The mean snow density was 400 kg m^{-3}. Thus, the winter accumulation in 1990 on the Loonney ice cap equalled 0.4–0.5 m water equivalent within the firn basin. This value is close to the accumulation measured at the same location in 1961 (Markin, 1964) but is more than twice as large as that measured in 1962 (Govoruha, 1964).

From data presented here, we have concluded that contemporary accumulation, firn stratigraphy and 10 m temperatures are very similar to those obtained earlier on the opposite shore of the Barents Sea — on the Vestfonna and Austfonna ice caps of Nordaustlandet, Svalbard. The deep-hole temperature profile from Vestfonna (Kotlyakov, 1985) paralleled the Alexandra Land profile (the latter is colder) to a tenth of a degree. Future deep drilling, involving detailed core investigations and new data on the englacial temperature distribution should enable us to determine whether there is also a similar history of development on the Loonney ice cap.

Institute of Geography,
U.S.S.R. Academy of Sciences,
Moscow 109017, U.S.S.R.

SERGEY A. SIN'KEVICH
PAVEL A. KOROLEV
KONSTANTIN E. SMIRNOV

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REFERENCES

Arkhipov, S. M. *and 11 others*. 1987. Soviet glaciological investigations on Austfonna, Nordaustlandet, Svalbard in 1984–1985. *Polar Geogr. Geol.*, **11**(1), 25–49.

Govorukha, L. S. 1964. Snegomernyye s"yemki na Zemle Frantsa-Iosifa [Snow measurements at Franz Josef Land]. *Mater. Glyatsiol. Issled.* 9, 263–265.

Grosval'd, M. G. *and 6 others*. 1973. *Oledeneniye Zemli Frantsa-Iosifa [Glaciation of Franz Josef Land]*. Moscow, Izdatel'stvo "Nauka".

Korolev, P. A., S. A. Sin'kevich and A. V. Tarusov. 1988. Stroyeniye firnovoy tolshchi lednikov Svea-Kongsvegen na o. Zapadnyy Shpitsbergen i ikh glyatsiologicheskaya zonal'nost' [The structure of the firn sequence of the Svea-Kongsvegen glaciers on Spitsbergen and their glaciological zonation]. *Mater. Glyatsiol. Issled.* 64, 78–83.

Kotlyakov, V. M. 1985. *Glyatsiologiya Shpitsbergena [The glaciology of Svalbard]*. Moscow, Izdatel'stvo "Nauka".

Markin, V. A. 1964. Snegomernaya s"yemka na lednikovykh kupolakh Zemli Aleksandry [Snow measurement at the ice caps of Alexandra Land]. *Mater. Glyatsiol. Issled.* 9, 265.

Sin'kevich, S. A. In press. Peculiarities of firn layers and conditions of ice formation at firn basin of Austfonna, Svalbard.

Zagorodnov, V. S. and S. M. Arkhipov. 1989. Ekspress-analiz kerna dlya izacheniya stroyeniya i temperaturnogo rezhima Vostochnogo ledyanogo polya [Express tests of the core made in order to study the structure and temperature regime of Austfonna]. *Mater. Glyatsiol. Issled.* 66, 149–158.

Zagorodnov, V. S., S. A. Sin'kevich and S. M. Arkhipov. 1990. Gidrotermicheskiy rezhim ledorazdel'noy oblasti Vostochnogo ledyanogo polya, o. Severo-Vostochnaya Zemlya [Hydrothermal regime of the Austfonna ice divide, Nordaustlandet]. *Mater. Glyatsiol. Issled.* 68, 133–142.

The accuracy of the references in the text and in this list is the responsibility of the authors, to whom queries should be addressed.

SIR,

Unusual discoveries of corpses immersed in glacier ice after fatal accidents — glaciological aspects

The rare occurrence of a corpse becoming exposed on a glacier surface is closely connected with the glaciological situation at the scene of the accident. The discovery in August 1990 of two corpses on the Mitterkarferner (Oetztal Alps, Tyrol) initiated a glaciological comparison of this recent discovery with earlier discoveries made on Tyrolean glaciers. There are three known cases, which can be characterized as follows: accident in the accumulation area (fall over a rock face) and discovery in the accumulation area near the equilibrium line (1990); accident in the ablation area (fall down a crevasse) and discovery in the ablation area (1973); accident in the accumulation area and discovery on the ice-free terrain at the very end of the glacier (1952). Furthermore, a further case is described which is glaciologically obscure.

Case 1. Following a fall down a rock face with a gradient of 45–50° and a height of 260 m, the casualties (a married couple) came to rest in the accumulation area of the Mitterkarferner, close to the base of the headwall (3400 m a.s.l.). The accident occurred on 25 August 1965 and the casualties were recovered in the accumulation area at altitudes of 3320 and 3340 m a.s.l., respectively, on 21 September 1990. They had therefore been immersed in glacier ice for 25 years. In view of the immersing component of the flowlines, it is to be expected that the casualties would have been exposed in the ablation area at a much later date. It is because of the high rate of ablation in the years 1984–85 to 1989–90 (personal communication from G. Markl) that the casualties were only discovered in the accumulation area near the equilibrium line after 25 years. Flow path and time yield a mean flow velocity of <6 m year^{-1}, which agrees with measurements taken on the Kesselwandferner, a glacier located in the near vicinity (Schneider, 1970).

The Mitterkarferner has a length of 2.1 km and a maximum width of 1.2 km. The upper part (>3300 m a.s.l.) is exposed to the southwest and the lower part to the southeast. The lowest part is strongly covered by rock debris, deposited by rockfalls from the slopes above and transferred by the stream lines. Above the discovery location, the glacier has a gradient of 35–40°. This could have caused the casualties to slide down several meters in the course of the accident and could have led to a lower averaged flow velocity. There is no bergschrund.

The mean equilibrium-line altitude for the periods 1965–66 to 1989–90 is estimated at 3150 m a.s.l. on the basis of exposures and steepness. For comparison, the

equilibrium-line altitude of the Hintereisferner is 2990 m a.s.l. and that of the Kesselwandferner is 3095 m a.s.l. (personal communication from G. Markl). Comprehensive glaciological investigations have been carried out for many decades on both glaciers which are immediately adjacent. The Mitterkarferner is close to Wildspitze which is the highest peak in the Tyrol.

Case 2. Following a fall down a crevasse (>40 m) in the ablation area of the Gurglerferner (Oetztal Alps, Tyrol) at approximately 2800 m a.s.l., the casualty was discovered on the glacier surface in 1973, about 150 m below the scene of the accident. The fatal accident occurred in 1965 and the corpse had been immersed in glacier ice for 8 years. Flow path and time of flow movement yield a velocity of approximately 20 m year^{-1}. Considering the size of the Gurglerferner (length 6.5 km, maximum width 3.0 km, depth at the accident site ~140 m), this value seems consistent with glaciological measurements (Schneider, 1970).

Case 3. After a fatal accident in the upper part of the Madatschferner (Oetztal Alps, Tyrol) in 1923, the casualty was discovered in 1952 at the very end of the glacier on the ice-free terrain, but not at the terminus of the glacier. The casualty had therefore been immersed in glacier ice for 29 years. The circumstances of the accident are unknown. There is a trail leading across the uppermost part of the Madatschferner. Assuming that the accident happened on this trail, path and time of the movement would have resulted in an average velocity between 25 and 35 m year^{-1}. Glaciological experience shows that this value is too high, because the Madatschferner is a relatively small glacier (length 1.1 km, maximum width 0.6 km). It is therefore to be concluded that the accident occurred some distance from the trail and at a lower altitude.

A glaciologically obscure case is the discovery of bones of a human skeleton in the ablation area of the Rotmoosferner (2700 m a.s.l., Oetztal Alps, Tyrol) in 1982 and in 1990. Both discoveries were made at the same location. Both sets of bones were identified as belonging to the same person reported missing in March 1943. This person had therefore been immersed in glacier ice for between 39 and 47 years, respectively. The time difference between the two discoveries at the same location is unclear from a glaciological viewpoint.

A discovery of particular historical interest was made on Theodulgletscher (Wallis Alps, Switzerland) and was reported earlier by Krämer and others (1988).

For forensic medicine, glaciological data are interesting in relation to the post-mortem findings.

Sincere thanks are due to officials of the rural police station in Soelden (Oetztal, Tyrol) for supplying necessary information. Also, G. Markl is thanked for making data available.

Institut für Medizinische Physik,
Universität Innsbruck,
A-6020 Innsbruck, Austria
W. AMBACH

Institut für Gerichtliche Medizin,
Universität Innsbruck,
A-6020 Innsbruck, Austria
E. AMBACH
W. TRIBUTSCH

24 November 1990

REFERENCES

Krämer, M., P. Lehner and P. Zink. 1988. Über zwei Gletscherleichen mit "Eiszeiten" von 70 und 400 Jahren. *In* Bauer, G., *ed. Festschrift für Wilhelm Holczabek 'Gerichtsmedizin'*. Wien, Franz Deuticke Verlagsges. m.b.H., 5–8.

Schneider, H. 1970. Die Grundlagen der Vermessung am Kesselwandferner (Ötztaler Alpen) und die Bewegung dieses Gletschers in den Haushaltsjahren 1965/66, 1966/67 und 1967/68. (Thesis, Universität Innsbruck.)

The accuracy of references in the text and in this list is the responsibility of the authors, to whom queries should be addressed.

SIR,

Reply to: "Comments on: '6000-year climate records in an ice core from the Høghetta ice dome in northern Spitsbergen' "

First, we appreciate the comments and suggestions by Dowdeswell and others (1990) on our chronology and palaeoclimatic interpretation of the ice cores obtained in northern Spitsbergen (Fujii and others, 1990). Since reliable chronology of the ice core obtained from the superimposed ice zone, as at our research site (Høghetta) is difficult because of the disappearance of seasonal and even annual stratification by melting, percolation and/or wash-out, there might be a case for some chronological interpretation on the basis of the analysed data.

We should like to describe our chronological interpretation of the ice core giving some recent data and other evidence additional to that already described. In table II of the paper there is a misprint: 1770 in column "Period" should be read as 1700 as appears in the text. Therefore, we should read 1770 in the comments by Dowdeswell and others as 1700.

Core chronology for recent decades

The ice-coring site at Høghetta, Spitsbergen, is located in a typical superimposed ice zone as no firn was observed in the core. Percolation of melt water to the lower layers is not so important in superimposed ice because the water channels developed at grain boundaries only in the upper 20 cm, as was observed in the cob-webbed air-bubble layer. So the annual characteristics of the ice are considered to be preserved when the annual balance is positive, even though percolation occurs.

The tritium profile shown in figure 3 of the paper (Fujii and others, 1990) is, therefore, thought to reflect the annual characteristics when mass balance was positive. The variation pattern is compared with the recent results of tritium analyses (Izumi, in press) for firn cores obtained at site J (67.5° N, 43.5° W), southern Greenland (the