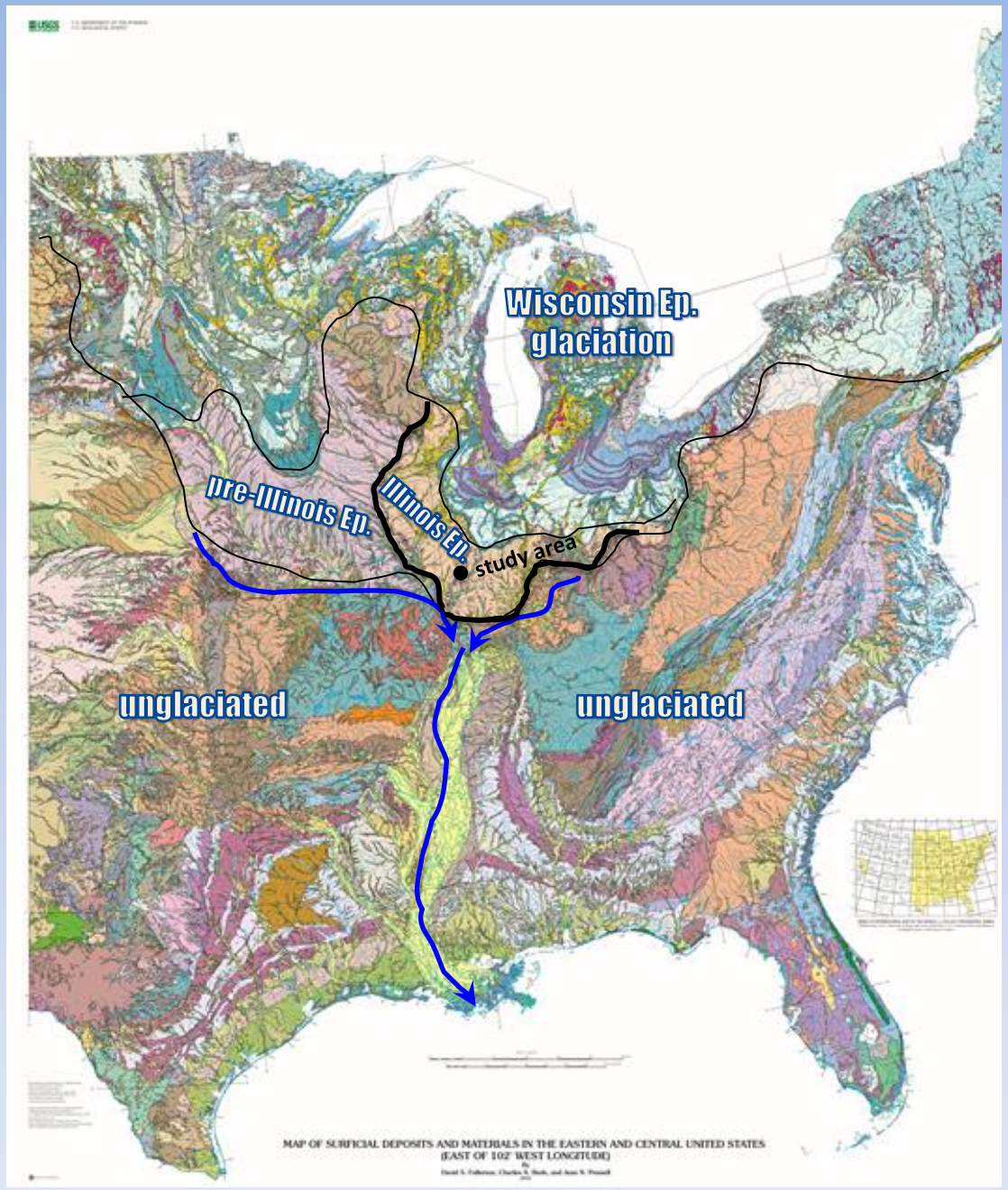
Ice-pressed ridges of the penultimate glaciation in the Kaskaskia Sublobe, south-central Illinois.

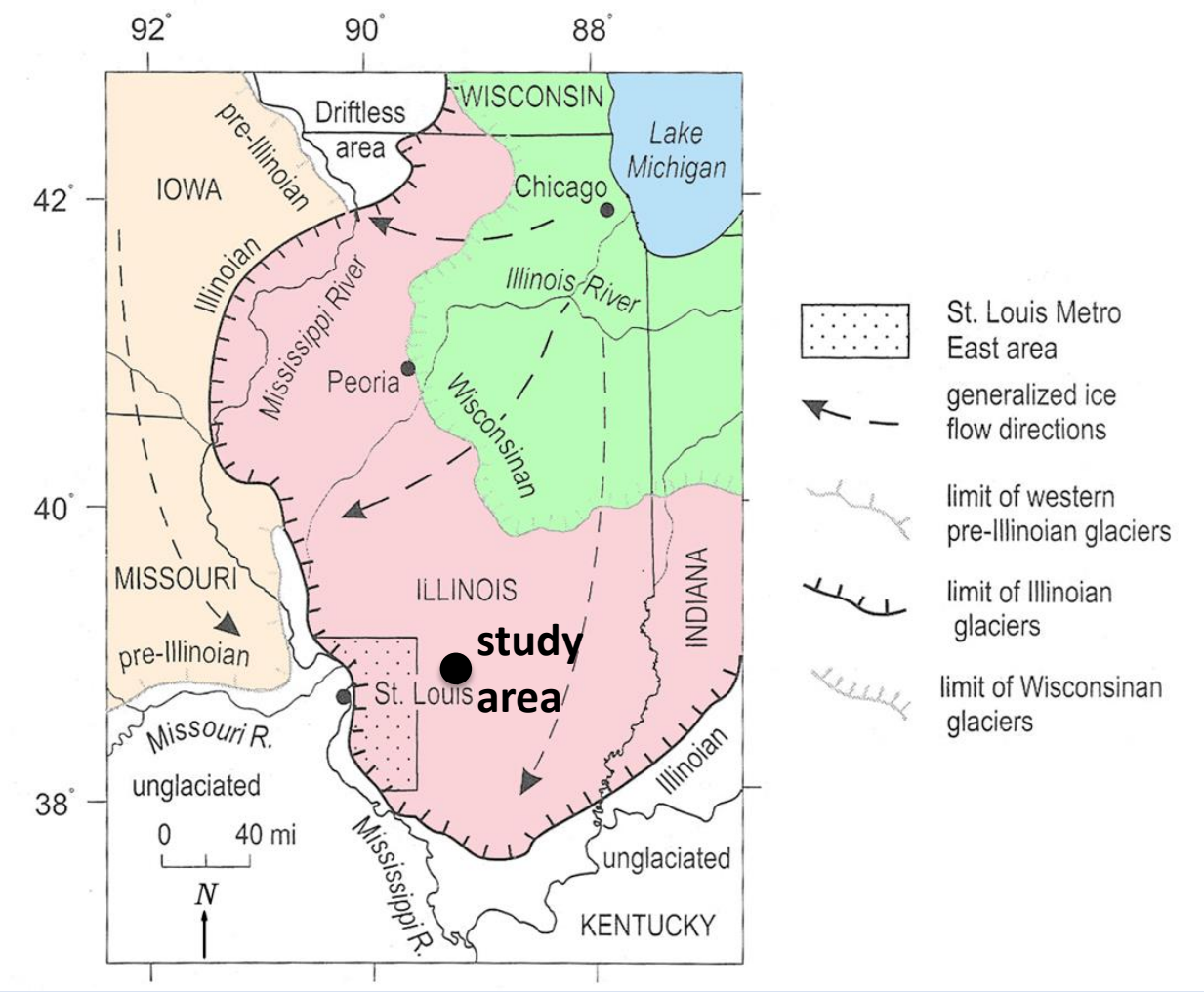
David A. Grimley, Johanna M. Gemperline, and Timothy H. Larson

Illinois State Geological Survey
Prairie Research Institute
University of Illinois



Quaternary / Surficial Deposits in Eastern USA

Quaternary Glaciations in Illinois

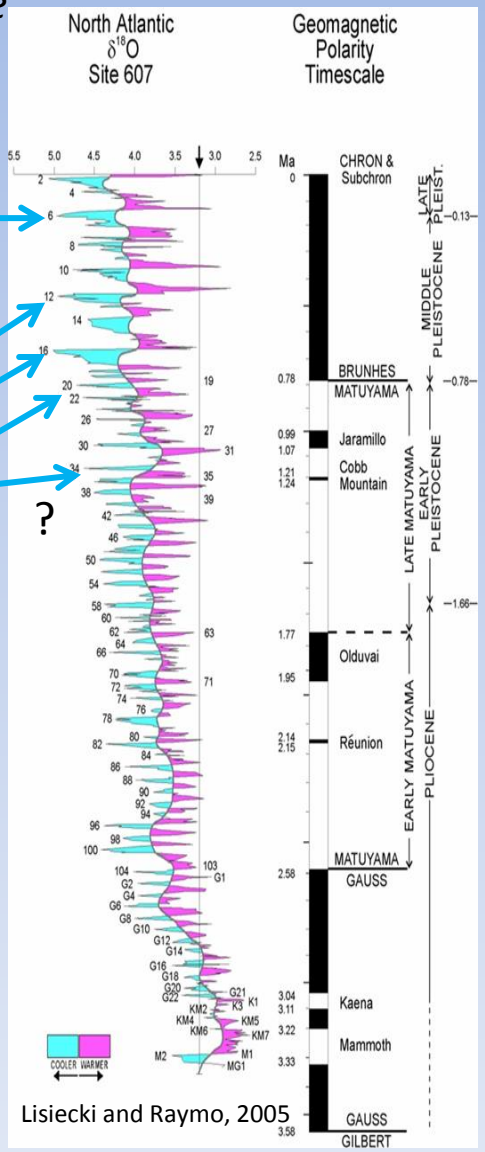


Correlation with Global Records

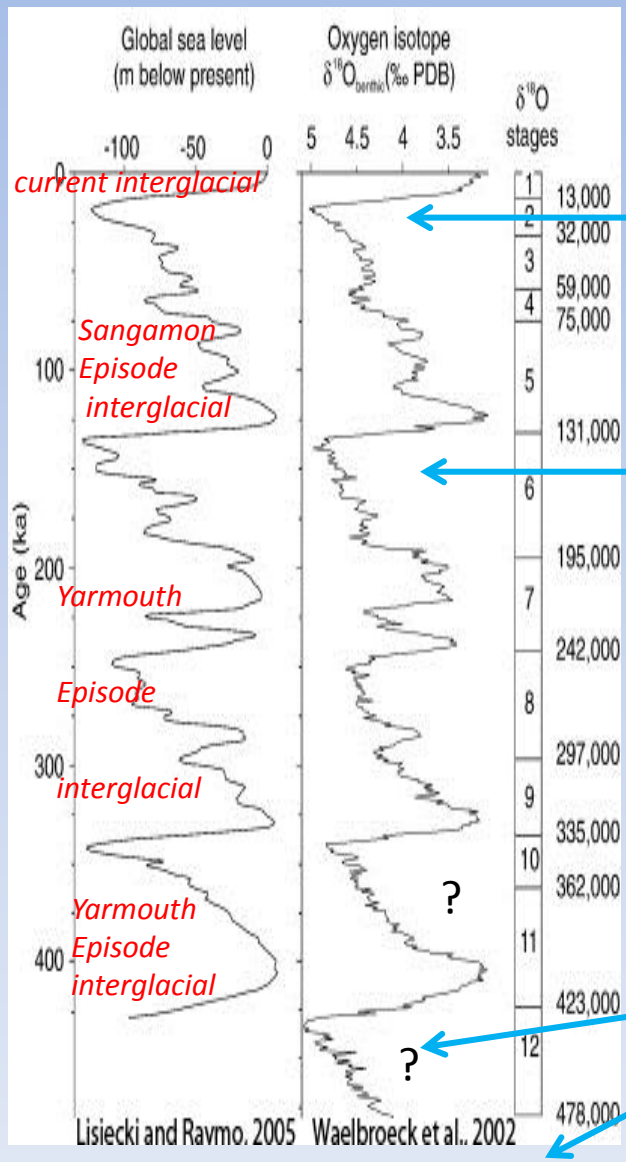
Illinois Episode glaciation

pre-Illinois Episode glaciations

?



Lisiecki and Raymo, 2005



Wisconsin Episode glaciation

Illinois Episode glaciation

Pre-Illinois Episode glaciations

Cartoons of Illinois Episosde Ice Margin thru Time

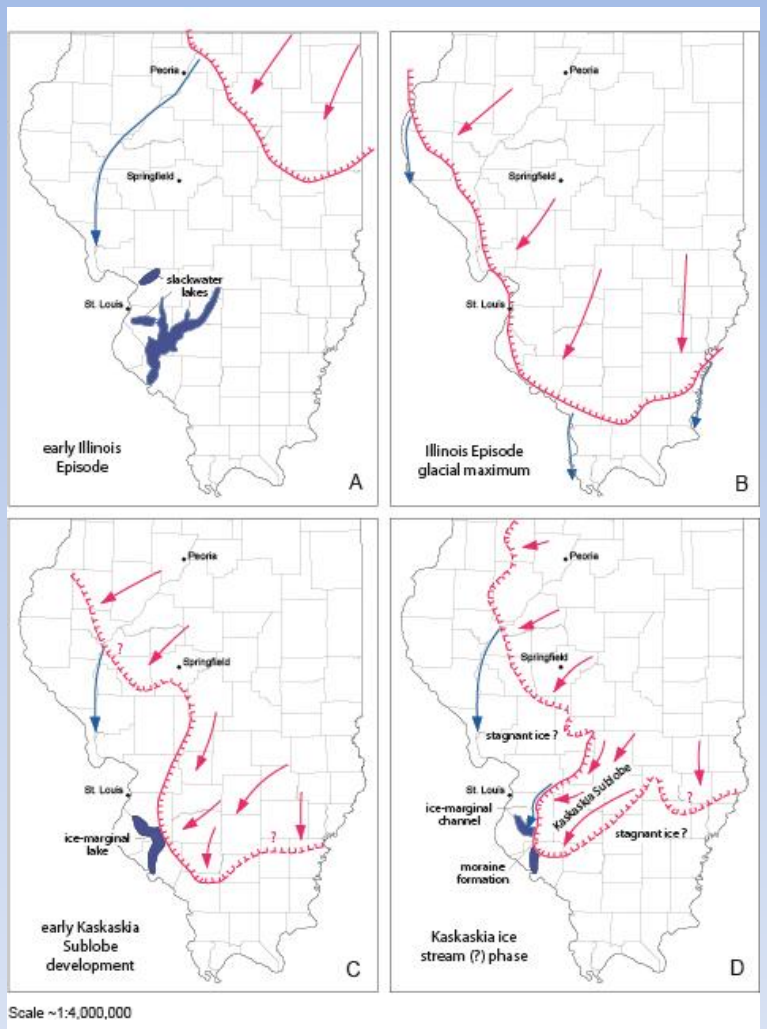


Figure Q4. Cartoon diagrams of ice advances and geologic events in southern Illinois (Kaskaskia Basin) during the middle to late Quaternary.

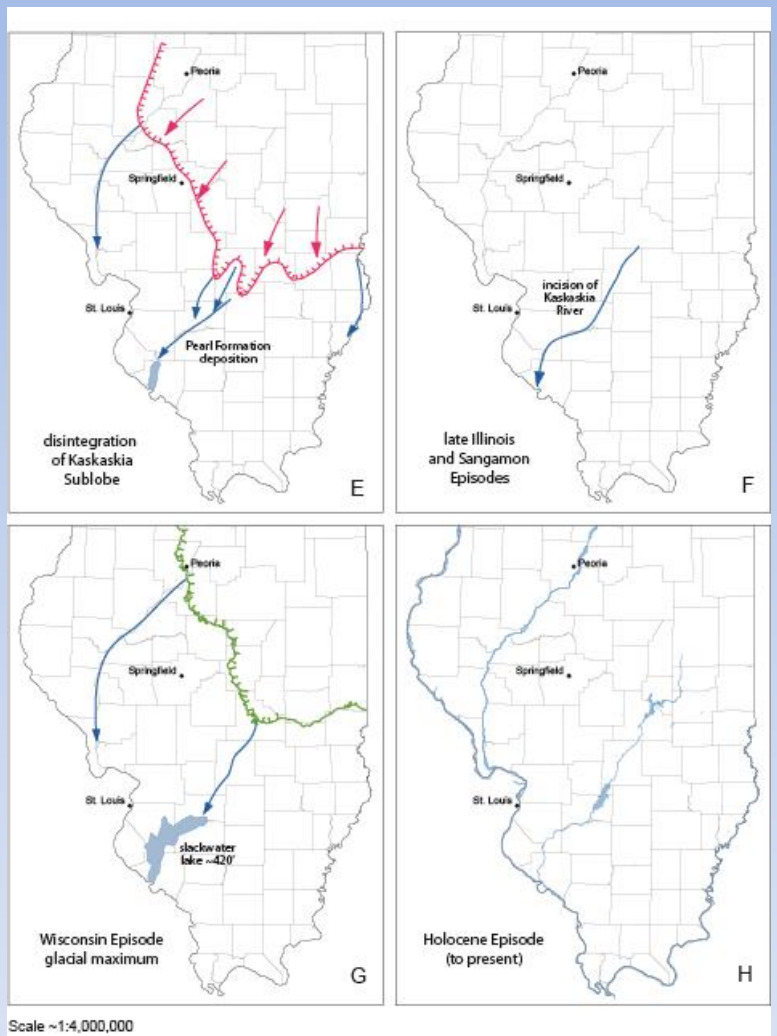
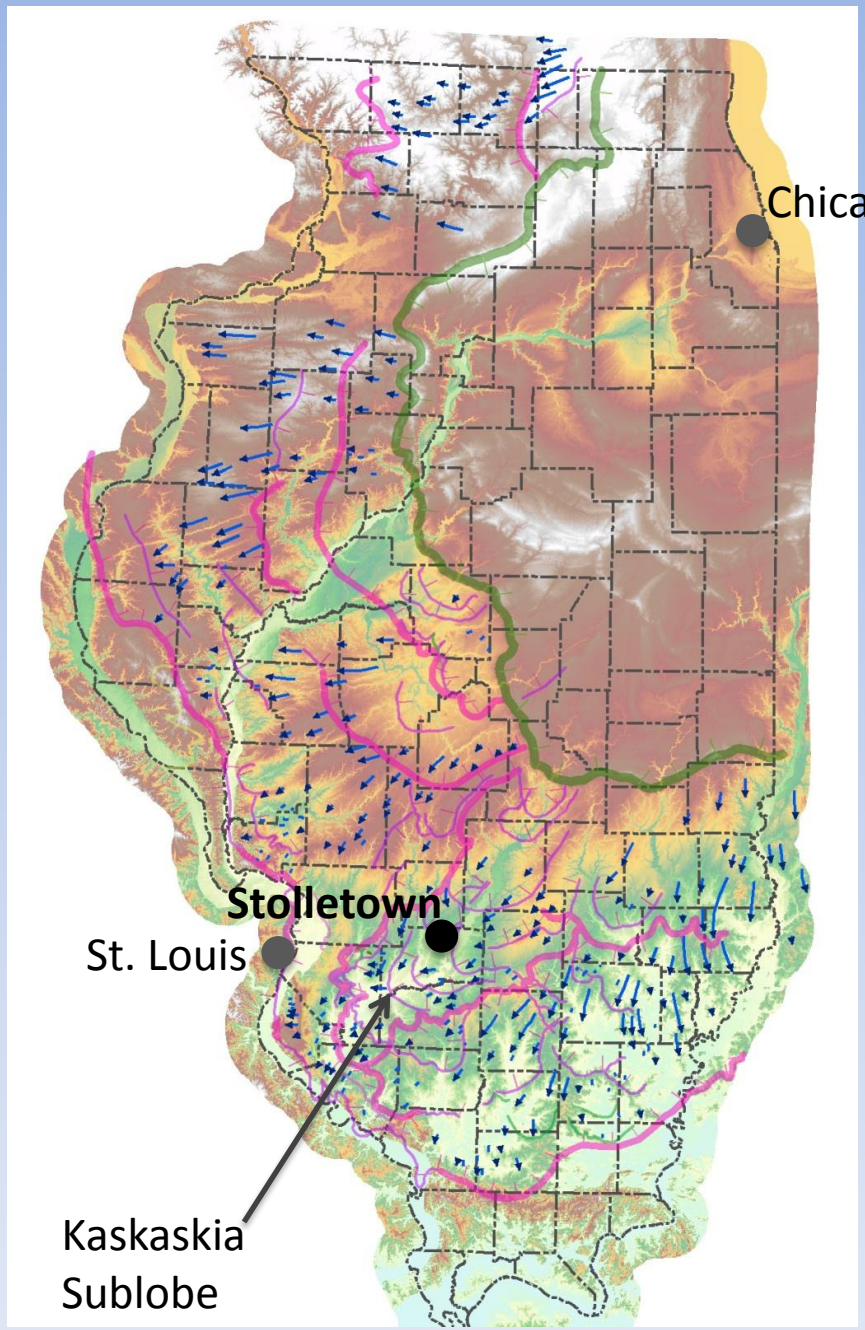


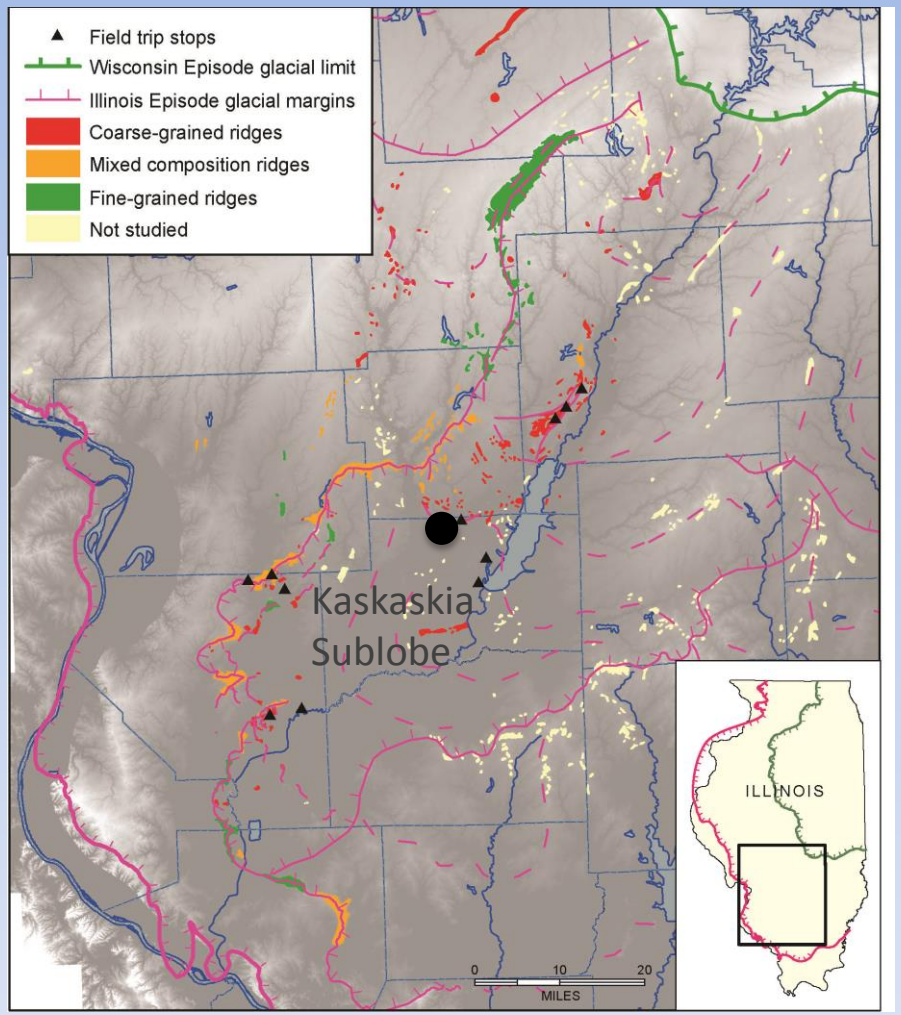
Figure Q4. Cartoon diagrams of ice advances and geologic events in southern Illinois (Kaskaskia Basin) during the middle to late Quaternary.



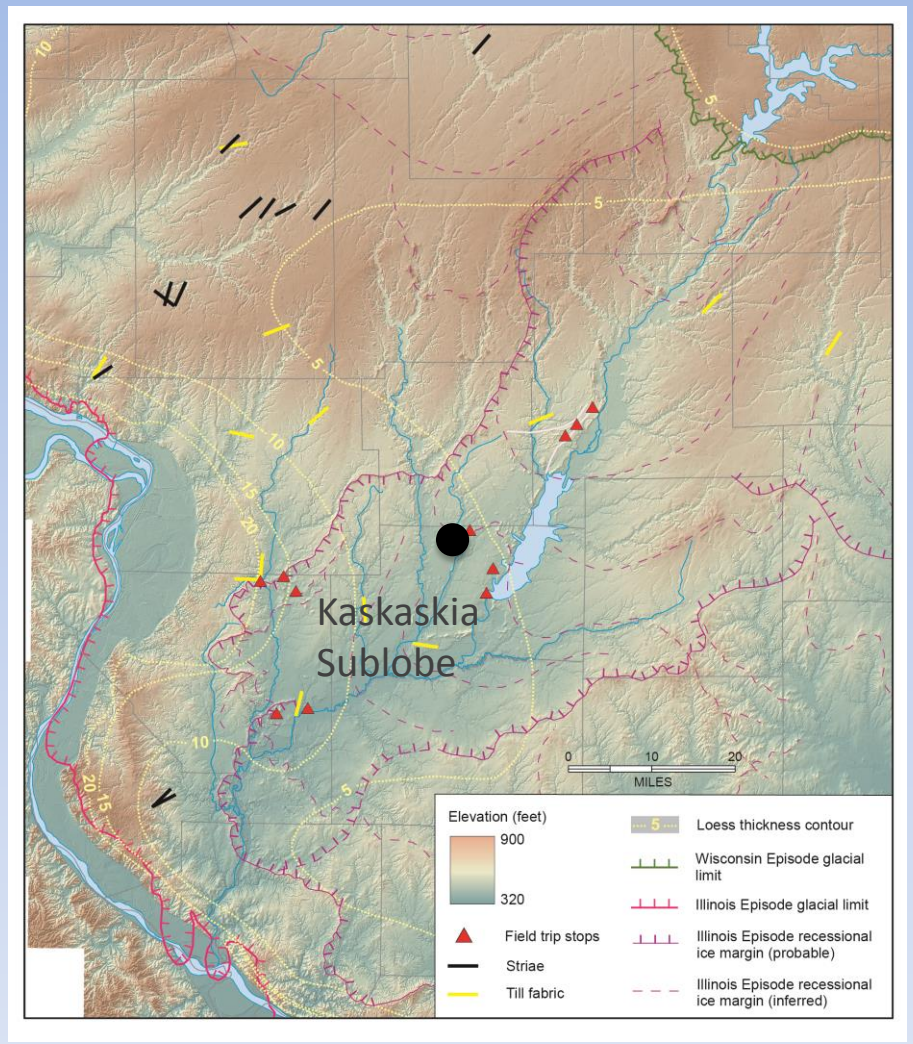
Ice Flow Directions (Illinois Episode)

- based on regional of areal scour
- drumlins, flutings, eskers (some)
- till fabrics and striations (limited)
- ice margins from field mapping and geomorphology on 10m DEM
- suspected sublobe development

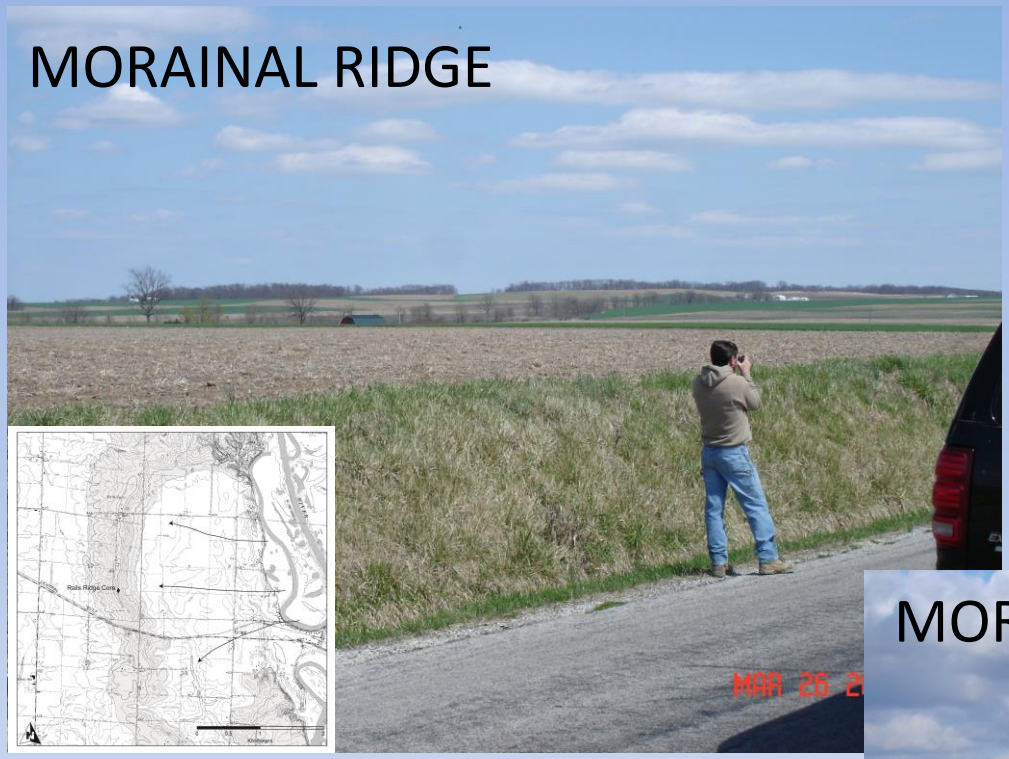
3 ridge types in the Kaskaskia Sublobe region



modified from Webb et al., 2012, Quaternary Research



from Grimley and Phillips, 2011, FOP Guidebook

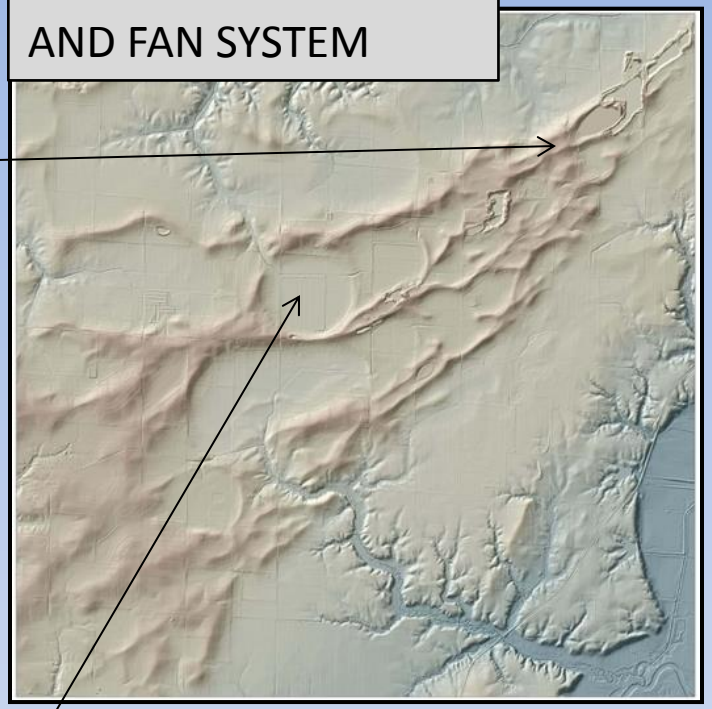


Illinois Episode Morainal Ridge
[Randolph-St. Clair Co., IL]

South of Highland on IL-160

Central Illinois Materials Pit

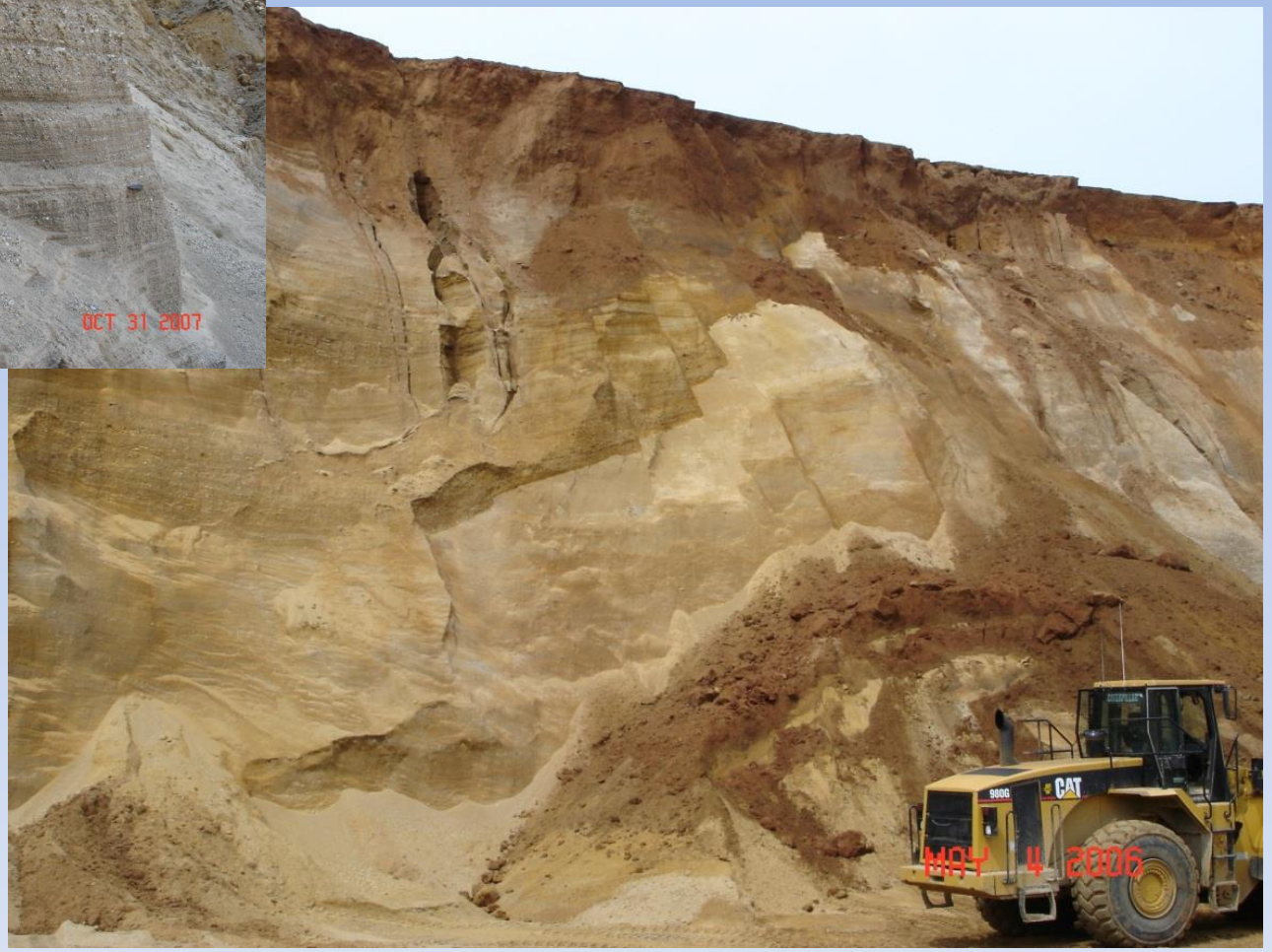
ICE-WALLED CHANNEL AND FAN SYSTEM



Pittsburg Basin; kettle fill

- Ice-walled glacial meltwater fan
- formed during glacial disintegration
- period of stagnation following advance of sublobe

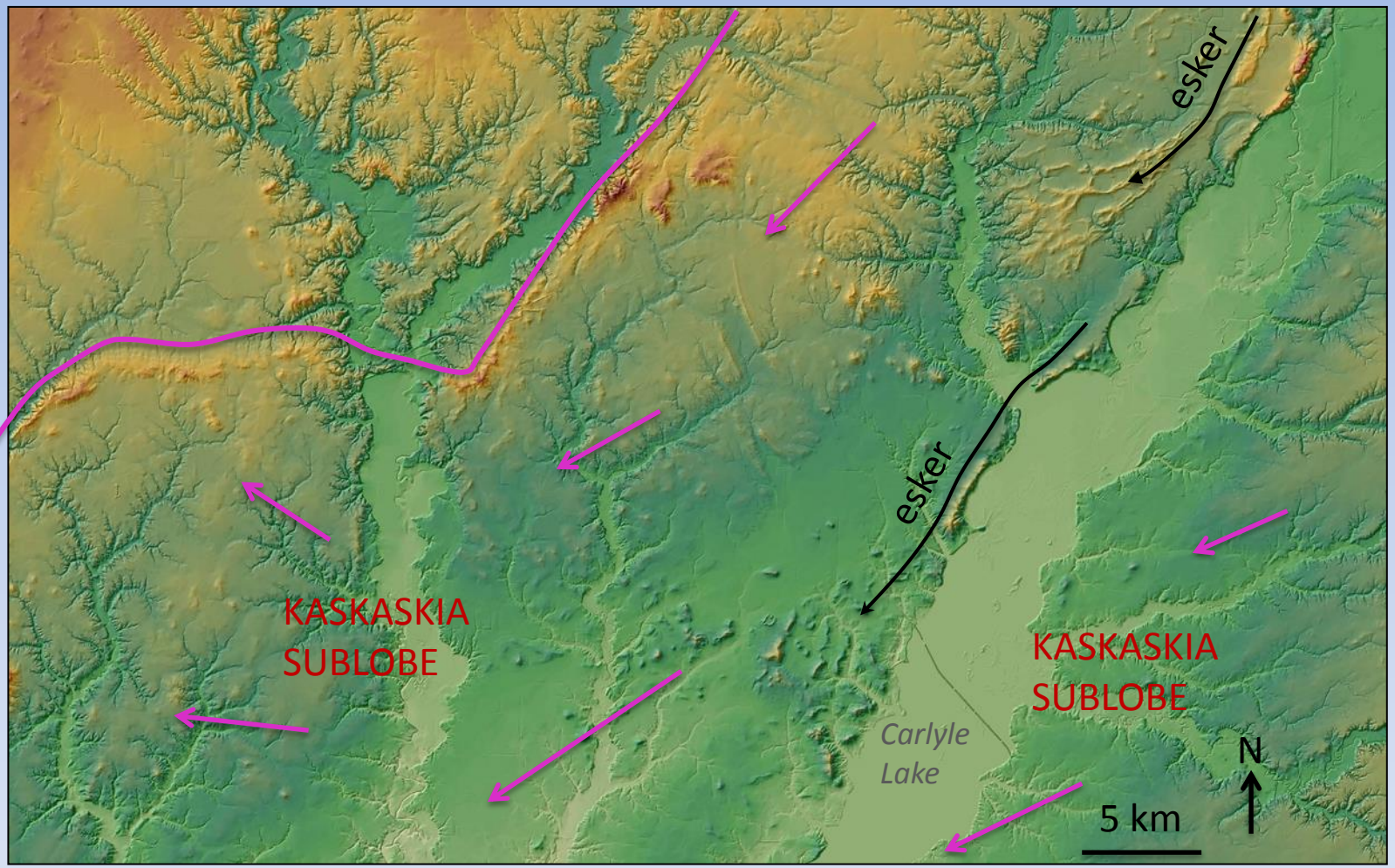
Ice-walled Channel Deposits



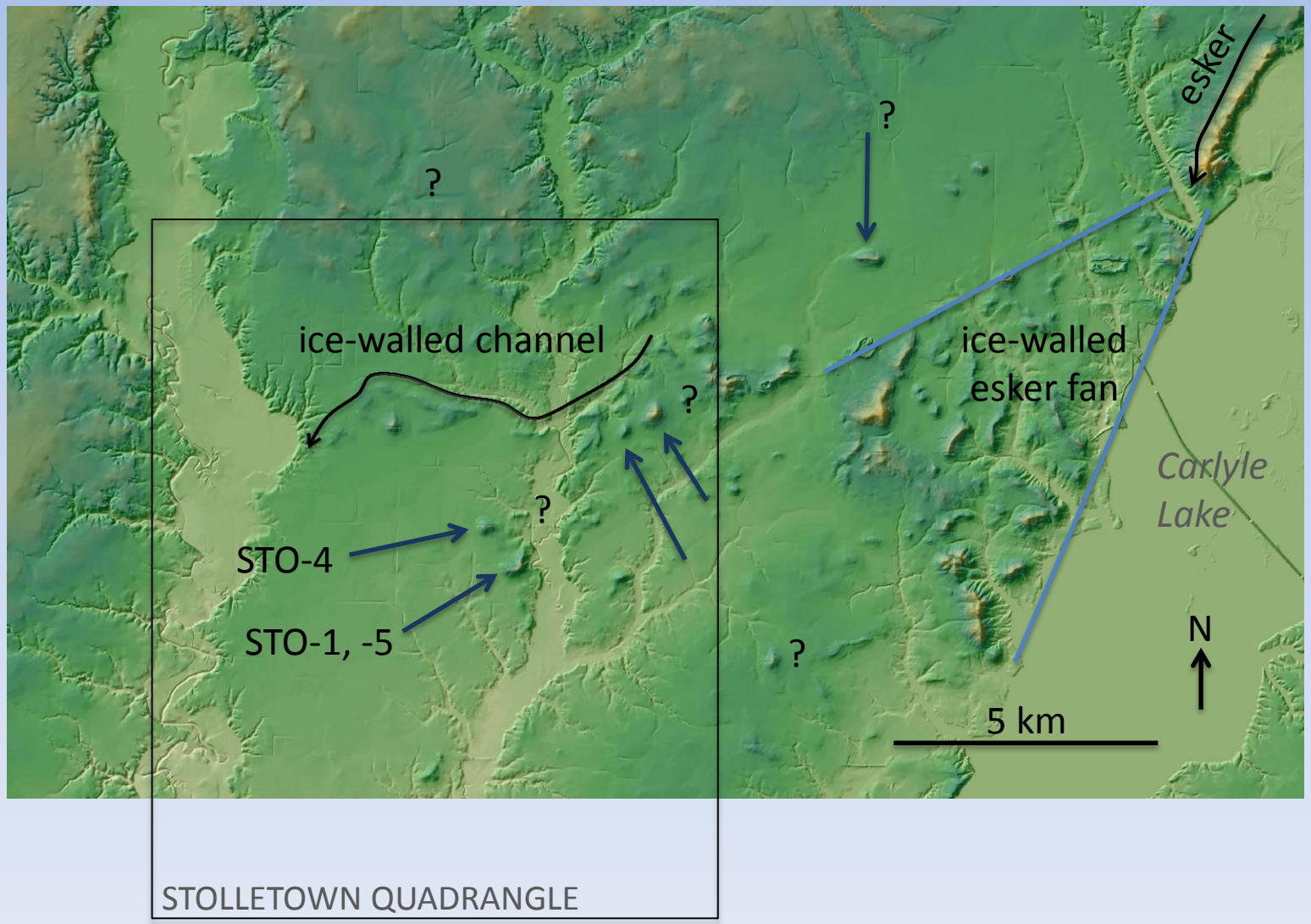
- OSL ages of ~ 130-160 ka (OIS 6)
- evidence of **stagnant ice** and melting ice blocks

Keyesport Sand and Gravel Pit: Clinton County, IL

Geomorphology within Kaskaskia Sublobe



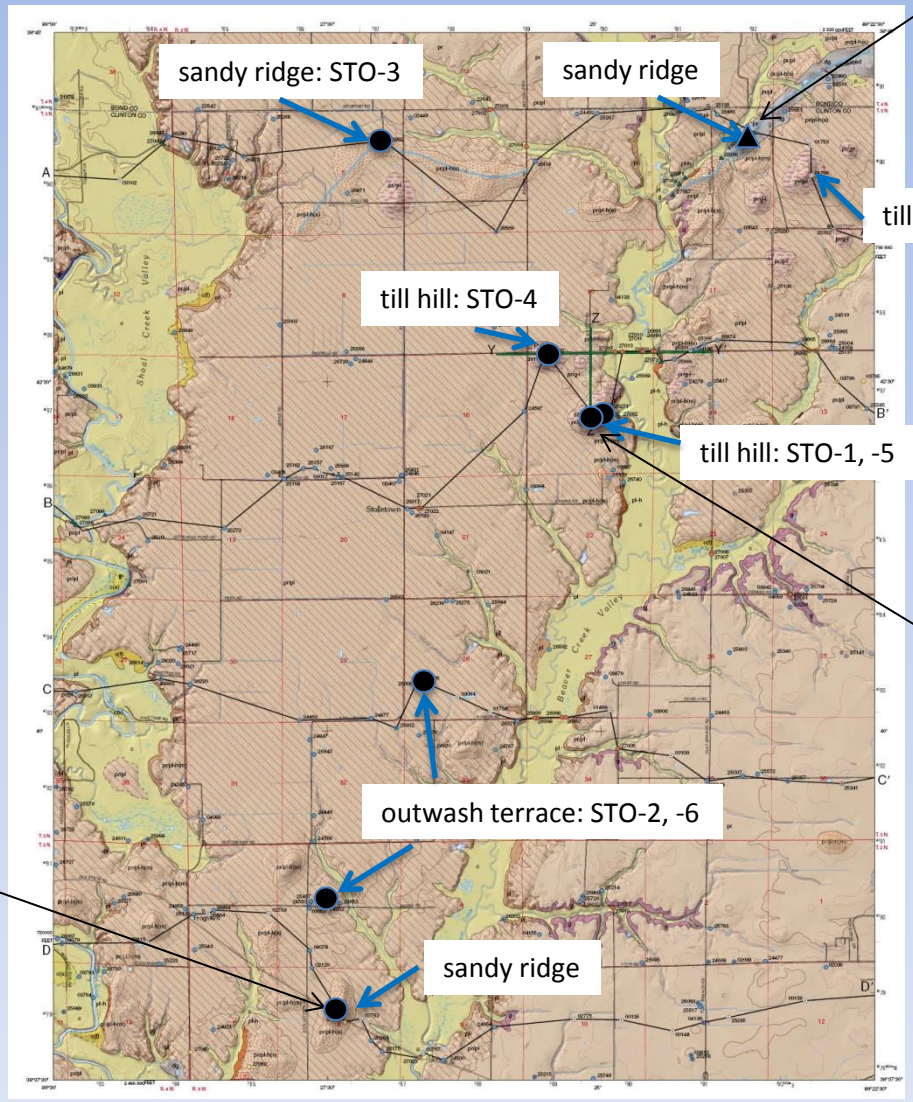
Stolletown-Keyesport area: stagnant ice deglacial landforms (?)

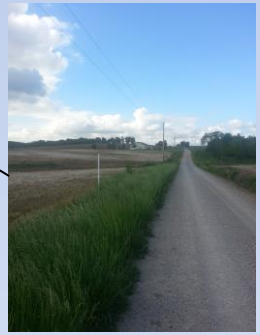


Stolletown Surficial Geology Map

● stratigraphic test holes

▲ sand and gravel pit exposure





elongate ridge with sand at depth

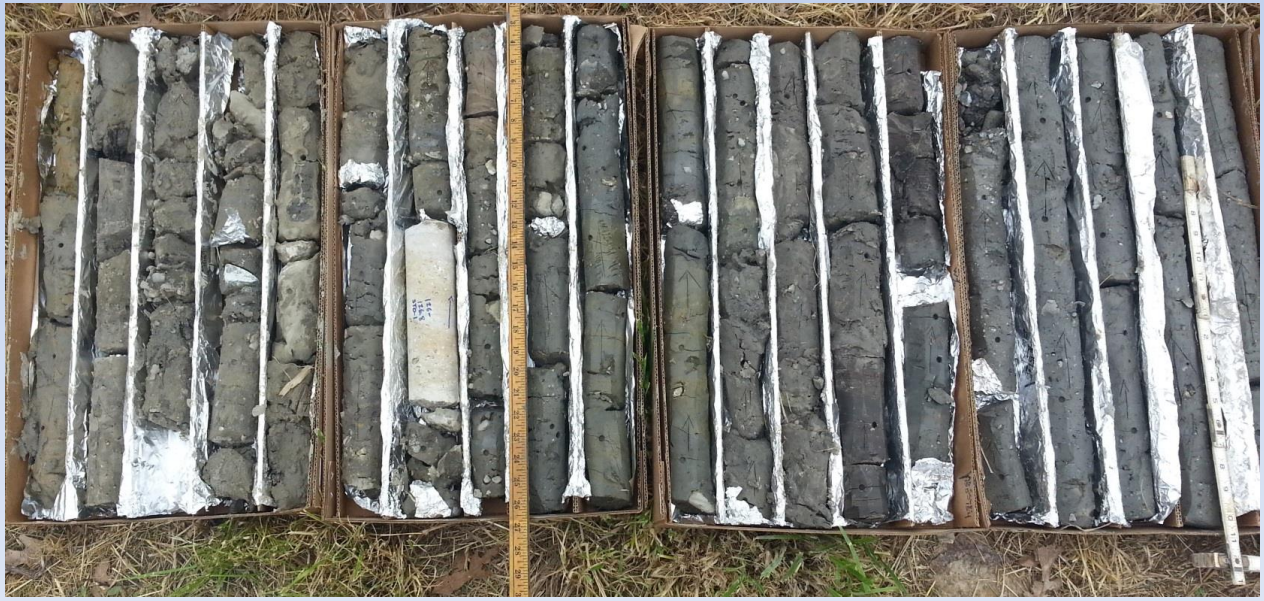
Core STO-1: McQuade Hill

Drillhole

- hill composed mainly of till
- 178 feet (54 m) to bedrock

Glasford Fm.

Banner Fm.

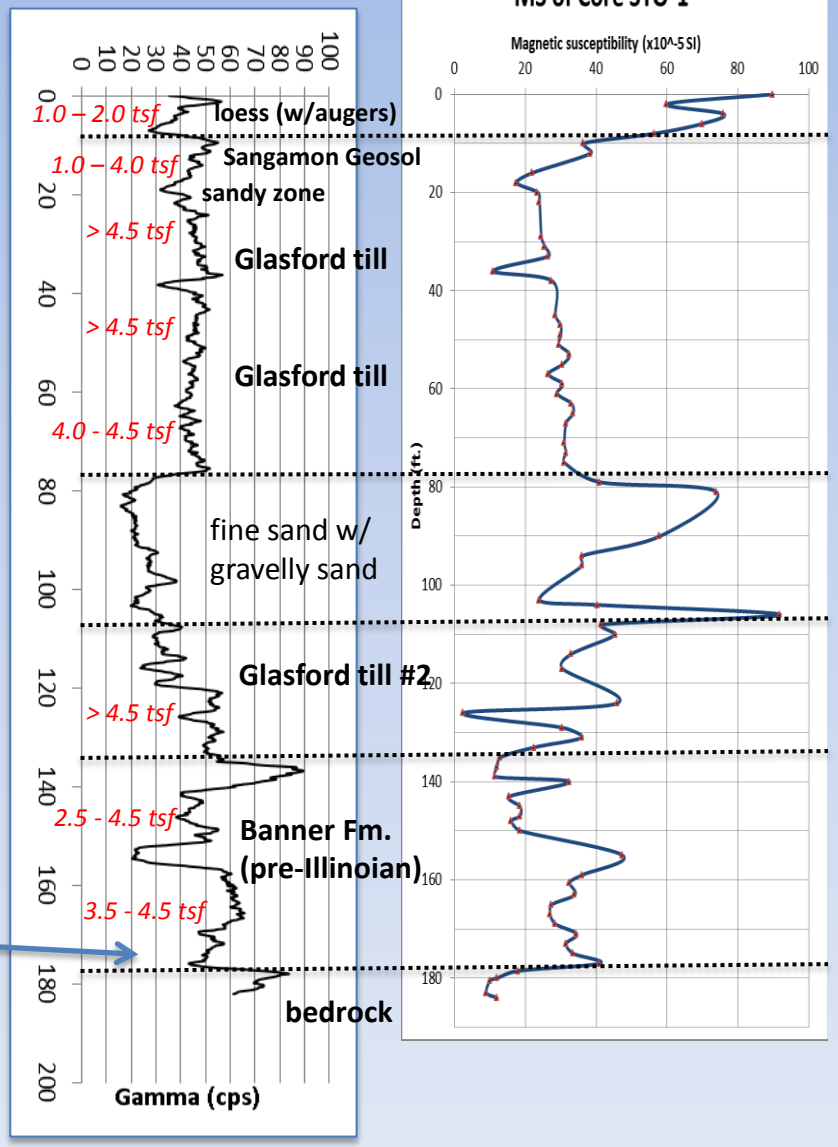


Lierle Clay.

Gamma and MS Logs: STO-1 Drillhole

Gamma

Magnetic Suceptibility



Core STO-4

view to drillsite from SE

view from drillsite to NW

35 ft. (11 m) core into hillcrest

inclusion of shale residuum in Illinois Episode till

Core STO-5

view to drillsite from north

view from drillsite to NW

15 to 40 ft. depth (5 to 12 m)

close-up of diamicton with small sheared inclusions of shale residuum

Natural Water Contents in 3 Illinois Episode Till Hills

Sample	Unit	Water Content (%)
STO-1 6'	Roxana Silt	20.7%
STO-1 8'	Sang. in Glasford	17.9%
STO-1 10'	Sang. B in Glasford Fm.	18.4%
STO-1 12'	Glasford Fm., CB hor.	17.5%
STO-1 19'	Glasford Fm.; C hor.	14.8%
STO-1 20'	Glasford Fm.; C hor.	13.5%
STO-1 31'	Glasford Fm.; C hor.	12.8%
STO-1 37'	Glasford Fm.; CD hor.	13.2%
STO-1 44'	Glasford Fm.; D hor.	12.8%
STO-1 48'	Glasford Fm.; D hor.	12.4%
STO-1 55'	Glasford Fm.; D hor.	12.4%
STO-1 75'	Glasford Fm.; D hor.	12.6%
STO-1 98' silt	silt bed	19.5%
STO-1 108'	lower Glasford Fm.; D hor.	12.1%
STO-1 128'	lower Glasford Fm.; D hor.	11.4%
STO-1 131'	lower Glasford Fm.; D hor.	13.7%
STO-1 137'	Lierle inclusion ?	18.2%
STO-1 140'	Glasford/Banner?, clay lm. dm.	13.6%
STO-1 149'	lacustrine clay and fine sand	23.4%
STO-1 161'	Banner diamicton	14.4%
STO-4 6'	loess (Peoria / Roxana)	20.9%
STO-4 15'	Glasford till (CB horizon)	17.6%
STO-4 25'	Glasford till (CD horizon)	11.5%
STO-4 30'	Glasford till (D hor.)	11.5%
STO-4 33'	Glasford till (D hor.)	11.8%
STO-5 10'	wx. Glasford (Sang. Bt)	14.9%
STO-5 15'	wx. Glasford (Sang. BC, CB)	18.3%
STO-5 20'	Glasford till C hor.	11.0%
STO-5 25'	Glasford till D hor.	11.7%
STO-5 30'	Glasford till D hor.	11.1%
STO-5 35'	Glasford till D hor.	10.6%
STO-5 40'	Glasford till D hor.	9.4%

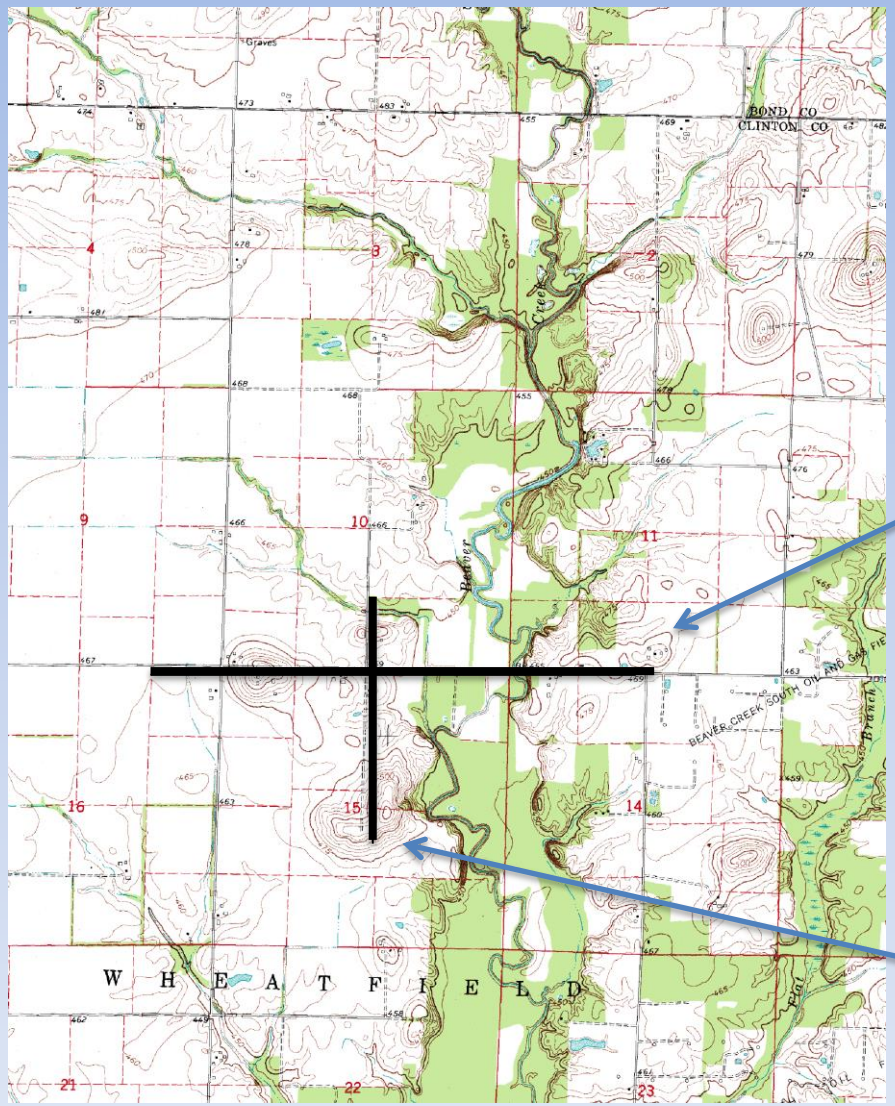
STO-1

STO-4

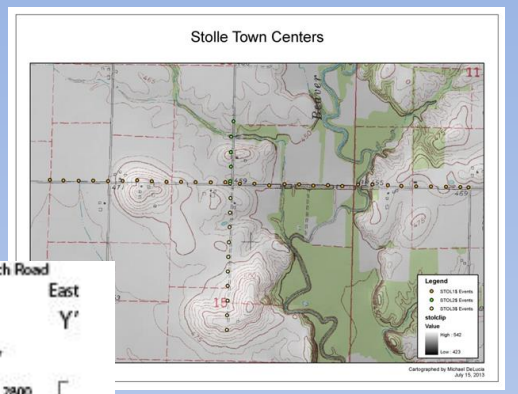
STO-5

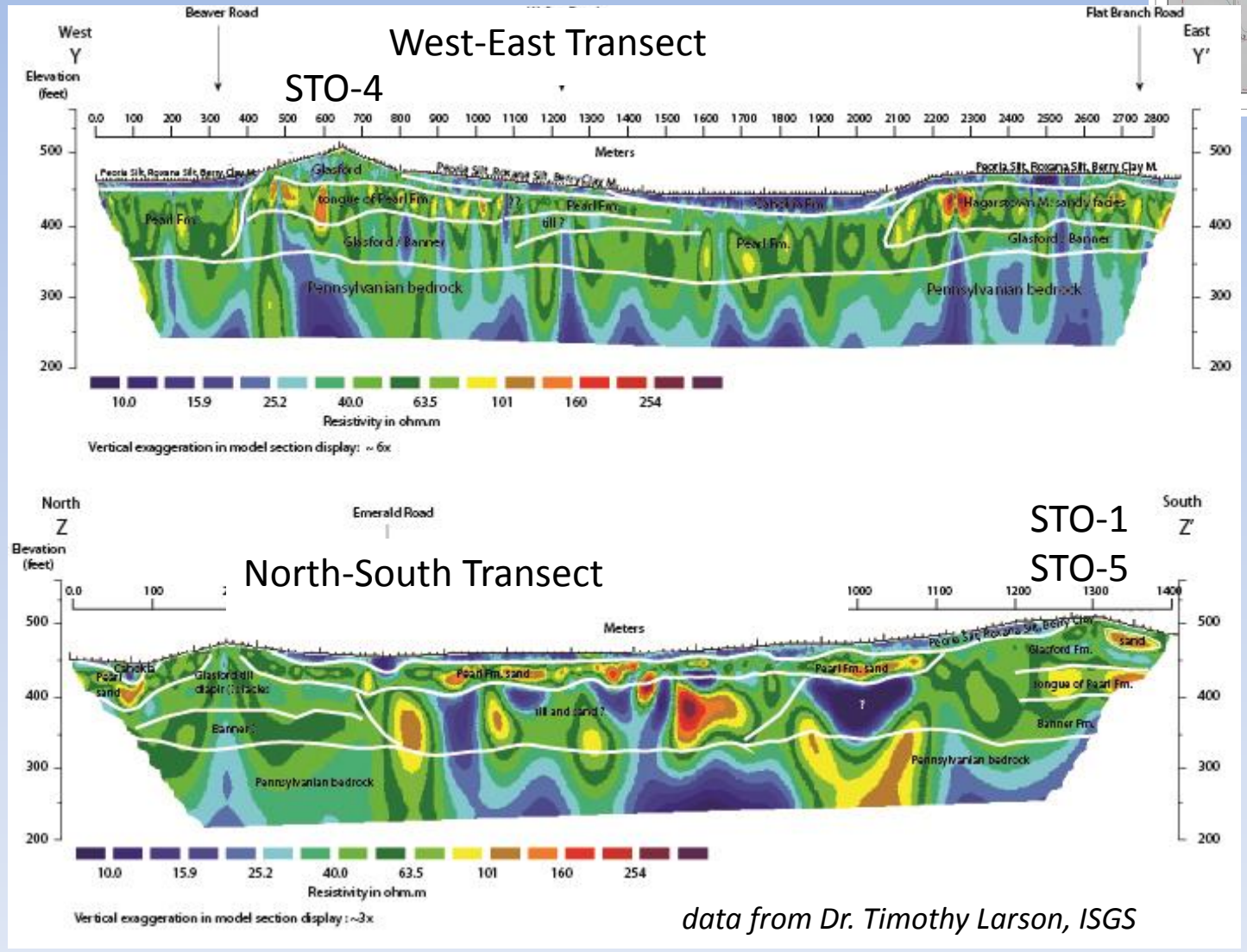
- w = 9 to 15 % in calcareous till (relatively unaltered below 15 ft. depth)
- Qu (unconfined compressive strength) mostly > 4.5 tsf
- comparable to subglacial till in other areas
- dense, compact and consolidated (water mostly squeezed out)

Electrical Resistivity Profiles



Electrical Resistivity Profiles

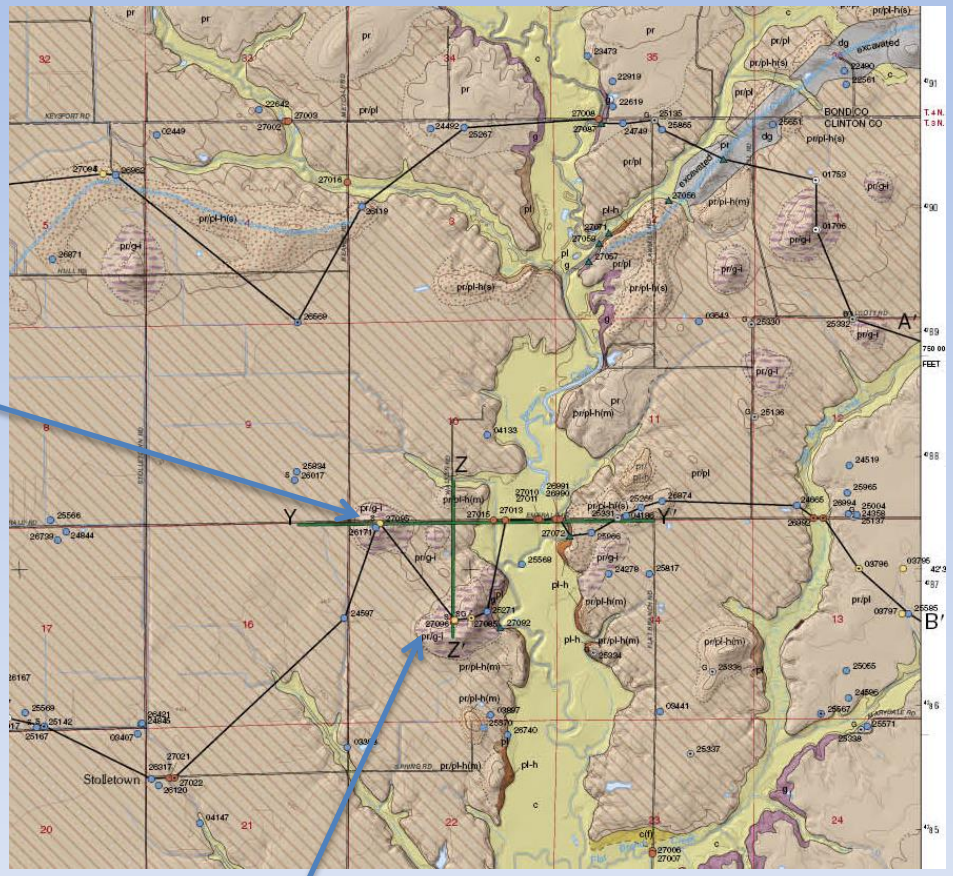




data from Dr. Timothy Larson, ISGS

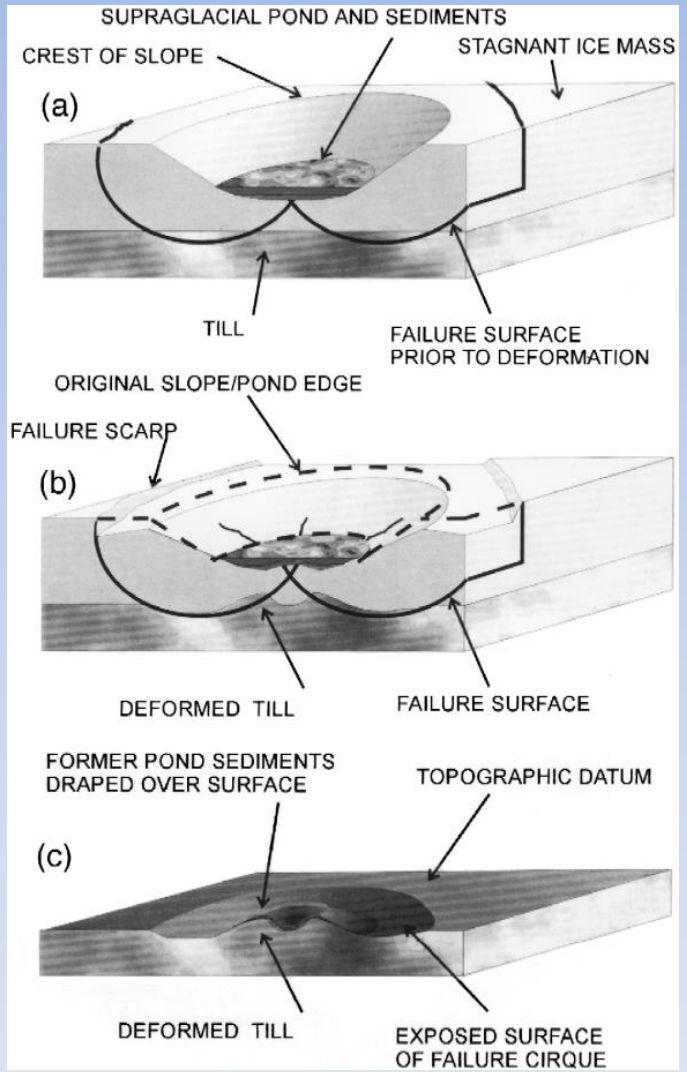
Possible Origin of Fine-Grained Till Hills

- **Bedrock hills; Beaded eskers; Moulin kames** ----- *ruled out based on subsurface material*
- **Eroded moraine** --- *hills circular in map view*
- **Supraglacial** (inversion of topography): *till too hard, dense, and uniform; lacks heterogeneity*
- **Ice-pressed hills** (Boone and Eyles, 2001): *possible ?*



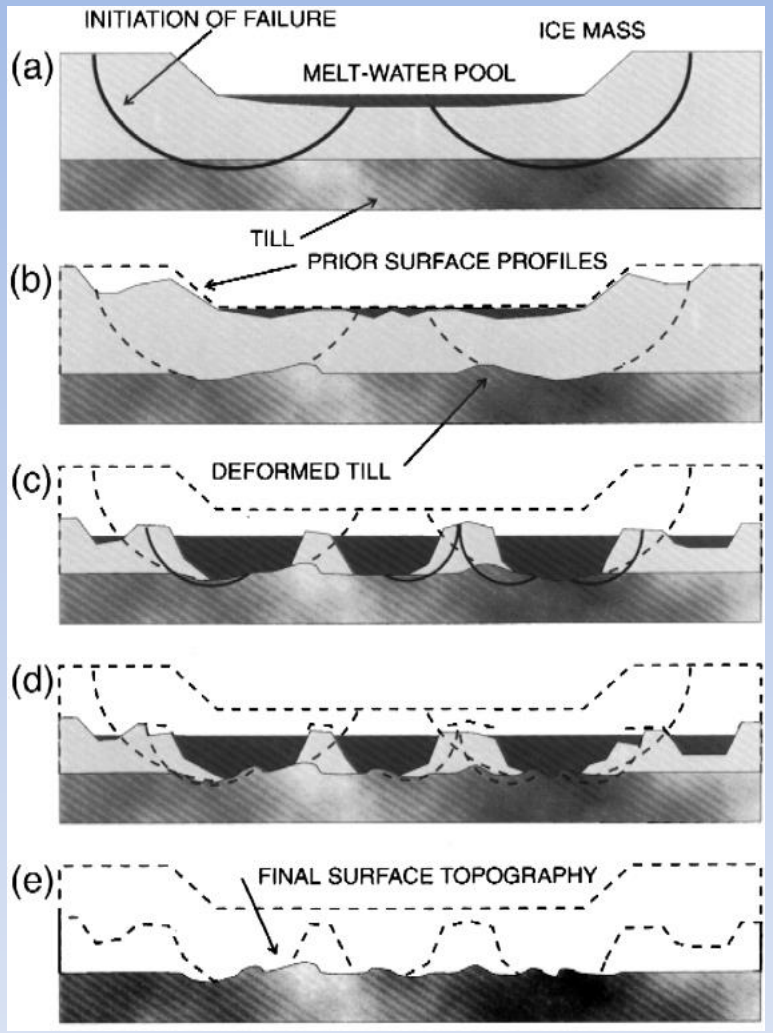
Ice-pressed hill model

- from Boone and Eyles (2001, *Geomorphology*)
- conditions required
  - ❑ till deformation below stagnant ice
  - ❑ differential pressure at glacier-bed contact
  - ❑ perforation of stagnant ice lobe by water-filled depressions
- repeated cycles of subglacial till failure may occur



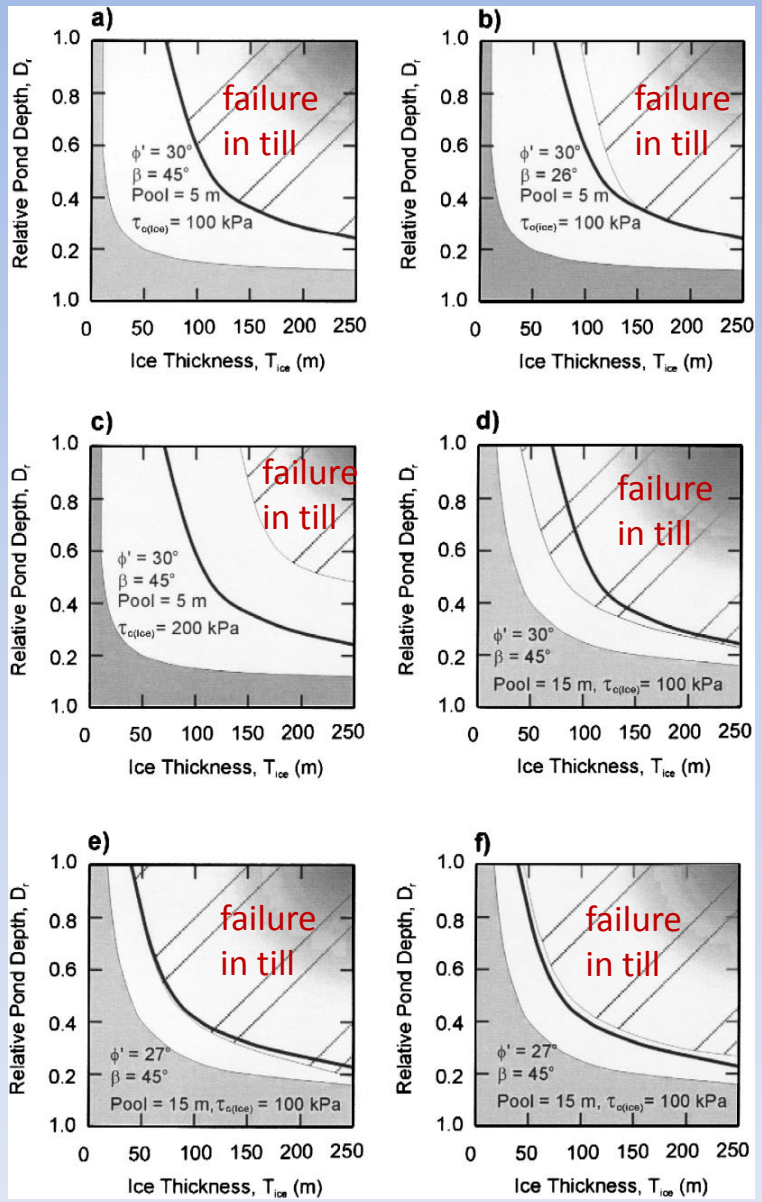
Boone and Eyles (2001)

from Stalker, 1960 ---- till diapir in Alberta; “subglacial pressing”



from Boone and Eyles (2001)

Ice Thickness Required for Subglacial Failure



from Boone and Eyles (2001)

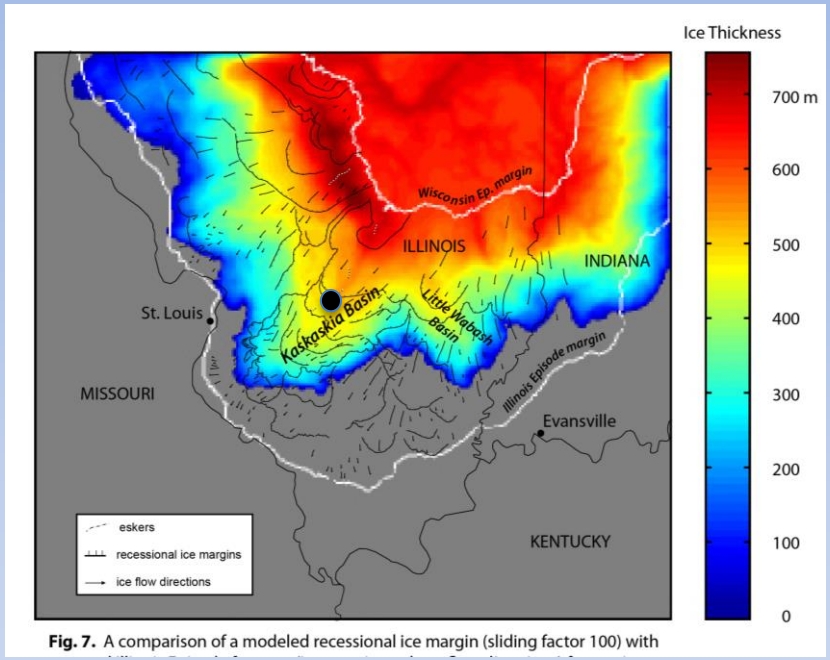


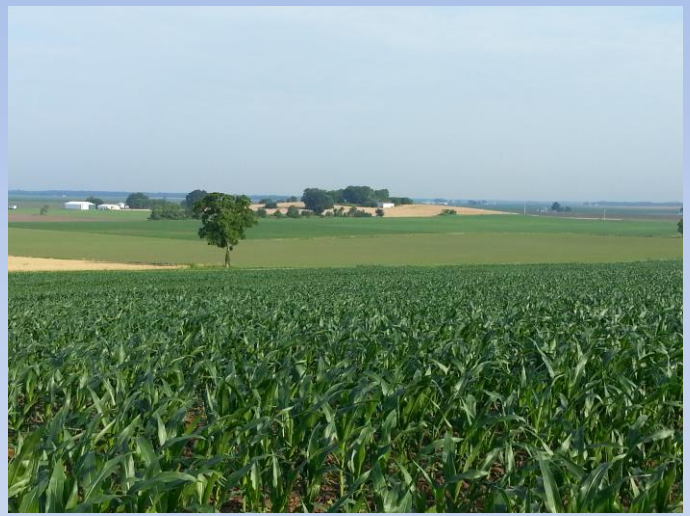
Fig. 7. A comparison of a modeled recessional ice margin (sliding factor 100) with

Modeled ice thickness during recession of Illinois Episode glacier from maximum extent. (~ 500 m just prior to stagnation – plenty thick) *(Gemperline, M.S. Thesis, 2013)*

- *At 250 m ice thickness, a relative pond depth of ~ 25 % is required (> 62 m depth) to provide enough differential stress for subglacial failure.*

General conditions in Kaskaskia Basin favorable to ice-pressed hill development

- Thick enough glacial ice (250-500m)
- Surging glaciers
- Wet-based glaciers
  (high pore-pressure)



Observations/possible evidence

- Presence of subglacial till in hills (high Q_u)
- Sheared inclusions in cores STO-1, -3, -4
- Fine-grained material in core of hills from electrical resistivity surveys

Sequence of Illinois Episode Events (timing of stagnation)

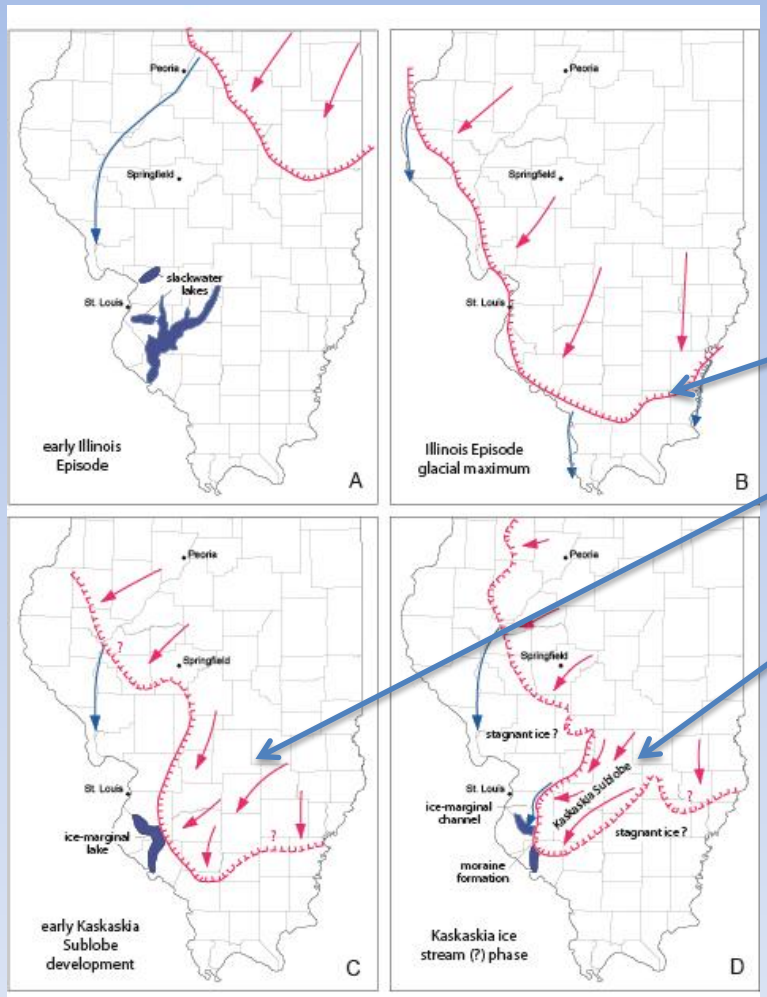


Figure Q4. Cartoon diagrams of ice advances and geologic events in southern Illinois (Kaskaskia Basin) during the middle to late Quaternary.

1. advance to the terminus
2. recession of ice margin
3. possible ice stream or surge
4. followed by widespread stagnation conditions
5. moraines, eskers, ice-pressed hills left behind

Conclusions

- A portion of the glacial hills (5 to 20 % ?) in south-central Illinois could be **ice-pressed ridges** (Boone and Eyles, 2001), at least in part.
  - fine-grained material composition (drilling, ER)
  - engineering/physical properties
  - sheared inclusions of basal sediment
  - lack of significant supraglacial material (perhaps some component)

- Possible future work and testing:
  - multiple till fabrics in well exposed sections (if located)
  - more test holes on sides of hill: drilling transects
  - more detailed geophysical tests across relevant features