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Timing of maturation of a Neoproterozoic oceanic arc during Pan-African Orogeny: the Asmlil complex (Anti-Atlas, South Morocco)

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Many intra-oceanic paleo-arcs are exposed in the Pan-African belt surrounding the West African Craton. In the Moroccan Anti-Atlas, remnants of Intra-Oceanic Subduction Zone (IOSZ) are preserved in few erosional windows moulded along the Anti-Atlas Major fault. These complexes highlight a Neoproterozoic paleo-suture made of 760 My back-arc ophiolites thrusted to the south onto a dismembered band of oceanic arc relics.
The Asmlil arc complex, located in the southern part of the Bou Azzer inlier, is made of (i) 755 to 745 My- intermediate banded gneiss interpreted as metavolcanic products of a juvenile oceanic arc. This latter has been intruded by (ii) medium-grained hornblende-gabbro and dioritic magmas, in turn intruded by (iii) medium- to coarse grained hornblenditic-granodioritic decametric intrusions under sub-magmatic HT conditions. Hornblende-gabbros are made of garnet + amphibole/cpx relics + epidote + rutile paragenesis. Calculated pseudosections yielded P $\sim$ 11-12 kbar for T ranging between 600 and 720°C for garnet growth. Measured Zr-in-rutile thermometer gave slightly higher temperature ranging between 710-790°C. On the field, garnet-rich leucocratic veinlets suggest that moderate partial melting of the mafic rock or localized dehydration reactions took place under garnet-granulite conditions (>800°C for hydrated chemical system). New geochronological data on garnet-bearing leucogabbros constrain their emplacement at 700 $\pm$7 My (U-Pb zircon with low Th/U < 0.3). Cooling age (< 700°C) of these HP-HT rocks yielded to a younger age of 654 $\pm$7 My (U-Pb method on rutile). Geochemical data of each mafic and ultramafic facies (hornblende gabbro, garnet-bearing facies and hornblendite) show typical arc signature (marked by e.g. Nb-Ta anomaly, (La/Sm)N: 0.8–1.6 ; (Nb/La) < 0.46 ; high Nb/Ba ratio ; 0.4 < K2O < 2.1 wt%). Intrusive granodioritic magmas show depleted HREE trend similar to granitoids in the Kohistan paleo-arc. Melting modeling suggests they are produced by partial melting of a REE-depleted gabbronorite with cpx + garnet-rich residue, as typically observed in the basal crustal part of paleo-arc sections (e.g. Talkeetna, Kohistan arcs).
Field observations, geochemical signatures, P-T estimates and new geochronological data allow to track the timing of Asmlil arc maturation. Combining our results to the entire Pan-African suture (Sirwa and Bou Azzer inliers), geochronological data clearly show that three distinct flare-ups give the tempo of arc magmatism during Pan-African Orogeny. First event is the early construction of the 755-745 My oceanic arc marked by intermediate volcanic to subvolcanic massifs. Second event occurred around 700 My and results from mafic products intruding previous arc. A last event also dated at 660-650 My in the Sirwa window marks the emplacement of hot hornblenditic arc-magmas into older arc massifs during the tectonic extrusion of the arc section. This late event is also related to intense melt production at different level of the arc contributing to differentiation of the whole arc complex. We thus interpreted the Asmlil complex as the final composite product of successive magmatic pulses during arc life cycle which can be compared to relatively long-lived and paced active arc systems (e.g. Aleutian, IBM arcs).