

Comparison between theoretical electrical conductivity and seismic velocity of rocks with transversely isotropic cracks

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SUMMARY

The subsurface electrical conductivity is generally anisotropic. For example, fluid-filled cracks, faults, and dikes can make the electric current flow preferably to a direction, and previous studies have found strong anisotropic conductivity structures in volcanic areas and around faults. The anisotropy of the subsurface electrical conductivity provides important information for elucidating the stress-strain state and transport property in the crust. To quantitatively interpret the conductivity structures estimated by electromagnetic surveys, the mixing model, which gives bulk conductivity from the conductivities of different phases composing a rock, is essential. However, mixing models considering the anisotropy have rarely been investigated, although various theoretical and empirical mixing models for isotropic conductivity have been proposed. Recently, Usui (2024) developed a theoretical mixing model for transversely isotropic rocks with interconnected cracks using a statistical approach. The derived model can represent general transverse isotropy. For transversely isotropic rocks with fluid-filled cracks, several models of anisotropic seismic velocity have been proposed. In many areas, seismic explorations were performed in addition to electromagnetic explorations. Theoretical relationships between the anisotropic electrical conductivity and velocity can potentially help us to elucidate the crack geometry and orientation in the crust. In the present work, I compare the theoretical values of the anisotropic electrical conductivity and velocity for equivalent crack geometries. By changing the probability distributions of the size and orientation of cracks, I show how the relationship of two physical parameters depends on those crack parameters.

Keywords: anisotropy, electrical conductivity, mixing model, crack, seismic velocity
