Effects of pressure and water on electrical conductivity of carbonate melt with implications for conductivity anomaly in continental mantle lithosphere

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Electrical conductivity of Na, Mg-bearing carbonate melts was measured in a Kawai-type multi-anvil apparatus as a function of pressure. The carbonate samples were mixtures of $MgCO_3$ and Na_2CO_3 or $Mg_5(CO_3)_4(OH)_2 \cdot 4(H_2O)$ and Na_2CO_3. High pressure experiments on the carbonate systems were performed up to 1800 K in a wide pressure range from 3.4 to 10.9 GPa. The sample conductivity abruptly changes at eutectic temperature, which increases with increasing pressure. Hydrous carbonate yields lower eutectic temperature than anhydrous carbonate and has weaker pressure dependence. Molten state carbonates show a very high electrical conductivity with temperature dependence following an Arrhenius law. As pressure increases, the conductivity decreases. The negative pressure dependence on electrical conductivity of hydrous carbonate melt is larger than that of the anhydrous one. Activation volumes were determined to be $\Delta V = 1.81$ and 3.61 cm・mol^{-1} for anhydrous and hydrous carbonate melts, respectively. The high electrical conductivity observed in the mantle beneath the Slave and Brazilian cratons can be explained by the process of lithospheric rejuvenation due to small amounts of hydrous carbonated melt released from crystallization of kimberitic magma at the base of continental mantle lithosphere.

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