Fluid path in the lower crust estimated by S-wave reflection analysis

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The Role of geofluids on geodynamics and earthquake generation has long been investigated. It is well known that high pore pressure can reduce the strength of seismogenic faults, and that strain rates increase with high water contents within ductile faults below the seismogenic layer. Furthermore, it is thought that these phenomena are originally related to geofluids upwelling from subducting oceanic plates. The physical and/or chemical processes concerning these phenomena are clear, however, direct evidence about them in the real crust has been rarely obtained until now. For example, high pore pressures have not been measured directly in the fault zone, and low velocity or low resistivity anomalies of a fault width scale have not estimated in the lower crust.

In this study, in order to clarify geofluid paths from mantle to seismogenic faults and its role on earthquake generation, we estimated detailed crustal structures mainly by an S-wave reflection analysis using waveforms of natural earthquakes. Since we used the data from the dense seismic network operated by the “manten” project, we estimated relative reflection strengths with a very fine scale of 1.5km in the lower crust.

It is found that near the Moho discontinuity, regions of high reflection strengths are limited at several sites in a region of about 50km x 50km in the central to northern Kinki district in Japan. Further, it is found that low frequency earthquakes (LFE) occur near most of those regions near the Moho discontinuity, and that high reflectivity regions extend from those locations of LFE to the seismogenic fault. These results suggest that fluid paths are limited from mantle to crust and that low frequency earthquakes can be an index of these fluid paths.