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The Tethys history in Southeast Iran: a tale from Makran and Sistan.

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The E-W trending Makran accretionary wedge and the N-S trending Sistan Suture Zone, in southeastern Iran, are important segments of the Tethys suture system. We took advantage of new field work to integrate stratigraphic and sedimentologic observations with petrographic descriptions, trace element, isotope analyses and U-Pb zircon geochronology to determine the time frame of magmatism and sedimentation in these regions.

In Makran, three magmatic episodes are identified: (1) Granites, dated at 170–175 Ma, represent crystallized melt with a strong continental isotopic contribution. (2) A diorite-trondhjemite-plagiogranite sequence is 165–153 Ma old and derives from a mantle magma source with minor continental contribution. (3) East-west trending diabase dikes and bodies intruded the granitoids, which were eroded and then covered by Valanginian (140–133 Ma) alkaline lavas and sediments. Alkaline dikes and lavas have a mantle isotopic composition. Temporal correlation with plutonites of the Sanandaj-Sirjan Zone to the northwest defines a narrow, NW-SE striking and nearly 2000 km long belt of Jurassic intrusions. The increasing mantle influence in the magma sources is explained by thinning of continental lithosphere and related mantle upwelling/decompression melting. Accordingly, the formation of the studied igneous rocks is related to the extension of the Central Iran continental margin, which ultimately led to the formation of the Tethys-related North Makran Ophiolites. This history is mirrored in the clastic content of turbiditic sediments. Glaucophane and spinel clasts in Upper Cretaceous sediments indicate that the North Makran ophiolites were exposed at that time.

The Sistan Suture Zone represents an oceanic embayment that separated the Central Iran from the Afghan continental blocks. Intermediate to granitic intrusions occur along the southern segment of this suture zone. U-Pb zircon crystallization ages combined with major and trace element analyses, dated the series of granite-granodiorite-rhyolite at ca 40.5-44.3 Ma and ca 28.9-30.9 Ma. Isotopic geochemistry, including Sr-Nd isotopes and Hf isotope analyses, and petrological modelling suggest that the 40.5-44.3 Ma plutons crystallized from melts largely derived from the turbidites of the host accretionary wedge. Melting of the deep wedge was induced by the intrusion of mantle magmas interacting with the crustal turbiditic melts, which is responsible for the wide range of compositions. Most of the 28.9-30.9 Ma magmas were generated from mantle melting, with assimilation of the surrounding turbidites. The rare setting of within-wedge intrusions is attributed to mantle upwelling reaching wedge sediments at the inception of delamination processes, which sign the end of subduction-related deformational and thermal events in the Sistan Suture Zone. Numerical modelling of subduction – magma production – intrusion and melting of wedge sediments further constrains this collisional to post-collisional scenario.

Makran and Sistan suture zones both bear evidence for a Cretaceous island arc which has to be taken into account in the closure of the Tethys Ocean and the subsequent collisional history.