Biological control of magnetite crystal formation in the magnetotactic bacteria: hints concerning the possible evidence from ALH84001 for life on Mars

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One of the strongest lines of evidence for the existence of ancient life on Mars is the possible presence of bacterial magnetofossils in the carbonate globules of the ALH 84001 meteorite[1, 2]. Of the ~seven magnetite-based criteria currently being used to identify life on Mars, one of the most distinctive features is the presence of magnetosome chains[3]; these structures are common in living magnetotactic bacteria and in a variety of terrestrial magnetofossils. However, there is a debate about whether they can form through other non-biological processes. In living magnetotactic bacteria, it is known that individual magnetite crystals are formed within a string of vesicles, each of which is composed of a proper lipid-bilayer membrane. At present, the biological process that forms these structures is completely unknown.

Several inorganic processes using heavy metals are known to precipitate linear strings of similarly-sized crystals in a highly viscous media that contains large organic matrix molecules [4]. Our hypothesis is that organic material in ALH 84001 may have helped organize the chain-like magnetite structures. We will also report our attempts to observe the internal structures of the magnetosomes in the magnetotactic bacteria using electron microscopy, to test for the presence of a similar organic matrix.

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The dependency of cosmognenic nuclides to climate and surface uplift in transient landscapes

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Geomorphological and geological studies as well as drainage system analyses (e.g. Mortimer 1980, Wörner et al. 2002) point to the existence of 10-20 Ma-old surfaces in Northern Chile that have been preserved due to arid/hyperarid climate conditions. Because of the excellent preservation of these surfaces, they bear information on temporal and spatial variations in tectonic and climate forcing. In an effort to extract this information, we currently apply the cosmogenic stable ^{21}Ne and radionuclide ^{10}Be methodology to the Miocene bedrock and alluvial surfaces. The samples are collected in a transect from the Coastel Cordillera through the Longitudinal Valley, the Pre- and Western Cordillera from west to the east.

Measured concentrations of cosmogenic nuclides (without correction for erosion rates and surface uplift) imply Pliocene/Pleistocene apparent ages for the Miocene surfaces. These ages correlate with the topographic roughness and the content of moisture in the air (coastel fog, orographic precipitation). However, the correction for erosion rates of 20-50 cm/My as indicated by 21Ne /10Be - 10Be ratios (Ivy Ochs 1996) yields Middle Miocene ages for the analyzed surfaces. These ages, however, are still significantly younger than expected (i.e. 10-20 Ma). Consequently, the difference between the corrected ages and the formation ages results from either unsteady erosion or variable surface uplift rates. Current efforts aim at analyzing depth profiles and modelling of erosion / surface uplift scenarios to detect possible unsteadiness in surface erosion and / or surface uplift.

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