Elemental redistribution in zircons of felsic gneiss from the Harvey Nunatak in the Napier Complex, East Antarctica

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Zircon ($ZrSiO_4$) is one of the most often-used minerals for U-Pb geochronology, thanks to good retention of radiogenic Pb (>1000 °C; Cherniak, 2010; Kooijman et al., 2011). On the other hand, ultrahigh-temperature metamorphism (>1000 °C) caused radiogenic Pb redistribution in zircon crystals and modified the U-Pb ages (Kusiak et al., 2013; Whitehouse et al., 2017). The behavior of radiogenic Pb in zircon crystal is important for U-Pb zircon geochronology. Therefore, in order to verify the retention of Pb and other trace elements in zircon crystal under (ultra)high-temperature, we focus on the Napier Complex, East Antarctica, which has the evidence of the ultra-high temperature metamorphism (e.g., Sheraton et al., 1987; Harley & Hensen 1990). We analyzed U-Pb age and trace-element contents (Hf, Ti, P, Ca, Mn, Fe, Al, Mg, K, Li, B, F, Cl, and rare earth element (REE)) of zircon collected from an orthopyroxene-felsic gneiss at the Harvey Nunatak using a sensitive high-resolution ion microprobe (SHRIMP IIe) at the National Institute of Polar Research, Japan.

The sample (an orthopyroxene-felsic gneiss, Sample No. 23-2A-09) was collected at the Harvey Nunatak, which is located close to Mt. Sones, during the fieldwork at the 2016-2017 Japanese Antarctic Research Expedition (JARE). The sample was crushed by a high-voltage pulse power fragmentation device (Selfrag Lab) to preserve the external morphology of zircons and prevent contamination (Takehara et al., 2018). After pulverizing, the zircon grains were concentrated using conventional mineral separation techniques, including heavy liquid separation with methylene iodide and magnetic separation.

Zircon grains collected from the sample have mostly fractures but slightly inclusion based on the observation of transmitted light images by an optical microscope. BSE images show that some zircon grains have darker BSE-response domains. As the results of the trace element contents analyses of the zircons, both of depletion of Zr and incorporation of Ca, Mn, Fe, Al, and K are shown in the darker BSE-response domains. These results suggest leaching of Zr and incorporation of non-formula elements during hydrothermal alteration of zircon even in the ultrahigh-temperature metamorphic region. In the darker BSE-response domains in zircons, small inclusions (~3 μm) of galena (PbS), which were associated with the hydrothermal alteration of zircon, are observed. U–Pb data of the zircons show mostly concordant data and discordance (Disc.(%) = 1 − (^{206}Pb/^{238}U age)/(^{207}Pb/^{206}Pb age)} × 100 (e.g, Song et al., 1996)) ranges from -5 to +9%. The ^{207}Pb/^{206}Pb ages (n=35) range from about 2440 Ma to 2532 Ma, and the MSWD is 16, which means the dispersion of the total ^{207}Pb/^{206}Pb ages is too large compared to the analytical errors of the individual ^{207}Pb/^{206}Pb ages. Therefore, Pb in the zircons of the felsic gneiss has been redistributed by hydrothermal alteration and (ultra)high-temperature metamorphism, which is important for the geochronological discussion of the metamorphism in the Napier Complex.

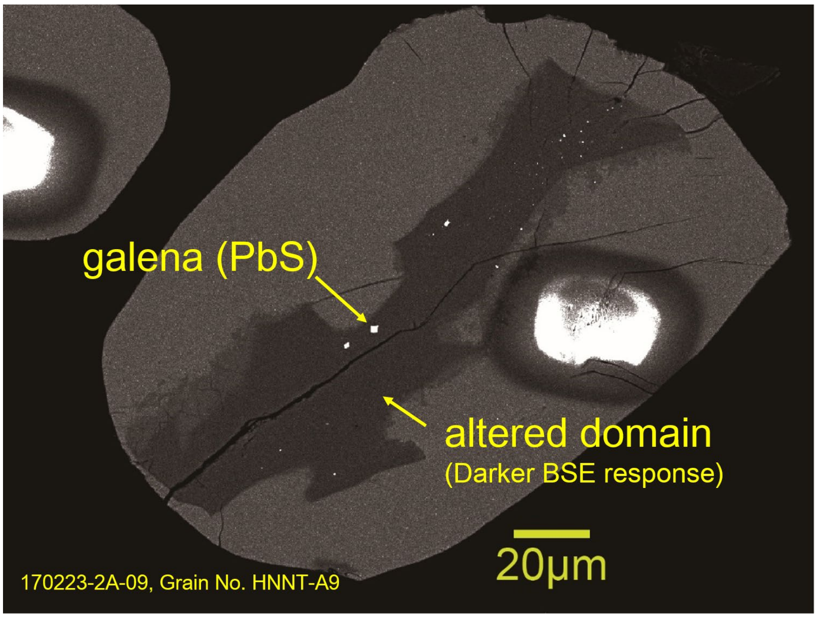

Figure 1. The BSE image of zircon grains including altered domain and galena.

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