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IS THERE ANY REAL EVIDENCE FOR A HUGE SHELF ICE SHEET IN EAST SIBERIA?

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Hypothesis of an 'Antarctic-style' ice sheet in the Arctic (Grosswald, 1984, 1988) implies that during the last glacial maximum (Late Weichselian), extensive marine-based glaciers covered the present shelf of the Laptev, East Siberian and Chukchi Seas, and intruded south onto the coastal lowlands of East Siberia. According to this hypothesis, the islands on the East Siberian shelf were covered by a 1 km or more thickness of ice as late as ca. 15–20 ka. A recent development of this concept (Hughes *et al.*, 1991; Hughes and Hughes, 1994) speculates how ice overflowing to the Bering Sea could influence the Beringian faunal migrations and peopling of the Americas.

Discussions at the recent Symposium on Problematic ice sheets (Stockholm, October 1994) revealed a striking difference in the strength of arguments for the Arctic ice sheets between the West Siberian and East Siberian Arctic. While the scale, timing and detailed pattern of shelf glaciation were debated for the Barents and Kara Seas, the very presence of shelf glaciers over the East Siberian Seas was seriously questioned. The present status of the East Siberian Arctic Shelf Ice Sheet (ESASIS) is briefly summarized below.

Contrary to the Western Arctic with its extensive record of glacial geology, the ESASIS hypothesis was not based on geological evidence except for some interpretations of surface topography. It was theoretically postulated for East Siberia, and its most enthusiastic supporters never conducted field studies in the area except only during brief excursions. They consider that the main bulk of previous Quaternary work in Arctic East Siberia is inadequate as it does not confirm to the theory. Among the various results of Quaternary research made by numerous workers in East Siberia, which contradict the ESASIS hypothesis, the following points seem the most relevant:

(1) The extremely wide distribution of fine-grained sediments ('Yedoma') with syngenetic ice wedges. These sediments are present over, and south of the coastal lowlands, and on the shelf islands, such as Lyakhovskiy and Kotelniy. Although the nature of these sediments is debated, they are probably of polygenetic origin (fluvial, lacustrine, eolian, slope and etc.; neither glacial, nor marine sedimentation was involved. Accumulation of the Yedoma type sediments on both the lowlands and the islands has occurred since the late Middle Pleistocene through to ca. 12–13 ka. They were also deposited during the Sartanian (Late Weichselian) times, which could not have happened under a 1 km thick ice sheet. The sediments in question have very high amounts of segregated ice, large vertical ice wedges, and are known to be prone to plastic deformation. However, nothing has ever been reported that could be interpreted as glacial deformation.

(2) The youngest (Sartanian) sediments of the Yedoma type formed terrace-like surfaces ca. 15–20 m above sea level along the coastal areas, and the Severnaya Zemlya and Novosibirsk Islands (Sher and Plakht, 1988; Ovander *et al.*, 1987; Makeev *et al.*, 1979, 1989). In the lower courses of the Kolyma, Indigirka and Yana Rivers, fluvial terraces of the Sartanian age are well studied (e.g. Sher *et al.*, 1979). Development of this topography beneath a thick ice sheet is highly questionable.

(3) No raised beaches have been reported for the shores of the East Arctic Seas; instead, submerged shorelines are widespread (e.g. in the Laptev Sea of Fartyshev, 1993).

(4) The strongest evidence against the ESASIS hypothesis is provided by paleoecological studies. Multidisciplinary research suggests the existence of extensive exposed shelf land in East Siberia during the late Weichselian. The area, including the present coast and shelf islands, was occupied by dry grassland communities (tundra-steppe) and diverse fauna of grazing mammals (Sher, 1992). Admitting that "the only evidence against a marine ice sheet in the East Siberian and Chukchi Seas is a 20 ka date on a single mammoth tooth on Wrangel Island", Hughes and Hughes (1994) were not aware that this is not the only date of that kind in the East Siberian Arctic. Even if only radiocarbon dates obtained directly from woolly mammoth bones were obtained and the samples were restricted to the time period between 22 and 14 ka, excluding possible overlapping with the previous warming and the deglaciation, the following dates become evident (Sher and Sulerzhitzky, *in preparation*):

(a) 19.3 and 19.7 ka dates on the October Revolution Island, Severnaya Zemlya (Makeev *et al.*, 1979);

(b) 15.4 and 20.0 ka dates for mammoth on Kotelniy Island (Makeev *et al.*, 1989), 20.9 ka on Faddeyevskiy Island (Novosibirsk Islands);

(c) the mentioned 20 ka date on Wrangel Island;

(d) 15.1 ka date from Chukotka (Anadyr Lowland, the Main River);

(e) 14.3, 14.8, 17.8, 18.7, 21.3, 22.0 and 21.6 ka mammoth dates from the coastal lowlands between the Taimyr Peninsula and the Lena River. The last date is especially indicative, as it comes from a mammoth bone found in place in a well-studied section of the Bykov Peninsula, Tiksi area (Tomirdiaro *et al.*, 1984), just a few km north from the only area where the field observations were reported to support the ESASIS idea (Grosswald *et al.*, 1992); and,

(f) 16.3, 20.4, 23.5 and 23.8 ka dates from unglaciated areas of the Taimyr Peninsula.

The reliability of radiocarbon dates on bone collagen, especially for the bones collected in the Arctic, has been confirmed by extensive methodological research by Sulerzhitzky (Sher and Sulerzhitzky, *in preparation*).

(5) When the broad-scale ESASIS hypothesis is applied to any particular region of the East-Siberian Arctic, contradictions with the available evidence surface. This has been documented in the following regions:

(a) Severnaya Zemlya, where the area covered by the Sartanian upland glaciers was even less than at present, and the periglacial deposits of the same age are well dated (Makeev *et al.*, 1979);

(b) Bykov Peninsula, Tiksi area (see above);

(c) Kotelniy Island, with its succession of terraces (Makeev *et al.*, 1989);

(d) lower courses of the Kolyma and Indigirka Rivers with well-studied Sartanian terraces (Sher *et al.*, 1979; Sher, 1992);

(e) Anadyr lowland with its perfect end moraines confined to the areas of the maximum Pacific moisture input (Sher, 1962, Heiser, 1994); and,

(f) the Bering Sea, where the glacial geology suggests that there is no evidence for glaciers originating on the Arctic Shelf (Heiser *et al.*, 1992; Hopkins *et al.*, 1992).

Summary of the evidence cited above suggests that the answer to the question addressed in the title is probably negative.

REFERENCES

Fartyshev, A.I. (1993). *Cryolithozone of the Laptev Sea*. Moscow, Nauka, p.156.

Grosswald, M.G. (1984). Glaciation of the continental shelves. *Polar Geographical Geology.*, **8**, 194–351.

Grosswald, M. (1988). Antarctic-style ice sheet in the Northern Hemisphere: Toward the new global glacial theory. *Polar Geographical Geology.*, **12**, 239–267.

Grosswald, M.G., Karlen, W., Shishorina, Z. and Bodin, A. (1992). Glacial landforms and the age of deglaciation in the Tiksi area, East Siberia. *Geographical Ann.*, **74(A)**, 295–304.

Heiser, P. (1994). Pleistocene glacier extent in Chukotka, Russia: A study of moraine sequences using satellite synthesis aperture radar. International Conference on Arctic Margins, 2nd, Magadan, Abstracts.

Heiser, P., Hopkins, D.M., Brigham-Grette, J., Benson, S., Ivanov, V.F. and Lozhkin, A.V. (1992). Pleistocene glacial geology of St Lawrence Island, Alaska. *Geological Society of America Abstracts and Programs*, **V. 24(7)**, p. 345.

Hopkins, D.M., Benson, S., Brigham-Grette, J., Heiser, P. and Ivanov, V. (1992). Ice Sheets on the Bering shelf? International Conference on Arctic Margins, 1st, Anchorage, AK, Abstracts, p. 27.

Hughes, B.A. and Hughes, T.J. (1994). Transgressions: rethinking Beringian glaciation. *Palaeogeography, Palaeoclimatology, Palaeoecology*, **110**, 275–294.

Hughes, T., Bonnichsen, R., Fastook, J.L. and Hughes, B. (1991). Pleistocene Beringia: An outright land bridge or a glacial valve constraining Asian migration to North America? *XIII Int. Conf., Int. Union Quat. Res.*, Beijing, p. 144.

Makeev, V.M., Arslanov, Kh.A., Baranovskaya, O.F., Kosmodamiansky, A.V., Ponomaryova, D.P. and Tertychnaya, T.V. (1989). Late Pleistocene and Holocene stratigraphy, geochronology, and paleogeography of Kotelny Island. *Bulletin of Commission for Study of the Quaternary 58*, 'Nauka', Moscow, pp. 58–69. (In Russian).

Makeev, V.M., Arslanov, Kh.A. and Garutt, V.E. (1979). Age of mammoths of Severnaya Zemlya and some questions of palaeogeography of the latest Pleistocene. *Doklady AN SSSR, 245*, **2**, 421–424. (In Russian).

Ovander, M.G., Lozhkin, A.V., Bashlavin, D.K. and Zhigulyovtseva, S.N. (1987). Paleogeographic situation during the time of deposition of the Yedoma Suite in the Yana-Indigirka Lowland. In: *Quaternary of North-East Asia. SVKNII AN SSSR*, pp. 119–134. (In Russian).

Sher, A.V. (1962). Quaternary glaciation of the Amguema Depression and Kanchalan Lowland. MD MS in Geomorphology, Department of Geography, Moscow State University, p. 120 (In Russian).

Sher, A.V. (1992). Biota and climate in Arctic Northeast Siberia during the Pleistocene/Holocene transition. In: *The 22nd Arctic Workshop, March 5–7, 1992*, Boulder, pp. 125–127.

Sher, A.V. and Sulerzhitzky, L.D. (1995). Radiocarbon dating of fossil mammals in the Siberian Arctic: implications on paleoecology of the Mammoth Fauna. *(in preparation)*.

Sher, A.V., Kaplina, T.N., Giterman, R.E., Lozhkin, A.V., Arkhangelov, A.A., Kiselyov, S.V., Kouznetsov, Yu, V., Virina, E.I. and Zazhigin, V.S. (1979). Late Cenozoic of the Kolyma Lowland. *XIV Pacific Science Congress*. Guide, Tour XI. Acad. Sci. USSR, Moscow, 1–115.

Sher, A.V. and Plakht, I.R. (1988). Radiocarbon dating and problems of Pleistocene stratigraphy in the North-East USSR lowlands. *Izvestiya AN SSSR, Series Geology*, **8**, 17–31. (In Russian).

Tomirdiaro, S.V., Arslanov, Kh.A., Chyornen'kiy, B.I., Tertychnaya, T.V. and Prokhorova, T.N. (1984). New data on the formation of loess-ice sequences in Northern Yakutia and mammoth fauna environment in the Arctic during the late Pleistocene. *Doklady AN SSR, 278*, **6**, 1446–1149. (In Russian).