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The effect of Edge-Driven Convection on the generation and characteristics of oceanic volcano chains

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While many oceanic volcano chains have been related to whole-mantle plumes, other chains are not generally consistent with the predictions of mantle-plume theory. Edge-Driven Convection (EDC), i.e. a mode of Small-Scale Convection triggered by steps in the lithosphere, is an alternative mechanism for intraplate volcanism close to continental margins. For example, off the coast of Western North Africa, several volcanic chains align with the cratonic margin (e. g., Canary Islands, Cape Verde...). In this study, we explore 3D geodynamic models of EDC as well as of the interaction of EDC with mantle plumes using the finite-element code CITCOM. In order to predict the volume and compositional characteristics (major elements, isotope ratios) of primary melts, we combine new (for peridotite) and existing (for pyroxenite) parameterizations of mantle melting. The new parameterization is based on statistical fitting of experiments (where data is available) and the predictions of the thermodynamic model pMELTS (when not). We find that EDC alone is insufficient to generate extensive and persistent mantle melting. Instead, when plumes with at least moderate thermal anomalies ($\geq$100 K) interact with EDC, they can generate time-dependent volcanic tracks that are related to plate movement, but not strictly in a hotspot-like fashion. This prediction may explain some of the irregular ages found along e. g. the Canary Islands, like coeval volcanism over large distances. We also find that the pyroxenite signature and alkalic character of plume-EDC volcanism systematically strengthens with decreasing excess temperature of the plume. Spatio-temporal patterns and geochemical signatures of intraplate volcanism can indeed be used to constrain the underlying mantle dynamics.