Partial melting experiments of a MORB at 1.5 GPa: constraints on the generation conditions of adakite magmas

Haixiang Zhang[1]; # Hiroaki Sato[2]; Kazuyoshi Sangen[3]

[1] GIG, CAS; [2] Earth and Planetary Sci, Kobe Univ; [3] Earth and Planetary Sci., Kobe Univ

http://www.edu.kobe-u.ac.jp/fsci-volcano/hsato/hsato.html

Adakite magma is characterized by high Sr/Y values and low Y and HREE contents, suggesting that garnet is in the residue of the partial melting of subducted MORB source. Previous experimental studies showed that garnet appears ca. 1.0 GPa in MORB systems. Simple element partition calculation shows that modal contents of garnet more than ca. 30 wt%, plagioclase less than 10wt%, and glass less than 25% are required to produce the chemical characteristics of adakite from MORB sources. To constrain the conditions of adakite formation, we conducted reversed melting experiments on a typical MORB sample at 1.5 GPa to evaluate the equilibrium modal compositions. Two types of the starting materials are prepared; i.e., raw powder of plagioclase-phyric MORB of DSDP Leg 46, Hole 396B, 287.6m depth, which contains SiO2=48.53wt%, TiO2=1.20, Al2O3=17.00, FeO∗(total Fe as FeO)=7.90, MgO=7.31, CaO=11.78, Na2O=2.49, K2O=0.21 and P2O5=0.12 wt%, and eclogite synthesized from the above MORB powder at 2.5 GPa and 1200 C. The starting powder was sealed in a Pt capsule with 2 wt% of distilled water, and processed at either 1050 C or 900 C for a certain period of time, then quenched by cutting the electric current to the heater. Each charge is examined by electronprobe microanalyzer, and the modal composition was obtained by least square calculation from the compositions of the bulk starting sample and constituent phases of the run charges. Run time ranged from 30, through 90 to 270 hours at 900 C, and from 15, through 45 to 135 hours at 1050 C. Although we expected near equilibration in the longest runs, different starting materials resulted in different modal composition of the run products. At 900 C, modal content of the 270 hour runs resulted in garnet 15.4wt%, cpx 54.4%, kyanite 8.8%, glass 20.6%, rutile 0.6%, spinel 0.2% for the basalt starting material experiment, whereas in the eclogite starting material run, modal contents are garnet 35.5wt%, cpx 36.4%, glass27.4%, and rutile 0.5%. At 1050 C, the run charges of 135 hours duration consist of garnet 19.7wt%, cpx 43.3%, plagioclase 12.9%, glass 24.2%, and spinel 0% for the basalt starting material run, whereas in the eclogite starting material run, run charge consist of garnet 25.1wt%, cpx 37.9%, glass 37.0%. Therefore, the equilibrium conditions are not fulfilled even in those long runs. The glass composition are fairly low in totals (87-90 wt% for runs at 900 C, and 91-93wt% for runs at 1050 C) consistent with the solubility of water at 1.5 GPa (more than 10 wt%). Glass compositions recalculated to total=100% are SiO2=70-72 wt%, Al2O3=18-19wt%, CaO=3.8-4.5wt% for the 900 C runs, and SiO2=62-63wt%, Al2O3=20wt%, and CaO=6.5-6.8wt% for the 1050 C runs. Present experimental result shows that modal compositions of phases during melting at 1.5 GPa are near the critical conditions for the production of adakite melt, and when we take the previous experimental studies (Rapp et al.1991; Sen and Dunn, 1994; Rushmer, 1991, Nakajima and Arima, 1991; Springer and Seck, 1997) into consideration, it is suggested that 1.5 GPa is the minimum pressure for the generation of adakitic magma from usual MORB compositions.