

Ravine Alluvial Fans as Records of Holocene and Western Settlement Disturbances

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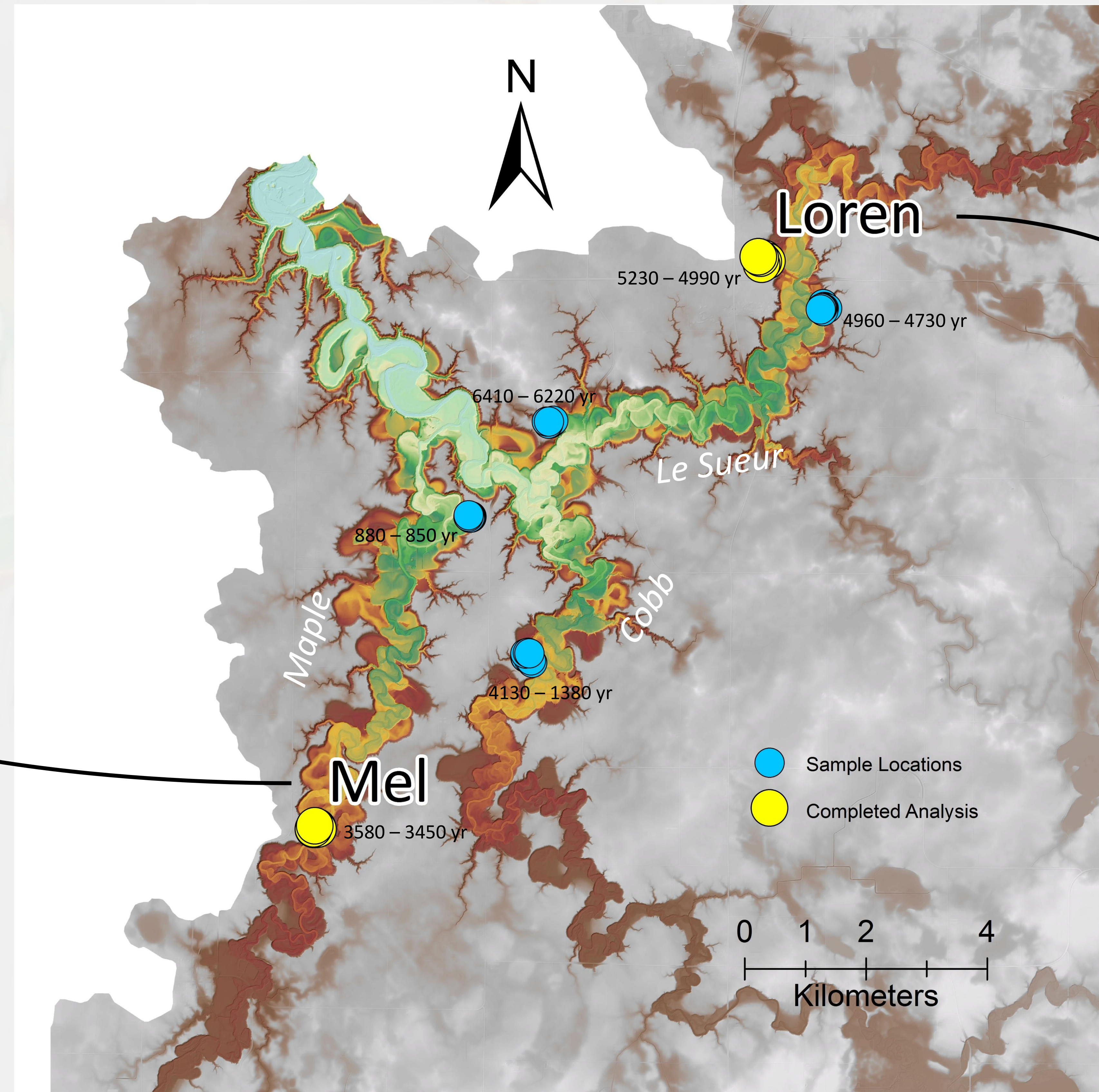
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Abstract

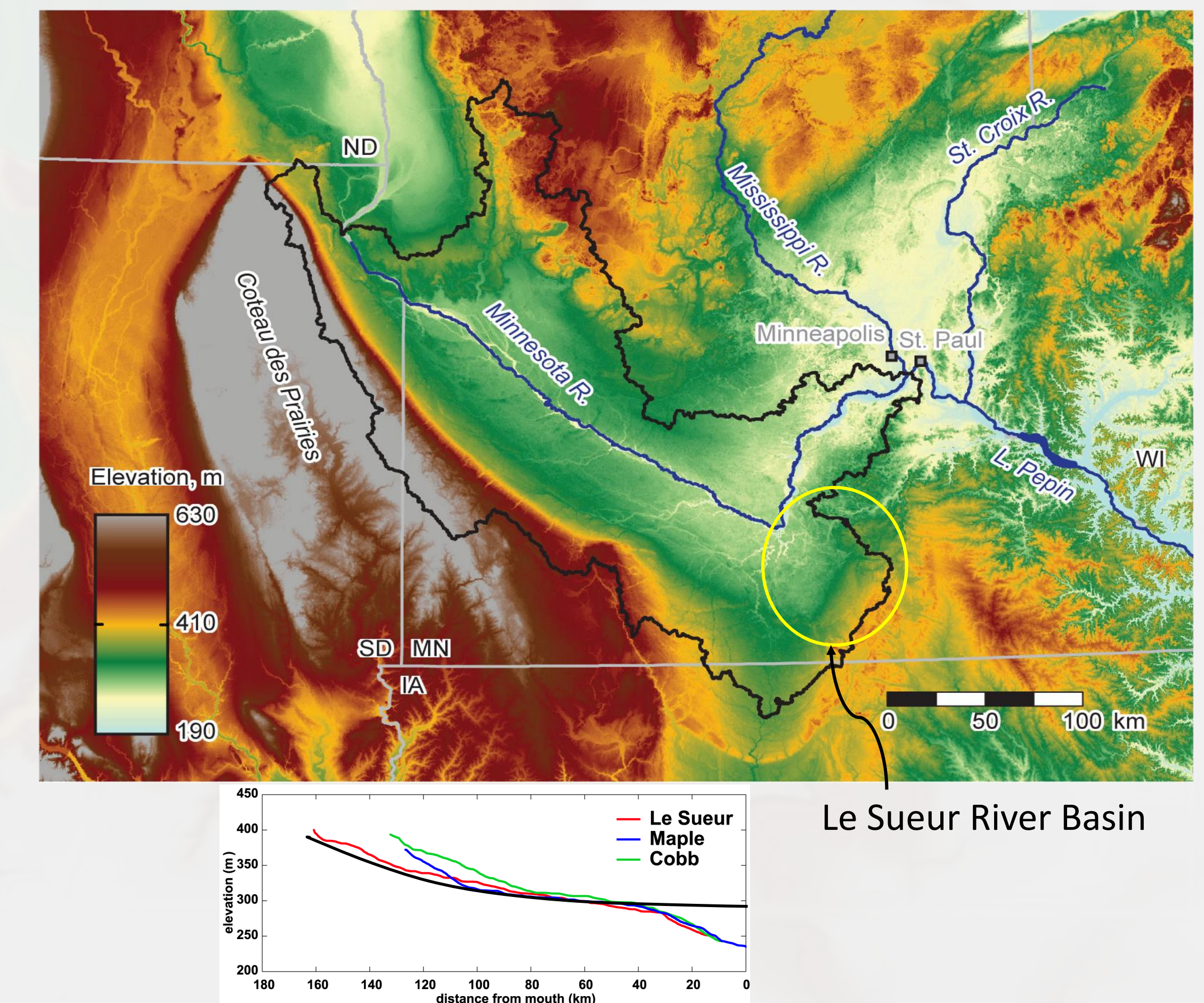
The Le Sueur River Basin in southern Minnesota preserves the records of early Holocene and modern anthropogenic disturbances. Seventy meters of base-level drop at the end of the last glaciation initiated millennia of incision that continues on the Le Sueur River and its tributaries today. Onto this template of on-going incision, Euro-American land clearing and drainage of previously stable upland prairie in the mid-1800s may have further increased erosion rates in the basin. Ravines that link the low-gradient uplands with the deeply incised channel network have experienced changes in erosion rates over time from both of these impacts, with the erosional history preserved in alluvial fans at the mouths of ravines where they terminate on fluvial terraces. We are studying six ravine fans to better understand the long-term evolutionary history and how fans responded to Euro-American land clearing. These alluvial fans were chosen to encompass a range of size, depth of incision, and distance from the mouth of the Le Sueur River. Radiocarbon dating of organic-rich sediment, wood, and charcoal is being used to obtain depositional ages near the base of the alluvium. Fly ash from coal combustion is being used as a stratigraphic marker recording an event (Western settlement) in the fan's history; it was sampled at 10, 20, 40, 100, and 200 centimeters on the fan surface as well as in any incised channels cut into the fan surface. The scale of the impact that settlement has on ravines is largely unknown, but initial results show that in one ravine, there is at least 135 centimeters of post-settlement alluvium marked by a metal pin found at that depth. If regional coal combustion began in the 1850s, that produces an initial post-settlement alluvium deposition rate of 0.81 cm/yr. Combining detailed stratigraphy with basal ages and post-settlement markers, we will be able to determine if background rates of deposition on fans changed with the onset of land clearing for agriculture.

Study Area



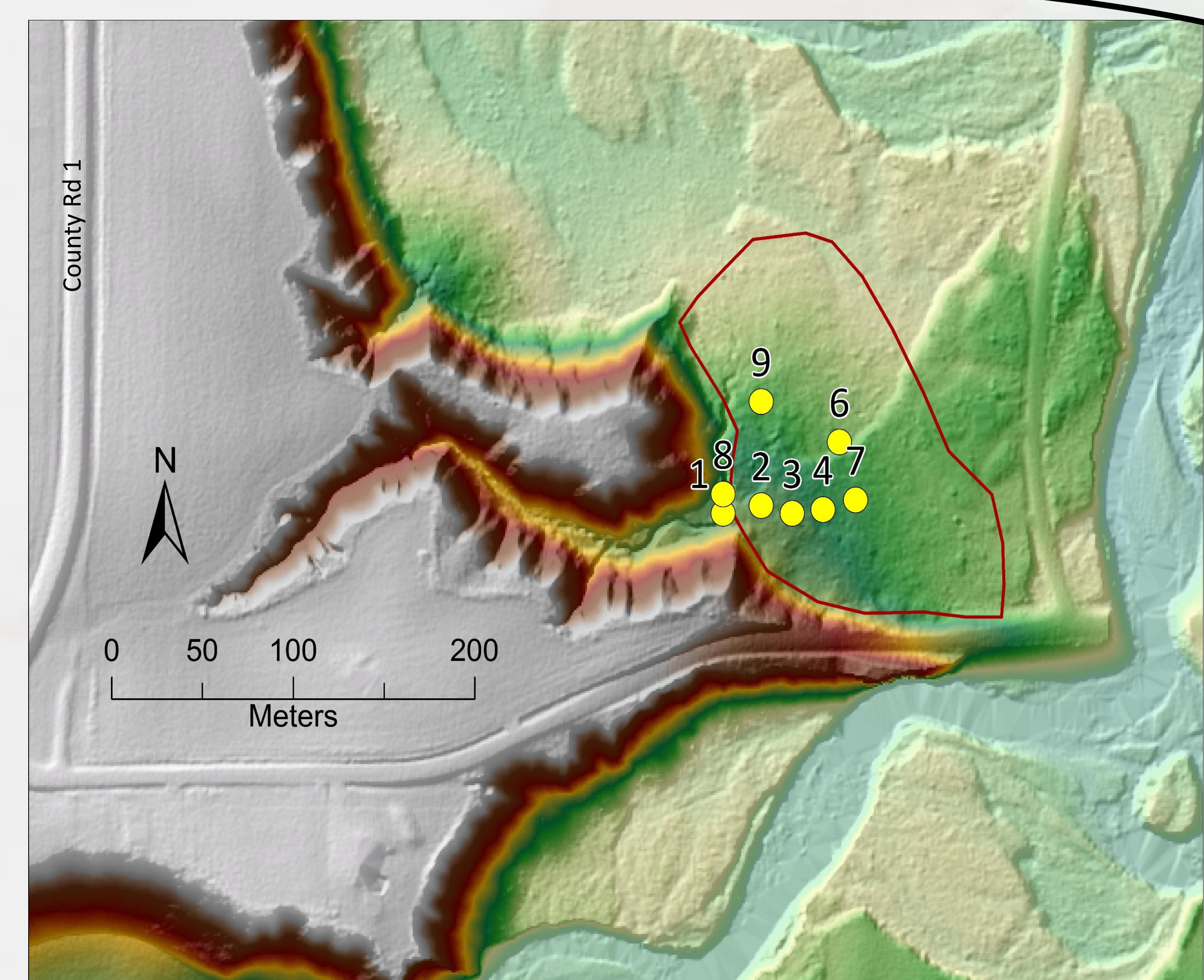
Ravines and their alluvial fans were sampled over a widespread geographic distribution within the knickzone of the Le Sueur River. Hand augering and in-channel sampling were used to collect sediment for fly (coal) ash analysis. A numerical model determined terrace ages where ravine fans deposited (Noah Finnegan's model in Gran et al., 2013).

Geologic Setting

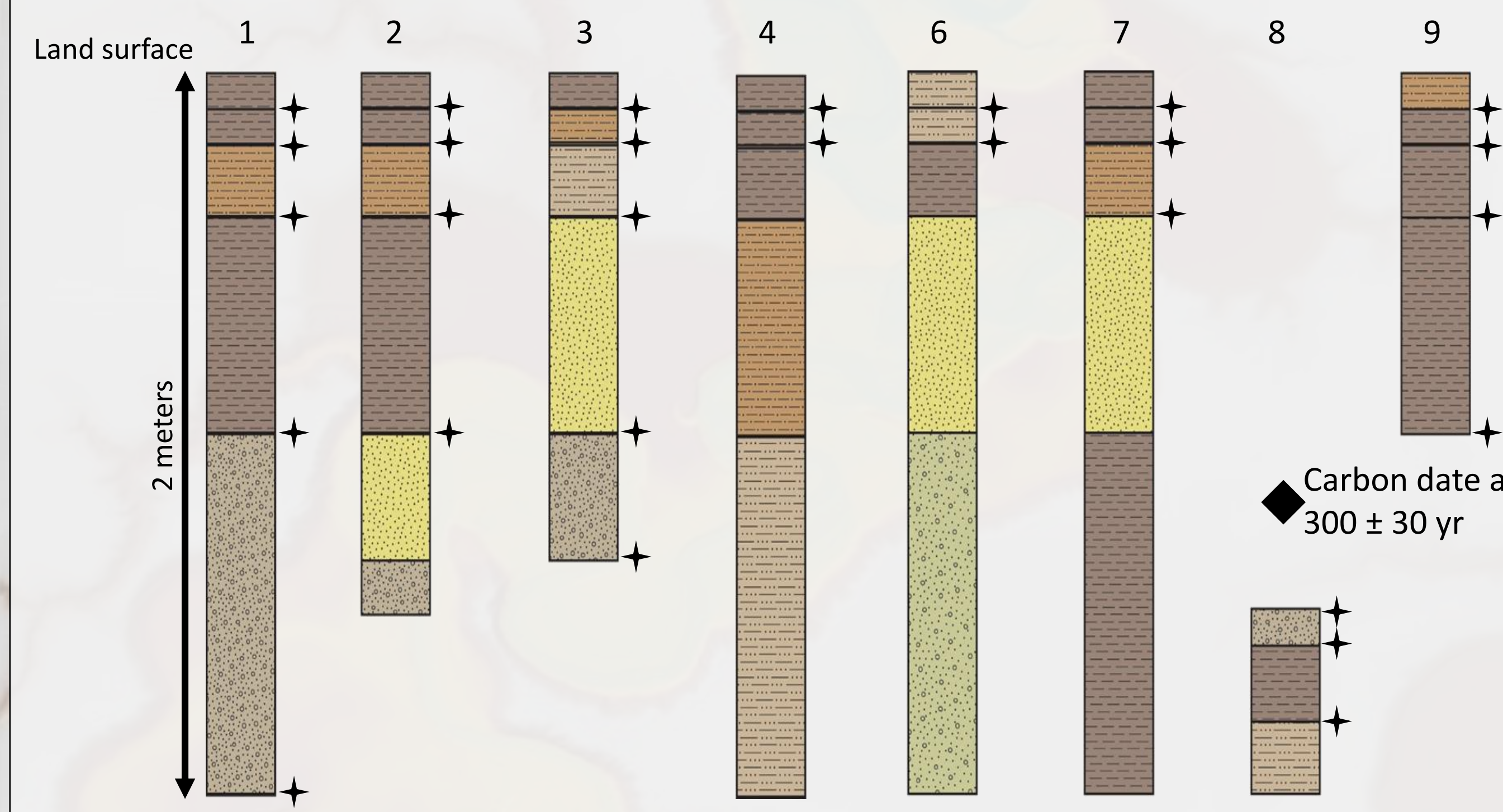


Location of the Le Sueur River Basin within the Blue Earth River Basin. As base-level adjustment continues on the Maple, Cobb, and Le Sueur Rivers, knickpoints migrate upstream. (Image from Jon Czuba.)

Mel



Sample sites 1 and 8 were taken within the channel dissecting the alluvial fan. Samples 6 and 9 were taken on the lower (younger) of the two terraces. Samples 2, 3, 4, and 7 were taken on the higher (older) of the two terraces.



Ravine fan stratigraphy



Sample collection and storage

Methods

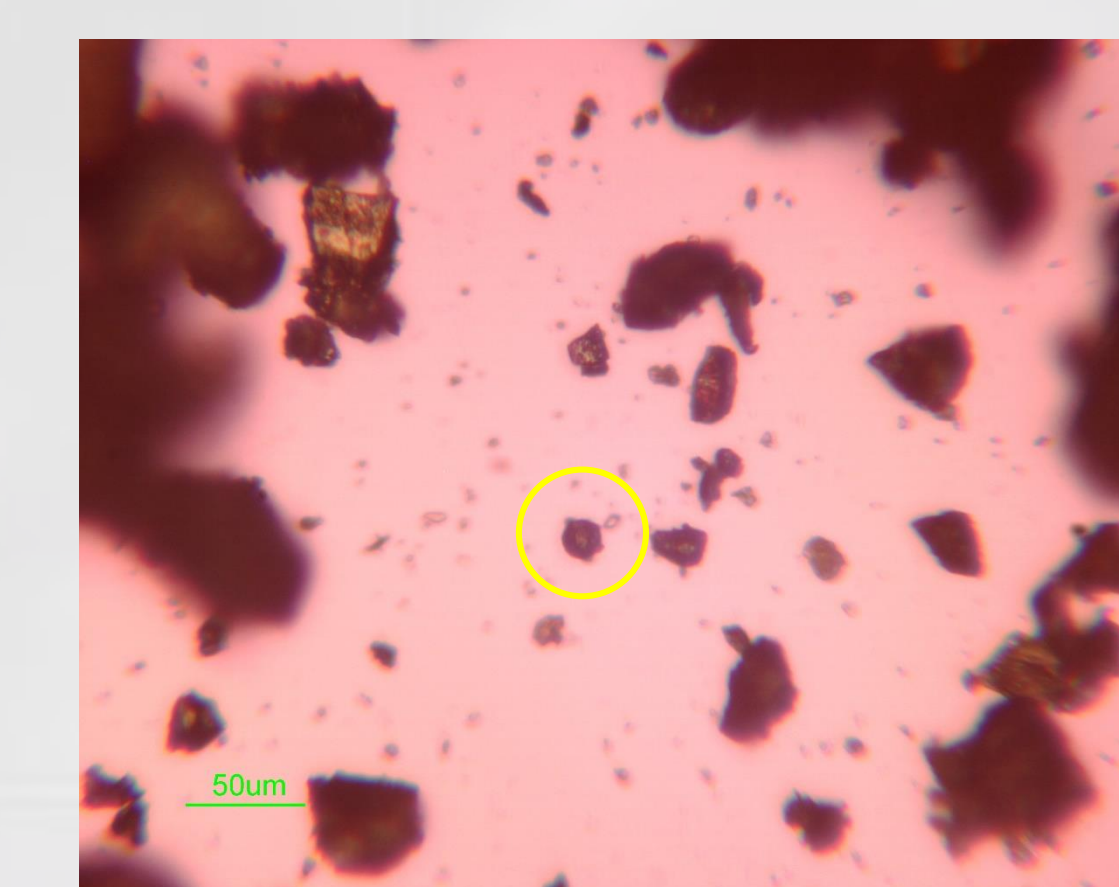
Sediment from hand augering and in-channel incision sites was collected for fly ash analysis and for radiocarbon dating. Sediment for fly ash was dried, crushed, and sieved to 180µm. This was added to a 250mL beaker with a magnetic stirrer and 10mL of sodium-hexametaphosphate. After stirring for seven minutes, magnetic material was rinsed into a 100mL beaker for solution evaporation, particle isolation, and microscope analysis. Microscope analyses are used to determine presence and abundance of fly ash.

Key

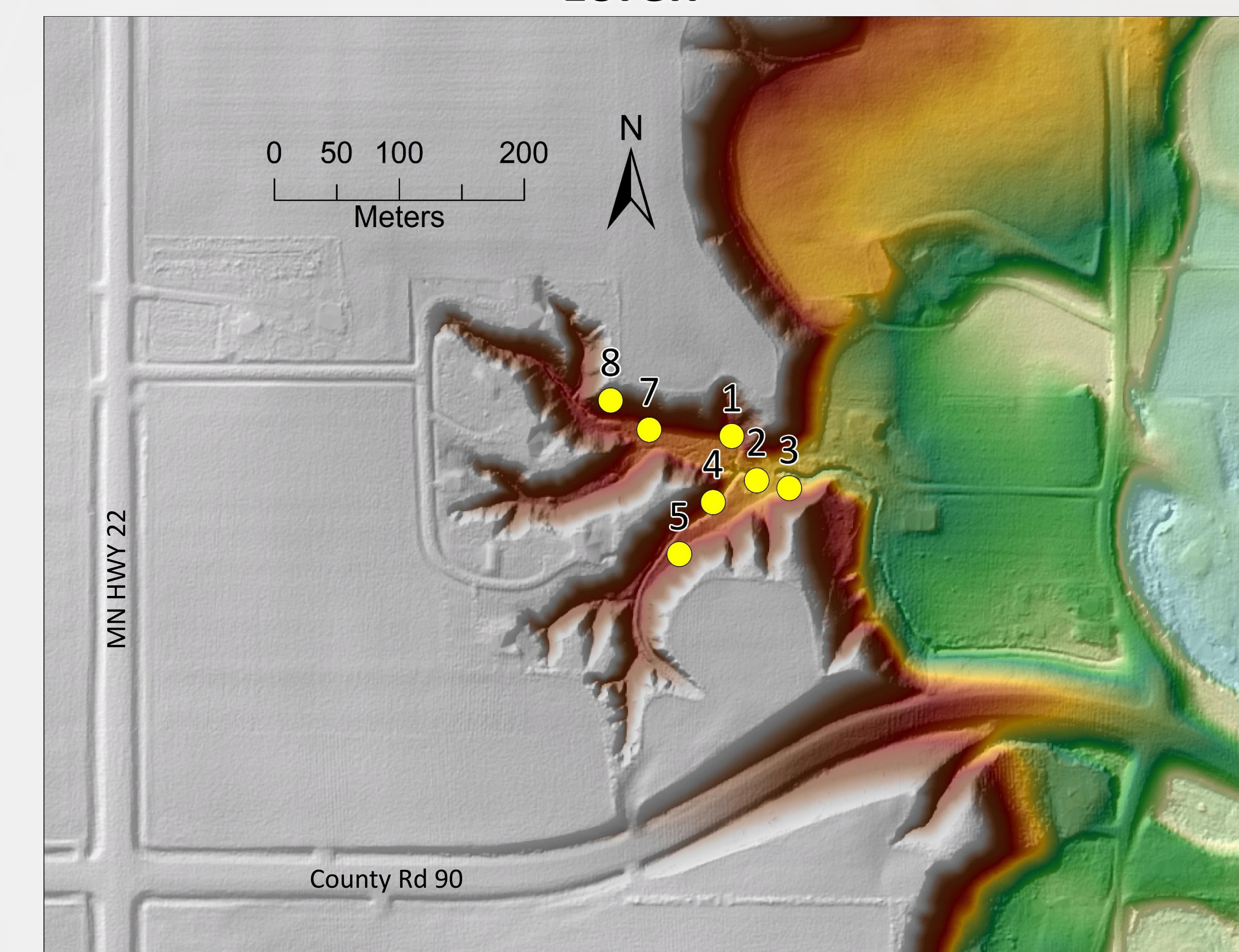
Silt	Sandy Silt	Silty Sand
Sand	Sand and Granule	Sand and Gravel
★ Fly Ash	◆ Radiocarbon Sample	



Fly ash from Loren 5



Loren



No samples were taken on the alluvial fan of Loren because the ravine is filling itself in, thus behaving like a fan within itself. A small channel incises into the sediment at site 1, but runs on the ground surface further up the ravine.

