^{3}He from extraterrestrial dust as a constant flux proxy: Estimation of the present-day flux

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Extraterrestrial ^{3}He is delivered to the earth surface by interplanetary dust particles (IDPs) characterized by a very high $^{3}He/^{4}He$ ratio (2.4×10^{-4}), several orders of magnitude higher than ratios measured in terrigeneous matter (*e.g.* review by Farley, 2001, and Schlosser and Winckler, 2002).

Several recent studies in marine sediments (Marcantonio *et al.* 2001, Higgins 2001) and polar ice (Brook *et al* 2000, Winckler and Fischer 2006) have opened up the application of extraterrestrial ^{3}He as a constant flux proxy, at least over the last 400 ka, with a mean flux around $8 \pm 3 \times 10^{-13}$ ccSTP/cm^{2}/ka. In order to measure the present $^{3}He_{ET}$ flux, we started in 2001 to collect dust in the Paris region every two months, corresponding to an area-time product of 0.03 m^{2}.a.

As expected from such small area-time products, the data are scattered due to the small number of IDPs sampled, preventing the obervation of any seasonal variability: the observed total ^{3}He flux range from 1 to 200×10^{-13} ccSTP/cm^{2}/ka, with a mean value of $(32 \pm 9) \times 10^{-13}$ ccSTP/cm^{2}/ka. However, $^{3}He/^{4}He$ ratios are often below 10^{-7} and the terrestrial ^{3}He component has to be estimated. Our measurements can be considered as binary mixings between an IDP and a terrigeneous end-member with a $^{3}He/^{4}He$ ratio of 1×10^{-8}, leading to an estimate of the present $^{3}He_{ET}$ flux of $(30 \pm 9) \times 10^{-13}$ ccSTP/cm^{2}/ka.

This flux is significantly higher than the mean accepted value of $8 \pm 3 \times 10^{-13}$ ccSTP/cm^{2}/ka, which is all the more surprising that we would expect statistical underestimation due to the small area-time products sampled, especially compared to marine sediments where values up to 0.2 are frequent (Farley *et al*, 1997). Different explanations can be considered: (1) There may be temporal variations which are smoothed in sediments. For instance, Brook *et al.* measured values of 22 and 25×10^{-13} ccSTP/cm^{2}/ka around 93 ka in Vostok ice. (2) Lateral winds may remobilize dust with IDPs in addition to the vertical flux.

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Chemical and isotopic constraints on water/rock interactions at the Lost City hydrothermal field, Mid-Atlantic Ridge

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Low temperature vent fluids issuing from the ultramafic-hosted hydrothermal system at Lost City, 30^{o}N Mid-Atlantic Ridge, are enriched in dissolved volatiles (H_2, CH_4) while attaining elevated pH values, indicative of the serpentization processes that govern water/rock interactions deep in the oceanic crust. Most importantly, serpentinization described mainly by the exothermic hydrolysis of Fe-bearing olivine has been directly linked to the heat source that drives subseafloor hydrothermal alteration at Lost City. The extent of exothermic heat generation, however, has been shown to be strongly dependent on the availability of fresh peridotite, with theoretical calculations indicating that low fluid/rock mass ratios (<1) are prerequisites for exothermic reactions to be the primary source of heat in this system [1].

Based on the Sr and $^{87}Sr/^{86}Sr$ composition of vent fluids sampled from Lost City [2], however, estimations of the integrated w/r ratios range between 6 and 8. Furthermore, constraints on the fluid/rock mass ratios together with reported $\delta^{18}O$ isotopic vent fluid compositions (0.7‰) permit subseafloor reaction temperatures in excess of 250^{o}C to be approximated, following the temperature-dependent oxygen isotope fractionation between serpentine and water. These estimations are in general agreement with previous theoretical studies [1], further supporting, however, extensive conductive heat loss occuring within the upflow zone of the Lost City hydrothermal system. Evidence of such extended conductive cooling stage include the relatively elevated precipitation temperatures (130-220^{o}C) predicted by the negative $\delta^{18}O$ composition values (<-14.2‰) reported for carbonate veins in basement peridotite. In addition, endmember dissolved boron concentrations of the Lost City vent fluids (~30 μmol/kg) [3] are significantly lower than those measured in other MAR hydrothermal systems, while with $\delta^{11}B$ isotopic composition maintaining values (~30‰) [3] reflective of elevated temperature hydrothermal alteration conditions, an substantial boron uptake into secondary phases along the discharge zone can be suggested; a process consistent with the proposed extensive conductive cooling that appears to greatly affect the chemical evolution of the Lost City hydrothermal vent fluids.

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