PIXE Elemental Composition of Mineral Dust from EPICA ice cores

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I. INTRODUCTION

The European Project for Ice Coring in Antarctica (EPICA) is aimed at reconstructing the paleo-climate and the paleo-environmental conditions at the high latitudes of the Southern Hemisphere through two deep ice cores from the East Antarctic plateau. The first core, drilled at Dome C site (EDC) provides today the longest climatic record ever obtained from polar ice cores (740 kyrs EPICA Community Members, 2004). The second one, drilled in the Dronning Maud Land sector of Antarctica (EDML) is aimed at producing a high-resolution record of likely two glacial–interglacial cycles.

Insoluble atmospheric dust represents a small fraction of the total mass of atmospheric aerosols. It may play an important role in climate and, in turn, it is sensitive to climatic changes. The temporal variability of its flux as well as the changes of mineralogical composition within different climatic periods may explain both source-related environmental (i.e. atmospheric circulation) changes and the potential dust influence on biogeochemical cycles for several key elements (such as Si and Fe) and the supply of micronutrients to the oceans. Silicon is the second most abundant element in the Earth’s crust and its biogeochemical cycle is of great interest because of its possible impact on global CO2 concentrations. Silicon measurement represents a unique feature of the PIXE technique.

II. MATERIALS AND METHODS

New Si, Al, Fe, Ti, K, Ca, Mg, Na data were obtained by PIXE measurements performed at Legnaro laboratory [1] on the insoluble dust from 21 intercomparison samples from EDC ice core, spanning the Last Glacial Maximum to Holocene transition (20 to 10 kyr B.P.), along with the total dust mass determined by Coulter Counter on the same samples. Improved experimental set-up and data evaluation have been applied for the first time to the analysis of about 42 samples from the two EPICA ice cores (EDC and EDML). This work is an upgrading of a previous study from the first 2200 m of EDC ice core [1,2].

Within this work, substantial improvements on the experimental set-up and data evaluation have been applied for the first time to the analysis of about 42 samples from the two EPICA ice cores (EDC and EDML). This work is an upgrading of a previous study from the first 2200 m of EDC ice core [1,2].

Within this work, substantial improvements on the experimental set-up and data processing have been performed on the irradiation chamber line up; the collimation of beam spot, the accuracy of solid angle calculation; the background and blank subtraction; the software code performances.

III. RESULTS AND COMMENTS

The EDC and EDML PIXE data for Si, Al, Fe, Ti, K, Ca, Mg, Na PIXE data allows the calculation of the sum of oxides of these insoluble elements. The first oxides record is calculated on SiO2, FeO, TiO2, K2O only.

Theses profiles represent the major fraction of the total dust mass calculated by Coulter Counter on the same samples.

The EDC oxides sum represents almost the total dust mass (in the 0.7-5 µm range, average density 2.5 g/cm3) during the Holocene, but not during the LGM, when PIXE oxides are ca. 30% lower than the dust mass. This behaviour confirms preliminary suggestions from Ghermandi et al., 2003. For EDML samples, the oxides sum exceeds the total mass both during Holocene and LGM.

For both EDC and EDML ice cores, the pie charts show elemental abundances coherent with Upper Continental Crust abundances. While LGM dust from the two ice cores shows a very similar elemental composition, slight differences can be observed for the Holocene. In particular, Mg is quite abundant in EDML samples.

IV. ACKNOWLEDGEMENTS

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