Experimental study of aqueous fluid distiribution and textural maturation in dunite and wherlite

Tomohiro Ouchi[1], Michihiko Nakamura[2]

[1] Mineralogy,Petrology and Economic Geology, Tohoku Univ, [2] Inst. Mineral. Petrol. Econ. Geol., Tohoku Univ.

Background: Aqueous fluid is one of the important geological fluids in the Earth's upper mantle. The distribution of aqueous fluid affects not only to rheological properties and seismic attenuation, but also to material transport.

Recently, many dihedral angles between mineral anf fluids have been reported in order to estimate the fluid distribution in rocks. Altough dihedral angles between fluids and major minerals are no doubt fundamental parameters ,a lot of important properties on fluids distribution in natural rocks might arise from multi-characters such as change of fluid composition due to coexistence of the second mineral phase,and interaction between grain growth rate and grain size effect on fluid distribution in multi-phase rocks.

Experimental Conditions: We conducted pyston-cylinder experiments at uppermost mantle conditions to investigate the distribution of aqueous fluid in wherlite . Significant preferential distribution of fluid between olivine(Ol) and clino-pyroxene(Cpx), because dihedral angle of Ol- H2O is similer to that of Cpx- fluid in the experimental conditions (Ol-fluid : 70deg,@1GPa,T=1000 ; Watson and Brenan,1987) (Cpx-fluid : 67deg,@1.5GPa,T=950 ; Watson and Lupulescu,1993). We conducted similar experiments on dunite for comparison.

Starting materials were prepared from reagent and natural mineral powder. Distilled H2O(1wt.%) was added to Pt-lined Ni capsule using the ashtray method start of the experiments. Run durations were about 1week.

Experimental Results :

1 Dunite-H2O system

Wet triple junction(sfilled with H2O fluid) , fluid pools and fluid inclusions were formed in all the run. The fluid pools enable surrounding grains to have their ideal crystal habits, resulting in a lot of flat faces. Faceting tendency of olivine was reported in Ol-basalt system (e.g. Waff & Faul, 1992) and Ol-H2O system (Niida &Green, 1999). Wet triple junctions were observed more often in T=1100 experiment than in the T=1200 runs, in which most of the triple junctions are dry. This difference can be explained by difference in the degree of textural maturation, because temperature effect on dihedral angle (Watson & Brenan, 1987 ; Watson et al, 1991) and principal of minimum interfacial energy (minimum energy melt fraction :MEMF ; Lupulescu& Watson, 1999) are inconsistent with the result.

2 Wherlite-H2O(Ol-Cpx-H2O) system

Preferential distribution of the fluids around Ol relative to Cpx was observed when average grain sizes of Ol and Cpx are similar. It was observed also for finer Ol grains relative to coarser Ol grains . This observation can be explained by effect of grain size on distribution of fluids (Wark and Watson,2000) and dependence of grain boundary mobility on fluid fraction (Nakamura,2000). Ol and Cpx grains were frequently faceted and fluid pools were frequently observed. Triple junctions were rarely observed.

In summary, 1) Ol and Cpx flat crystal faces are frequently observed. 2) Preference distribution of H2O fluid for Ol relative to Cpx was observed when average grain size of Ol and Cpx are similar. 3) Preference distribution of H2O fluid for finer Ol grains relative to coarser was observed. Moreover, various rock textures were formed due to effects of coexisting H2O fluid in wehrlite-H2O system. Fluids in natural rocks may play important roles in textural formation and maturation.