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Coastal erosion rates of lava deltas around oceanic islands

Neil Mitchell (1), Zhongwei Zhao (1), Rui Quartau (2), and Ricardo Ramalho (3)

(1) University of Manchester, School of Earth, Atmospheric and Environmental Sciences, Williamson Bldg, Williamson Building, Manchester, United Kingdom (neil.mitchell@manchester.ac.uk), (2) Instituto Hidrográfico, Divisão de Geologia Marinha, Lisboa, Portugal, (3) Departamento de Geologia, Faculdade de Ciências, Universidade de Lisboa, Lisboa, Portugal

Rates of coastal erosion are needed for planning purposes and to develop understanding of how the shelves of islands develop and how islands ultimately evolve by erosion to become submerged banks. Nearshore platforms created by erosion of lava deltas provide an opportunity to quantify erosion rates, and to investigate how they vary between different types and ages of lava flows, as well as how they vary with wave climate. We have studied lava deltas around the central Azores Islands, Hawaiian Islands and Ascension Island, which were fed by both historical and prehistorical ‘a‘ā and pāhoehoe lava flows. Multibeam sonar, bathymetric Light Detection And Ranging (LiDAR) and historical sounding data were used to characterize their nearshore dipping platforms. Time-averaged shoreline retreat rates were calculated by combining the best published age estimates of each delta with the distance between the modern coastline and the platform edge. The data, encompassing 61 platforms, reveal rugged dipping surfaces left behind by erosion of lava delta with an average gradient of 5 degrees, eroded distance of 416 m and depth of platform edge of 24 m. The largest retreat distances ($\geq$ 800 m) are associated with platforms developed from older lava flows and in areas with large wave height, as expected. Depths of the platform edges are found partly to increase with the age of the lava delta and partly with the wave orbital maximum speeds in the area. Retreat rates are surprisingly varied (from 0.1 m/kyr to 12.5 m/yr), and variability is not obviously due to data issues or wave climate variability. We suspect this is because the blocks between joints in lava deltas vary greatly in size (from thick ‘a‘ā flow to shell-like layering in pāhoehoe). The lavas may also extend differently into the ocean; there have been studies showing pāhoehoe flows extending only into very shallow areas offshore or filling coastal strips, whereas ‘a‘ā flows have been observed to extend a significant distance.