Goldschmidt 2000
September 3rd–8th, 2000
Oxford, UK.

Journal of Conference Abstracts
Volume 5(2), 904

Evidence of Silicate Liquid Immiscibility in the Early Proterozoic Andesitic Rock, Dongargarh Supergroup, Central India and Possible Tectonic Implication

Sarajit Sensarma (sensarma@min.uni-koeln.de)[1], **Herbert Palme** (palme@min.uni-koeln.de),[1]
Etienne Deloule (deloule@crpg.cnrs-nancy.fr)[2] & **Dhruba Mukhopadhyay** (dhruba@cucc.ernet.in)[3]

[1] Institut für Mineralogie, und Geochemie, Zülpicher Strasse, 49b, D-56074 Köln, Germany
[2] CRPG-CNRS, BP20, 54501 Vandoeuvre les, Nancy Cedex, France
[3] Department Of Geology, University of Calcutta, Calcutta-700 019, India

Introduction

The evidences of silicate liquid immiscibility, i.e. FeO-rich, silica-poor globules separated from a FeO-poor, silica rich phases are mostly recorded in relatively fresh younger rocks of tholeiitic composition. Since evidence of liquid immiscibility is unlikely to be preserved in deformed Precambrian rocks, reports of melt unmixing in older lavas are scarce. Here we present evidences in support of melt unmixing recorded in an early Proterozoic andesitic lava from the Dongargarh Supergroup, India. Major and trace element distribution between the two phases were determined by electron microprobe (EMP) and ion microprobe (IMP). In the Dongargarh Supergroup acidic volcanics occur at the base of the succession with three formations of basic/intermediate volcanics cropping up towards the top of the succession. The entire succession of rocks is mildly deformed and shows low grade metamorphism. The andesitic lava (SiO_2 57-58 wt%, Na_2O + K_2O = 4.7 wt%, Fe/Mg = 2.5) with liquid immiscibility constitutes the upper volcanic unit (Mangikhuta Formation). Phenocrysts of pyroxene (augite) and plagioclase (albitic) are set in a matrix of very small flower-like pyroxene and glassy material. Ophitic clusters of plagioclase and pyroxene are also common. The rock is relatively little altered.

Petrography

Textures characteristic of melt unmixing were recognized only with backscattered imaging, including globular iron rich melt with silicic fraction in the core, coalescence of globules of iron rich liquid, lobate margin of the pyroxene crystals, iron rich liquid with quenched structure, sharp margins separating both fractions of liquid. Similar features were observed in experiments of liquid immiscibility (Phillpots, 1978).

Chemistry

a) Major elements

The two different melt compositions (FeO-rich, SiO_2-poor and FeO-poor, SiO_2-rich) were clearly identified by EMP and x-ray mapping. The composition of the bulk rock and the immiscible liquid fractions are shown in Table 1. The striking similarity of the melt compositions with other published data on unmixed liquids are shown in a SiO_2- FeO+MgO+CaO-K_2O+Na_2O+Al_2O_3 plot (Fig. 1). Although our compositions plot within the range of other published data, our FeO-rich phase is lower in FeO and TiO_2 and higher in MgO than most of the data reported in the literature (FeO > 30%).

b) Trace elements

Bulk trace elements were done by INAA, lithophile trace elements in the two liquids by IMP (CRPG-CNRS, Nancy). The light REE are about 3 to 10 times higher in the SiO_2-rich phase than in coexisting SiO_2-poor phases. Heavy REE have similar concentrations in both liquids. Experimental results of the distribution of REE between the two phases show enrichment of REE in the SiO_2-poor, FeO-rich phase, contrary to what we find here. However, all experiments were done within very FeO rich system (Watson, 1976; Ryerson and Hess, 1978). The distribution of lithophile elements between the two melts are apparently sensitive to the bulk composition, in particular to the FeO-content. There are no other trace element determinations in natural unmixed melt phases, except those reported here.

Tectonic implication

For unmixing to take place, the melt has to be sufficiently iron rich and should crystallize under reducing conditions to avoid early crystallisation of magnetite. The absence of primary hydrous phases in our rock reflects low oxygen fugacity during crystallisation, typical of fractionation along a tholeiitic trend rather than a calc-alkaline trend where simultaneous crystallisation of pyroxene and magnetite deplete the residual melt in iron. Since calc-alkaline fractionation is characteristic of convergent setting, the residual liquid in this hydrous environment are not expected to have silicate liquid immiscibility. This clearly suggest the anorogenic character of the Dongargarh andesite. Most of the evidences of liquid unmixing are also reported from many 'within plate' magmas such as the Deccan, the Skaergaard complex, Iceland and even MORB. We, therefore, suggest that presence of liquid unmixing in residual basaltic/andesitic melt can possibly be used as a tectonic indicator.

Phillpots A, *Mineral. Mag.*, **42**, 413-425, (1978).
Phillpots A, *Contrib. MIneral. Petrol*, **80**, 201-218, (1982).
Ryerson FJ & Hess PC, *Geochim. Cosmochim. Acta*, **42**, 921-932, (1978).
Turner FJ & Verhoogen J, *Igneous and Metamorphic Petrology. McGraw Hill Book Company*, (1960).
Wager LR & Brown GM, *Layered Igneous Rocks. Oliver & Boyd*, (1967).
Watson EB, *Contrib. Mineral. Petrol.*, **56**, 119-134, (1976).

Goldschmidt 2000
September 3rd–8th, 2000
Oxford, UK.

Journal of Conference Abstracts
Volume 5(2), 905

	bulk rock	Fe-rich fraction	SiO_2-rich fraction)
SiO_2	57.84	44.82	73.28
TiO_2	0.91	0.06	0.56
Al_2O_3	12.83	3.85	10.51
FeO	9.69	20.27	4.43
MnO	0.14	0.76	0.04
MgO	3.85	8.04	0.51
CaO	6.40	17.84	5.27
Na_2O	2.93	0.15	3.84
K_2O	1.93	0.01	0.04
P_20_5	0.12	n.d.	n.d.
LOI	2.38	n.d.	n.d.
Total	99.02	95.80	98.48

Table 1.

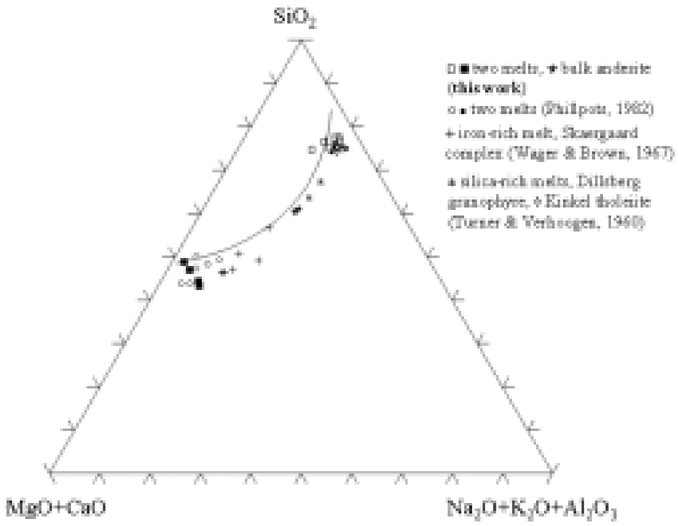

Fig. 1: Two immiscible melt phases in terrestrial basalts / andesites