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Air fractionation in plate-like inclusions within the EPICA-DML deep ice core

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On ice samples from the ice core recovered in the frame of the European Project for Ice Coring in Antarctica at the deep drilling site in Dronning Maud Land (75°00S; 00°04E) micro-Raman spectrochemical analysis was applied to typical relaxation features appearing after the extraction of an ice core. Essentially, these relaxation microinclusions are little planar polygonal cavities possessing hexagonal symmetry i.e. thin negative crystals lying on the basal plane of the hosting ice crystallite. Usually named plate-like inclusions, PLIs, they tend to change their aspect ratio becoming in general rounder, thicker or thinner depending on the equilibrium established between the structure-composition of the ice and the minute environmental temperature-pressure conditions around a specific PLI, but still preserving a very large aspect ratio (typically 20:1). Muguruma and others (1966) and Mae (1968) have reported studies on plate hexagonal voids, i.e. PLIs, produced (only) in tensile deformation tests of natural and artificial single ice crystals while the first report of PLIs in Antarctic ice cores was presented by Gow (1971). In spite of these early studies and the abundance of PLIs in stored ice core samples, extended investigations of these relaxation features are scarce. We present the results of the first successful study of the chemical composition of PLIs using microfocus Raman spectroscopy (Nedelcu and others, in press). We observe that the relaxation features contain mainly O2 and N2 in their interior, with N2/O2 ratios smaller than 3.7 (the nowadays atmospheric air N2/O2 ratio), indicating a general oxygen enrichment that is not so different from O2 enrichments reported in other investigations on polar ice samples (Nakahara and others, 1988, Ikeda and others, 1999). These results seem to lend support to the current hypothesis that O2 diffuses faster than N2 through the ice matrix (Ikeda-Fukazawa and others, 2001, 2005; Severinghaus and Battle, 2006). More than this, they suggest that the diffusion of chemical traces in the ice matrix may not be negligible, at least locally, on a timescale of few years. These results could be important for the interpretation of ice-core paleoclimate records.

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