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Development of a new scheme for the joint-inversion of seismic and resistivity structures.

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Recently, detailed 2-D and 3-D images of both seismic velocity and electrical resistivity structures can be obtained for the deep crust. These structures sometimes show a good correlation between velocity and electrical resistivity. Usually, low velocity zone corresponds to electrically low resistive zone and vice versa. This correlation can be explained by the existence of fluid phase. Quantitative comparison between seismic and resistivity structures is important to precisely estimate porosity, pore geometry, and pore connectivity in the crust. The goal of this study is to develop the method of joint inversion of MT and seismic data. To obtain an appropriate scheme for join inversion, we investigate the relation between the electric and elastic properties of crustal rocks, and similarity and difference between MT method and seismic tomography.

First, the quantitative relation between electrical resistivity and seismic velocity was examined using borehole data, laboratory experimental data, MT and seismic tomographic images, and theoretical models of solid-liquid composites. A distinct positive correlation can be obtained only when variation of both properties are controlled by porosity variation. However, when these properties are controlled by host rock composition, fluid connectivity, or pore geometry, distinct correlation does not exist. This also means that the information of the crustal fluid obtained from resistivity and velocity is different.

Next, to investigate similarity and difference between MT method and seismic tomography, inversion program codes of these two methods were developed for 1-D and 2-D structures. The results of the synthetic test show that the model resolution of velocity structure depends on the distributions of sources and stations, whereas that of resistivity structure strongly depends on target depth. Resolution is higher for high-velocity zone than low-velocity zone and for low-resistivity zone than high-resistivity zone. Because low-velocity zone usually corresponds to low-resistivity zone, the two relations are complementary with respect to the resolution. The present results show that joint inversion of MT and seismic data will be a powerful method for imaging the distribution of crustal fluids. We propose a new joint inversion scheme constraining the relation between velocity and resistivity. We further perform some joint inversions based on the new scheme.