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Dehydration from hydrated minerals and its relation to the chemical and isotopic compositions of mud volcanic fluids

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Mud volcanoes found in the tips of subduction zones are thought to be related to fluids which subducted with descending slab in the form of pore water and hydrous minerals. Fluids in subduction zones and mode of their circulations are closely related to dynamic processes such as seismicity, island volcanism, and geochemical cycles. Thus, fluid chemistry of mud volcano is one of the most important topics in order to understand the fluid cycle and earthquake generation mechanism in subduction zones. The major origins of mud volcano fluids are considered to be pore water in the subducting sediments squeezed by tectonic compaction, dehydration from minerals, decomposition of gas hydrate, meteoric water and seawater. In shallow subduction zones, smectite is a major mineral which dehydrates between about 60 – 160 ℃. This study aims to quantify the chemical and isotopic compositions of fluids from dehydration of hydrous minerals using the chemical and isotopic data of fluids from mud volcanoes. In this study, a three-component mixing model using Cl concentration, oxygen and hydrogen isotope compositions of mud volcano fluids, are used for constraining the oxygen and hydrogen isotope compositions of mineral dehydration fluids. Rayleigh fractionation equation was also used to constrain the isotopic compositions, because the isotopic fractionation factor during smectite dehydration are reported to be temperature-dependent. As a result of Rayleigh fractionation equation, δ^{18}O=+ 9.5 ‰, δD=-17.7 ‰ are obtained as the isotopic composition of smectite dehydration fluids at 160 ℃. Three-component mixing model could explain chemical compositions of most of mud volcano fluids in Taiwan which are distributed on land, and those off Costa Rica. However, mud volcano fluids off Tanegashima Island and East Mediterranean, in addition to CKF group mud volcanoes in Taiwan would not be well explained by three-component mixing model. For these mud volcanoes, another component such as deep sheeted brine, like an Arima-type brine are considered as the fourth end member. This four-component mixing model could explain these mud volcanoes better than the three-component mixing model. Reported fluctuation of chemical and isotopic composition in CKF mud volcanoes can also be well explained as the change in contribution ratio of Arima-type brine. This result supports that deep sheeted brine like an Arima-type brine would contribute to the fluid circulation in shallow subduction zone.