Illinois' glacial landscapes, deposits, and history; its societal relevance.

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ILLINOIS
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- *Feel free to email or call with questions outside of class times.*

Course Outline

1) **Overview of Illinois' glacial history (Sept. 3rd)**

2) **Causes of glaciations; early recognition (Sept. 10th)**

3) **Glacial and interglacial deposits in Illinois (Sept. 24th)** **NO CLASS SEPT. 17TH**

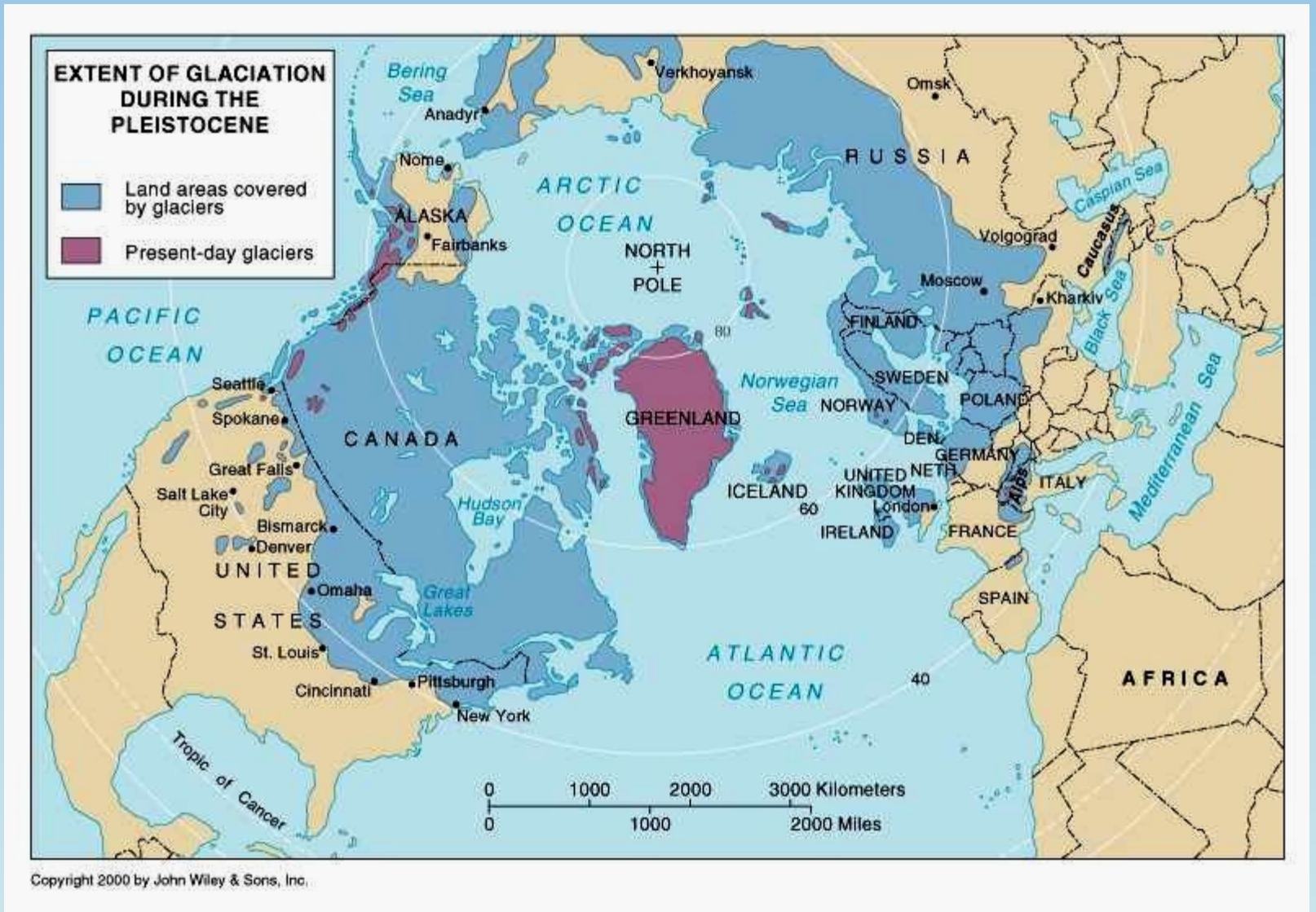
4) **Modern glaciers [analogs] (Oct. 1st)**

5) **Glacial landforms in Illinois (Oct. 8th)**

6) **Ice-age fossil records / paleoclimate (Illinois); age dating (Oct. 15th)**

7) **Societal Issues related to glacial sediments (resources / hazards) (Oct. 22nd)**

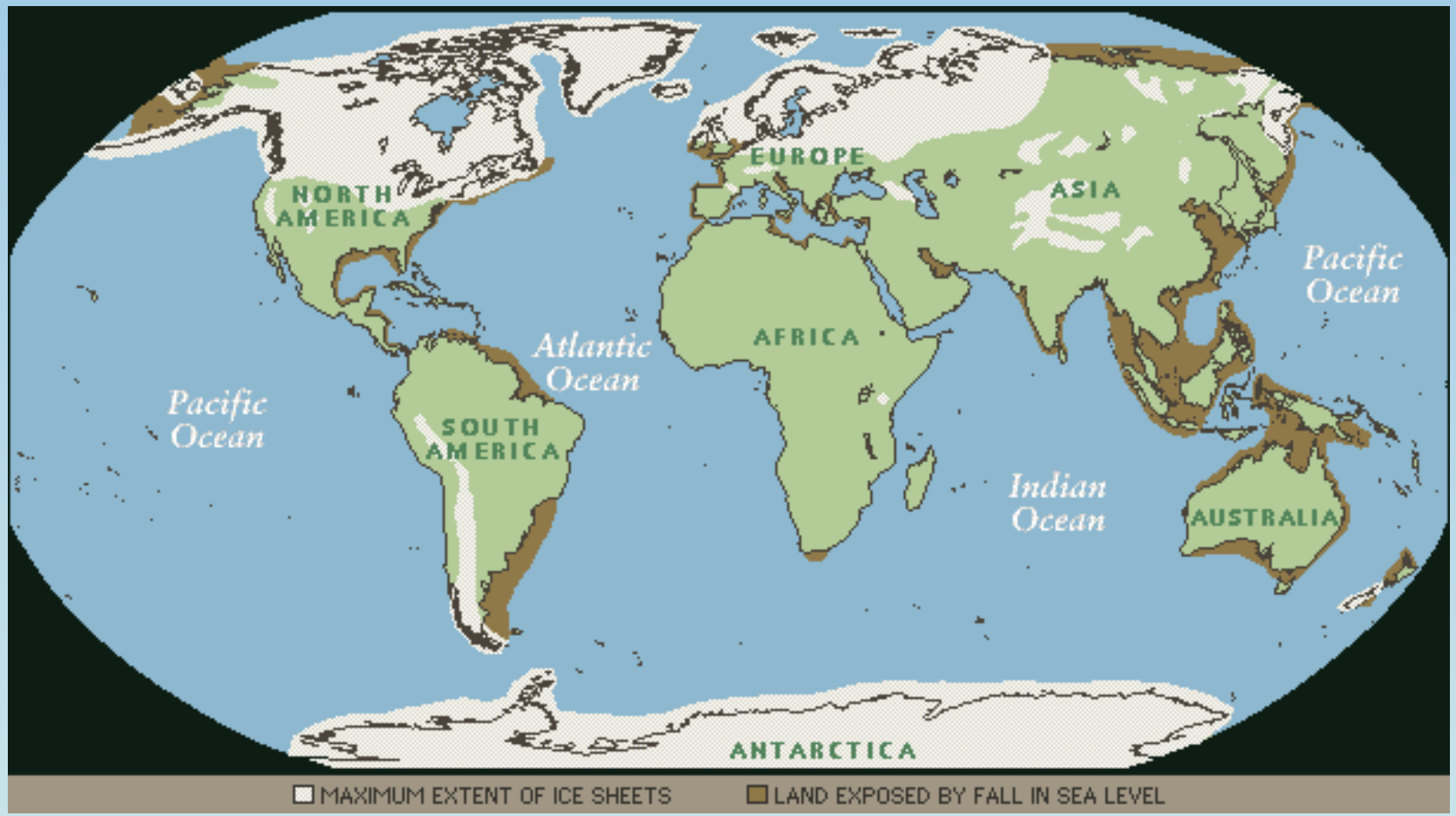
Map of Pleistocene Glaciation in Northern Hemisphere



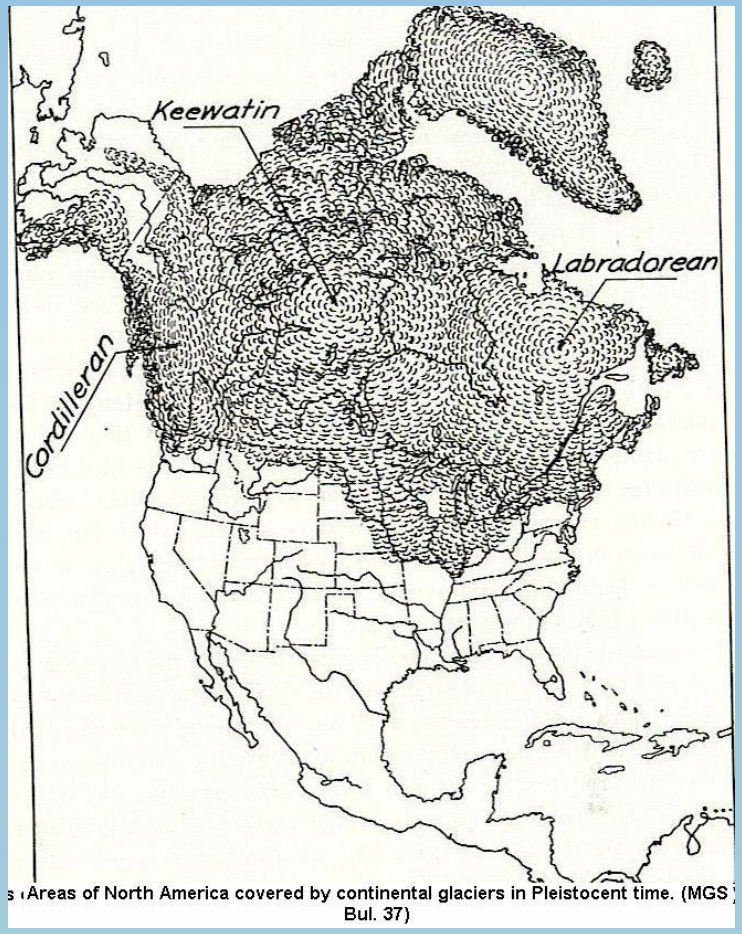
http://www.roebuckclasses.com/105/regions/namer/namericaphys/physnamer.htm

Glacial Extent ~ 20,000 years ago....

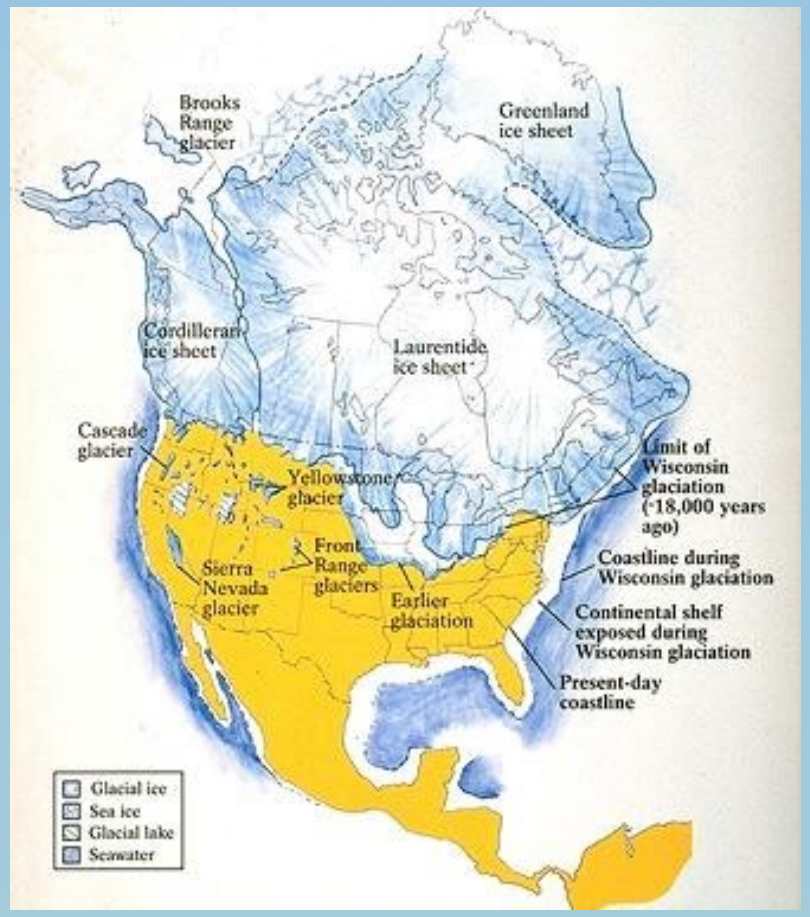
(~ 30% of land area glaciated)



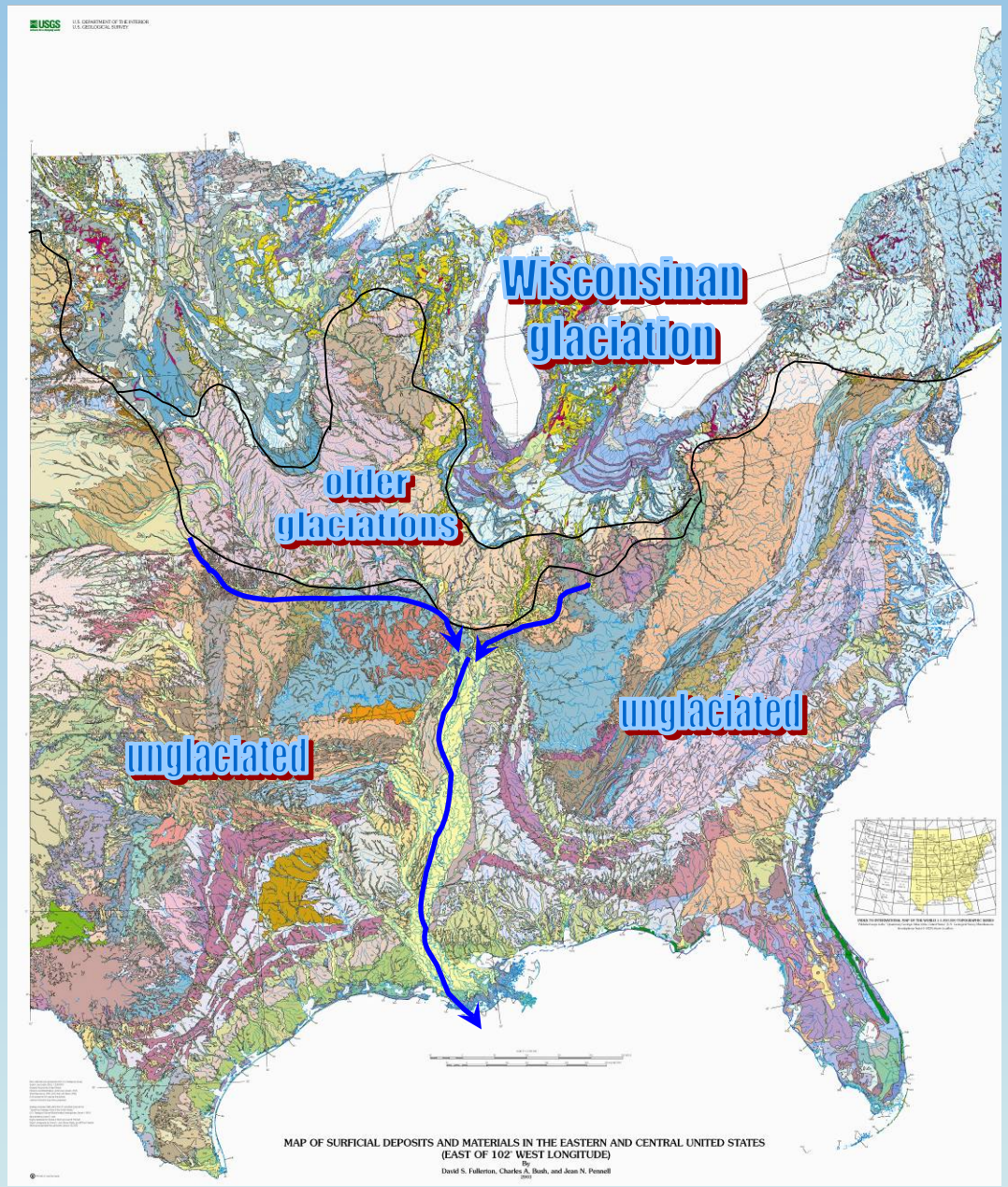
Glaciation in North America



Areas of North America covered by continental glaciers in Pleistocent time. (MGS Bul. 37)



- Southernmost extent of Pleistocene continental glaciation in N. Hemisphere



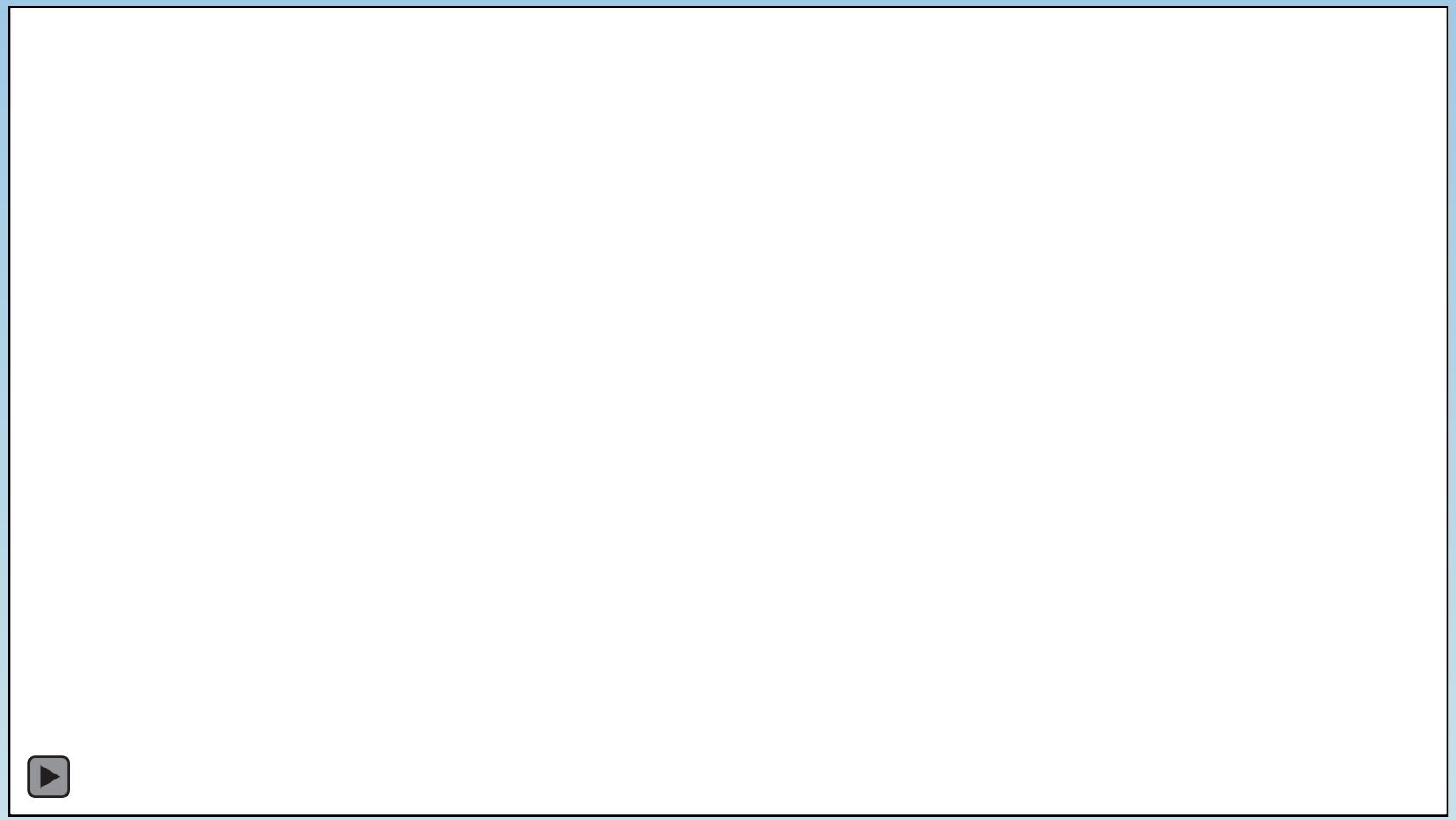
Quaternary / Surficial Deposits in Eastern USA

- glacial lobes
- glacial meltwater drainage
- http://www.youtube.com/watch?v=wbsURVgoRD0

  (video of glacial retreat)

Northern Hemisphere Ice Sheet Changes

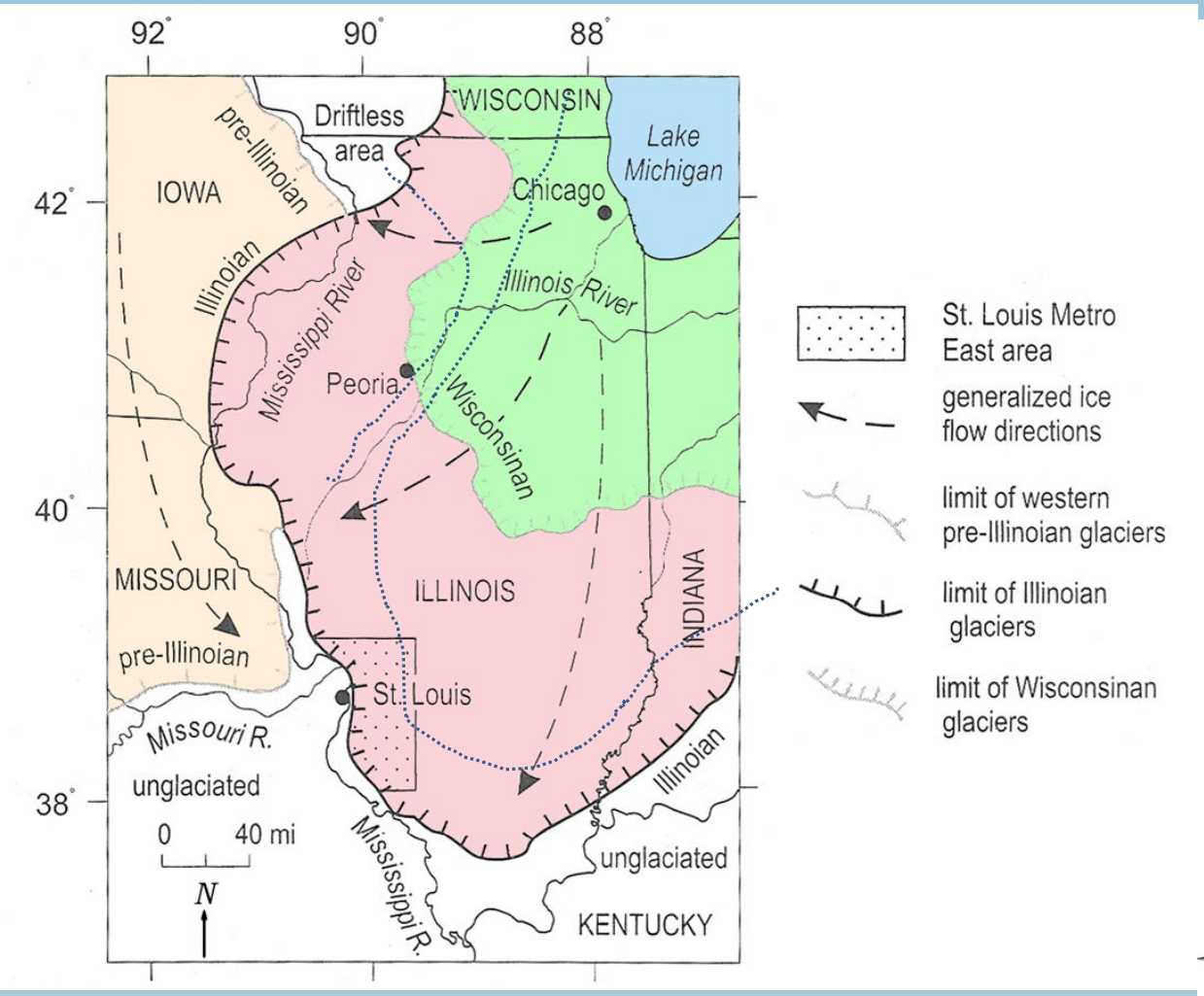
(400,000 years ago to the present)

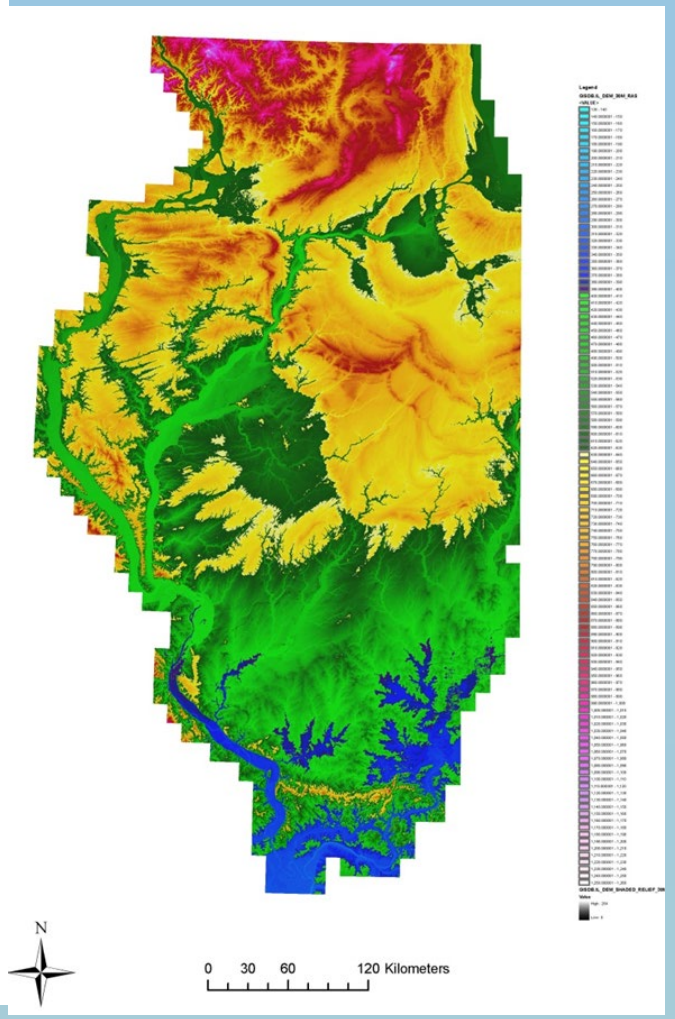


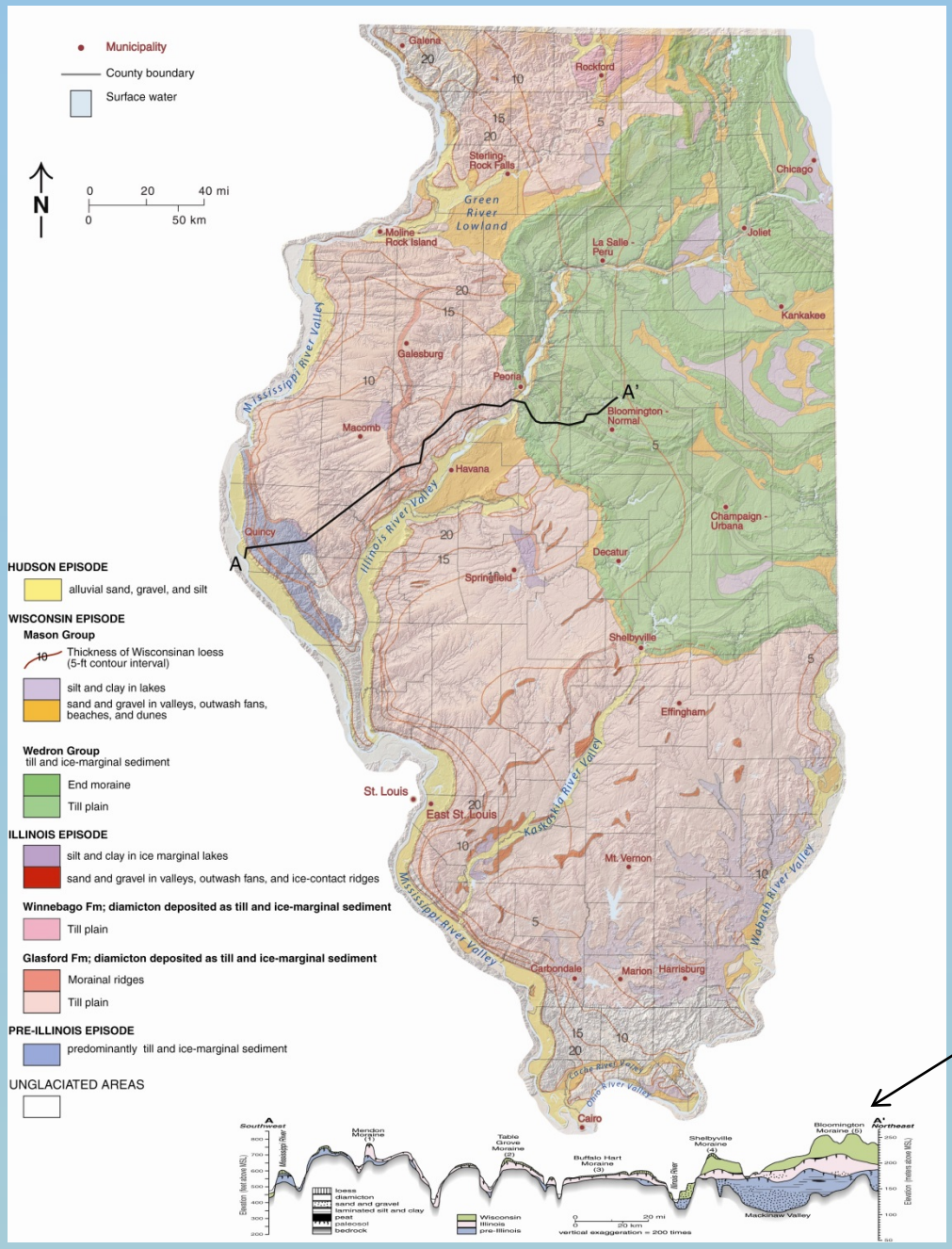
from Abe-Ouchi et al. 2013, Nature.

Pleistocene glaciations in Illinois

Surface landscape (DEM)



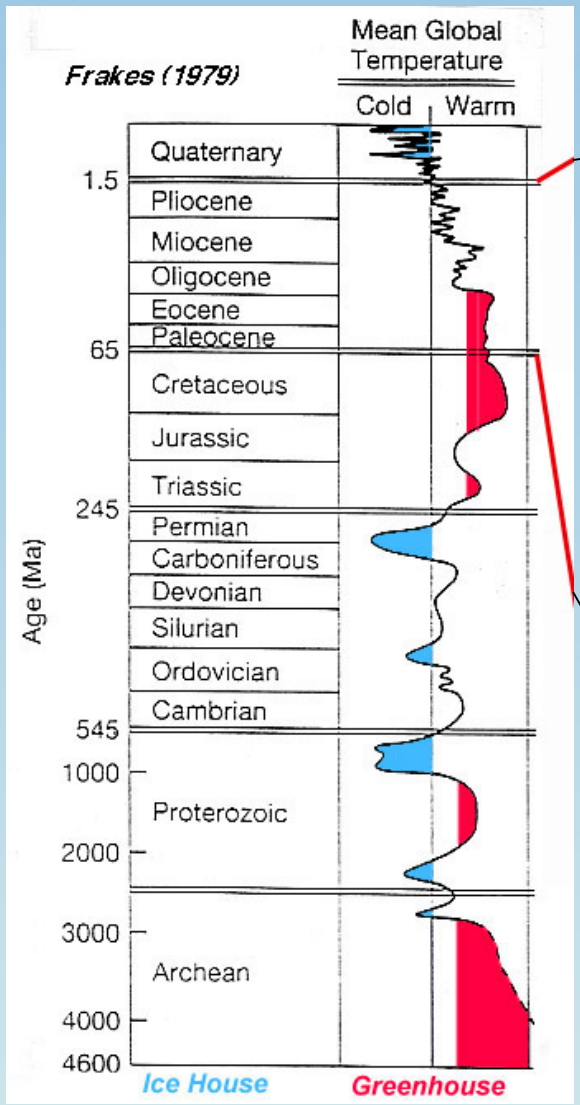




cross section

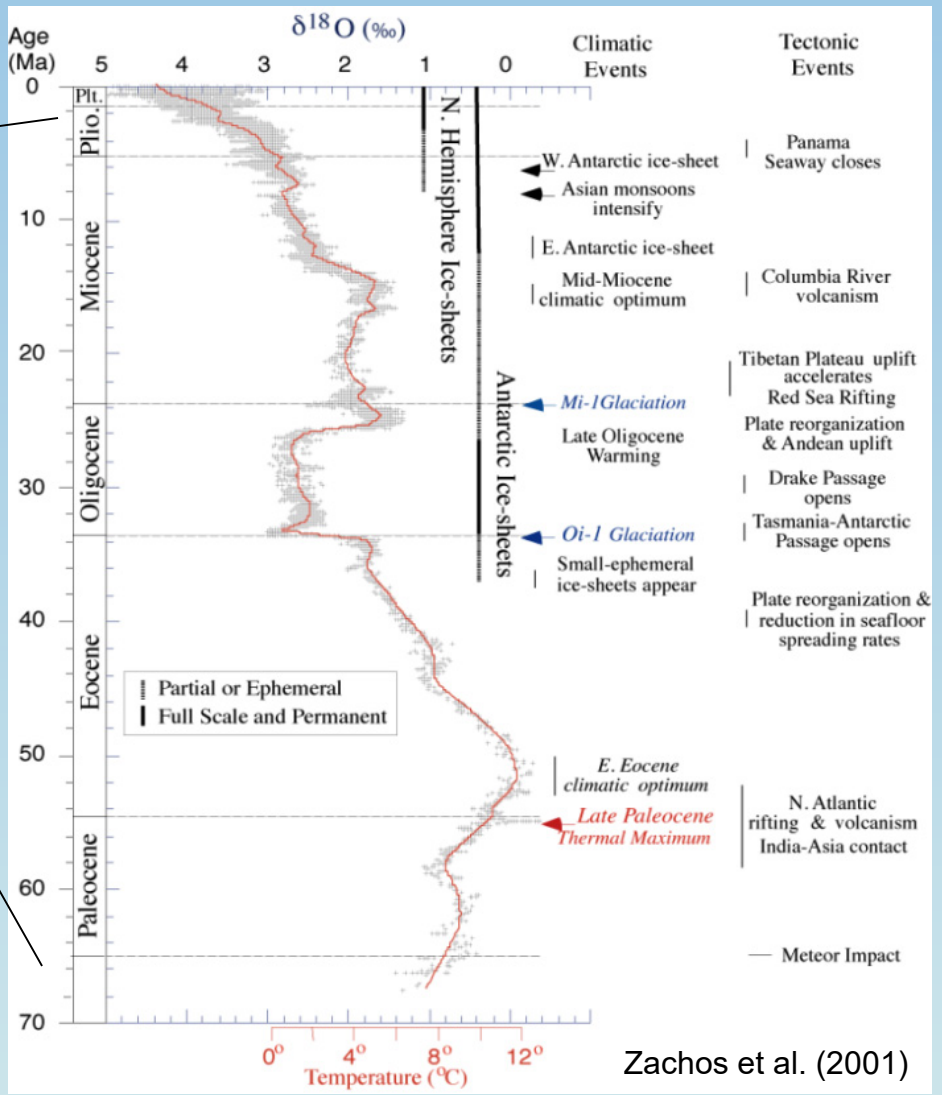
Climate change over Earth's History

(4.6 Billion years)



Cenozoic climate change

(last 65 My)



Zachos et al. (2001)

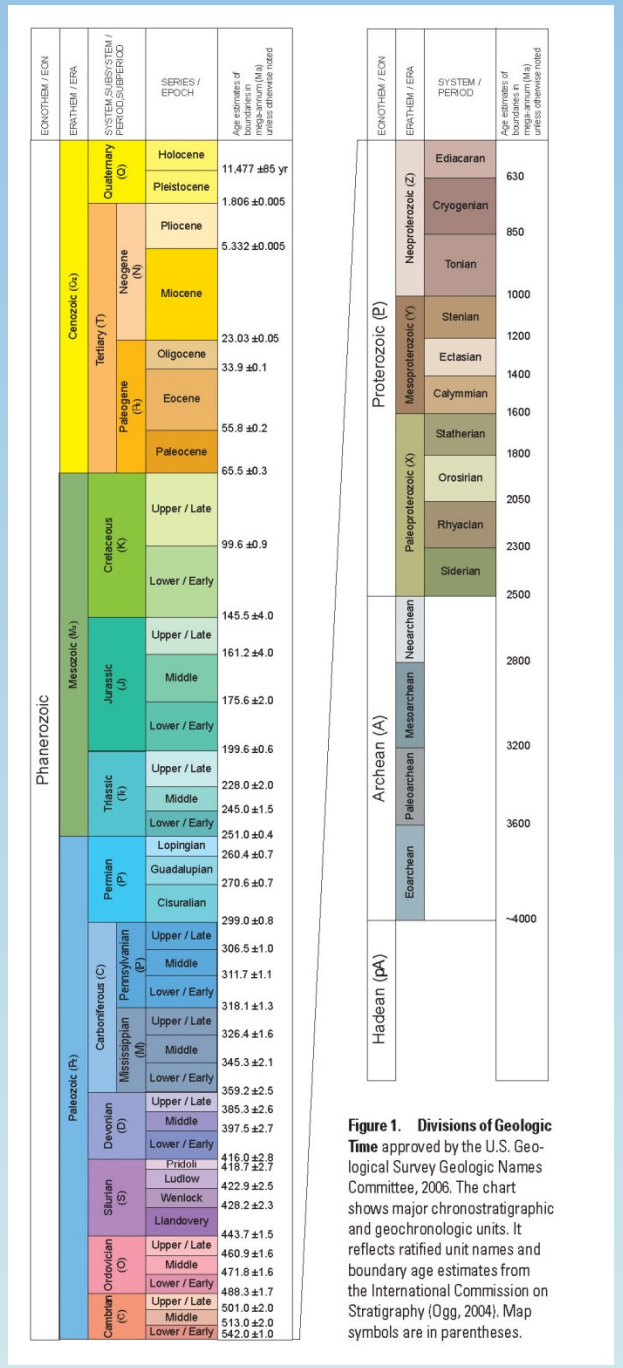
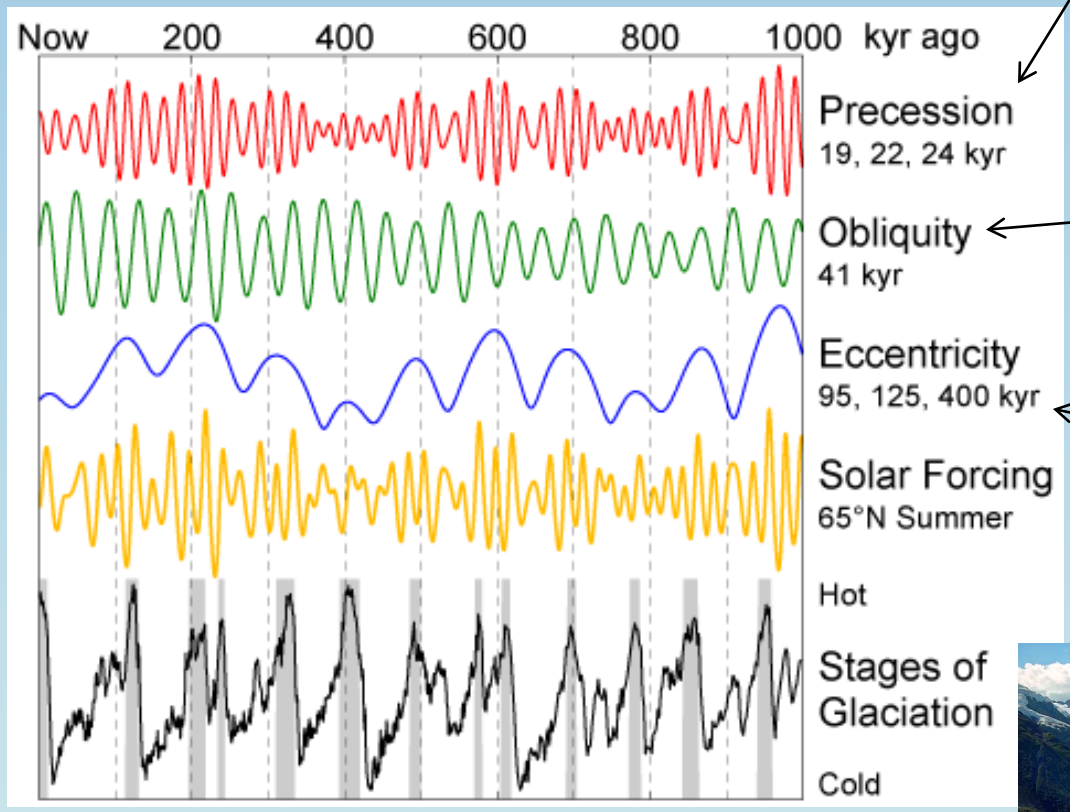


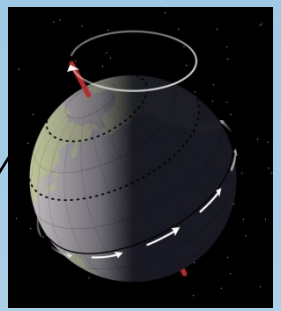
Figure 1. Divisions of Geologic Time approved by the U.S. Geological Survey Geologic Names Committee, 2006. The chart shows major chronostratigraphic and geochronologic units. It reflects ratified unit names and boundary age estimates from the International Commission on Stratigraphy (Ogg, 2004). Map symbols are in parentheses.

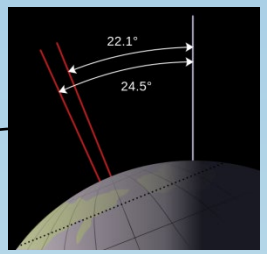
What is the Quaternary ?

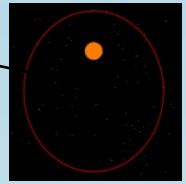
- time period from ~2.6 mya to the present (period of human evolution and ice ages)
- includes **Pleistocene** and **Holocene** (last 11,500 years --- period of human civilization)
- period of major glacial and interglacial periods (globally cooler on average than rest of Cenzoic, Mesozoic)

Astronomical (Milankovitch) Cycles

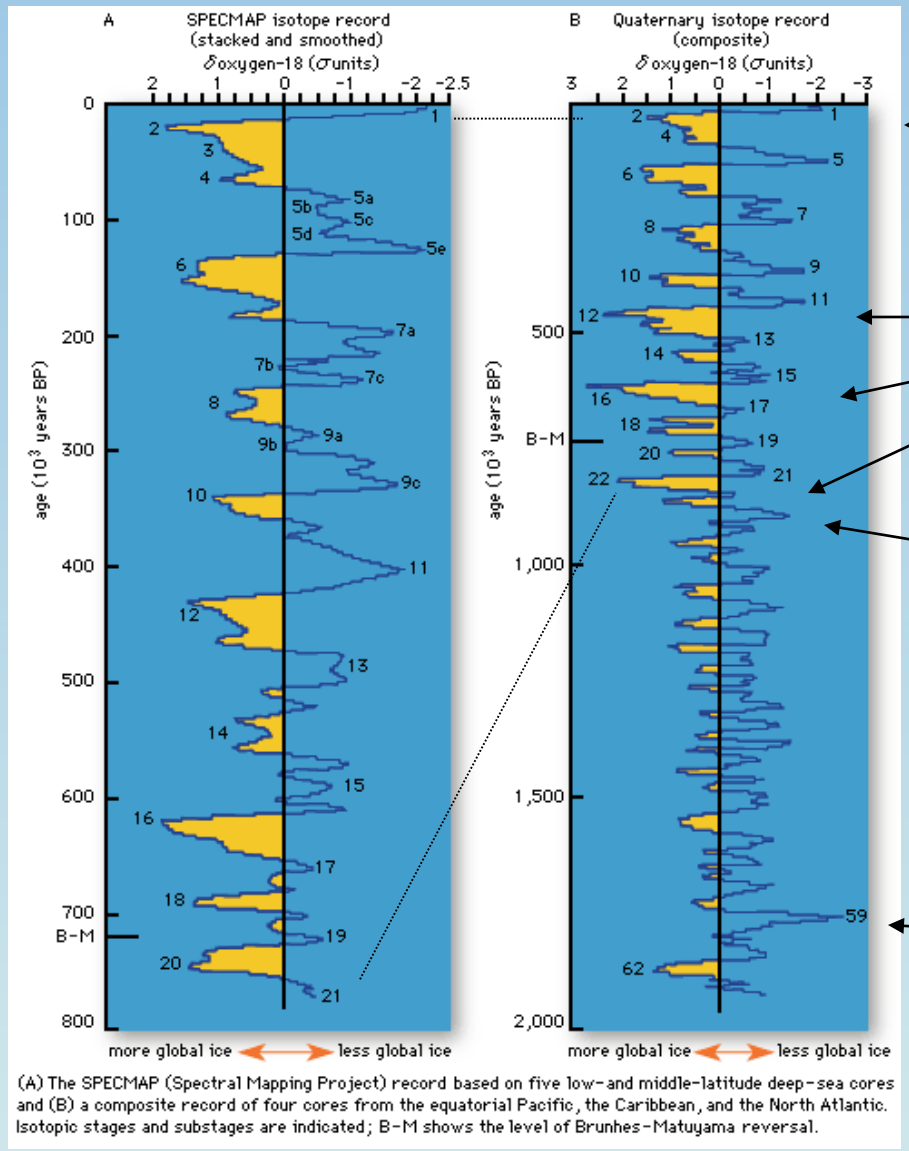








Global Ice Volume Record



(A) The SPECMAP (Spectral Mapping Project) record based on five low- and middle-latitude deep-sea cores and (B) a composite record of four cores from the equatorial Pacific, the Caribbean, and the North Atlantic. Isotopic stages and substages are indicated; B-M shows the level of Brunhes-Matuyama reversal.

Wisconsinan glaciation

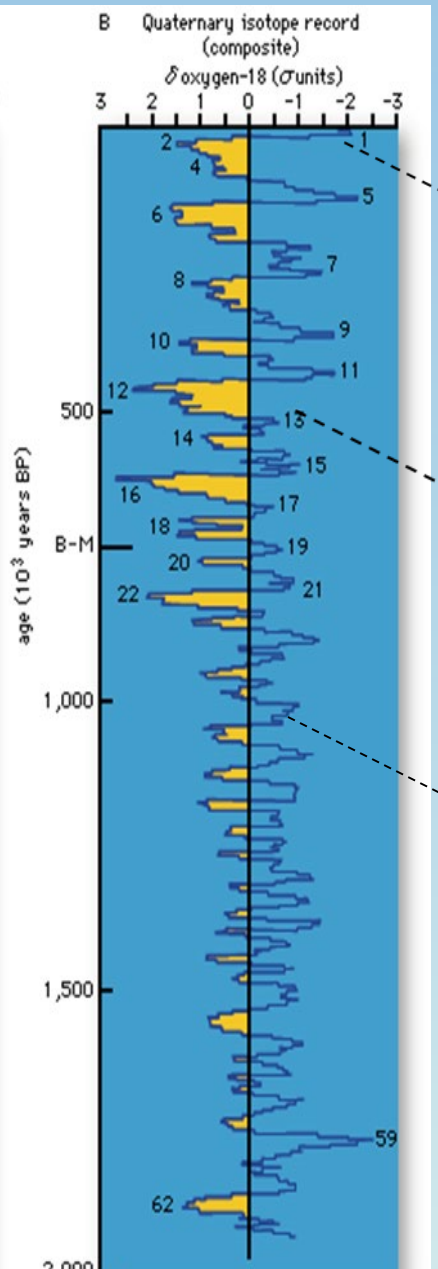
Illinoian glaciation

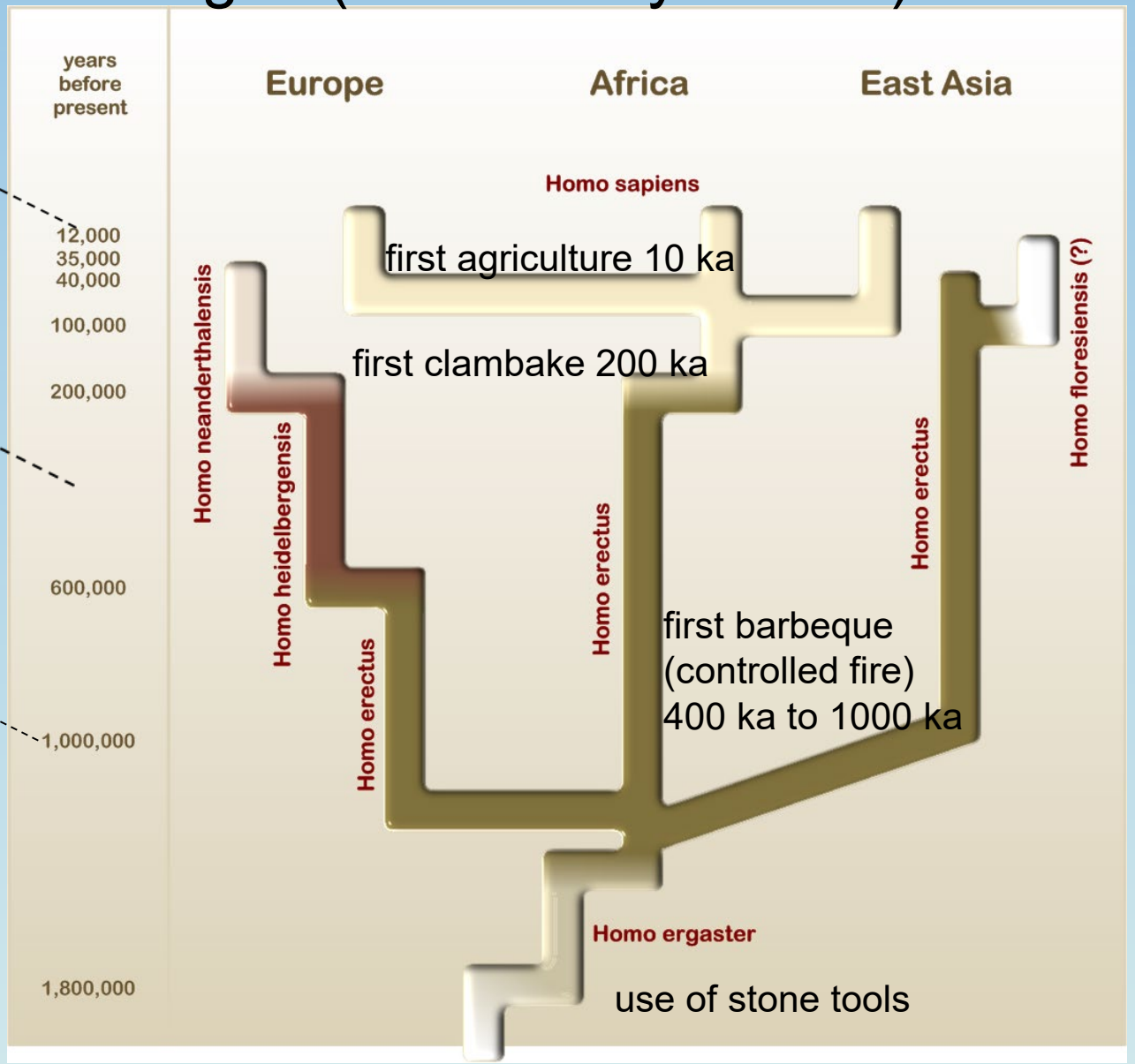
pre-Illinoian glaciations

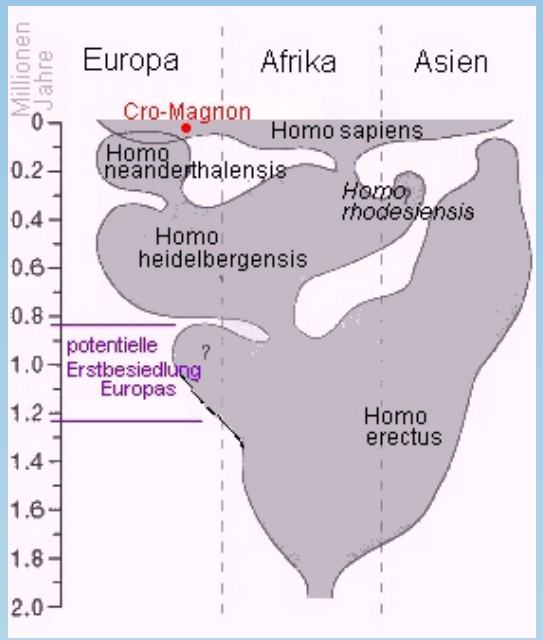
initiation of high amplitude changes in global ice volume < 1 Mya

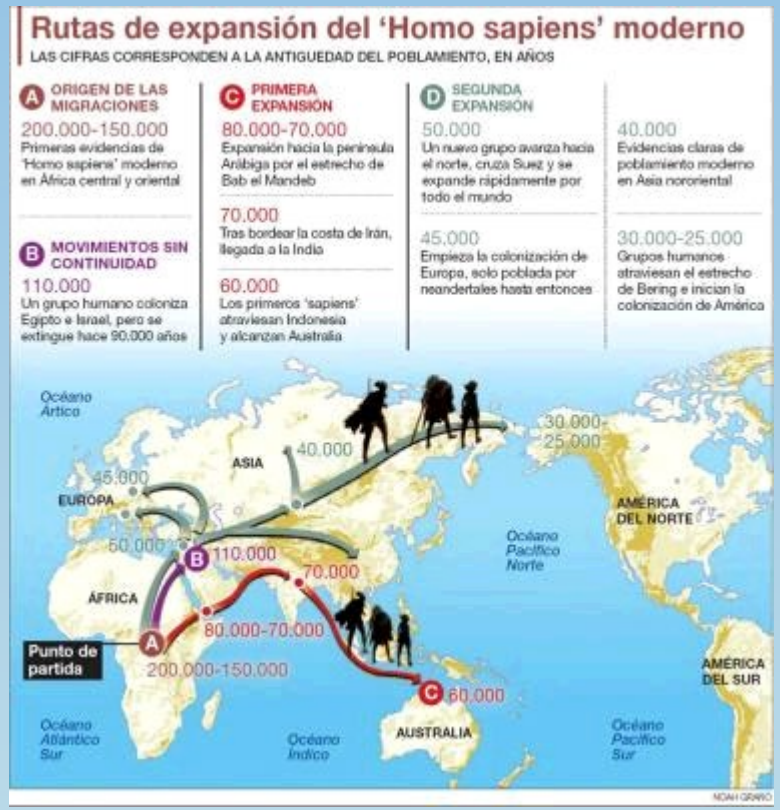
beginning of Pleistocene 1.8 Mya

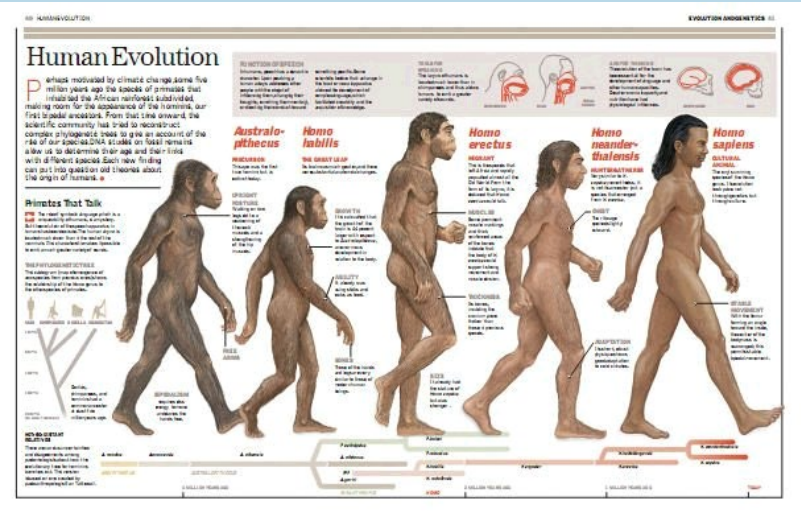
Human Evolution during the Ice Ages (Quaternary Period)





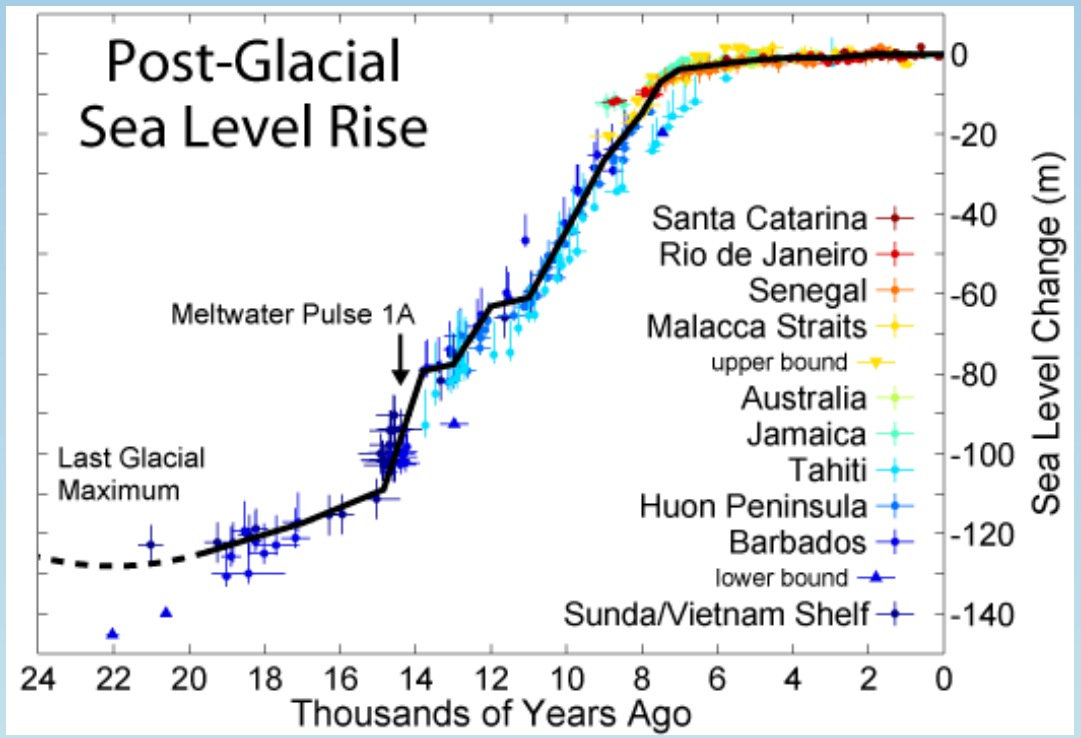

Millionen Jahre
Europa
Afrika
Asien
Cro-Magnon
Homo sapiens
Homo neanderthalensis
Homo rhodesiensis
Homo heidelbergensis
potentielle Erstbesiedlung Europas
?
Homo erectus
0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
1.8
2.0


Rutas de expansión del 'Homo sapiens' moderno
LAS CIFRAS CORRESPONDEN A LA ANTIGUEDAD DEL POBLAMIENTO, EN AÑOS
A ORIGEN DE LAS MIGRACIONES
200.000-150.000
Primeras evidencias de 'Homo sapiens' moderno en África central y oriental
B MOVIMIENTOS SIN CONTINUIDAD
110.000
Un grupo humano coloniza Egipto e Israel, pero se extingue hace 90.000 años
C PRIMERA EXPANSIÓN
80.000-70.000
Expansión hacia la península Arábiga por el estrecho de Bab el Mandeb
70.000
Tras bordear la costa de Irán, llegada a la India
60.000
Los primeros 'sapiens' atraviesan Indonesia y alcanzan Australia
D SEGUNDA EXPANSIÓN
50.000
Un nuevo grupo avanza hacia el norte, cruza Suez y se expande rápidamente por todo el mundo
45.000
Empieza la colonización de Europa, solo poblada por neandertales hasta entonces
40.000
Evidencias claras de poblamiento moderno en Asia nororiental
30.000-25.000
Grupos humanos atraviesan el estrecho de Bering e inician la colonización de América
Océano Ártico
ASIA
EUROPA
ÁFRICA
AMÉRICA DEL NORTE
AMÉRICA DEL SUR
AUSTRALIA
Océano Pacífico Norte
Océano Atlántico Sur
Océano Índico
Océano Pacífico Sur
Punto de partida
45.000
40.000
30.000-25.000
50.000
110.000
70.000
80.000-70.000
200.000-150.000
60.000
NOAH GRIKO

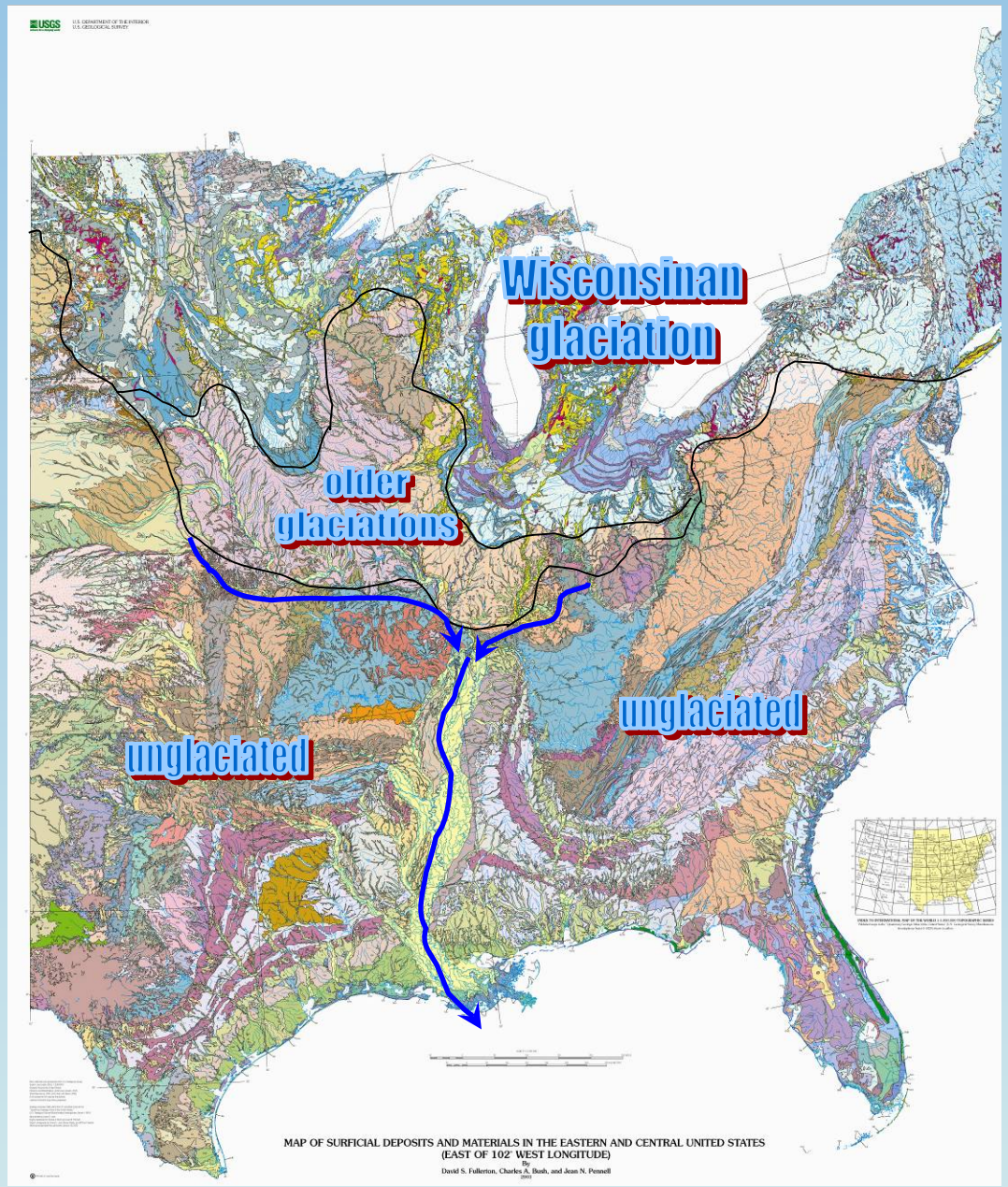

Human Evolution
Australopithecus
Homo habilis
Homo erectus
Homo neanderthalensis
Homo sapiens
Primates That Talk

Sea Level Rise during Glacial-Interglacial Transitions

Sea level ~120 m lower



Questions ?



Quaternary / Surficial Deposits in Eastern USA

Why study Quaternary Geology ? (surficial deposits)

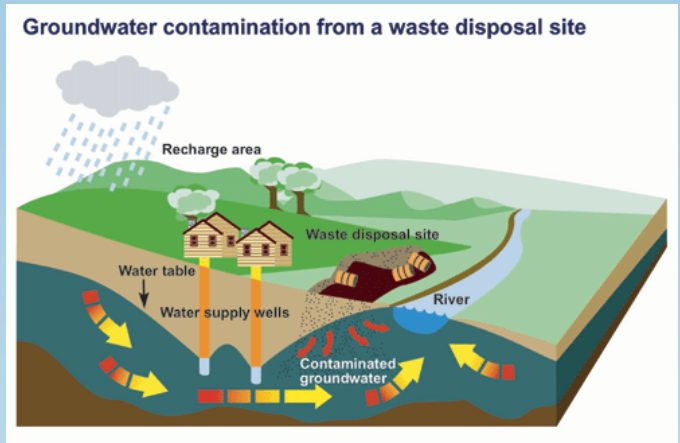
1.) **Scientific reasons** ---- basic research on geologic processes, history, and climate change

2.) **Societal issues** ---- practical concerns (material on which we live)

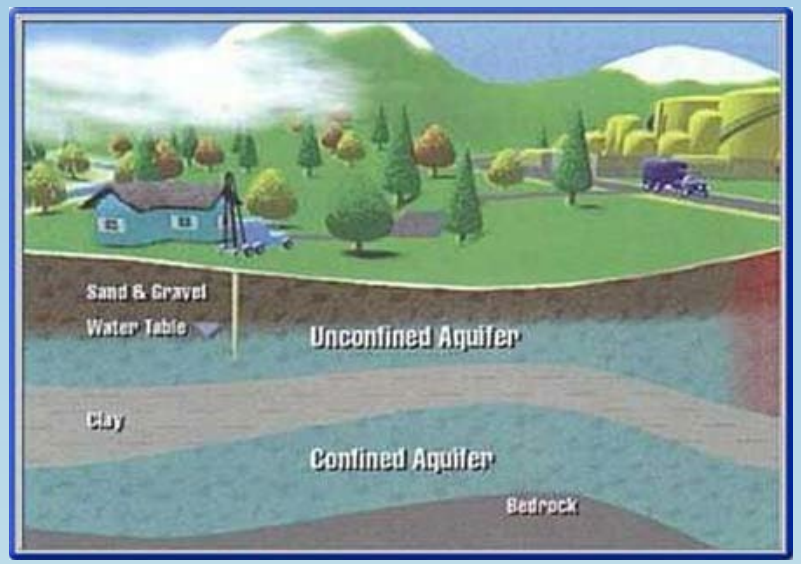
3.) **Public understanding** --- and appreciation of our landscapes, deposits, and glacial history.

Societal Impacts

- Groundwater resources and protection
- Landfill or waste siting
- Seismic shaking hazards
- Construction suitability and stability
- Sand and gravel resources
- Overburden above coal mines / oil fields
- Agriculture (drainage)
- Landscape appreciation
- Understanding of past climates / environments



Groundwater



Sand and gravel resources

Keyesport, Bond County, IL

Sand and Gravel Pits

Central Illinois Materials Sand Pit
(near Vandalia)

Taylorville Sand Pit (red dog)

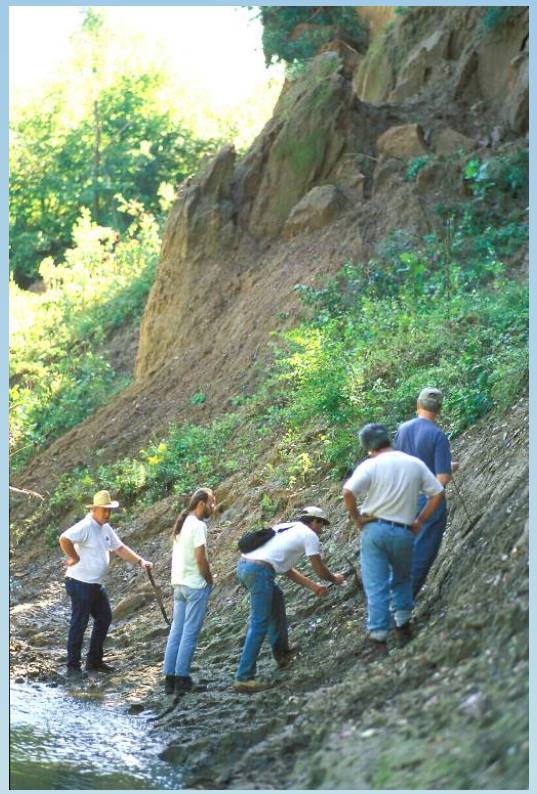
Keyesport Sand and Gravel,
Clinton County, IL

Construction

Seismic Hazards

- soft, low strength sediments susceptible to ground shaking and liquefaction

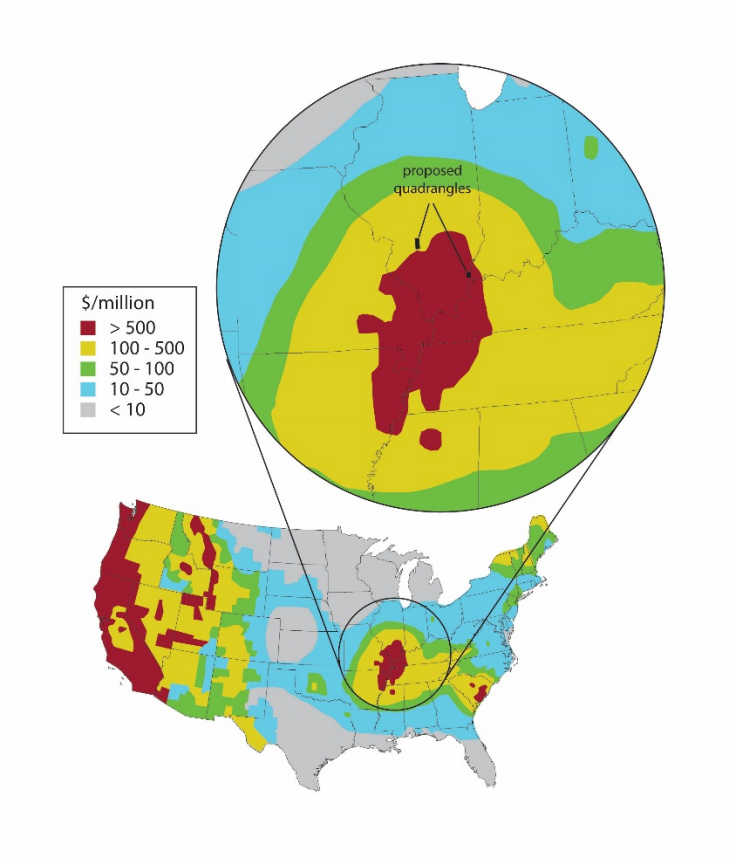
Slumping



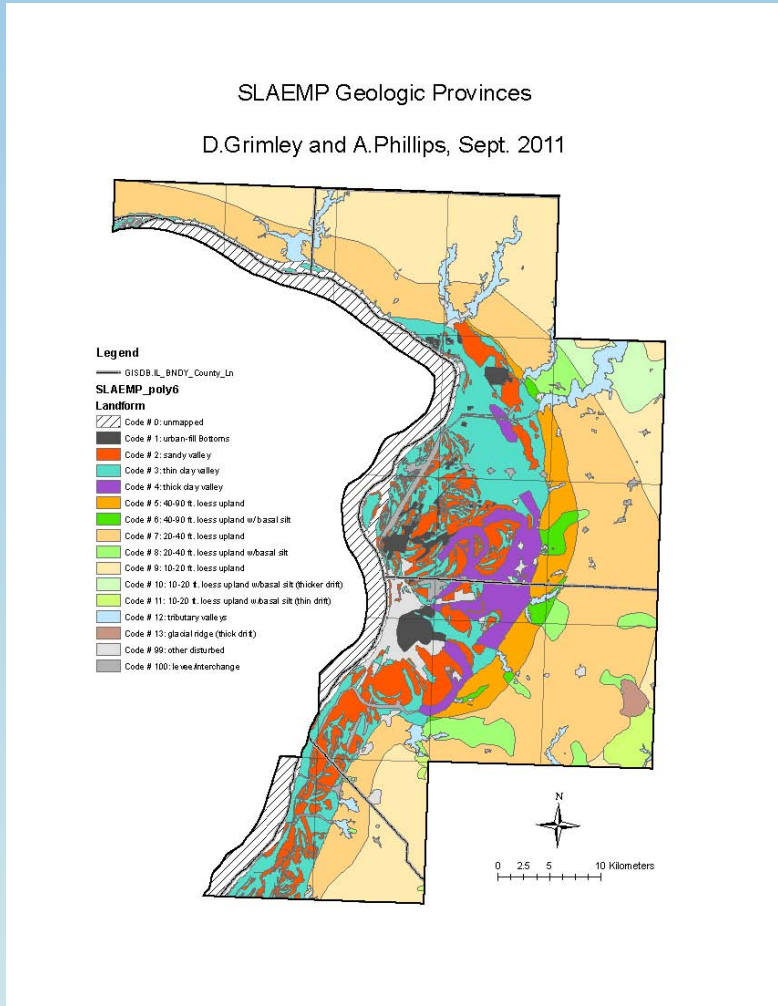
- major problem in steep sloping areas with thick loess

- or at permeability contrasts

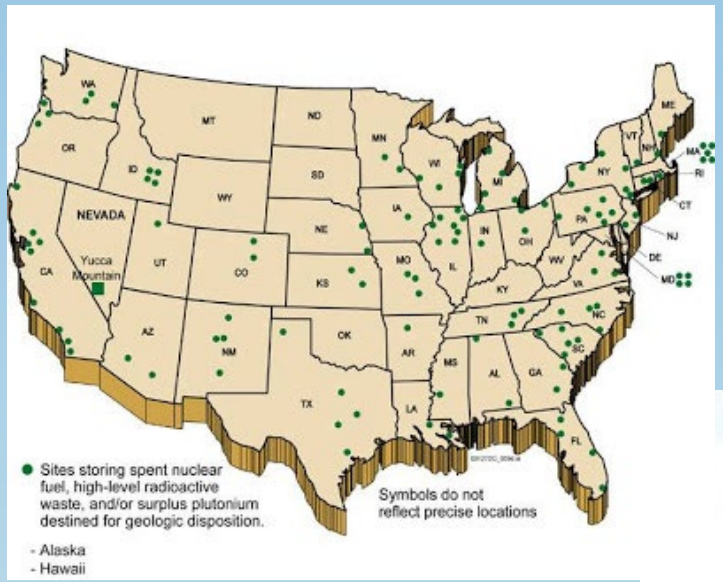
Earthquake Hazards



Seismic Hazards



Waste Siting



Martinsville study….

Roxana Landfill north of Edwardsville, IL

Brick Making

Till and shale mined in NW Bond County

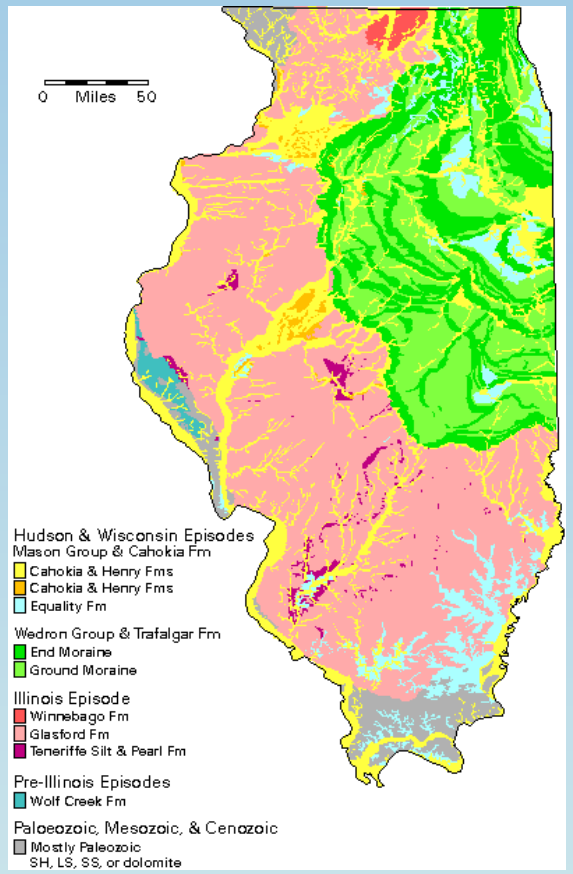
Material utilized for bricks must be low in carbonate content and high in clay content, among other considerations. Weathered till and shale units are here ideally located at shallow depths with limited loess cover.

Quaternary materials: Illinois

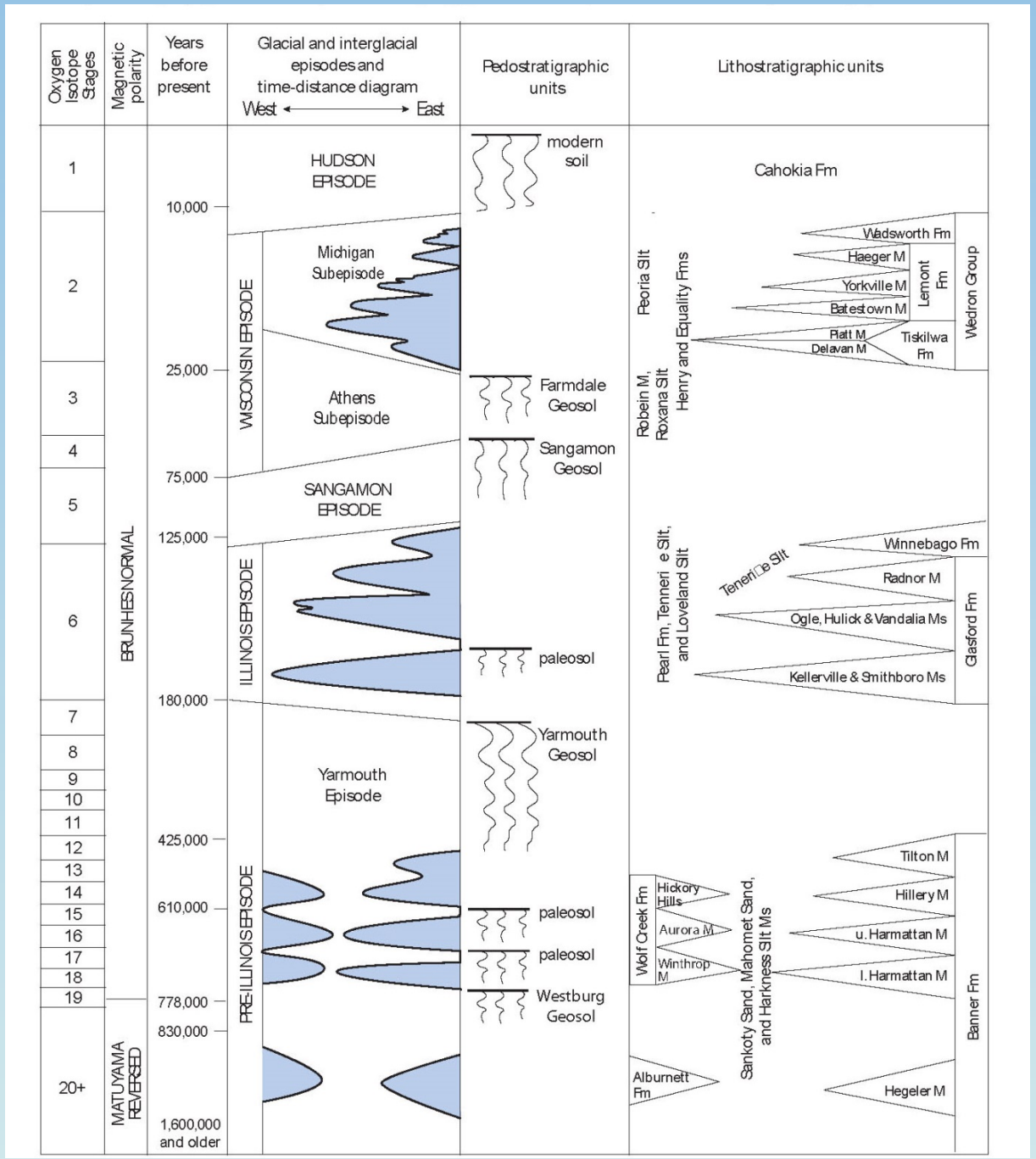
- loess (windblown silt)
- till and debris flows (diamicton; glacial)
- lake sediment (stratified silt and clay)
- outwash (stratified sand and gravel; glacial)
- alluvium – nonglacial (stratified silt, sand, and clay)
- colluvium (diamicton; nonglacial)
- dune sand (well sorted, fine sand)

Quaternary landforms: Illinois

- moraines
- eskers, kames
- lake plains
- sand dunes
- terraces
- floodplains

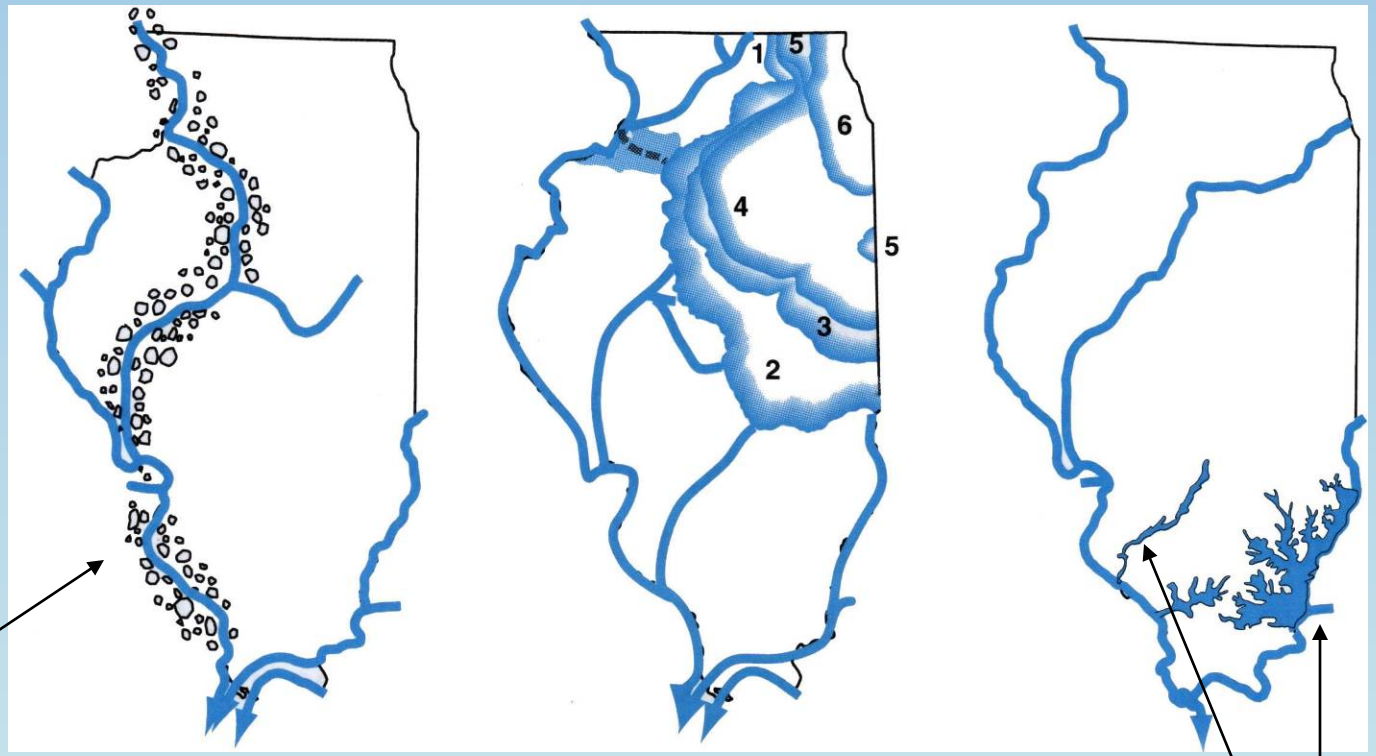


Quaternary time scale and stratigraphy (Illinois)



from Hansel and McKay, 2009

Wisconsin Episode
(or Wisconsinan Stage)



outwash

pre-20,000

diversion of
Mississippi R.

~ 55,000 to 12,000 years ago

slackwater
lakes

Moraines.....

Ralls Ridge, Randolph Co., IL

Wisc. till deposits

Mahomet pit: interbedded till and sands

FOP 2008, last stop, McHenry Co., IL

Moraine blocked lakes

Glacial Lake Pingree --- near Pingree Grove, Kane County, IL

varved lake deposits

Outwash

Thelan Pit: northeast Illinois (McHenry-Lake Counties)

Glacio-tectonic deformation

Thelan Pit: northeast Illinois (McHenry-Lake Counties)

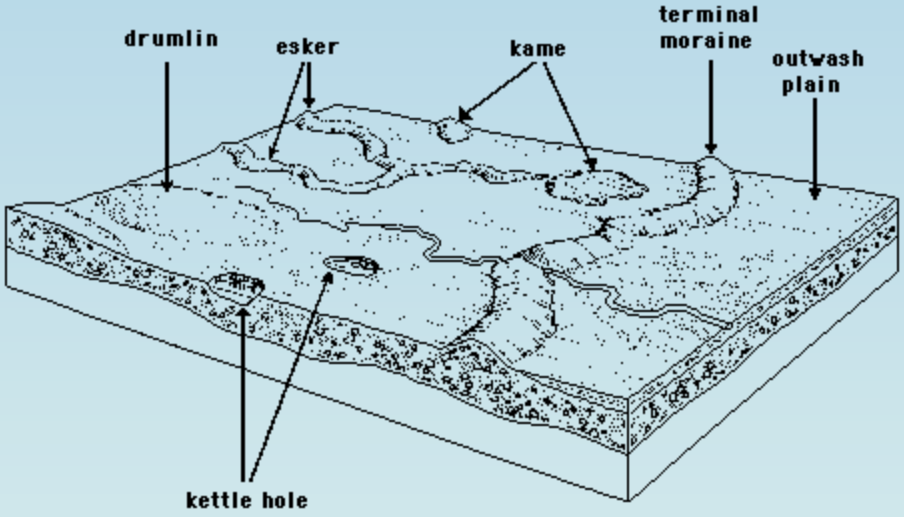
Dune sand

Green River Lowlands --- NW Illinois (Miao Xiaodong)

Kames

Monticello Rd. kame (Wisconsinan)

near Sugar Grove, Kane Co., IL



Striations

Lohr Quarry, Madison County, IL

(Illinoian)

local Wisconsin Episode deposits

First St. and Springfield Ave., Champaign, IL; 2009

loess w/modern soil over stratified sands over clayey till

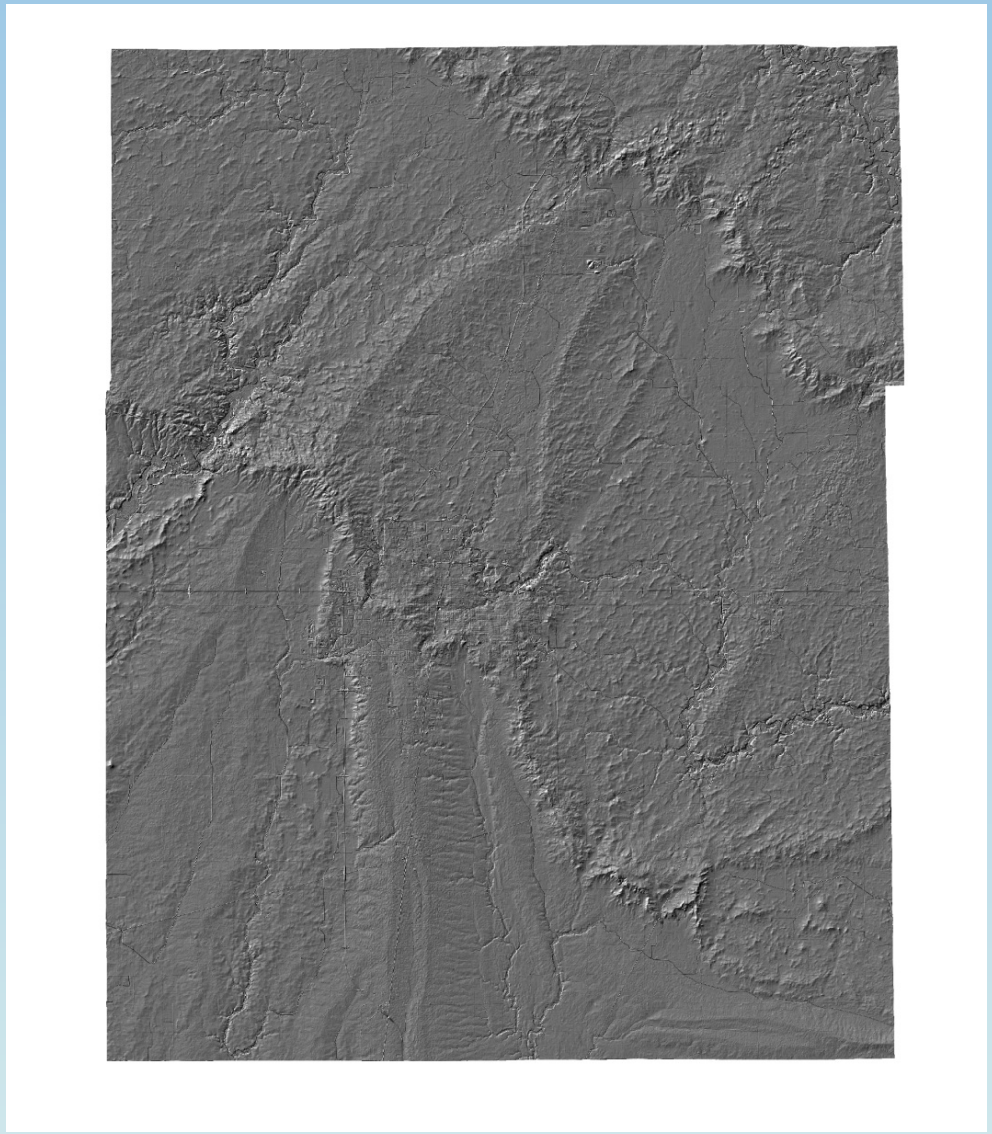
loess/till; 5th and Univ. Ave. 1999

1st and Spring.; loess/outwash 1999

West Champaign excavation (west of Staley Rd.)

retention pond excavation --- just west of moraine and on east side of Kaskaskia Valley (near Bill Shilts house)

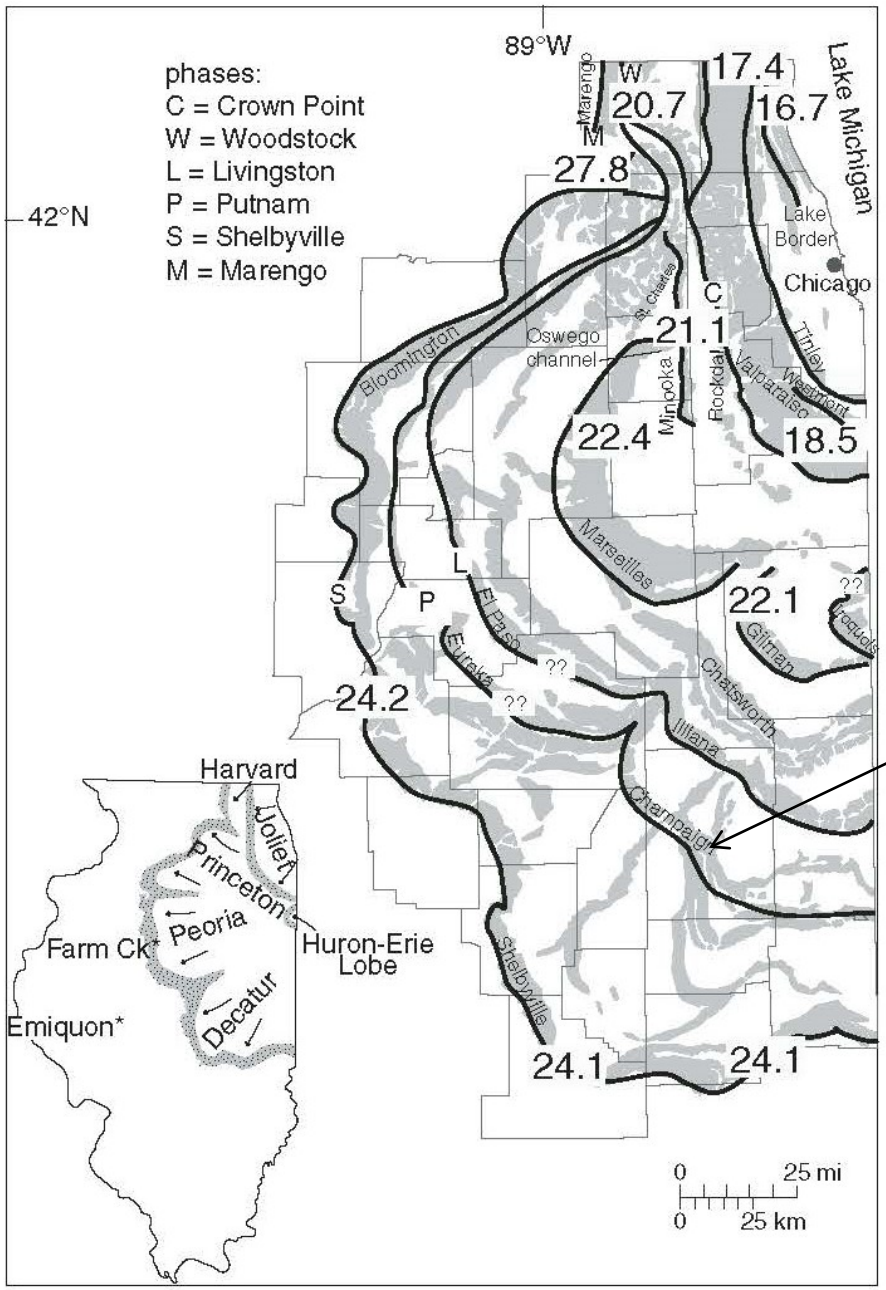
LiDAR image, Champaign County



Questions ?

Moraine Ages

17,000 to 28,000



Champaign-Urbana

From Curry et al. 2018, GSA Special Paper 530

Glacial chronology in NE Illinois

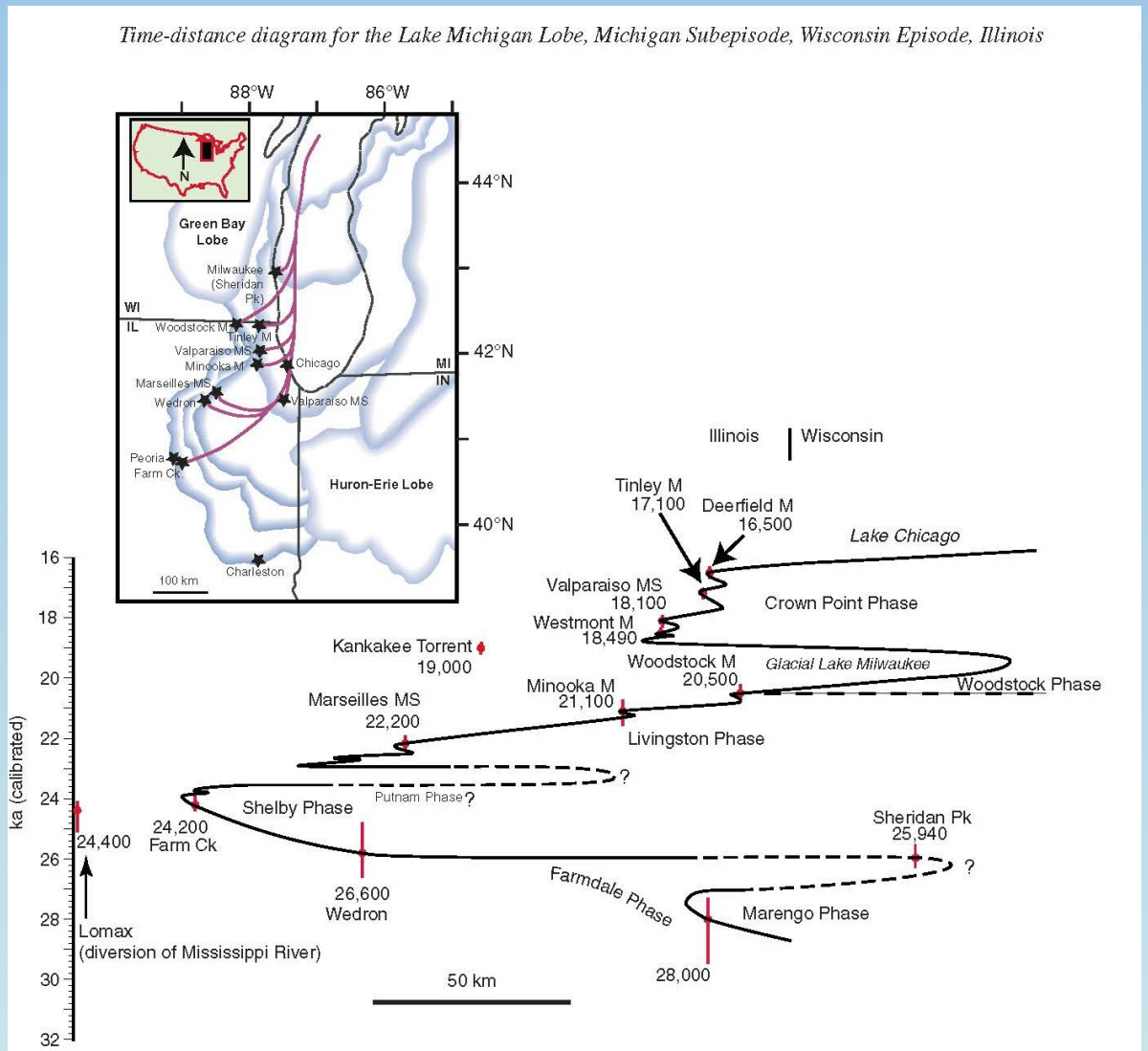


Figure 15. Revised time-distance diagram of Lake Michigan Lobe with conservative maximum ages (probability density function [pdf] mode plus the σ_2 error) below the schematic ice margin, and conservative minimum ages (pdf mode minus the σ_2 error). The inset map shows presumed flow lines used to determine relative distances. M—moraine; MS—moraine system. State abbreviations: WI—Wisconsin, Il—Illinois, MI—Michigan, IN—Indiana.

From Curry et al. 2018, GSA Special Paper 530

Wisconsin Episode deposits: indirectly related to glaciation

massive **loess deposits**: Collinsville, IL

(up to 90 feet thick)

stratified **lake sediments**:

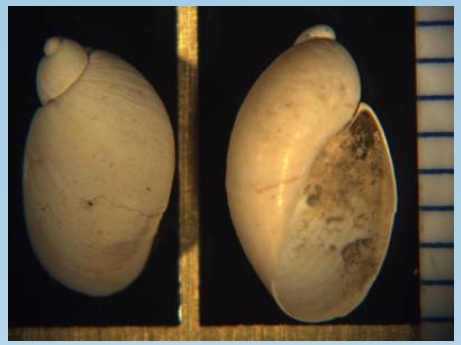
exposed along Kaskaskia River

loess and lacustrine sediment

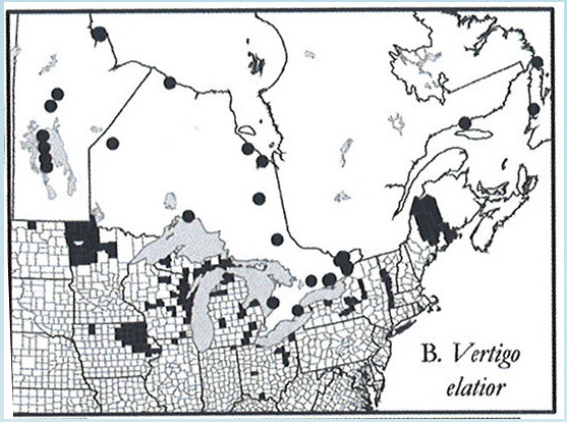
Fulton Section (along Mississippi River, western TN)

common terrestrial gastropods in Illinois loess

Anguispira alternata (tiger snail) --- common in woodlands today in SW Illinois



Succinea sp. - common terrestrial snail in Midwest loess



Fossil Mammoth (~ 20 ka) found in loess deposits (Principia College)

Benny the Mammoth (Jeffersonian) --- Elsah, Illinois

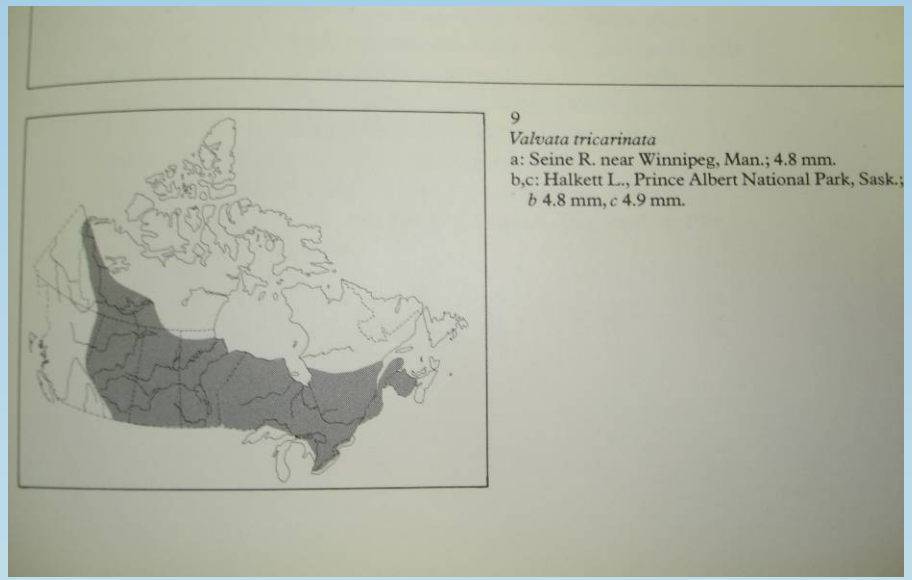
http://content.principia.edu/sites/mammoth/

Slackwater lake deposits in terraces

New Athens East Quadrangle,

St. Clair Co., IL

Valvata tricaranata --- common to permanent lakes



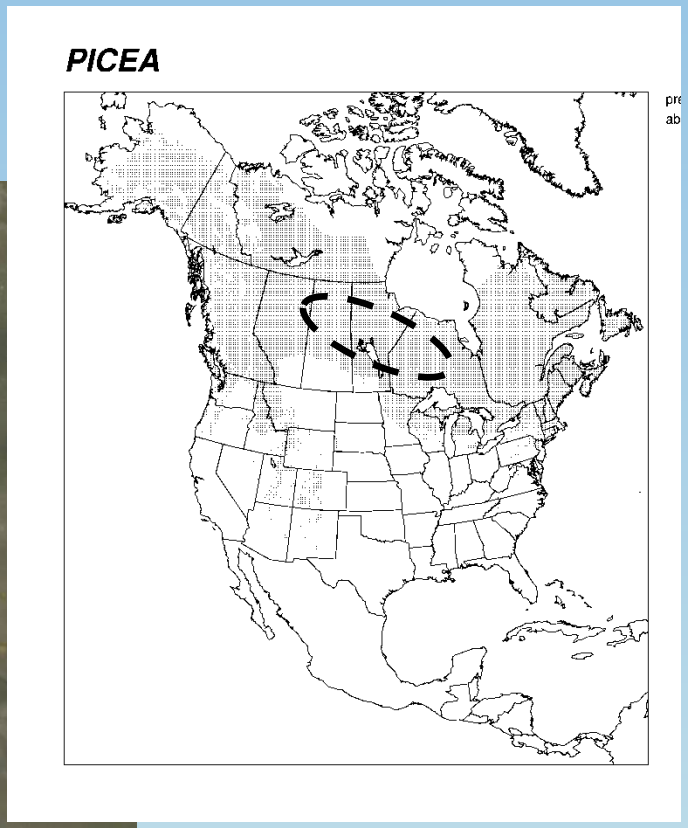
Valvata tricaranata ----- aquatic; permanent lakes; often associated with small bivalves (pea clams)

Clarke, 1981; distribution in Canada today

Pomatiopsis lapidaria ---- an amphibious gastropod common to slackwater lake sediments

Pomatiopsis lapidaria -- amphibious

Coldwater Creek Section



Modern distribution of spruce forest

fossil spruce log: Coldwater Creek Missouri (17,640 +/- 120 C^{14} years)

Sangamon Geosol (fossil soil) development

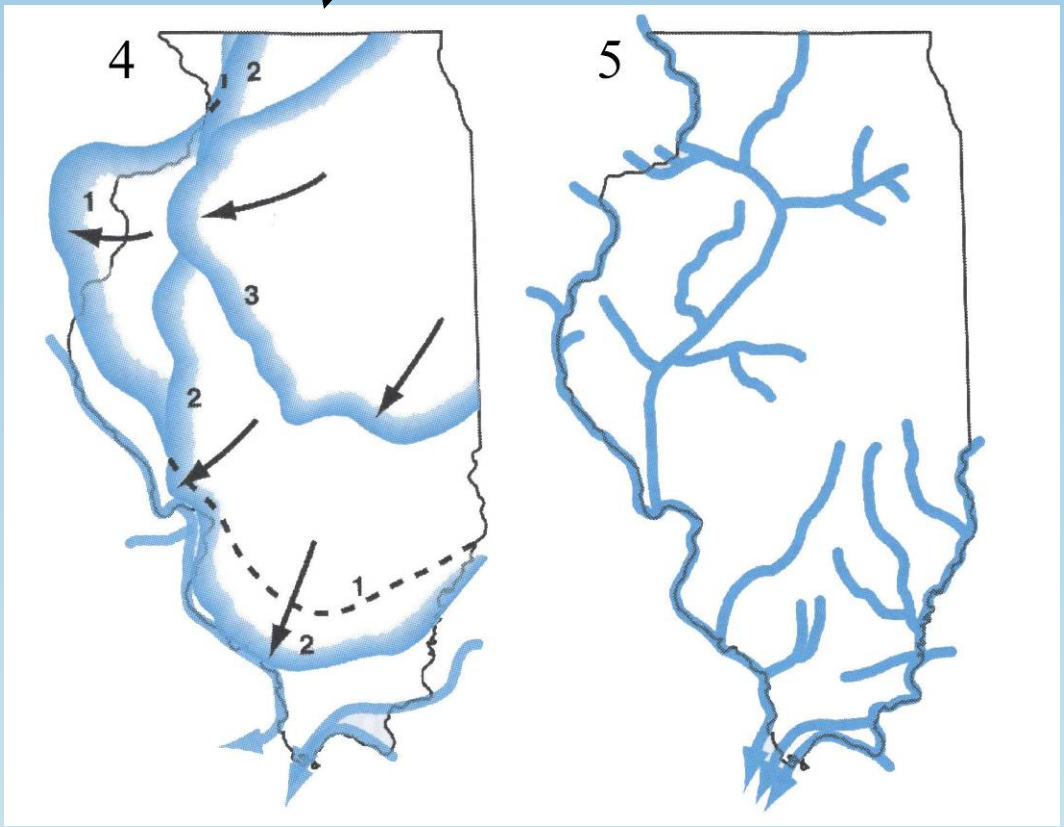
- Sangamon Geosol in sand and gravel

- *Highland, Madison County, IL*

- Sangamon Geosol developed in glacial till

- *Ogles Creek Section, St. Clair County, IL*

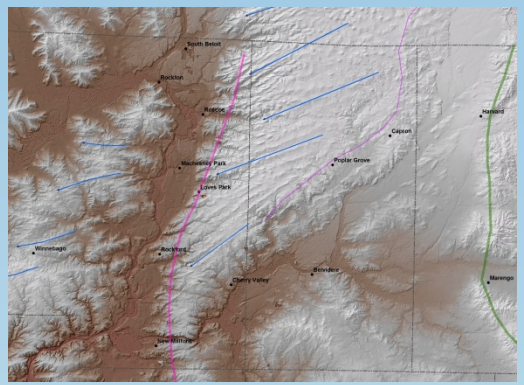
Illinois Episode



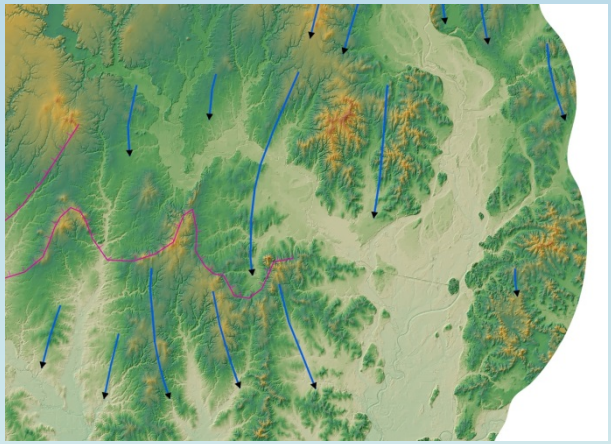
~ 200,000 to 130,000 years ago

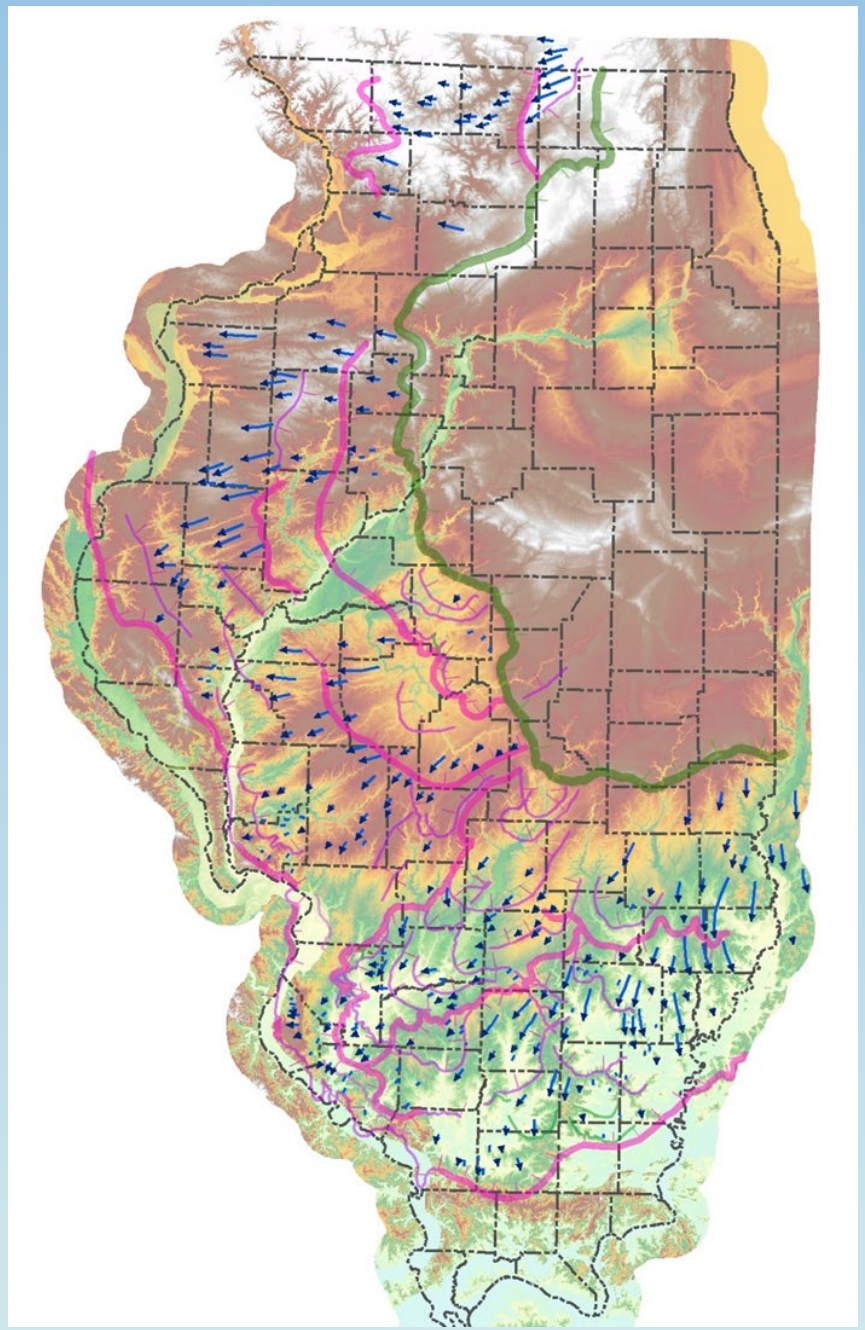
Ice Flow Directional Indicators

Northern Illinois flutings



Mega-lineations on 10m DEM from southeastern Illinois





Illinois Episode deposits and features

fractured **glacial till** (oxidized along fractures); unsorted, massive deposit with erratic pebbles

striations

hairpin erosion mark (Alton, IL)

Ogles Creek Section (paleosol, till, lake sediment): St. Clair County, IL

Prairie du Pont Section: St. Clair County

gastropods present:

Carychium exiguum, common in wet prairie/fen/wet woods throughout NE North America; sometime at springs

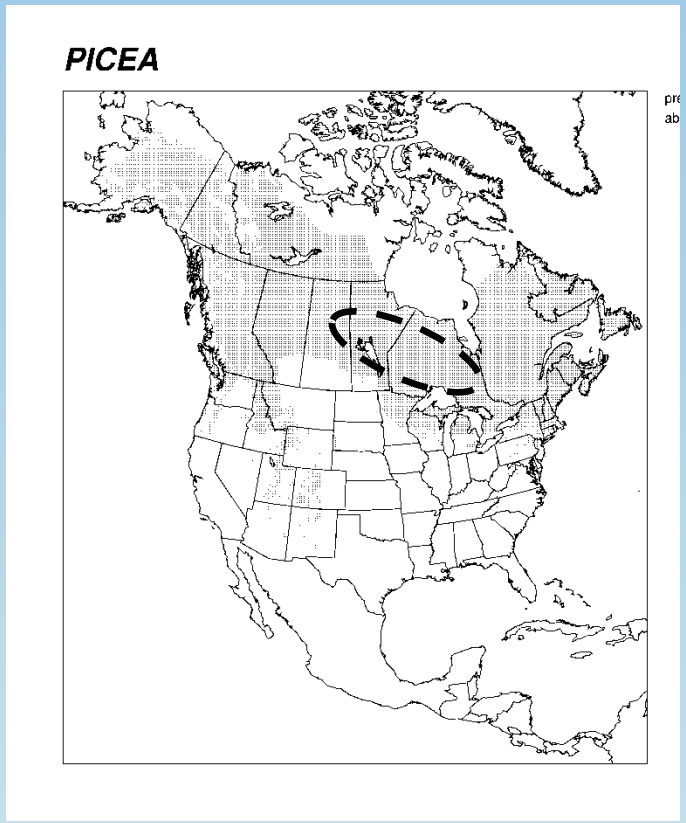
Vertigo elatior, which frequent fen/conifer wetlands in northern U.S. to Hudson Bay

Overall interpretation: area similar to wetland in Canadian boreal forest (north of Great Lakes); loess, shells and wood washed into a lowland adjacent to a hillside


AUG 17 2005

fossil spruce log in growth position

oriented spruce wood and needles

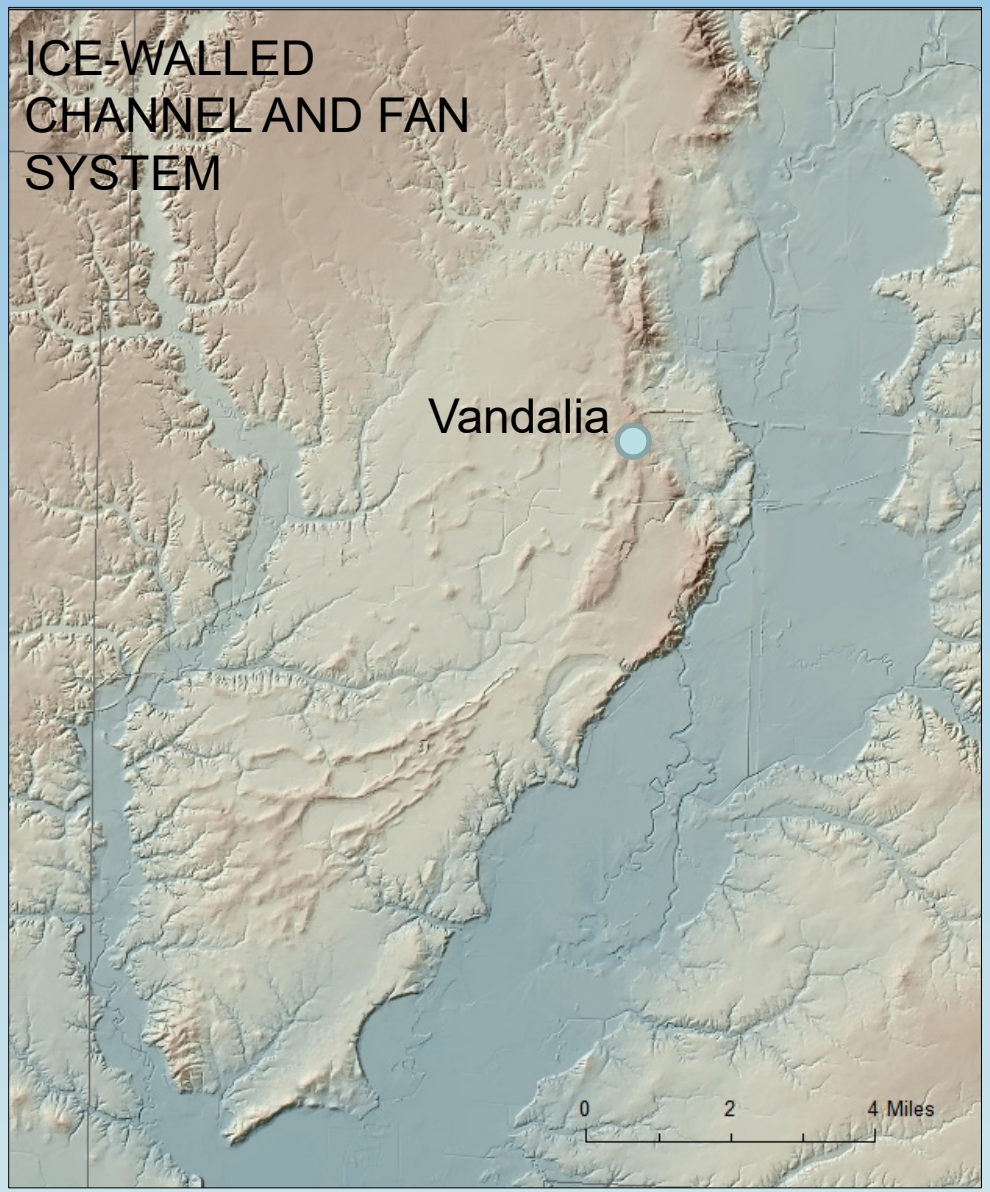


Modern distribution of spruce forest

Glacial ridges in south-central Illinois

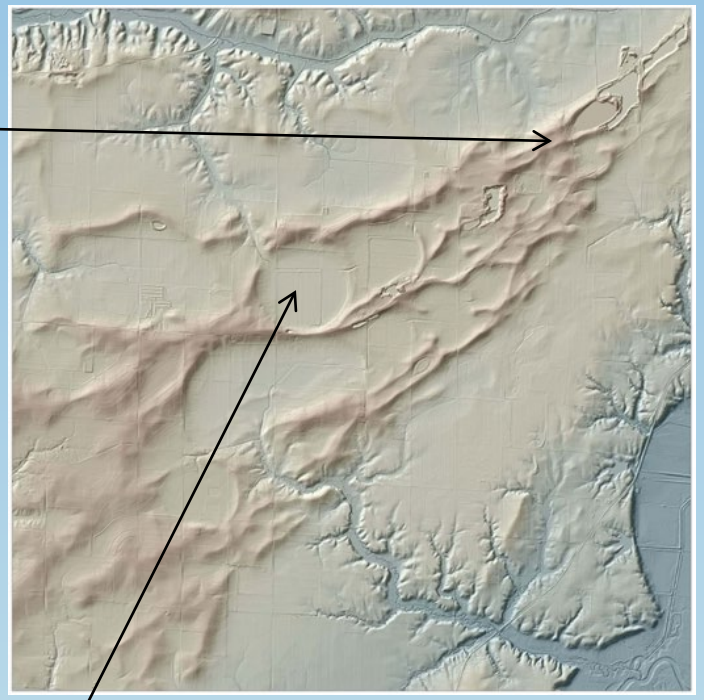
Neudecker's Mountain, Madison County

Keyesport sand and gravel pit, Bond County



(Fayette County)

Central Illinois Materials Pit

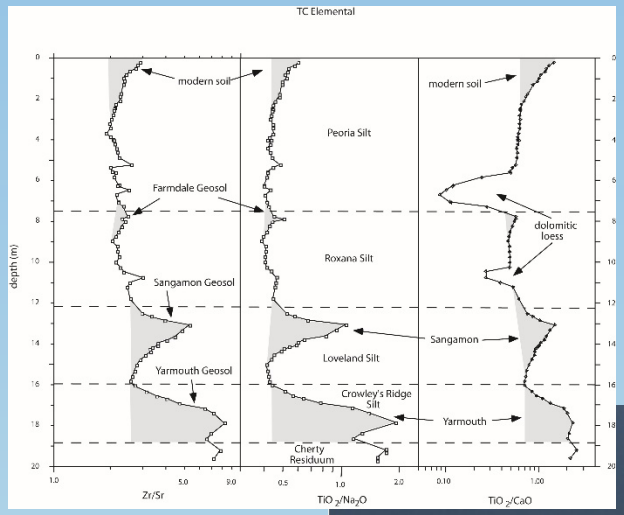


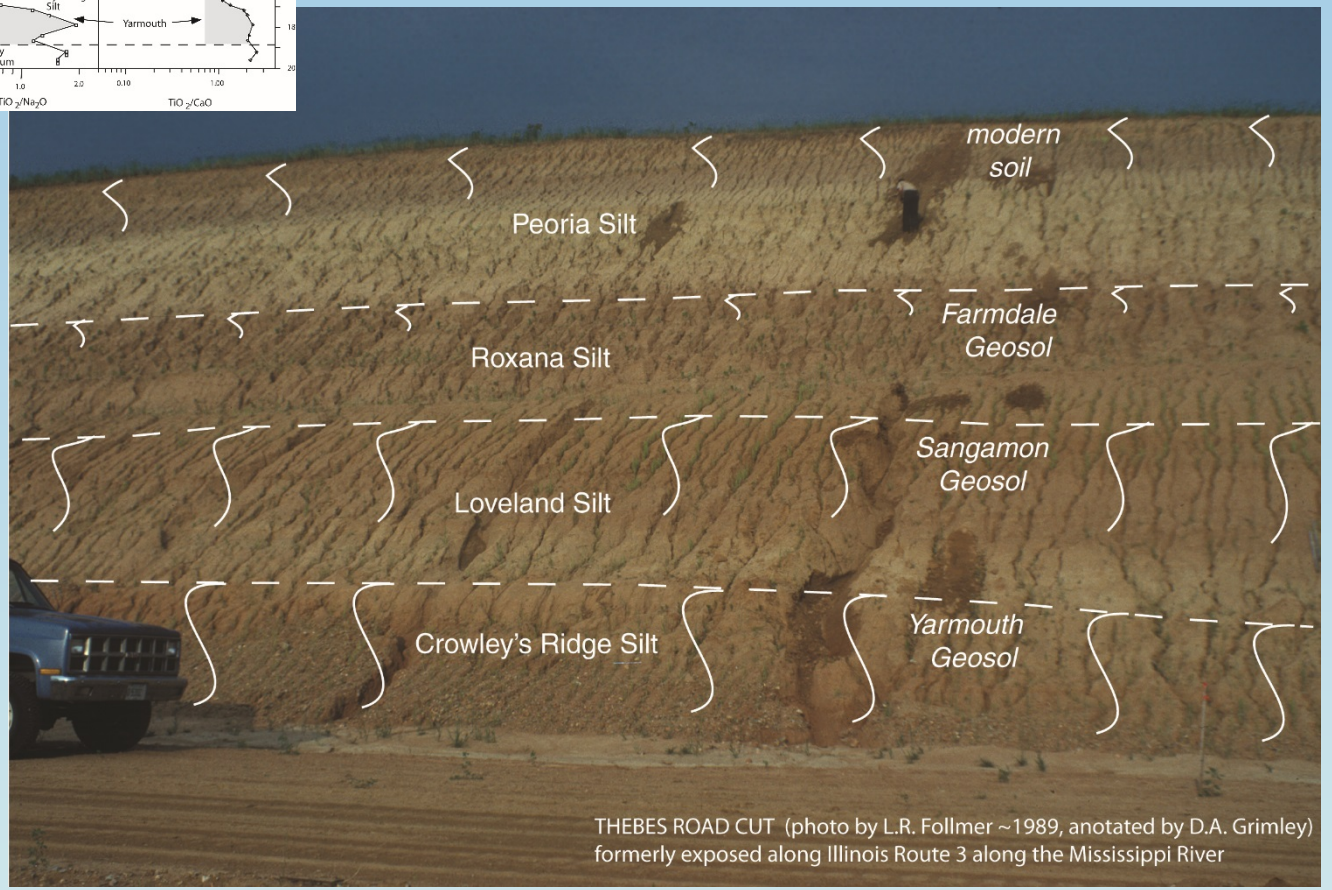
N

Ice-walled glacial meltwater fan ---

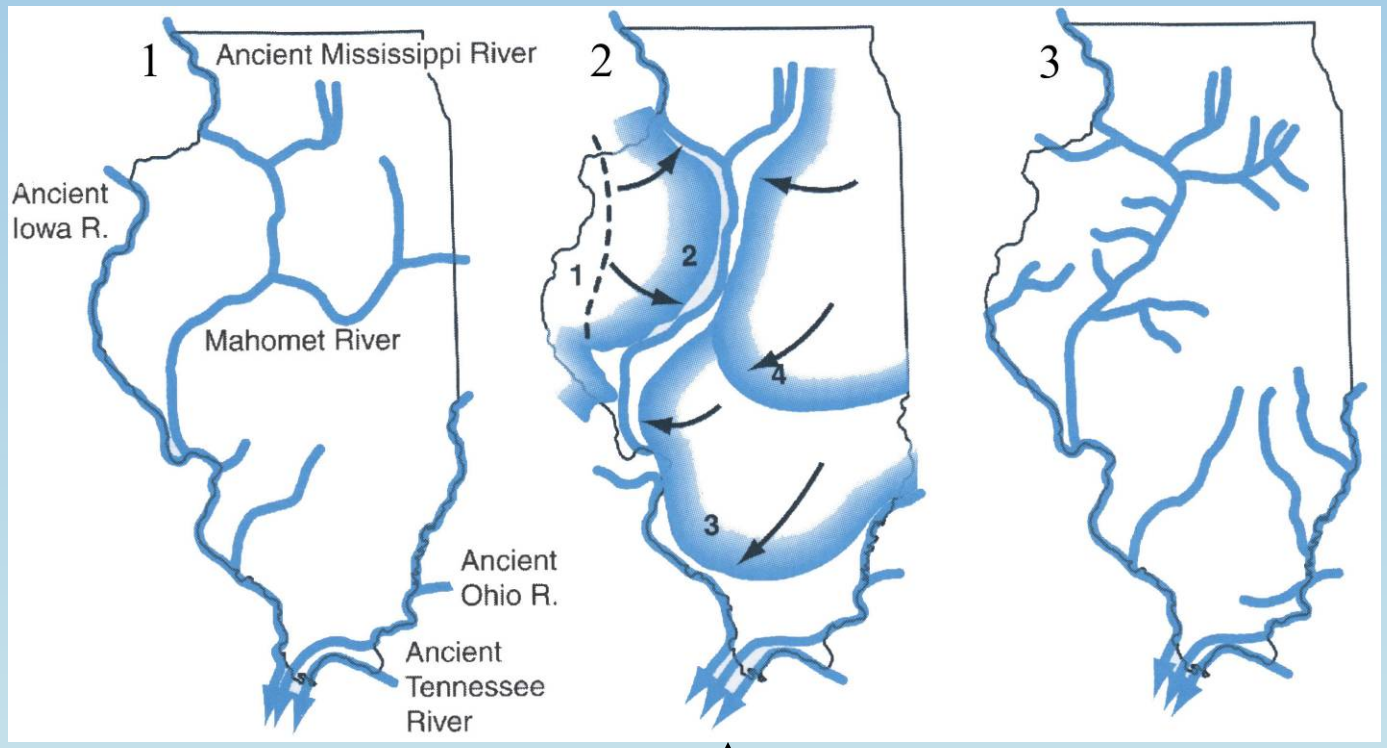
Pittsburg Basin

Yarmouth Geosol (fossil soil) development





pre-Illinois Episode



~ 800,000 to 420,000 years ago (mid-Pleistocene)

pre-Illinoian deposits

Paddock Creek Section, Prairietown 7.5’ Quadrangle, Madison Co., IL

pre-Illinoian till

Banner till ---- Ames Quadrangle (AMS-2), Randolph County

pre-Illinoian deposits

Robbins Core, St. Clair County, IL

Wisconsinan loess

Sangamon Geosol (interglacial soil)

Illinoian till

Petersburg Silt (Illinoian)

Yarmouth Geosol (interglacial soil)

Banner Formation (glacial till)

Harkness Silt (lacustrine and loess)

Canteen Member (preglacial alluvium)

bedrock

PRE-ILLINOIAN