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高温高圧実験から見たハワイプルームにおけるマグマの起源：揮発成分の効果
High-pressure melting experiments on magma genesis in Hawaiian plume: effect of volatiles

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Introduction: Compared with OIB, Hawaiian tholeiitic basalt is thought to be relatively drier (about 0.5 wt.% H2O content; Muenow, 1979). In front of the plume core, overlying mantle is metasomatized by hydrous partial melts derived from the Hawaiian plume. Downstream from the plume core, lavas tap a depleted source region similar to enriched Pacific mid-ocean ridge basalt (Dixon & Clague, 2001). Magma genesis model has been proposed by some authors (Hauri, 1996; Takahashi & Nakajima; 2002; Sobolev et al., 2007) that magma produced near the axis of the plume head may be mixtures of two types of melts 1) basaltic andesite melt formed by melting of eclogite and 2) picritic melts formed by the reactive melting of eclogite and peridotite. A series of high temperature high pressure experiments were conducted to explore the genesis of tholeiite magma from Hawaiian plume and investigate the role of volatiles in magma genesis.

Experiments: A series of experiments were conducted under dry and slightly hydrous conditions at 2.85GPa for 1, 3 to 9 hours and from 1460 to 1520C with a piston cylinder by making basalt peridotite sandwich which using MgO-rich CRB72-180 (Takahashi et al 1998) and a fertile peridotite KLB-1 (Takahashi 1986) as starting materials.

Results: Three factors that might affect melting progress and chemical reaction among minerals – temperature, duration and water content –were examined, respectively.

1) Temperature: (1460~1520C and every 20C as an interval.)

Basalt went partial molten at 1460C and completely molten when temperature went above 1500C. Orthopyroxene reaction rim formed on the border area due to the reaction between high Si-rich melt and olivine in the peridotite matrix. The opx film becomes more visible and thicker with the increasing of temperature. Partial melting degree of peridotite is also related to the increasing of temperature but the change is not very sensitive when 20C as an interval. The higher temperature, the more peridotite molten. The area of the peridotite near the opx film has a higher degree of partially melting than areas away from the boundary.

2) Duration: (1, 3 and 9 hours.)

Longer time do accelerate the speed of chemical reaction between basalt and peridotite in this study. Basalt molten completely as the running time longer than 3 hours. The orthopyroxene reaction rim on the boundary between peridotite and basalt becomes thicker. Large clinopyroxene crystals formed on the border (the minerals on the border from melt to peridotite are cpx, opx, garnet) momentarily yet faded away as the chemical reaction went on with time.Partial melting of peridotite is also positively related to duration. When the melt of peridotite is too much and unable to support the weight of basalt and it would got rid of the crack and finally went to the basalt side and mixed with the basalt melt.

3) Water content

Basalt layer melted completely, and large orthopyroxene crystallized in the basalt side. Peridotite layer also melted considerably at the same time than its anhydrous counterparts owing to the reason that the join of water could lower the peridotite liquidus line and finally made it more partial melted than in hydrous condition.

Discussion: Under dry conditions below peridotite solidus, melting is limited in eclogite layers and chemical reactions with ambient peridotite is hindered by opx film. On the other hand, under slightly wet conditions, water could accelerate the melting process of both eclogite and peridotite layer. As a result, melts formed under wet conditions are saturated with oliv+opx whereas those formed under dry conditions could be saturated with only opx. Changing nature of Hawaiian magma during the shield building stage will be discussed in the light of present melting experiments.

キーワード: ハワイプルーム, 高圧, マグマ, 揮発成分
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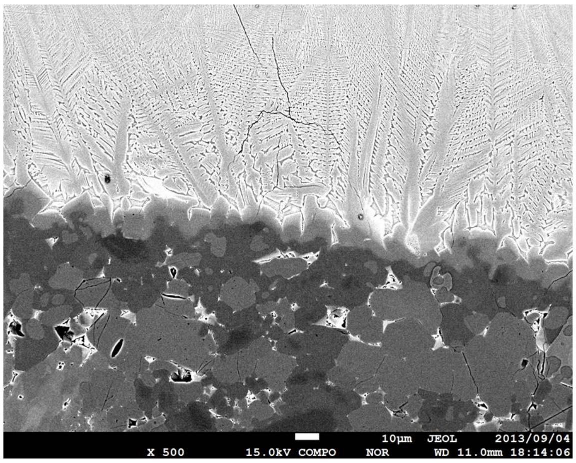
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