FILLING A WHITE SPOT ON THE YEDOMA MAP: THE BALDWIN PENINSULA, WEST ALASKA

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Vast regions of Arctic Siberia, Alaska and the Yukon are covered with ice-rich silts penetrated by large ice wedges, resulting from syngenetic sedimentation and freezing during the Pleistocene. These deposits are termed yedoma permafrost. Because of rapid incorporation of organic material into permafrost during sedimentation, yedoma deposits are expected to store poorly degraded organic matter. The total amount of organic carbon in the yedoma region is estimated to be approx. 400 gigatons. As a consequence of the high ground ice content, yedoma deposits are especially prone to degradation triggered by climate changes and/or human activity. When yedoma deposits degrade, large amounts of previously sequestered carbon as well as nutrients will be released which is of global significance for the climate system.

Following on the tracks of permafrost pioneer David M. Hopkins, who studied this region during his conceptualization of the Bering Land Bridge in the 1950/60s (Hopkins et al. 1959, 1962), we conducted a field campaign to the Baldwin Peninsula in West Alaska. Based at the town of Kotzebue, one of the aims of this expedition was to describe yedoma landscapes and start a carbon inventory of this previously undocumented part of yedoma. The intention was to search for and characterize yedoma deposits whose presence was inferred from landscape morphometrics typical for yedoma (deep thermokarst lake basins, multiple overlapping lake basin generations, rolling hills with uplands where small deep thermokarst ponds are found, steep erosion margins along lake and coastal shores) on the neighboring Seward Peninsula and in Siberia as identified in remote sensing imagery. We were able to identify several yedoma upland exposures eroded by the Chukchi Sea on the western shore of the Baldwin Peninsula. We found clear evidence of yedoma permafrost occurrence at Cape Blossom, 20 km south of Kotzebue. We used a cryostratigraphical approach to sample yedoma and drained thaw lake basin exposures at this site. Moreover, different generations of drained lake basins in the hinterland of the cape were sampled with a SIPRE permafrost auger. For landscape scale estimation we used Landsat and high resolution WorldView imagery, airborne IfSAR digital elevation datasets as well as aerial survey flights during the expedition.

The yedoma layer at Cape Blossom was characterized by a height of approx. 12 m including massive syngenetic ice wedges. The mean carbon content of the 7.8-m high sampled profile was 2.0 wt%. The average ice content for the sediment, not including ice wedges, was 45.2 wt%. Another bluff close by exposing sediments of a drained thermokarst basin contains 6.8 wt% carbon and 41.1 wt% pore ice. We were able to detect a chaotic layer at the bottom of the sediment sequence indicating lake initiation.

This study gives evidence for the occurrence of ice-rich late Pleistocene yedoma deposits in Western Alaska. This yedoma is of importance because of its paleoenvironmental implications for the widespread occurrence of yedoma in the Bering Land Bridge region (e.g. mammoth steppe conditions), as well as for the future vulnerability of the landscape to thaw because of its high excess ground ice content. Permafrost thaw will affect these yedoma areas first, as its location is close to the continuous/discontinuous permafrost zone border, with the result that a considerable amount of carbon becomes available for microbial activity.

References:

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