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Along-strike supply of volcanic rifted margins: A mechanism for sudden along-strike transitions between volcanic and non-volcanic rifted margins

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The existence of sudden along-strike transitions between volcanic and non-volcanic rifted margins is an important constraint for conceptual models of rifting and continental breakup. We think there is a promising indirect approach to infer the maximum width of the region of upwelling that exists beneath a rifted margin during the transition from rifting to seafloor-spreading. We infer this width of 30km from the minimum length of the ridge-offsets that mark the limits of the 'region of influence' of on-ridge plumes on the axial relief, axial morphology, and crustal thickness along the ridge and at the terminations of fossil volcanic rifted margins.

We adopt Vogt's [1972] hypothesis for along-ridge asthenospheric flow in a narrow vertical slot beneath the axis of plume-influenced 'macro-segments' and volcanic rifted margins. We find that: (1) There is a threshold distance to the lateral offsets that bound plume-influenced macrosegments; all such 'barrier offsets' are greater than 30km, while smaller offsets do not appear to be a barrier to along-axis flow. This pattern is seen in the often abrupt transitions between volcanic and non-volcanic rifted margins; these transitions coincide with >30km ridge offsets that mark the boundary between the smooth seafloor morphology and thick crust of a plume-influenced volcanic margin and a neighboring non-volcanic margin, as recorded in 180Ma rifting of the early N. Atlantic, the 42Ma rifting of the Kerguelen-Broken Ridge, and the 66Ma Seychelles-Indian rifting in the Indian Ocean. (2) A similar pattern is seen in the often abrupt transitions between 'normal' and plume-influenced mid-ocean ridge segments, which is discussed in a companion presentation by Phipps Morgan and Ranero (this meeting). (3) The coexistance of adjacent volcanic and non-volcanic rifted mar-

gin segments is readily explained in this conceptual framework. If the volcanic margin macrosegment is plume-fed by hot asthenosphere along an axial ridge slot, while adjacent non-volcanic margin segments stretch and upwell ambient cooler subcontinental mantle, then there will be a sudden transition from volcanic to non-volcanic margins across a transform offset. (4) A 30km width for the region of ridge upwelling and melting offers a simple conceptual explanation for the apparent 30km threshold length for the existence of strike-slip transform faults and the occurrence of non-transform offsets at smaller ridge offset-distances. (5) The conceptual model leads to the interpretation of the observed characteristic 1000km-2000km-width of plume-influenced macro-segments as a measure of the maximum potential plume supply into a subaxial slot of 5-10 km^3yr^{-1}. (6) If asthenosphere consumption by plate-spreading is less than plume-supply into a macro-segment, then the shallow seafloor and excess gravitational spreading stresses associated with a plume-influenced ridge can lead to growth of the axial slot by ridge propagation. We think this is a promising conceptual framework with which to understand the differences between volcanic and non-volcanic rifted margins.