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Geophysical evidences for a compositional heterogeneity as origin of the Galapagos hotspot

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The Galapagos Volcanic Province (GVP) includes several aseismic ridges resulting from the interaction between the Galapagos hotspot and the Cocos-Nazca Spreading Center. In this work, we compare seismic velocity and density models of the crust and uppermost mantle along five transects crossing the Cocos, Carnegie, and Malpelo ridges. The similar results obtained in all profiles suggest that all the volcanic edifices of the GVP are the product of a single, long-lasting, stable mantle melting anomaly, in conjunction with a regular process of ridge edification, which has been active for at least the last 20 m.y. Oceanic Layer 2 thickness is quite uniform along the five profiles regardless of the total crustal thickness variations, hence crustal thickening is mainly accommodated by Layer 3. Lower crustal velocities are systematically lower where the crust is thicker, thus contrary to what would be expected from melting of a hotter-than-normal mantle. The velocity-derived crustal density models account for the gravity and depth anomalies considering uniform and normal mantle densities (3300 kg/m3), which confirms that velocity models are consistent with gravity and topography data, and indicates that the ridges are isostatically compensated at the base of the crust. Finally, a 2D steady-state mantle melting model is developed and used to illustrate that the ridges' crust does not seem to be the product of anomalous mantle temperature, even if hydrous melting coupled with vigorous subsolidus upwelling is considered in the model. In contrast, we show that upwelling of a normal temperature but fertile mantle source that may result from recycling of oceanic crust prior to melting, accounts more easily for the estimated seismic structure as well as for isotopic and major element patterns of the GVP-basalts.