Geophysical Research Abstracts, Vol. 7, 00481, 2005
SRef-ID: 1607-7962/gra/EGU05-A-00481

Characteristics of the Central American volcanic front

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Volcanoes at convergent margins provide the relatively easily measured output of a complex series of subduction factory processes that otherwise can be studied only indirectly. Central America is a convergent margin with a particularly rich output signal. The volcanoes cluster into 39 Holocene centers separated by a mean spacing of about 28 km. This close spacing allows the subduction processes to be sampled with greater precision than is possible at most other convergent margins. The robust sampling rate is further enriched by clear regional variations in the structural and geochemical characteristics of the volcanoes.

The structure of the Central American volcanic front consists of two somewhat overlapping patterns. The first is the segmentation of the volcanic front into eight volcanic lineaments separated by right stepping jogs or changes in strike. The second is the roughly lognormal distribution of volcanic products. Eight volcanic centers are substantially larger than their neighbors. Moving away from the large ones, the volcanic centers become progressively smaller and more closely spaced. This skewed distribution of erupted mass requires different mass eruption rates, different ages or a combination of both. Age determinations of basal lava fields from Costa Rican volcanoes suggests that volcano size is proportional to age and that the volcanic centers grow at similar rates. This means that the central Costa Rican volcanic line has had an accelerating mass eruption rate as new volcanoes appeared at its NW end. This is unsustainable and strongly implies that volcanism occurs in pulses rather than as a steady state.

Large variations in incompatible element ratios occur along the Central American volcanic front. The ratios that have the most systematic along strike variations involve one or more elements that are strongly enriched in the sediment column on the Cocos Plate adjacent to the Middle America Trench (e.g. ^{10}Be, Ba, U). The ratios $^{10}Be/^{9}Be$, Ba/La, U/Th show essentially the same chevron pattern, with maxima in Nicaragua at the center of the margin and minima at the ends, western Guatemala and central Costa Rica. The similarity of these three regional variations implies that the U/Th and Ba/La signals primarily originate in the subducted Cocos sediments because the upper 100 m of the sediment section is the only source for the ^{10}Be. These three ratios correlate negatively with La/Yb, implying that higher flux from the subducted sediment (and likely the slab) causes higher degrees of melting in the mantle wedge, the source of most of the La and Yb. The chevron shaped regional variation is thus caused by linked variations in flux concentration and the degree of melting, but it is not clear what tectonic process leads to changing flux concentrations.

With the higher precision available from ICP-MS it is now possible to see some details in the regional variations. For example, some offsets of the volcanic front correlate with abrupt changes in Ba/La, while others do not. Furthermore different segments of the volcanic front appear derived from varying amounts of the two main sediment sections on the Cocos Plate. These refinements of the temporal, spatial and geochemical characteristics of the Central American front should restrict the range of plausible forward models of this subduction factory and may eliminate some models altogether.