Field-based constraint on dehydration behavior of altered oceanic basalt at the seismogenic subduction boundary

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Recent progress on phase equilibria modelling in a complex chemical system allows us to model dehydration behavior of subducting crustal rocks along a given P-T path. However, there is limitation of such equilibrium approaches to model low temperature (<350 deg.C) domains of subduction zones (i.e., the seismogenic zone), because of the predominance of non-equilibrium features and the lack of reliable thermodynamic data and solid-solution models for low-T minerals. Nevertheless, phase equilibria modelling has shown that extremely high H_2O content is required for H_2O saturation in a basaltic system at low-T conditions, implying that the seismogenic depths of the subduction interface should be largely H_2O deficient or fluid absent due to the progress of basalt hydration reactions. However, detailed processes and extent of low-T equilibration of basaltic rocks are poorly known, and it remains unclear whether basaltic oceanic crust acts as a H_2O sink or a H_2O source at the seismogenic zone. Field-based studies are important to better understand the behaviour of subducting basaltic rocks into the seismogenic zone. The Northern Chichibu belt of SW Japan represents Jurassic accretionary complexes that formed around the brittle-ductile transition of quartz-rich rocks in a subduction zone setting. Widespread occurrence of lawsonite-rich veins in altered basalt is newly recognized from a non-metamorphic unit (230–240 deg.C) in the brittle part of this belt. Microstructural observations suggest that those lawsonite-rich veins formed by dehydration of pre-existed laumontite (zeolite) veins. The reaction laumontite -> lawsonite + quartz + H_2O took place during burial and compression to 0.35 GPa, which corresponds to ˜12 km depth. This lawsonite-forming reaction is a discontinuous reaction in the simple CaO-Al_2O_3-SiO_2-H_2O (CASH) system, and thus reactive system of subducting basaltic rocks at the seismogenic zone is highly localized and deviated from basaltic bulk compositions. Zeolite dehydration may be an important source of water in deeper parts of the seismogenic plate boundary.

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