Geoscience Canada

The 12th Arctic Workshop

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Volume 10, Number 3, September 1983

URI: https://id.erudit.org/iderudit/geocan10_3con03

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Publisher(s)

The Geological Association of Canada

ISSN

0315-0941 (print)
1911-4850 (digital)

Explore this journal

Cite this article

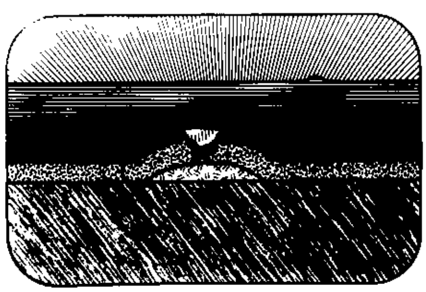
Vilks, G. & Hardy, I. A. (1983). The 12th Arctic Workshop. *Geoscience Canada*, *10*(3), 125–127.

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 detractors) 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 geological evidence to calculate an absolute width for the Iapetus 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 resources might involve Colonel Khaddafi rather than Pierre Trudeau.

Papers presented by Bill Morris and Dave Strong (co-authored by Ted Irving) addressed the question of Late Paleozoic strike-slip motions in the northern Appalachians. Both papers presented arguments against major movements of the magnitude suggested by Van der Voo, Kent and Opdyke, etc. Morris surveyed existing paleomagnetic data for Devonian and Carboniferous movements, and concluded that the data are the result of Permian lateritic weathering or Hercynian metamorphism, 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 Formations), 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 Newfoundland, which on the basis of field relationships was deposited directly on the craton! There are no major faults between these sediments and the interior of the craton. The reason that the discrepancy in paleopole positions exists is not due to real strike-slip movements. Rather, it is the result of a strong Permian overprint which has been successfully filtered from the Appalachian data, but which has been erroneously ascribed to Carboniferous magnetization on the craton. The implications of this discovery are clear and profound. 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 obtaining 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 true test of theories that suggest major plate movements is to be found in outcrops on the ground. The paleomagnetic hypothesis 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 America in western Newfoundland. Clearly this resulted from the inclusion in the program of papers from many fields in the earth sciences, including crustal geodynamics, sedimentology, stratigraphy, structural geology, geochemistry and paleomagnetism. 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 Amherst, 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 environmental studies, including biology, geology, physics and history. Thus, the workshops are interdisciplinary, an event at which palynologists, glaciologists, botanists and marine geologists may find it interesting to listen to each other mainly because of the many overlaps in their work and the comraderie 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 devoted to poster sessions touched upon a wide range of topics. Although interaction between subdisciplines was very strong, the major topics could be ranked as follows: glacial geology, climate, botany, paleoceanography 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. Fittingly, 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 expeditions were undertaken with eleven countries participating. This was the first truly international scientific investigation of polar regions and, although intended to focus on meteorology, terrestrial magnetism and auroral studies, a number of participants made geomorphological observations that remain significant, considering their early date. For example, an excellent description of pingoes 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 Mackenzie Delta. In northern Labrador, Dr. K.R. Kock from the German expedition (1883) noticed a sharp contact between the shattered felsenmeer of the upper slopes and the heavily glaciated lower slopes of the Torngat Mountains. He concluded that the higher peaks of these mountains had escaped the last glaciation.

The Marine Environment and Climate

Three papers dealt with the ocean as a climatic modifier and as a source for ancient climatic paleosignals. P.M. Kelly, University of East Anglia, discussed a scheme devised by the Soviet Union to direct the flow of a number of Siberian rivers to the south for the purpose of land irrigation. The project would involve the diverting of up to 200 to 300 km^3 of water per year by the middle of the next century. The interference with the Arctic hydrologic system at this magnitude could have profound climatic effects. For example, it is believed that Siberian river runoff is a major factor in maintaining a strong pycnocline that favours the formation of sea ice over the Arctic Ocean and its marginal seas. The runoff also apparently reduces the rate of heat exchange between the deeper intermediate Atlantic water and the seasonal layer at the sea surface. This simple runoff-ice cover relationship is controversial because some evidence suggests a direct dynamic relationship between the volume of the warmer 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 Geological 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. According to the Milankovich theory, the orbital and axial perturbations of the earth are the basic causes for major climatic changes and the overall net effect varies with latitude. Along latitudes higher than 45° the 100,000 year and 41,000 year cycles are dominant, whereas along the lower latitudes the 23,000 year cycles are major. Following the Milankovich theory, the strong 100,000 year carbonate cycle in the Arctic Ocean indicates a paleoceanographic response to the glacial-interglacial fluctuations during the Quaternary Period. The carbonate relative percent in cores has potential for providing a chronostratigraphic 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 extensive. 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 Antarctic circumpolar water became cooler and fresher, favouring the formation of extensive sea ice. This is the mechanism by which the deep waters of the Atlantic Ocean provide the "teleconnection" between northern and southern hemisphere climatic events.

Glacial Margins in Northern Labrador

P. Clark (INSTAAR) and H. Josenhans (Atlantic Geoscience Centre) in a two-paper series made an attempt to correlate onshore-offshore glacial chronology in Northern Labrador. The onshore glacial events were deduced from the relative freshness of glacial terrain, degree of soil development, amino acid ratios and ^{14}C dates of molluscan shells. The offshore glacial events were deduced from high resolution seismic profiles and by mapping the occurrence of characteristic acoustic features believed to represent tills.

The onshore evidence suggests an early Wisconsinan ice advance over the continental shelf. The altitude of a moraine deposited 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 series 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 followed by a mid-Wisconsinan retreat, as indicated by fossiliferous glaciomarine sediments at Iron Strand. A minor late Wisconsinan advance was restricted to the major valleys and did not advance beyond the mouth of these valleys. Evidently, large areas of Torngat mountains and coastal regions, such as the Iron Strand, remained unglaciated during the late Wisconsinan glacial interval.

Glacial margins on Ellesmere Island

John England, University of Alberta, discussed 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 determined by ^{14}C dates of *in situ* molluscan shells. The isostatic rebound curves describe the history of glacial unloading and are in agreement with paleosealevels predicted by a model that calls for a minimum glacial extent in the area. The paleosealevel curves are unique in showing a relatively stable peleosealevel 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 Massachusetts, also delivered a strong case for a limited glaciation over the Queen Elizabeth Islands. He used stratigraphic evidence collected near Robertson Channel on Ellesmere Island for a late Wisconsinan ice-free corridor between Greenland and Ellesmere Island. An early Wisconsinan maximum advance of the northwest Greenland ice deposited moraines and stratified drift in proglacial lakes. The dates of fossiliferous 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 determine the duration and extent of the sea that occupied the peripheral depression between the Greenland ice sheet and Ellesmere Island. Radiocarbon dates from the marine-lacustrine boundary in these cores will assist in reconstructing the relative sealevel history that postdates the marine maximum.

Jan Bednarski, University of Alberta, discussed a history of deglaciation along Clements Markham Inlet, a major reentrant on the northernmost coast of Ellesmere Island. He used 40 radiocarbon dates of shells in raised marine deposits to reconstruct the chronology of ice margin dynamics and to derive local emergence curves. Mountain-top erratics and other evidence suggest that the penultimate glacial episode 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 emergence between 8,000 yBP and 5,000 yBP and a progressively slower emergence towards the present. The nearly stable early strandlines would suggest that rapid deglaciation did not take place until about 8,000 yBP.

J. Svoboda, University of Toronto, discussed 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, general 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 different colour zones distinguished the recently 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 contact 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 ^{14}C 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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