THE PANJAL TRAPS: ACID AND BASIC VOLCANIC ROCKS

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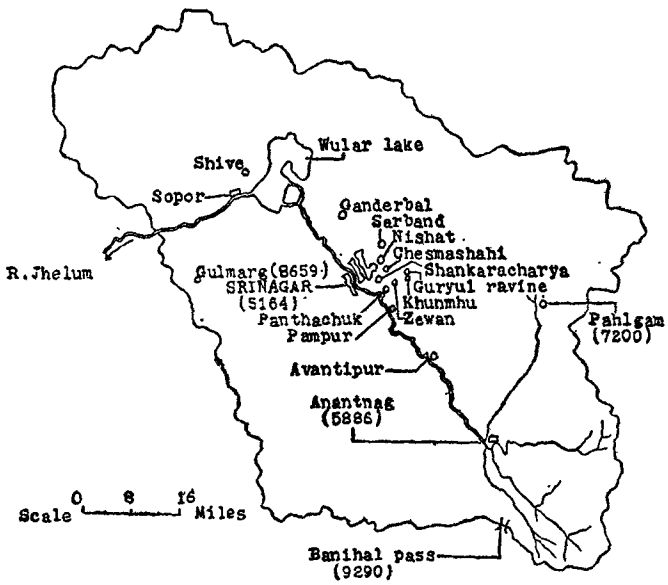
THE material on which this paper is based was collected by the author, mainly during the field work done in the summer of 1937 under the very valuable guidance of Prof. Raj Nath and partly alone, again in the summer of 1941. The material was collected from various localities in the vicinity of Srinagar and at such far off places as Gulmarg, Banihal pass, Pahlgam and Shive (near Sopore). The work was carried out in the Geology Department of the Benares Hindu University where the material is preserved.

Towards the close of the last century Lydekker and McMahon (1883, p. 218) established the volcanic origin of the Panjal traps. Middlemiss (1910, p. 235) described these rocks as "Genuine old basic lava flows". The late Professor K. K. Mathur (1933, p. 126) in a letter to *Current Science* described a specimen of rhyolite occurring in the Panjal traps at a locality named Panthachuk near Srinagar. About this discovery West (1935, p. 492) remarked "Although these rhyolites may be quantitatively unimportant, nevertheless their discovery is of much interest." Mr. D. N. Wadia (1939, pp. 412–13) describes these traps as "A basic variety of augite andesite or basalt of acidity varying 49% to 60% of a prevailing dark or greenish colour.....Acid and intermediate differentiation products also occur locally and in small masses, *e.g.*, trachyte, ceratophyre, rhyolite, acid tuffs, etc."

The Panjal traps generally overlie the Agglomeratic slate series of Upper Carboniferous age but at most places these lie unconformably over much older rocks. The upper limit is also different at different places. Sometimes these are found overlain by Lower Permian beds, as in the Vihi district where the traps are overlain by Gondwana plant bearing beds, while at other places the volcanic activity continued till Upper Triassic.

The presence of the acid rocks in the Panjal traps made their study very interesting. The author, therefore, studied this problem in greater detail. The results obtained clearly prove the true nature of acid volcanic rocks and their occurrence on a much larger scale than that previously thought of.

The trap rocks were studied at Cheshmashahi, Sarband to Nishat along the canal road behind the Moghul Gardens, Panthachuk, Khunmhu, Zewan, Avantipur, Pahlgam, Banihal pass, Gulmarg, Ganderbal and Shive. The relative position of these places is shown in the outline map of Kashmir (Text-Fig. 1).



TEXT-FIG. 1. Outline sketch map of Kashmir showing the localities where the Panjal trap rocks were studied

The acid volcanic rocks have been found occurring in great amount at the localities of Panthachuk, Avantipur and Cheshmashahi. At other places the basic volcanic rocks predominate.

At Panthachuk, the Panjal trap formation appears to show a sort of bedded structure and each bed may have been an individual outflow of lava. These beds are of different thickness and the bedding planes merge one into another after a short distance which makes their individual study rather difficult. With the idea of finding variation in constituents, specimens were collected at intervals of different heights from the base of the formation to its top and from what appeared to be different beds of lava flows. Near the top there is a vein formed of calcite and quartz and about 20 ft. below this there is an another vein having similar constituents. The specimen K/P6 lies immediately below the lower vein. The specimens K/P3–K/P6 were taken at intervals of different heights (Text-Fig. 2) one over the other.

The Acid Volcanic Rocks

In hand specimen the acid volcanic rocks are compact and greyish in colour. Quartz can be easily seen with the help of a lens. The specific gravity varies from 2·69 to 2·79 at the two extremes.

Under the microscope these rocks (Figs. 1, 2 & 3) are porphyritic. Among the phenocrysts euhedral to subhedral crystals of quartz are quite abundant. Crystals of alkali felspars are present in fairly large amount. Some of these are turbid. A few crystals of plagioclase felspars showing polysynthetic twinning are also present in some specimens (P/4 and K/C1 from Panthachuk and Cheshmashahi respectively). A general characterstic, however, is the presence of green chloritic matter produced as a result of alteration. The chlorite usually occurs in association with felspars. The ground mass is usually turbid and is crypto- to micro-crystalline and shows crystals of quartz and felspar at places (Fig. 3). In a specimen from Cheshmashahi (K/C1) the ground mass is glassy and shows a sort of flow structure. Magnetite and ilmenite are present in fairly large amount. In a specimen from Panthachuk (K/P5) veins filled with secondary quartz are present.

Seven rocks were analysed, five from Panthachuk and one each from Cheshmashahi and Avantipur. The values of analyses and norm are given in Tables I and II.

The Basic Volcanic Rocks

These rocks are compact and dark green in appearance. Small pieces of ferromagnesian minerals are present in sufficient quantity and can be seen in hand specimen. The specific gravity of these varies from 2·8 to 3·0 at the two extremes.

Under the microscope the basic volcanic rocks (Fig. 4) are porphyritic. Phenocrysts of plagioclase felspars are present in fairly large amount. As a rule these rocks are very much altered and have undergone secondary silicification. Epidotisation is also a common phenomenon in these. Green chloritic product produced as a result of altertion is present in sufficient quantity. Big cavities filled with secondary quartz, secondary mica and epidote are fairly common. The ground mass is usually crypto-crystalline and at places consists of minute needle-shaped prisms of felspar most of which show polysynthetic twinning (*e.g.*, K/G4 from Guryul ravine). Magnetite and ilmenite is present in fairly large amount. Specimens from near Ganderbal are very much metamorphosed and show schistose structure.

TABLE I

Analyses of Acid and Basic Volcanic Rocks

	Acid							Basic
	Panthachuk					Cheshmashahi	Avantipur	Sarband-Nishat Canal Road
	K/P3	K/P4	K/P5	K/P6	P/4	K/C1	K/A3	K/SN2
SiO_2 ..	66·87	64·96	66·22	64·89	68·43	63·59	64·99	57·37
Al_2O_3 ..	15·04	16·61	15·57	16·78	15·39	16·36	17·06	18·70
TiO_2 ..	0·90	0·94	1·00	1·08	0·93	1·09	0·93	1·16
MnO ..	0·04	0·09	0·05	0·06	0·03	0·02	0·06	0·10
Fe_2O_3 ..	1·47	1·97	2·77	1·54	1·41	1·58	1·94	3·24
FeO ..	2·46	2·99	2·61	2·62	2·84	2·86	1·76	3·88
CaO ..	3·36	2·87	2·72	3·28	1·99	4·45	3·44	5·86
MgO ..	1·03	1·10	1·21	0·98	0·66	1·44	1·32	2·64
Na_2O ..	4·22	3·85	2·36	4·68	3·68	5·32	3·52	3·75
K_2O ..	3·87	4·71	5·62	3·28	4·82	2·52	4·36	2·27
H_2O (-) ..	0·28	0·32	0·19	0·21	0·43	0·22	0·23	0·28
Total ..	99·54	100·41	100·32	99·40	100·61	99·45	99·61	99·25
Sp. gr. ..	2·77	2·74	2·70	2·73	2·69	2·76	2·75	2·77
Microscopic characters	Porphyritic. Fairly large phenocrysts of quartz. Ground mass glassy.	Porphyritic. Phenocrysts of quartz and alkali felspar. Ground mass more or less glassy.	Porphyritic. Phenocrysts of quartz and orthoclase felspar. Ground mass contains crystals of quartz and felspar. Secondary quartz present in cavities.	Porphyritic. Phenocrysts of quartz and orthoclase felspar. Ground mass more or less glassy.	Porphyritic. Phenocrysts of quartz, alkali and a few plagioclase felspar. Ground mass mostly glassy with a few crystals of quartz and felspar.	Porphyritic. Much decomposed. Phenocrysts of alkali and a few plagioclase felspar. Ground mass glassy showing flow structure. Cavities filled with secondary minerals are common.	Porphyritic. Phenocrysts of quartz only. Ground mass mostly glassy with a few quartz and felspar crystals.	Porphyritic. Phenocrysts of plagioclase felspar only. Ground mass contains needle-shaped crystals of felspar. Cavities filled with secondary minerals very common.
Analyst	P. N. Ganju							

TABLE II

Norm of Acid and Basic Volcanic Rocks

	Acid					Basic		
	Panthachuk					Cheshma-shahi	Avantipur	Sarband-Nishat Canal Road
	K/P3	K/P4	K/P5	K/P6	P/4	K/C1	K/A3	K/SN2
Quartz ..	19·32	15·84	22·92	16·20	22·32	12·24	17·46	9·66
Orthoclase ..	22·79	27·80	33·36	19·46	28·36	15·01	27·24	13·34
Albite ..	35·63	32·48	19·91	39·30	31·44	45·06	29·86	31·44
Anorthite ..	10·56	14·17	13·34	15·00	10·01	13·06	16·95	27·52
Corundum ..	..	..	0·70	..	0·41	..	..	..
Diopside ..	5·00	..	..	1·14	..	7·23	..	1·35
Hypersthene ..	1·99	5·07	4·05	3·65	3·61	2·19	3·43	8·70
Magnetite ..	2·08	2·78	3·94	2·32	2·09	2·32	2·78	4·64
Ilmenite ..	1·67	1·82	1·82	2·12	1·67	2·12	1·82	2·12
Water ..	0·28	0·32	0·19	0·21	0·43	0·22	0·23	0·28
Total ..	99·32	100·28	100·23	99·41	100·34	99·45	99·77	99·05

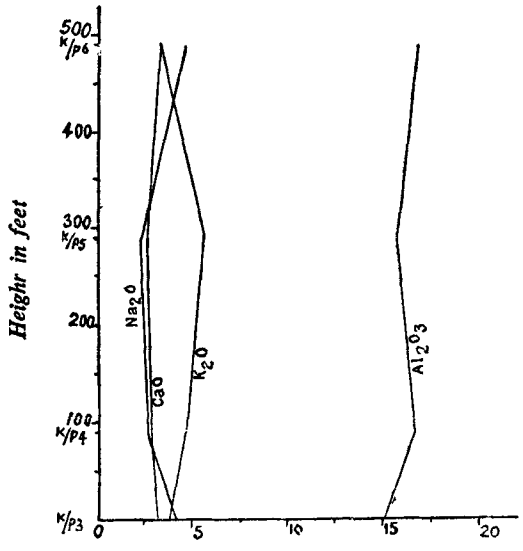
Only one rock sample K/SN2 from Sarband-Nishat Canal road was analysed. The values of analyses and norm are given side by side with the acid volcanic rocks in Tables I and II, for comparison.

Discussion

From the microscopic description, chemical analysis and other characters of Panjal traps occurring at Panthachuk, Avantipur and Cheshma-shahi, it is quite clear that acid volcanic rocks of the nature of rhyolites, trachytes and dacites do occur in the Panjal traps. That these acid rocks have not been formed by secondary silicification of andesites is also quite clear from the photomicrographs given (Figs. 1–3) where crystals of original quartz as well as those of the alkali felspars can be very clearly seen. A comparative glance at the analysis values of acid and basic rocks also proves beyond doubt the true nature of these acid rocks. It is true that most of the basic rocks have undergone secondary silicification, the secondary quartz being present in veins and amygdales but it is clearly different from the primary quartz seen in true acid volcanic rocks.

At Panthachuk, as already stated, specimens were collected at different heights from the base of the formation. Some of these were analysed chemically (see Table I) and the variation of various oxides with height has

been plotted (Text-Fig. 2). As is clear no definite change can be observed and the variations seem to be more or less irregular. The calcite and quartz veins at Panthachuk may have been formed by the steam and carbon dioxide evolved during the eruptions. These together may have decomposed the felspars producing calcium carbonate and silica deposited in the form of veins.



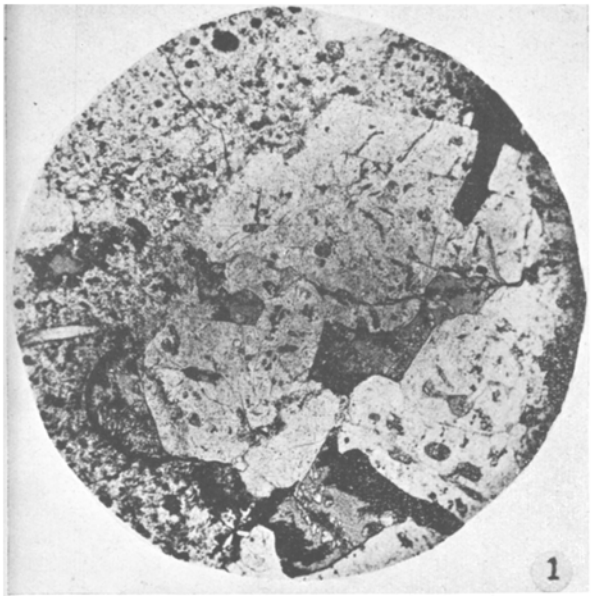
TEXT-FIG. 2. Graph showing the variation of different oxides with 'height' at Panthachuk

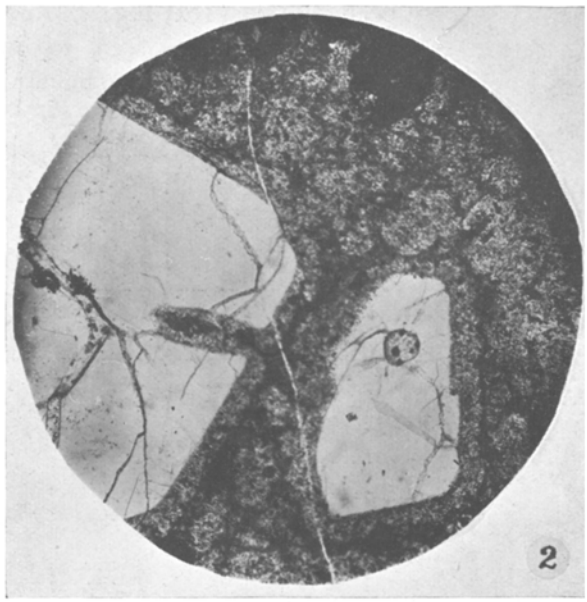
The acid rocks, however, show higher specific gravity than is usual. This may be explained as due to the high quantity of magnetite and ilmenite that these have been observed to contain.

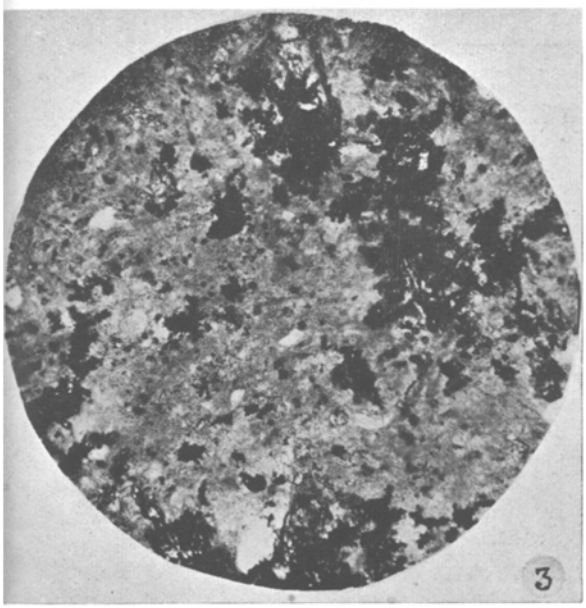
As regards the quantitative importance of these, the author has traced the outcrop of acid rocks at three places within the distance of about 24 miles from Cheshmashahi to Avantipur. This shows that quantitatively these occur on a fairly large scale and it is likely that these occur on a much greater scale in Pir Panjal and other hills. It will be very interesting to get an idea of the total amount of the acid rocks as compared to basic rocks, their age, the time interval between the two outflows and their origin. The author hopes to continue the study of these points in detail.

Conclusion

The presence of rhyolites in the Panjal traps at Panthachuk was first brought to notice by late Prof. K. K. Mathur. The author studied the







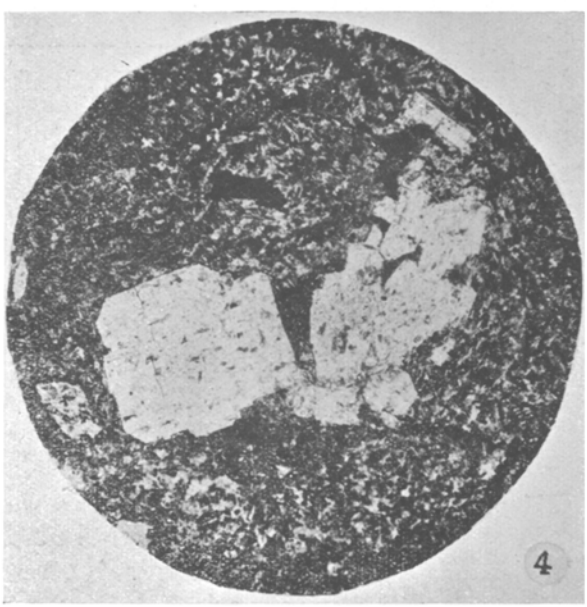


Fig. 1. Acid volcanic rock from the base of the quarry at Panthachuk, Srinagar, Kashmir. No. K/P 3.

Fig. 2. Acid volcanic rock from a height of about 300 feet at Panthachuk quarry. No. K/P 5.

Fig. 3. Acid volcanic rock from the Panjal trap formation at Avantipur, Kashmir. No. K/A 16.

Fig. 4. Basic volcanic rock from the Panjal trap formation along the Sarband-Nishat Canal road, Srinagar, Kashmir, No. K/SN 2.

Panjal traps in some detail and as a result the acid rocks have been found to occur at two other places also, *viz.*, at Cheshmashahi and Avantipur. These acid volcanic rocks are of the nature of rhyolites, trachytes and dacites and are very clearly different from basic volcanic rocks like andesites and basalts. These rocks are fairly abundant and must have played an important part in the Panjal volcanic activity.

Acknowledgment

I wish to express my great indebtedness to Prof. Raj Nath, M.Sc., Ph.D., D.I.C., for kindly suggesting this problem and the very valuable guidance he gave me throughout the work.

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