Isotopic evidence of microbial methane in ultrabasic reducing waters at a continental site of active serpentinization in N. California

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Gases exsolving from ultrabasic reducing groundwater at a site of shallow, low temperature, active serpentinization in Northern California were studied to determine if the gases were microbial, thermogenic, and/or abiogenic in origin as has been recently suggested for sites on the seafloor. A clear geochemical distinction was evident between springs at higher and lower elevations. The upper springs were characterized by high levels of N_2 (up to 66%), H_2 (up to 23%) and CH_4 (up to 17%), with trace amounts of C_{2+} gases. The lower springs were dominated with H_2 (up to 50%) and N_2 (up to 54%), and lesser amounts of hydrcarbon gases. Carbon and hydrogen isotopic values of CH_4 (-68.4 to -57.5 ‰ and -368 to -302‰ respectively) along with gas compositions (CH_4/ C_{2+} upto 5178) indicated that in all springs the primary source of CH_4 was microbial methanogensis via acetate fermentation pathway. In the lower springs there is evidence of a secondary process, which decreases the concentration of CH_4 while at the same time enriches the CH_4 in ^{13}C. The role of methanotrophy is currently being investigated, as well as possible additional sources of CH_4 either from abiogenic related to serpentinization or thermogenic hydrocarbons derived from underlying Franciscan greywacke. Methane from other ophiolite outcrops in the Philippines, Oman, and Turkey has been suggested to have an abiogenic origin. This is the first site of continental serpentinization where the primary source of the methane has been determined to be microbial. The differentiation between the upper and lower springs demonstrates that within the extreme conditions of the ultrabasic nutrient poor groundwater there is heterogeneity with respect to microbial activity, but all sites provided the first clear evidence of microbial methanogensis within groundwaters associated with terrestrial serpentization.

Ar-Ar ages for lunar basalt meteorites: A 881757, Y 793169, MIL 05035, LAP 02205, NWA479 and EET 96008

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New Ar-Ar data are presented for the lunar unbrecciated basaltic meteorites A 881757, Y 793169, MIL 05035, LAP 02205, and NWA 479 (paired with NWA 032) and the basaltic/gabbroic fragmental breccia EET 96008 to determine the crystallization age and timing of shock events experienced by these meteorites. Step heating Ar-Ar analyses of several bulk fragments of A881757, Y793169, and MIL 05035 give crystallisation ages of 3.763±0.046 Ga, 3.811±0.098 Ga and 3.910 ± 0.012 Ga. These Ar-Ar ages are comparable with those determined by Sm-Nd, U-Pb Th-Pb, Pb-Pb and Rb-Sr [1-5]. The K-release of Y793169 also suggests a major degassing event at 199±4 Ma. Bulk samples of LAP02205 and EET96008 were also step heated and crystallisation ages obtained of 2.985±0.008 Ga and 3.755±0.171 Ga are within error the same as those determined previously by Sm-Nd, Rb-Sr and U-Pb [6,7]. The Ar release for EET 96008 shows evidence of an impact event at 631±28 Ma. A crystallisation age of 2.734±0.040 Ga determined for NWA 479 is the same as the weighted mean age obtained from three samples of NWA032, 2.779± 0.056 Ga, supporting their parity. The overlap of the Ar-Ar ages determined with those obtained using other isotopic systematics suggests that the K-Ar systematic is robust for rocks that have not been subjected to prolonged heating regimes even if showing effects of a shock event(s).

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