Component geochronology of the ca. 3920 Ma Acasta Gneiss

N.L. Cates[1]*, S.J. Mojzsis[123], G. Caro[4],
M. D. Hopkins[1], D. Trail[5], O. Abramov[16]
M. Guitreau[27] J. Blichert-Toft[2] and W. Bleeker[8]

[1]University of Colorado, Boulder, CO, USA
[2]ENS & UCBL1, Lyon, France
[3]Hungarian Academy of Sciences, Budapest, Hungary
[4]CNRS, Vandoeuvre-les-Nancy, France
[5]Rensselaer Polytechnic Institute, Troy, NY, USA
[6]USGS, Flagstaff, AZ, USA
[7]University of New Hampshire, Durham, NH, USA
[8]Geological Survey of Canada, Ottawa, Canada
* (cates@colorado.edu)

The oldest compiled U-Pb zircon ages for the Acasta Gneiss Complex (AGC) in the Northwest Territories of Canada span about 4050-3850 Ma; yet older ca. 4200 Ma xenocrystic U-Pb zircon ages have also been reported for this terrane. The AGC comprises gneissic exposures across several large basement domes, but only a small portion (~5x5 km) of one such dome has been documented in the detail required to investigate a complex history. To better understand this history, ion microprobe ^{235,238}U–^{207,206}Pb zircon geochronology was combined with whole-rock (WR) and zircon rare earth element compositions ($[\mathrm{REE}]_{\mathrm{zirc}}$), Ti-in-zircon thermometry (Ti^{xln}) and ^{147}Sm-^{143}Nd geochronology for a subdivided ~60 cm^2 slab of Acasta banded gneiss comprising five separate lithologic components. Results were compared to other variably deformed AGC granitoid- and plagioclase-hornblende gneisses. Micro-sampling shows that different gneissic components host distinctive $[\mathrm{Th/U}]_{\mathrm{zirc}}$ vs. Ti^{xln} and $[\mathrm{REE}]_{\mathrm{zirc}}$, correlative with zircon age populations and WR compositions,but not with ^{147}Sm-^{143}Nd isotope systematics. Lattice-strain theory used to model D_{WR}^{zircon} [REE] reconciles the U–Pb zircon geochronology only for the ca. 3920 Ma age component, which also preserves strong positive Euanomalies. Modeling shows that the magmas which gave rise to the indigenous ca. 3920 Ma component formed at ~IW (iron-wüstite) to <FMQ (fayalite-magnetite-quartz) oxygen fugacities. Emplacement of the AGC was contemporaneous with the Late Heavy Bombardment (LHB Later superimposed Eoarchean events (3850-3720 Ma) are reminiscent of formation times for the Nuvvuagittuq Supracrustal Belt in northern Québec, and the Manfred Complex in Western Australia. Equilibration of the ^{147}Sm-^{143}Nd whole-rock chronometer occurred at the scale of individual components over the course of one or more of these later events.

Fe-serpentines to Fe-chlorites experimental synthesis: An iron metal- shale interaction between 60 and 300°C

M. Cathelineau[1], R. Mosser-Ruck[1,] I. Pignatelli[1],
M.C. Caumon and L. Truche[1]

[1]GeoRessources, CNRS, Universite de Lorraine, 54500,
Vandoeuvre-les-Nancy, France

Interactions between a shale and iron metal have been studied experimentally at 90, 150 and 300°C, as well as at decreasing temperature from 90 to 50°C. These experiments simulate the mineralogical and chemical reaction of clays in contact with steel in high level nuclear waste repository, at the highest temperature to test the potential kinetic effects due to the rather short duration of the experiments with respect to the waste disposal time scale, and the experiments at decreasing temperatures to simulate the effects of the progressive cooling in the waste site due to decline of the radioactive heat (ANDRA research programme). The starting products are : a shale from the Callovo-Oxfordian series from the Paris basin (Quartz, illite and I/S rich in illite, calcite), a fluid which composition is close to the interstitial fluids of the geological formations, and iron metal added as plates or powder. The effects of the liquid on rock ratio (L/R), iron/ clay ratio (I/C) have been tested. The following mineral assemblages have been found as run products:

- di- sm > Fe-serpentine, so-called berthierine-like or greenalite for high iron/clay ratio or Fe rich di Sm + Fe rich tri-Sm for low iron/clay ratios (near neutral pH) at 90°C
- di-octahedral smectite (di-sm) > saponite at 150°C > trioctahedral Fe-chlorite + feldspar + zeolite (300°C).

New experiments at decreasing temperatures have produced other Fe-serpentines within the 60-80°C range such as cronstedtite. Thus, at each temperature, illite and I/S are unstable, and replaced by Fe-rich silicates at low temperature and Fe-Al silicates above 150°C. Within the range 60 -90°C, quartz is almost entirely dissolved as illite and I/S up to the total consumption of iron. Iron silicates are in competition with iron carbonates (siderite) and iron oxide (magnetite). Iron silicates are predominant near neutral pH when $p\mathrm{CO}_2$ is not too high, and magnetite is found in most run samples but in low amounts, and iron/clay ratio >1. A thermodynamical modelling of the main mineralogical changes has been undertaken to interpret experimental data.