



Long-term erosion rates of Neogene to Quaternary volcanoes of the Altiplano–Puna plateau, Central Andes: an SRTM DEM study

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Neogene to Quaternary volcanism of the Central Andes offers a unique opportunity to study long-term erosion of stratovolcanoes. On the basis of SRTM DEM data, we investigated 35 stratovolcanoes of the 3,800-4,000 m high, arid-hyperarid Altiplano–Puna plateau (from 14°S, 64°W to 27°S, 74°W). The volcanoes have been selected on geomorphological criteria such as (1) a single, “mature” cone-shape with considerable size, (2) location on a relatively flat basement, (3) no overlap with other volcanic centres, and (4) lack of calderas or sector collapse scars. Volcanoes of various age (Mid-Miocene to Quaternary based on sporadic radiometric dates) and various degradation stage have been included in order to infer long-term erosion rates.

The method we follow is to quantitatively compare the existing topography with the present-day active volcanoes, e.g. Parinacota (Northern Chile). By applying an advanced computational method, we fit the relief of the undissected, almost perfect reference cone over the degraded volcanic edifice. This way, we can precisely calculate (a) the degree of denudation by difference between the computed initial volume from the fit and the observed volume, and (b) for volcanoes with radiometric age constraint the erosion rate (m/Ma) as the areal mean of denudation divided by age.

Our results show that

(a) the studied volcanoes are degraded to various extent up to ~40% (denudation ratio) of the paleo-volume. In accordance, their relative height which is progressively lower shows a moderately good correlation with denudation ($r^2 = 0.70$). Using the available age constraints, we obtained a stronger correlation between age and denudation ($r^2 = 0.82$ for all volcanoes, and $r^2 = 0.95$ without the southernmost hyperarid and northernmost semihumid volcanoes).

(b) Therefore, calculating erosion rates gives highly reliable results. The youngest volcanoes (e.g. Ollagüe, Tacora) shows 50-100 m/Ma erosion rates which fits well to the initially rapid degradation of active volcanic edifices without vegetation cover. Long-term erosion rates of the Pliocene to Miocene volcanoes, in contrast, are much lower and more uniform (7-17 m/Ma), in agreement with other, similarly low erosion rates obtained by other methods (e.g. cosmogenic nuclides) for the Altiplano-Puna highland. Our rates show the smallest values for the hyperarid Puna and the southern Altiplano (e.g. Maricunga volcano), and the greatest values for the semihumid Southern Peru (e.g. Ccarhuasco, Jatunpuco volcanoes). Moreover, using the very good age vs denudation correlation as a geomorphological dating tool, we are able to estimate ages for undated volcanoes of the Central Andes or for other regions under similar climate conditions.