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高压下华北北缘二辉麻粒岩电导率的研究

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Electrical conductivity of two-pyroxene granulite under high pressure in northern margin

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摘要

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摘要 借助于YJ-3000t紧装式六面顶固体高压设备,在1.0~2.0 GPa、523~1173 K条件下,利用Agilent 34401A数字电表Solartron IS-1260阻抗-增益/相位分析仪,同时使用三种方法:交流阻抗谱法(频率范围0.05~10⁶ Hz)、单频交流法(0.1 Hz)和直流法,测量了华北北缘二辉麻粒岩的电导率。结果表明:在实验的温度和压力范围内,二辉麻粒岩电导率的变化在2.66×10⁻⁵~0.056 S·m⁻¹之间,电导率对压力没有很强的依赖性;随着温度的升高,电导率增大,遵循Arrhenius关系式,其指前因子为8.95~17.9 S·m⁻¹·eV。对比三种方法获得的电导率数据,发现阻抗谱法测量结果大于单频法测量结果,直流法测得的结果最低,但法获得的电导率差值除两个低温点外,绝大多数都很小(Δlgσ<0.20 lg(S/m))。结合现今华北克拉通地壳参数及地壳分层模型,验证获得的电导率-温度关系建立了电导率-深度剖面。并将其与大地电磁测深获得的地壳电性结构进行了对比,结果表明二辉麻粒岩与华北北缘的中地壳底部和下地壳底部电导率值的区域相交,再结合高温高压下二辉麻粒岩的弹性波速度剖面与地震折射比,认为二辉麻粒岩有可能是组成华北北缘下地壳的岩石之一。

关键词: 二辉麻粒岩 电导率 高压 下地壳 华北克拉通

Abstract: Electrical conductivity of two-pyroxene granulite, collected from north margin of North China was measured at 1.0~2.0 GPa and 523~1173 K by using three different methods at the same time. The methods are an impedance spectroscopy for a broad frequency range of 0.05 to 10⁶ Hz, a single lower frequency (0.1 Hz), and the DC-method. The experiments were carried out in a measurement system of electrical conductivity, which consisted of an YJ-3000t multi-anvil apparatus, a Solartron IS-1260 Impedance/Gain analyzer, an Agilent 34401A Multimeter, and a computer. The experimental results indicate that within the range of experimental temperature and pressure, the electrical conductivity of two-pyroxene granulite changes from 2.66×10⁻⁵ S·m⁻¹ to 0.056 S·m⁻¹, and hardly has a dependence on the given pressure. With increasing temperature, the electrical conductivity increases. The conductivity-temperature relation follows an Arrhenius behavior. The pre-exponential factor and activation energy of the Arrhenius formula are 8.95~17.9 S·m⁻¹·eV, respectively. The comparison of the results obtained by the three methods indicates that the result measured by the impedance spectroscopy is always higher than that of the 0.1 Hz's and the result determined by the DC-method is always the lowest. Nevertheless the difference among the data points is less than 0.20 lg(S/m) except for two low-temperature points. Based on the experimental results, the regional model and the geothermal gradient, we constructed the profiles of conductivity versus depth. The comparison of the calculated results with the electrical structure of this area reveals that the electrical conductivity of pyroxene granulite intersects the range of the electrical conductivity of the lower middle crust and the lower crust beneath this area. Combining with the conclusion of the in situ seismic velocity measurement and the seismic refraction profile, we can conclude that the two-pyroxene granulite could be a constituent of the lower crust in the northern margin of North China craton.

Keywords: Two-pyroxene granulite Electrical conductivity High pressure The lower crust North China

