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Cyclicity of prograding coarse-grained facies in a foreland basin system: an example from the southern Alborz, northern Iran

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The significance of the progradation of coarse-grained deposits in foreland basin systems has been controversially discussed in the past. Coarse intervals have been either interpreted as a response to active shortening and uplift or in terms of representing tectonic quiescence. Importantly, in proximal areas, structural control plays a pivotal role in determining foreland-basin subsidence patterns. However, tectonic signals can be influenced by climatically forced conglomerates, especially during periods of high-frequency climatic change and variability. The good quality of the exposure as well as the lateral continuity of strata in the Southern Alborz mountains, Iran, offer opportunities to decipher the meaning of prograding coarse grained-facies in foreland-basin systems.

Here, we combine sedimentary facies analysis, sandstone and conglomerate provenance data, growth-strata analysis, and remote sensing to unravel the history of a $\sim$ 8400-m-thick stratigraphic section in the Southern Alborz foreland basin. This sedimentary succession is mainly composed of Upper Eocene to Pleistocene (?) continental clastic sediments, which supersede volcanoclastic deposits associated with a regional phase of extension (Karaj Formation, Lower to Middle Eocene).

The lower part of the section constitutes 500-m-thick evaporites (Kond Formation, Upper Eocene), showing several progressive unconformities, and a pinch-out geometry toward the north. Separated by an angular unconformity follow 80-m-thick con-

glomerates (Lower Red Formation, Oligocene). The overlying Qum Formation (Upper Oligocene to Lower Miocene) consists of 220-m-thick shallow-marine limestones, that pinch out to the north and pass westward into terrestrial deposits.

Upsection, the Upper Red, Hezardarreh and Kahrizak formations reflect a terrestrial depositional environment (Middle Miocene to Pleistocene?). These deposits are $\sim$ 7600-m-thick and have been divided into a basal paleosoil-bearing unit, followed by three coarsening upward units. The paleosoil contains 80-m-thick calcrete and gypcrete. The first coarsening upward unit has been divided in 3 sub-units (U1A, 1B and 1C), which show a gradual passage from lacustrine to braided river system environments. The conglomeratic U1C unit is in angular unconformity with the underlying formations and pinches out northward. The coarsening upward unit comprises two sub-units (2A and 2B), which again reflect an evolution from a lacustrine to a braided river system. U2A and the base of U2B have onlap geometries against the sub-unit U1C. The third unit consists of three sub-units (3A, 3B and 3C), characterized by a transition from lacustrine to braided river, and alluvial fan systems. A progressive decrease of stratal dip angles marks the onset of alluvial fan deposition.

Paleocurrent data show that the sediment source, at least since deposition of unit U1C, has been located in the inner part of the Alborz. Sandstone provenance data shows two main compositional changes: the first one at the base of U1A, with a sharp increase of low-grade metamorphic lithic fragments; the second one occurs at the base of U3A and is associated with an increase in carbonate clasts. Conglomerate provenance is relatively uniform (volcanoclastic pebbles are dominant), but a change is observed in the third unit (U3B) with the appearance of low-grade metamorphic clasts, carbonates and intrabasinal sandstones.

In summary, the studied area is interpreted to have been part of a wedge-top depozone from Upper Eocene-Oligocene time to Pleistocene (?). This is supported by (1) the occurrence of at least four coarse-grained prograding bodies (Lower Red Formations, and the top of Units 1, 2 and 3) that are always associated with a tilted depositional base and offlap geometries; (2) the pinch-out geometries toward the interior of the belt coupled with onlap geometries; (3) the northward provenance of sediments; (4) the reworking of deposits documented by intrabasinal clasts. This implies that late Cenozoic shortening in the Alborz range predates the Arabia-Eurasia continental collision. We infer that the cyclicity of coarse-grained facies observed in this area is linked to local tectonic activity above the wedge-top depozone, which was punctuated by phases of inactivity or hindward shift of shortening, as suggested by the occurrence of fine-grained facies and sandstone provenance results.