Reports

Radiocarbon Dates of Mankato Drift in Minnesota

The town of Mankato on the Minnesota River in south-central Minnesota is the type locality for the deposits of the Mankato substage of the Wisconsin glacial stage. The surface drift in this area was deposited by the Des Moines lobe of the Keewatin ice sheet, according to Leverett (*1*). Recent work by Ruhe and Gould (*2*) has shown that at least the outer part of the Des Moines-lobe drift is Cary, rather than Mankato, in age, and investigations by Wright (*3*) near Minneapolis indicate that at least some of the drift of the Grantsburg sublobe of the Des Moines lobe is also Cary in age. On the other hand, in northern Minnesota, the St. Louis sublobe of the Des Moines lobe, still presumed to be Mankato in age, seems to have been contemporaneous with the Valders advance of the Superior lobe, implying correlation of Mankato with Valders (*4*).

Certain difficulties in delineating the deposits of Cary and Mankato age in the Des Moines lobe and its Grantsburg sublobe have led to the hypothesis that activities of these ice masses were confined to the Cary glacial substage prior to the Two Creeks interstadial rather than to the Valders advance, which postdates the Two Creeks interstadial. Radiocarbon dates assessed in this report (*5*) strongly support this hypothesis.

The radiocarbon dates pertinent to the age and correlation of the Mankato drift (Table 1) fall into three groups: (i) dates for the Anoka sand plain and Mississippi valley train, which were described by Cooper (*6*) as having formed during and soon after the retreat of the Grantsburg sublobe of Mankato age; (ii) dates for basal organic sediments in lakes on Mankato drift; (iii) dates for the deposits of Lake Agassiz, which was presumed to record the retreat of the Des Moines lobe in Mankato time.

The Anoka sand plain was initiated when the Mississippi River was diverted eastward to the St. Croix River by the Grantsburg sublobe. As the ice margin withdrew to the southwest, the sand plain broadened over the exposed terrain and finally adopted its present relatively straight course from St. Cloud to Minneapolis. The latest outwash episode is represented by the Mississippi valley train, at a level slightly below the Anoka sand plain proper. The valley train has since been terraced by the postglacial Mississippi River.

Peat and wood buried beneath 5 feet of Anoka sand were discovered by R. Farnham in a drainage ditch 3 miles southeast of North Branch, western Chisago County, about 5 miles from the St. Croix River. They represent an early phase in the development of the sand plain, when the Mississippi still flowed east to the St. Croix. The peat (sample W-389) was dated by the U.S. Geological Survey laboratory as 12,700 ± 250 years and the wood (W-354) as 12,030 ± 200 years old.

The Mississippi valley train episode is effectively dated by analyses of material collected in 1923 by W. S. Cooper (*7*) from sand at a depth of 3 to 12 feet in a building excavation at Loring Park, Minneapolis. A piece of wood was dated as 11,790 ± 200 years old (sample W-454) and peat as 10,200 ± 300 years old (sample W-445). The peat date might be the less accurate because of the greater possibility of unseen contamination by modern roots and other intrusions.

Inasmuch as the Two Creeks interstadial at the type locality has been dated many times as about 11,400 Before Present (BP), the North Branch and Loring Park dates suggest that the Anoka sand plain and Mississippi valley train represent wastage of the stagnated Grantsburg sublobe during the Two Creeks interval. This indicates that the Grantsburg sublobe itself is pre-Two Creeks rather than post-Two Creeks in age, as has generally been assumed. Inasmuch as the Grantsburg sublobe had its source to the southwest in the Des Moines lobe, in our opinion the surface drift at the town of Mankato in this direction should also be correlated with the Cary rather than with the Valders.

The physiographic evidence on which Cooper accepted a late Wisconsin (that is, Valders) age for the Anoka sand plain may be reinterpreted in favor of a late Cary age subsequent to the Cary maximum but prior to the Valders advance. The Cary maximum in this area is represented by near-simultaneous advance of ice lobes from both the northeast (Superior lobe) and west (Grantsburg sublobe), and their drifts are interbedded in the area of contact (*3*). The Superior lobe then retreated to the Lake Superior basin. Its meltwater drainageways, directed to and beyond the site of the Mississippi River, were completely abandoned by the time they were overridden by the readvancing Grantsburg sublobe. According to the radiocarbon dates, the Grantsburg readvance (this time all the way to Wisconsin) should be assigned to the late Cary and was matched perhaps by a readvance of the Superior lobe, for which there is some evidence farther north. During the Two Creeks interstadial, the Superior lobe retreated once again, and the Grantsburg sublobe protrusion stagnated, permitting the formation of the Anoka sand plain and the Mississippi valley train.

Terminal dates for Mankato ice cover

Table 1. Radiocarbon dates related to correlation of drift at Mankato, Minnesota. W = Washington, C = Chicago, Y = Yale.

Description	Sample No.	Age (yr BP)
Anoka sand plain and Mississippi valley train		
North Branch, Chisago County. Wood from sand of Anoka sand plain.	W-354	12,030 ± 200
North Branch. Peat from same horizon as W-354.	W-389	12,700 ± 250
Cedar Creek Bog Lake, Isanti County. Gyttja at depth 28 ft, pine-pollen zone B.	C-332	7,988 ± 420
Cedar Creek Bog Lake. Same spot as C-332. Gyttja at depth 30 ft, just above sand.	W-466	11,830 ± 200
Lake on Grantsburg till near Blomford, Isanti County. Basal organic sediment at a depth of 12 ft below water surface.	W-465	4,890 ± 200
Loring Park, Minneapolis. Wood from sand of Mississippi valley train at a depth of 3 to 12 ft.	W-454	11,790 ± 200
Loring Park. Peat from same sand as W-454.	W-445	10,200 ± 300
Lake Agassiz		
Moorhead, Clay County, Minn. Peat from a depth of 45 ft in lake clay.	C-497	11,283 ± 700
Moorhead. Duplicate sample of C-497.	W-388	9,930 ± 280
Rossendale, southern Manitoba. Peat from Lake Agassiz II sediments. Solid carbon analysis.	Y-165	13,230 ± 600
Same as Y-165, by acetylene analysis.		12,400 ± 420
Rossendale. Shell from material correlative with Y-165.	Y-166	11,230 ± 480

in any region may be taken from analysis of basal organic sediments in lakes on Mankato drift. Such dates supply only a minimum age, of course, because many lakes represent buried ice blocks that may have melted out long after disappearance of surface ice. Buried ice blocks of Cary age in this area thus may have survived the Two Creeks interstadial and the Valders cold interval as well. Two lakes (at Cedar Creek Bog and at Blomford) were sampled in an attempt to find a lake that originated immediately after withdrawal of surface ice; the Cedar Creek Bog lake sample is indicative.

Cedar Creek Bog is an ice-block feature in the Anoka sand plain in south-central Isanti County. An earlier sample had been taken by M. Buell from a depth of 28 feet from the pine-pollen zone of Lindeman (*8*) and was dated as 7988 ± 420 years old (sample C-332) (*9*). A new sample, however, collected by F. M. Swain and H. E. Wright from about the same spot at a depth of 30 feet just above the sand at the very base of the organic sediment, yielded at date of 11,830 ± 200 (sample W-466). The result suggests that the lake was already in existence during the Two Creeks interval. This date, in conjunction with the date from the Anoka sand itself at North Branch, only 13 miles to the east, seems to bracket the time of formation of the Anoka sand plain and further supports the late Cary correlation of the drift at Mankato.

The basal organic sediment of a second lake was also analyzed. This lake (near Blomford in central Isanti County) is a ground-moraine lake of the Grantsburg sublobe and should have started its existence very soon after the ice retreat. The date, however, is too late for consideration—4890 ± 200 years (sample W-465).

Glacial Lake Agassiz was initiated when the Des Moines lobe retreated into the Red River valley, which has a normal northward slope (*1*, p. 119). The early outlet was south by way of the Minnesota River valley (Glacial River Warren), but as the ice withdrew to the north it uncovered lower outlets across western Ontario to Lake Superior. Johnston (*10*) and Elson (*11*) have postulated a readvance of the ice to close the eastern outlets and raise the lake level to form Lake Agassiz II.

Whereas Leverett (*1*, p. 119) had considered Lake Agassiz to mark the retreat of the Mankato ice, radiocarbon dates suggest that it was older. Wood studied by Rosendahl (*12*) from a sewer excavation at Moorhead, Minnesota, beneath 25 feet of varved lake deposits (1800 varves) at a depth of about 45 feet below the lake plain was dated as 11,283 ± 700 BP (sample C-497) (*9*). A duplicate sample has recently been reanalyzed in Washington, D.C., as 9930 ± 280 BP (W-388).

Peat collected by Elson from Lake Agassiz II sediments near Rossendale in southern Manitoba was dated as 13,230 ± 600 BP by the solid-carbon method and 12,400 ± 420 BP by the more accurate acetylene method (sample Y-165), and shells from correlative sediment at a nearby locality as 11,230 ± 480 BP (Y-166) (*13*).

The Agassiz dates (except for the rerun of the Moorhead sample) suggest that the lake started its formation before the Valders advance, and even the Moorhead rerun is compatible with this hypothesis. The lake deposits were never overridden by ice in Minnesota, North Dakota, and adjacent southern Manitoba. The Des Moines lobe thus would also predate the Valders. Elson postulates that the Valders ice margin fell along certain moraines that blocked eastern lake outlets in central Manitoba and western Ontario and caused the growth of Lake Agassiz II. There are still difficulties with a Valders border this far north, inasmuch as drift of Valders age in the Superior sublobe and St. Louis sublobe have been identified in Minnesota (*4*), but the Lake Agassiz radiocarbon dates certainly point to a pre-Valders age for the Des Moines lobe proper and thus also for the drift at Mankato.

The radiocarbon analyses discussed in the preceding paragraphs all serve to date the drift at Mankato indirectly. Only one dated specimen of wood has been recovered from the Mankato drift itself. This was collected by R. Schneider from the surface drift near Redwood Falls, 60 miles up the Minnesota River from Mankato, and was dated as > 31,000 years old (sample W-99) (*14*). The drift is believed to be continuous with the surface drift at Mankato, but the date is so much greater than that anticipated for either Cary or Valders time that it must be considered anomalous; the wood may possibly have been derived from older drift. Wood collected by J. H. Zumberge from an oxidized drift that underlies the surface drift at Mankato itself was dated as > 37,000 BP (sample W-300, W-301). This drift must be pre-Wisconsin.

The radiocarbon dates discussed here suggest that the surface drift at Mankato should be correlated with the Cary (pre-Two Creeks) rather than with the Valders (post-Two Creeks). This possibility was discussed by Horberg (*15*) and Flint (*16*). We therefore favor the use of the term *Valders* over the term *Mankato* for the last major substage of the Wisconsin. Adoption of this term would establish the several important intervals of the middle and late Wisconsin—Tazewell, Cary, Two Creeks, and Valders—as units of reference based on the activity of a single ice lobe (Lake Michigan lobe). Most of the stratigraphic and geomorphic relationships can be reconciled to a late Cary correlation for the Grantsburg sublobe, Anoka sand plain, the Des Moines lobe proper, and Lake Agassiz I. The St. Louis sublobe is considered to be Valders in age, but its relationship to Lake Agassiz is not certain at the present time.

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References and Notes

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Structure of Small "Spherical" Viruses

The recent x-ray diffraction study by Caspar (*1*) on a crystal of tomato bushy stunt virus (TBSV) and the electron microscope studies by Williams and Steere (*2*) and by Rice, Kaesberg, and Stahmann (*3*) on frozen-dried preparations of several so-called "spherical" viruses suggest that these particles have a remarkably symmetric structure. The x-ray diffraction study shows that the TBSV particle has twofold and threefold symmetry axes and quite possibly also fivefold axes. The electron microscope studies show that tobacco ringspot virus (TRSV) and squash mosaic virus (SMV) often appear hexagonal in contour and TBSV sometimes appears hexagonal. All of these viruses cast shadows having several straight sides. On the other hand, a polyhedral contour has not been demonstrable previously in frozen-dried preparations of polio virus (*4*) or in turnip yellow mosaic virus (*5*). No detailed electron microscope structure has been reported for any air-dried preparations of small (around 300 A in diameter) viruses, probably because of the distorting effects of surface tension.

Lightly shadowed viruses can be imaged clearly in properly adjusted microscopes, but their shadows are not sufficiently well defined to be very useful. However, *heavy* shadowing with a mate-