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tends to resist erosion. The balance between concentration and physical energy can lead to mud belts on any part of modern or ancient shelves. McCave also challenged Miles Hayes’ interpretation of the process by which hurricanes generate seaward-flowing bottom currents that result in graded storm layers on shelves. Moreton (I.A.S. Special Publication 5) has shown that hurricanes do not pile water up against the coastline to later flow seaward as the storm abates. Instead, there is a continuous bottom flow set up which may be directed either offshore or along shore. McCave favours this continuous flow as the mechanism by which storm layers are emplaced.

The most fascinating, and potentially most significant, aspect of this meeting was the general discussion of hummocky stratification. Philip Allen proposed three possible mechanisms for production of the poorly understood structure: 1. supercritical unidirectional flow; 2. intense oscillatory flows causing rolling-grain ripples; and 3. combined oscillatory and steady unidirectional flows with the waves propagating either with or against the current. Allen did not consider seaward-flowing density currents to be a reasonable alternative. After discussion of the problems associated with generation solely by oscillatory currents, he concluded that the best model for the production of hummocky stratification should be based on the combined effect of waves of moderate height and energy, and gentle steady currents. In the ensuing discussion, two additional mechanisms were suggested. Trevor Elliot noted that hummocky stratification resembles an interference pattern, and wondered if it might be produced by waves propagated at some angle to a steady bottom current. This model is remarkably like that suggested by Nick McCave on the basis of modern shelf studies. John Allen suggested that this structure could be the result of an attempt to form meganipples under waves. Chris Pound, in a later presentation, emphasized that the currents that produce hummocky stratification are commonly erosive, as scour and drape is the most commonly observed feature in the field. Clearly there is no agreement yet on the origin of hummocky stratification, but some of the suggestions presented at this BSRG meeting may yet supplant current explanations.

The 70 short papers, which were interspersed between the reviews, provided a complete cross-section of sedimentological topics, ranging from the practical (reservoir properties) to the academic (Zechstein subtidal stromatolites) and from ancient to modern. Most were well-presented and illustrated, and on time, so that a succession of chairmen, in what was largely a single-session meeting, were able to guide us through an almost bewildering variety of topics.

This meeting was an excellent 21st birthday party for the BSRG. Much of the enthusiasm seen in formal and informal discussions is due to the participation of young researchers and students, and the general acceptance of their views on a par with those of established experts. This format is different to that of many North American meetings, and certainly to that of most specialist meetings like Penrose Conferences and SEPM Research Conferences, where the major participants are predominantly from academia, industry or government agencies. We find the BSRG format very appealing and intellectually stimulating. Perhaps meetings of this type should be encouraged in the Canadian geoscience community.

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The 1983 spring meeting of the Newfoundland Section, Geological Association of Canada, took place from April 7-8. The program of 30 papers was organized by Chris Barnes and included all aspects of the Paleozoic geology of western Newfoundland. Registrants were provided with a formal program, including abstracts in GAC format. Copies of these abstracts may be obtained from Chris Barnes, Program Chairman, Memorial University of Newfoundland.

Only two papers presented at the symposium broke away from the main theme. Phil Rice (Petro-Canada, CSPG Special Lecturer) presented a seismic journey through the modern continental-margin sequence of the Grand Banks, complete with aerial photographs of modern analogues of coastal and terrestrial ancient environments. Rice showed a novel three-dimensional seismic record depicting the upper surface of one of the Mesozoic reservoir sands. This intriguing technique allowed recognition of the form and plan-view features of a braided distributary complex. The perspective was much like that of an aerial photograph. Wayne Goodfellow (GSC, GAC Robinson Fund Special Lecturer) carefully documented the occurrence and genesis of lead-zinc deposits associated with starved basin sedimentation during rifting of the western Canadian Selwyn Basin. He stressed the importance of basement break-up faults in providing conduits for metaliferous fluids in their journey to a site of precipitation at the sediment-water interface.

The Paleozoic talks were preceded by two general keynote papers. Chris Beaumont, Steacie Fellow from Dalhousie University, provided a stimulating discussion entitled “Rifting, collision of plates and the formation of sedimentary basins”, as an introduction to the mechanisms of basin formation at both passive and convergent continental margins. He emphasized that the mechanical properties of the lithosphere can largely account for various aspects of basin development, including subsidence history. Thick, cool lithosphere acts like a stiff spring and flexes for a greater distance away from the continental margin than does thinner, hotter lithosphere. The peripheral bulge associated with flexure during emplacement of thrust sheets at active continental margins is found furthest from the margin when the lithosphere is thickest. If true, then the width of foreland basins produced by flexure would be a function of lithosphere thickness, and indirectly a function of the time interval between rifting to form a passive continental margin and subsequent destruction of the margin. Although in Phanerozoic orogenies we commonly have good biostratigraphic control on the timing of these events, this relationship between foreland basin width and “age” of the passive margin could be useful in unravelling the timing of Precambrian continental-margin tectonics and in estimating the properties of the Precambrian lithosphere. It might also be possible to calculate from such data the approximate width of Precambrian oceans. Beaumont illustrated his talk with examples from the Scotian Basin, the western Canadian foreland basin and the Appalachian foreland basin. In the latter example, Beaumont considered interaction with nearby intracratonic basins. When the peripheral bulges associated with foreland and intracratonic basins overlap, intermediate arches are elevated, and when the bulges pass by one another, as a result of increased thrusting and widening of the foreland basin, the
arches subside and the intracratonic basin becomes yoked to the foreland basin. This dynamic model was used by Beaumont to explain the observed geologic history of deposition on the Flanday Arch and Nashville Dome, both located between the Appalachian foreland basin and two adjacent intracratonic basins, the Michigan and the Illinois.

Beaumont also suggested that the sub-Middle Ordovician (sub-Table Head) unconformity in the Appalachians may be the result of migration of a peripheral bulge across the margin as thrust sheets were emplaced further east. This hypothesis is intriguing because it suggests an alternate and testable explanation for regional (but not world-wide) unconformities, and also predicts that such unconformities would be diachronous.

James Lee Wilson (University of Michigan, CSPG Special Lecturer), in his paper entitled "Patterns of carbonate infestations controlled by tectonism", provided a spectacular visual tour through the variety of carbonate platform margins found in the Mesozoic of western Canada, Texas, Mexico, Morocco, Tunisia, the eastern edge of the Arabian Shield and the Alps. Wilson emphasized the fundamental control that basement faults play in the location and orientation of carbonate platforms. Bob Stevens, in a later presentation, noted that uncertainty still exists as to whether the deep-water Cow Head Group is allochthonous or autochthonous, even though the carbonate platform terrain from which it was derived is found both to the west and to the east of the present Cow Head outcrops. If, as Wilson claims, passive margins are commonly characterized by detached, small carbonate banks on fault blocks, then suggestions that the Cow Head Group may be in place must be given serious consideration. This problem may be no less serious than that of locating the root zones of sedimentary and ophiolite klippen in the northern Appalachians.

A third keynote paper was presented by Noel James, recent AAPG Special Lecturer and Steeie Fellow. Noel provided a comprehensive stratigraphic framework for many of the subsequent talks in the program, with a detailed discussion of the Cambro-Ordovician platform sequence of western Newfoundland and southern Labrador. The stratigraphy was interpreted in terms of early extensional tectonics (passive margin) followed by post-early Ordovician compressional events (convergent margin). There still does not seem to be a good explanation for the relative thinness of the passive-margin sequence in western Newfoundland (Ca. 2.0 km), particularly when Beaumont's models for passive-margin subsidence would predict a thicker mio-geocinal sequence. Perhaps the carbonate platform margin in this region was located unusually far from the actual continental margin and closer to the hingeline about which the marginal subsidence took place.

The remaining shorter papers presented on the first day were grouped into three themes, namely, the carbonate platform, the coeval slope succession, and aspects of regional correlation. The more important contributions are discussed below. Our comments on these and on other papers will only mention the names of the speakers, even though many papers had multiple authorship. Detailed analysis by Ian Knight of the Middle and Upper Cambrian package on both sides of the Great Northern Peninsula convincingly demonstrated the west to east change from a middle shelf facies belt to an outer shelf facies belt. Within this sequence, Doug Boyle recognized an important faunal hiatus caused by a major Early Ordovician regressive-transgressive event. In discussion, Chris Beaumont stressed the possible link between this unconformity and peripheral-bulge tectonics.

Slope sediments of the Cow Head Group were described in terms of condont paleontology (Chris Barnes), gravity-induced sediment slides (Mario Coniglio) and debris flow geotechnical properties (Rick Hiscott). Snouts and projecting blocks associated with the Cow Head debris flows suggest strengths like those reported for modern subaerial flows. Bottom slopes calculated from debris strengths and bed thicknesses are consistent with the common occurrence of sedimentary slides and slide-induced shear zones in the Cow Head sequence.

The papers dealing with regional relationships summarized earlier work, and will not be specifically discussed here. Hank Williams closed the first day's proceedings with a keynote paper that humbly revealed territorial losses and gains sustained by continents bordering the modern Atlantic Ocean during earlier orogenic events. Northern Africa lost substantial ground to eastern Canada (i.e., Avalon and Meguma Zones), whereas the northward extension of the ancient eastern continental margin of North America was expropriated by the British Isles during formation of the modern Atlantic.

The morning of the second day was devoted to collision and obduction processes. Mike Searle introduced this session with a visual extravaganza on ophiolite obduction and thrust sheet emplacement in western Newfoundland, Oman, the United Arab Emirates and the Himalayas. Searle discussed the problems in structural analysis and construction of balanced cross-sections even in orogenic belts as well exposed as the Oman Mountains and the Himalayas. To perform such analysis, it is essential to know the original thickness of rock units involved in thrusting; the fold style must also be concentric for production of truly accurate cross-sections. Such information is not available in most parts of the Appalachian Orogen, particularly in the north. This creates serious roadblocks to any attempts at palinspastic restoration of transported terranes. As pointed out in the talk by Bob Stevens, application of models involving emplacement of large thrust sheets to western Newfoundland is a recent phenomenon. Many problems in detailed interpretation still remain. Bob reminded us that this meeting was being held on the 20th anniversary of the Rodgers and Neale publication that first pointed out the presence of allochthonous terranes in western Newfoundland.

Most of the remaining papers of this session described structural and stratigraphic relationships in the allochthons of western Newfoundland, based on recent field studies. Highlights included Beckie Jameson's assertion that the apparent prograde metamorphism toward the peridotite contact in the aureole beneath the St. Anthony Ophiolite Complex is simply the result of fortuitous preservation of relict high grade assemblages within a greenschist facies shear zone. If true, then earlier explanations of the "aureole", including thermal models, must be re-examined. Papers by Greg Dunning and Derek Wilton closed this part of the meeting with a firm rejection of the idea that rocks east of the Cape Ray Fault in southwestern Newfoundland represent basement from the eastern side of Iapetus. These rocks are ophiolitic, with locally gneissic Ordovician fionalite intrusions produced by partial melting of sediments of the Fleur de Lys type. Derek presented structural, geochemical, and Rb-Sr age-date evidence that the fault itself is not a cryptic suture, but only a more modest, though large, shear zone.

The last session of the meeting dealt mainly with paleomagnetism, and Late Palaeozoic geology and strike-slip tectonics in the northern Appalachians. Garry Quinlan set the stage with a general discussion of the production of pull-apart basins. The lithospheric responses are much like those involved in formation of rifts. The observed Carboniferous stratigraphy of the Magdalen Basin can be explained by two phases of extension and thermal subsidence. The second phase accounts for an increase in subsidence rate prior to deposition of the Windsor Group. Discussion after this talk included some criticism of the coarseness of the stratigraphic subdivisions that had been used to constrain the calculated subsidence curves, although the procedure certainly is promising.

Dick Hyde presented geological results from the Carboniferous Deer Lake Basin
that demonstrated clearly the importance of
dextral strike-slip movements during the
early (Ancestral) 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 abso-
lute 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 oil resources
might involve Colonel Khaddafi
rather than Pierre Trudeau.

Papers presented by Bill Morris and
Dave Strong (co-authored by Ted Irving)
dressed the question of Late Paleozoic
strike-slip motions in the northern Appala-
ehians. Both papers presented arguments
against major movements of the magnitude
suggested by Van der Voo, Kent and Op
dyke, etc. Morris surveyed existing paleo-
magnetics for Devonian and
Carboniferous movements, and concluded
that the data are the result of Permian lat-
teritic weathering or Hercynian metamor-
phism, 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 cra-
ton. 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-
plachian data, but which has been erro-
neously 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 hypo-
thesis 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-
herst, 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-
lymonists, 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-
lows: glacial geology, climate, botany, pa-
leoecanography 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
cosmic 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 au-
roral studies, a number of participants made
gmromorphological observations that remain
significant, considering their early date. For
example, an excellent description of pingus
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
pingus in the Lena Delta, although they are
similar to those described for the Mack-
enzie Delta. In northern Labrador, Dr. C.R.
Kock from the German expedition (1883)
noticed a sharp contact between the shel-
tered felsenmeer of the upper slopes and the
heavily glaciated lower slopes of the
Tormag Mountains. He concluded that the
higher peaks of these mountains had es-
aped 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 pyrocotone 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-ice 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