

Revealing the significance and polyphase tectonothermal evolution of a major metamorphic unit in an orogen: the central Sanandaj-Sirjan zone, Zagros Mts., Iran

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The Dorud-Azna region in the central Sanandaj-Sirjan metamorphic belt plays a key role in promoting the tectonic evolution of Zagros orogen, within the frame of the Arabia-Eurasia collision zone. From footwall to hangingwall, structural data combined with the U-Pb zircon and extensive ^{40}Ar - ^{39}Ar mineral dating survey demonstrate three metamorphosed tectonic units, which include: (1) The Triassic June complex is metamorphosed within greenschist facies conditions, overlain by (2) the amphibolite-grade metamorphic Galeh-Doz orthogneiss, which is intruded by mafic dykes, and (3) the Amphibolite-Metagabbro unit. To the east, these units were intruded by the Jurassic Darijune gabbro. We present U-Pb detrital zircon ages of a garnet-micaschist from the Amphibolite-Metagabbro unit, which yield six distinctive age groups, including a previously unrecognized Late Grenvillian age population at ~ 0.93 to 0.99 Ga. We speculate that this unique Late Grenvillian group coupled with biogeographic evidence suggests either relationship with the South China craton or to the "Gondwana superfan". The laser ablation ICP-MS U-Pb zircon ages of 608 ± 18 Ma and 588 ± 41 Ma of the granitic Galeh-Doz orthogneiss reveals a Panafrican basement same as known from the Yazd block of Central Iran. Geochemistry and Sr-Nd isotopes of alkaline and subalkaline mafic dykes within the Galeh-Doz orthogneiss show OIB-type to MORB-type and indicate involvement of both depleted and enriched sources for its genesis. The new ^{40}Ar - ^{39}Ar amphibole age of ca. 322.2 ± 3.9 Ma from the alkaline mafic dyke implies Carboniferous cooling age after intrusion. The metagabbros (including the Dare-Hedavand metagabbro with a $^{206}\text{Pb}/^{238}\text{U}$ age of 314.6 ± 3.7 Ma) and amphibolites with E-MORB geochemical signature of the Amphibolite-Metagabbro unit represent an Upper Paleozoic rift. The geochemical composition of the Triassic greenschist facies metamorphosed June complex, implying formation in a same, but younger tectonic environment. The Darijune gabbro with the mean U-Pb zircon age of 170.2 ± 3.1 Ma postdates greenschist facies-grade metamorphism. This age marks the beginning of the initial subduction of Neotethyan oceanic in a continental arc setting. The best average P-T estimates for the metamorphic mineral assemblages of the Galeh-Doz orthogneiss range between 600 ± 50 °C at 2 ± 0.8 kbar. The subsequent cooling history after an amphibolite facies-grade metamorphism has been constrained with ^{40}Ar - ^{39}Ar amphibole ages of plateau ages between 240–260 Ma. The estimate P-T conditions for the Carboniferous metagabbro from core (580 ± 50 °C, 4.0 ± 0.8 kbar) to rim (700 ± 20 °C, 7.5 ± 0.7 kbar) are in favor of a prograde P-T path. The new ^{40}Ar - ^{39}Ar mineral ages integrated with structural field and microfabric studies reveals that the amphibolite-grade Carboniferous metagabbro indicate a Late Carboniferous age of amphibolite-grade metamorphism associated with ductile deformation of the new-detected Galeh-Doz nappe (Galeh-Doz orthogneiss and Amphibolite-Metagabbro unit). In the same unit, two lenses of metapelite including a garnet-muscovite-biotite schist give a P-T estimate of garnet cores from 640 ± 20 °C at 6.2 ± 0.8 kbar and garnet rims from 680 ± 20 °C at 7.2 ± 1.0 kbar, as well as garnet-biotite schist that yield lower P-T conditions, which vary from 620 °C at 5.5 ± 0.5 kbar in garnet cores to 600 ± 30 °C at 4.0 ± 1.0 kbar in garnet rims. Chemical monazite ages from garnet micaschists are at 322 ± 28 Ma. ^{40}Ar - ^{39}Ar experiments on white mica in the first and second types yield staircase patterns from ca. 36 to 170 Ma and a plateau age of 137.84 ± 0.65 Ma, respectively. Taking all data together, we suggest that amphibolite-grade metamorphism is Carboniferous and is overprinted by two events: (1) during Late Jurassic- Cretaceous during ductile dextral transpressive nappe emplacement of the Galeh-Doz nappe over the June complex (peak conditions of greenschist facies metamorphism at ca. 107 Ma followed by an overprint at 50 Ma) and (2) in ca. 50–32 Ma during shortening and emplacement of the metamorphic nappe complexes over unmetamorphic units of the Zagros orogen.