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Mantle to surface gas triggers of magmatic activity at Erebus volcano, Antarctica

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Intraplate volcanoes are associated with extensional tectonics, mantle upwelling and high heat flow. Erupted magmas have an alkaline nature and are rich in volatiles, especially CO2, that are inherited from fluid-rich magmatic sources in the mantle. Localized alkaline centers emit gas fluxes that exceed what can be sustained by the rates of magma erupted. At Mount Erebus this dichotomy is evidenced by open-path Fourier transform infrared (FTIR) spectroscopy of gases released from the lava lake. Different gas signatures are associated with explosive and non-explosive gas emissions, representative of volatile contents and redox conditions that identify the overlap between shallow and deep degassing sources. We show that this multiple signature of magma degassing provides a unique probe for magma differentiation and transfer of CO2-rich oxidized fluids from lithospheric roots up to the surface, and show how these processes operate in time and space. Magma deeper than 4 km equilibrates under vapour buffered conditions, whereas shallower magmas allow deep, CO2-rich fluids to accumulate and prior to release either via open-system degassing conditions and reduced oxidation states, or as volatile-enriched, phonolitic blobs that preserve the deep oxidized signature, and ascend as a closed-system to explode at the surface during Strombolian phases.