

# Early middle Pleistocene glacial sediments (780 000–620 000 BP) near Kansas City, northeastern Kansas and northwestern Missouri, USA

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Two lithologically distinct tills are present near the pre-Illinoian glacial boundary in northeastern Kansas and northwestern Missouri. The tills are probably early middle Pleistocene (780 000–620 000 BP) based on normal polarity and their stratigraphic relationship to dated terraces. The upper till is sandier than the lower till and contains more expandable clay minerals and less illite than the lower till. Glaciofluvial and supraglacial sediments are preserved between the tills, yet palaeosols, or other evidence of an interglacial, are not present, suggesting that the tills were deposited during a single glaciation. Southeasterly and southwesterly trending striae and till fabric suggest that the glacial succession was deposited by at least two fluctuations (phases) of a lobe, which probably advanced down the axis of the present Missouri River lowland. These tills probably correlate to early middle Pleistocene tills in southwestern Iowa and eastern Nebraska, although it is possible that the lower till may correlate to even older tills in these areas.

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Despite 100 years of glacial geological research in the mid-continent of the United States, few detailed stratigraphic or sedimentologic studies of glacial sediments have been completed in northeastern Kansas or northwestern Missouri (Fig. 1). Such information is critical in correlating these glacial sediments to better-known deposits in other parts of the US mid-continent, and to the oxygen–isotope record reconstructed from deep marine sediments. This paper reports on the stratigraphy and sedimentology of glacial sediments along the pre-Illinoian glacial boundary near Kansas City, Missouri and suggests that there is evidence for two phases of glacial deposition in this area.

## Previous work

In northeastern Kansas and northwestern Missouri there are few quantitative lithologic, stratigraphic, and chronological data available for reconstruction of depositional environments, correlation, and age control for pre-Illinoian glacial deposits (Todd 1896; Holmes 1942; Frye & Leonard 1952; Davis 1955; Howe & Heim 1968; Bayne *et al.* 1971; Guccione 1983; Aber 1991; Rovey & Kean 1996). Dort (1987a) and Aber (1988, 1991) provide summaries of the glacial geology of northeastern Kansas, and Guccione (1983) provides a description of glacial sediment in north-central Missouri. Rovey & Kean (1996) present evidence for five tills in north-central Missouri, based on lithology, clay mineralogy, and palaeomagnetism. No detailed studies have been completed in northwestern Missouri,

a region that lies between northeastern Kansas and north-central Missouri (Fig. 1).

In northeastern Kansas and northwestern Missouri, glacial sediments overlie Late Pennsylvanian bedrock and underlie Wisconsinan, and Illinoian loess units (Frye & Leonard 1952; Davis 1955). Truncating glacial deposits and loess are a major erosional unconformity marked by the regionally extensive and complex, Yarmouth–Sangamon palaeosol (Ruhe 1969, Hallberg 1980, 1986; Richmond & Fullerton 1986; Woida & Thompson 1993). This palaeosol developed from the end of the last pre-Illinoian glaciation to when loess was deposited during the late Wisconsin. The Yarmouth–Sangamon palaeosol is buried by late Wisconsinan loess (up to 30 m thick) in most of the region.

During most of this century, glacial sediments in the region were interpreted with respect to the four-fold North American stage classification (see Frye & Leonard 1952; Howe 1961). Early studies identified two tills north of Kansas City, which were assigned a Nebraskan and Kansan age based on stratigraphic position and relation to palaeosols. The Kansan till was thought to be more extensive, reaching Kansas City, whereas the older Nebraskan till was thought to terminate about 80 km north of Kansas City (Flint 1957: 338). There is no evidence that later Illinoian and Wisconsinan advances ever reached as far south as Kansas and Missouri. Bayne (1968) and Dort (1965, 1966, 1985) described several tills in northeastern Kansas (Fig. 1), suggesting a more complex record similar to that of pre-Illinoian glacial deposits in Iowa and Nebraska (Boellstorff 1973; Hallberg 1980, 1986). Since then, the terms Nebraskan and Kansan have been