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Calc-alkaline and adakitic magmatism in the Sistan Suture Zone (Eastern Iran): evidence for eastward dipping subduction during the Late Cretaceous

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Progressive closure of the Neotethys ocean led to the formation of numerous mountain belts from the Alps to the Himalayas. At the crossroads, the Sistan belt stretches ∼700 km N-S at a high angle to the adjacent Iranian major structures of Zagros, Makran or Alborz. It is characterized by extensive Mesozoic ophiolites, large-scale Mezo-Cenozoic sedimentary basins, profuse Cenozoic magmatism, and varied metamorphic rocks, including high-pressure low-temperature relicts (blueschists and eclogites). Currently, four main geometries and timing of the oceanic subduction have been proposed to explain the Sistan geodynamics and tectonic evolution. In order to discriminate between existing hypotheses, we conducted field, petrological and geochemical analyses of the oldest post-spreading magmatic rocks in the region. These Upper Cretaceous magmatic rocks are always found in the Eastern part of the Sistan belt, within and on the edge of the Afghan Block. They are intrusive into the Campanian to Maastrichtian flysch and always below the unconformity of the shallow-water, Paleocene reef limestone. Basalts to rhyolites form two coexisting groups: 1) a typical low K calc-alkaline series and 2) high-silica adakites (HSA) as indicated by major elements, trace elements and isotopic data. These results allow us to conclude that a magmatic arc developed during the Upper Cretaceous (probably around 80 Ma) on the Afghan Block. This confirms the existence of a northeast dipping subduction of the Sistan ocean. HSA are produced by partial melting of the downgoing oceanic crust. As this magmatism is younger than the dated eclogites, we envision that the thermal regime of this subduction must have been warmed by slab break-off and/or subduction of an oceanic ridge.