Comparative study of mantle helium release through active faults

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In order to investigate any relations of big earthquake occurrences to the soil gas characters, we carried out soil gas survey along the western part of the North Anatolian Fault (NAF). The NAF was displaced during 17 August 1999 Marmara earthquake (M 7.4). We carried out soil gas survey at 22 sites along two traverses crossing the 'zmit-Sapanca and 'znik-Mekece Faults of the NAF and 20 sites along two traverses across the Gazikvy-Saros Fault. At every site, we carried out CO_2 efflux measurements and collected soil gas samples for elemental and carbon isotope analyses. The O_2 depletion was observed in samples with large amounts of CO_2. Overall range of H_2 concentrations in soil gases are from 1 ppm to 11 ppm, which are significantly lower than the reported H_2 data in active faults of Japan (Sugisaki et al., 1983). CO_2 efflux was measured at 180 points of the total 42 sites to be (1 to 309 g m- ^{2}d- ^{1}) and CO_2 concentration in soil gas to be (0.1 to 3.7 %). The CO_2 efflux was observed to be higher at faulted NAF, relative to comparable background areas, reaching values as high as 309 g m- ^{2} d- ^{1}. Efflux anomalies (18 g m- ^{2} d- ^{1}) showed peak along fault-crossing transects at some sampling sites, suggesting zones of high diffusivity/permeability, but don't coincide with CO_2 concentration anomalies. Carbon isotope compositions of 42 soil gas CO_2 samples range from -24 to -15.6 per mili, while they are -22.6 to -18.2 per mili for fault trace gas sample. These values of *Delta* ^{13}C for soil gas CO_2 are characteristic of CO_2 of biogenic origin. The CO_2 flux anomalies are therefore consistent with fault-related biogenic gas flow and do not yield evidence for degassing of deeply derived CO_2.

In the same study area, we investigated He, Ne, Ar, Xe, Kr isotope ratios for the spring water sources. We also measured *Delta*^{13}C values in case bubbling gases are available from these spring waters. Measured ^{3}He/^{4}He ratios for 36 samples in this study range from 0.26 R/R_A, to 4.22 R/R_A,. Our data reveal that samples with high ^{3}He/ ^{4}He ratios (1.2 R/RA) are distributed in restricted areas of the fault zone of the NAF, arkvy (4.75R/R_A, 2.97 R/R_A), Tekirda (1.32) and Mudurnu (2.25 R/R_A). When we consider the surface geology of the spring sites, crustal helium should be dominant, because there is no recent volcanism in the area. Since the high ^{3}He/ ^{4}He ratios along the NAF are observed in the 70 km zone to the north and 90 km south of the strike of the NAF. Our data suggest the release of mantle helium through the NAF and it is attributable to the effective transfer of mantle helium through this fault system with fluids.