Meteorite impact-triggered diffusion of Pb and REE in crystalline Moho zircon

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

[1] Dept. of Earth Sciences, University of Western Ontario; desmond.moser@uwo.ca
[2] Geological Survey of Canada; bidavis@NRCan.gc.ca
[3] iThemba Laboratories, Johannesburg; hart@tlabs.ac.za

The Jurassic Lace kimberlite intrusion, 150km SW of the center of the ~250km diameter, 2020+/-3 Ma Vredefort impact structure, contains myloniitic, granulite-facies mafic xenoliths – fragments of Neoarchean (2670+/-4 Ma ID-TIMS; 2667+/-5 Ma GSC-SHRIMP) basaltic sills that crystallized at or near the southern African Moho following marginal Ventersdorp rifting. Autometamorphism in the presence of garnet is evidenced by ~2670 Ma HREE-depleted zircon rims around relatively HREE–enriched, planar growth banded cores. Continuous annealing at ambient Moho temperatures would have made the zircon population highly resistant to subsequent chemical alteration. Nevertheless many Neoarchean grains exhibit significant Pb loss at the time of the Vredefort impact event based on discordant arrays yielding lower intercepts of 2019+/-14 Ma (ID-TIMS) and 2017 +/-5 (GSC-SHRIMP). Apparent reverse core-rim U-Pb age zonation (below) coincident with LREE enrichment and CL 'fogging' suggests that Pb diffusion was assisted by high temperature metasomatic fluids reacting with the grain interior along high density defect populations. The latter may have been initiated by the shock wave and prolonged by consequent mylonitization of the Moho region during the ~10km post-impact vertical rebound of the overlying crater floor. Single grain, microXRD analyses of the GSC-SHRIMP mount confirm intragrain lattice distortions.

Diffusional loss of Pb from crystalline zircon during ductile deformation is currently believed uncommon; however the locally complete U-Pb age re-setting noted here suggests that combined shock, thermal and dynamic metamorphism may permit such behaviour.