GENERAL DISCUSSION

Chairman: W. F. Budd

ANTARCTICA AT 20 ka BP

D E SUGDEN: A few years ago the idea of an expanded late Wisconsin ice sheet in West Antarctica was not readily accepted. During this conference it has been. There is perhaps a danger of accepting the idea uncritically, and it is important to distinguish between evidence and assumption. For example, a radio-carbon date on shells of 31 ka found in till on the floor of the Weddell Sea (as reported by O Orheim) is not, on its own, unambiguous evidence of a late Wisconsin grounded ice sheet. Amino-acid work has shown many such dates to be unreliable.

T J HUGHES: If George Denton were still here he would recommend ice coring along the West Antarctic ice divide between the Ellsworth, Whittmore, and Thiel mountains to see if air-bubble pressures show a higher ice elevation to the limit of glacial erosion in these mountains caused by a uniformly thicker ice sheet. Secondly, could the air-bubble pressures link these higher ice levels to late Wisconsin/Weichselian time?

ICE-CORE STUDIES: DUST AND VOLCANISM

M M HERRON: In Greenland there is abundant evidence that the higher insoluble particle concentrations found in late Wisconsin-age ice are continental dust, a bit more calcareous in nature than today. However, measurements of volcanogenic species such as SO, Cd, and Zn show peaks at about 10, 30, and 60 ka in the Camp Century core. These horizons correlate extremely well with radio echo layers at appropriate depths at sites in Greenland where they are not masked by bottom echoes.

NITRATES

E J ZELLER: Our group has had a lengthy discussion with Mike Herron and we find points of both agreement and disagreement. In brief, both groups get roughly the same mean nitrate value in South Pole firn from cores. Our major disagreement is over the Maunder minimum. Herron analysed the nitrate in a short section of firm core from South Pole, at a depth which he dates as belonging to the Maunder minimum, and he does not find the low nitrate values that we find throughout the Maunder minimum. At this time there is no explanation for this disagreement.

Our laboratory has available a second 60 m Vostok core and we will complete analyses on this within the next six months. This will be of further aid in confirming the results from South Pole and Vostok.

M M HERRON: I have found no evidence of lower nitrate concentrations during the Maunder minimum in solar activity in either the South Pole or in the Dye-3 Greenland, ice core. The latter core has the great advantage of being dated with an accuracy of ±1 a. I have also not found a cycle of 11 a in nitrate concentrations, nor the spurious concentration spikes that were attributed by Rood and others (1979) to supernovae. I believe that analytical problems, including sample handling, may be responsible for the results of Parker, Zeller and Gow which I cannot duplicate.

U RADOIK: As a meteorologist I was very intrigued to hear that at long last there was a claim of a surface phenomenon that related unambiguously to the 11 and 22 a cycles. This has been sought for a century but never identified convincingly. The difficulty seems to be that if you have an event that occurs in the upper atmosphere, the time that is needed to bring its effects down to the surface is such that for any event lasting only that long, and possibly longer, the effects are not very likely to survive the trip. I would like to raise the question: how definite is it that you really have found this elusive phenomenon in the nitrates?

E J ZELLER: We now have high-resolution pit samples from South Pole station which have been collected in three replicate vertical columns spanning 52 a. We see evidence not only of solar activity related to the sunspot cycle, but also of the intense solar flare that occurred in 1972. In addition we have found a correlation of r = 0.54 between nitrate in pit samples and satellite data on charged particle abundance that is available from 1972 to 1979.

WEST ANTARCTIC GROWTH AND DECAY

J WEERTMAN: Will a warming of the oceans actually lead to a reduction of the Antarctic ice sheet even if, as seems likely, it leads to a reduction in size of the ice shelves? For example, we learned at this symposium that Pine Island Glacier is really a "one-dimensional" 100 km long floating ice shelf. Why would chopping off, say, 50 km of this ice shelf lead to any significant change in the size of the West Antarctic ice sheet?

T J HUGHES: Some people object to my talking of disintegration of the West Antarctic ice sheet. I do this because disintegration means breaking into bits, that is, converting the ice sheet into icebergs. This brings the ice to the heat, which seems to me a more efficient way of removing ice sheets than bringing heat to the ice. Therefore, I would recommend more research on icebergs, both in modelling how icebergs form, as Bill Schmidt and Jim Fastook have done, and in monitoring their size and numbers as Olav Orheim has done. I am impressed with Bob Thomas's model for irreversible grounding-line retreat once a confining ice shelf is removed, and a few giant icebergs can remove an ice shelf in a hurry.
VOLCANIC HEAT AND THE WEST ANTARCTIC ICE SHEET
C S BENSON: An anomalously high regional geothermal heat flux associated with volcanism beneath most of the West Antarctic ice sheet may be a major factor in its recent acceleration. In its most extreme form it could be the most important as well as the least understood of all the factors contributing to the acceleration of ice flow, a major cause of the world sea-level rise over the last several decades. Studies in the circum-Pacific volcanic belt suggest that geothermally driven basal melting is an important factor in ice sheet instability in Alaska and elsewhere. The normal geothermal heat flux is adequate to melt 5 mm a\(^{-1}\) of ice. The heat flux calculated by LeMasurier and Wade (1968) for the base of the Byrd Station ice sheet is about 10 mm a\(^{-1}\). It is not unusual for regional heat flux values to be several times higher than this in volcanic areas. Indeed, from a volcanological point of view, polar regions are perhaps best known for the unique record of volcanic rocks and the potential for accumulating them in lake-like reservoirs with subsequent discharge.

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REFERENCES


Benson C S, Bingham D K, Wharton G B 1975 Glaciological and volcanological studies at the summit of Mt Wrangell, Alaska. International Association of Hydrological Sciences Publication 104 (General Assembly of Moscow 1971 – Snow and Ice): 95-98

Bindschadler R 1982 The importance of pressurized subglacial water in separation and sliding at the glacier bed. Annals of Glaciology 3: 349


Motyka R J, Macketh P, Benson C S 1980 Mt Wrangell caldera: utilization of glacier ice to measure heat flow and infer thermal regime. EOS. Transactions of the American Geophysical Union 61(6): 69

Oswald G K A 1975 Investigation of sub-ice bedrock characteristics by radio-echo sounding. Journal of Glaciology 15(73): 75-87

Rood R T, Sarazin C L, Zeller E J, Parker B C 1979 X- or y-rays from supernovae in glacial ice. Nature 282(5740): 701-03

Vinogradov V N 1975 Sovremennye oledeneniye rayonov aktivnogo vulkanizma [Modern glaciation of regions of active volcanism]. Materialy Issledovaniy po Mezhdunarodnym Geofizicheskim Proektam (Unnumbered series)
