On the Nature of the Basic Rock Erratics from the *Dakshin Gangotri* Landmass, Antarctica

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Black and brown erratics characterised by autobrecciated nature and small pebbly appearance were observed on *Dakshin Gangotri* landmass. These erratics, transported by inland ice sheet, show no outcrop either in this landmass or in immediate vicinity.

Petrographically these erratics represent a pyroxene-olivine basalt with phenocrysts of pyroxene, olivine and plagioclase with no flow structure in groundmass, indicating that the crystallisation has taken place mostly either after the flow has come to rest or the crystallisation was contemporaneous with a turbulent movement which did not allow any regular orientation in groundmass.

Chemical analysis indicates a Ni content upto 0.16% and iron upto 10% with silica content of 42%

INTRODUCTION

Dakshin Gangotri landmass (70°45'S, 11°37'E) in East Antarctica exposes rocks of the Basement Complex comprising primarily banded and augen gneisses, garnet sillimanite gneiss, and metabasics with intrusions of melasyenites, aplites and dolerites. During the geological mapping of this landmass, small erratics of a basic rock were located north-west of the *Dakshin Gangotri* glacier at a locality marked E in the geological map of the area. They occur as boulders spread over a radius of 10 m and between 10 cm to 1 m in size and were located in loose rubble of a rock slide, at the bottom of a small gully originating from under the inland ice sheet.

The erratics, black to brown in colour, are fine grained in nature and show almost an autobrecciated character with well rounded to polygonal pebbles incorporated within the fine grained groundmass. Size of the incorporated pebbles varies from 1 cm to 5 cm. Boulders with smaller pebbles show a very hard and compact nature while those with larger pebbles, on striking, crumble into a powdery mass releasing the well rounded incorporated pebbles. The latter, in general, show a rounded but pitted surface and are very hard to break. A few pebbles even exhibit a dumb-bell shape.

PETROGRAPHY

They show porphyritic texture with phenocrysts of augite, olivine and calcic plagioclase set in a groundmass consisting of small plagioclase laths, granular augite, small skeletal opaque grains and glass charged with opaque mineral grains (Fig. 1) The idiomorphic phenocrysts constitute about 20% of the rock with pyroxene being the most abundant (about 80%) followed by olivine (about 20%). Oilvine phenocrysts form clusters, surrounded by granular augite. Some grains of olivine are, however, completely pseudomorphed by green chlorite. Olivine grains tend to partially or completely enclose laths of plagioclase in a poikilitic manner. Phenocrysts of olivine contain round glass inclusions containing iron ore, pyroxene and glass quenched from them. The average composition of these oliviness is Fe_{59} ($2V_X = 78^\circ$)

Fig.1. Photomicrograph showing the tyipical appearance of basalt (Plane polarized light, 61 X).

Fig. 2. Photomicrograph showing intergranular texture (Crossed nicols, 61 X).

Plagioclase phenocrysts are lath-like and show twinning on albite and albite-Carlsbad laws (Fig. 2*).* Some grains show conspicuous zoning and contain glass inclusions along the zonal boundaries. The composition of the phenocrysts varies from An_{71} to $An_{67.5}$ (X' 010 = 42˚ to 39.5˚) indicating their calcic nature.

Augite phenocrysts form subhedral to euhedral plates and commonly form clusters. Twinning is seen in some grains, and the hour glass structure is present at places. The average composition is Ca_{38} Mg_{49} Fe_{13} (N_Y = 1.683 ± .002; $2V_z$ = 47˚).

The microcrystalline groundmass shows intergranular texture. The plagioclase of the groundmass is lath-like and twinned and contains inclusions of small grains of augite, elongated skeletal, dendritic patterns of opaque oxides and glass along the twin planes. Rarely biotite and brown hornblende is also seen. In the chilled glass areas plagioclase laths are forked. Their average composition is $An_{60.5}$ (X' 010 = 33.5˚).

Augite grains of the groundmass are granular and those enclosed in glass are fibrous microlites. They are colourless to dark light pink and are intimately associated with plagioclase. Some grains show sector zoning. Some fine skeletal of iron oxides grains are attached to the boundaries of the augite grains.

Titanomagnetite grains show a profuse development and are represented by octahedral crystals. Some skeletal and a few needle like-crystals of ilmenite are also present. These mostly occur in the cryptocrystalline groundmass.

Devitrification has resulted in the formation of plagioclase and augite microlites.

The SiO_2 content of the groundmass glass is about 53%(R.I 1.560 ± 0.004), indicating a slight differentiation of the residual liquid. Alteration to orange, isotropic palagonite is common influence of chemical alteration/leaching.

In the interstitial spaces, brown immiscible liquid (glass) globules occur in a high-silica pale coloured glass base owing, probably to silicate liquid immiscibility.

THE OPAQUE MINERALS

Under the ore microscope, the oxide minerals identified have been titanomagnetite and ilmenite, both being small interstitial and skeletal.

Titanomagnetite grams are poikilitic against the silicates, at places even against ilmenite grains. A few equant grains are present and they form straight chains in glass area or border the silicates near glass areas. They are 0.01 to 0.10 mm in length and 0.01 to 0.80 mm in width

Abundant interstitial skeletal ilmenite grains are present having a poikilitic tendency against the silicates. At places they occur along the cracks of the titanomagnetite grains. Their size varies in length from 0.05 to 0.06 mm and in width from 0.03 to 0.04 mm.

Intergrowth of ilmenite and titanomagnetite is both primary and secondary. Primary intergrowth is common with irregular blocks or bands of ilmenite being present within titanomagnetite. Secondary intergrowth is represented by the few oxidation-exsolution lamellae of ilmenite along (111) plane of titanomagnetite (oxidation index II of Watkins *et al.,* 1970).

Sulphides are rare, mostly globular chalcopynte grains occurring in glass areas, at places exsolution lamellae of bornite have been noticed. Pyrite is isolated in glass. Chalcopyrite globules are at places attached to the oxides with a flat base suggesting the existence of a silicate melt (glass) *versus* sulphide liquid (now represented by globular sulphide mineral grains) immiscibility. Oxides are generally devoid of sulphide inclusions.

The boundaries between the oxide phases in the intergrowth texture were found to become prominent after etching with cone. HC1. The number of ilmenite lamellae, in the secondary intergrowth texture, became clearly detectable after etching, and consequently their number was taken for the estimation of the oxidation index according to the method of Watkins *et al.* (1970).

Petrographic analysis thus indicates the erratics to be of terrestrial origin rather than being a stony meteorite or a lunar basalt. This rock, tentatively named as pyroxene-olivme basalt, contains phenocrysts of three major minerals and is comparable to the "three phenocryst Basalt" as identified by West (1958) in the case of the Deccan Traps. The rock does not show any flow structure in the groundmass which indicates that most of the crystallisation has either taken place after the fluid lava had come to rest or the crystallisation might be contemporaneous with movement which was turbulent enough to have any regular orientation of the groundmass constituents (mainly plagioclase laths). Presence of sufficient olivine, plagioclase and pyroxene phenocrysts, forming glomeroporphyritic clusters, also indicates that the liquid lava was below the liquidus temperature of these minerals and the movement was very turbulent to have any regular orientation of the phenocrysts from the chambers to the surface.

CHEMICAL COMPOSITION

Samples of both the whole rock as well as that of the rounded pebble inclusions were subjected to detailed analyses in the Geochemical Laboratory of the Geological Survey of India, in Lucknow. Chemical analyses (Table I) show a high percentage of Nickel in both the samples. In fact the chemical analyses data has revealed the rock to be more akin to a stony meteorite than to any terrestrial basalt.

CONCLUSION

Occurrences of erratics within a limited aerial extent in absence of any *in situ* outcrop at *Dakshin Gangotri* and Wohlthat range, 100 km further south, and the chemical analyses data suggest that these might have an extra terrestrial origin. Their petrography, however, indicates the facts to be contradictory. These erratics, obviously transported by the inland ice sheet, are thus presenting an interesting aspect of future study and is hoped will be takenup by ensuing expeditions.

TABLE I

Chemical composition of erratics.

	Pebble	Whole rock		Pebble	Whole rock
SiO_2	45.18	44.65	CO_2	1 52	0 70
TiO_2	2 16	2.24	$+H_2O$	0 96	1.65
AljO,	12 22	10.42	$-H_20$	0 08	0.01
Fe,0_3	165	4 42			
FeO	9 95	8.80	Total	99 71	100 10
MnO	0.19	0 18			
MgO	10 03	11.15	*Trace element in paid per million*		
CaO	11.70	12 05	Cu	580	670
Na,0	3.01	2.94	Pb	250	280
K,0	0.72	0.66	Zn	670	690
P_20,	0.29	0.23	Ni	1600	1640
			Co	500	540

Oxides are in weight percent.

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