Conjugate REE tetrad effect from leuco-granitic gneiss and weathered schist in Imweon area, South Korea

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Introduction

The Imweon leuco-granitic gneiss of 2.25 Ga is the oldest granite showing M type of REE tetrad effect in the world. Masuda et al. (1987) and Lee et al. (1994) suggested that M type of REE tetrad effect was due to removing of water and/or fluid phase, and, therefore, there would be existed the counterpart with W type of REE tetrad effect. In this paper, in order to find both types of REE tetrad effects from one block, we determined REE abundances of leuco-granitic gneisses as well as its neighbouring schists and pegmatites using ICP-MS and ID-TIMS. The schists are severely weathered to become soils.

Results and Discussion

In this study area, pegmatite occurs in the contact between schist and leuco-granitic gneisses.

In Fig. 1, we observed that the leuco-granitic gneisses show M type of REE tetrad effect, while the schist and pegmatite show W type of REE octad effect. Especially, the M type is observed in H_2O free phase such as leuco-granite, while the W type is recognised in H_2O bearing phases such as soils or pegmatites. Our results confirm that the REE tetrad effect has close relationship with water and/or fluid phase in its formation mechanism.

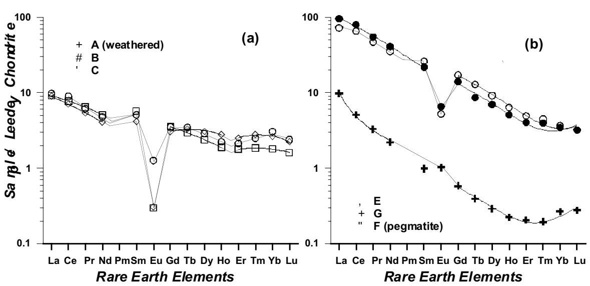

Fig. 1. Chondrite-normalized REE patterns of (a) leuco-granitic gneiss, (b) pegmatite(F) and soils (E & G)

References

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Structure and disorder of silicate melts at high-pressure: ^{17}O 3QMAS NMR, quantum calculations & thermodynamic modeling

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The extent of disorder of magmatic melts at high-pressure influences on their transport and thermodynamic properties and thus controls dynamics and melting processes in the mantle and crust. While some data on pressure-induced coordination changes of framework cations in oxide glasses and melts exist and the strong link between the extent of intermixing among network units and macroscopic properties were recently established for melts at ambient pressure (Lee and Stebbins 2002), the extent of intermixing and disorder among these higly coordinated network polyhedra (e.g. $^{[6]}$Si, $^{[5]}$Si, $^{[5,6]}$Al) at high pressure are far from being understood.

Here we present experimental evidence supporting chemical ordering among network polyhedra in sodium silicate and sodium aluminosilicate glasses quenched from melts at 6-10 GPa by using solid state NMR, which resolves new oxygen sites at high pressure, including $^{[5,6]}$Al-O-$^{[4]}$Si, $^{[5,6]}$Si-O-$^{[4]}$Si and Na-O-$^{[5,6]}$Si. Improved resolution of 2-dimensional O-17 MQMAS (multiple quantum magic angle spinning) NMR spectra allows us to evaluate the extent of intermixing among network polyhedra at high pressure, whose distribution is deviated from random distribution but favors formation of oxygen linking dissimilar pairs such as $^{[5]}$Si-O-$^{[4]}$Si or $^{[5,6]}$Al-O-$^{[4]}$Si. The presence of non-bridging oxygens (NBOs) such as Na-O-$^{[5,6]}$Si indicates that the formation of highly coordinated Si can also occur at depolymerized silicon tetrahedra such as Q^3 or Q^2 upon densification. Quantum chemical calculations were used to assign these new oxygen clusters for the NMR spectra. For instance, the calculated isotropic chemical shift of $^{[n]}$Si-O-$^{[4]}$Si is more deshielded with increasing n from 4 to 6.

We finally explore the microscopic orgins of inonic diffusivity and configurational thermodynamic properties of silicate melts at high pressure using statistical mechanical modeling, in conjunction with information of the extent of disorder from NMR data. These methods and results given here yield improved prospects for atomistic origin of magmatic processes in the Earth's interior (Lee et al. 2003).

References

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