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The behavior and property of metamorphic fluids in Paleotethyan oceanic subduction zone: constraints from eclogites in the Hong'an orogen

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Metamorphic fluids released from the subducting crust are of great importance to understand the recycling of volatile materials at convergent plate margins. Garnet in metamorphic rocks can retain chemical zonation and crystal inclusions produced during crustal subduction, providing the record of geochemical recycling in subduction zones. We presents a combined study of mineralogy and geochemistry for metamorphic garnets in oceanic-type eclogite from the Paleotethyan subduction zone in the Hong'an orogen, east-central China. The results show distinct zonation of major and trace elements, crystal inclusions, water contents, and oxygen fugacity in garnet. Garnet grains exhibit a decrease of water content from core to rim, indicating a gradual decrease of bulk water content in host eclogite during the garnet growth. Combined with the theoretical calculation based on the mineral modes and mineral water contents, it is suggested that the subducting oceanic crust would release reduced amounts of fluids during prograde metamorphism from greenschist to eclogite facies. The different garnet zones have f_{O2} values varying from ΔFMQ+1.77 to ΔFMQ+3.26, suggesting that the fluids released from the subducting oceanic crust were oxidizing during subduction to peak eclogite facies and its early exhumation stage. These garnet f_{O2} values are correlated with the water contents of water-saturated garnet, implying that the water content of metamorphic garnet is a potential means to recover the redox state of its host eclogite. This demonstrates that a combined study of water content, major and trace elements, and mineral inclusions in metamorphic garnet can potentially provide a new perspective into the behavior and property of fluids released from the subducting oceanic crust.