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Chemistry of microparticles trapped in last glacial period ice of EPICA-DML deep ice core

Aneta F. Nedelcu (1), Sérgio H. Faria (2), Sepp Kipfstuhl (3), and Werner F. Kuhs (2)

(1) Faculty of Geoscience and Geography, University of Göttingen, Germany (nedelcuaneta@yahoo.com), (2) Geoscience Centre, University of Göttingen, Germany (sh.faria@geo.uni-goettingen.de, wf.kuhs@geo.uni-goettingen.de),, (3) Alfred Wegener Institute for Polar and Marine Research, Bremerhaven, Germany (Sepp.Kipfstuhl@awi.de)

The EDML ice core, drilled within the framework of the European project for Ice Coring in Antarctica, (EPICA), in the interior of Dronning Maud Land, DML, Antarctica (at 75°S, 0°E), is the first deep ice core in the Atlantic sector of the Southern Ocean region that provides higher-resolution atmosphere and climate records for the last glacial period, when compared with other ice cores retrieved from the East Antarctic plateau [1]. The chemical impurities embedded in the ice matrix of an ice sheet are basic proxies for climate reconstruction, and their concentration and composition usually determine the occurrence of distinct (cloudy or clear) strata in the ice sheet structure. The easiest observable impurities in polar ice are air bubbles. But a considerable amount of the impurities trapped inside ice layers are observed as microscopic deposits of solid (soluble or insoluble) particles, not bigger than a few micra in size, called microinclusions. Layers of ice with a high content of (micro)inclusions are in general called cloudy bands and are considered to have been formed from the precipitations deposited during colder periods. Roughly, we expect that the colder the climate during the time the snow accumulated, the cloudier the ice stratum that forms afterwards [2]. Mainly by means of in-situ micro-Raman spectroscopy, it has been shown that in Antarctic glacial ice the soluble microinclusions occur mostly as sulphate and nitrate salts [3], while in Arctic ice more commonly as carbonate salts [4]. These findings could be explained in terms of different aerosol compositions determined by the specific regional environments and climatic conditions [5]. Regarding the insoluble particles that might exist in natural ice, with higher frequency in ice layers formed during glacial type stages, the general findings classify them in the (alumino)silicate mineralogical class [6]. Microinclusions existent in solid samples taken from clear and cloudy ice layers, corresponding to the Marine Isotope Stage 2 of the EDML deep ice core, were subjected to in-situ Raman scattering measurements. The overall results [7] resemble the observations [8] that a high content of sulphate anions could characterize the chemical composition of the aerosols arriving at the EDML ice core drilling site. Many microparticles provided a Raman signal different from what would be expected if only simple compounds were forming them (and dissimilar with those in [3]). For example, it resulted that in the same microinclusion nonequivalent sulphate groups are present (20% of all), or that sulphate and silicate anions coexist (10% of all). On the one hand, this can be explained by a simple post-depositional aggregation of very small inclusions of simple sulphate salts into microclusters. On the other hand the results might be interpreted in terms of aerosol chemistry, when a mixture of sulphate salts could have been already formed prior to deposition. This work will offer answers for questions related with the existence of a post-depositional alteration of the initial impurities deposited in the LGP ice at the EDML ice core drilling site.

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