# Calculation of diffusivity from electrical conductivity in minerals through compensation law

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Arrhenius diffusion is written as $D=D_0\exp(-Q/RT)$, where $D_0$ is pre-exponential factor, $Q$ is activation energy. The relation between diffusion and electrical conductivity is given by the Nernst-Einstein equation[1],

$$D = H_R \cdot \sigma kT/(z^2 e^2 n), \qquad (1)$$

where $H_R$ is the Haven ratio related to the correlation factor which usually has a value between 0.1 and 1. The problem is that many minerals are mixed conductors with electrical and ionic conductivities, one has to separate partial conductivity due to individual ion from total conductivity to calculate diffusion coefficient. However, the compensation law for electrical conductivity was observed for minerals such as calcite, corundum, etc., which is referred to a linear correlation between the logarithm of pre-exponential factor and activation energy for the electrical conductivity in each mineral. It was suggested that the electrical conductivity due to different conducting species tends to converge to a constant at a characteristic temperature resulting in the compensation law in each mineral. On this basis, $D_0$ for the oxygen diffusion coefficient was calculated from the electrical conductivity by equation (1) without knowing anything about the dominate conduction mechanism, while $Q$ was determined by anion porosity. The estimated oxygen diffusion coefficients were in good agreement with the experimentally determined data[2]. A large number of experimental diffusion data in olivine also test the validity of the suggestion[3]. In summary, I proposed a method to calculate the diffusion coefficient from the compensation law and gave a different perspective on the origin of the compensation law for the electrical conductivity in minerals, which is still unclear.

**References**
[1] Chakraborty, S. (1995) *Rev. Mineral.* **32**, 453-454.
[2] Wu X. P. and Zheng, Y. F. (2003) *J. Geophys. Res.* **108** (B3), 2139.
[3] Wu X. P. and Zheng, Y. F.(2005) *Appl.Phys. Lett.* **87**, 252116.