In-situ petrographic thin section U-Pb dating of zircon and titanite by laser ablation-MC-ICP-MS

A. SIMONETTI[1], L.M. HEAMAN[1], T.G. MACHATTIE[1], T. CHACKO[1], R.P. HARTLAUB[1] AND D.R. ECCLES[2]

[1]Earth & Atmospheric Sciences, Univ. Alberta, Edmonton, AB, Canada (antonio.simonetti @ualberta.ca; lheaman@ualberta.ca; trevor@maildrop.srv.ualberta.ca; Tom.Chacko@ ualberta.ca; hartlaub@ualberta.ca)

[2]Alberta Energy and Utilities Board, Alberta Geological Survey, Edmonton, AB, Canada (roy.eccles@gov.ab.ca)

U-Pb geochronological studies of accessory minerals (zircon, monazite, titanite) using laser ablation-MC-ICP-MS have typically involved mounting carefully selected grains subsequent a labour-intensive crushing and heavy mineral separation procedure. Apart from the time-consuming aspects involved with this mounting procedure, more importantly the textural context of the grains is lost. This in-turn significantly limits the ability to place the geochronological data within the broader framework of the petrogenetic and deformational history of a rock. In contrast, the capability of acquiring in-situ U-Pb dates in petrographic thin section provides the opportunity to directly link age information, deformational fabrics, and pressure-temperature data derived from analysis of mineral grains.

The laser ablation (UP213 nm)-MC-ICP-MS (NuPlasma) instrument configuration at the University of Alberta is equipped with a collector block that includes three ion counters and twelve Faraday buckets. This configuration allows for the simultaneous detection of ion signals ranging from mass ^{238}U to ^{203}Tl. Advantages of the multiple ion counting system include the capability to readily measure low Pb ion signals ($<1 \times 10^6$ counts per second), conducting ablation runs using relatively low laser energy output (~2 J/cm^2), and high spatial resolution using predominantly single spot analysis of ≤ 40 µm. During a typical 30 second analysis, the depth of the laser pit is ~15 µm and corresponds to a small amount of total ablated mass (~90 nanograms) for zircon. An analytical protocol and data reduction scheme were developed that typically yield external reproducibility (2σ) for ^{206}Pb/^{238}U (and ^{207}Pb/^{235}U) and ^{207}Pb/^{206}Pb values of *ca.* 3% and ~0.7%, respectively. We have dated and titanite from several petrographic thin sections representing samples of lower crystal xenoliths and plutonic intrusions; for example, a thin section study of the Wathaman Batholith (northern Saskatchewan/Manitoba) yields a concordant age of 1845.4 ± 5 Ma (2σ; n=5 grains) and corroborates available (ID-TIMS) age determinations (~1850 to 1865 Ma).

In-situ Fe Isotopic Fractionation Determination by Laser Ablation MC-ICP-MS

A. TUNHENG AND T. HIRATA

Laboratory for Planetary Sciences, Tokyo Institute of Technology, O-okayama 2-12-1, Meguro, Tokyo, Japan 152-8551 (apinya_t@geo.titech.ac.jp, hrt1@geo.titech.ac.jp)

Stable isotope geochemistry using heavy elements such as Ca, Zn or Fe has become a strong tool to understand the origin or formation sequences of the sample. Among the heavy elements, iron has been receiving a great interest in the past few years to reveal geochemical and biological cycling because of its ubiquitous presence as well as various in chemical form and oxidation state in nature (Anbar 2004 and Beard et al 1999). In the case of isotopic analysis of Fe, multi-collector-ICP-MS coupled with solution introduction technique has been widely adopted. However, sample decomposition or chemical separation precedures prior to the analysis were required and therefore, we can not achieve *in-situ* isotopic analysis of Fe based on the solution sample introduction technique. In this study, laser ablation (LA) sample introduction in stead of solution nebulization was used for the isotopic analysis of Fe. Although we first reported the *in-situ* isotopic data on Fe obtained with LA-MC-ICP-MS technique. However, resulting precision on ^{56}Fe/^{54}Fe was 2-3 ‰ level, which was not high enough to detect the natural variation in Fe isotopic ratios (Hirata and Ohno 2001). In this study, LA system utilizing shorter wavelength (193 nm) was applied to improve the precision of the Fe isotopic ratio measurements. With a stabilizer device, aiming at stabilizing the signal intensity (Tunheng and Hirata 2004), resulting precision of the ^{56}Fe/^{54}Fe and ^{57}Fe/^{54}Fe ratio measurements as 0.3‰ and 0.5‰ (2SD), respectively. The results obtained here clearly demonstrate that LA-MC-ICP-MS technique can promote further application of the stable isotope geochemistry using heavy elements.

References

Anbar, A. D. (2004) *Earth Planet. Sci. Lett.* **217,** 223-236.

Beard, B. L., Johnson, C. M., Cox, L. Sun, H., Nealson, K. H. Aguilar, C. (1999) *Science* **285**, 1889-1892.

Hirata, T. and Ohno, T. (2001) *J. Anal. At. Spectrom.* **16**, 487-491.

Tunheng, A. and Hirata, T. (2004) *J. Anal. At. Spectrom.* **19,** 932-934.