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The work of N. H. Winchell on various phases of Glacial Geology is well represented in his Final Reports of the Geological and Natural History Survey of Minnesota. Nearly all of it had been published earlier in Annual Reports and in journals, but the matter is assembled in better form in the Final Reports of the Survey.

A very large part of the state of Minnesota is covered by deposits that come directly or indirectly from the melting ice-lobes, of the great continental glaciers of Pleistocene time, and the state geologist had many an occasion for noting and describing this so-called drift. He might have written much more about it than he did if there had not been so much other geology in the State that demanded his time and attention. He wrote enough, however, to show what would have been the result had his time and attention been directed wholly toward glacial geology. Winchell noted the fundamental relations of the glacial drift very clearly, and made rapid progress, for several years, toward what is now our most advanced knowledge of the drift.

The distinctions between older and younger drift sheets, as described by Winchell in chapters on county geology, are very noteworthy in showing the extent and quality of his work. In the chapter on Fillmore county (p. 313, Vol. 1, Final Rep., 1884), he says of the drift on the east side of the county: "These patches of northern drift present the appearance of greater age than the drift of the western portion of the county, and are believed to belong to a glacial epoch that preceded the great drift sheet of the northwest. An inter-glacial epoch separated them." Further, "It is the older drift that is covered deeply by the loess loam . . . ." He described also beds of peat in Fillmore and Mower counties (loc. cit. p. 363), lying between the two drift sheets there, as conclusive evidence of an "inter-glacial epoch." The full meaning of these quotations from Winchell become more

clear to us now when, if instead of the descriptive term "greater age" of drift we use the up-to-date term pre-Kansan (Nebraskan), and instead of "the great drift sheet" we say Kansan drift. The "inter-glacial epoch" is the Aftonian now. In short, Winchell discovered and described, at that early date, the differences between those two "older drift" sheets, which are now recognized under the names pre-Kansan and Kansan.

The drift "of the last glacial epoch," as distinguished from the "older drift," was described by Prof. Winchell (loc. cit. p. 544, 581), in writing of the geology of Rock and of Brown counties, and it is made quite clear, incidentally, in that way, that he looked upon the greater part of the state as a young drift covered area. In writing of the glacial drift sheets in Dakota county (Final Report, Vol. 2, pp. 86-88), the red drift, which is found there, is well described and interpreted. He says in one sentence that "the later gray till lies on the later red, but the latter lies on the older gray" (p. 88), i. e., the older drifts as described formerly in Fillmore county are here called "older gray," and the "latest drift," as formerly called, is now called "younger gray." A "red drift" which lies between those two is classed and described as "younger red,"—as if quite contemporaneous with the "younger gray." His conclusion was correct. The younger gray and younger red are of course the Wisconsin drift sheets, according to our present nomenclature.

The method employed by the State Survey, of describing the state's geology piece meal—county by county—of course, had this disadvantage, that the geologist had rather too many local details to record and moreover could not well discuss general principles without getting beyond the limits of the county. That must explain why it is necessary to turn from one county to another to find N. H. Winchell's *general* knowledge of the glacial drift. The same disadvantage, of course, applies to the work of others of the survey and explains, in part at least, why they did not take up and advance the most important of Winchell's ideas on the drift here in Minnesota. As it is, that work was done elsewhere and is now brought in, so to speak, from Illinois and Iowa to be applied here. Instead of Prof. Winchell's old gray drift, young gray drift, red drift, etc., we thus have borrowed terms, Kansan, Illinoisan, Wisconsin.

His work on "The Recession of the Falls of Saint Anthony," for which Prof. Winchell justly received much praise, was read as a paper before the Geological Society of London in 1878, and it is very fully presented in "The Geology of Hennepin County," in Final Report, Vol. II, 1885. General G. K. Warren had pointed out in 1868 that the Minnesota valley was the channel of a glacial river at the end of the glacial period. That Saint Anthony Falls was receding was well known. Prof. N. H. Winchell put a logical interpretation upon the whole matter, however. By determining the rate of recession of the falls, then the distance through which the falls had receded, he calculated the age of the falls and the time in years of the end of the glacial period. Excepting in some details this work has not been questioned and has needed little revision in 40 years. Following his example geologists have calculated the recession of Niagara Falls and quite remarkably the most complete results there now agree closely with the results as given for Saint Anthony Falls here.

In "The Geology of Carlton County" (Final Report Vol. IV, 1899), his knowledge of "Glacial Geology" was again employed. He wrote very pertinently of many details regarding the drift there, and of glacial rivers and glacial lakes. I think, however, his interest in the subject was not great at that time since his work is neither complete as to observation of phenomena nor accurate in interpretation.

Since the closing of the State Survey, Prof. N. H. Winchell's ready knowledge of Glacial Geology enabled him to write several papers or addresses on phases of the subject. One of these, the "Glacial Lakes of Minnesota" (Geol. Soc. Am. Bull., Vol. 12, p. 109, 1901), is a very suggestive, speculative article, but unlike his earlier work it follows rather than leads in the advance of science. I consulted with him to some extent during his preparation of that paper. Not having been taught by him as student, nor employed in the Survey of which he was director, my personal acquaintance with him came chiefly from such occasional informal conferences. Familiarity with his Final Reports and other writings on my part made scientific discussion or personal conferences on glacial,—or other geology in fact,—a very easy matter. His persistent deep interest in science

impressed me greatly and an hour or two was easily spent, with him, even when our views were as widely different as possible on the subject under consideration. I enjoyed during the last winter his account of important field observations which he had made lately in Kansas and in New Jersey, on archeology and glacial geology. His study of human relics in relation to the glacial stages was leading again to important field work and study of the drift.

For upwards of forty years Professor Winchell stood as the pioneer, as the leader and director of scientific knowledge in the state of Minnesota in its broadest and truest sense,—and this to a far greater degree than we at present are able to comprehend. The Minnesota Academy, the University, and the State may count itself fortunate in having had a man of this character as the pilot during the trying times of pioneering days.