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TITLE: Ancient Yedoma carbon loss: primed by ice wedge thaw?

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ABSTRACT BODY: Northeast Siberian permafrost is dominated by frozen Yedoma deposits containing ca. 500 Gt of carbon, nearly a quarter of northern permafrost organic carbon (OC). Yedoma deposits are Pleistocene-age alluvial and/or aeolian accumulations characterized by high ice wedge content (~50%), making them particularly vulnerable to a warming climate and to surface collapse upon thaw. Dissolved OC in streams originating primarily from Yedoma has been shown to be highly biolabile, relative to waters containing more modern OC. The cause of this biolability, however, remains speculative. Here we investigate the influence of ice wedge input upon the bioavailability of Yedoma within streams from as a potential cause of Yedoma carbon biolability upon release into the Kolyma River from the thaw-eroding river exposures of Duvannyi Yar, NE Siberia.

We measured biolability on (1) ice wedge, Kolyma, and Yedoma leachate controls; (2) ice wedge and Kolyma plus Yedoma OC (8 g/L); and (3) varying ratios of ice wedge water to Kolyma river water. Biolability assays were conducted using both 5-day BOD (biological oxygen demand) and 11-day BDOC (biodegradable dissolved organic carbon) incubations.

We found that ancient DOC in Yedoma soil leachate alone was highly biolabile with losses of 52±0.1% C over a 5-day BOD incubation. Similarly, DOC contained in pure ice wedge water was found to be biolabile, losing 21±0% C during a 5-day BOD incubation. Increased ice wedge contributions led to higher overall C losses in identical Yedoma soil leachates, with 8.9±0.6% losses of Yedoma C with 100% ice wedge water, 7.1±1% (50% ice wedge/ 50% Kolyma) and 5±0.3% with 100% Kolyma River water. We discuss potential mechanisms for the increased loss of ancient C using associated measurements of nutrient availability, carbon quality (CDOM/FDOM) and extracellular enzyme activity rates.
Our initial results indicate that ice wedge meltwater forming Yedoma streams makes Yedoma OC more bioavailable than it would be if mixed with Kolyma River water

alone, suggesting that leach water origin acts as a control on the turnover of old C. The higher reactivity of Yedoma OC in ice wedge meltwater compared to Kolyma River water suggests that further ice wedge and permafrost thaw in Yedoma deposits will likely result in increased CO2 flux into the atmosphere.