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Rifting, landsliding and magmatic variability in the Canary Islands

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Rifts, probably the most influential structures in the geology of the Canary Islands, may also be responsible for the development of central felsic volcanoes, which are consistently nested in the collapse basins of the massive lateral collapses found in the Canaries.

Three main types of post-collapse volcanism have been observed, particularly in the western Canaries: 1. Collapses followed by relatively scant, non-differentiated volcanism inside the collapse depression (El Golfo, El Hierro; La Orotava and Güímar, Tenerife), 2. those with important, although short-lasting (tens of thousands of years), post-collapse activity including felsic (phonolitic, trachytic) central volcanism (Bejenado, La Palma; Vallehermoso, La Gomera), and 3. those with very important, long-lasting (>100 kyr) post-collapse activity, evolving from primitive to felsic magmatism, eventually resulting in very high stratovolcanoes (Teide, Tenerife).

Three consecutive sector collapses (Micheque, Güímar and La Orotava) mass-wasted the flanks of in the NE rift of Tenerife after intense and concentrated eruptive activity, particularly from about 1.10 Ma to 0.96 Ma, with periods of growth up to 15-25 m/kyr. Volcanic activity completely filled the Micheque collapse, evolving from basaltic to differentiated trachytic eruptions. Conversely, nested volcanism was less abundant in the Güímar and La Orotava collapses. This requires two fundamentally different scenarios which may be a function of active versus passive flank collapse trigger mechanisms: 1. The collapse occurs as a result of one of these short but intense intrusive-eruptive periods and probably triggered by concurring extensional stresses at the rifts (rift push), or 2. the giant landslide is derived only from gravitational instability. In the first scenario, the collapse of the flank of the rift may disrupt an established fissural feeding system that rapidly fills the collapse basin. Due to its disruption and the progressive new overburden of dense basaltic and ankaramitic lavas, the plumbing system increasingly favours shallow emplacement of new magma batches and subsequent differentiation, leading to intermediate and felsic nested eruptions. In contrast, a pure gravitational collapse will unload the edifice and allow for a limited amount of dense and primitive magma to erupt that may otherwise have been stored and solidified at depth, e.g. in upper mantle underplating zones. Rifts and their collapse may therefore act as an important factor in providing petrologic variability to oceanic volcanoes. Ad contrarium, it can be argued that felsic nested volcanoes in the Canaries frequently form because giant landslides provide the particular conditions required for primitive rift magmas to differentiate.