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Submarine Platform Development by Erosion of a Surtseyan Cone at Capelinhos, Faial Island, Azores

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Erosion of volcanic islands ultimately creates shallow banks and guyots, but the ways erosion proceeds to create them over time and how coastline retreat rate relates to wave conditions, rock mass strength and other factors are unclear. The Capelinhos volcano was formed in 1957/58 during a Surtseyan and partly effusive eruption that added a ∼2.5 km2 tephra and lava promontory to the western end of Faial island (Azores, central North Atlantic). Subsequent coastal and submarine erosion has reduced the subaerial area of the promontory and created a submarine platform. This study uses historical information, photos and marine geophysical data collected around the promontory to characterize how a submarine platform developed following the eruption. Historical coastline positions are supplemented with coastlines interpreted from 2004 and 2014 Google Earth images in order to work out the progression of coastline retreat rate and retreat distance for lava- and tephra-dominated cliffs. Data from swath mapping sonars are used to characterise the submarine geometry of the resulting platform (position of the platform edge, gradient and morphology of the platform surface). Photographs collected during SCUBA and ROV dives on the submarine platform reveal a rugged surface now covered with boulders. The results show that coastal retreat rates decreased rapidly with time after the eruption and approximately follow an inverse power law relationship with coastal retreat distance. We develop a finite-difference model for attenuation over dipping surfaces to predict how increasing wave attenuation contributed to this trend. The model is verified by reproducing the wave height variation over a dipping rock platform of McCall et al. (2017). Applying the model to the dipping platform around Capelinhos, using varied resisting force of cliffs predicted from known lithologies, we are able to predict erosion rate trends for some, but not all, coastal sectors of the edifice. We also explore wider implications of these results, such as how erosion creates shallow banks and guyots in temperate oceanic archipelagos like the Azores.