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Electrical conductivity measurement of albite-quartz-water system under high P/T conditions

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Magnetotelluric surverys have revealed that the high conductivity anomalies exist in the middle to lower crust. Electrical conductivity (EC) of dry crustal rocks are much lower than the high conductivity anomalies, suggesting the existence of conductive material in the crustal rocks that are stable only with the middle to lower crustal conditions. Aqueous fluids seem to be most likely candidate to explain the high conductivity anomalies. Quartz-water system has been investigated recently, but it cannot account for the high conductivity anomalies. Therefore, other ionic species, such as Na^+, in addition to silica phases dissolved in fluid is required to increase conductivity. In this study, albite was introduced to add the ionic species in the fluids. The electrical conductivities of albite- water and albite- quartz-water systems have been measured using an impedance analyzer at 1 GPa and 400-1100 K. Albite-water samples with water contents of 0.5, 1, 5, 9.3 wt.% were prepared by natural albite powder and mixture of $1Na_2SiO_3$, $5SiO_2$ and $2Al(OH)_3$ (mole ratio) in designed ratios. Albite-quartz-water samples with water contents of 0.34, 1.2, 5.6, 10 wt.% were prepared by natural albite powder and silicic acid ($SiO_20.5H_2O$) in designed ratios. EC and temperature relationship of all the other samples cannot be expressed by the Arrhenian formula except for the sample with 0.34 wt.% water content. The electrical conductivity of these samples decreased from highest designed temperature (e.g., 1000 K) during cooling, but the temperature dependence was getting weaker and weaker. EC, however, increased upon further cooling from 800 K until around 500 K. Then temperature dependence of EC was negligible. The tendency of EC changes with temperature indicates the concentration of electrical charge carrier changes with temperature assuming the charge carrier series will not change. The thermal dynamic calibration shows the total electric charge carriers (including H^+, OH^-, Na^+, AlO_2^- and $HSiO_3^-$) solved in water decreases with decreasing temperature from 908 to 773 K and then increases with decreasing temperature down to 573 K. The experimental result can be well explicated by the theoretical calibration. EC of the albite-quartz-water or albite-water systems are much higher than that of quartz-water system. We can well explain the high conductive anomalies in the crust even the temperatures are lower than the normal geotherm by dissolved albite in fluids.

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