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UHT metamorphism from the In Ouzzal terrane (Hoggar, southern Algeria)

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The In Ouzzal terrane (Hoggar, southern Algeria) is an Archean crustal segment (3.3–2.5 Ga) that was completely remobilized by a regional-scale tectono-metamorphic event during the Paleoproterozoic at c. 2 Ga. In order to constrain the crustal development and geodynamic evolution of the In Ouzzal terrane, we performed U-Pb dating of zircon from meta-igneous and meta-sedimentary lithologies, and used calculated pseudosections to determine the P–T path evolution for a great diversity of granulites, including quartz-bearing and quartz-absent assemblages from Al-Mg granulites, garnet-pyroxenites and marbles. UHT metamorphism in the In Ouzzal terrane is well defined from Al-Mg granulites that exhibit orthopyroxene + sillimanite + quartz, osumilite and sapphirine + quartz + Mg-spinel assemblages. The rare assemblage orthopyroxene + corundum is inferred to have been stable prior to sapphirine + sillimanite + garnet during the prograde P–T evolution. The Al-Mg granulites, together with garnet pyroxenites, indicate a clockwise P–T path characterized by near-isobaric heating to peak conditions (800–1000°C at 10–11 kbar), followed by significant decompression to 5 kbar. The latter stages of the evolution occurred through near-isobaric cooling to 700°C, resulting in the growth of garnet coronas in garnet-pyroxenites.

Anorthositic mafic–ultramafic layered complexes and carbonatites are the only lithologies of magmatic origin that are contemporaneous with UHT metamorphism. Rb–Sr and Sm–Nd isotope data indicate that the anorthosites formed through melting of Archean crust. The emplacement of carbonatites, which occurred during the retrograde stage of metamorphism, corresponds to the ascent of carbonate fluids of mantle origin. The absence of mantle-derived Palaeoproterozoic magmatism that either precedes or occurs contemporaneous with UHT metamorphism narrows the possible geodynamic settings of this terrane. Ouzegane et al. [1] suggest that the crust of In Ouzzal has probably endured several anatectic events during previous orogenies, and particularly at 2.5 Ga, when charnockitic calco-alkaline massifs of types CA1 and CA2 were emplaced. The successive melt production and melt escape events are responsible for the heterogeneous and highly residual composition of these lithologies. As highlighted by Vielzeuf et al. [2], partial melting buffers the maximum temperatures that the crust can reach. These authors suggest that in order for crust to experience UHT metamorphism, it has to first become refractory during preceding orogenic events; alternatively, the heat source driving metamorphism has to be maintained for a long time. While the metamorphic peak is considered to have occurred at c. 2 Ga, it is possible that the crustal melting responsible for the anorthosites and associated mafic rocks at 2.045 Ga, might have contributed to the preparation of the lower crust in the In Ouzzal terrane for UHT metamorphism. This suggests the persistance of high geotherms over a protracted period of time, which is corroborated by metamorphic zircons with an age spread of more than 150 Ma, between 2.045 and 1.900 Ga, indicating a very slow cooling rate. The geodynamic context that seems most appropriate for

these data is the partial subduction of a passive margin that was pulled down by a denser oceanic lithosphere under other continental lithosphere. Long-lived UHT metamorphism could be achieved after delamination of lithospheric mantle during separation and sinking of the slab into the mantle.

References:

[1] Ouzegane K et al. (2003) Journal of African Earth Sciences, 37: 207-227

[2] Vielzeuf et al. (1990) In: Vielzeuf D and Vidal Ph (Eds) *Granulites and Crustal Evolution*: NATO, 59–85