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Ocean Island Uplift, the Cape Verde Example

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Uplift reconstructions based on field evidence gathered in the Cape Verde islands suggest that the intrusion of magmatic bodies at the base of the edifices is a major uplift mechanism for ocean islands in a stationary plate environment, substantially raising the volcanic edifices above the underlying seafloor. Additional regional uplift related to the development of the hotspot swell underlying the islands is also inferred and suggests a process acts at the swell scale that also contributes to island uplift. The Cape Verde archipelago is considered stationary with respect to its melting source so the hotspot-driven uplift mechanisms affecting the ocean islands are expected to be enhanced. In this study, Ar–Ar and U–Th geochronology techniques were used to date a set of palaeo-markers of sea-level from Santiago's and São Nicolau's edifices, two of the main Cape Verde Islands. A comparison between relative sea-level and eustatic sea-level (from a modern eustatic curve) was established to extract the vertical displacement undergone by the markers, and to reconstruct the uplift/subsidence history of each island. The resulting uplift reconstructions show that both Santiago and São Nicolau experienced a general uplift trend over the last 6 Ma, seemingly synchronous with the vigorous volcanic activity that built their exposed edifices. These islands, however, exhibit different uplift histories despite their common uplift trend. Several uplift mechanisms were tested and a local rather than regional mechanism appears to be the main cause of uplift, generally unrelated with far-field effects of surface loading. This mechanism is probably associated with the intrusion of basal laccoliths restricted to the islands' footprint. It has been shown that laccoliths form at rigidity contrasts between materials, such as the one between the seafloor sediments and the extrusive volcanics at the base of the island edifice, and on Maio in Cape Verde a Mesozoic seafloor carbonate enclave of a few km2 is exposed, indicating that a process exists that is capable of raising formerly deep material to shallow levels. At a broader scale, the island uplift histories in conjunction with inter-island spacing, uplift rate and timing differences also rule out flexural, thermal or dynamic pressure contributions for the hotspot swell. We also find that uplift cannot be reconciled with models that advocate the spreading of melt residue in swell development unless swell growth is episodic. Instead, we infer from the uplift histories that two processes have acted to raise the islands during the past 6 Ma. During an initial phase, mantle processes acted to build the swell. Subsequently, magmatic intrusions at the island edifice caused 350 m of local uplift at the scale of individual islands. Finally, swell-wide uplift contributed a further 100 m of surface rise.