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oric and beautiful part of Tioga Coun-
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eferences

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ille conglomerates (Pennsylvanian) in the Cen-
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The West Liberty Esker

by Gary M. Fleeger
Denver, Colorado

The West Liberty Esker (Figure 1) was deposited during the Kent deglaciation about 23,000 years ago. It occurs in three segments over a distance of 6½ miles between Harlansburg, Lawrence County, and West Liberty, Butler County, separated by post-glacial erosion by Slippery Rock Creek and Taylor Run. The northwestern, upstream segment consists of several short eskers that appear to form a tributary pattern with the main esker. The southeastern segment ends at a kame delta that was deposited in a proglacial lake. The esker is com-

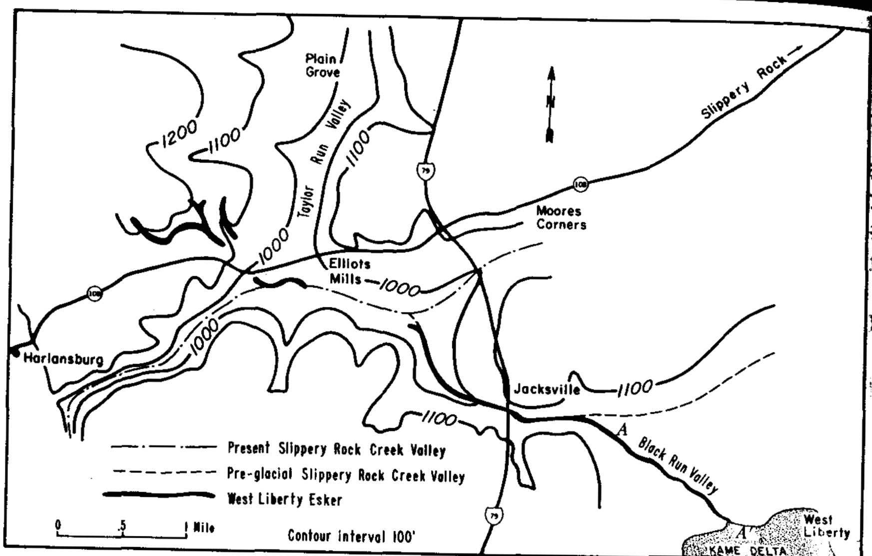

Figure 1. Bedrock contour map (from Poth, 1963) showing location of West Liberty Esker.

posed of cobbles, gravel, and sand, with grain size generally increasing downstream. Till caps the esker sediment in some places, while glaciofluvial gravels are present to the top in other sections. Delliquadri (1951) reported pebble lithologies of predominantly granite, gneiss, sandstone, and quartzite.

Eskers were once assumed to have been deposited only by streams flowing through subglacial meltwater tunnels. However, they can also be deposited in englacial tunnels, open supraglacial channels, or at the glacier front where a meltwater channel or tunnel emerges. A close look at the structure and morphology indicates that the West Liberty Esker was deposited at both subglacial and ice frontal positions.

Evidence that the esker was deposited in a tunnel is the downstream increase in elevation of the base of the esker, from 1100 feet at Slippery Rock Creek to 1215 feet at the kame delta. Water can flow uphill only when a sufficient hydrostatic head is developed in a full flowing tunnel because of the greater thickness of the overlying ice upstream than downstream. An esker extending uphill can also result from the lowering of an englacial tunnel esker or a supraglacial channel esker during melting of the supporting ice, or a time transgressive esker deposited at the ice front as the glacier retreated downhill (Banarjee and McDonald, 1975). There is no deformation of the entire esker to indicate melting of supporting ice. Extensive faulting only along the edges (Geyer and Bolles, 1979), because of slope failure during the melting of the ice walls, indicates that the West Liberty Esker was deposited in a subglacial tunnel, and not at an englacial, supraglacial, or ice front position. Some ice front deposition did occur, but is not the main location of deposition.

Another indication that the esker \
tunnel is that most of it follows the bu
pery Rock Creek and Black Run (Figu
the tunnel is at the base of the glacie
face (Banarjee and McDonald, 1975).

The morphology of the West Liber
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near its terminus when the str
deposited. A very thin glacier is co
tinuous Kent Till in northeastern (
sylvania.

Figure 2. Profile along A downstream portion of West Liberty Esker between locations A and A' shown on Figure 1.

The esker southeast of Jacksville
at 1700 foot intervals (Figure 2).
discharge may have deposited grea
of the subglacial tunnel esker at th
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retreat of the Kent glacier was 170(

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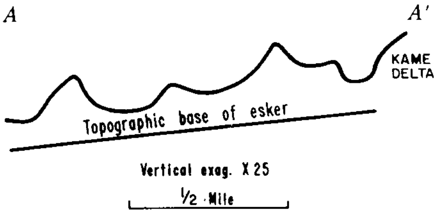
Another indication that the esker was deposited in a subglacial tunnel is that most of it follows the buried, preglacial valleys of Slippery Rock Creek and Black Run (Figure 1). This can happen only if the tunnel is at the base of the glacier, in contact with the land surface (Banarjee and McDonald, 1975).

The morphology of the West Liberty Esker also gives an indication of the character of the Kent glacier. The esker is sinuous in the upstream part, but changes southeast of Jacksville, where it has angular bends and parallel straight segments. This is due to differences in ice thickness. At depths greater than 100 feet in a glacier, the overlying weight causes the ice to behave plastically (Sugden and John, 1976) so that crevasses will not extend into the glacier more than about 100 feet. Subglacial tunnels follow fractures in the ice where they reach the base of the glacier (Stenborg, 1968), suggesting that the Kent glacier was 100 feet thick or less near its terminus when the straight esker segments were deposited. A very thin glacier is consistent with the thin, discontinuous Kent Till in northeastern Ohio and northwestern Pennsylvania.

Figure 2. Profile along downstream portion of West Liberty Esker between locations A and A' shown on Figure 1.



The esker southeast of Jacksville has higher mounds, or beads, at 1700 foot intervals (Figure 2). Increased summer meltwater discharge may have deposited greater amounts of sediment on top of the subglacial tunnel esker at the tunnel mouth as the ice front melted back. This would indicate that the initial rate of annual retreat of the Kent glacier was 1700 feet.

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