Electrical conductivity of rhyolitic melts with up to 8 wt% H_2O

HUAIWEI NI[1], XUAN GUO AND LI ZHANG

[1]CAS Key Laboratory of Crust-Mantle Materials and Environments, School of Earth and Space Sciences, University of Science and Technology of China, Hefei 230026, China

Electrical conductivity of silicate melts, as a function of temperature, pressure, melt composition, and volatile contents, is a critical parameter for interpreting the nature of conductive zones in magnetotelluric survey. Rhyolitic melt is particularly important for its association with many devastating explosive volcanic eruptions. Previous experimental investigations of electrical conductivity of rhyolitic melt are restricted to low pressure (up to 0.4 GPa) and low water concentration (up to 3 wt%). With sweeping-frequency impedance analyses, we have carried out electrical conductivity measurements of rhyolitic melts at 700-1600 K, 0.5-1.0 GPa, and 0-8 wt% H_2O using a coaxial setup in piston cylinder apparatuses. We find that the water effect is much stronger than predicted from extrapolation of previous electrical conductivity models. As water concentration increases from 0.1 wt% to 8 wt%, the activation enthalpy decreases from ~85 kJ/mol to less than 40 kJ/mol, and electrical conductivity increases by 0.9-1.5 log units. The wide pressure range allows more precise assessments of the activation volume, which ranges between 8 to 21 cm^3/mol. Comparison between experimental data of electrical conductivity and Na diffusivity and the Nernst-Einstein relationship reveals that sodium ion is the major charge carrier, consistent wit previous studies. Water enhances electrical conduction by lowering melt viscosity and promoting Na transport, not by the transport of hydrous species themselves. We provide a general model for electrical conductivity of rhyolitic melts applicable to a wide range of temperature, pressure and water concentration, which is useful for understanding the physicochemical conditions of felsic magma reservoirs.