EGU2020-19968
https://doi.org/10.5194/egusphere-egu2020-19968
EGU General Assembly 2020

Activity and stability of zebra stripes in the central Atacama Desert based on geomorphological and geochronological evidence

Dennis Wolf[1], Simon Matthias May[1], Dominik Brill[1], Dirk Hoffmeister[1], Benedikt Ritter[2], Steven Binnie[2], and Olaf Bubenzer[3]

[1]University of Cologne, Institute of Geography, Germany (dwolf1@smail.uni-koeln.de)

[2]University of Cologne, Institute of Geology and Mineralogy, Cologne, Germany

[3]Heidelberg University, Institute of Geography and Heidelberg Center for the Environment, Heidelberg, Germany

The hyperarid parts of the Atacama Desert, N Chile, are among the driest places on Earth, and a number of studies have emphasized the remarkable slowness of Earth surface processes since the late Tertiary. Despite episodic overland flow or flash flood activity, salt-driven shrink-swell processes, dust deposition, and seismic shaking have significantly contributed to the formation of the characteristic landscape. The enigmatic and Atacama-specific zebra stripes are contour-parallel, thin lateral bands of rather angular gravels on hillslopes, characterized by grain sorting, a lateral succession of 1-3 m-wide frontal lobes, and specific wavelengths, occurring generally in areas with lowest rainfall and low to no fog occurrence. While previous investigations suggest that zebra stripes represent fossil evidence of overland flow, a recent study challenged their water-related evolution and emphasized the role of seismicity in their formation, and in shaping the Atacama landscape in general. Similar landforms may also be found on Mars, although related processes may be different to those on Earth.

We use UAV-derived orthophotos and digital elevation models, geomorphological surveys and sediment sampling, as well as OSL rock surface dating and cosmogenic nuclide (^{21}Ne, ^{10}Be) analysis of surface clasts to provide new insights into zebra stripe activity and stability in the Atacama Desert. Our investigations show that zebra stripes are found in numerous areas in the hyperarid core of the Atacama, implying a wider distribution of zebra-striped hillslopes than previously suggested. Inter-site comparison illustrates considerable differences between individual zebra stripe sites, and geomorphological characteristics suggest that zebra stripes may be active or inactive forms, depending on their location. Active forms are indicated by well-developed frontal lobes, reduced dust contents, and clearly developed downslope sorting trends with a high percentage of freely floating clasts, whereas inactivity seems to be indicated by poorly visible frontal lobes, high dust contents, poor sorting trends and a high proportion of clasts embedded into the underlying vesicular soil horizon. At the same time, preliminary chronological data based on OSL rock surface dating suggests that active stripes contain clasts with active bleaching fronts at top and bottom sides, pointing to late Pleistocene to Holocene activity and clast overturning. Inactivity, in contrast, is indicated by similar IR50 and pIR225 bleaching curves (equilibrium of bleaching and dosing) in upper clast surfaces and the lack of a bleaching front at the bottom side,

pointing to long exposures without clast overturning. Combined with cosmogenic nuclide concentrations, our results allow for inter-site comparisons and a better understanding of (relative) stripe chronologies and activity-stability patterns. Alongside further investigations on the significance of fog, wind, rain and seismicity, future work will aim at constraining time scales on which active/young and inactive/old forms have developed. If these forms are seismicity-related, our study contributes important information on the paleoseismic evolution of the central Atacama.

How to cite: Wolf, D., May, S. M., Brill, D., Hoffmeister, D., Ritter, B., Binnie, S., and Bubenzer, O.: Activity and stability of zebra stripes in the central Atacama Desert based on geomorphological and geochronological evidence, EGU General Assembly 2020, Online, 4–8 May 2020, EGU2020-19968, https://doi.org/10.5194/egusphere-egu2020-19968, 2020