

Elevated SF₆ concentrations in soil air near New York City and its effect on the utility of SF₆ for dating of groundwater

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Recent work has shown that in principle SF₆ is a tracer well suited for dating of young groundwater (e.g., Busenberg and Plummer, 2000). In order to derive quantitative information (e.g., apparent tracer ages) from SF₆ data, its source and sink terms in the unsaturated soil zone, as well as in groundwater have to be known. Whereas the temporal evolution of SF₆ in its principal environmental source, the atmosphere, is well known for clean-air sites, it has been shown that there is significant variability near large urban centres such as New York City (e.g., Ho and Schlosser, 2000). In such environments, excesses above clean-air values can reach two orders of magnitude for short periods of time, whereas a long-term average excess value for 1998-1999 was determined to be about 90 %. Such values significantly affect the SF₆ dating method in groundwater studies. Therefore, it is of significant interest to determine the spatial patterns of elevated SF₆ values in the atmosphere around major urban centres.

To determine the spatial pattern of atmospheric SF₆ excesses above clean air concentrations, we tested the utility of soil as low-pass filter for atmospheric SF₆ values. After ensuring that soil averages the atmospheric SF₆ concentrations over time scales of several weeks to several months, we measured SF₆ in soil along three traverses away from New York City. The results show that the impact of New York City can be felt over distances of ca. 100 km (SF₆ excess above clean air at this distance: ca. 25%).

Our data show that for SF₆ dating of shallow groundwater in the vicinity of large urban or industrial centres great care has to be taken in defining the atmospheric concentrations to avoid significant biases in the calculated tracer age of the groundwater.

Busenberg, E.; Plummer, L. N. *Water Resour. Res.* **2000**, *36*, 3011-3030.

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He isotopes in peridotite xenoliths from Sicily, Southern Italy

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Basaltic diatreme pipes and lava flows from the Iblean Plateau (Sicily, southern Italy) host large numbers of upper mantle xenoliths. Spinel-facies harzburgites and lherzolitic harzburgites (Fo₉₀₋₉₁, En₈₉₋₉₀, Cr-diopside, Cr-rich spinel) represent the dominant types. Mineral and whole-rock chemistries testify to their depleted character. Nevertheless, there is evidence of cryptic (e.g. La_n/Nb_n = 3.85-21.48) and rare modal (phlogopite) metasomatism. The nature of the metasomatizing agent(s) is still matter of debate.

Secondary fluid inclusions are ubiquitous in xenolith olivines and pyroxenes. Microthermometric analysis reveal the presence of almost pure CO₂ with densities from 0.756 to 1.145 g/cm³. The densest inclusion trails occur in orthopyroxene grains and indicate an entrapment pressure of 0.98-1.15 Gpa which corresponds to a depth of ~34-39 Km (for an estimated equilibration temperature of 1000°C for a pure CO₂ system).

To constrain volatile provenance, He isotope analyses have been performed by crushing peridotite mineral phases (olivine, orthopyroxene, clinopyroxene) from 5 selected xenoliths. ³He/⁴He ratios fall in the range 7.26±0.33 Ra (Ra = atmospheric ratio) except olivine grains from one sample (6.06 Ra). He abundances vary widely (2-87 He nccSTP/g) with significantly higher abundances (up to almost 5 times) in clinopyroxenes compared with coexisting olivine and orthopyroxene.

He isotope ratios lie in the lower limit of the MORB range (7-9 Ra). This value is similar to that found in hydrothermal fluids from Pantelleria island (Sicily Channel), which is part to the same lithospheric domain as the Iblean Plateau (Pelagian Block: African Plate?). Significantly, He isotope ratios found in Iblean peridotite samples are higher than those found in the other Italian volcanic zones. Thus, it seems likely that the metasomatizing agent in the south-central Mediterranean upper mantle is derived from a MORB-type fluid reservoir, reflecting either closed-system ageing (~ 4 Myr) within the lithosphere or the moderate influence of a slightly more radiogenic He-component – e.g. a HIMU-type component.