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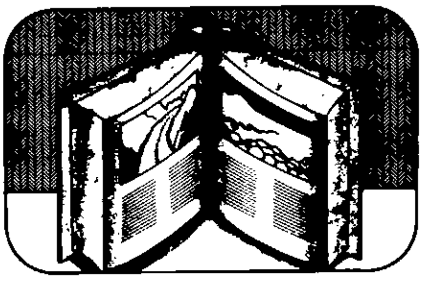

The Growth of Glacial Geology and Glaciology: Opening Remarks

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As we honour a great contributor to the field of glacial geology, we need to look briefly at how, when, and where this discipline of science grew, and at its twin, glaciology. Two centuries and more ago there were only generalists, called naturalists, and they did not recognize the widespread growth of ice sheets in Pleistocene time. Careful observers, like Peter Martel (1744), a Swiss engineer, told of what he saw at Mer de Glace: the ice is made high up, because of snowfall, and then the ice slides down its valley. From striae and big boulders he thought the glaciers had once been thicker and extended even further down valley. Another engineer in Sweden, Swedenborg (1719), is said to have seen similar erratic boulders, and esker (asar) ridges, but he, like many others, resorted to "universal ocean" (Noah's flood), as glaciers were so far away. A whole century later in 1824, a Norwegian, Jens Esmark, postulated a former great extension of the small Norwegian glaciers.

The impact of these ideas came slowly during that 19th century. In 1821 Ignaz Venetz, another Swiss, showed how the Alpine glaciers were once much more extensive, and Reinhard Bernhardi (1832), a professor in northern Germany, postulated polar ice to bring north German erratics from Scandinavia.

In the meantime many others were studying the glaciology of Alpine glaciers in earnest. Jean de Charpentier (1841) from Paris published his "Essai sur les glaciers" on ice motions, and F.J. Hugi (1843) had built a stone hut on Aar Glacier some years earlier and showed that the middle moved faster than the sides. J.D. Forbes (1842) of Scotland put pegs up and down a crevasse wall and showed that the top moved faster than the bottom. He introduced the idea of a very viscous fluid flowing under pressure. That plastic-viscous property of ice had been recognized in the laboratory 90 years earlier. John Tyndall (1860) of Ireland argued a "shearing" theory, with intergranular motion and regelation. Even young Louis Agassiz (1840) from Neuchâtel, Germany, spent a summer in Hugi's hut studying motion (200 feet/year) and structure. Glaciology was off to a strong start, but then it marked time for most of the next century. To be sure, in Hintereisferner there was drilled the first hole to a glacier bottom, and the great geologist, T.C. Chamberlin, re-enforced the "shear plane faulting" idea in Greenland, and Hess (1904) showed the effect of an asymmetric bed on surface velocity. I.C. Russell noted the effects of debris loads on glaciers in Alaska and, before World War I, Tarr and Martin (1914) produced their classic study there. But these were the less dramatic descriptive glaciological advances.

Through most of this same late 19th century the story of the Ice Age (i.e., glacial geology) forged ahead gaining converts to past ice sheets, but not convincing all. John Playfair (1802) got things going by attributing erratic boulders to glaciers. This information he obtained from James Hutton (1795) who found erratics far out in the Jura Mountains. The zoologist, Louis Agassiz, promulgated the former ice sheet idea in mid century after "seeing the light" on glaciers in 1836 with Hugi and de Charpentier. However, he did not recognize a similar ice sheet all over eastern North America when he moved there in 1846 and 1848. Sam Mitchell (1818), a physician, Peter Dobson (1825), a cotton manufacturer, and W.W. Mather, reporting geology in Ohio (1838) and New York (1843), argued that boulders were dragged by icebergs in "the flood" and made striae where they dragged over ledges. Finally, the North American ice sheet became the contribution of Edward Hitchcock (1841) in western Massachusetts. His greatest support was from J.D. Dana of Yale University (see Merrill, 1924).

As in Europe, the recognition of features made by the ice sheet in North America came very early in the 18th century. About 1750 Lewis Evans, a surveyor, clearly recognized that the Great Lakes were once much higher, and then beaches got tilted. In 1753 Peter Kalm (see A.B. Benson, 1937) made clear mention of the erratics. The real advances in modern concepts of ice sheets in North America began almost a century later when T.C. Chamberlin (1888) mapped younger and older drift limits and described rock erosion, N.H. Winchell (1876) discussed buried vegetation in Minnesota, John Newberry (1862) recognized alternate advance-retreat of ice over Ohio and Indiana, and James Geikie (1871) wrote on the rapidly fluctuating Pleistocene climate. By the end of the 19th century Frank Leverett (1898) named and described the standard interglacials and was in the midst of a gigantic job of mapping moraines, by topography, from Pennsylvania to Minnesota. The last major opposition to such widespread glaciation was J.W. Dawson of Canada, but he had produced good studies from Manitoba west before he died in 1899. Similar progress in ideas was made simultaneously in Europe and the introduction of warm and cold climatic fluctuations was clearly demonstrated in the Alps (Albrecht Penck, 1882). Glacial geology forged ahead while glaciology moved slowly toward the turn of the century.

In the early part of this 20th century, glacial geology kept on moving ahead. In eastern North America each province and state had its specialists producing field studies regularly, most noteably: Perkins in Maine, J. Walter Goldthwait in New Hampshire and the St. Lawrence, J.B. Woodworth and N.S. Shaler in Massachusetts, Herman L. Fairchild in New York, Arthur Coleman in Ontario, Richard Foster Flint in Connecticut, Frank Carney in Ohio, Morris M. Leighton in Illinois, Fred T. Thwaites in Wisconsin, and George Kay in Iowa. Of course, a few worked further west, like J.B. Tyrell, Bailey Willis, and J. Harlen Bretz, and were versatile in many fields. A few devoted much time to the whole intercontinental correlation ofr Quaternary time, especially Dick Flint. Others settled here from Europe for special jobs, as did Ernst V. Antevs for varve chronology. Although all the geologists above thought and published about glacial processes, few except Flint and Antevs had ever really studied a glacier!

The events of World War II required knowledge of Arctic regions, so glaciology had a major rennaissance by the second half of the 20th century. Gerald Seligman got a glaciological society and journal started in Great Britain (1948), and Hans Ahlmann (1948) classified glaciers and their regimen. Arctic institutes flourished (North America and USSR), military and civilian services demanded cold weather research labs (e.g., CRREL, Japanese low temperature labs). The International Geophysical Year fuelled lasting interest in most countries. At last physicists, climatologists, and engineers, as well as geologists and geographers, were attracted to studies of glaciers. Symposia yearly now draw more than 100 participants, whereas 40 years ago you could count the world's real glaciologists on your fingers.

Glacial geology, too, which had grown some earlier, expanded even more after 1950. It has become more process oriented, and highly physical. Whereas in 1933 the Friends of the Pleistocene drew less than a dozen people in New England, by 1980 there were four branches, across USA and Canada, struggling to limit meetings to a manageable 100 people! The time frame of chronologies had been enlarged as well; Quaternary Period was now over 2.2 million years long (it had been just one million). INQUA, the international Quaternary association, grew by leaps and bounds from its humble 1932 beginnings. Every province and state had several enthusiastic field workers and they were joined, in most cases, by good soils people. Quaternary studies are emphasizing the environmental insight from pollen, insects, animals, and the archaeology of man himself. As with many other scientific disciplines, after a half century of development of the theoretical, we now seek all the practical applications and uses of glacial geology and glaciology.

In the mushroom growth of these two disciplines Aleksis Dreimanis made his start in North America just at the right time. The combination of glacial process, bearing on glaciology, and careful glacial history, based upon stratigraphy and absolute dating, was just right for Aleksis to step into, work hard, and make lasting contributions. By virtue of his INQUA commission chairmanship he has indeed become "Mr. Till". We cherish and celebrate his great part in the last three decades.

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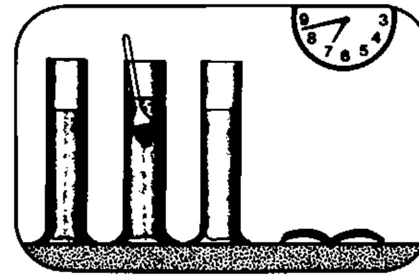

The Influence of Researchers Upon Glacial Stratigraphy

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Abstract

In order to illustrate how glacial stratigraphy may become influenced by the subjectivity of researchers, the grain size composition of till will be discussed as an example. Most particle size data do not refer to the entire till, but mainly to its matrix, plus smaller clasts. Though the granulometric data, even if just referring to till matrix, are considered to be reliable and objective, various amounts of subjectivity enter the analytic results during the sampling, pretreatment, analyses and statistical evaluation of data.

The subsequent interpretation involves even more subjectivity. This will be illustrated by using tills of Southwestern Ontario and Denmark as examples. While colour and texture of till once used to be the main criteria for differentiation and correlation of tills, more complex multiple criteria are applied now. During the last 15 years a score of genetic varieties of tills have become recognized, each of them playing its role in stratigraphic interpretation. Now more attention than before is paid to glaciotectonic deformations and fabric in deciphering stratigraphy of glaciogenic sequences.

Quaternary glacial deposits cover most of Canada. If their stratigraphy has been properly deciphered, the extraction of Quaternary economic deposits and the planning of major construction projects may be done rationally. The knowledge of glacial stratigraphy is useful also in hydrogeology and in planning waste disposal. In the search for bedrock ore deposits by indicator tracing, an understanding of Quaternary glacial stratigraphy is essential in areas with more than one layer of glaciogenic deposits over bedrock.

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