Late Neogene-Recent Evolution of the Northern Range, Trinidad

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Abstract

In the southeast Caribbean plate corner progressive east-directed lithospheric tearing accommodates subduction of the oceanic South American plate. Trinidad's Northern Range is located above the lithospheric tear zone and north of the current dextral Caribbean-South American plate boundary, which pre- ca. 10 Ma accommodated oblique-collision. Exhumation, uplift, and erosion of the Northern Range are quantified to help clarify the orogen's deformation history and to explore potential relationships with plate boundary zone changes through the late Cenozoic. With the integration of several geochronometers, spatial and temporal patterns of processes are measured over multiple timescales. Exhumation of the Northern Range occurring over million-year timescales was addressed with (U-Th)/He and fission-track thermochronology from apatite (AHe and AFT) and zircon (ZHe and ZFT). New bedrock ZHe ages and published ZFT and AFT ages from the Northern Range young toward the west from ~18–5 Ma, ~25–11 Ma, and ~15–4 Ma, respectively. These data indicate asymmetric exhumation of the Northern Range, at ~1.1–0.8 mm/a (west) to ~0.6–0.4 mm/a (east), until at least the early Pliocene. Although asymmetric, these data show that bedrock-cooling rates were fairly steady through the postulated late Miocene transition of plate motion.

Surface uplift rates were calculated from marine terraces along the northeast flanks of the Northern Range to investigate late Neogene-recent tectonics. Twelve marine terraces were sampled for optically stimulated luminescence (OSL) dating. Preliminary results indicate the terraces preserve periodic surface uplift over at least the last 60 ka. Uplift rates systemically increase from west to east, from ~2 to 6 mm/a, and indicate eastside-up tilting, which is spatially inverted with respect to the long-term exhumation pattern. Possible causes of relatively high and focused vertical strain may be related to recent (<104 a) Caribbean-South American strain partitioning and/or to deep lithospheric tear processes.

Quaternary erosion of the Northern Range was measured with terrestrial cosmogenic nuclide (TCN) analysis to examine tectonic-surface process relationships over millennial timescales. Detrital-sand samples from 23 Northern Range catchments yield TCN basin-averaged erosion rates of ~0.01–0.15 mm/a, over time periods of ~5–50 ka. Erosion rates show no difference across the range divide (north-south), but increase from west to east, similar to the Quaternary uplift rates determined using marine terraces, by about a factor of four. The order of magnitude difference between the average millennial-scale erosion and uplift rates, indicate topographic growth and markedly little exhumation (only m/Ma) of the Northern Range through at least the late Quaternary.

Taken as a whole, exhumation of the Northern Range during the Quaternary is at least an order of magnitude slower than long-term (106 a) exhumation and the pattern of exhumation has spatially inverted. The timing of these changes may suggest a major transition of plate dynamics perhaps as recently as the late Pliocene. Patterns in the spatial distributions of exhumation and uplift, associated with rate and magnitude variations, have several implications for changes in the style and nature of the southeast Caribbean plate boundary zone through time.