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Reconstruction of the metamorphic evolution of the Hamadan high-grade metapelites, Sanandaj–Sirjan Zone, western Iran

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The high-grade metamorphic Hamadan complex occurs to the southwest of the Alvand pluton, Sanandaj–Sirjan Zone, western Iran. The spatial relationship of high grade metamorphic rocks adjacent to the pluton favours a contact metamorphic setting. However, no systematic decrease in PT with distance to the pluton is observed. Based on new P-T determinations and geochronological data we present a new model of the metamorphic evolution of the Hamadan complex.

Gabbros and granites of the Alvand pluton were dated by U-Pb zircon geochronology with an age between 166.5 ± 1.8 and 153.3 ± 2.7 Ma (Shahbazi et al., 2010; Mahmoodi et al., 2011). The observed contact aureole is about ∼600 km2 in extent and can be texturally divided into two main zones: (i) approximately a 4 to 5 km wide hornfels zone, extending from the contact with the pluton where large spots of cordierite can be observed to the last occurrence of large andalusite grains, and (ii) a schistose zone, developed up to 12 km distance from the contact, comprising staurolite-bearing rocks. This zone is followed by rocks with abundant porphyroblasts of andalusite. At some places fibrolite and rare fine-grained sillimanite within large andalusite crystals occur indicating slightly higher temperatures.

Classical thermobarometry shows a uniform pressure of 3.5 to 5.5 kbar and temperatures varying between 550 to 700 °C. P-T conditions for different zones determined by quantitative phase equilibria modelling in the system MnNCKFMASH also exhibit low- to medium-pressure at elevated temperatures, which is compatible with the "Buchan" style marked by the widespread growth of andalusite and occasionally staurolite and cordierite at higher grade. A P–T path calculated from garnet zoning pattern (Moynihan and Pattison 2013) for andalusite-bearing rocks in the schistose zone documents two prograde stages of distinct temperature, one roughly constrained at 570 to 600 °C and another at higher temperatures of 700 to 740 °C, suggesting that garnet growth is the result of two growth cycles.

Despite textural differences, U-Th-Pb monazite geochronology revealed similar ages between 168 ± 11 Ma and 149 ± 19 Ma for schistose/hornfels rocks, which is within the same timeframe of the Alvand pluton intrusion. 40Ar-39Ar white mica age patterns yielded total gas ages ranging from 80 to 70 Ma over the entire transect.

Microfabrics indicate formation of the foliation during garnet growth, which is followed subsequently by a retrogression to chlorite. Consequently, the Ar-Ar ages most likely indicate the final stage of foliation formation and accompanying cooling of the Hamadan complex to less than ca. 425 ± 25 °C (argon retention temperature in white mica). Temperature-time paths from all accessible mineral ages suggest, therefore, slow cooling and exhumation within two episodes toward the contact.

Since absence or lack of plutonic rocks in the higher-grade sillimanite-bearing rocks and irregular metamorphic zones, we postulate that the Alvand batholith extends at shallow levels below the entire basement or is disturbed by shearing or a large number of smaller granitoid intrusions are hidden below the surface at mid- to upper-crustal depths.

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