Geophysical Research Abstracts
Vol. 16, EGU2014-13261, 2014
EGU General Assembly 2014

Variations in erosional efficiency modulate orogenic growth of the Alborz Mountains (N Iran)

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The recognition that redistribution of mass by erosion governs orogenic evolution has radically changed our perspective on the coupling between climate and mountain building processes. Climate modulates the efficiency of surface processes, which modifies crustal stresses and this is expected to produce the cessation of shortening at the orogenic front, onset of out-of-sequence thrusting, and increased rates of rock -uplift and sediment supply. Unambiguous characterization of these multiple responses through field-based studies, however, has remained challenging.

Here, we show that coordinated changes in the rates and patterns of exhumation and deformation during the development of the Alborz Mountains (N Iran) were driven by abrupt, large magnitude (0.6 to 1.5 km) fluctuations in base level in the adjacent Caspian Sea. We argue that sustained regression of the paleoshoreline from $\sim$6 to 3.2 Ma enhanced erosional efficiency of fluvial systems and increased exhumation within the axial orogenic zone and along the northern range flank which, in turn, drove coordinated retreat of the deformation fronts. When base level rose again at 3.2 Ma, exhumation in the orogen interior slowed and range-bounding faults were reactivated. This was associated with the progressive establishment of positive feedbacks loop between orographically-induced precipitation, focused erosion, exhumation, and rock uplift.

Overall, these coordinated changes offer compelling evidence that enhanced erosion can indeed trigger a structural reorganization within an actively deforming orogen.