A temperature-independent method for estimating paleo-elevation and its application in the Tibetan Plateau

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Estimating paleo-elevation of orogenic belts has great significance for understanding the evolution of plate tectonics and paleo-climate. Many current paleoaltimetry approaches need a presupposition of paleo-temperature, which brings about more uncertainties. Here, we propose a temperature-independent method to quantitative constrain the paleo-elevation of orogens. Geophysical models and observations show that the Moho depth and elevation of orogens have a positive linear relationship. Sr/Y and $(La/Yb)_N$ ratios of magmtic rocks have been used to estimate paleo-Moho depth of orogens [1-3]. We compiled mamgatic data from global active subduction/collision zones and strong correlations (R^2>0.85) are found between the smoothed elevations and Sr/Y and $(La/Yb)_N$ ratios.

We applied our obtained equations to constrain the elevation changes of the Tibetan Plateau since the Cretaceous. The estimated results are broadly in consistent with previous elevation data and geological observations, indicating a differential uplift history. Our data confirmed a proto-plateau (Lhasaplano) with elevation >3000m was once formed during the Late Cretaceous. However, this proto-plateau was collapsed prior to the India-Asia collision. During the India-Asia collision, a Basin-and-Range type landform was formed at the Paleogene and a modern-like topography was achieved at the Miocene. The proposed method could greatly extend the knowledge of the paleo-elevation to the Pre-Cenozoic era and provides support for simulations of the paleo-climate.

[1] Chapman et al., 2015, Geology 43, 919-922.
[2] Profeta et al., 2015, Sci. Rep. 5, 17786.
[3] Hu et al., 2017, Sci. Rep. 7, 7058.