

マントルプルーム内部でマグマ形成に果たす揮発成分の役割 Role of volatiles in magma genesis of ascending mantle plume

*高橋 栄一¹、王 錦団¹、李 立¹

*Eiichi Takahashi¹, Jintuan Wang¹, Li Li¹

1. 中国科学院广州地球化学研究所

1. Guangzhou Institute of Geochemistry, Chinese Academy of Science

It is now widely accepted that recycled former oceanic crust component (eclogite) plays a great role in magma genesis of OIBs and flood basalts (Hauri, 1996; Takahashi et al, 1998; Sobolev et al, 2005). In this study we investigated the effect of H₂O and K₂O in magma genesis of heterogeneous mantle plume that contains large amount of recycled eclogite component. K₂O was studied as a group of volatile component, because it is incompatible to most mantle minerals at P<7 GPa (Tsuruta and Takahashi, 1998) and it drops the solidus of both peridotite and eclogite dramatically (Wang and Takahashi, 1999, 2000).

High-pressure melting experiments were carried out using a piston-cylinder and a 2500 ton cubic-type multi-anvil that have been moved from Tokyo Institute of Technology to Guangzhou Institute of Geochemistry in 2017. In order to understand the melting reaction between recycled eclogite and surrounding peridotite, we investigated melting of layered eclogite/peridotite starting materials both under dry and wet conditions. Spinel lherzolite KLB-1 (Takahashi 1986) was employed as peridotite component in this study. Two basalt components were used as recycled crust component: 1) Columbia River basalt (CRB72-180, Takahashi et al., 1998) which is relatively enriched in K, Ti and LREE (K₂O=1wt%, TiO₂=3.2wt%), N-type MORB (NAM-7, Yasuda et al., 1994). The 2.9GPa experiments (corresponding to about 80km depth which is the top most horizon of the Hawaiian plume head) were carried out with Boyd-England type piston-cylinder apparatus at (1460~1540°C for dry experiments; 1400~1500°C for hydrous experiments), The 5GPa and 8 GPa experiments (corresponding to about 150km and 200km depth on the plume axis) were conducted cubic-type multi-anvil apparatus (1550~1650°C for dry experiments; 1350~1550°C for hydrous experiments).

Melts formed by reactive melting of dry eclogite and peridotite changes dramatically in the temperature range across the solidus of peridotite KLB-1 from basalt (below dry solidus) to picrite (20-40°C above dry solidus). Basaltic melts are not saturated with olivine both at 2.9 and 5 GPa and therefore they are separated by peridotite matrix by Opx film. Chemical reaction between the basalt melt and the peridotite matrix proceeds only slowly by solid-diffusion across the Opx film. In hydrous experiments, solidus of peridotite decreases significantly, Opx film was not formed, therefore, the reaction between hydrous melt and the partially molten peridotite matrix proceeds significantly even at temperatures much below peridotite dry solidus.

Melt composition produced by reactive melting of dry basalt and peridotite are similar to basaltic andesite (below peridotite solidus), Hawaiian tholeiite (slightly below peridotite solidus) to picrite (above peridotite dry solidus). On the other hand, melt compositions formed by reactive melting between hydrous basalt and peridotite show a great diversity depending on the amount of H₂O and K₂O. At H₂O-rich conditions (3 to 5 wt.% in bulk), melting took place both in peridotite and eclogite layers and composition of partial melts are similar to silica-deficient basanite and nephelinite at temperatures 1300-1400°C both at 3 and 5 GPa. At low H₂O conditions (1 wt.% in bulk) partial melts formed in the MORB layer at 1300°C are similar to silica-rich dacite both at 3 and 5 GPa. On the other hand, partial melts formed in the

CRB72-180 layer with 1 wt.% H₂O at 3 and 5 GPa are similar to K-rich alkali acidic magma (phonolite, tracyte, hawaiiite).

Post shield stage phonolite and hawaiiite magmas in Hawaii were considered to be fractionation product of alkali basalts under crustal magma chambers (e.g., Frey et al, 1990). However, our experimental results demonstrated an alternative scenario that phonolite and hawaiiite magma were derived from partial melting of alkali basaltic blocks at deeper part (150-200km) of the plume. On the other hand, basanite and nephelinite which appears in rejuvenated stage in Oahu and Kawai may represent partial melts of peridotite portion of the plume beneath Pacific plate. Volatiles control the solidus and the depth of melting as well as enhancing chemical interaction between the peridotite and entrained eclogite component in the ascending plume. In this presentation, we discuss the role of volatile and K₂O in magma genesis in ascending plume based on our melting experiments and field occurrence of diverse magma types both geographically and in growth history of given shield volcanoes in Hawaii.

キーワード：マグマ生成、揮発成分の影響、マントルプルーム、ハワイホットスポット
Keywords: magma genesis, effect of volatile, mantle plume, Hawaii hot spot