Speckled zircon from mafic granulite: mechanism and meaning

N.M. RAYNER[1*], D. E. MOSER[2], M. SANBORN-BARRIE[1]

[1]Natural Resources Canada, Ottawa, Canada, nrayner@nrcan.gc.ca (* presenting author)

[2]Western University, London, Canada, desmond.moser@uwo.ca

Located in northern Hudson Bay, Southampton Island, Nunavut, is uniquely situated to provide critical insight into the assembly and evolution of northeast Laurentia. Archean and Paleoproterozoic plutonic rocks with 3.0-3.6 Ga Nd model ages dominate the eastern half of the island and include a layered ultramafic complex of which gabbroic anorthosite makes up a minor component. Mineral assemblages and thermobarometry record evidence of granulite-facies metamorphism with peak conditions of 900°C and 10kbar [1]. Zircons recovered from the gabbroic anorthosite are characterized by a distinct speckled zoning pattern in cathodoluminesence (CL) images (Figure 1).

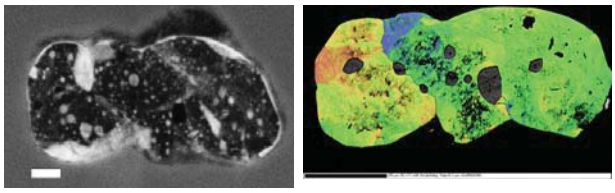

Figure 1: (Left) CL image showing speckled texture in zircon from mafic granulite. Scale bar 20µm. **(Right)** EBSD texture map (after re-polishing) showing relative crystallinity and low angle (up to 4°) misorientation of zircon lattice. Plagioclase inclusions show in grey.

Detailed geochronology, imaging, microstructural analysis and trace element geochemistry are applied to characterize the mechanism(s) responsible for this texture. SHRIMP U-Pb results define a discordia with an upper intercept of ca. 3.0 Ga and a lower intercept of ca. 1.87 Ga. Two interpretations of these results are feasible; the upper intercept may represent the crystallization age of the anorthosite or an inherited component. Accordingly, the lower intercept may record the timing of granulite-facies metamorphism or its crystallization age. EBSD mapping reveals that bright CL 'speckles' are subhedral domains of highly crystalline, unstrained zircon within a zircon matrix exhibiting finer-scale microstructure. Subgrains have rotated by several degrees across transverse, low -angle boundaries, possibly annealed fractures. The latter are sites of zircon recrystallization, suggesting a dynamic deformation and thermal annealing process. This combined isotopic, geochemical and microstructural study allows us to evaluate the two end-member tectonic scenarios; whether the mafic intrusive complex was emplaced and cooled within the deep crust (ca. 30km) during the Paleoproterozoic or whether Paleoproterozoic deep-crustal burial of a Mesoarchean layered complex produced the 'speckled' zircon microstructure and host granulite-facies mineralogy.

[1] Yakymchuk et al (2008) *Atlantic Geoscience Society, 34th Colloquium & Annual Meeting, Program with Abstracts*

Contribution of natural tracers (Cl, He) to development of 3D basin model. Paris Basin, France

ROMAIN REBEIX[1, 2*], HAKIM BENABDERRHAMANE[1], CORINNE LE GAL LA SALLE[3], BERNARD LAVIELLE[2], VERONIQUE LAVASTRE[4], PHILIPPE JEAN BAPTISTE[5], ELISE FOURRE[5], AGNES VINSOT[1], PHILIPPE LANDREIN[1], JEAN-MICHEL MATRAY[6], MAURICE PAGEL[7] AND JEAN-LUC MICHELOT[7]

[1] CENBG, University of Bordeaux, France (rebeix@cenbg.in2p3.fr)

[2] ANDRA, Chatenay-Malabry, France

[3] GIS-CEREGE, University of Nîmes, France

[4] LMV-LTL, University of Lyon, France

[5] LSCE, CEA, Saclay, France

[6] IRSN, Fontenay-aux-Roses, France

[7] IDES, University of Paris XI, France

The French Radioactive Waste Management National Agency (Andra) is preparing submission of a license to build application for a high level and long lived radioactive waste repository in the Callovo-Oxfordian geological formation in the eastern Paris basin. In this context, flow and solute transport modelling is carried out at the Paris Basin scale in order to understand past and predict future hydrogeological behaviour. The past to present transport characteristics of the basin must be understood to constrain this model. Cl, He and their stable isotopes are considered as good natural tracers to be used for investigating the transport processes and behaviour within a multi-layered aquifer system at regional and local scales. Synthesis of data resulting from over 20 years of study and covering the entire Paris basin provides valuable information which was used to constrain and consolidate a conceptual model of basin evolution.

Chloride transport is dominated by vertical diffusion from the halite level of the Keuper formation in the east of the basin. The mix between primary and secondary brines associated with this level moved laterally into the rest of the basin since the early cretaceous due to uplift of the east border of the basin, generalizing the upward diffusion of chloride from Triassic levels to the entire system. Paleo circulation occurred two times in Dogger and Rhetian at -149±6My and -99±2Ma [1] before general uplift of the basin at the beginning of the Paleogene. Chloride spatial distribution indicates local activities of faults which induced hydraulically conductive links between Triassic, Liassic and Dogger formations.

Helium transport also appears to be dominated by global vertical diffusion from crust to the top of the sedimentary pile in the central and western parts of the basin. This system is separated into two independent domains in the east of the basin by the Keuper halite levels which act as a barrier to diffusion. In the vicinity of present Triassic outcrops in the east of the basin, $^{3}He/^{4}He$ ratios are characteristic of a mantel-derived ^{3}He contribution, quickly changing to a crustal-type $^{3}He/^{4}He$ ratio further along the flow path. The $^{3}He/^{4}He$ ratio in the centre of the basin corresponds to a binary mixing of a southern mantel-derived component and an eastern crustal component.

Simplified 1D modelling of He, Cl, Br and δ37Cl for last 70 My suggests that current lateral advection in the Oxfordian and Dogger formations over and underlying the Callovo-Oxfordian are active since 20 My and 5 My respectively, in the sector considered for the radioactive waste repository.

[1] Pisapia et al., (2011) *; Goldschmidt conf abstract 2011*