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CO2 concentration of fluid inclusions in hydrothermal quartz: evidence for Archean CO2-rich seawater

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CO2 is a key element to understanding the Precambrian surface environment because of its greenhouse effect in atmosphere and influence on seawater chemistry. The purpose of this study is to estimate CO2 concentration of ancient seawater from fluid inclusions in quartz formed in subseafloor hydrothermal system. The crushing extraction system was established to measure CO 2 concentration of fluid inclusions entrapped by hydrothermally precipitated quartz, and was applied to natural samples from the 3.0 Ga Pongola area and the 2.2 Ga the Ongeluk area, Kaapvaal Craton, South Africa. The quartz deposits occur in drain cavity and interpillow space of pillow lavas, and in vesicle of sheet flow, the size of which ranges from several to 15 cm across. The precipitates in the drain cavity are smooth oval tube in shape and oriented parallel to the pillow tube, and never cut pillow rim. The quartz precipitate in the interpillow is shaped by primary structure of the pore surrounded by pillows and also never cut the pillow rims. Some quartz crystals show a point symmetrical structure that grew from surface to center of the cavity, and form banded growth plain defined by repeated changes of grain size. Because hydrothermally precipitated quartz has both primary and secondary inclusions, we classified quartz samples into primary-rich and secondary-rich samples based on the detailed microscopic observation. The CO2 concentration of extracted fluid from the primary-rich samples in the Pongola quartz is approximately 100 times higher than present-day seawater, while primary-rich samples in the Ongeluk area have relatively low CO2 concentrations up to 20 times the present. These results imply that the CO2 concentrations of hydrothermal fluid and seawater decreased from 3.0 Ga to 2. 2 Ga.