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Helium isotopes distribution in NW Iberian peninsula: evidences of a local neotectonic activity

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In this work we report new data on He abundances and isotope ratios ($^3He/^4He$) from gas associated to some thermal and CO_2-rich mineral waters in N-Portugal. Collected gas samples are mainly CO_2-dominant except two sites where gas is N_2-rich. All the sampling sites are characterized by exceptionally high helium contents with $^3He/^4He$ ratios, corrected for air contamination, varying considerably from 0.09 to 2.68 Ra. In all sites, the $^3He/^4He$ ratios are higher than that typical for stable continental areas thus indicating a variable but not-negligible (up to 30%) contribution of mantle-derived primordial He. In all the CO_2-rich waters, $CO_2/^3He$ ratios and $\delta^{13}C_{CO2}$ are comparable with mantle values, thus suggesting a magmatic origin also for CO_2. On the contrary, in the N2-rich waters He is mainly radiogenic, and CO_2 is organic in origin. Since no recent volcanic activity is observed in NW Iberia, high $^3He/^4He$ values could be due, at least, to three processes:

a) releasing of gas from the local upper mantle through deep extensional fault systems. b) releasing of magmatic volatiles from crustal reservoir(s) formed during past volcanic activity; c) degassing of a subsurface emplaced magma body.

Mantle He flux in N-Portugal has been estimated to be up to 3 orders of magnitude higher than that typical for stable continental areas, thus suggesting, in this area, the presence of a tensional tectonic regime. This implies that mantle gases could migrate upward probably through inherited tectonic structures reactivated by neotectonic activity. The third possible scenario seems to be less plausible since seismic surveys carried out in NW Iberian didn't find any significant evidence of mantle intrusion in the crust. The observed spatial variability in mantle-derived contribution could reflect the geometry of the granitic plutons in this area, thus supporting the hypotheses of an upper mantle degassing. Alternatively, it could be the result of a lateral migration of magmatic volatiles stored in a crustal reservoir.

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