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Assessing tectonic and climatic causal mechanisms in foreland-basin stratal architecture: insights from the Alborz Mountains, northern Iran

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The southern foreland basin of the Alborz Mountains of northern Iran is characterized by an approximately 7.3-km-thick sequence of Miocene sedimentary rocks, constituting three basin-wide coarsening-upward units spanning a period of 106 years. We assess available magnetostratigraphy, paleoclimatic reconstructions, stratal architecture, records of depositional environments, and sediment-provenance data to characterize the relationships between tectonically-generated accommodation space (A) and sediment supply (S).

Our analysis allows an inversion of the stratigraphy for particular forcing mechanisms, documenting causal relationships, and providing a basis to decipher the relative contributions of tectonics and climate (inferred changes in precipitation) in controlling sediment supply to the foreland basin.

Specifically, A/S > 1, typical of each basal unit (17.5-16.0, 13.8-13.1 and 10.3-9.6 Ma), is associated with sharp facies retrogradation and reflects substantial tectonic subsidence. Within these time intervals, arid climatic conditions, changes in sediment provenance, and accelerated exhumation in the orogen suggest that sediment supply was most likely driven by high uplift rates.

Conversely, A/S < 1 (13.8 and 13.8-11 Ma, units 1, and 2) reflects facies progradation during a sharp decline in tectonic subsidence caused by localized intra-basinal uplift. During these time intervals, climate continued to be arid and exhumation active, suggesting that sediment supply was again controlled by tectonics.

A/S < 1, at 11-10.3 Ma and 9-6-7.6 Ma (and possibly 6.2; top of units 2 and 3), is also associated with two episodes of extensive progradation, but during wetter phases. The first episode appears to have been linked to a pulse in sediment supply driven by an increase in precipitation. The second episode reflects a balance between a climatically-induced increase in sediment supply and a reduction of subsidence through the incorporation of the proximal foreland into the orogenic wedge. This in turn caused an expansion of the catchment and a consequent further increase in sediment supply.