Reaction progress and deformation of basic shicsts during retrograde metamorphism

ATSUSHI OKAMOTO, MITSUHIRO TORIUMI

[1] Shizuoka University, saokamo@ipc.shizuoka.ac.jp
[2] Tokyo University, tori@k.u-tokyo.ac.jp

Microboudin structure of amphibole in basic schists is considered to have been developed as the result of synmetamorphic deformation, because the pulled-apart spaces are commonly filled by later amphibole compositions. Separation of fragments gives an estimates of the extensional strain, and the amphibole compostion constrains the P-T condition of the deformation.

Basic schists in the Sanbagawa metamorphic belt, Japan, are mainly composed of amphibole, epidote, plagioclase, chlorite and quartz. Amphibole in the Sanbagawa schists commonly shows a compositional zoning and is ofiten broken into several fragments. Coupling of the analyses of a growth zoning and a microboudin structure of amphiboles reveals that the extensional strain was accumulated during actinolite overgrowth, which corresponds to the late stage of the exhumation of the Sanabagawa belt.

For evaluating the extent of the actinolite-foming reaction, each amphibole grain is divided into two, mantle and core. Mantle is the portion with actinolite composition (Al^{T1}<0.5, Ca^{M4}>1.5), and core is mainly composed of hornblende in high grade zone rocks. The proportion of the amount of mantle to the amount of whole amphibole was measured from a X-ray maps of EPMA. The average of the porportion among a lot of amphibole grains in a same thin section is defined as X_{act}. Analyses of X_{act}, mineral modes, and bulk rock chemistry revealed that (1) there are no systematic change in bulk rock composition among the rocks with different X_{act} values, and (2) as X_{act} increases, the amounts of chorite and actinolite increases while the amount of hornblende decreases. Thus, it is expected that retrograde reaction proceeded at the expense of hornblende. Mass balance relations for the actinolite-forming reaction was solved to evaluate the condition of rock before the reaction. As the result, it is found that the reaction is distinct hydration, and that the X_{act} value is available as the indicator of the progress of the overall reaction.

Relation between the extensinal strain deduced from amphibole microbudin and the X_{act} reveals that the deformation proceeded as the actinolite-forming reaction proceeded. This may be result from the fact that the sepation of amphibole fragments correlates to the average grwoth amount of amphibole grains in the actinolite-forming stage. A spatial distribution of X_{act} of basic rocks in the central Shikoku shows that the actinolite-forming reaction associated with deformation proceeded at the garnet zone and the bottom of the albiti-biotite zone significantly.

FeTi-oxide in the garnetite; An experimental constrain on the MORB+H_2O system

K. OKAMOTO AND Y. IIZUKA

Institute of Earth Sciences, Academia Sinica, P.O. Box 1-55 Nankang, Taipei, 115, Taiwan, R.O.C. (kazu@eaerth.sinica.edu.tw)

One of the mantle components, HIMU is believed to represent subducted oceanic crust, hydro-thermally altered and dehydrated during subduction. Dixon et al. (2002) suggest that FOZO ('focused zone') represents dominantly primitive mantle, metasomatized by a small amount of a small extent melt of a HIMU component. They also consider that water in FOZO plume is a combination of primitive and recycled water. In order to know the fate of subducted oceanic crust in the mantle transition zone, multi-anvil experiments were conducted in the MORB+H_2O system (Okamoto & Maruyama 2003). We carefully identified chemical compositions of their run charges at isobaric conditions of 19 GPa, and temperatures of 900-1300 °C. Even though majorite and stishovite were expected to be the only major phases stable at such conditions, jadeite (modal ratio is 20 %), Na-, K-hollandite, $CaTiSiO_3$-perovskite, and FeTi-oxide were identified. In T higher than 1000 °C, FeTi-oxide contains large amounts of alkali elements; Na_2O to 3wt.%, and K_2O to 2 wt%, and coexists with hollandite. Similar compositions of FeTi-oxide were reported from kimberlite (yimengite=$K[Cr,Ti,Fe,Mg]_{12}O_{19}$,). Yimengite is considered to be formed from metasomatising melt (Haggerty, 1991). It has been considered that potassium might be incorporated into the core because K transforms from alkali- to transition-metal character under pressure (e.g.; Parker et al., 1996; Lee & Jeanloz, 2002). The present study indicates that subducted crusts either stagnant in the transition region (400-1000 km) would also be a K-reservoir.

References

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