**Climate driven carbon and microbial signatures through the last ice age**

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**Introduction**

 Here we present organic matter (OM) molecular composition and microbial community structure from the Byrd Station (Byrd) and West Antarctic Ice Sheet Divide deviation #3 (WD\_3) ice core sections from the Last Glacial Maximum (LGM) and last deglaciation (LD) periods. Stringent next generation sequencing protocols and Fourier transform ion cyclotron resonance mass spectrometry (FT-ICR MS) were applied in concert with bulk characterization metrics to link deep ice core OM molecular composition and microbial assemblages to different climate periods.

**Experimental**

 Ice cores were decontaminated, melted, and aliquoted for a suite of biological and chemical analyses including: major ion and organic matter concentrations, bacterial cell abundances, next generation sequencing (DNA extraction and PCR amplification), fluorescent OM spectroscopy, and OM molecular composition analysis by Fourier transform ion cyclotron resonance mass spectrometry (9.4 T FT-ICR MS, ICR Facility at the NHMFL).

**Results and Discussion**

 Microbial assemblages and organic matter (OM) composition from Byrd and WD\_3 ice cores may serve as palaeoecological markers from the Last Glacial Maximum (LGM; section ~20.5 ka BP) and last deglaciation periods (LD; section ~14.5 ka BP), reflecting environmental changes. Fluorescent analyses determined OM from both cores to have similar amino acid-like signatures; however, more comprehensive molecular characterization showed only 12 % overlap in molec­ular formulae, with Byrd OM being more chemically labile. Microbial diversity in both cores was low, and together with predicted metabolic capabilities, differed significantly between communities. Variation in OM composition and microbial diversity reflects changes in environmental sources and deposition patterns onto the Antarctic Ice Sheet during distinct climate periods (Fig. 1), with OM composition potentially shaping microbial communities post-deposition.

**Conclusions**

 Distinct chemical and biological signa­tures were detected in the Byrd and WD\_3 ice cores, unique to each climate period. Major ion concentrations were consistent with values reported for Antarctic ice. Dissimilarities in cell and phylogenetic abundances, and OM concentrations collectively support our view of different deposition patterns onto the Antarctic Ice Sheet during distinct climate periods. Changes in the OM composition between the LGM and LD may further reflect changes in environmental sources. Therefore, similar to other palaeo-ecological materials, OM composition and microbial assemblages in ice preserves past environmental conditions.

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**Fig. 1** Antarctic palaeoecological markers of organic matter

and microbial community structure from the LGM and LD.