that demonstrated clearly the importance of
dextral strike-slip movements during the
early (Anguille) stages of deposition. The
major evidence is structural (e.g., fold axes
oriented obliquely to master faults) and not
sedimentological.
The paleomagicians (and their detrac-
tors) held the spotlight for the final talks of
this session. Ernie Deutsch re-evaluated
paleomagnetic data from the British Isles,
and combined this information with other
geochemical evidence to calculate an abso-
late width for the Lepetit Ocean of 3600 ±
2200 km! If the uncertainty in the position
of modern Newfoundland was so great,
then the current dispute with the federal
government over offshore petroleum re-
sources might involve Colonel Khaddafi
rather than Pierre Trudeau.

Papers presented by Bill Morris and
Deve Strong (co-authored by Ted Irving)
addressed the question of Late Paleozoic
strike-slip motions in the northern Appala-
chians. Both papers presented arguments
against major movements of the magnitude
suggested by Van der Voo, Kent and Op-
dyke, etc. Morris surveyed existing paleo-
magnetic data for Devonian and
Carboniferous movements, and concluded
that the data are the result of Permian lat-
etic weathering or Hercynian metamorph-
ism, and have nothing to do with primary
rock magnetism. Strong presented new
data gathered from Carboniferous rocks in
eastern and western Newfoundland. These
data are consistent for all localities, and
yield a paleolatitude of about 20 degrees
south. This latitude is 40 degrees different
than supposed Carboniferous cratonic data
(Mau Chunk, Barnett and St. Joe Forma-
tions), and on this basis other workers have
suggested major wrench movements. Strong
and Irving, however, obtained identical data
from the Deer Lake Basin of western New-
foundland, which on the basis of field rela-
tionships was deposited directly on the
craton! There are no major faults between
these sediments and the interior of the crat-
on. The reason that the discrepancy in pa-
leopole positions exists is not due to real
strike-slip movements. Rather, it is the re-
result of a strong Permian overprint which
has been successfully filtered from the Ap-
palachian data, but which has been erco-
ecously ascribed to Carboniferous
magnetization on the craton. The implica-
tions of this discovery are clear and pro-
found. Proponents of major sinistral strike-
slip movements in the Appalachians during
the Late Paleozoic will have to return to
the drawing board and begin anew by obtain-
ing true Carboniferous paleomagnetic data
from the craton! Geologists working on
the ground in eastern Canada will be pleased
with this turn of events, as all hard geologic
data have indicated Late Paleozoic dextral,
not sinistral, movements, usually of minor
magnitude. As many of us suspected, the
test of theories that suggest major
plate movements is to be found in outcrops
on the ground. The paleomagnetic hypoth-
esis has, in this case, failed the test.

This meeting left all participants with a
better understanding of the rock sequences
and problems associated with the ancient
continental margin of eastern North Amer-
ica in western Newfoundland. Clearly this
resulted from the inclusion in the program
of papers from many fields in the earth sci-
ences, including crustal geodynamics, se-
dimentology, stratigraphy, structural
geology, geochemistry and paleomagne-
tism. The program chairman, Chris Barnes,
is to be congratulated on his success in
putting together such a multidisciplinary
symposium.

The 12th Arctic Workshop

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Introduction
The 12th Arctic Workshop was held in Am-
erst, Massachusetts, March 16-18, 1983
and was sponsored by the Institute of Arctic
and Alpine Research (INSTAAR). The
workshops normally bring together about
70 people engaged in cold region environ-
mental studies, including biology, geology,
physics and history. Thus, the workshops
are interdisciplinary, an event at which pa-
lynologists, glaciologists, botanists and ma-
rine geologists may find it interesting to
listen to each other mainly because of the
many overlaps in their work and the com-
raderie that normally develops between
those who work in remote areas.

During the three days of this workshop a
total of 28 papers and one afternoon de-
voled to poster sessions touched upon a
wide range of topics. Although interaction
between subdisciplines was very strong,
the major topics could be ranked as fol-
loows: glacial geology, climate, botany, pa-
laeoecnology and paleoclimate, history of
polar research and anthropology. In this
report we discuss the main points of ten
papers which are most relevant to our own
interests in Arctic geological research.

The First International Polar Year
This year's workshop was held against the
background of the centennial of the First
International Polar Year, 1882-1883. Fit-
tingly, the first paper, by W. Barr, University
of Saskatchewan, dealt with some of the
pioneer geomorphological investigations
that took place during the First International
Polar Year. At that time 14 polar expedi-
tions were undertaken with eleven coun-
tries participating. This was the first truly
international scientific investigation of polar
regions and, although intended to focus on
meteorology, terrestrial magnetism and aur-
oral studies, a number of participants made
geomorphological observations that remain
significant, considering their early date. For
example, an excellent description of pin-
goes and tundra polygons in the Lena delta
region was made by the members of the
Russian expedition (1881-1884). To date,
this has been the only published mention of
pingoes in the Lena Delta, although they are
similar to those described for the Mac-
kenzie Delta. In northern Labrador, Dr. K.R.
Kock from the German expedition (1883)
noticed a sharp contrast between the shat-
tered felsenmeer of the upper slopes and the
heavily glaciated lower slopes of the
Torrngat Mountains. He concluded that the
higher peaks of these mountains had es-
cape the last glaciation.

The Marine Environment and Climate
Three papers dealt with the ocean as a cli-
matic modifier and as a source for ancient
climatic paleosignals. P.M. Kelly, University
of East Anglia, discussed a scheme de-
vised by the Soviet Union to direct the flow
of a number of Siberian rivers to the south
for the purpose of land irrigation. The pro-
ject would involve the diverting of up to 200
to 300 km³ of water per year by the middle
of the next century. The interference with
the Arctic hydrologic system at this magni-
tude could have profound climatic effects.
For example, it is believed that Siberian
river runoff is a major factor in maintaining
a strong pycomcline that favours the forma-
tion of sea ice over the Arctic Ocean and
its marginal seas. The runoff also appar-
ently reduces the rate of heat exchange
between the deeper intermediate Atlantic
water and the seasonal layer at the sea
surface. This simple runoff-air cover rela-
tionship is controversial because some evi-
dence suggests a direct dynamic
relationship between the volume of the war-
mer Atlantic water entering the Arctic
Basin and river runoff in to the Kara Sea. In this hypothesis reduced runoff minimizes the volume of the warm Atlantic water and heat flux to Siberian Shelf waters. This, in turn, will favour the formation of thicker winter ice and delay spring ice decay. It is clear that the net effect of river diversion to the south is far from being understood. Dr. Kelly also pointed to the unusually open and heated discussion of these questions in the Soviet scientific literature.

W. Ruddiman, Lamont-Doherty Geologi- cal Observatory, talked about a revised time scale for Late Pleistocene sediments of the Central Arctic Ocean. His work re- evaluates the interpretation of lithostratigraphy based on approximately 500 sediment cores. Spectral analyses of carbonate relative percent in sediment show strong 100,000 year cycles, followed by weaker 41,000 year and 23,000 year cycles. Ac- cording to the Milankovitch theory, the or- bital and axial perturbations of the earth are the basic causes for major climatic changes and the overall net effect varies with lati- tude. Along latitudes higher than 45° the 100,000 year and 41,000 year cycles are dominant, whereas along the lower lati- tudes the 23,000 year cycles are major. Following the Milankovitch theory, the strong 100,000 year carbonate cycle in the Arctic Ocean indicates a paleoceneo- graphic response to the glacial-interglacial fluctuations during the Quaternary Period. The carbonate relative percent in cores has potential for providing a chron stratigraphic framework for Arctic Ocean sediments of that period.

Detmar Schnitker, University of Maine, explained how the deep water formation in the Norwegian-Greenland Sea influences major climatic events on a global scale. At about mid-Miocene time the modern deep water circulation pattern was established in the Atlantic Ocean. It is characterized by deep water formation in the subpolar seas, such as the Norwegian-Greenland Sea and Weddell Sea in the South Atlantic. At about the same time the Antarctic Ice Cap started to expand to its present dimensions. During interglacial intervals the formation of the North Atlantic Deep Water (NADW) in the Norwegian-Greenland Sea is most exten- sive. The NADW flows toward the south pole at bathyal depths and becomes an important component to the circumpolar Antarctic Current by contributing to it some of its heat and salt. During the glacials the deep water formation in the Norwegian- Greenland Sea was considerably reduced or ceased altogether. As a result, the Ant- arctic circumpolar water became cooler and fresher, favouring the formation of ex- tentive sea ice. This is the mechanism by which the deep waters of the Atlantic Ocean provide the "teleconnection" be- tween northern and southern hemisphere climatic events.

**Glacial Margins in Northern Labrador**

P. Clark (INSTAAR) and H. Josenhans (At- lantic Geoscience Centre) in a two-paper series made an attempt to correlate onshore-offshore glacial chronology in Nor- thern Labrador. The onshore glacial events were deduced from the relative freshness of glacial terrain, degree of soil develop- ment, amino acid ratios and 14C dates of molluscan shells. The offshore glacial events were deduced from high resolution seismic profiles and by mapping the occur- rence of characteristic acoustic features believed to represent till.

The onshore evidence suggests an early Wisconsinan ice advance over the contin- ental shelf. The altitude of a moraine de- posited during this advance indicates a minimum ice thickness of 650 metres. An ice sheet of this thickness near the coast would terminate 20-30 km offshore. A se- ries of offshore tills mapped as moraines at this distance from the shore are believed to mark the limit of this early Wisconsinan ice advance.

The early Wisconsinan advance was fol- lowed by a mid-Wisconsinan retreat, as indi- cated by fossiliferous glaciomarine sediments at Iron Strand. A minor late Wis- consinan advance was restricted to the major valleys and did not advance beyond the mouth of these valleys. Evidently, large areas of Tornqat mountains and coastal re- gions, such as the Iron Strand, remained unglaciated during the late Wisconsinan glacial interval.

**Glacial margins on Ellesmere Island**

John England, University of Alberta, dis- cussed the evidence for an ice-free corridor that apparently existed between northeast Ellesmere Island and the ice sheets of northwestern Greenland during the late Wisconsinan glacial interval. The open water had all the characteristics of a "full glacial sea" that occupied a peripheral depression due to the Greenland ice sheet. The marine maximum and subsequent regressions of this glacial sea were deter- mined by 14C dates of in situ molluscan shells. The isostatic rebound curves de- scribe the history of glacial unloading and are in agreement with paleostratigraphies pre- dicted by a model that calls for a minimum glacial extent in the area. The paleosea- level curves are unique in showing a rela- tively stable paleosealevel at the marine limit between 11,000 yBP and 8,000 yBP, followed by a slow emergence from 8,000 yBP to 6,200 yBP and a relatively rapid emergence after 6,200 yBP in response to a prominent interval of-amelioration.

Michael J. Retelle, University of Massa- chusetts, also delivered a strong case for a limited glaciation over the Queen Elizabeth Islands. He used stratigraphic evidence collected near Robertson Channel on El- lesmere Island for a late Wisconsinan ice- free corridor between Greenland and Elles- mere Island. An early Wisconsinan maxi- mum advance of the northwest Greenland ice deposited moraines and stratified drift in proglacial lakes. The dates of fossilifer- ous horizons from these deposits are older than 36,000 yBP. No evidence exists for a major over-running or cross-cutting of these old deposits by late Wisconsinan ice.

Sediment cores from basins of the coastal zone are being studied to deter- mine the duration and extent of the sea that occupied the peripheral depression be- tween the Greenland ice sheet and Elles- mere Island. Radiocarbon dates from the marine-lacustrine boundary in these cores will assist in reconstructing the relative sea level history that postdates the marine maximum.

Jan Bednarski, University of Alberta, dis- cussed a history of deglaciation along Clements Markham Inlet, a major reentrant on the northermost coast of Ellesmere Island. He used 40 radiocarbon dates of shells in raised marine deposits to recon- struct the chronology of ice margin dynam- ics and to derive local emergence curves. Mountain-top erratics and other evidence suggest that the penultimate glacial epis- ode was more extensive than the last one, which was restricted only to low-lying areas. The greater part of the inlet was ice free before 10,690 yBP and relative sea level curves indicate moderately stable strandlines at around 11,000 yBP, rapid emerg- ence between 8,000 yBP and 5,000 yBP and a progressively slower emergence to- wards the present. The nearly steady early strandlines would suggest that rapid degla- ciation did not take place until about 8,000 yBP.

J. Svoboda, University of Toronto, dis- cussed flora that is being uncovered by a retreating glacier at Alexandra Fjord on Central Ellesmere Island. Of the papers delivered at the workshop, this paper could be ranked as first in terms of quality, gen- eral interest and imagination. The paper was introduced with a series of excellent slides showing a glacial ice tongue resting on a sparsely vegetated terrain where dif- ferent colour zones distinguished the re- cently uncovered area from areas that are in the process of being reinvaded by new plants. The visual impact of the completely undisturbed nature of the ice-terrain con- tact was convincing if not dramatic.

The uncovered vegetation consists of a Cassiope tetragona—Dryas integrifolia dominated community. Two uncovered
specimens of Cassiope and Salix gave an average 14C date of 415 yBP. Many of these plants are in excellent condition, for example, Vaccinium uliginosum (arctic blueberry) and Salix arctica (arctic willow) had foliage still attached. Spectrophotometric analysis recognized remnants of chlorophyll on some plants, although seed viability tests were unsuccessful. The excellent preservation of the plants suggests that this glacier was frozen to its base and that ice movement was by internal deformation, rather than by erosive basal sliding.

This paper is a good example of how research in one discipline (botany) can elucidate processes in other disciplines (glaciology, geology). Interactions of this kind make the participation in the Arctic Workshops particularly worthwhile.

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Edited by J.T. Teller and Lee Clayton
Geological Association of Canada Special Paper 26, 1983

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