DECOMPOSITION OF ZIRCON IN MISTASTIN LAKE IMPACT MELT GLASS: AN INTEGRATED SIMS, HYPERSPECTRAL-CL, RAMAN AND EPMA STUDY

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Introduction: The Mistastin Lake impact-structure (~28km Ø) formed in mixed anorthosite-mangerite-granodiorite target rocks in northern Labrador, Canada [1, 2]. Two exceptionally well-preserved zircon grains were identified in a holohyaline impact melt glass from the Discovery Hill outcrop that were quenched during decomposition (i.e. solid-state dissociation of $ZrSiO_4$ to ZrO_2 and SiO_2). The grains contain a relict core and a 20-50 micron thick reaction rim formed when the zircon grains were entrained in impact melt ~36 Ma [1-3]. We used secondary-ion mass spectrometry (SIMS), electron-probe microanalysis (EPMA), hyperspectral cathodoluminescence (CL), and laser Raman spectroscopy (LRS) to perform an integrated study of impact induced decomposition of zircon in a natural sample, discriminate between intrinsic and REE-quenched CL in impact zircons, and to determine the impact age from the reaction rim.

Methods: The NORDSIM Cameca 1280 SIMS in Stockholm was used for spot measurements of U-Th-Pb ratios of both the zircon cores and rims. Additional ion mapping of U-Th-Pb and Y, Dy, Er, and Yb was done for age dating of the rim through ion-ratio mapping, and for comparison to CL and EPMA measurements. Hyperspectral CL data were collected at the National Institute of Standards and Technology (NIST). LRS mapping of areas of the decomposition rim were done at 0.6 µm pixel resolution. EPMA x-ray stage intensity maps, quantitative spot analyses for REE, and wavelength scans for element inventory were acquired on a JEOL JXA-8200 at Washington University.

Preliminary Results: Multiple 10µm SIMS spot analyses in the cores show that the grains have similar ages to- and most likely formed in- the granodiorite target rocks 1417±22 Ma, within error of other impact melt zircon grains from the Discovery Hill outcrop [2]. Work is in progress to determine the age of the ZrO_2 decomposition rim (and thus the age of the impact) from ion-ratio maps. The hyperspectral CL spectrometry identified both intrinsic and REE quenched CL zoning in the zircon cores, and also established the extent of the thermal pulse into the zircon core not seen in the other techniques in this study. LRS imaging indicates most of the decomposition rim is baddeleyite and amorphous-SiO_2 (mixed with surrounding melt), with isolated blebs of tetragonal-ZrO_2, helping to constrain the temperatures of the impact melt at above 1676ºC [4]. X-ray mapping by EPMA shows an enhanced Zr halo and flow texture around the grains which demonstrates that the zircon grains were mobile in the melt and may be useful for constraining viscosity of the melt.

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