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SHRIMP U-Pb zircon geochronological constraints on Cryogenian–Ediacaran tectonomagmatic events in the northwestern Arabian Shield

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The northwestern Arabian Shield is dominated by juvenile Neoproterozoic crust of the Midyan terrane (MT), composed of volcanosedimentary and multiple phases of intrusive rocks. Terrane protoliths are ∼780-550 Ma, and reflect geotectonic changes within a regional framework of the East African Orogeny reflecting progression from a juvenile oceanic island arc and suprasubduction ophiolite to arc-arc collision to continental magmatic arc to crustal thickening with thrusting and strike-slip shearing (Najd fault system) to extensional collapse, within-plate magmatism and final cratonization.

The oldest intrusive rocks (the Muwaylih suite) yield middle Cryogenian SHRIMP U-Pb zircon ages: 748±9 Ma for Imdan complex gabbro, and 736.6±9.6 Ma and 738.8±4.2 Ma for Nabt complex diorite and tonalite. They represent pretectonic intrusions in a ∼750-720 Ma oceanic island arc made up of Zaam group volcanosedimentary rocks, diamictite, and banded iron formation. Bayda group subaerial felsic metavolcanic rocks (Hijr formation: ∼710±12 Ma) are believed to stratigraphically overlie the Zaam group and are interpreted as volcanic equivalents of a younger phase of Muwaylih suite magmatism (∼720-710 Ma).

Arc-arc collision at ∼710-700 Ma between the MT and the Jiddah terrane (JT) to the south resulted in the Yanbu suture and formation of an Andean-type, continental magmatic arc. This phase of continental magmatism is represented by syntectonic, calc-alkaline intrusions such as granodiorite of the Buwaydah complex (686.5±3.7 Ma), a rhyolite dike that intrudes the granodiorite (687.4±2.2 Ma), and late gabbro/diorite of the Imdan complex (676±6 Ma), all of which are assigned to the Hamadat suite (700-680 Ma).

Exhumation and erosion of the magmatic arc resulted in formation of post-amalgamation (as related to the already sutured MT and JT), syntectonic basins. One of the oldest basins in the MT, filled with the few-km thick Thalbah group, appears to be intruded by granitic bodies comparable with monzogranite of the Liban complex dated at 634.5±4.6 Ma. Similar, Cryogenian/Ediacaran ages are obtained from syenogranite of the Kara Dakha complex (631.8±4.0 Ma) and Abu Suar complex (626±4 Ma). All three granitoids belong to an early stage of the Marabit suite, and represent peak activity of calc-alkaline, syntectonic arc-related magmatism. A mafic dike dated ∼617.7±4.4 Ma intrudes basal sedimentary rocks in the Thalbah basin, constraining the basin minimum deposition age.

Ediacaran ages of 609±3.6 Ma from syenogranite of the Ash Shab complex and 608.9±2.8 Ma from monzogranite of the Habd complex, belong to a late stage of the Marabit suite (610-600 Ma), and represent late-tectonic, calc-alkaline magmatism resulting from extensive crustal melting in an extensional regime.