OSMIUM ISOTOPES AT THE ONSET OF YOUNGER DRYAS USING THE GRIP ICE CORE. Ji-Hye Seo¹, Changhee Han², J. P. Steffensen¹, Sungmin Hong¹, and Mukul Sharma¹, ¹Department of Earth Sciences, Dartmouth College, Hanover, NH 03755, ²Department of Ocean Sciences, Inha University, Incheon, South Korea, ³Korea Polar Research Institute, Incheon, South Korea, ⁴Centre for Ice and Climate, University of Copenhagen, Denmark.

Introduction: The Younger Dryas (YD) was an abrupt cooling period during the last deglaciation between 12.9-11.7 ka and is well recorded in the Greenland ice cores [1-2]. The main mechanism behind the short-term cooling is a temporary slowdown of North Atlantic thermohaline circulation due to catastrophic release of meltwater from proglacial Lake Agassiz during the integral retreat of the Laurentide Ice Sheet [3]. An alternative hypothesis states that the cooling was directly/indirectly initiated by one or more cosmic air-bursts/impacts, resulting in destabilization of the ice sheet [4]. In support of the hypothesis, the evidence of the extraterrestrial impact, including microspherules, nanodiamonds, magnetic grains, and glass-like carbon, has been documented [5-9]. However, this hypothesis remains controversial as there has been no evidence associated with the impact markers and no YD-age impact crater found [10-13].

Petaev et al. [14] discovered an unusually high Pt/Ir ratio of ~1200 associated with high Pt of ~82 ppt in a Greenland ice core (GISP-2) at the onset of YD. The observed Pt/Ir ratio is much higher than average chondrites (= 2.0) and average continental crust (= 23). Petaev et al. [14] inferred that this high ratio resulted from the impact of Sikhote-Alin type iron meteorite, which has a Pt/Ir ratio of >108. Using the estimated Pt fluence, Petaev et al. [14] assessed the diameter of the YD impactor to be ~0.8 km.

Here, we report Os concentration and isotopic composition from Greenland ice core (GRIP) spanning the period through YD. The key issue we seek to address is whether Os concentration and isotopic composition (\(^{187}\text{Os}/^{188}\text{Os}\) ratio) in Greenland ice cores provides an independent confirmation of the inferred meteorite impact. The \(^{187}\text{Os}/^{188}\text{Os}\) ratio of meteorite/cosmic dust is ~0.13 and quite distinct from that of the upper continental crust (=1.26). This distinction has allowed Os isotopes to be used as a robust tracer of meteorite impacts, to evaluate the size of the impactor, and also to assess the temporal variations in the cosmic dust flux (see [15] and references therein).

**GRIP ice core sampling: ** We examined GRIP ice core from a depth of 1659.35 m through 1664.30 m (~12811-12937 years old) curated at the Centre for Ice and Climate, University of Copenhagen, Denmark. During the drilling operations and core handling processes, the surface of an ice core is heavily contaminat-
ary electron multiplier). The OsO$_4^-$ ion beams were obtained using highly sensitive and reproducible face-to-face filament geometry. The Os reagent blank concentration of 2.70 fg and the $^{187}$Os/$^{188}$Os ratio of 0.15 are used as blank correction.

**Results:** We have so far obtained data on 12 samples. All but one of these ice samples show unradiogenic Os isotope ratios but are associated with low concentrations (Fig 1). While the $^{187}$Os/$^{188}$Os ratio in Sikhote-Alin meteorite is ~0.13, its Os concentration is abnormally low (=19 ng/g) [17]. If Os from this impactor were globally distributed over the surface of the Earth it would provide an Os fluence of only 10 pg/cm$^2$. After decontamination, the expected Os concentration at the anomalous Pt peak should be ~600 fg/g. If the peak is present in a sample, Os concentrations should be distinct among the background concentrations in ice. However, no such concentration and isotopic composition has been observed in these samples.

The sample at depth 1662.56m, near the YD boundary, the $^{187}$Os/$^{188}$Os ratio is 0.31, suggesting a mixing of unradiogenic dust source. If it is a mixture of meteorite and continental sources, 85% of Os should come from the meteorite. However, Os concentration is quite low (=2.8 fg/g). So far, Os isotopes suggest contributions from cosmic dust. In addition, the sample at depth 1663.29m near the Laacher See volcanic eruption has $^{187}$Os/$^{188}$Os ratio of 0.34 with the concentration of 0.98 fg/g. This indicate the volcanic signal, which has an isotope ratio of 2.1 and the concentration of 16 pg/g [8], is absent in the GRIP ice core.

The Ni/Co ratio of continental crust (=2.2) and Sikhote-Alin (=13; [18]) are quite distinct. We find that at depths of 1659.90m and 1662.01m the Ni/Co ratios are 17 and 19, respectively. However, the Os concentrations and the $^{187}$Os/$^{188}$Os ratio do not show any correlation with Ni/Co ratio. Additional measurements are underway to search for the impact near the YD boundary.

**Acknowledgements:** This study was supported by NSF Polar Program (Award No. 1417395).

**References:**

![Fig. 1. δ¹⁸O, Ni, Ni/Co, Os, $^{187}$Os/$^{188}$Os ratios in the GRIP ice core as a function of the GRIP depth. Blue arrow at the top of the δ¹⁸O graph provides the depth of onset of Younger Dryas. The green line indicates observed NH$_4^+$ anomaly in the GRIP ice core. The orange shade indicates Laacher See eruption based on the ECM peak observed in the GRIP ice core.](3005.pdf)