CO_2 rich vents in Costa Rica: mantle volatiles behind the volcanic front

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Here we report the first analyses of gas discharges from CO_2-rich wells and springs located behind the volcanic front in Costa Rica. We collected gas samples from hydrothermal springs, dry CO_2 vents (30C) and CO_2 wells. Samples contain >87mol% CO_2, with the majority of samples >95 mol% CO_2 and well samples at >98% CO_2. Other gases are CH_4 (to 0.3 %), N_2 (0.5 to 11 %), O_2 (to 0.7 %), H_2 (0.004 to 0.26 %), Ar (0.003 to 0.25 %), He (to 0.015 %). All but one sample have significant ^{4}He enrichment relative to ^{36}Ar and ^{22}Ne [F(^{4}He) 7 to 1120] and have air corrected ^{3}He/^{4}He ratios from 5.3 R_A to 7.7 R_A. δ ^{13}C values of CO_2 range from -0.29 to -4.3 ‰, indicating mixing between mantle and carbonates. CO_2/^{3}He ratios range from from 3.3 x 10^9 to 1.6 x 10^{10}. CO_2-N_2-He abundances of well samples place them in the mantle field (CO_2/N_2 = 80 to 200) whereas spring samples have lower CO_2/N_2 ratios that imply crustal contamination or water-gas fractionation. N_2-He-Ar abundances place most samples in the mantle field. Spring samples have heavier noble gas (Kr, Xe) abundances similar to air-saturated water and suggest fractionation during degassing. Low ^{4}He/^{40}Ar* for average crustal (and mantle) U,Th/K suggest He-Ar fractionation. Based on CO_2-He systematics the median carbonate (L), sediment (S) and mantle (M) C contents are 68%, 6%, and 26%, respectively with a L/S of 12. The L and S components of these samples are lower than the Costa Rica average (L= 82%, S=9%) and the M component is significantly higher than the volcanic front average (M=10±3%) (Shaw et al., 2003, de Leeuw et al., 2007). Therefore, these samples represent volatiles with the highest proportion of mantle CO_2 sampled to date in Central America. The L/S ratio is higher than that of Central America (9.7) and the world (6) average (Shaw et al., 2003). We interpret samples to represent volatiles from a region in the mantle wedge that has experienced the least contribution of subducted CO_2 and N_2 in Central America, likely the result of sediment off-scraping and slab devolatilization. We did not determine the CO_2 flux from this region, but the commercial plant alone produces about 3 x 10^9 mol CO_2/yr, about 0.1% of the MORB flux. Future work on global volatile emissions should include these sources of mantle derived CO_2.

de Leeuw GAM et al. (2007) EPSL 158:132-146

Shaw AM et al.(2003) EPSL 214:499-5