First lipid biomarker evidence for aerobic methane oxidation in the water column of Lake Untersee (East Antarctica)

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Lake Untersee is a perennially ice-covered freshwater lake (6.2 km x 4.2 km, max. 169 m water depth) located in the Gruber Mountains of central Queen Maud Land, East Antarctica. Lake Untersee receives water only from glacier runoff (Anuchin Glacier) and has no outflow. Comparatively high evaporation rates lead to high sulphate concentrations in surface waters (ca. 1.5 mM). Most of Lake Untersee's water column is supersaturated with respect to oxygen and characterised by very low rates of primary production. However, Lake Untersee also features a 100 m deep trough at its southern tip, with anoxic bottom waters containing high amounts of biogenic methane (up to 22 mM) and sulphide (up to 2 mM). In a previous study in Lake Untersee (Wand *et al*. Limnol. Oceanogr. 51, 2006), high rates of sulphate reduction and anaerobic oxidation of methane (AOM) were observed at 84 m water depth, just a few meters below the oxycline (80 m water depth) A negative shift in the stable carbon isotope composition ($\delta^{13}C$) of suspended particulate organic carbon (SPOC) from -30‰ to -45‰ in a constrained water layer (84 – 86 m water depth) provides further indication for methane consumption at this depth. To gain further insights into methane cycling in Lake Untersee, we analysed the lipid biomarker composition and stable carbon isotope signatures from SPOC samples collected during the 1995 sampling campaign. Against our initial expectation, we could not detect any isoprenoidal lipid compounds typical for *Archaea* involved in the sulphate-dependent mode of AOM (e.g. the dialkyl-glycerol-diethers 'archaeol' or '*sn2*-hydroxyarchaeol'). However, we were able to detect substantial amounts of two specific steorids (4α-methyl steroid and 4, 4-dimethyl steroid) and one hopanoid (diplopterol). These compounds displayed very low $\delta^{13}C$-values (as low as -68‰) and were, again, confined to water depths between 84 – 86 m. The biomarker composition and isotopic signatures are consistent with an origin from aerobic methanotrophic bacteria, possibly *Methylococcus sp*. As a consequence, aerobic (MOx), rather than anaerobic methanotrophy most likely accounts for the low $\delta^{13}C$-values found for POC at 84 – 86 m water depth and is responsible for a significant fraction of methane consump-tion. These results have important implications for our understanding of the spatial stratification of biogeochemical TRUNCATED

Tungsten isotopic evolution during late-stage accretion: Constraints on Earth-Moon equilibration

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We couple the results of N-body simulations of late-stage accretion (O'Brien *et al*. 2006) to a hafnium-tungsten (Hf-W) isotopic evolution code to investigate the evolution of planetary bodies in the inner solar system. Simulations can simultaneously produce planets having Earth- and Mars-like masses and Hf-W systematics by assuming that the tungsten partition coefficient decreases with increasing semi-major axis (e.g. due to increasing oxidation). Simulations assuming that Jupiter and Saturn occupied circular orbits while the terrestrial planets were forming are more successful at reproducing the Hf-W systematics than those assuming present-day Jupiter and Saturn orbits. To generate Earth-like tungsten anomalies, 30-80% of each impactor core is required to re-equilibrate with the target mantle. Some model outcomes yield a target and final impactor having similar (Earth- and Moon-like) tungsten anomalies. However, in no case can the inferred lunar Hf/W ratio be simultaneously matched. This result suggests that the Moon isotopically equilibrated with the Earth's mantle in the aftermath of the giant impact (cf. Pahlevan and Stevenson 2007). Alternatively, either the dynamical models which show the Moon being derived primarily from the impactor mantle, or the accretion timescales obtained by the N-body simulations, are incorrect.