Episodic Hotspot Swell Growth inferred from variable uplift from the Cape Verde Hotspot Islands

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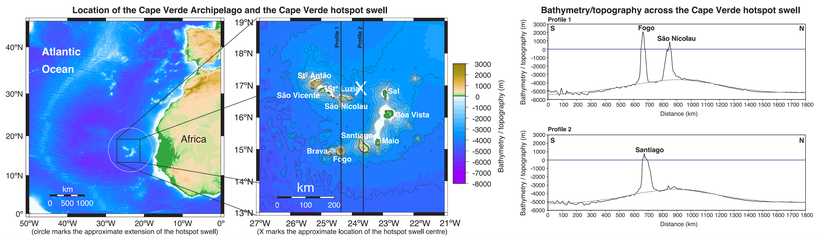
1. Introduction

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 geocronology techniques were used to date a set of palaeo-markers of relative sea-level from Santiago's and São Nicolau's Island 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. Consequences for ocean island uplift mechanisms and for models of hotspot swell formation are discussed.



2. Freeboard Tracers/Palaeo Sea-level Markers

- raised marine terraces
- lava-deltas
- submarine volcanic units

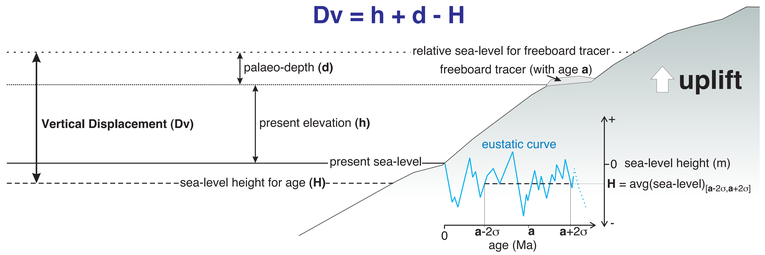
Local freeboard tracers:

1- top of Shield Complex 1 (submarine)
2- passage zone Shield Complex 2
3- passage zone Post-erosional Formation(s)
4- raised marine terraces (Quaternary)

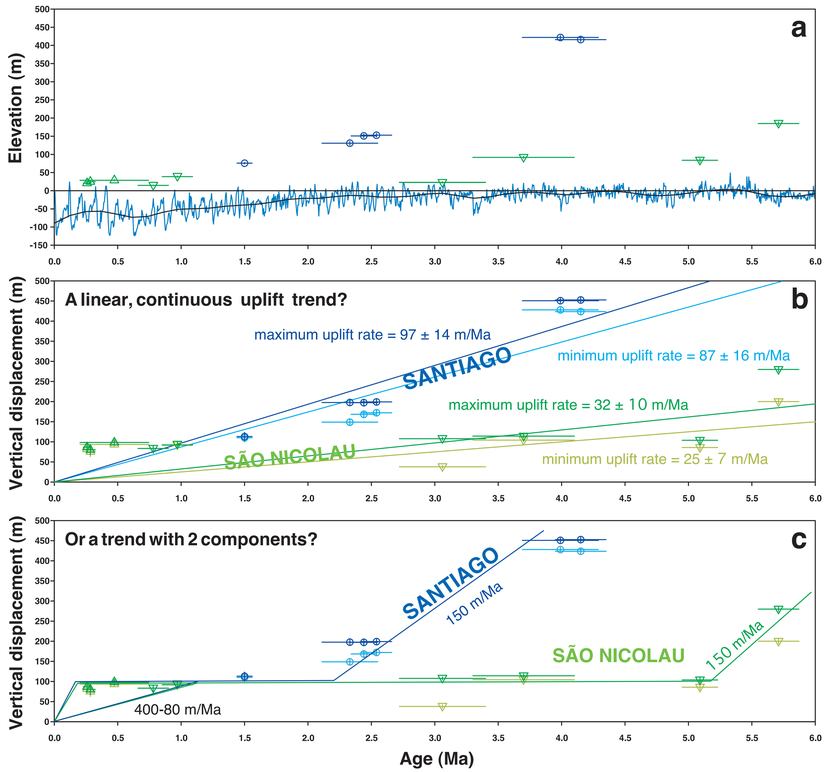
	Santiago	palaeo sea-level height	São Nicolau	palaeo sea-level height
marine terraces (Quaternary)	marine terraces (Quaternary)	≤ 100 m asl	marine terraces (Quaternary)	≤ 50 m asl
Post-erosional Formation(s): subaerial volcanics (piroclasts), subaerial volcanics (flows), submarine volcanics, sediments	Assomada/Monte das Vacas (only subaerial)	≤ 40 m asl	Monte Gordo Formation Preguiça Formation	≤ 5 masl ≤ 40 m asl
Shield Complex 2 (subaerial shield-building stage): subaerial volcanics, submarine volcanics, sediments	Pico da Antónia Complex	≤ 270 m asl	Main Eruptive Complex	≤ 100 m asl
Shield Complex 1 (submarine shield-building stage): submarine volcanics, sediments	Flamengos Formation	≥ 450 m asl	Figueira de Coxe Formation	≥ 270 m asl
Basement Complex (relics of seamount stage?): intrusive, extrusive	Ancient Eruptive Complex	(unknown)	Ancient Eruptive Complex	(unknown)

For each tracer we determined its age and calculated its vertical displacement (**Dv**):

$$Dv = h + d - H$$



3. Freeboard Reconstructions - Santiago and São Nicolau



a) Sample ages vs current elevation. Sea-level height also plotted (eustatic curve from Miller et al. [2005]).

- Santiago Ar-Ar
- São Nicolau Ar-Ar
- São Nicolau U-Th

±2σ elevation; ±2σ age

b & c) Vertical displacement (Dv) versus age, and uplift rates for Santiago and São Nicolau. Uplift rate regression lines in **b** were calculated using a weighted linear model.

- Santiago Ar-Ar, with the estimated palaeo-depth for the age
- São Nicolau Ar-Ar, with the estimated palaeo-depth for the age
- São Nicolau U-Th, with the estimated palaeo-depth for the age

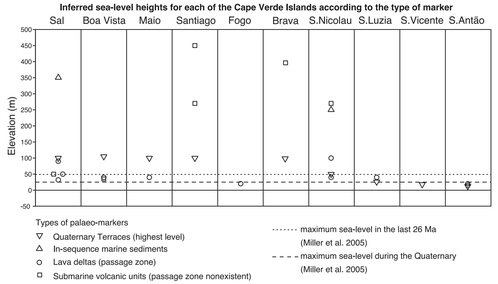
} Used to calculate maximum uplift rates (in dark colors) in plot **b**

- Santiago Ar-Ar, assuming 0 m as the palaeo-depth for the age
- São Nicolau Ar-Ar, assuming 0 m as the palaeo-depth for the age
- São Nicolau U-Th, assuming 0 m as the palaeo-depth for the age

} Used to calculate minimum uplift rates (in light colors) in plot **b**

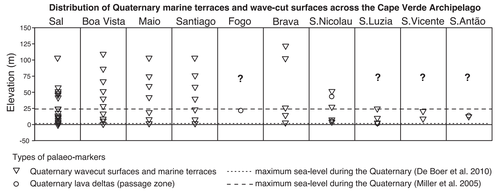
± 2σ (sea-level height & elevation); ±2σ age

4. Local vs regional uplift components

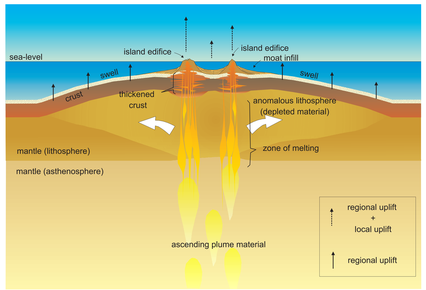


Inferred relative sea-level heights for each island show that uplift is differential throughout the archipelago and that uplift trends/histories can be very different for nearby islands. This suggests that a local rather than regional mechanism of island uplift is dominant

However, an additional regional component is present, as attested to by the distribution of a series of Quaternary marine terraces and wave-cut surfaces, ubiquitous in the Cape Verde islands.



5. Comprehensive model



We interpret the local uplift mechanism to be associated to the intrusion of basal laccoliths, restricted to the islands' footprint and probably at the rheological contrast between the seafloor sediments and the volcanic island edifice - as suggested by the Mesozoic seafloor enclave exposed on Maio Island, brought to the surface by intrusive processes.

The regional uplift mechanism must act at the swell's length scale and suggests that swell growth is episodic.

6. Conclusions

This study shows that:

1. significant uplift movements maybe synchronous with vigorous volcanic stages of island building, in a clear contrast with the prototypical hawaiian model for island evolution

2. at least two mechanisms cooperactively act to raise the seafloor under ocean islands:

- **one acts locally and is probably associated with the intrusion of basal laccoliths under each island base**
- **the second acts at the swell's length scale and suggests episodic hotspot swell growth**

3. at a broader scale, island uplift histories in conjunction with inter-island spacing, uplift rate and timing differences favour a model that advocates spreading of melt residue in swell development, but only if swell growth is episodic

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