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Effects of Subduction Parameters on Behavior of Fluid Flow in Mantle Wedge and Their Implications for Arc, Back-arc and Intraplate Volcanism

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Subduction zones in the world show a large variations in subduction parameters such as convergence rate and age of the subducting slab. The dehydration style of the subducting slab and behavior of the free water in the mantle wedge should be affected by the temperature and flow structures of the subduction zone while a comprehensive evaluation of the effects of the subduction parameters on the dehydration style of the subducting slab and behavior of the free water in the mantle wedge. In this study, we evaluate the effects of convergence rate and age of the subducting slab on the dehydration of the subducting slab and porous flow of the free water in the subduction zone using a series of two-dimensional numerical models with realistic phase diagrams of the oceanic crust and mantle peridotite. The model calculations show that dehydration of the oceanic crust is little sensitive to the subduction parameters while the dehydration of the lithospheric mantle is significantly controlled by the parameters. Faster or older subducting slab resulting in colder subducting slab deepens the dehydration depth of the lithospheric mantle. Compared with the complete dehydration of the lithospheric mantle from the other experiments, the experiments using the fastest (9 cm/y) or oldest (100 Ma) subducting slab show partial dehydration of the lithospheric mantle by changes in the mineral assemblages bearing from serpentine to phase-A. We consider two end-member subduction zones representing very hot or cold subducting slab (e.g., Cascadia or Northeast Japan). Very hot subducting slab yields two dehydrations of the lithospheric mantle at depths of $\sim$100 and 140 km corresponding to the changes in mineral assemblages bearing from serpentine to chlorite and from chlorite to garnet, respectively. Very cold subducting slab shows no dehydration of the lithospheric mantle by a depth of 200 km in the model domain. These distinct dehydration styles of the lithospheric mantle are consistent with rehydration melting of the oceanic crust in the Cascadia and deep slab dehydration in the back-arc side of the Northeast Japan. The deep dehydration of the lithospheric mantle which delivers water into the back-arc mantle or even transition zone implies for the back-arc and intraplate volcanism. Other mechanisms such as grain size evolution and compaction pressure which are not considered in this study may enhance focusing of arc volcanoes.