High-resolution spectroscopy of radiation-damaged zircon

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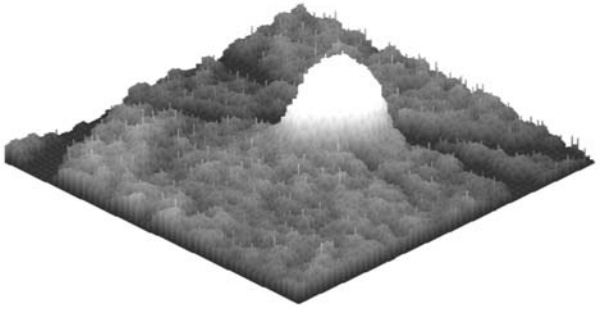
Spectrosopic techniques, especially those with high volume resolution on the micrometer scale, have become extremely useful tools for the detailed characterization of zircon. Applications include the investigation of (1) natural and artificially induced radiation-damage ("metamictization"; e.g., Ewing 1994) and (2) non-formula elements and their position in the zircon structure, including accompanying effects on physical properties and the chemical reactivity of zircon.

The talk will concentrate on light spectroscopy techniques, (e.g., vibrational spectroscopy, optical absorption, and luminescence) with examples from current research projects. For example, various spectral parameters are sensitive to radiation damage in zircon (e.g., Nasdala et al. 2002), which in turn allows one to quantitatively estimate the degree of metamictization in micron-sized areas based on the spectroscopic data, and to study annealing processes (Fig. 1). The potential and reliability of recently proposed models for the use of spectroscopic data to obtain genetic and geochronologic information will also be discussed.

Figure 1: Photoluminescence map (plot of the bandwidth of a Sm^{3+} emission; 18 μm × 18 μm size) of a natural zircon. The impact of the electron beam during microprobe analysis has caused local partial recovery from radiation damage.



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U-Pb geochronology and geochemistry of zircon from the Franceville series at Bidoudouma, Gabon

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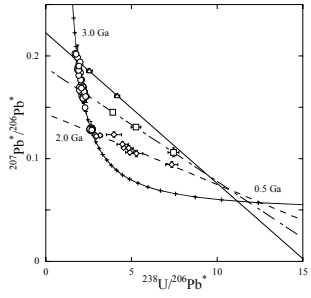
The Franceville basin in Gabon includes unique uranium deposits at Oklo, Okelobondo and Bangombé that are known as fission reactors. Previous chronological works provided the deposition age of the basal unit which is the host rock of uranium deposits, but this result, 2143 ± 143 Ma, shows a large analytical uncertainty. In this study, we tried to estimate the precise deposition age of the Franceville series and deduce the later geologic events at the Bidoudouma site from U-Pb geochronology and rare earth elements (REE) geochemistry of zircon.

Samples were taken from Bidoudouma which is located 63km north from Oklo. All samples are welded tuff in the FD formation mainly consisting of cinerite and ignimbrite. Quantitative analysis of major elements of zircon was carried out by EPMA. *In-situ* U-Pb and REE analyses of zircon were performed by using a SHRIMP at Hiroshima University.



U-Pb data of the Franceville zircons show three populations with concordant ages (2.8, 2.5 and 2.1 Ga). The youngest age (2083±6 Ma) restricts the deposition age of the Franceville sediments. As shown in Figure, some zircons show distinctly discordant U-Pb data, which indicates that U-Pb system of the discordant zircon having the same origin with concordant zircon was disturbed around 500 Ma. The REE abundance patterns for the discordant zircons are obviously different from those of the concordant grains. They are characterized by high contents of REE and positive Eu anomaly. The correlation between Ca contents and degree of Eu positive anomalies in the discordant zircon suggests that the preferential incorporation of Eu^{2+} in low crystallinity zircons occurred through the interaction with reducing hydrothermal fluid.