

Hydrocarbon-fluid inclusions in authigenic quartz from Torinosu limestone at Sakawa town, Kochi Prefecture, Japan

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Hydrocarbons in the uppermost earth's crust are thought to be produced mainly from biogenic organic matters in marine sediments during diagenesis. Organic-rich limestone is important as a source and storage rocks of the hydrocarbons. In addition, limestone often includes calcite and quartz crystals as authigenic minerals during the diagenesis, and their minerals sometimes have trapped the hydrocarbons as fluid inclusions. Thus, the inclusions are a significant information source of hydrocarbon fluids in the uppermost crust. Despite the importance of the inclusions, there are few data for chemical features of such the inclusions from island arc areas. For this reason, we measured UV fluorescence, homogenization temperature, and Raman spectra of hydrocarbon-fluid inclusions trapped in authigenic quartz from organic-rich Torinosu limestone at Sakawa town, Kochi Prefecture, Japan, to investigate characteristics of hydrocarbon fluids in uppermost sediments at the island-arc settings.

Authigenic-quartz crystals were collected from the limestone and a psammitic rock associated with the limestone. Both crystals were a euhedral shape with a few millimeters in size and contained large amounts of fluid inclusions and small amounts of bituminous substances and tiny calcite crystals as solid inclusions. The quartz crystals contained two types of fluid inclusions; liquid-rich two-phase and vapor-rich inclusions. The two-phase inclusions contained a transparent to pale-brown hydrocarbon liquid, a bubble, and small amounts of bituminous precipitates. A liquid water phase was absent in the inclusions, and no aqueous inclusion was observed in the quartz. The hydrocarbon liquid mostly exhibited a UV fluorescence with blue to blue-white color, indicating a presence of some type of aromatic compounds. A green and yellow UV fluorescence and rare non-fluorescence were also observed for a few two-phase inclusions. Upon heating, most of two-phase inclusions in quartz from the limestone homogenized to the liquid phase at temperatures between 45 °C and 49 °C, and those from the psammitic rock demonstrated the homogenization temperature of mostly around 37 °C. The vapor-rich inclusions contained a large bubble and very small amounts of fluorescent hydrocarbon liquid. In Raman microscope measurements, two-phase inclusions in quartz from the limestone showed characteristic peaks (around 1350 cm⁻¹ and 1600 cm⁻¹) for polycyclic aromatic compounds observed frequently in bitumen from organic-rich limestones. A detection of the polycyclic aromatic compounds was consistent with the fluorescence properties of the two-phase inclusions. No peak due to liquid H₂O or CO₂ molecules were also observed. These results showed that the organic-rich limestone at the island-arc setting had produced a hydrocarbon fluids with a relatively lower homogenization temperature and a large amount of polycyclic aromatic compounds.

Keywords: Fluid inclusion, Oil Quartz, Torinosu limestone, UV fluorescence, Microthermometry, Raman spectroscopy