Flood basalt-like magmatism from lower crustal delamination in the Trans-Mexican Volcanic Belt

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The voluminous Upper Miocene mafic province of the Altos de Jalisco in the western Trans-Mexican Volcanic Belt indicates that crustal delamination can promote abundant basaltic flooding at continents, thus balancing loss of lower crust. The volcanic products of the Altos de Jalisco range in composition from tholeiitic basalts to calc-alkaline andesites, with a small proportion of high-K rocks that erupted along the borders of the volcanic district. Partial melting of a spinel peridotite was responsible for the generation of the most primitive tholeiitic magmas with the lowest La/Yb and Gd/Yb ratios, whereas negative correlations of these ratios with MgO contents, Rb/Nd ratios and Nd isotopes indicate that the more evolved compositions were produced by high-pressure fractional crystallization and crustal contamination. Stronger garnet signatures and marked enrichments in highly incompatible elements in the high-K suite support a derivation from a garnet- and phlogopite-bearing pyroxenitic source, presumably formed by reaction of mantle peridotites with silicic melts derived from the foundering block. The geochemical features of the Altos de Jalisco sequences are not consistent with melting of a mantle plume, nor with melting of a wet mantle wedge induced by the ascent of hot asthenosphere through a slab window. Instead, the mafic province more likely represents the surface manifestation of a lower crustal delamination event, in which the fluids and melts released from the foundering block, as well as mantle upwelling around the sinking mass, enhanced abundant mantle melting and the production of large volumes of tholeiitic magmas, that subsequently experienced contamination with the newly exposed felsic continental crust.

Interrelationship of dissociating oceanic hydrates and global climate: Methane hydrate response to rising water temperatures

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Vast amounts of CH_4 are trapped in oceanic hydrate deposits. Because CH_4 is a powerful greenhouse gas (about 26 times more effective than CO_2), there is considerable concern that a rise in the temperature of the oceans will induce dissociation of oceanic hydrate accumulations, potentially releasing very large amounts of CH_4 (and CO_2 resulting from the oxidation of CH_4) into the atmosphere. Such a release could have potentially dramatic climatic consequences because it could lead to a sequence of cascading effects, involving cycles of further atmospheric and oceanic warming and amplification of the problem by accelerating dissociation of the remaining hydrates.

It is important to determine the effect of the potential release of oceanic, hydrate-originating greenhouse gases on global climate. This study is the first step in this effort. It investigates by means of numerical simulation the response of three types of hydrates—I) deep-ocean deposits, II) shallow, warm deposits, and III) shallow, cold deposits—to moderate ocean temperature increases. The results indicate that the stability of deep-ocean hydrates is unaffected by moderate increases in ocean temperature. Conversely, shallow deposits can be very unstable and release significant quantities of CH_4 into the water column under the influence of as little as 1°C of seafloor temperature increase. Because methanotrophic biota on the ocean floor (which are more prevalent in warmer environments) can attenuate to a significant degree such releases, Type III deposits appear to be associated with substantially larger potential releases of CH_4 into the atmosphere, and a correspondingly larger adverse impact. Sensitivity analysis has indicated that (a) less permeable sediments, or burial underneath sediment layers, affect both the rate of hydrate dissociation and CH_4 transport to the seafloor, but may not prevent CH_4 release, and (b) deposits with higher hydrate saturations can lead to larger CH_4 releases. These results suggest possible worst-case scenarios for CH_4 releases induced by oceanic water temperature rises associated with climate-changes, and point toward the need for detailed assessment of the hydrate-related climatic hazard.