3.04) occur as extremely fine grained and often microcrystalline to cryptocrystalline aggregates. They may also occur as tiny needles. They form due to the alteration of feldspars. Both illite group as well as kaolinite group minerals occur.

Hematite/limonite (X=3.43, ρ =2.50) are fine grained. Hematite may occur as discrete tiny grains which are black and opaque and which under reflected light (non-incident) show blood red colour. It may also occur as colour stains. Limonite occurs as tiny amorphous looking specks, aggregates and also as a staining and colouring matter. Both these minerals are secondary and form due to the alteration of ferromagnesians as well as magnetite. They are mostly intimately associated.

Magnetite (X=1.05, ρ =1.35) occurs as randomly dispersed tiny grains. Occasionally they may form small aggregates. They are from subhedral to anhedral and may show varying degrees of alteration to hematite/limonite. They are black and opaque and in non-incident reflected light show steel grey colours.

K-feldspar (X=2.52, ρ =6.66) occurs as small anhedra. It is commonly associated with plagioclase. It appears to be orthoclase. It shows alteration to sericite and clay.

Chalcedony (X=1.90, ρ =2.81) forms tiny sheaf like to subradial to radial aggregates. At places even salt and pepper structure may be seen. It occurs either in the interstices or as a cavity filling mineral. In some vesicules it is closely associated with chlorite.

Glass (X=2.52, ρ =5.44) occurs as small patches, pods and as interstitial matter. In plane polarised light it is colourless and in cross nicols it is opaque.

Calcite is from fine to medium grains. It is mostly fine grained and is forming in the body of plagioclase and pyroxene due to their alteration. At places it may occur as independent grains which are often interstitial. Rarely it may form small patches.

Sphene (X=0.69, ρ =1.31) occurs as fine euhedral to subhedral grains. They show preferred association with epidote. It is mostly khaki coloured.

Amphibole occurs in a few samples and ranges from 5.0 to 20.0% either as what looks like independent grains or as associate of pyroxene. It also suffers alteration to epidote.

Biotite occurs in a few samples. It occurs as tiny flakes and their streaky aggregates. It is mostly interstitial. Its colour vary from greenish brown to dark brown. It is moderately to strongly pleochroic.

CHEMISTY

Twenty four samples of the Panjal trap were chemically analysed. The results of averages and standard deviations of individual constituents are given in the following:

Average (X) for SiO_2 is 48.07 and ρ =4.07, X= for Al_2O_3 is 19.73 and ρ =2.55, X for CaO is 8.32 and ρ is 2.28, X for MgO is 6.11 and ρ is 2.47 and X for Fe_2O_3* is 11.03 and ρ is 1.91 X for Na_2O is 2.65 and ρ is 1.30, for K_2O X is 0.54 and ρ is 0.52, X for TiO_2 is 0.30 and ρ is 0.25 and X for MnO is 0.12 and ρ is 0.13, and X for I/L is 3.14 and ρ is 1.30.

The overall chemical composition shows these rocks to be basaltic. However, the composition varies from basalt to andesite.

Trace Elements: Eleven samples of the Panjal trap were analysed by spectrochemical methods. The content of Zr is nil in three samples, 0.002% in one, 10 ppm in two samples and 0.007% in five samples. Y is absent in one sample, 10 ppm in one sample and 5 ppm in nine samples. The contents of V range from 0.001 to 0.01%. Mo is absent in seven samples, and 5 ppm in four samples. Sc is absent in two samples, 5 ppm in two samples and 10 ppm in seven samples. The contents of Co and Ni were determined in five samples only and they were 20 ppm in each case. Sn was determined in five samples, was found absent in four samples and was 50 ppm in one sample. The content of Pb was determined in ten samples and was 50 ppm in each sample. Cu was determined in ten samples. It was 10 ppm in one sample, 5 ppm in four samples and from 0.001 to 0.005% in five samples. Cr was determined in five samples and varied from 0.01 to 0.001%.

The results do not show anomalies and therefore, from the flows from which these samples were collected, mineralization of the elements studied appears remote.

VOLCANIC ASH

Volcanic tuffs and ashes occur towards the top of the Panjal trap flows. A particularly good section of these pyroclasts is exposed on the jeep track between Kangiran and Tholangar at a distance of about 1.5 km north of Kangiran (along the road). The ash beds are fissile, shaly looking and sometimes mottled. The tuffaceous beds are harder and poorly foliated. These tuffs and ashes are an integral part of the Panjal trap of basaltic to basalt andesitic composition which occurs as inliers within Paleocene/Eocene rocks along the foot of the Pir Panjal Range in the Upper Haveli Tehsil. The samples studied were taken from Tholangar area.

PETROGRAPHY

Four samples of pyroclasts were petrographically studied. The rocks are from poorly laminated to well laminated. The grains are mainly of quartz, tridymite and feldspar, and the matrix and cement/binding matter is composed of glassy/crytocrystalline matter and clay/sericite. All the samples are merocrystalline.

Quartz/tridymite: High quartz and tridymite both occur. They are angular to subangular and fine to medium grained. Tridymite may show typical twinning. They compose from 25.0 to 30.0% of the rock.

Sericite/clay occur in the other three samples. Here they range from 30.0 to 45.0%. The two minerals are extremely fine grained and intimately admixed. The clays appear to belong to the montmorillonite as well as kaolinite groups.

Plagioclase appears to be oligoclase. It occurs as subprismatic to angular, subhedral to anhedral grains. It shows moderately well developed albite twinning. At places complex twin patterns are also seen. It shows from slight to moderate alteration to clay and sericite. It occurs in three samples and ranges from 6.0 to 8.0%.

Sanidine occurs as subprismatic to anhedral angular crystals. It occurs mostly as medium grains and shows alteration to clay and sericite.

Cryptocrystalline and glassy matter occur in all the samples. In three samples it ranges from 17.0 to 20.0% and in one sample its amount is 62.0%. It is mostly colourless to light brown and dark grey to dark black under crossed nicols.

Hematite/limonite occur in three samples and in them they vary from 1.0 to 6.0%. They occur as specks, tiny grains, stains and coloured streaks.

Tiny anhedral grains of magnetite are present in three samples. In them it ranges from 1.5 to 2.0%

CHEMISTY

Four samples of volcanic ash were chemically analysed. The contents of SiO_2 vary from 57.38 to 69.06%, of Al_2O_3 from 7.40 to 21.96%, of Fe_2O_3* from 5.61 to 11.08%, of MgO from 0.37 to 1.88%, of CaO from traces to 3.02%, of Na_2O from 0.57 to 1.98%, of K_2O from 3.37 to 4.01% and of I/L from 3.72 to 7.80%.

As compared with the flows, these rocks are richer in SiO_2 and K O and poorer in CaO and MgO. These rocks are distinctly potassic.

CONCLUSIONS

The volcanic rocks of Poonch can be divided into two groups.

(i) Dogra trap of Precambrian age occur in Dogra slates as synvolcano sedimentary rocks. Chemico-mineralogical studies show these rocks to be basaltic.

(ii) The Panjal trap flows as well as pyroclasts are of Upper Carboniferous age and occur as inliers within Paleocene/Eocene rocks. The flows are basaltic to andesitic while the pyroclasts are volcanic ashes and tuffs, distinctly richer than the flows in SiO_2 and K_2O and poorer in CaO and MgO.

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