"Sources and pathways of fluid migration in Mt. Amiata area (central Italy): novel insights from full noble gas isotope investigations"

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The origin of the gas emissions from Central Italy and, in particular over the widely extended Mt. Amiata geothermal area (MGA) where several hundred tons of carbon dioxide are emitted every day, still has not been exhaustively constrained, also owing to a highly complex geo-structural setting. In MGA 18 free-gas samples were collected in correspondence to different outgassing sites, the latter including both natural features (i.e. bubbling pools, cold and dry gas vents, bubbling thermal waters) and anthropic structures (i.e decommissioned mining wells, tunnels or, alternatively, exploratory drillings) with the aim to better delineate the sources and the likely migration pathways of such CO_2(H_2S)-rich gases.

Being noble gas isotopes powerful tracers of the fluid migration within shallow reservoirs, a standardized multi-isotope approach was adopted. Measurements of the full noble gas isotope composition (He, Ne, Ar, Kr, Xe) were thus performed along with δ^{13}C-CO_2, δ^{13}C-CH_4, δD-CH_4 and δ^{15}N-N_2 determinations.

The gas samples showed a chemical composition dominated by CO_2 (up to 98-99 % by vol.) and minor concentrations (i.e. few µmol/mol to few thousands µmol/mol) for the other species. The δ^{13}C-CO_2 isotopic values were from -7.05 to -0.05 ‰ (vs. V-PDB). R/Ra values were ranging from 0.11 up to 0.67 and ^{40}Ar/^{36}Ar from 295 to 478 whilst N_2/Ar ratios between 37 and 5870. These preliminary data suggested the origin of the emitted gas compounds could be related to metasomatic crustal fluids (i.e. formed by thermo-metamorphic decarbonation processes) although minor contributions from a deep mantle source as well as secondary processes (i.e. fractionation via precipitation/dissolution and/or fluid mixing at shallower levels) cannot be ruled out.