$^{40}Ar/^{39}Ar$ geochronology and Pb isotopic evidence for the role of ridge subduction in generating orogenic gold mineralization in the Otago Schist Belt, New Zealand

J.K. MORTENSEN[1]*, D. CRAW[2], D.J. MACKENZIE[2], T. ULLRICH[1] AND J.E. GABITES[1]

[1]University of British Columbia, Vancouver, V6T 1Z4, Canada (*correspondence: jmortensen@eos.ubc.ca)
[2]University of Otago, Dunedin, New Zealand

Orogenic gold mineralization in the Otago Schist Belt (OSB) of South Island, New Zealand, occurs as syn- to late tectonic veins and disseminations in brittle-ductile shear zones (e.g., Hyde-Macraes, Rise&Shine), as well as in late and post-tectonic fissure veins. Gold is hosted within lower to upper greenschist facies metaclastic rocks of the Otago Schist that comprise part of a long-lived (Triassic to mid-Cretaceous) accretionary complex that developed along the active margin of Gondwana. Orogenic gold mineralization in the OSB is thought to have formed from fluids produced during prograde dehydration reactions within the Otago Schist at depth that also liberated and mobilized S and metals (including Au). $^{40}Ar/^{39}Ar$ dating of muscovite within veins at the Macraes Mine (Hyde-Macraes shear zone) and the Glenorchy District yield ages in the range of 135-141 Ma, and are interpreted to represent the age of veining. Previous $^{40}Ar/^{39}Ar$ dating of muscovite from the Rise&Shine shear zone and several late gold-bearing fissure veins elsewhere in the OSB suggest ages for that mineralization of ~101-106 Ma. Pb isotopic analyses of 48 sulphide separates from all of the various styles of gold mineralization within the OSB define two distinct clusters: a less radiogenic cluster of analyses that includes samples from Macraes and Glenorchy, and a more radiogenic cluster that includes samples from the Rise&Shine shear zone and other veins that have yielded younger $^{40}Ar/^{39}Ar$ ages. Together the age and Pb isotopic data suggests that gold mineralization in the OSB formed during two discrete and relatively short-lived pulses, at ~135-141 Ma and ~101-106 Ma. The highly episodic nature of the gold mineralization argues that hydrothermal activity that produced orogenic gold mineralization in the OSB was not simply part of a steady-state process related to the normal development of an accretionary complex, but rather was related to specific tectonic events that affected the wedge. Age and geochemical studies of the associated arc complex suggest that a ridge subduction event occurred under the OSB at ~135-140 Ma, and reconstructions of probable plate motions in the region appear to require a younger ridge subduction event at ~100 Ma. We suggest that gold mineralization in the OSB was related to two discrete ridge subduction events, analogous to gold mineralization in the Chugach accretionary complex in southern Alaska.

Zircon U-Pb age discordance and trace element alteration due to deep, post-impact flow: Implications for planetary chronology

D.E. MOSER[1], W.J. DAVIS[2], S. REDDY[3], R.L. FLEMMING[1] AND R.J. HART[4]

[1]Dept. of Earth Sciences, Univ. of Western Ontario, London, Ontario, Canada N6A 5B7 (desmond.moser@uwo.ca)
[2]Geological Survey of Canada, 601 Booth St., Ottawa, Canada, K1A 0E8 (bidavis@NRCan.gc.ca)
[3]Dept. of Applied Geology, Curtin University of Technology, GPO Box U1987, Perth, WA 6845, Australia (s.reddy@curtin.edu.au)
[4]iThemba labs, Johannesburg, South Africa (hart@tlabs.ac.za)

The discovery of a new process whereby U-Pb isotopic ages in normally robust, crystalline zircon are made discordant, and primary trace element compositions are altered, has broad implications for geo- and cosmochronology. Here we present the first definitive evidence for partial to complete U-Pb age discordance due to a sub-solidus, ductile deformation event that, in our case, was triggered by large meteorite impact. The zircons occur in mylonitic mafic xenolith samples of the Archean lower crust exhumed by the 0.15 Ga Lace kimberlite, 60 km from the center of the 2.02 Ga, 300 km-diameter Vredefort impact structure. We have combined *in situ* and single-zircon U-Pb isotope analysis (SHRIMP, ID-TIMS) with microstructural analysis by micro-XRD, EBSD and colour SEM-CL to directly date the deformation fabric at 2023±15 million years, indicating deep level flow in the aftermath of crater excavation and rebound. LREE enrichment proportional to degree of discordance in a 'shear zone' within a single zircon suggests Pb-loss was fluid-assisted along fast-diffusion pathways on sub-grain boundaries. Our discovery demonstrates the importance of microstructural analysis when interpreting isotopic and trace element mineral compositions as primary, and proves a new technique for strain chronometry of planetary materials.