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An experimental investigation on the fluid distribution in amphibolitic lower crust

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The connectivity of COH fluids in the polycrystalline aggregates of pargasite, anorthite, and those two was assessed in terms of the geometry of crystal-crystal-fluid triple junction in the synthetic rocks. All the experiments were carried out at 600 degreeC and 0.7 GPa with fluid fraction of 0.1?3%. To estimate the true dihedral angles without a sectioning effect, the effect of surface energy anisotropy was considered using the cumulative frequency curve of the apparent dihedral angle measured on cross sections.

In the anorthite?fluid systems, populations of the curved-curved (CC) type triple junction were ca. 45% irrespective of the fluid composition, whereas their median dihedral angles depend on the fluid composition; 80 degree for H2O, 93 degree for CHO and 70 degree for 6 wt.% NaCl aqueous solution. The true CC type dihedral angles, estimated according to the theory of Laporte and Provost (2000), range from 53 to 102 degree. Since most of the dihedral angles is >60 degree in the anorthite aggregate, the intergranular fluid will not be connected as long as the fluid fraction is small. In the pargasite aggregate, the CC type was less dominant; ca. 65% of the triple junction was faceted?faceted (FF) type. It should be noted that most of the FF type were impingement grain boundary. If I assume that the true dihedral angle does not have a single value but constant probability distribution, then its range is calculated to be 28?88 degree. Assuming for simplicity that the pore geometry is equilateral triangular pyramidal, the true dihedral angle has this range when the ratio of hypotenuse to base of the pyramid is 0.7?5.6. This simple model shows that the pyramid of pore fluid in the pargasite aggregate has a finite height and will not be interconnected, because if the fluid is interconnected, its geometry approaches a tube lacking the base plane and the maximum value of the true dihedral angle (formed only with two side faces) is less than 60 degree. In the anorthite-pargasite-fluid system, the population of the triple junction consisting of a curved anorthtie and a faceted pargasite faces is >65%. It is calculated that the true dihedral angle of this type of triple junction has a range of 31?57 degree on the basis of the cumulative frequency curve of the measured apparent dihedral angle.

The FE-SEM observation showed that most of the FF and FC type boundaries were formed by impingement, and thus surface tensions at these grain boundaries were not balanced. However, such boundaries were stable as long as the experimental duration. In addition, it is observed that the impingement grains are common in natural amphibole or biotite in the high-grade metamorphic rocks. Therefore, the pore geometry determined by the impingement grains seem to represent a stable structure. Judging from the observed pore-type populations, the FFC and FCC type pores are most likely in the amphibolitic aggregate. The connectivity of these types of pore are relatively high, because the FC type dihedral angle is relatively low (31 - 57 degree) even at the small fluid fraction of the present experiments and the curvature can be continuous along the curved grain boundary (von Bargen and Waff, 1986). The fluid may be interconnected along the edges surrounded by the faceted plane(s) and curved edge(s). The possibility of interconnection at the grain corners is also high. Thus, the connectivity of fluid in the aggregates of amphibole and anorthite is strongly dependent on the modal composition.

Keywords: continental lower crust, low electrical resistivity, interconnected fluid, dihedral angle, surface energy anisotropy