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Climatic control on the intermontane basin evolution and paleolake overspill in the Iranian Plateau: insights from the Mianeh Basin

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Orogenic plateaus are extensive and elevated regions with a subdued internal relief, steep and dissected margins, and internal drainage conditions. The sedimentary infills of these endorheic basins constitute a record of the uplift and erosion of nearby ranges, thereby represent premiere long-term tectonic and environmental archives.
The orogenic Iranian Plateau is part of the Arabia-Eurasia continental collision zone and comprises the Sanandaj-Sirjan metamorphic zone, the Urmia –Dokhtar magmatic belt, and part of the high Zagros Mountains. The plateau consists of six endorheic basins. Two of these basins, however, are now externally drained and characterized by a fluvial network that is adjusting to base levels outside the plateau. In this study, we focused on the evolution of the Mianeh Basin (NW Iranian Plateau), which is currently connected to the Caspian Sea by the Qezel-Owzan River (QOR) via a narrow bedrock gorge (Amardos) at the plateau margin. There, fluvial incision provides exposure of the sedimentary archive that recorded the plateau growth and therefore offer the opportunity to understand the basin-fill processes as well as to explore timing and mechanisms that led to the development of an external drainage system and plateau incision. Our stratigraphic data and U-Pb zircon ages from intercalated volcanic ashes in basin-fill sediments document that the basin was internally drained at least between $\sim$7 and 4 Ma, and that from $\sim$5 to 4 Ma it was characterized by a $\sim$2-km-high and $\sim$0.5-km-deep lake (Mianeh paleolake), most likely as a result of wetter climatic conditions. The combination of high lake level and subdued topography at the eastern plateau margin led to lake overspill, which resulted in the cutting of Amardos gorge by QOR from $\sim$4 Ma.
To test the wetter climatic condition hypothesis as a controlling factor for the lake level rise and overspill in the Mianeh Basin, we used the surface process and flexural isostasy model, TISC. We adopted model parameters such as precipitation/evaporation (P/E) ratio and rock erodibility based on the spatiotemporal distribution of the basin-fill sediments, to achieve the expected sedimentary facies distribution and the related base levels. Model results show that climatic conditions with a P/E ratio of 1/10, comparable to the present-day situation, are responsible for a low base level and a terminal lake like the situation recorded from $\sim$7 to 5 Ma. A higher P/E ratio (6/10) can trigger a lake level rise up to the basin bounding sill at $\sim$2000 m of elevation and form a deep and large lake similar to the Mianeh paleolake (5-4 Ma). The basin remains endorheic in these climatic conditions. Finally, a P/E ratio of 1/1 or higher is responsible for lake overspill and the consequent formation of external drainage ($\sim$4 Ma).
Finally, our study demonstrate that the efficiency of surface processes, mostly driven by climate, can control the morphology and the life span of orogenic plateaus, and that lake overspill can be an efficient mechanism leading to the capture of endorheic basins and the destruction of the typical low-relief plateau morphology.