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Slab melting, adakite differentiation and emplacement in a fossile subduction channel: the late Paleocene Sabzevar magmatism (NE Iran)

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This study describes the structural setting, petrogenesis, and geochronology of a suite of acidic magmatic rocks that are intruded in the metamorphic core of the Tertiary ophiolitic suture zone of the Sabzevar Range, NE central Iran. This ophiolitic complex consists of a ductile-to-brittle, S/SE-verging orogenic domain, where a frontal nonmetamorphic and an inner metamorphic sector can be identified in the field. The metamorphic domain consists of a major ophiolitic tectonic mélange, where variably sized, foliated metabasic rocks (blueschists, greenschists, and amphibolites) occur dispersed as centimetre- to kilometre-size blocks into a highly sheared serpentinite matrix. The granitoids occur as leucocratic tabular bodies, with variably developed contact metamorphic zones that are typically gradational in the field and concordant with the regional country rock foliation. The field relations with the host rocks and the internal (magmatic to solid state) fabrics in the Sabzevar granitoids document a syntectonic magma emplacement scenario, based on: (1) concordance of pluton shapes and internal structures with regional structures (S-L fabrics); (2) the existence of a continuum of magmatic through solid-state noncoaxial flow consistent with the regional sense of shear (top-to-the-SSE); and (3) occurrence of foliated wall-rock xenoliths, incorporated by flowing magma into the marginal sectors of the intrusive bodies. These points, together with the evidence that magma preferentially migrated along flats, attest that the Sabzevar granitoids intruded into rocks that were actively deforming during compressional shearing. In the TAS diagram, the granitoid compositions define a medium-K calc-alkaline suite, spanning from basaltic andesite to the dacite and rhyolite fields. They show characteristic low MgO (0.15–0.60 wt%) and Ni (<20 ppm), high Sr contents, a negligible Eu anomaly, and extremely fractionated REEs, with high La/Yb and Sr/Y (up to 900) ratios, but very low Yb and Y contents. Remarkably, the Sabzevar melts show correlative variations in major and key trace element ratios during magma differentiation. In particular, the La/Yb and Dy/Yb ratios both decrease with differentiation, whereas Sr/Y markedly increases, with a more pronounced adakitic signature that correlates with increasing SiO_2. Inverse and forward thermobarometry constrains conditions of magma crystallization in the upper-pressure field of the amphibolite facies (ca. 1.2–1.5 GPa and 750 ˚C). Integrated U-Pb zircon and $^{40}Ar/^{39}Ar$ white mica and amphibole geochronology applied both to the granitoids and country rocks constrains genesis and emplacement of Sabzevar magmatism to the late Paleocene (c. 58 Ma). Genesis of the Sabzevar magmatic suite is interpreted in terms of prograde, high-pressure wet amphibolite melting during oceanic subduction, within a pressure-temperature range between a plagioclase-out and a hornblende-out boundary. Magma differentiation and high-pressure amphibole fractionation of pristine slab melts are proposed as the dominant factors that imparted the adakite signature to the Sabzevar granitoids. The space creation mechanism for pluton emplacement was provided by the compressive shear zone network development, which controlled the pathways for ascent, differentiation, and intrusion of the magma generated at depth within the subduction channel. Implications in terms of the regional tectonic scenario are discussed and framed within the advancing and retreating evolution of the Neotethyan subduction during the Mesozoic–Tertiary time span.