

## SIGNIFICANCE OF PERLITE IN THE PRECAMBRIAN ACID VOLCANIC ROCKS OF WESTERN RAJASTHAN, INDIA

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### INTRODUCTION

Glass is metastable and tends to devitrify. The hydrated silicic glass is perlite which shows characteristic curving concentric 'perlitic' cracks, and results from hydration and expansion of glass (Friedman and Smith, 1958). The occurrence of glass is rare in Precambrian rocks because of their antiquity; nevertheless, its occurrence in Precambrian acid volcanics assumes great significance because of the chemical changes involved during hydration and devitrification.

This note describes the significance of occurrence of perlite from Mandli area ( $26^{\circ} 10' : 72^{\circ} 30'$ , 60 km west of Jodhpur, Rajasthan). The rocks exposed in and around Mandli area are rhyolite, volcanic breccia, tuff and perlite belonging to the Malani igneous suits. The Malani igneous suite (55,000 sq km; 750 Ma) comprising non-orogenic, subvolcanic, hypersolvus (Siwana) and subsolvus (Tosham and Jalor) granites with cogenetic carapace of acid volcanics (welded tuff, rhyolite, breccia) occurs on the northwestern flank of the great Aravalli Chain and is characterised by ring structure (Kochhar, 1984). The representatives of the Malani suite also occur at Kirana hills, Pakistan. The Malani suite is the example of the third largest felsic volcanism in the world.

The characteristic chemical feature of the Malani volcanics is its low soda content as compared with the felsic lavas of the world (Table 1).

### PERLITE OF THE MANDLI AREA

The occurrence of perlite in the Mandli area was first reported by La Touche (1902). He described the area to be the site of a volcanic vent. Bhushan (1985) described this vent as Vulcanian to Ultra-vulcanian type. This volcanic cone is about 20 m high; its base is marked by volcanic breccia composed of dark green perlite embedded in a light green tuff followed by 13 m of maroon rhyolite tuff, and the upper 7 m is covered by green perlitic tuff cap. Under the microscope, the green perlite shows beautiful perlitic cracks (Fig. 1) and the matrix is characterised by cusped shards (Fig. 2). The perlite under crossed-nicols appears as alternate light and grey crosses characteristics of spherulites (Fig. 3).

### CHEMISTRY

Table 1 gives the chemical composition (major elements) of the perlite and the associated tuff. The chemical analyses of felsic rocks from the Allen Complex (Pinto Canyon, Texas), and a few other places are also given in Table 1.

Fig. 1. Photomicrograph of perlite showing perlitic cracks.  
Uncrossed nicols  $\times 60$

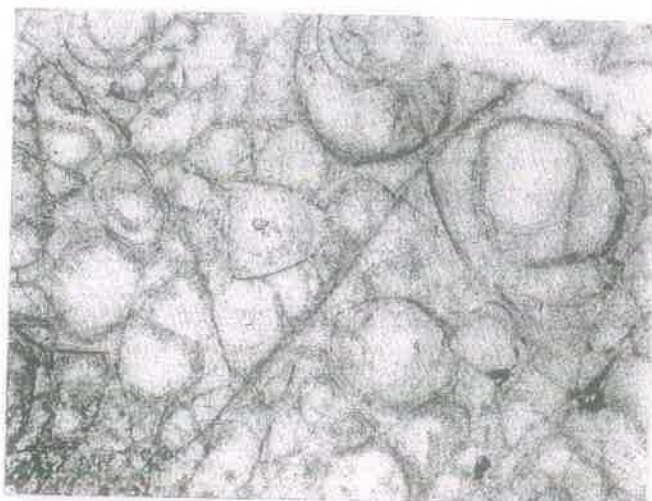
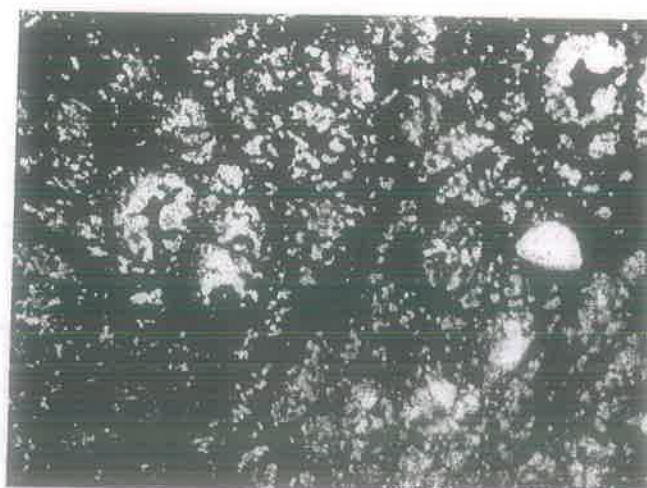


Fig. 2. Photomicrograph showing cusped shards in the matrix of tuff.  
Crossed nicols  $\times 60$



Fig. 3. Photomicrograph of perlite showing alternate dark and grey areas characteristics of spherulites.  
Crossed nicols  $\times 60$



A perusal of Table 1 shows that the Mandli perlite is depleted in  $\text{Na}_2\text{O}$  (0.50%) whereas the potash content is quite high ( $\text{K}_2\text{O}=7.53\%$ ). The acid volcanics of the Tosham area have soda content of 0.30% and the potash content is 5.20% (Kochhar, 1977). Similarly, the rhyolites of Kirana hills (Pakistan) have an average  $\text{Na}_2\text{O}$  content of 0.70% and the potash content is 4.07% (Davies and Crawford, 1971). Pareek (1981) observed that the acid volcanics of north-eastern part of the Malani suite are potassic, whereas those of northern and northeastern part are mainly sodic. The loss of soda in these cases has been attributed to hydrothermal alteration and devitrification (Kochhar, 1977; Pareek, 1981, 1986).

The evidence for hydrothermal alteration in the acid volcanics are the alteration of potash feldspar to sericite, magnetite to haematite and the intersection of quartz phenocrysts by veinlets of sericite of the groundmass.

TABLE 1  
CHEMICAL ANALYSES OF SOME ACID VOLCANIC ROCKS

Oxide	Sample								
	1 (6)	2 (6)	3 (26)	4 (24)	5 (1)	6 (1)	7 (1)	8 (1)	9 (1)
$\text{SiO}_2$	74.82	77.06	71.80	72.17	70.10	72.89	73.09	72.50	71.60
$\text{TiO}_2$	0.04	0.18	0.21	0.26	0.16	0.15	0.29	0.17	0.26
$\text{Al}_2\text{O}_3$	15.03	11.04	12.58	14.60	13.44	13.54	12.15	13.15	10.80
$\text{Fe}_2\text{O}_3$	3.60	1.04	2.62	2.30	0.63	0.15	1.12	0.51	0.74
FeO	0.71	1.04	0.67	0.51	0.40	0.36	0.75	0.36	0.30
MnO	0.03	0.12	0.04	0.04	Trace	Trace	0.08	0.09	0.02
MgO	0.21	0.42	0.66	0.53	3.68	3.13	0.07	0.07	0.29
CaO	0.29	0.65	1.68	0.96	1.15	0.93	0.47	0.80	1.81
$\text{Na}_2\text{O}$	0.30	0.72	1.44	1.98	0.50	0.94	3.79	3.36	6.95
$\text{K}_2\text{O}$	3.97	4.07	4.52	4.75	7.53	6.50	5.18	4.88	5.00
$\text{P}_2\text{O}_5$	0.03	0.02	—	0.14	0.64	0.14	0.00	0.02	0.01
$\text{H}_2\text{O}^+$	0.52	1.91	0.96	1.99	1.12	1.16	3.26	4.76	3.73

Number in parentheses ( ) indicate the number of analysed samples .

Description of samples:

1. Felsite from Tosham hill, India (Kochhar, 1977)
  2. Felsite from Kirana hills, Pakistan (Davies and Crawford, 1971)
  3. Malani tuff, India (Pareek, 1981)
  4. Malani rhyolite, India (Pareek, 1981)
  5. Mandli perlite, India (Present study)
  6. Mandli tuff, India (Present study)
  7. Black glass
  8. Grey perlite
  9. Yellow green devitrified rock
- } Allen Complex, Pinto Canyon, Texas (Barker, 1983)



The rapidly cooled acid volcanics have cristobalite in the groundmass and are more prone to alkali modification, whereas more slowly cooled rocks, such as the associated granites, have primary quartz in their groundmass and are not susceptible to the leaching of sodium (Noble, 1965).

Barker (1983) emphasised that appreciable changes take place in  $\text{Na}_2\text{O}$ ,  $\text{FeO}$ ,  $\text{Fe}_2\text{O}_3$  and  $\text{CaO}$  during progression from black glass with sparse perlitic cracks, through light grey and thoroughly fractured perlite to yellow green and completely devitrified equivalent of the black glass.

Lofgren (1970, 1971) suggested that devitrification proceeds in two stages: first glass becomes hydrated by introduction of water (probably as  $\text{H}^+$  and  $\text{OH}^-$ ) and then other ions, particularly  $\text{Na}^+$  and  $\text{K}^+$ , promote the growth of crystals. Hydration leads to expansion of the polymeric  $\text{SiO}_4$  network and reaction with  $\text{OH}^-$  to break some of the polymeric chains. The expanded glass network also allows diffusion of network modifiers, such as  $\text{Na}$ ,  $\text{K}$  and  $\text{Fe}$ , to proceed out of the system more rapidly and possibly facilitates reorientation of  $\text{SiO}_4$  tetrahedron. Thus, there is movement of  $\text{Na}$  and  $\text{K}$  ion during devitrification.

Laursen and Lauford (1978) emphasised that hydration also involves removal of ions of monovalent alkalis like  $\text{Na}^+$  and  $\text{K}^+$  by interdiffusion of hydronium ions ( $\text{H}_3\text{O}^+$ ) in the obsidian.

From the above discussion, it appears that alkali modifications do take place during hydration and devitrification of glass. It is suggested that the acid flows of the Malani suite, which are depleted in soda, were originally glassy and perlite and may not represent true magmatic compositions.

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#### REFERENCES

- BARKER, D. S., 1983. *Igneous Rocks*. Prentice-Hall, New Jersey, 417 p.
- BHUSHAN, S. K., 1985. Malani Volcanism in Western Rajasthan. *Ind. J. Earth Sci.*, Vol. 12, pp. 58-71.
- DAVIES, R. G. AND CRAWFORD, A. R., 1971. Petrography and Age of the Rocks of Bulland Hill, Kirana Hills, Sargodha Hill, West Pakistan. *Geol. Mag.*, Vol. 108, pp. 235-246.
- FRIEDMAN, I. AND SMITH, R. L., 1958. The Deuterium Content of Water in Some Volcanic Glasses. *Geochim. Cosmochim. Acta*, Vol. 15, pp. 218-228.
- KOCHHAR, N., 1977. Post-Emplacement Alkali Modifications in Rapidly Cooled Acid Volcanic Rocks. *Am. Mineral.*, Vol. 62, pp. 333-335.
- , 1984. The Malani Igneous Suite: Hot-Spot Magmatism and Cratonization of the Northern Part of the Indian Shield. *J. Geol. Soc. Ind.*, Vol. 25, pp. 155-161.
- LA TOUCHE, T. H. D., 1902. Geology of Western Rajputana. *Mem. Geol. Surv. Ind.*, Vol. 35, 116 p.

- LAURSEN, T. AND LAUFORD, A., 1978. Hydration of Obsidian. *Nature*, Vol. 276, pp. 153-156.
- LOFGREN, G., 1970. Experimental Devitrification Rate of Rhyolite Glass. *Geol. Soc. Am. Bul.*, Vol. 81, pp. 553-560.
- , 1971. Experimentally Produced Devitrification Textures in Natural Rhyolitic Glass. *Geol. Soc. Am. Bul.*, Vol. 82, pp. 111-124.
- NOBLE, D. C., 1965. Ground-Water Leaching of Sodium from Quickly Cooled Volcanic Rocks (Abstr.). *Am. Mineral.*, Vol. 50, p. 289.
- PAREEK, H. S., 1981. Petrochemistry and Petrogenesis of the Malani Igneous Suite, India. *Geol. Soc. Am. Bul.*, Vol. 12, pp. 206-273.
- , 1986. Petrography and Geochemistry of the Tosham Hill Felsic Volcanics, Haryana. *J. Geol. Soc. Ind.*, Vol. 27, pp. 254-262.

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