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Neoproterozoic oceanic arc remnants in the Moroccan Anti-Atlas: reconstructing deep to shallow arc crustal sequence and tracking Pan-African subduction-accretion processes

Antoine Triantafyllou (0,1,4), Julien Berger (2), Jean-Marc Baele (1), Olivier Bruguier (3), Hervé Diot (4), Nasser Ennih (5), Gaëlle Plissart (6), Christophe Monnier (4), Paul Spagna (7), Arnaud Watlet (1), and Sara Vandycke (1)

(0) FRIA-FNRS fellow, (1) Fundamental & Applied Geology – Mining Geology, University of Mons (Belgium), (4) LPGN, Université de Nantes (France), (2) Laboratoire GET, Université de Paul Sabatier – Toulouse III (France), (3) Géosciences Montpellier - UMR-CNRS 5243 - Univ. Montpellier II - Montpellier (France), (5) Université Chouaib Doukkali, El Jadida (Morocco), (6) ICAEV, Austral University of Chile, Valdivia, (Chile), (7) Institut Royal des Sciences Naturelles de Belgique (Belgium)

The Pan-African belt of West and North Africa exposes many intra-oceanic arc complexes while they are rather uncommon in Phanerozoic orogenic belts. Intra-Oceanic Subduction Zone (IOSZ) in the Moroccan Anti-Atlas crop out in two tectonic windows moulded along the Anti-Atlas Major fault: the Sirwa (western-) and the Bou Azzer (eastern- part) inliers, associated with 760 Ma back-arc ophiolites. These arc sequences are located at the south of the ophiolites and are named the Iriri-Tachakoucht (Sirwa window) and the Asmlil arc complexes (Bou Azzer inlier).
(i) The Iriri-Tachakoucht unit is composed of coarse grained hornblendite lenticular plugs, medium-grained hornblende gabbro dykes intruding andesitic to dacitic porphyroclastic gneiss. The contact between both lithologies is gradual and marked by an increasing migmatitization of the gneisses towards hornblendite intrusions. Phase diagram calculation were performed on garnet-bearing gneisses. Garnet cores have grown during a prograde P-T path up to upper amphibolite facies conditions (660°C at ∼9 kbar) and recorded the burial of the Tachakoucht metavolcanics, while rims composition indicates that the rock recrystallized under higher temperature conditions (800°C at 4-5 kbar). These HT conditions match those for hornblendites igneous emplacement (850°C and 4 kbar) and this event leaded to more pronounced but still limited partial melting (< 10% melting) of the porphyroclastic gneisses. New geochronological data on the migmatitic gneiss (zircon U-Pb dating) constrain the protolith age at 733 ±7 Ma (zircons core) and the HT tectono-metamorphic event at 654 ±7 Ma (zircons rim).
(ii) The Asmlil arc complex is made of hornblende gabbros and garnet-bearing gabbros intruded under HT conditions by dykes of medium-grained hornblendites, hornblende-gabbros and leucodiorites. These metagabbroic intrusions have been dated at 697 ± 8 Ma (U-Pb zircons). P-T pseudosections were calculated for garnet-bearing gabbros and established that they were recrystallized under garnet-granulites P-T conditions (up to ∼1000°C at 12 kbar). Preliminary geochemical data of hornblende-gabbros and garnet-bearing granulites portray similar trace geochemical signatures ((La/Sm)N: 0.8–1.6 ; (Nb/La) < 0.46) as studied paleo-arc complexes. These P-T results and new geochemical data argue that Asmlil mafic complex could represent a deep arc root comparable to the deep section of exposed oceanic arcs (i.e. Kohistan, Talkeetna, Amalaoulaou).
We propose that Iriri and Asmlil units depict the deep-to-shallow sequence of a single Cryogenian oceanic arc (760-740 Ma), as discrete exposures along the southern edge of Anti-Atlas ophiolitic assemblages. Nevertheless, this primary arc has been likely broke up and intruded by subsequent hydrous arc-related magmas under medium- to high-grade P-T conditions (700 to 650 Ma). We interpret this period as an oceanic pre-collision stage when subduction geometry is intensively perturbed (c.g. composite subductions, polarity inversion), doping production of typical hydrous arc magma that intrudes original arc. This complex arc melange has been lastly accreted and sealed on the West African Craton margin.