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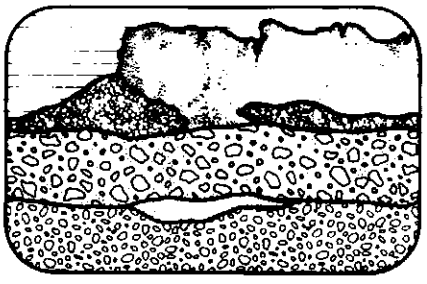

Quaternary Stratigraphy Symposium

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A Symposium on the Quaternary Stratigraphy of North America, sponsored by the Atkinson College of the York University at Toronto, and organized by William C. Mahaney of its Department of Geography was held on May 23 and 24, 1975. It attracted 160 participants, and 24 papers were presented by invited speakers. The evenings were taken by panel discussions and the sessions were followed by a field trip to the classical Scarborough Bluff sections on May 25, guided by Jaan Terasmae.

A review of: (a) Quaternary stratigraphic criteria currently used in North America, (b) their problems, (c) selected regional stratigraphies, and (d) their correlations will be presented here, though not in the sequence of presentation of the papers, but in attempted summaries on topics selected by the reviewer. As the papers will be published in Proceedings of the Symposium, by Dowden, Hutchinson and Ross, their titles are not listed here. Instead, references are given to the authors of the papers only, with a summary reference on the Abstracts at the end.

At the Symposium, regional stratigraphic schemes, discussions of local problems and correlations were presented along a traverse from the east to the west, zigzagging from the northern border of the glaciated areas to nonglaciated areas in the south. Most reports dealt with the peripheral zones of the formerly glaciated terrain, thus unfortunately, omitting the central areas, though some of the latter ones, e.g., James Bay Lowland and central British Columbia, have produced interesting stratigraphic records.

Multiple criteria were used for the testing and re-interpretation of existing stratigraphic schemes and building new ones, but their details varied considerably, depending upon availability and type of interpretation, and the research methods applied. The greater variety of criteria, used for the dating of individual units in single sections and their correlations in one region, was reported by J. T. Andrews and G. H. Miller for the eastern Canadian Arctic: biostratigraphy, Th^{240} and Pa^{231} dating of marine molluscs, enriched C^{14} dating of marine shells and peats considered to be 30,000 to 70,000 years old, stable isotope analyses of marine bivalves, amino acid diagenesis, composition of growth rates of the marine bivalve faunas, relative sea level changes, paleomagnetism, landforms, and differences in weathering of highland areas, but, surprisingly, the usual lithostratigraphic criteria were hardly mentioned by them.

The Quaternary volcanism of the Cordilleran Region has made it possible to apply K-Ar dating and tephrachronology, besides other criteria, for building or checking the chronostratigraphy of the western regions (P. W. Birkeland: Sierra Nevada; D. J. Easterbrook: Pacific Northwest of United States; J. W. Hawley, G. O. Bachman and K. Manley: Basin and Rangė, southern Rocky Mountains, Great Plains of New Mexico and western Texas; T. N. Karlstrom: Colorado Plateau; G. M. Richmond: western Wyoming). Application of tephrachronology was mentioned as far east as Texas (C. C. Reeves) and in southern Saskatchewan (A. M. Stalker) where it has led to re-interpretation of some previous stratigraphies.

Preliminary paleomagnetic investigations have enabled dating of Pleistocene marine deposits in Alaska (T. L. Péwé) and assigning the 0.7 million years age to the Kansan glaciation in Illinois (W. H. Johnson). The Gohtenburg magnetic reversal (dated here about 12,600 B.P.) has been reported from eastern Canada (J. Terasmaé and A. Dreimanis), but it could not be detected in the west (Easterbrook), and therefore it probably presents a paleomagnetic excursion.

Various relative age determination methods and similar criteria for site-to-site correlations dominate over the absolute dating methods, because of their wider applicability, for instance field tracing, lithostratigraphy of the materials investigated, soil stratigraphy, supplemented by weathering data on clasts and rock surfaces in mountains and highlands, morphostratigraphy, biostratigraphy, interrelationship of terrestrial and marine or glacio-lacustrine deposits, etc. However, several problems in their application were pointed out by some authors. Thus R. V. Ruhe warned, that some of the soil-stratigraphic and loess units of the Mid-continental United States are so strongly time transgressive, that they create dilemmas in the Late-Quaternary

stratigraphy of that region, by crossing the formal time-stratigraphic substages *defined in Illinois*.

Application of lithostratigraphic investigations, particularly of tills, appears to have expanded considerably. For instance, S. R. Moran and nine co-authors reported some 50 formal and informal new and recently published formations and their members, most of them of probable *Wisconsinan age, plus numerous* unnamed older units, from North Dakota, Manitoba and Minnesota. Equally high numbers of lithostratigraphic units have been established for some time in the Great Lakes - St. Lawrence Region (R. F. Black: Wisconsin and Upper Michigan; N. R. Gadd: St. Lawrence Lowland; R. P. Goldthwait: Ohio; Johnson: Illinois; *Terasmae and Dreimanis: southern* Ontario; see also D. R. Coates correlation table with southeast Canada *in* Mahaney, ed., 1975).

In biostratigraphy, vertebrate paleontology is producing new and interesting data, particularly in the southwestern Canadian Prairies (Stalker) and Alaska (Péwé). Though *vertebrates as stratigraphic* criteria were mentioned by Reeves also for the Southern High Plains in United States, no details were given. Péwé noted that vertebrate remains of Illinoian and pre-Illinoian age in Alaska indicate that many taxa were present there considerably earlier than is generally recognized as being present in central North America. It is still too early to judge how these findings will affect the presently developing vertebrate paleontology chronology of southwestern Canadian Prairies (Stalker), where a wealth of new fossil material has been gathered from some 40 sites. Stalker already noted that the use of certain time terms of vertebrate paleontology chronology has not, in the past, always corresponded to their use by the glacial geologist.

Most papers dealt with the stratigraphy of the Wisconsin Glaciation or its correlatives, as their records are better preserved than those of the older Quaternary episodes. Also, the radiocarbon age determination, most popular among the radiometric dating methods, helps to establish absolute ages for local stratigraphies and their correlations, except for the Early Wisconsin which is beyond the radiocarbon dating range. Also, palynology has been applied mainly to studies of Late Pleistocene sediments. Still, no palynologic data were reported *from* most of the areas discussed, and the same applies to other microfossils.

Morphostratigraphy, though not recognized by the American Stratigraphic Code (American Commission on Stratigraphic Nomenclature, 1961), is still widely applied, for instance in Illinois (Johnson), but Coates, reporting on New York and Pennsylvania, suggested that the morphostratigraphic correlation of the 40 named moraines of his region should be abandoned, because the topographic form is not coincident with farthest ice advance, age relations change along the strike, and the materials consist of multiple drifts. H. E. Wright, Jr., discussing the western Great Lakes area, pointed out that the numerous fluctuations of ice lobes were neither synchronous, nor similar in magnitude, and stagnant ice remained in some areas for thousands of years after retreat of active ice. As the late-Wisconsin pollen diagrams from the periglacial region do not indicate any reversals in vegetational and climatic trends through a period of 10,000 years, the ice lobe fluctuations may have merely reflected changes in snow accumulation and ice flow far back from the ice front, rather than temperature changes in the ablation area and the adjacent periglacial area, concluded Wright. J. H. Hartshorn discussed also many other problems which make the stratigraphic interpretations and correlations uncertain and had to admit that, because of these difficulties, the Late Quaternary history of southern New England is still largely unresolved, in spite of nearly 135 years of investigation. He suggested returning to old-fashioned detailed quadrangle mapping, combined with studies of till fabrics, clay-mineral and heavy-mineral analyses, and clast provenance studies. In the Atlantic Provinces of Canada, a terrain similar to New England, D. R. Grant has found that ice-flow indicators have helped considerably to decipher and integrate the progress, pattern and sequence of glacial movements deciphered from scattered deposits. He further concluded that proper understanding of the glacial style of the area (or the local topographic and dynamic factors affecting ice movement and nourishment, as re-phrased by Karlstrum for Colorado Plateau) are essential for developing the regional stratigraphy and paleogeography. The glacial style in the Atlantic Provinces of Canada, according to Grant, is characterized by growth and coalescence of separate ice caps, their eventual incorporation by an advancing inland ice sheet, and the reverse sequence during deglaciation.

A comparison of the various regional reports on the marginal areas of the Laurentide ice sheet indicates quite clearly that the glacial dynamics or styles differed from one area to another. It appears, that at the beginning of the Wisconsin Glaciation, most rapid growth of glaciers took place in the northeast and east of our continent (Andrews and Miller; N. R. Gadd; Grant). This early glacial advance entered the St. Lawrence Lowland, but how far it expanded to the west is not known because of lack of absolute dates and direct step-by-step lithostratigraphic correlations. A temporary retreat during the St. Pierre Interstade (Gadd; Grant; Terasmae and Dreimanis) was followed by a major Early Wisconsin glacial re-advance. It was more extensive in the eastern Canadian Arctic, during the Alikdjuak stade of Andrews and Miller, than any of the subsequent Wisconsin advances. On the contrary, the correlative Early Wisconsin or Early Altonian glacial advances were less extensive than those of Late Wisconsin along the southern periphery, in the Great Lakes Region (Goldthwait; Johnson). Farther west, in the Prairies, both advances were essentially equally extensive (Moran and others).

Even more pronounced regional climatic differences were indicated for the Middle Wisconsin (or late Altonian plus Farmdalian in the Lake Michigan lobe terminology). During this substage, the Laurentide ice sheet had not retreated at all from the St. Lawrence Lowland (Gadd; Terasmae and Dreimanis), nor from the main portion of the Atlantic Provinces of Canada (Grant); in these regions minor ice marginal retreats have been recorded only from the coastal areas along the Atlantic, and from the northwestern slopes of the Appalachian Mountains. Farther southwest, the ice sheet retreated, though with oscillating readvances, from the Great Lakes Region (Goldthwait; Johnson; Terasmae

and Dreimanis), and also from the Great Plains Region (Moran and others; Stalker). However, the Middle Wisconsin climate remained cool in all these areas judging from biostratigraphic data, except for the Peace River area in Alberta, not discussed in this symposium, where an earlier report by J. A. Westgate and others suggest climate as warm as the present one. Similarly, in the eastern Canadian Arctic (Andrews and Miller) the *Chlamis islandicus* zone of the early part of Middle Wisconsin (probably 40,000 to 70,000 years B.P.) contains marine faunas not radically different from its Holocene counterparts. Middle Wisconsin glacial readvances, not necessarily contemporaneous, but about 30 to 40 thousand years B.P. have been reported from both the northeastern and southern margins of the Laurentide ice sheet.

The differences between the northeastern and southern borders of the ice sheet re-appear during the Late Wisconsin: while in the northeast the glacial advances were less extensive than before, the ice sheet experienced its maximum Wisconsin expansion along its southern boundary, though not at the same time in all lobal areas, and with a minor exemption in northwestern Pennsylvania.

When comparing the Cordilleran mountain glaciations with the Laurentide ice sheet, Karlstrom concludes a general synchronism, but he also points out significant regional differences in the timing of glacial maxima along continental ice margins and in different alpine valleys. In general, the Cordilleran Early Wisconsin equivalents were more extensive than those of Late Wisconsin (Easterbrook; Karlstrom; Madole, Mahaney and Fahey; M. M. Miller; Richmond).

Relatively little is known about the chronology of interaction of the Laurentide ice sheet with the Cordilleran glaciers, though the interrelationship of several lithostratigraphic units, of glacial advances, retreats and extra-glacial events have been established, as reported by Rutter and Stalker for Canada.

Holocene events were discussed only briefly: in six papers on the Cordilleran areas and four from the Laurentide ice sheet region. Neoglaciation was the main topic for the mountain areas, and lichenometric studies were mentioned by several authors besides the criteria used for older stratigraphic units. Birkeland noted that in Sierra Nevada, the type area for the Neoglacial deposits, his and J. C. Yount's new age assignments differ from those of previous workers for the same deposits.

Regional correlations with the adjacent areas were given by most authors, but only a few had attempted long distance correlations, particularly because of shortage of absolute dates. Karlstrom presented various correlation charts of paleoclimatic and other stratigraphically significant records for the last 130,000 years, and more detailed ones for the past 12,500 years, including also regions outside of North America, and discussed paleoclimatic evaluation of these data. He also concluded that volcanism increased during nonglacial intervals. Terasmae and Dreimanis presented correlations between the Great Lakes Region and oceanic records outside of North America, but this was done mainly because their Early Wisconsin chronology was based essentially upon ocean chronologies, due to absence of truly absolute dates older than 50,000 years B.P. in the Great Lakes - St. Lawrence Region. An attempt was made to correlate various chronologic schemes at one of the panel discussions, but shortage of time prevented arriving at definite conclusions.

In summary, the Symposium updated considerable numbers of regional stratigraphic schemes, some of which have been published or reported before, and also presented new stratigraphic information. Also, some of the problems involved in chronostratigraphy, geologic climate stratigraphy, lithostratigraphy, biostratigraphy, soil-stratigraphy and morphostratigraphy were pointed out, though there was not sufficient time to discuss them in detail. The emphasis was on glaciated and adjoining periglacial areas. The non-glaciated areas of North America have such a diversity of their own problems, that the few papers dealing with them indicated necessity of a separate symposium for the Quaternary stratigraphy of the non-glaciated regions of North America.

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