2. GEOLOGICAL HISTORY OF LAKE WINONA[1]

by Calvin R. Fremling

Approximately 600 million years ago, when the earth was already about 4 billion years old, the Winona area rested at the bottom of a shallow sea whose sediments would eventually form much of the continent of North America (Fig. 2-1). The earth's pliable crust rose and fell slowly, but relentlessly then as it does now. Sediments, eroded from existing ancient continents, slowly accumulated on the ocean floor for about 300 million years. Sand, the precursor of sandstone, was laid down as beaches, dunes and sand bars when the crust intersected the surface of the sea. Deposits of silt and clay formed layers of shale within the sandstone. When the sea bottom subsided far enough to escape the pounding of the surf, limey sediments produced by primitive plants and animals gradually accumulated, to become the Oneota dolomite which is now quarried as a building stone called Winona travertine.

During the past several hundred million years, the crust of the earth throughout most of North America rose from the sea to its present elevation, thus forming an expansive plateau of Paleozoic sedimentary rocks throughout the upper midwest. Subsequent erosion has produced the bluffs of dolomite, sandstone and shale which now rise 575 feet above the City of Winona (Fig. 2-2). The sandstone extends downward another 550 feet beneath Winona to the earth's ancient crust of igneous and metamorphic rock.

Approximately a million years ago, the first of many episodes of continental glaciation began. The most recent ice masses scarcely touched southeastern Minnesota, but earlier ones did. Most of the evidence of the older glacial episodes has been destroyed, however, by erosion or has been hidden by younger deposits of windblown dust called loess. Sparse glacial drift and scattered boulders of igneous or metamorphic rock are mute testimony to glacial episodes as recently as 500,000 years ago.[2]

Because the surrounding bluffs and valleys have not recently been scoured and rounded by glacial ice, the rugged landscape is spectacularly different from the surrounding recently glaciated regions which lie less than 50 miles to the east, 60 miles to the north and 40 miles to the west. Because of its early glacial history, however, the Winona area should not be called "driftless".

Current research reveals that the Mississippi River began its evolution about 500,000 years ago as an ice-marginal stream, incising its valley into the soft sedimentary rocks as it flowed along the edge of the Nebraskan glacier. The development of the master stream enabled

[1]Many of the concepts regarding recent geological events in the Winona area are from unpublished research done in collaboration with Dr. Dennis N. Nielsen and Dr. Thomas N. Bayer, Department of Geology, Winona State University.

[2]Supplemental information concerning glacial theory is contained in the Appendix of this chapter.

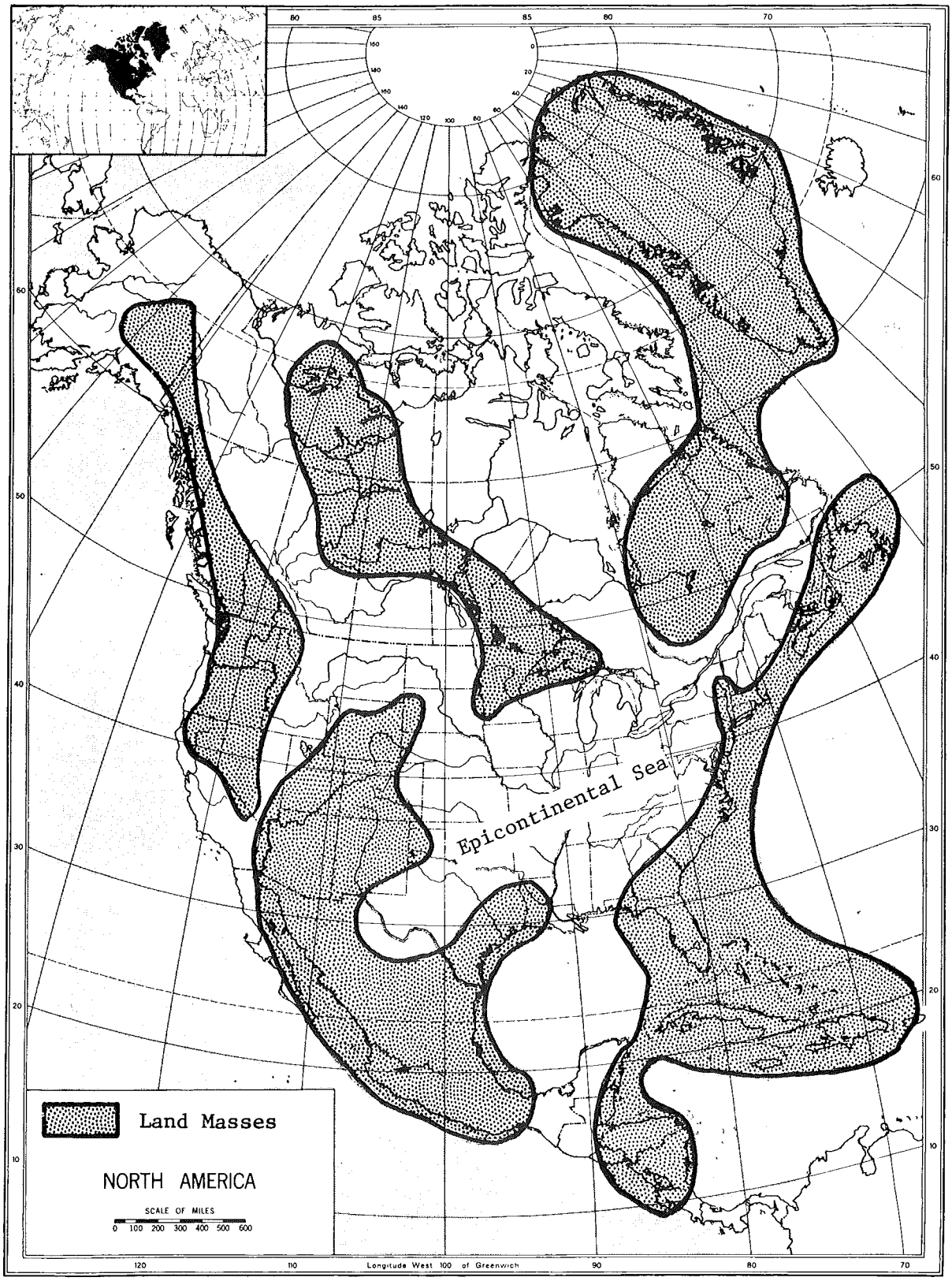

Fig. 2-1 Distribution of land and sea in the vicinity of North America about 600,000,000 years ago. Note that the North American continent, as we know it, did not exist and that the Winona area was covered by the sea (adapted from Schwartz and Thiele, 1954).

GEOLOGIC CROSS-SECTION OF THE WINONA AREA

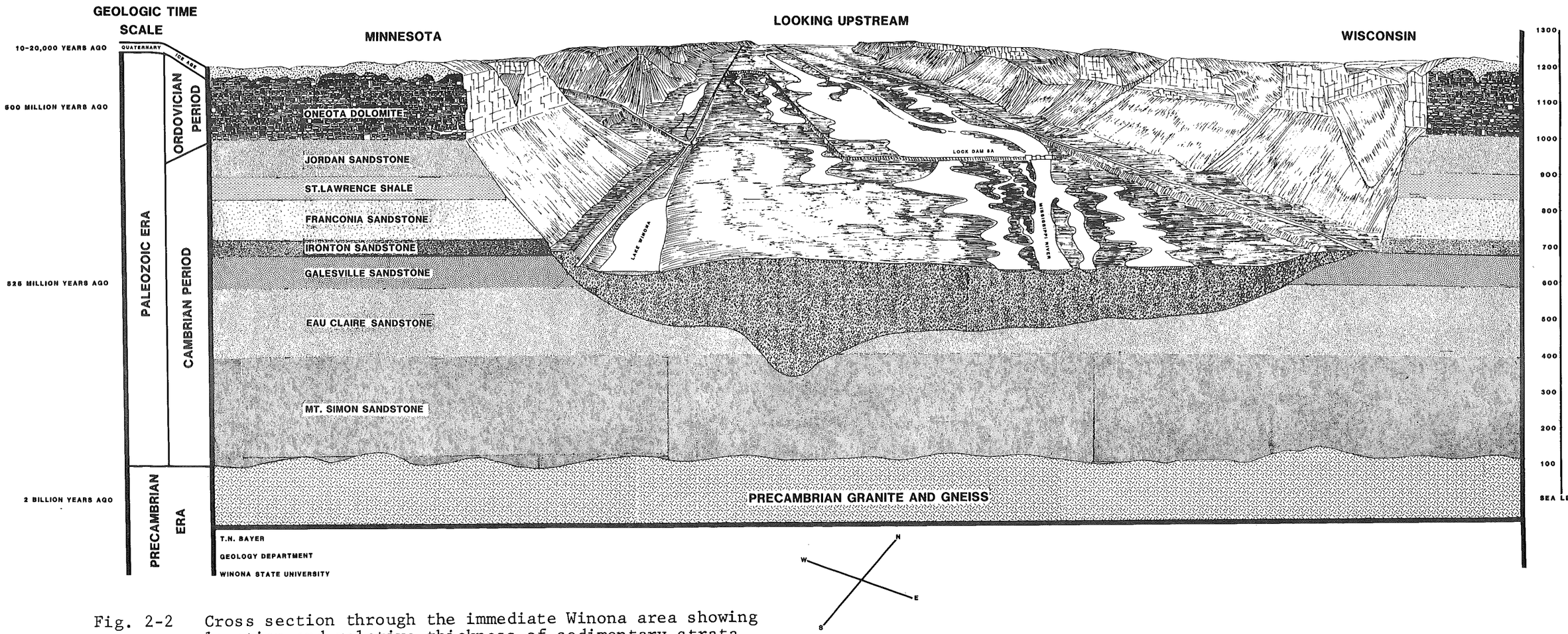

Fig. 2-2 Cross section through the immediate Winona area showing location and relative thickness of sedimentary strata. Drawing by Dr. Thomas N. Bayer, Geology Department, Winona State University.

a complex drainage network of tributary streams to develop. The major period of valley downcutting, however, was very recent, having occurred within the past 20,000 years.

During the early years of Wisconsin glaciation (about 30,000 years ago), a great lobe of ice moved southward from the Lake Superior basin and traveled as far as the present site of St. Paul (Fig. 2-3). Torrents of meltwater from the Superior Lobe transported such volumes of sand and gravel down the Mississippi and Chippewa Rivers that both rivers became overloaded with sediment and their valleys were filled to the level of the terrace upon which St. Mary's College is located.

Many tributary valleys were flooded by water which backed into them from the sediment-laden glacial Mississippi River; because the current was slowed in these estuaries, deposits of clay and other fine sediments were formed. The brickyards of yesteryear were constructed in valley floors which contained such clay deposits.

As glaciation continued northward, Lake Superior became so full of melt water that sediment-free lake water overflowed into the Mississippi via the St. Croix River (Fig. 2-4). The sediment load of the Mississippi River was thus reduced and it was able to export sediments faster than its tributaries brought them in. This resulted in trenching of the earlier deposits. Terraces, or remnants of the elevated flood plain, were thus left along both flanks of the Mississippi Valley.

The last of the Wisconsin glacial episodes climaxed only 14,000 years ago (just yesterday in the geological time scale). Again, southeastern Minnesota was scarcely touched as a glacial lobe advanced from the northwest, passed west of Rochester and extended southward as far as Des Moines, Iowa (Fig. 2-3). About 12,000 years ago, the lobe melted back into the Red River Valley and blocked its own drainage route towards Hudson Bay via the Red River. Because of this damming action, meltwater was ponded in front of the retreating glacier, forming Lake Agassiz, which covered much of northwestern Minnesota and parts of North Dakota, Ontario and Manitoba (Fig. 2-4). For about 3,000 years, Glacial Lake Agassiz spilled over its southern rim and poured down the Minnesota River Valley, forming a large river called the Glacial River Warren. The River Warren was many times larger than the present Minnesota River, but carried little sediment. The Glacial St. Croix River added sediment-free overflow from Glacial Lake Superior, rendering the sediment-hungry Mississippi capable of carrying all the sediment which was added to it by tributary streams - with still enough erosive ability to deepen the Mississippi channel by as much as 300 feet (Fig. 2-5).

As the most recent glacier retreated into Canada, its meltwaters were once again able to drain to the north through the Red River; and the River Warren lost the enormous supply of sediment-free water formerly contained in Glacial Lake Agassiz. Glacial ice also melted in eastern North America, enabling the Great Lakes to drain freely through the St. Lawrence River into the Atlantic Ocean. Consequently, the level of Lake Superior dropped until it no longer overflowed into the Mississippi via the St. Croix River. At this time, only about 9,000 years ago, the modern Mississippi, Minnesota and St. Croix Rivers came into being.

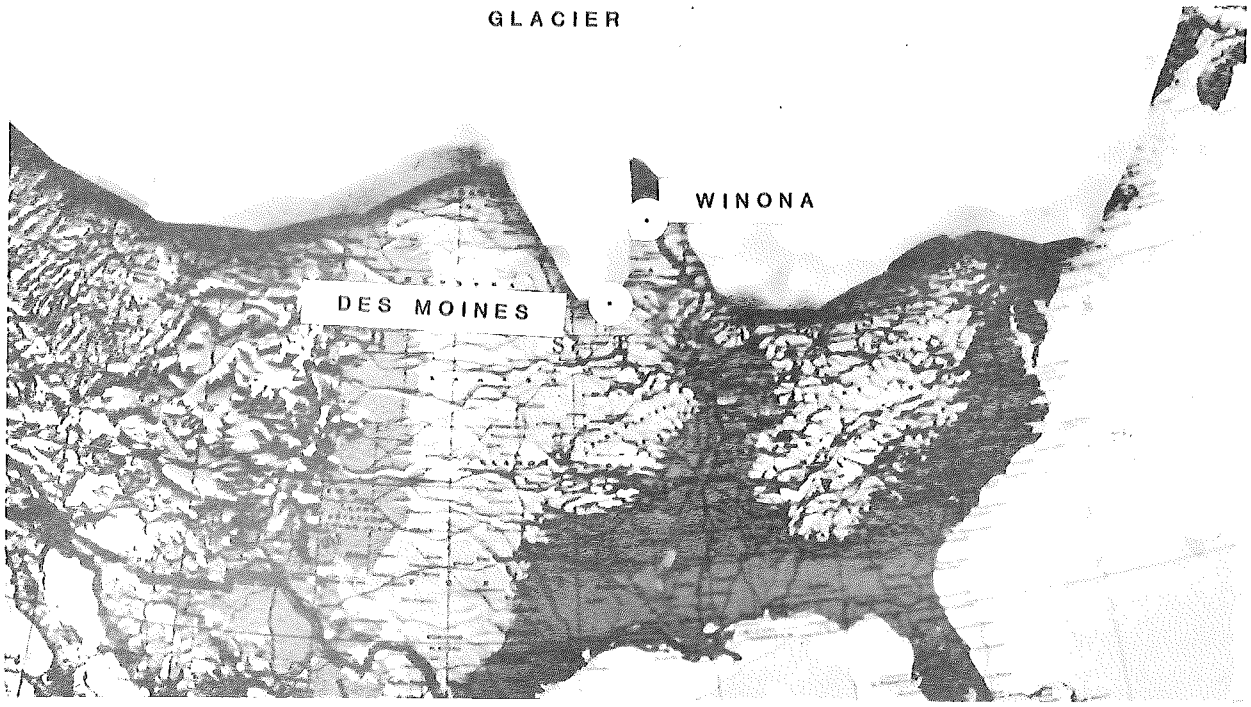

Fig. 2-3 Areas glaciated during Wisconsin glaciation. Because the glacier passed to the east and west of the Winona area, Winona's rugged bluff land was left unscathed.

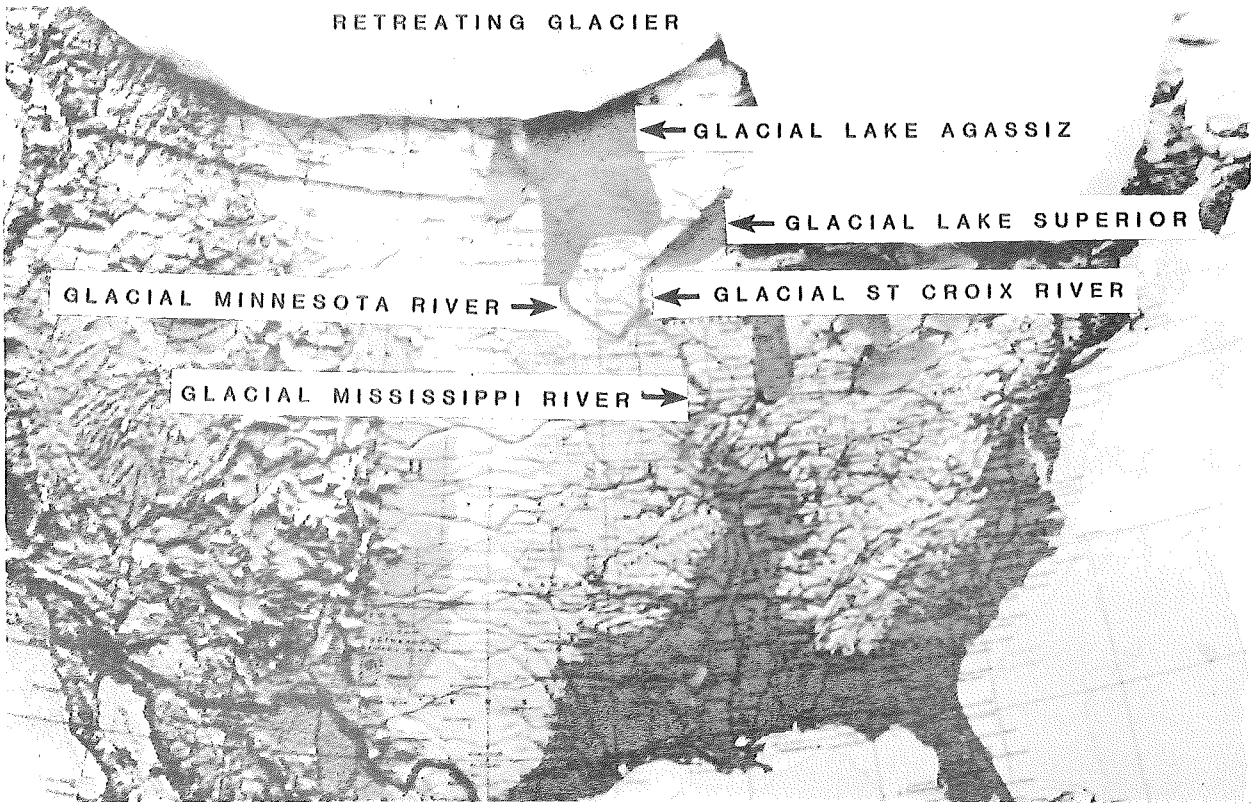

Fig. 2-4 As glacial lobes retreated northward they blocked the flow of their meltwaters to the north and east. Glacial Lake Superior overflowed into the Mississippi via the St. Croix River and Glacial Lake Agassiz overflowed into the Mississippi via the Minnesota River valley to form the Glacial River Warren.

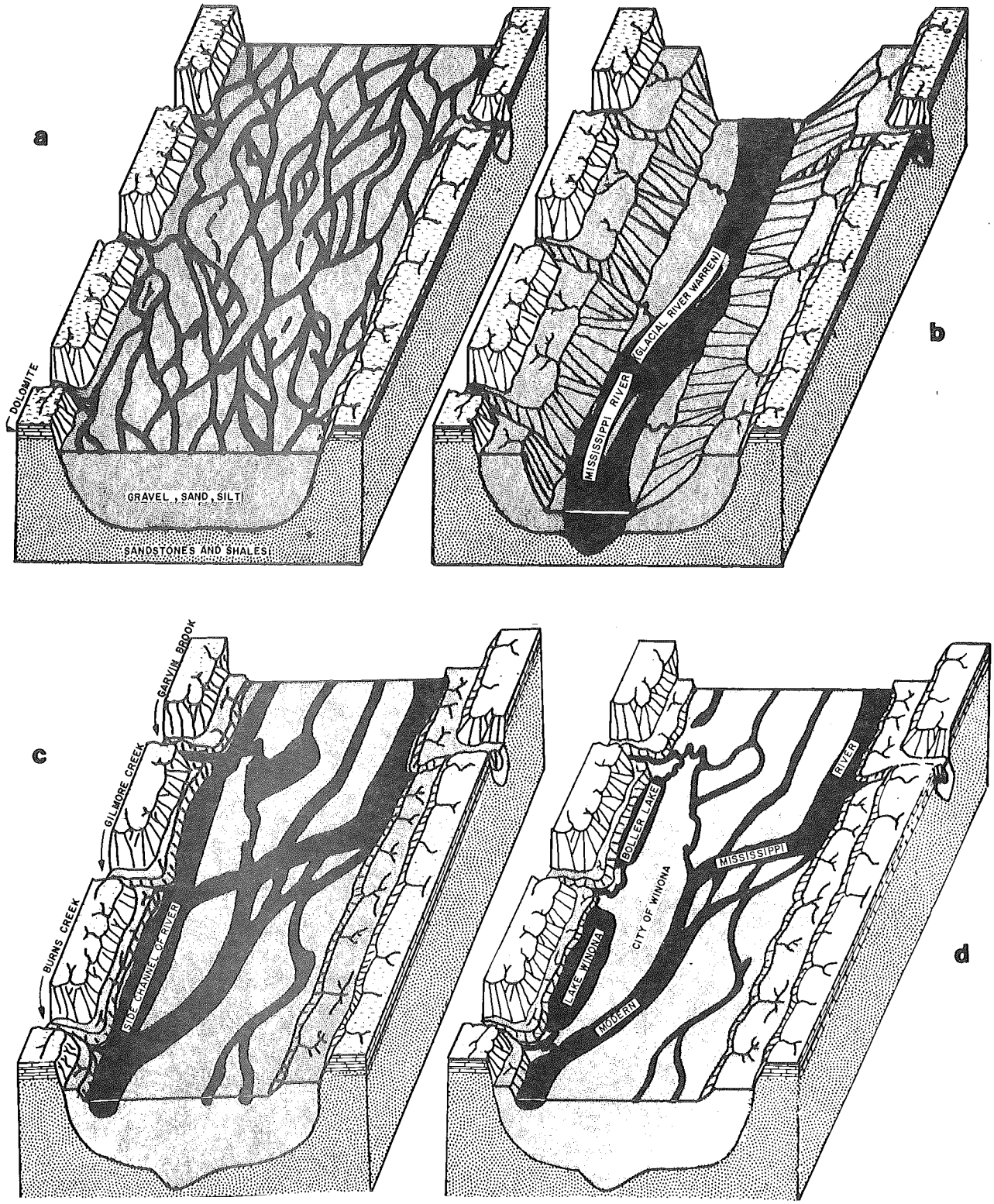

Fig. 2-5 Conceptual drawings of the Mississippi River valley at Winona, Minnesota showing the geological history of Lake Winona. a-Mississippi valley filled with glacial sediment. b-Valley scoured by the Glacial River Warren. Note the terraces which flank the river. c-Valley refilled with sediment from tributaries subsequent to the Glacial River Warren episode. Note the channel along the left (Minnesota) side of the valley. d-Side channel segmented by alluvial fans of tributaries to form Lake Winona and Boller Lake. Drawings by C. R. Fremling.

Because the volume of flow of the Mississippi was drastically reduced by loss of glacial meltwaters, and because its gradient was so gradual, the river once again lost its ability to transport the sediment load carried in by its steep-gradient tributary streams. As a result, the valley slowly filled with sediment to its present elevation (Fig. 2-5). Tributary rivers (especially the Chippewa) overloaded the Mississippi with sediment causing it to change from a single channel to a braided river consisting of many small, intertwined channels. The City of Winona lies atop a large sand bar which formed between two such channels. Even though the city lies in an area not recently glaciated, it owes its location to the glacial till which was washed into the Mississippi from tributary streams. The gravel, for example, which is quarried on the upstream end of the Winona sand bar is rich in Lake Superior agates, and igenous and metamorphic rocks not formed locally.

Within the last several thousand years, erosion of the surrounding highlands has resulted in the formation of alluvial deltas at each point where a tributary stream carries sediment into the Mississippi River Valley. Thus, an old channel of the Mississippi, which ran between Winona and the Minnesota bluffs, was cut off from the rest of the river by deposition from Rollingstone Creek on its upstream end and by deposition from Burns Creek on its downstream end (Fig. 2-5). Gilmore Creek added much of its own sediment at about midpoint, dividing the long, isolated channel into two lakes - known today as Lake Winona and Boller Lake.

When the first white man arrived at Winona, Lake Winona was a marshy lake which was connected to the river at its downstream end during flood time. Because of severe soil erosion during the late 1800's, the alluvial deltas of the various creeks increased in size, thus further separating Lake Winona and Boller Lake from each other and from the river. The raising of Mankato Avenue finally separated Lake Winona completely from the river during normal water levels. As late as 1852, however, steamboats passed through Lake Winona and the present site of Westfield Golf Course on their way up Crooked Slough during flood time.

There is a persistent myth that Lake Winona was formed when a large load of rock destined for court house construction sank and blocked an old river channel. The large load of rock did sink, but in Bathhouse Slough on the Wisconsin side of the river just north of Latsch Island (see Bunnel, 1897, pp. 402-403). The episode has much to do with the development of Winona, but it had nothing to do with the creation of Lake Winona.

APPENDIX

Scientists have documented at least 20 epochs of continental glaciation which have taken place during the past 2,000,000 years, each lasting about 100,000 years. Most of the ancient records have been obtained by analyzing sediment cores from the ocean bottom. Glacial and interglacial periods are demonstrated by the alternating layers of warm-ocean and cold-ocean fossils found in the cores. Ages of the layers have been determined by radiocarbon dating. Glacial periods apparently begin slowly and are long lasting, while interglacial periods begin abruptly and are shorter lived. Man's civilizations have evolved during the present interglacial period. It is important to realize that for at least the past 2,000,000 years, continental glaciation has been the norm, while interglacial periods have been abnormal.

Records of ancient periods of glaciation are difficult to obtain on land because each succeeding glacier tends to obliterate the record of the previous glacier. During the past 500,000 years or so, however, four ice ages can be demonstrated to have occurred in Minnesota. From oldest to most recent, they are called the Nebraskan, Kansan, Illinoian and Wisconsin. The period during which they took place is called the Pleistocene Epoch. We are now living in the interglacial period which has followed Wisconsin glaciation.

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