A Complex Paleoproterozoic Evolution of the In Ouzzal Terrane (Hoggar, Algeria) revealed by zircon and monazite Geochronology and P-T path of Al-Fe granulites

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The In Ouzzal Terrane (IOT) is an elongated block N-S trending, more than 400 km in length. Its northern part is 80 km in width and thins until complete disappearance to the south to- wards Malian borders where it is relayed by the Iforas granulitic unit. The majority of the orthogneiss and paragneiss lithologies of the IOT, dated at 3.3-2.5 Ga, present geochemical characteristics of the Archean crust. However, their mineral assemblages and structural characteristics were mostly overprinted during the Eburnean (2 Ga) granulitic stage by an UHT metamorphism exceeding 1000°C (Peucat et al., 1996 ; Ouzegane et al., 2003).

The present study is interested in Al-Fe granulites which outcrop in a little known region of In Ouzzal situated in its southeastern part. These granulites are mainly composed by quartz, corundum, spinel, garnet, sillimanite, cordierite, biotite, perthitic feldspar, ilmenite.

Phase relationship and classical thermobarometry coupled with pseudosections calculated in the NCKFMASHTO system suggest a clockwise P-T path characterized by prograde evolution at high pressures (800-1050°C at 9-11 kbar), followed by an isothermal decompression (7-6 kbar) then an isobaric cooling to 700°C. This P-T path is identical to that determined in other regions of the IOT.

New Laser-ablation U-Th-Pb analyses of zircon and monazite have been realized from four samples of these Al-Fe granulites. The primary results suggest three major events: 1- the existence of at least one metamorphism older than 2.5 Ga, completely obliterated by the Paleoproterozoic metamorphism; 2- a long live Paleoproterozoic high temperature metamorphism between 2 and 1.9 Ga ; 3- a moderate thermal event between 1.8 and 1.75 Ga.

As highlighted by Vielzeuf et al. (1990) and Clark et al. (2011), partial melting buffers the maximum temperatures that the crust can reach. These authors suggest that in order for the crust to experience UHT metamorphism, it has to first become refractory during preceding orogenic events; alternatively Brown and Korhonen (2009) suggest that the heat source driving metamorphism has to be maintained for a long time (>50 Ma). While the metamorphic peak is considered to have occurred at c. 2 Ga, it is possible that the 2.5 Ga event, revealed by this study, has contributed to the preparation of the lower crust in the IOT for UHT metamorphism. These results suggest also the persistence of high temperature geotherms during a long period of time.

The thermal event at 1.8-1.75 Ga is coeval with anorogenic magmatism exposed on both sides of the In Ouzzal granulite block (1837 ± 17/19 and 1755 ± 10 Ma, Caby and Andréopoulos-Renaud, 1985). It is propably related to a world-scale rifting event (1850-1750 Ma), at the scale of western Gondwana (Danderfer et al., 2009 and references therein).