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Large-wavelength deformation across the central Andean plateau interpreted from Salar de Uyuni (Bolivia) paleoshorelines

Gerold Zeilinger, Julius Jara-Muñoz, Jonathan R. Weiss, and Esther Lee
University of Potsdam, Institute of Geoscience, Potsdam/Golm, Germany

The Salar de Uyuni spans almost the entire width of the Bolivian Altiplano, thus providing a potential record of large wavelength deformation, which can be produced by various mechanism across the central Andean plateau interior. This study focuses on the mapping of paleo-lake terraces, which are geomorphic markers that represent past lake level positions and can be used to study differential vertical deformation. High-resolution TanDEM-X topography for the region, in combination with satellite imagery, reveal a wide range of well-preserved lake terraces in the Salar. Eleven prominent terraces have been identified in the study area at elevations ranging from 3701 m to 3815 m and with ages ranging from ~11.7-16.1 ka based on correlation with published ages. The elevation difference between the younger terraces (Level 1 to 5) is ~51 m in the west and ~46 m in the east, indicating an eastward tilting of about ~5 m across the Salar de Uyuni. The older terraces (Level 8 to 11), however, record an elevation difference of ~20 m in the west and ~ 24 m in the east, indicating a westward tilt of ~4 m. Thus a change in the polarity of tilting of the Uyuni paleo-lake basin occurred between the formation of terraces 5 to 8 from 13.1-14.8 ka.

We discuss different mechanisms that might drive this large wavelength deformation including 1) eastward tilting as a direct consequence of horizontal shortening in a compressional setting and “backtilting” by stress release during thrusting on a deep-seated structure, 2) addition of differentiated igneous bodies derived from the mantle perhaps associated with delamination processes, and 3) seismic coupling along the Chile subduction zone margin. Removal or delamination of mantle lithosphere is unlikely to produce 4 m of uplift in the relatively short, ~2 ka time span of our observations. Well-documented megathrust coupling and the subduction zone seismic cycle would explain the short time span but is unlikely to create significant vertical deformation ~200 km from the coast. We favour and explore the hypothesis that Andean shortening leads to large wavelength flexure (as the expression of an elastic deformation) as a result of strain accumulation that is eventually released by slip along structures beneath the Eastern Cordillera that are perhaps related to the active decollement and fold-and-thrust belt that comprise the Subandean ranges. The observed pattern of paleo-lake terraces may serve as a geologic archive recording a phase of major backarc seismic activity at ~14 ka.

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