SHORT COMMUNICATIONS

ROCK MELT EXTRUSION AT PURULIYA, WEST BENGAL

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A detailed investigation of the 'rock melt extrusion', reported about three years back in this journal from Puruliya district, suggests it to be a surface phenomenon. The heat generated by burning of the torn out overhead 11 KV electric lines melted locally the fragmentary amphibolite pieces as well as the enclosing deep brown soil to the south of Jabjabigora. Petrographic, physical and geochemical data suggest that both the deep brown soil and amphibolite fragments underwent possibly complete melting on the surface, the former at a temperature a little above 1100°C and the latter at above 1350° to 1360°C.

Introduction

The students of Geology Department of J.K. College, Puruliya have published (SGDJKC, 1999) an account of 'lava eruption' from Jabjabigora near Hura, 28 km east of Puruliya that was reported in a local newspaper (Puruliya Darpan, 25 May, 1998). Extrusion of rock-melt from different parts of India has been reported by several authors in recent times (eg., Khanna, 1999; Khanna and Maheswari, 1999; Rajamanickam and Chandrasekhar, 2000; Ramasamy, 2000; Subbaraman, 2000; Manimaran et al. 2001; Gaitan Vaz, 2001). Some of these authors have suggested melting of surface rock/soil to be related to high tension electric lines involving leakage of current through poles or tearing up and fall of high tension electric lines on to the ground. Ramasamy (2000) has speculated that the 'rise of lava tubes' may be related to the hitherto unknown subterranean volcanic activity in case of the incident reported by him from Tamil Nadu. Manimaran et al.(2001) who recorded a few occurrences of rock melt from Tirunelveli district, Tamil Nadu from lineament zones in close proximity to the elctrical installations doubted the magmatic nature of the melt as the rock melt was only a thin superficial veneer. It may be mentioned in this context that Jayakaran (1998) has reported formation of fulgurite related to lightning from Tamil Nadu.

The present paper provides data that aim to throw light on the genesis of the so-called 'rock melt' of Jabjabigora near Hura, Puruliya district.

Geological Set-up

The lava 'eruption' spot is about 500 m south of Jabjabigora situated between Hura and Lalpur, and is underlain by Proterozoic Chhotanagpur granite gneiss (Dunn and Dey, 1942) containing patches of older amphibolite. The area around Jabjabigora has been geologically mapped by Bhattacharyya (1992) and Pal (1992) and is shown in Fig.1 that also depicts the lava eruption spot. This spot is located on relatively higher ground strewn with sporadic boulders and slabs of amphibolites, and is enclosed by deep brown soil (Fig.2).

Sample Collection

A random sample of deep brown soil (weighing about 1 kg) from near the 'erupting' spot was collected for chemical analysis and a sample of amphibolite cropping out of the deep brown soil lying just by the side of the above was collected for petrographic and chemical analyses (Fig. 2). No remnant of neoformed lava rock was available at the spot. However, a sample of small chips of lava rock could be collected from the personal collection of N. Mondal, a teacher of the Hura High School.

Petrography

The amphibolite is coarse grained, shows weak schistosity and is composed of hornblende, plagioclase, scapolite, diopside, quartz, sphene, epidote and opaques (modal mineralogy in Table 1). Plagioclase shows occasional relic intergranular texture indicating that the amphibolite could be an orthoamphibolite.

The lava rock is glassy, pitch black with a distinct brownish tint and shows conchoidal fracture. Some unmelted coarse felsic mineral grains occur sticking to the glassy material.

Geochemistry

Chemical analyses (by XRF method) of representative samples of amphibolite, enclosing deep brown soil, and the 'lava rock' are given in Table 1 along with the EPMA of the 'lava rock' published by SGDJKC (1999) for comparison.

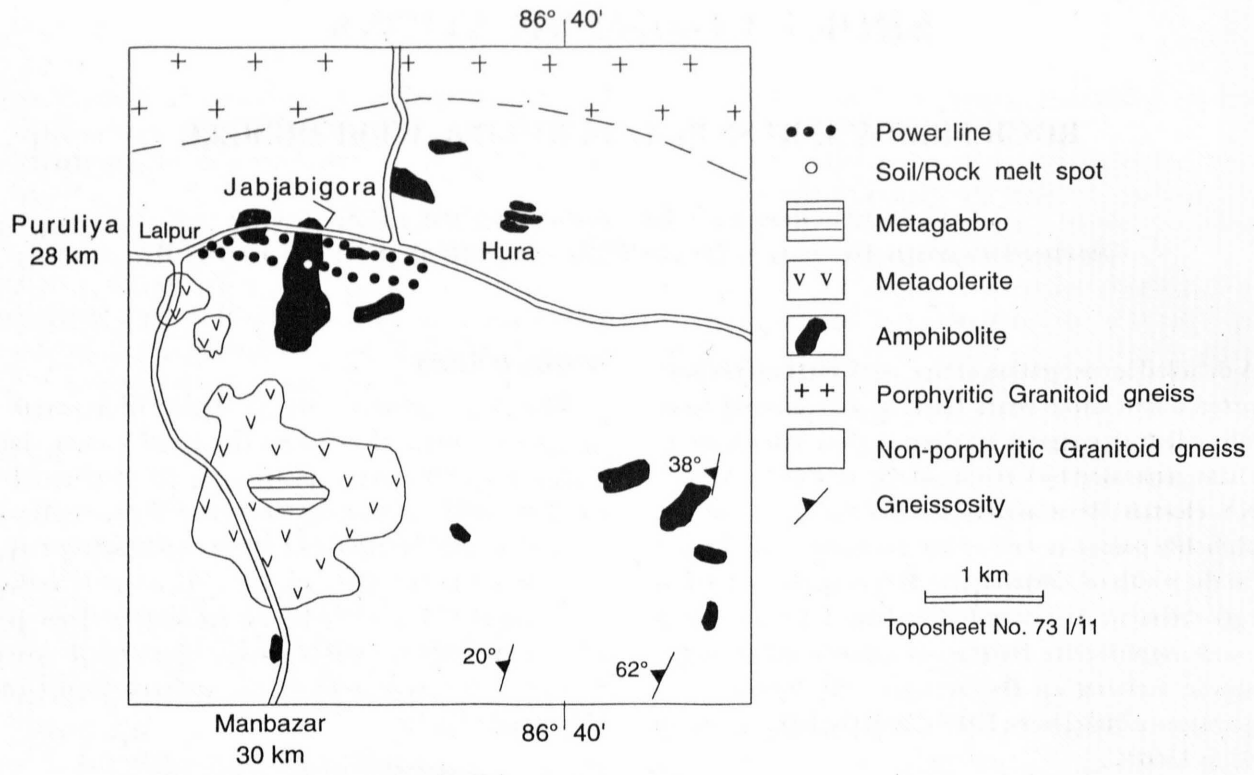

Fig.1. Geological map around Jabjabigora.

The lava rock analysis reported by us is of intermediate composition with unusually high $Fe_2O_3^t$ and low Na_2O+K_2O. There is a remarkable similarity in the major element composition of the lava rock with that of the deep brown soil, except in $Fe_2O_3^t$ being higher in the lava rock. Cr and Ni contents of the lava rock compare closely with those of the amphibolite. Major element compositions of the lava rock analysis presented in this work largely differ from that given in SGDJKC (1999) in SiO_2, Al_2O_3 and to some extent in alkali contents, and show smaller differences in values for other oxides. These differences perhaps can be attributed to inhomogeneous melting of source rock from which the 'lava rock' has originated. Though SiO_2 and Al_2O_3 in the SGDJKC analysis compare well with the amphibolite, there is small to large divergence in respect of other oxides whereas consistent differences exist in respect of all oxides between the amphibolite and the lava rock analysis reported in this work.

Genesis of the Melt Rock

The absence of lava rock at depth in the shallow pits (less than 30 cm from the surface) suggests the formation of the melt to be a superficial phenomenon that had nothing to do with fissure eruption or other kinds of volcanism in this area. Hence the lava rock could have formed from surfacial melting of either or both amphibolite and deep brown soil sources.

The significantly higher SiO_2 and lower MgO and CaO in the melt rock reported in this work than in the amphibolite (Table 1) rules out the possibility of complete melting of amphibolite in giving rise to the melt rock, and in the absence of any restite in the melt rock, possibility of partial melting of amphibolite can also be ruled out. It is probable that melting of the deep brown ferruginous soil may have resulted in the lava rock. This proposition is strongly supported by the good matching of the major element oxide percents of the melt rock with that of the deep brown soil (Table 1, no. 2,3). However, to account for the Cr and Ni contents of the amphibolite, lava rock, and deep brown soil it is suggested that the melt rock could have formed from melting of a mixture of dominantly deep brown soil and small amounts of amphibolite.

The approximate similarity in chemical composition of the melt rock of SGDJKC (1999) with the amphibolite of the present authors (Table 1, no.4,1) raises a probability that the melt rock sample available to SGDJKC for analysis may have been formed by partial melting of amphibolite fragment present in the deep brownish soil. In that case absence of restites in the melt rock could be explained due to (i) such evidence having been inadvertently removed

Table 1. Modal analysis (vol.%) of amphibolite and chemical analysis of amphibolite, deep brown soil and 'lava rock' from south of Jabjabigora

Amphibolite CB 2K1 1		Lava rock CB2K2 2	Deep brown soil CB2K3 3	Lava rock of SGDJKC 4
SiO_2	50.66	60.48	60.11	52.46
Al_2O_3	15.10	13.33	15.53	16.86
TiO_2	0.44	1.06	0.87	1.15
Fe_2O_3(t)	7.88	13.51	8.14	-
FeO(t)	-	-	-	12.02
MnO	0.15	0.37	0.16	0.33
MgO	8.72	4.11	3.57	6.55
CaO	13.36	4.72	4.52	7.79
Na_2O	1.07	0.57	0.99	0.96
K_2O	0.29	0.64	1.02	0.75
P_2O_5	0.07	0.06	0.07	-
L.O.I.	0.68	0.00	4.92	-
Total	**98.42**	**99.57**	**99.90**	**98.87**
	Trace element (ppm)			
Cr	689.8	625.2	192.6	
Ni	113.8	107.7	39.1	
Sr	389.8	95.75	106	
Y	15.6	17.4	20	
Zr	324.6	137	439.1	
Ba	141	505	n.d.	
Modal analysis (Vol.%)				
Hornblende	52.6			
Plagioclase	34.0			
Scapolite	5.8			
Diopside	3.4			
Quartz	1.5			
Sphene	1.4			
Opaque	1.1			
Epidote	0.2			

1 to 4 : Samples from lava generation spot, about 500 m south of Jabjabigora. No.4 refers to the microprobe analysis of the 'frozen rock-melt specimen' reported by SGDJKC (1999, p.613). n.d. not determined.

by the local people immediately after the incident, or misplaced and (ii) the samples handed over to both SGDJKC and us by two different local sample collectors, among many others, incidentally did not contain any restite material.

Heat Source for Melting

Of the two rows of high voltage electric lines running between Hura and Lalpur, the southern row of 11 KV line passes over the melt-rock pits, about 500 m south of Jabjabigora (Fig.1). The melting of the deep brownish soil/ amphibolite, in all probability, was brought about by the heat generated by the fall of this torn-out 11 KV electric line on to the ground. This inference is supported by the written report received by the present authors from the Superintending Engineer, Puruliya (D) Circle, West Bengal State Electricity Board. According to this report 'the high tension wire of 11 KV was torn out at 2.15 A.M. in the Jabjabigora area on May 9, 1998 and the line remained charged. The Back Current flow raised a certain high temperature with smoke and fire. The line was repaired at 7.50 A.M.'

Since the soil of the area is hard, its resistivity should be high. The snapped 11 KV overhead line conductor rested on the ground and remained 'live' till the next morning because it is likely that the tripping/fusing mechanisms were by-passed so that fairly high current could flow. Since the fault persisted for about six hours the fault current existed for a fairly long time. The heat developed in the conductor melted it and at the same time generated fumes from underlying soil that may have been observed by local people. The location of the cavities (Fig. 2) at intervals of less than a meter suggests that a certain length of the conductor had totally melted.

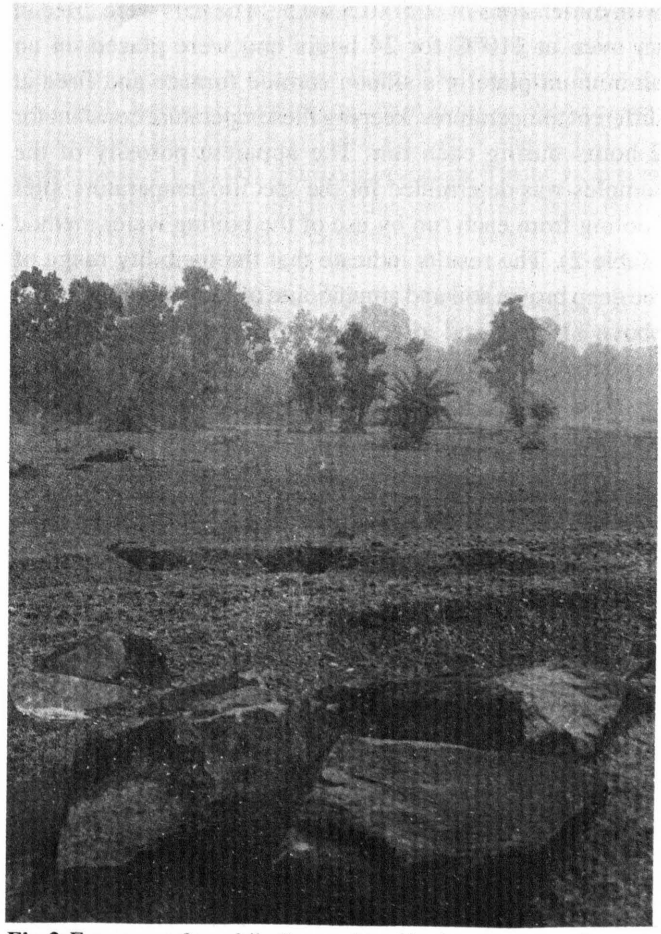

Fig.2. Exposure of amphibolite enclosed in deep brown soil, south of Jabjabigora.The three pits within deep brown soil represent ramnants of 'lava' eruption spots.

While describing the molten rock extrusions from Tamil Nadu, Ramasamy (2000) stated that a 'huge amount of electrical energy is required to melt rocks and soils of a few cu.m. volume below the ground level. Tamil Nadu Electricity Board had reported only two electricity trippings of 3 and 9 minutes from a 11 KV power line, which is insufficient to cause the scale of melting noticed in Thiruppanikarisalkulam'. In the present area the diameters of the mouths of the lava pits were less than 30 cm or so. Hence the huge amount of electrical energy, as conceived by Ramasamy (*op.cit.*), was not required to melt the small area being reported by us. There is no evidence for any lineament zone in the present area and hence the possibility of linking tectonic activity to melting phenomenon may be ruled out (cf. Manimaran et al. 2001).

Experimental Melting of the Soil and Amphibolite

The deep brown soil and the amphibolite were finely ground and a plastic mass for each of the samples was obtained by addition of water. Both the samples were aged for 24 hours. Rectangular bars were cut from these samples with dimensions of 2.5"x0.5"x0.5". The bars were dried in an oven at 110°C for 24 hours and were placed on an aluminium plate in a silicon carbide furnace and fired at different temperatures, keeping the temperature constant for 2 hours during each run. The apparent porosity of the samples was determined for the specific temperature after cooling from each run by use of the boiling water method (Table 2). The results indicate that the fusibility range of the deep brown soil and amphibolite of Jabjabigora is a little above 1100°C, and to be more precise 1350° to 1360°C, respectively.

Table 2. Results of firing experiment on deep brown soil and amphibolite from the lava generation spot, south of Jabjabigora

Material	Firing temperature (°C)	% Apparent porosity
	900	14.47*
Deep brown soil	1000	10.57
	1100	6.53
	1100	26.00
Amphibolite	1200	12.00
	1300	8.00
	1350	2.50

* Commencement of sintering

Some Comments on Soil/Rock Melting by High Tension Wire

The snapping of high tension wires in the Hura-Jabjabigora-Lalpur area is reported to have taken place four times during the period from 31 March to 11 June, 1998 as per written communication received from the Superintendent Engineer, Puruliya Circle,W.B. State Electricity Board. In a recent occurrence (March 10, 2000, 12.10 P.M.), the melting of brownish soil by the heat generated by falling of the snapped high tension wire near Silabati river of Napara-Baragram area, 10 km south of Hura, produced yellowish white glassy beads (maximum diameter 1.5 cm). This suggests that melting of soil/rock in contact with snapped high tension electric wire is not an uncommon incident and generally goes unnoticed by the electricians who repair such wires and who may not bother about such melting on an insignificant scale. The fall of high tension electric lines in the Hura-Jabjabigora-Lalpur area during the period March 11 to June 11, 1998 took place mostly at midnight or early in the morning which were generally repaired within a few hours, and hence any melting phenomenon went unnoticed. But in case of Jabjabigora, although the fall of a snapped 11 KV wire took place at 2.15 A.M. on May 9, 1998, it was repaired only at 7.50 A.M. the next morning as a result of which sufficient time was available for generation of appreciable amount of melt together with fire and smoke; and the spot being within 500 m from the main road passing through the Jabjabigora village helped to attract the attention of local people in the morning and got quickly publicised.

The snapping of high power transmission lines throughout India is likely to be a common phenomenon but reports of melting of soil/rock due to the same are not many. The reasons may be as follows:

1. The elctricians who repair high power transmission lines overlook the trivial amounts of rock melt that may have formed at the spot because they generally lack in curiosity or scientific interest for the phenomenon. If they are educated on the geoscientific importance of such phenomenon more such incidents can be documented from all parts of the country.
2. If the incidence of rock/soil melting takes place with formation of large amount of melt associated with smoke and fire that is observable by local people, then the news can spread quickly through the media (as in the present case) and interested geologists can rush to the spot and study the phenomenon. In the present case local people who witnessed the phenomenon were initially freightened at the possibility of volcanism and hence the local newspaper (Puruliya Darpan, 1998) highlighted the event.
3. Whether the rock melt is formed by the current supplied by high tension wires depends on factors, including (i) the nature of the material on which they come in contact, for example, if the body in contact

has low resistance (like water, green trees etc.) or has high melting point (e.g. dry rock) then there is no scope for formation of melt; (ii) if the faulty wires are repaired within a short time after the incidence, then too the melting of soil/rock may not take place.

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