CO_2 mass balance for the Central America Volcanic Front

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We report helium and carbon isotope and relative abundance data of fumaroles, hot springs, water springs, mud-pots and geothermal wells from El Salvador and Honduras to investigate both along and across-arc controls on the release of CO_2 from the subducted slab. The provenance of CO_2 released along the volcanic front is dominated by subducted marine carbonates (L) (= 76 ± 4%) and organic sediments (S) (= 14 ± 3%), with the mantle wedge (M) contributing 10 ± 3% to the total carbon flux. The L/S ratio of the El Salvador volatiles (average = 5.6) is comparable to volcanic front localities in Costa Rica and Nicaragua but is approximately one-half the input value of sediments at the trench. We use the L/S ratio of El Salvador geothermal fluids, together with estimates of the CO_2 output flux from the arc, to constrain the amount and composition of subducted sediments involved in the supply of $CO_2$to arc magmas. For the El Salvador segment of the volcanic front, a ~180 m continuous section of the incoming sedimentary pile – with the uppermost ~42 m removed by under-plating, is required. Significantly, there is no need for oceanic basaltic basement to supply CO_2 to El Salvador – or any other part of the volcanic front. This new approach, combining provenance characteristics of CO_2 from the slab (L/S ratio) and CO_2 flux estimates of the volcanic output, allows a more realistic estimate of the recycling efficiency of slab-derived sedimentary CO_2 through the Central American Volcanic Arc to the atmosphere (29%).

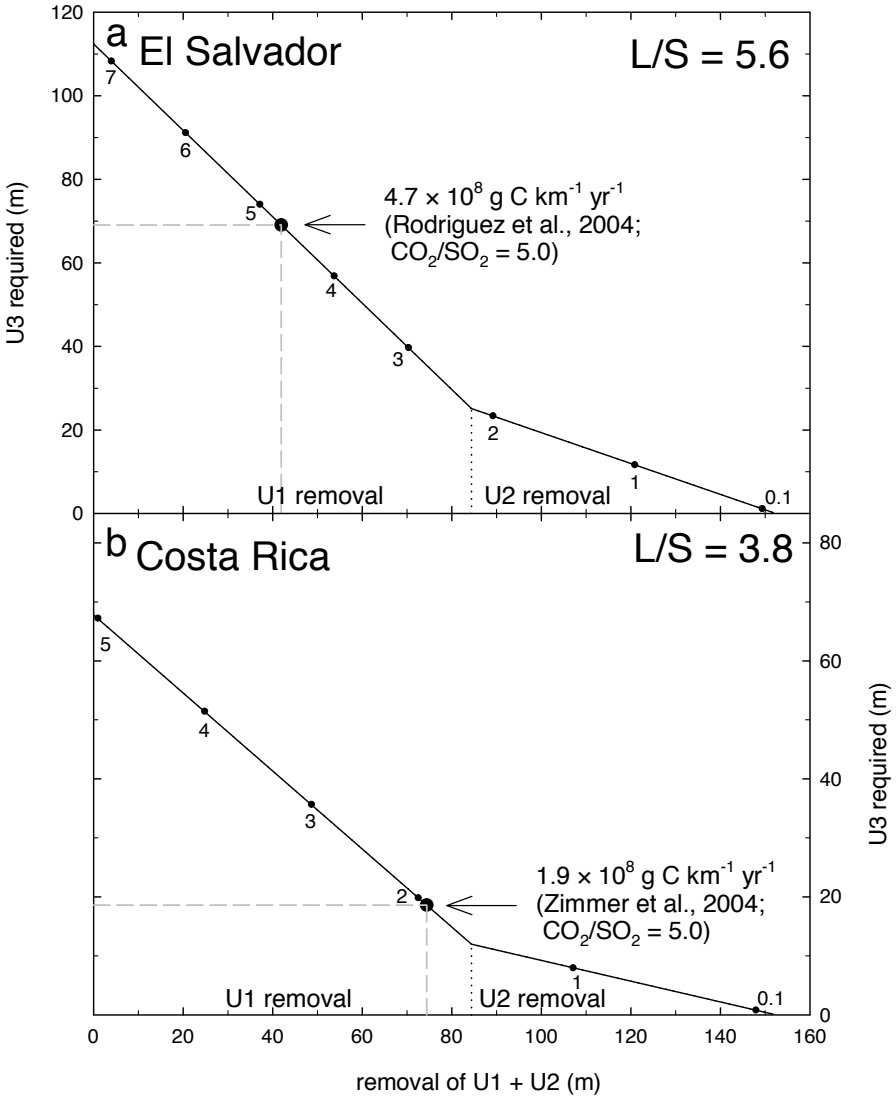

Figure: Plot of the relative proportions of U1, U2 and U3 sediment units from ODP Site 1039 required to satisfy the L/S ratio of 5.6 (upper plot – El Salvador) and 3.8 (lower plot – Costa Rica). In both cases, there is an inverse relationship (solid line) between the removal of uppermost units (U1 and U2) and the amount of U3 needed to satisfy the L/S constraint. CO_2 out put flux estimates limit the removal of U1 (underplating) to 42 m for El Salvador necessitating involvement of 69 m of U3 (dashed lines) in CO_2 supply. The corresponding values for Costa Rica are 74 m underplating of U1 + U2 with only 19 m of U3 needed.

G.A.M. De Leeuw, D.R. Hilton, T.P. Fischer and J.A. Walker, The He-CO_2 isotope and relative abundance characteristics of geothermal fluids in El Salvador and Honduras: new constraints on volatile mass balance of the Central American Volcanic Arc, Earth Planet. Sci. Lett. 258, 132-146, 2007