Geoscience Canada

Geodynamics Symposium on the Oceanic Lithosphere

W. S. Fyfe and A. MacDonald

Volume 10, Number 4, December 1983

URI: https://id.erudit.org/iderudit/geocan10_4con03

See table of contents

Publisher(s)

The Geological Association of Canada

ISSN

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

Explore this journal

Cite this article

Fyfe, W. S. & MacDonald, A. (1983). Geodynamics Symposium on the Oceanic Lithosphere. *Geoscience Canada*, *10*(4), 208–209.

The last paper, given by C. R. Harington, (National Museums of Canada, Ottawa) dealt with *Soergelia*, an indicator of Holarctic middle Pleistocene deposits.

A. Billard (C. N. R. S., Paris) opened the fourth group of papers, dealing with paleosol records, on Friday morning, with a presentation of the stratigraphic importance of paleosols in the Alps. The use of soils in reconstructing glacial history in the Chic Choc Mountains, Gaspésie, was evaluated by J. T. Gray (U. Q. A. M.) and C. Wang and G. J. Ross (Agriculture Canada, Ottawa). Then N. W. Rutter and P. L. Waters (U. of Alberta) evaluated the use of paleosols and tephra in correlating Holocene deposits in southern Alberta. The afternoon session on Friday was chaired by N. W. Rutter and W. Vortisch. It began with a discussion by W. C. Mahaney *et al.* of the glacial chronology in the Rocky Mountains. The last paper on Quaternary paleosols in the Canadian Rocky Mountains, and their significance in forming a chronological framework, was presented by R. King (U. of Western Ontario).

The fifth group of papers reviewed the glacial/interglacial record. It began on Friday afternoon with a discussion of the glacial sequence in Greenland by S. Funder (Geologisk Museum, Copenhagen, Denmark). Then W. Karlen (U. of Stockholm, Sweden) evaluated dendrochronology and its use in verifying glacial chronologies, followed by a paper on the late Cenozoic record on Banks Island, N. W. T., Canada, by J. S. Vincent (G. S. C., Ottawa). The topics then shifted to eastern Canada, with D. R. Grant (G. S. C., Ottawa) discussing the terrestrial record in Atlantic Canada and its correlation with offshore sediment cycles, and R. Stea (Nova Scotia Dept. of Mines & Energy) spoke on the surface mapping and correlation of ice flow changes in central Nova Scotia. Bog bottom ^{14}C dates and their importance in reevaluating glacial chronologies in the eastern U. S. were assessed and critically examined by J. Cotter *et al.* (Lehigh U., Bethlehem, PA).

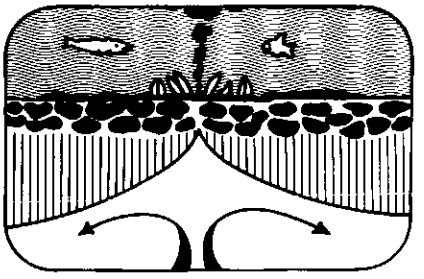
The fifth session continued on Saturday, May 28, chaired by H. B. S. Cooke and S. Funder. The first paper, by C. Burrows, dealt with problems of age assignment, correlation and environmental interpretation of the New Zealand Quaternary. This was followed by two papers given by I. J. Smalley on the 5th Paleosol Project and on the correlation of the loess sheets of New Zealand with those of Eurasia. Late Quaternary glacial chronologies in North America were discussed by D. F. Eschman (U. of Michigan, Ann Arbor), Q. H. J. Gwyn *et al.* (U. of Sherbrooke), Mark M. Fenton (Alberta Geological Survey) and N. and C. H. Eyles (U. of Toronto).

The Saturday afternoon session was chaired by B. Luckman (U. of Western Ontario) and O. L. White (Ontario Geological Survey). It began with a discussion by E. Derbyshire (U. of Keele, U. K.) of the Pleistocene lithostratigraphy in northeast England. Isotope-geochemical chronologies derived from glaciers in the Eurasian arctic were described by R. Vaikmäe, and J. M. Punning (Estonian Academy of Sciences, USSR) and F. Mayr (U. Q. A. M.) evaluated the possible magnetic control of climate and its geological implications.

The last group of papers dealt exclusively with the mountain and coastal areas of western North America. D. R. Butler et al. (Oklahoma State U., Stillwater) considered the glacial/interglacial sequence in the Lemhi Mountains, Idaho; S. M. Colman and K. L. Pierce (U. S. G. S., Denver, CO) used weathering rinds to correlate glacial deposits in the western U. S.; and T. C. Meierding (U. of Delaware, Newark) evaluated the correlation of alpine deposits using relative dating methods. The use of multiple methods for establishing the Pleistocene stratigraphy in Western British Columbia was examined by S. R. Hicock (U. of Western Ontario). The depositional history and correlation of three major river terraces in the Willamette Valley, Oregon, were reviewed by M. C. Roberts (Simon Fraser U.).

The papers were followed by two field trips in the Toronto area. The first trip, led by E. V. Sado, O. L. White, P. J. Barnett and D. R. Sharpe, was organized to investigate the glacial geology of the North Toronto area. The second field trip, led by C. H. and N. Eyles, was planned to investigate the sedimentary processes that operate on the floors of large proglacial lakes.

The proceedings of the Symposium will be published (in 1984) by Geoabstracts Ltd., Regency House, 34 Duke Street, Norwich, U. K., NR3 3AP.



Geodynamics Symposium on the Oceanic Lithosphere.

W. S. Fyfe and A. Macdonald
Department of Geology
University of Western Ontario
London, Ontario N6A 5B7

Texas A&M is in the process of developing a vigorous program in Geodynamics. John Handin, well known for his work in fundamental rock mechanics, was perhaps the originator of the concept, which is now being developed by Tom Hilde, George Sharman and others, with the support of Dean Mel Friedman and Seiyi Uyeda of Tokyo, a regular visitor at A&M. Additional incentive to the group has come from the decision that A&M will manage the next phase of the deep-sea drilling program. A&M are ideally suited in an environment with access to great expertise in drilling technology.

A&M are now organizing annual conferences on various aspects of ocean floor geodynamics. Their meeting on subduction of two years ago was perhaps one of the most exciting symposia W. S. Fyfe has recently attended. The proceedings, edited by Tom Hilde, will shortly appear as a special issue of *Tectonophysics*. The meeting reported here was no less exciting. Our congratulations must go to all who were involved.

The meetings are informal and allow a high degree of discussion and critical appraisal of what we do and do not know, a great pleasure in comparison with the massive national meetings. Student participation is extensive.

Parts of the present meeting which impressed us included the following:

New observations on the E. Pacific Rise are showing that structures are much more complex than commonly have been described. In particular, Francheteau and MacDonald described overlapping centres, two parallel ridges 12 km apart and perhaps overlapping for tens of kilometres. Between the two centres is a depressed zone. Obviously such zones raise questions about the geometry of the magma chambers feeding the two volcanic centres

and the style of hydrothermal cooling in such a situation. But one might just guess that such sites could be ideal for massive sulphide generation and perhaps preservation.

There was considerable discussion of the nature of magma chambers at ridges and the mechanics of forming the classic ophiolite structure. Rosencrantz (U. of T. at Austin) discussed the formation of the lid on magma chambers. Clagne and Eaby (U. S. G. S., Menlo Park) discussed the evidence for long-lived magma chambers on the Juan de Fuca ridge, where magmas evolve and hybridize with less evolved magma types. Norma Sleep (Stanford) presented multi-channel seismic evidence for the nature of a magma chamber on the East Pacific Rise at 9°, the Lau Basin and the Juan de Fuca. What appear to be excellent magma chamber roof reflections were reported at 3 km depth with widths of about 4 km. The roof regions were considered to be sill-like and underlain by mush zones with no detectable Moho reflectors.

Sleep also discussed problems of heat loss on the East Pacific Rise and suggested that 90% of the hydrothermal circulation occurs away from the ridge axis. Magnetic data indicate that the gabbro layers are above 580°C, 10 km off the ridge. Langmuir (Columbia) and Bender (Univ. N. Carolina) presented chemical evidence which suggests that basalts erupted from transform faults have evolved from parental magmas formed by a smaller degree of partial melting than did those far from the transform. This is consistent with the idea that ocean crust is thinner near fracture zones.

Girdler of Newcastle summarized recent magnetic, gravity and seismic data for the structure of the Red Sea lithosphere. It appears that while the southern parts of the Red Sea are normal, there are great problems in understanding phenomena at the northern end where magnetic anomalies are abnormal. The nature of the crust and lithosphere in the region is not resolved.

Several papers dealt with hydrothermal activity on ridges. Rona (Miami) reported interesting new data from the TAG field on the Atlantic ridge. The evidence points to intermittent activity, a record which can be found in variations in Cu-Fe-Mn in surface sediments. Some rather large Mn-Fe-oxide deposits are associated with fault scarps. Observations on a 1,500 km section of the ridge have shown hydrothermal sites with an average spacing of 265 km. It was suggested that lines of hydrothermal activity are longer-spaced on slow-spreading ridges than on fast-spreading ridges. Hajash (A&M) reported on experimental studies of the interaction of basalt cores with sea water. At 400°C, it was shown that K, Ca, Fe, Mn all increase in the fluid. Mg-rich smectites and anhydrite are major new phases formed. His work clearly shows that it is quite difficult to establish equilibrium in such systems, which suggests that when circulation is fast, the same may be true in natural systems.

Edmond and Von Damm (M. I. T.) reported on new data on solution chemistry from the East Pacific, Galapagos and Guaymas Basin. Solutions at 350°C had pH 3.5 and considerable H_2S concentrations, three times the sulphide-forming cations. Naturally, mixing of the acid solution with more alkaline normal sea water could cause sulphide precipitation. The important observation was made for the Guaymas situation that such fluids rising through biogenic (carbonate-rich) sediments could lead to large-scale sulphide precipitation and form a sediment hosted massive sulphide. It was suggested that this situation, and not the "black smoker", is needed for large deposits. The concept of a sediment cap being necessary for efficient precipitation of sulphides has great merit. Macdonald and Fyfe (U. of Western Ontario) reported on water diffusion rates through serpentine. They suggested that the rates are large enough that serpentinization should be a continuous process in sea floor environments, controlled only by water access to ultramafic rocks through their cover.

One of the discussions we found most instructive involved seismic studies of the nature of ocean crust. Purdy of Woods Hole emphasized that few seismic experiments had been conducted with the necessary planning to provide the needed resolution. "The scale upon which the experiments were carried out was almost always inappropriate to the processes that determine velocity structure."Mutter (Lamont) and colleagues from the U. S. A. and Germany presented data from a highly sophisticated two-ship seismic experiment which examined ocean crust from zero to nearly 200 Ma. Their data showed a clear Moho across 100 Ma of crust at uniform depths. Thin crust was found in Atlantic fracture zones. In very old crust they reported strong double reflectors near the Moho with a 2 km separation. Such an observation perhaps supports the case for serpentinization suggested in an aging model presented by Kempner of Chevron. He indicated that 1 km of serpentinization is suggested by their data.

Matsubayashi (Geol. Surv. Japan) described refined heat flow measurements in 100 Ma crust in the Pacific, east of the Phenix lineations and on the flank of the Manihiki Plateau. Values found (>1.5 HFU) appear to be higher than those expected from a t1/2 law. Later heat sources appear to be required. Uyeda (Tokyo) described heat flow measurements in the subduction zone of a young plate in the Nankai Trough. Here heat flow is >3 HFU. Deep earthquakes do not occur. It is clear that it is not necessary for lithosphere to be old and cold before subduction.

Several papers dealt with the new techniques for sea floor observations. Impressive data on SEA BEAM and SEA MARC I were presented for the East Pacific Rise by Crane and others (the Rise Axis Tectonic Team). Again, overlapping spreading centres were described. Hilde (Texas) used Gloria side-scan sonar mapping to iscuss interaction between subduction and the initiation of spreading. Okal (Yale) used SEASAT radar altimeter data for finding structure in the Pacific. Dixon (Cal. Tech) emphasized that SEASAT data can be used to fill many of the present blanks in our knowledge of the structure of the sea floor. Anomalous topography suggested by SEASAT can be used to locate detailed ship surveys. McAdoo (NASA) showed how SEASAT data indicates major flexure of the lithosphere seaward of deep trenches. Searle (Institute of Oceanographic Sciences, U. K.), discussed unresolved problems of sea-floor topography. In particular, he noted the problems in understanding the nature and frequency of inward and outward dipping faults near and away from ridges. Smoot (U. S. Naval Oceanographic Office) used bathymetry to show the topographic expression of magma diapirism in fracture zones. He suggested that new lithosphere, in the form of seamounts, ridges, volcanoes and blocks, flow continuously into fracture zones, produced by thermal contraction.

Numerous papers dealt with ophiolite structure and petrology. Robinson (Dalhousie) presented recent data from the Troodos project. In discussions which followed the meeting there was agreement with Francheteau that in understanding the complexities of the ocean crust there is no substitute for direct observation by all the modern tools available, and there was a feeling that data from ophiolites must not be overstressed in generalizations. Ridges are becoming more and more complex. With all the new tools of observation, describing the nature of ocean floor processes becomes one of our great present day challenges.