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Towards a comprehensive geodynamic evolution of Northern Sistan (E. Iran)

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The diachronous closure of the Neotethyan realm, from the Alps to the Himalayas, led to the formation of numerous mountain belts. The Sistan belt, which stretches N-S across ∼700 km, preserves extensive ophiolite fragments, is still poorly documented and is oriented at odds with respect to the other major adjacent structures like Zagros, Makran or Alborz. Five mains domains have been recognized in Sistan in the early 1980s: the Afghan and Lut continental blocks, the Neh and Ratuk ophiolitic complexes (respectively slightly and highly metamorphosed, the latter at high pressure low temperature conditions) and the overlying Sefidabeh basin. Currently, only local petrological and stratigraphic studies exist but the overall structure is still elusive and its geodynamic history is largely debated. In order to refine the tectonic style of each domain and their mutual relationships, detailed field investigations were performed in the northern part of the Sistan belt. Eleven representative cross sections, from the km to 10 km-scale, are combined into two large-scale (∼200 km long) comprehensive sections across Northern Sistan. These notably indicate that (1) the main vergence concords with a north-east dipping subduction polarity, (2) the Neh complex is a large-scale obducted ophiolite thrust onto the Lut block and (3) the migration of the deformation is essentially en sequence.
Metamorphic investigations (1) reveal for the first time the existence of a metamorphic sole in Sistan in support of intra-oceanic subduction (with P-T conditions around 700°C-0.7 GPa) and evidence for subordinate intra-oceanic slicing, (2) constrain the extent of burial in sedimentary basins through estimation of their maximum temperatures (∼250°C, via RAMAN spectroscopy on organic matter) and (3) document an older, much higher temperature event affecting former sediments of the Lut block (which we tentatively relate to the rifting stage). Petrological investigations on magmatic rocks reveal that (1) the ophiolite structure is that of an ultra-low spreading ocean and that (2) Upper Cretaceous magmatic rocks located on the Afghan block correspond to a calc-alkaline low-K magmatic arc associated with north-east dipping subduction.
These structural and petrological data, together with those of previous studies, allow to propose a refined geodynamic evolution for Northern Sistan, whose main stages are: a rifting stage prior to the Barremian, active spreading during the Aptian-Albian, onset of NE-dipping subduction during the Turonian, intra-oceanic subduction and inception of obduction during the late Campanian to Maastrichtien and onset of ‘soft’ collision during the early Eocene. Soft collision, together with ongoing mostly strike-slip deformation since the mid-Miocene, make Northern Sistan a key, well-preserved, ‘frozen-in’ example of the progressive evolution from subduction to collision.