Multiphase "former supercritical fluid" inclusion from the high-temperature and high-pressure pre-Sanbagawa metamorphism

Kenta Yoshida[1], Atsushi Okamoto[2], Yasuhiro Niwa[3], Masao Kimura[3], Ryosuke Oyanagi[4], Hikaru Sawada[1], Sota Niki[5], Kazuki Yoshida[2]

[1] Japan Agency for Marine-earth Science and Technology (JAMSTEC), 237-0061 Yokosuka, Japan;
[2] Graduate School of Environmental Studies, Tohoku University, 980-0845 Sendai, Japan;
[3] Photon Factory, Institute of Materials Structure Science, High Energy Accelerator Research Organization (KEK), 305-0801 Tsukuba, Japan;
[4] Kokushikan University, Setagaya 4-28-1, 154-8515 Tokyo, Japan;
[5] Geochemical Research Centre, The University of Tokyo, 113-0033 Tokyo, Japan

The Early Jurassic (c. 200 Ma) pre-Sanbagawa metamorphism with P-T conditions of 2.3–2.7 GPa and 1000–1200 ºC has been recognized in the calc-silicate rocks in the Sanbagawa metamorphic belt exposed in the southwest Japan (Yoshida *et al*., 2021).

We newly discovered quartz-fluid multiphase inclusion in the titanite recording high-T stage. The fluid-bearing inclusions coexisted with quartz single-phase inclusions in the same inclusion group, exhibiting ~ 5μm in size. The Raman spectra of the aqueous fluid show a high-salinity signature, although the salinity has not been determined due to its small size. Nanoscopic synchrotron radiation X-CT (performed at AR-NW2A of Photon Factory with the proposal No. 2019G569) combined with a focused-ion beam microsampling revealed the interfaces between quartz and the host titanite were rounded. In contrast, those between fluid and the host were faceted (Fig. 1a-b). The detailed 3D morphological observation indicated two generations of quartz: Q-1, sharing a gapless interface with the host titanite; Q-2 having faceted interfaces with the fluid. The Cathodoluminescence signature of Q-1 was bright, while that of Q-2 was dark, also indicating different generations (Fig. 1c). The characteristics of the inclusions indicated that the supercritical fluid with a considerable amount of dissolved silica had coexisted with solid quartz (Q-1), and had been heterogeneously trapped in titanite under high-T conditions. Subsequently, new quartz (Q-2) was precipitated from that fluid during cooling.

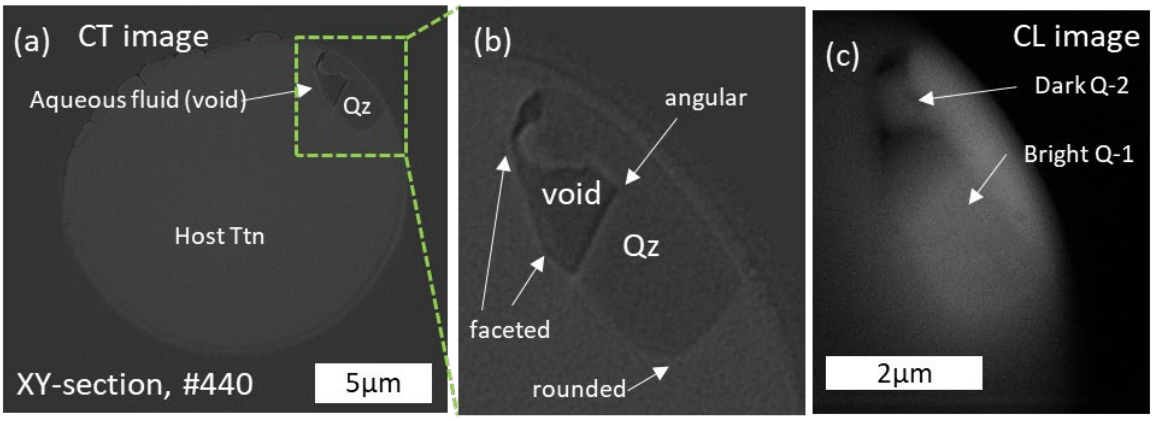

Figure 1- (a) A representative X-Y section of CT images containing fluid and quartz (Qz) inclusion in host titanite (Ttn). (b) Enlarged view of the rectangle, clearly showing faceted nature of fluid-host interface. (c) CL image, same area of (b)

Yoshida K., Niki, S., Sawada, H., Oyanagi, R., Hirata, T., Asakura, K., Hirajima, T., 2021. Discovery of the Early Jurassic high-temperature pre-Sanbagawa metamorphism recorded in titanite. *Lithos*, 398-399, 106349.