Contribution ID: **105** Type: **Oral presentation**

High resolution Laser-Ablation ICP-MS chemical impurity analysis of Skytrain Ice Core (Antarctica)

Tuesday, 4 October 2022 14:00 (20 minutes)

Polar ice cores are invaluable environmental archives, directly recording atmospheric conditions of the past. Investigations of periods of fast climatic changes and periods slightly warmer than present day climate, such as the Last Interglacial (LIG) 115-130 ka before present (BP), are of particular interest. The analysis of fast changes in the impurity signal, as well as of very old ice close to bedrock where the internal layers are highly thinned, both require a measurement depth resolution on the order of a millimetre or even less. This is far beyond the capabilities of conventional continuous flow analysis (CFA) systems. To achieve this high depth resolution, we have set up a system to perform high-resolution laser-ablation inductively coupled plasma – mass spectrometry (LA-ICP-MS) and a cryocell stage. This method was applied to selected segments of an ice core recently drilled to bedrock at Skytrain Ice Rise in the framework of the WACSWAIN (WArm Climate Stability of the West Antarctic ice sheet in the last Interglacial) project. The main objective of this project is to obtain unique information on the state of the Filchner-Ronne ice shelf during the LIG. Sections of 80 cm of ice from five different depth intervals covering time frames from Late Holocene to the LIG were analysed via LA-ICP-MS and compared for their overall impurity content as well their signal variability. Here we focus on the analysis of the most important marine and terrestrial markers: sodium, magnesium, calcium and aluminium. The high resolution (mm to sub-mm scale) LA-ICP-MS data is compared to low-resolution (cm scale) chemistry data from CFA of the Skytrain ice core performed on adjacent ice samples from the same depth. This comparison aims to evaluate the capabilities of the method in terms of improving depth resolution and detection of annual variability. We statistically evaluate the horizontal and vertical variability of the LA-ICP-MS signal across the ice core and the representativity of the LA-ICP-MS signal for an overall impurity content for different depth levels in the core. Finally, we investigate the potential of the method for resolving annual layers and fast changing climate signals within the selected core sections, especially the late LIG (about 115 - 120 ka BP).

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Track Classification: Progress in proxy development and interpretation