Complex lithosphere evolution in the Attawapiskat area, Canada – a tale of craton thinning and re-growth

KAREN V. SMIT[1]*, D. GRAHAM PEARSON[1], THOMAS STACHEL[1] AND MICHAEL SELLER[2]

[1]Earth and Atmospheric Sciences, University of Alberta, 1-26 ESB, Edmonton, AB, T6G 2E3, Canada (*correspondence:kvsmit@ualberta.net)

[2]De Beers Canada, 250 Ferrand Drive, Suite 900, Toronto, ON, M3C 3G8, Canada

Kimberlites in the Attawapiskat area of the western Superior sample the lithospheric mantle at two time periods, i) during the Mesoproterozoic, concurrent to 1.1 Ga Midcontinent Rift and ii) during the Jurassic. Peridotite xenoliths and xenocrysts from these kimberlites reveal a Palaeoarchaean mantle that was thinned at the time of Midcontinent rifting and then subsequently thermally annealed and thickened to provide a new host for diamonds.

Re-Os isotopes document the presence of a lithospheric root since the Palaeoarchaean (~ 3.6 Ga T_{RD}) preserved in sulphide and platinum group element (PGE) phases trapped in olivine. Mg# up to 93.6 in olivine require that protolith formation involved high degrees of partial melting, leading to harzburgitic / dunitic residues. Amalgamation of the Superior craton is reflected in T_{RD} ages of ~ 2.7 Ga in PGE / sulphide inclusions with residual PGE_N patterns, which indicate that additional melting occurred in the mantle due to subduction - accretion. Small-scale thinning (~30 km) of lithosphere and diamond destruction occurred due to plume impingement/rifting during the Mesoproterozoic (1.1 Ga). Melts related to the Midcontinent Rift interacted with variably depleted peridotite, leading to platinum-group PGE (P-PGE) enrichment and Mesoproterozoic T_{RD} ages. Cooling of lithosphere since the Mesoproterozoic provided a new stable, deep root for subsequent diamond growth.