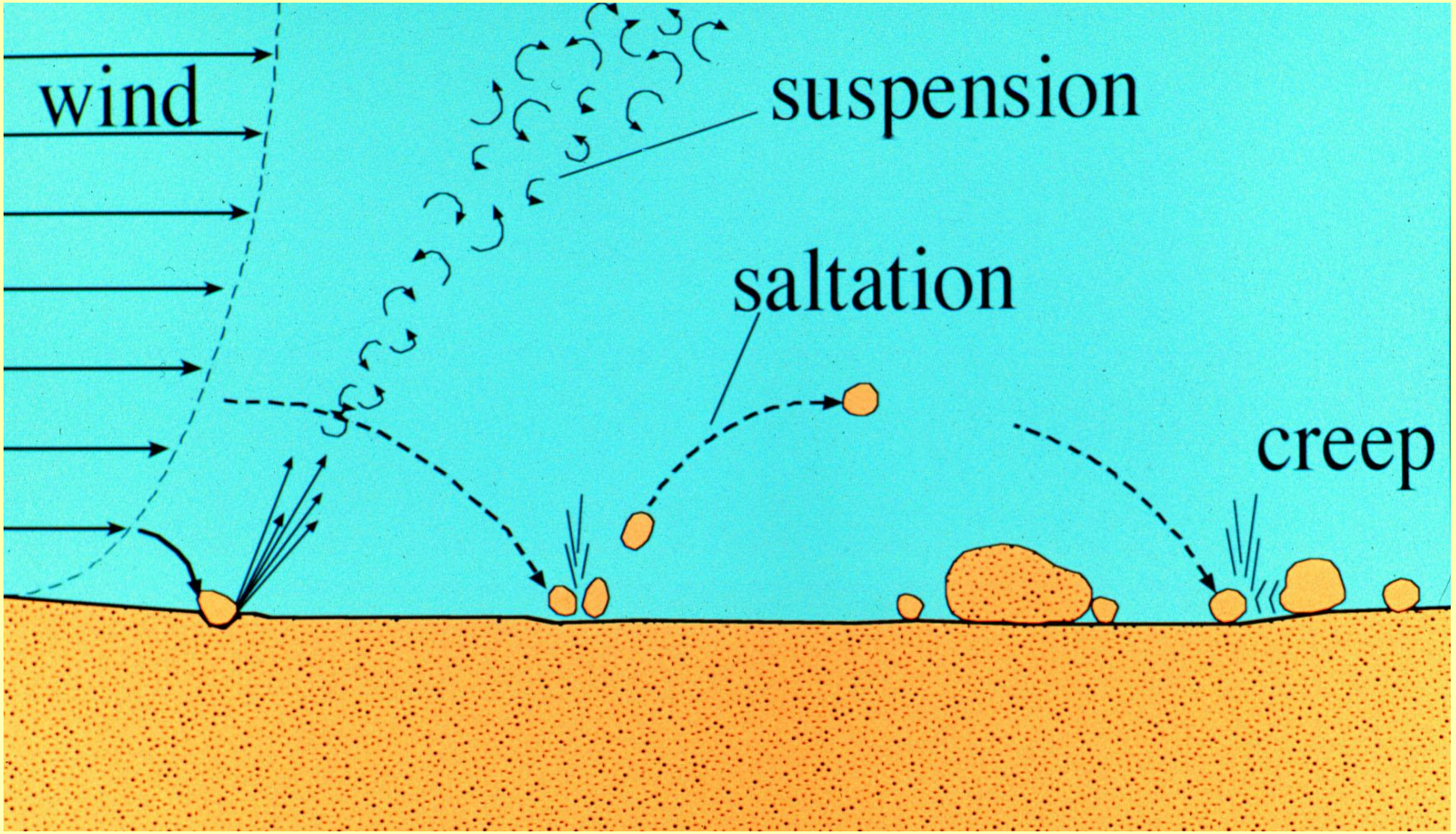
Unmasking Nebraska's "Desert in Disguise"

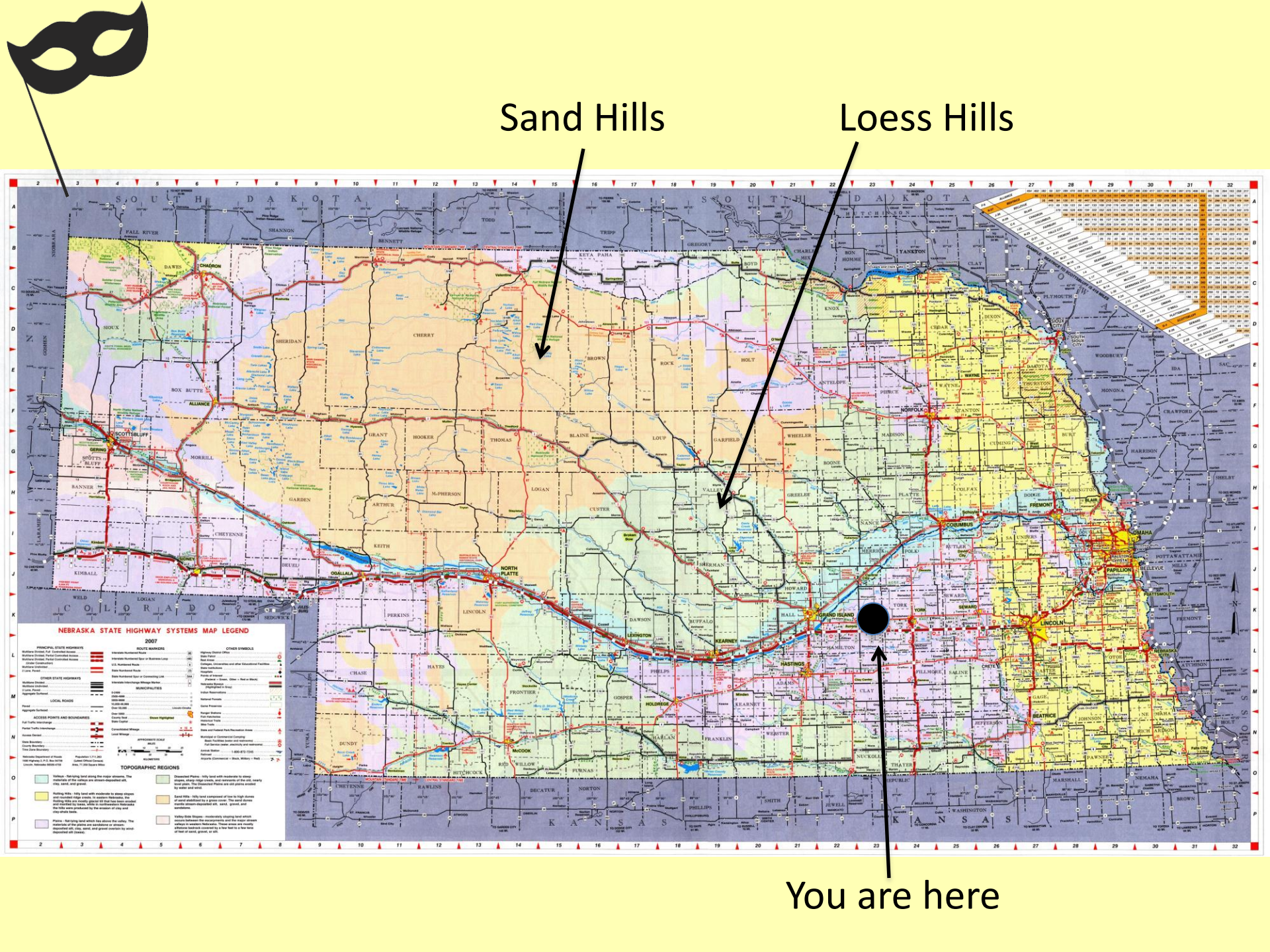
David Loope
Earth & Atmospheric Sciences, UNL

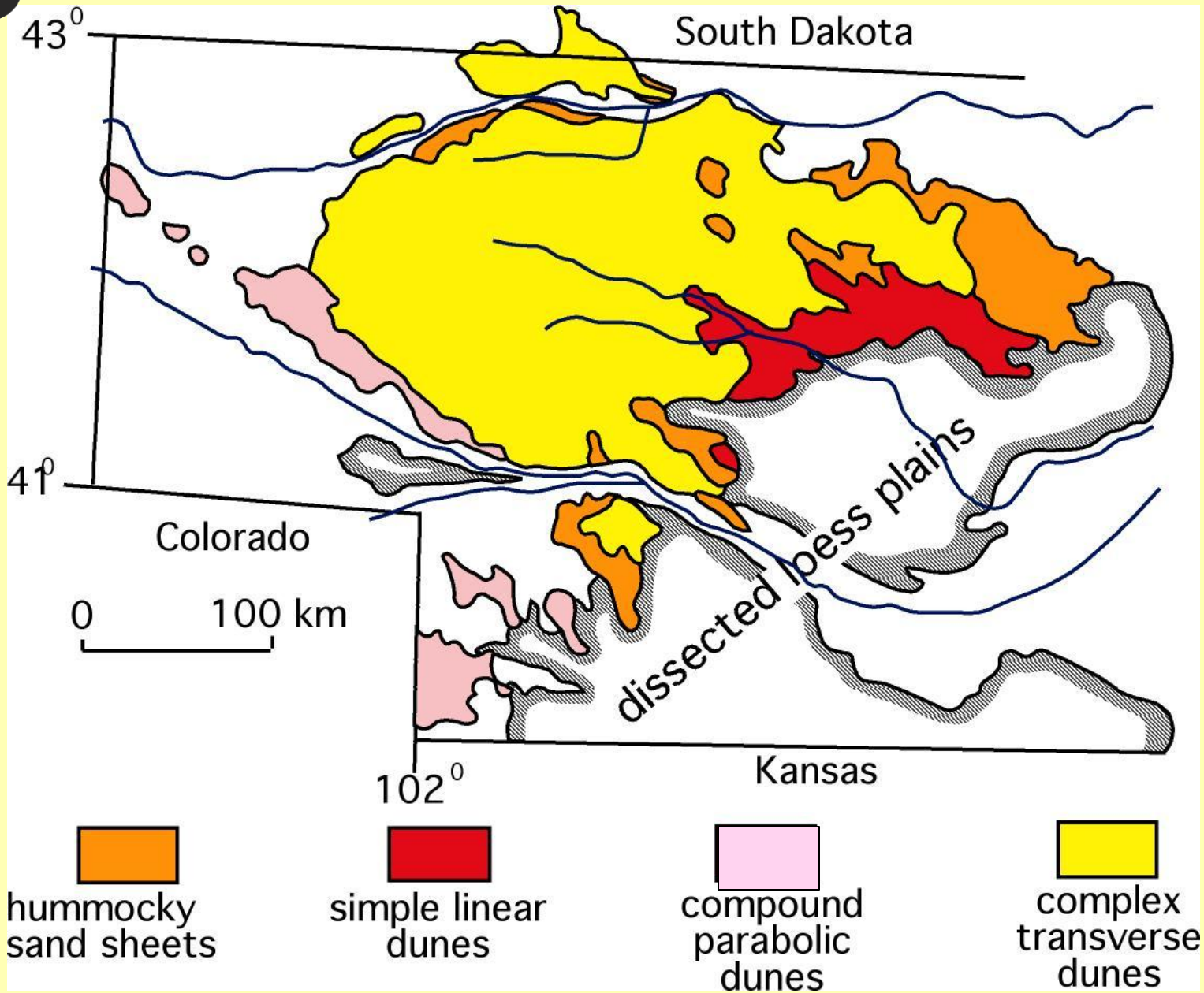
Sletto, B., 1997, Desert in Disguise: Earth 6(1), 42-49



Sand → Saltation → Dunes

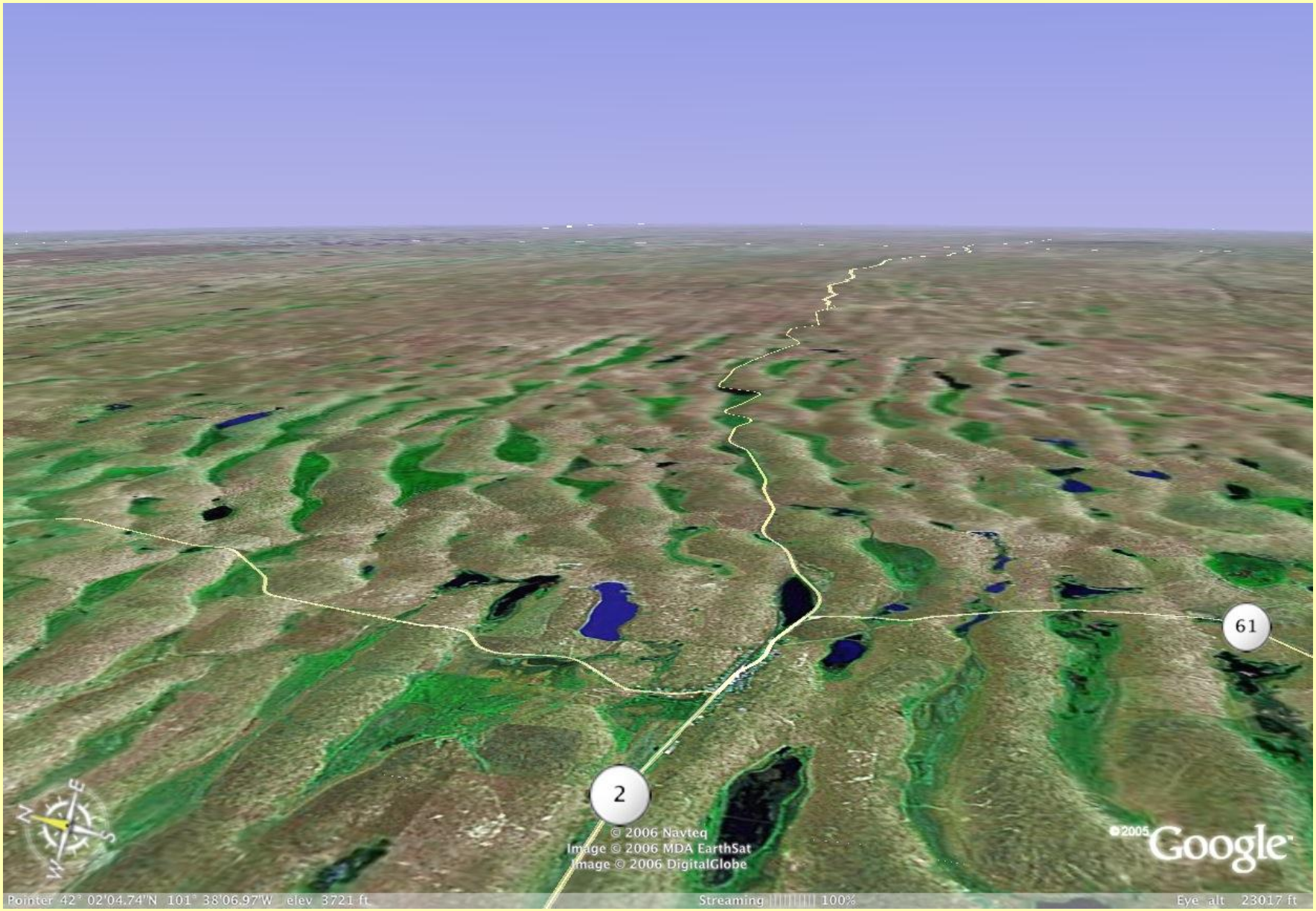
Silt → Suspension → Loess


Sand Hills
Loess Hills
You are here
NEBRASKA STATE HIGHWAY SYSTEMS MAP LEGEND
2007
TOPOGRAPHIC REGIONS
SOUTH DAKOTA
KANSAS
COLORADO
LINCOLN
OMAHA
GRAND ISLAND
NORTH PLATTE
SCOTTSBLUFF
ALLIANCE
HASTINGS
KEARNEY
NORFOLK
FREMONT
COLUMBUS
BEATRICE


43°
South Dakota
41°
Colorado
0 100 km
dissected loess plains
102°
Kansas
hummocky sand sheets
simple linear dunes
compound parabolic dunes
complex transverse dunes

about 2 miles

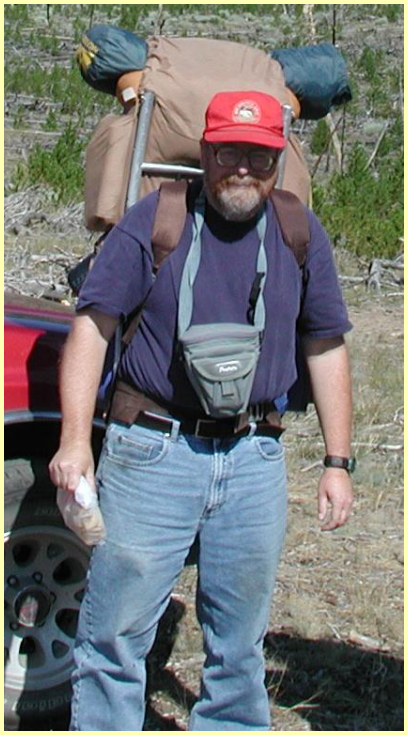
dunes in this image are up to 300 feet high



The south-facing slopes are steeper than the north-facing slopes.

Jim Swinehart, *Dune Messiah*

Joe Mason, *Lord of the Loess*

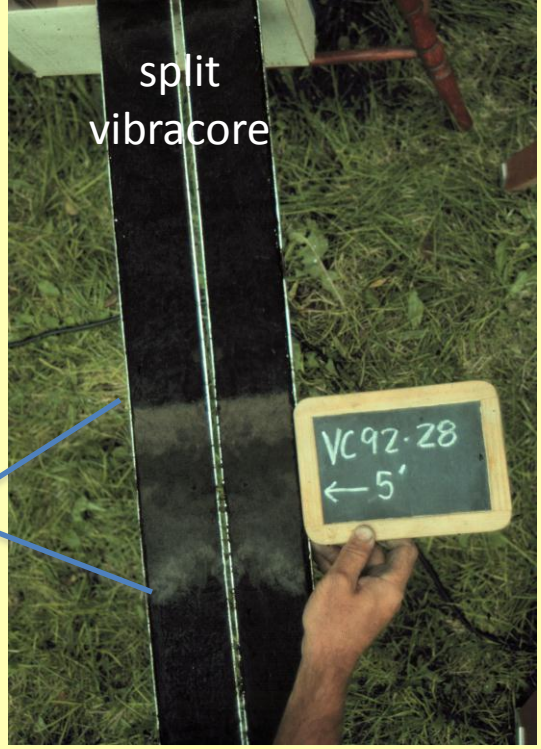


With only radiocarbon dating….

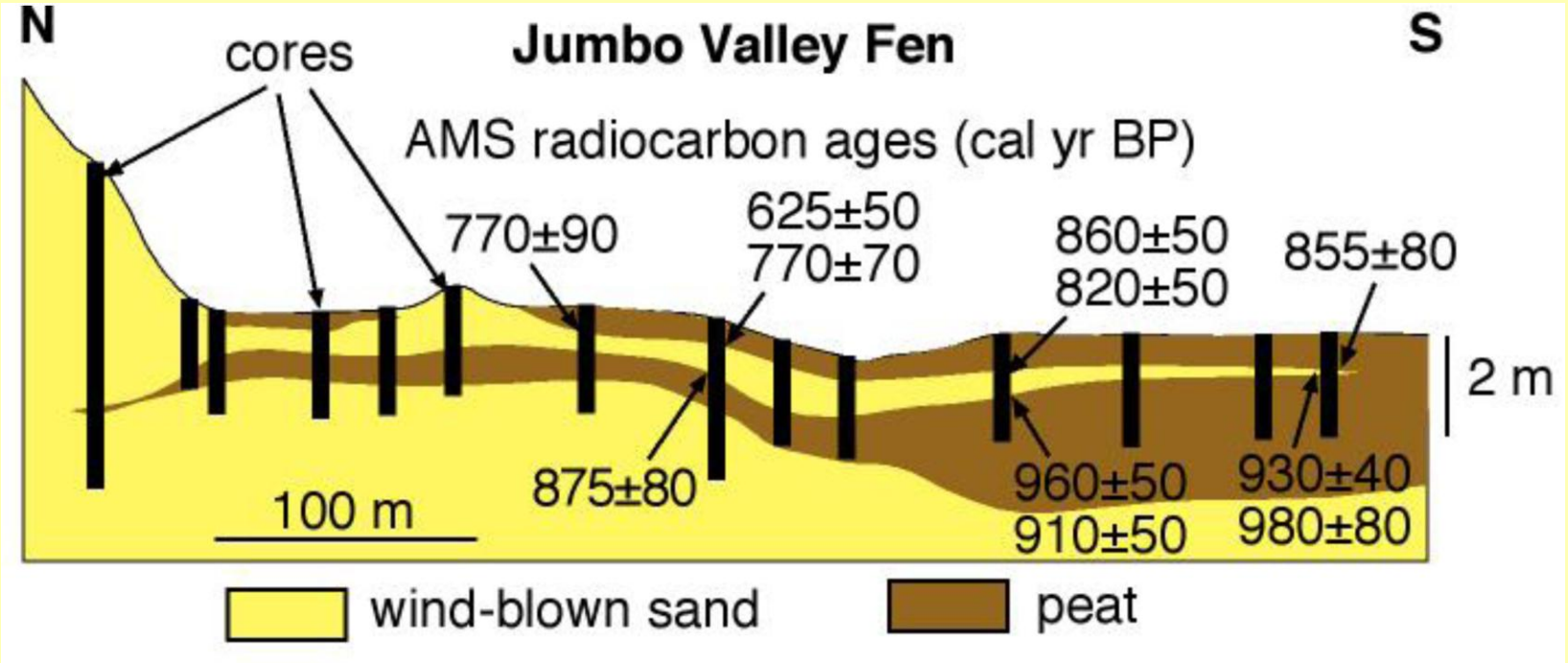
“We were working on mysteries without any clues.”

Bob Seger, *Night Moves*

Vibracoring in the Sand Hills



Wind-blown sand sheet between thick peat layers



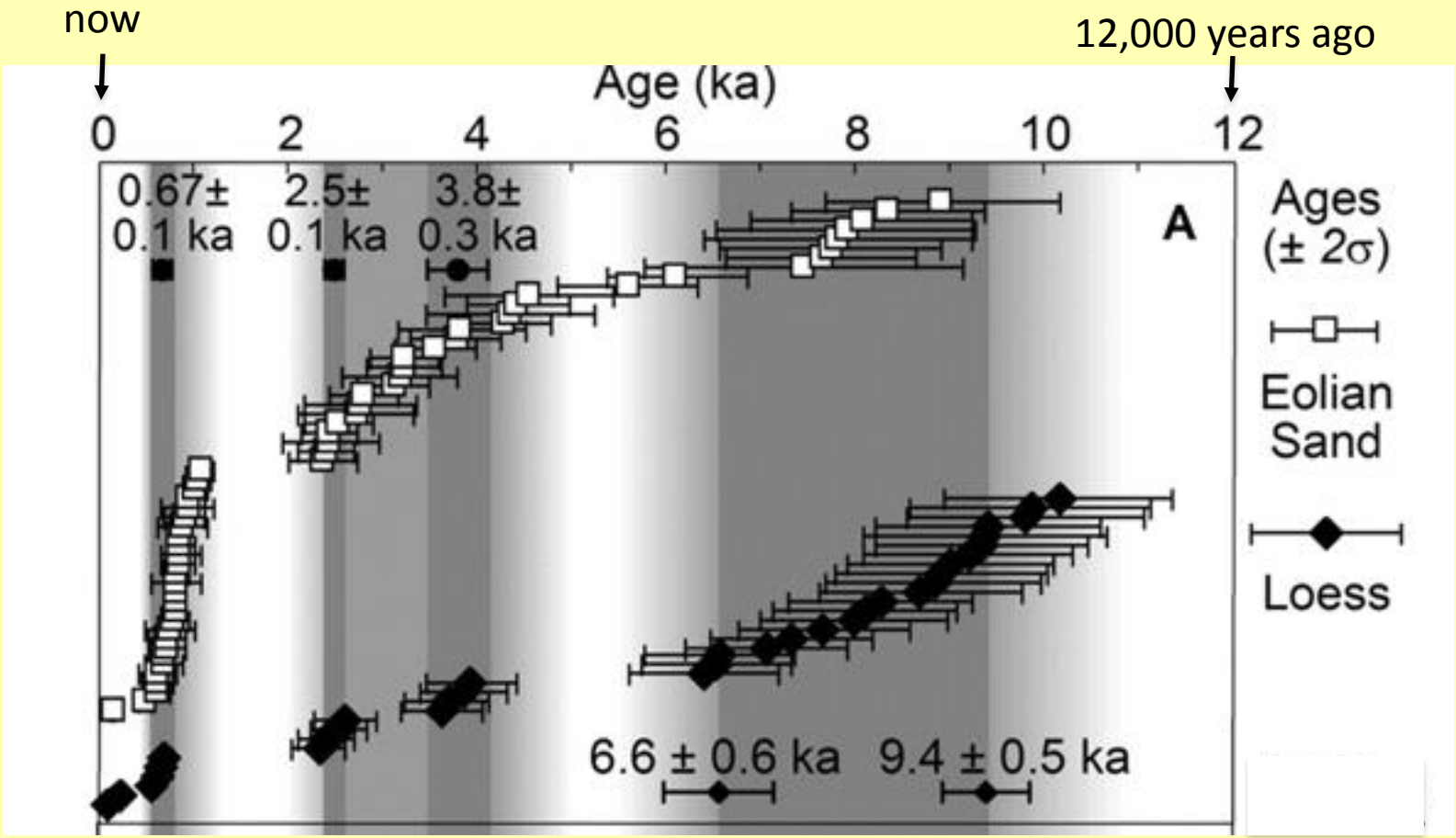
enter
Ron Goble, *OSL guru*

Optically **S**timulated **L**uminescence

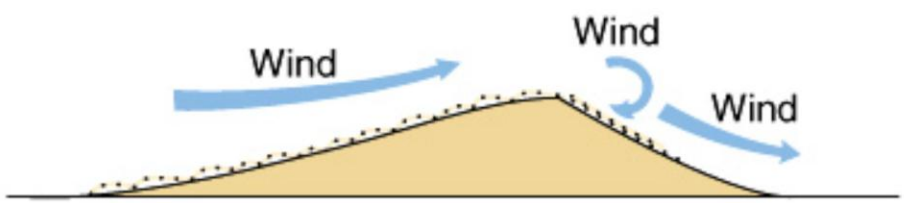
enter
Ron Goble, *OSL guru*

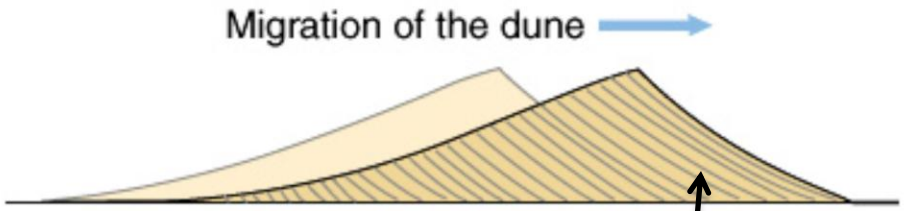
Optically **S**timulated **L**uminescence

OSL dates on Sand Hills sand and down-wind silt

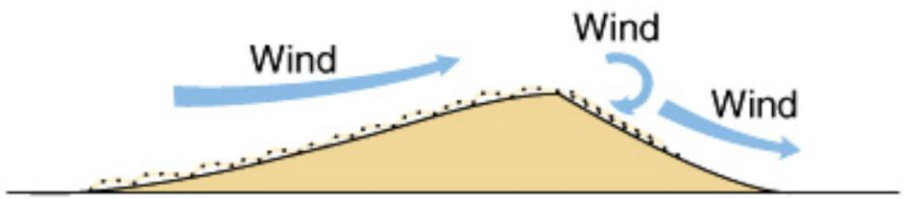


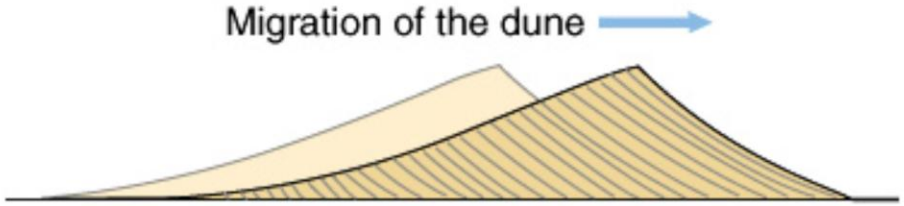
from Miao et al., 2007,
Geology, v. 35, p. 119-122





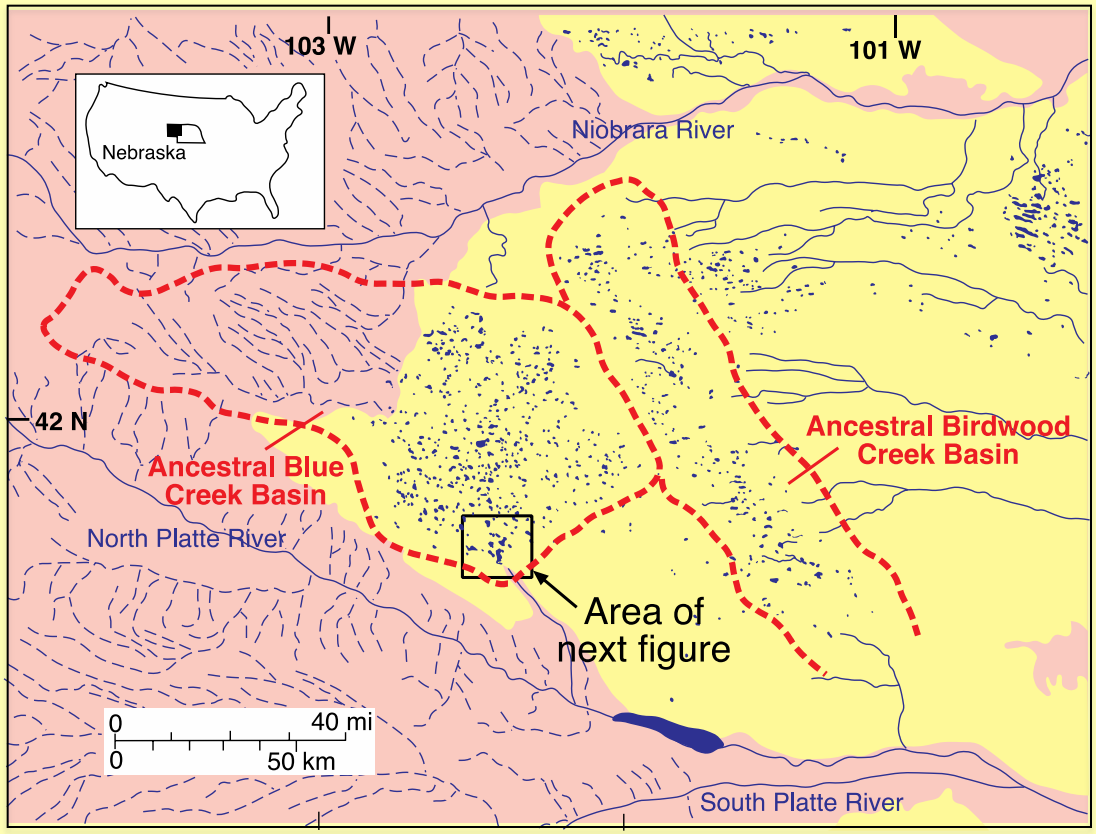
Dunes on the Great Plains roll along like a tank tread:
Deposition at the front end, erosion at the back end.

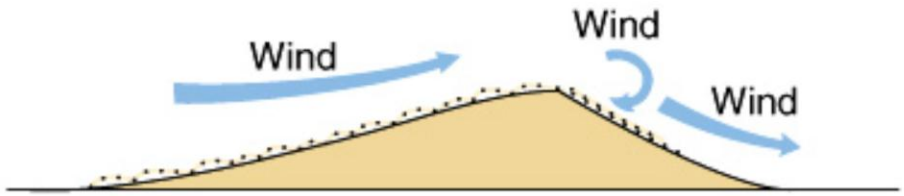


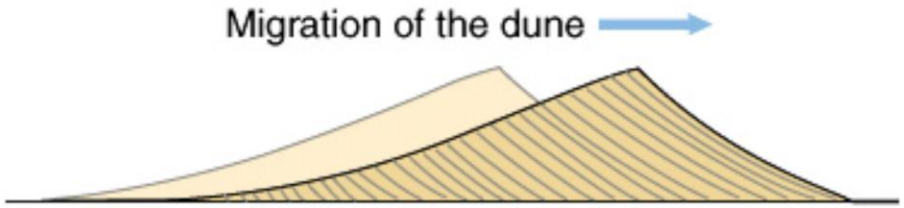


Dunes on the Great Plains roll along like a tank tread:
Deposition at the front end, erosion at the back end.

For the most part, the dunes in the Sand Hills rest on river-deposited sand and gravel.

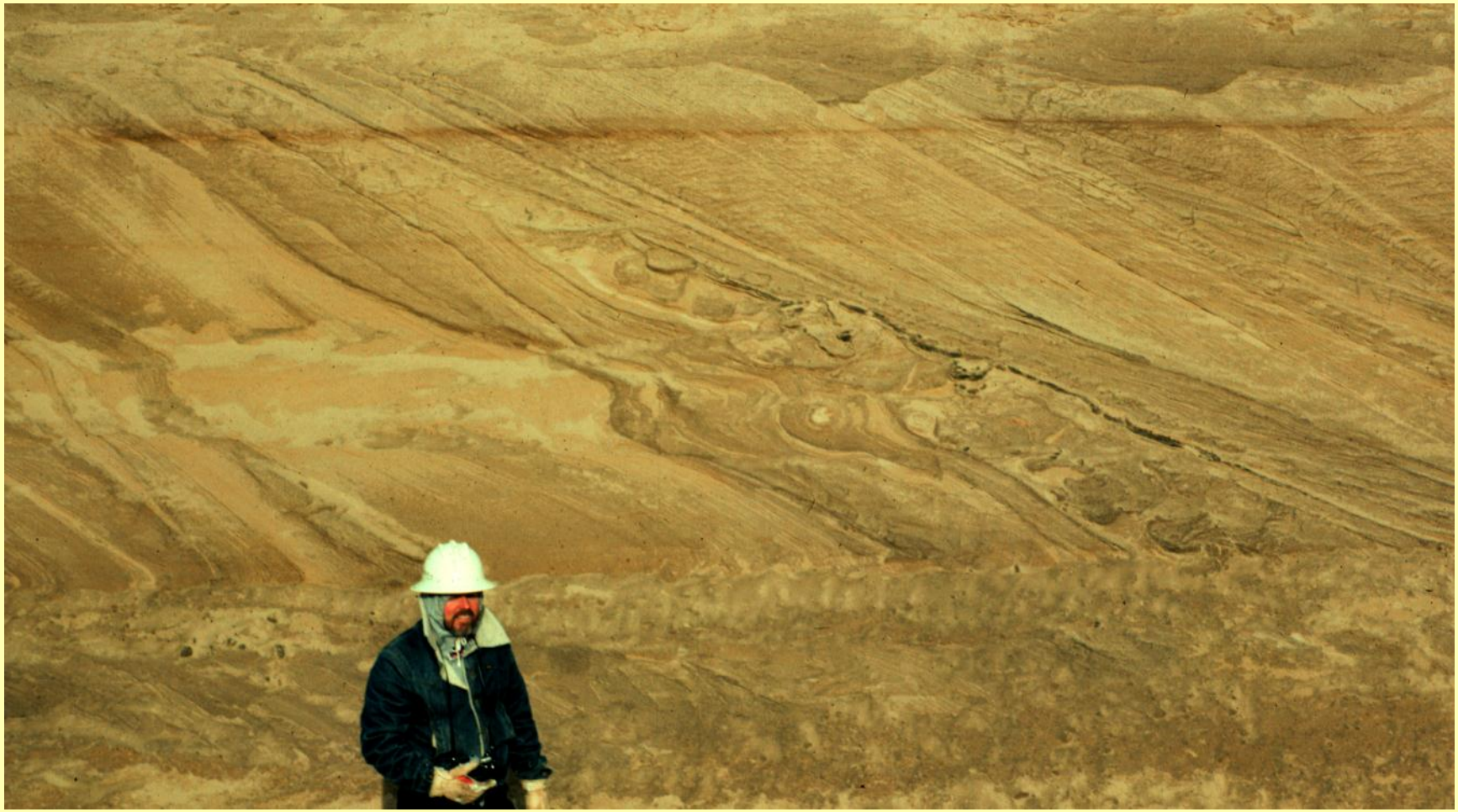






Navajo Sandstone, southern Utah

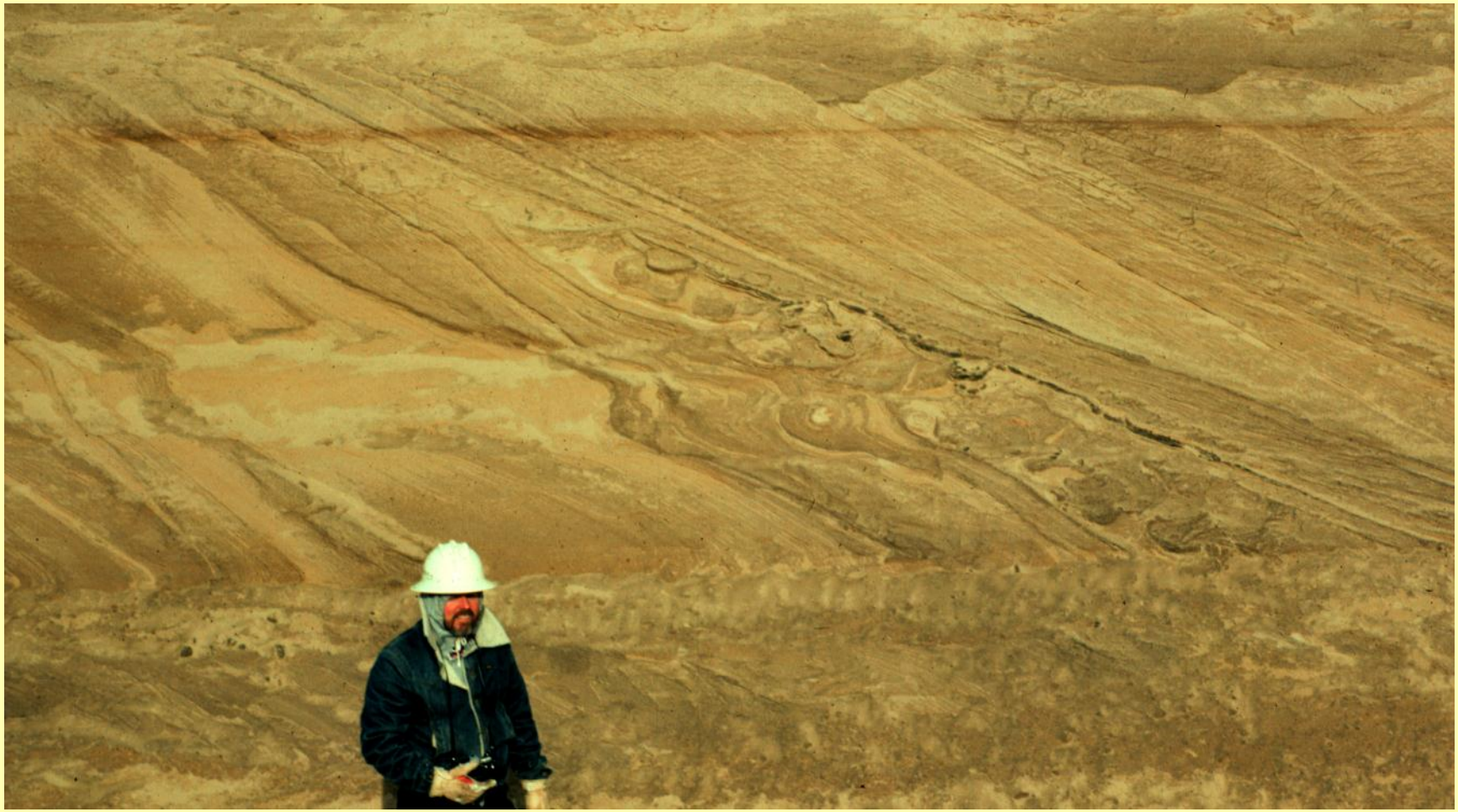
Back to Nebraska:
What did the Sand Hills look like when the dunes were active?



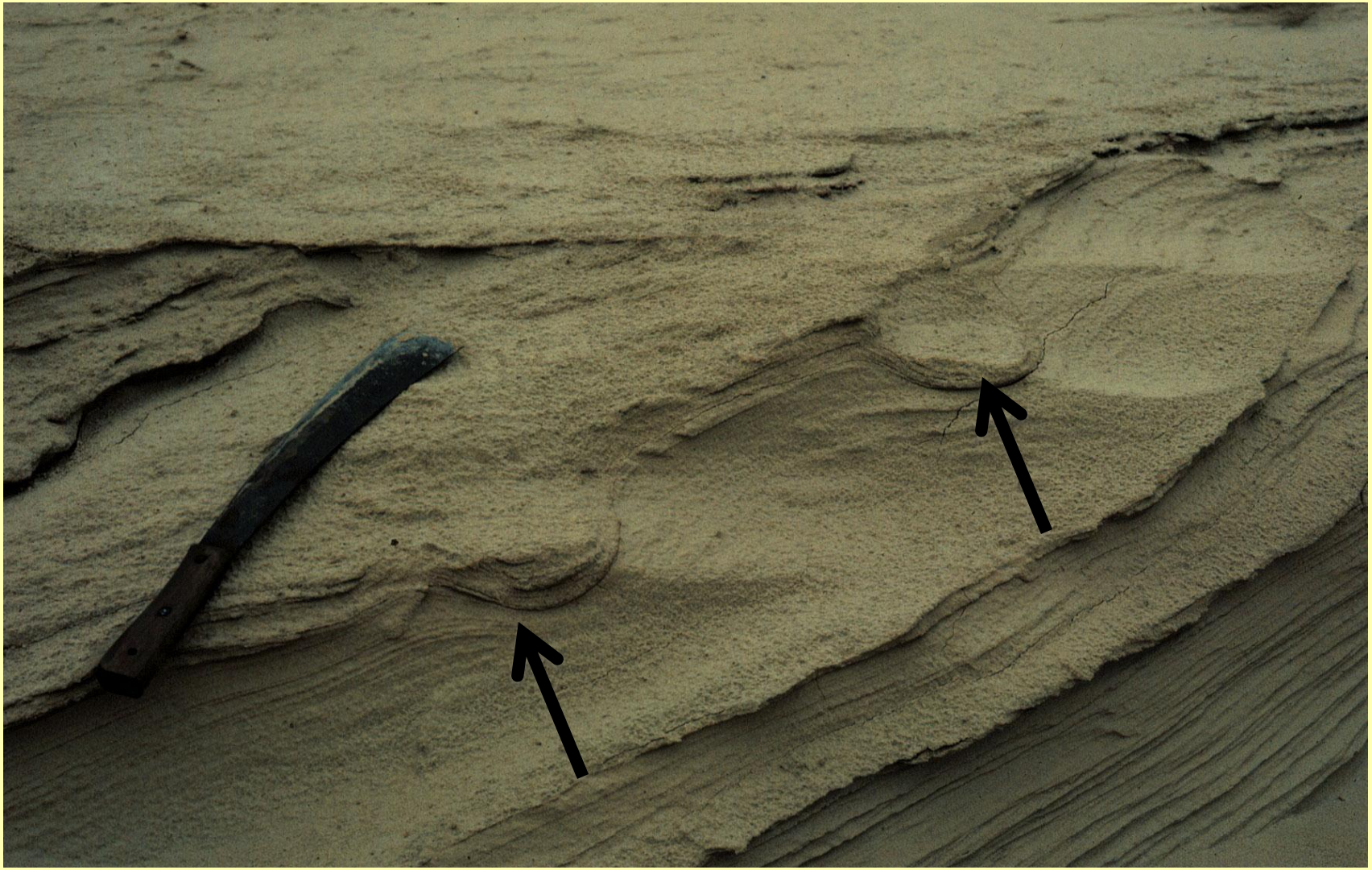
Crossbedding exposed during construction of Calamus Dam near Burwell. Frozen paleontologist (Bob Hunt) for scale.

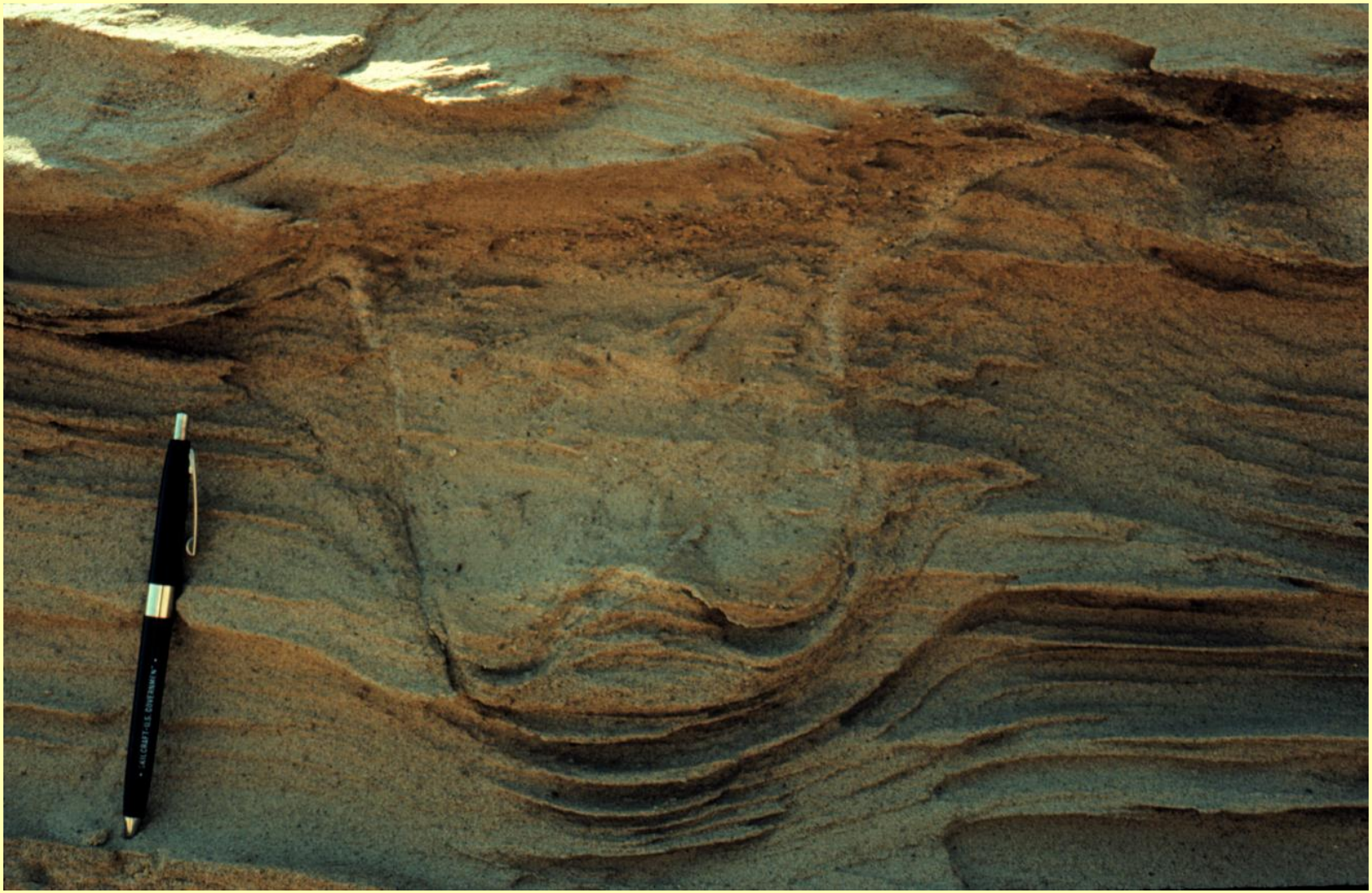
Navajo Ss, southern Utah

Interpretation: Dune sand was changed to quicksand by earthquake.



But these crossbedded dune sands have never been water-saturated–
Need a new hypothesis!



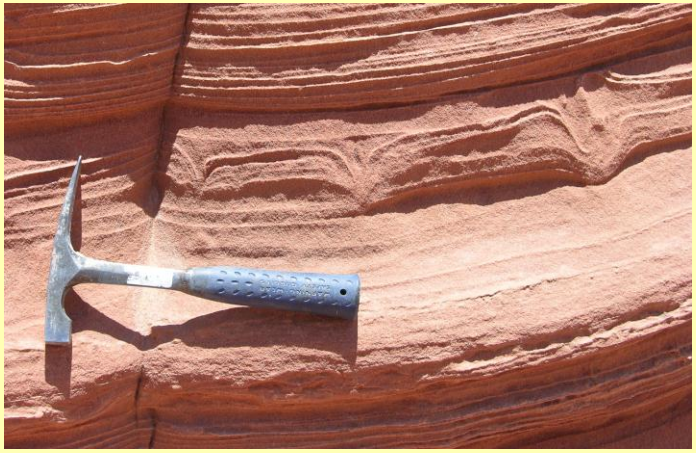


Bison track in vertical cross-section.

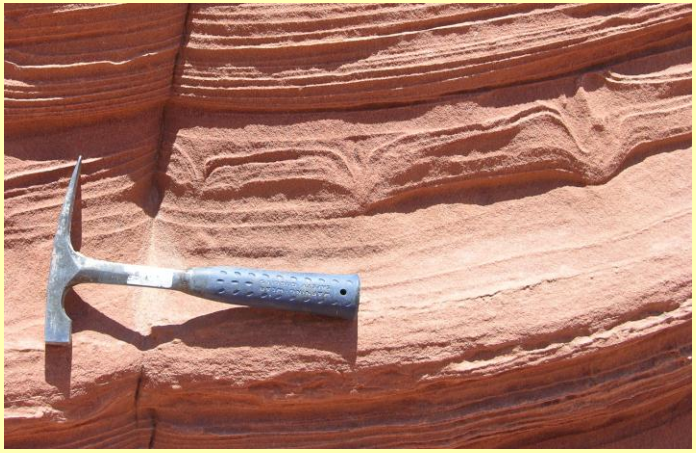
Bison tracks in plan view, central Sand Hills

What did the Sand Hills look like when the dunes were active?

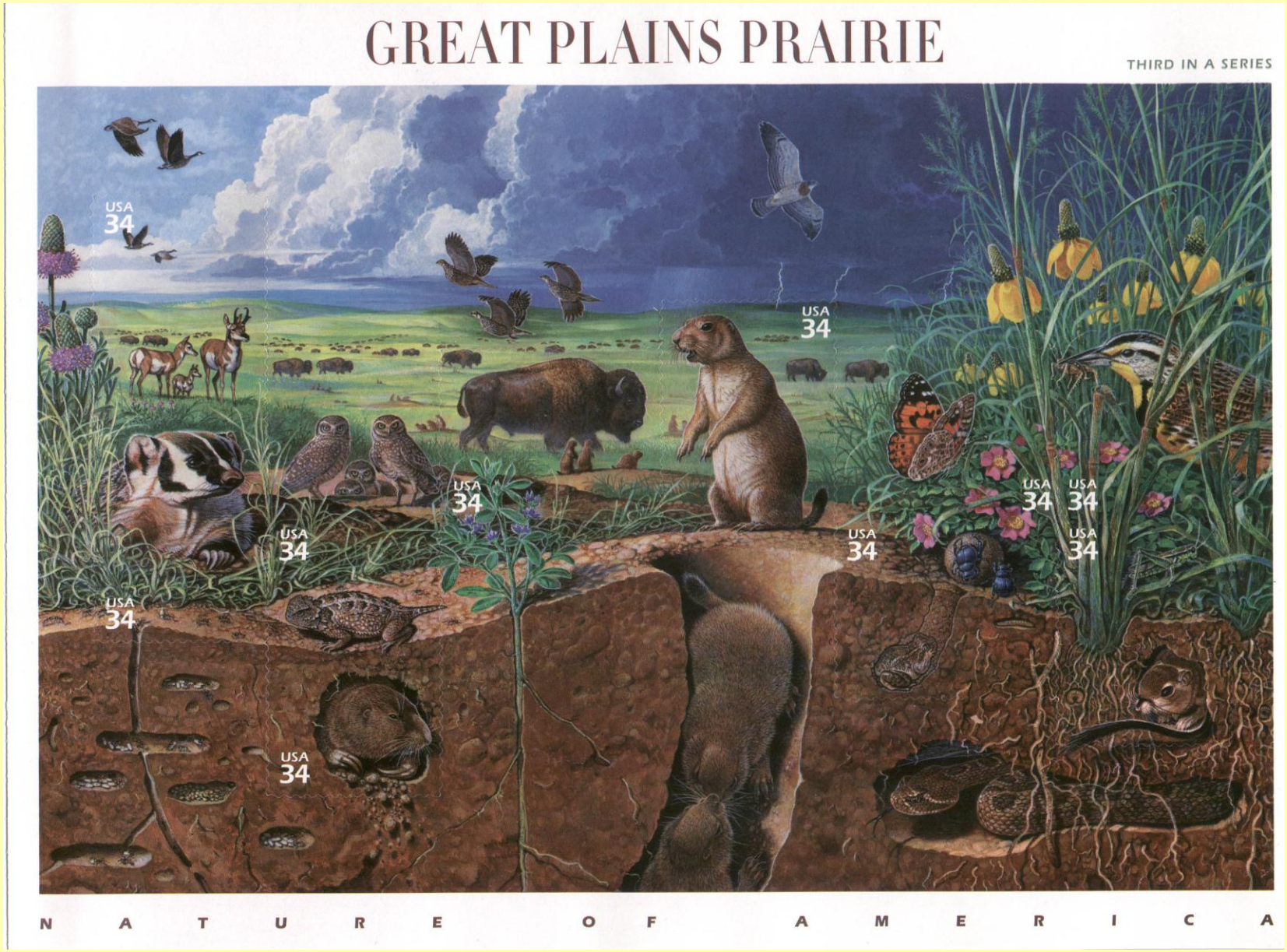
Killpecker Dunes, north of Rock Springs, WY.



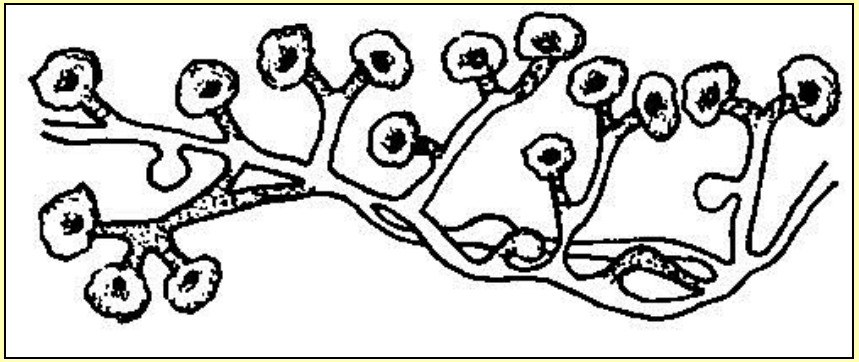
Jurassic dinosaur tracks in cross-section, southern Utah



How did the rest of the prairie ecosystem fare as dunes became active?



Gopher diggings, Nebraska Sand Hills

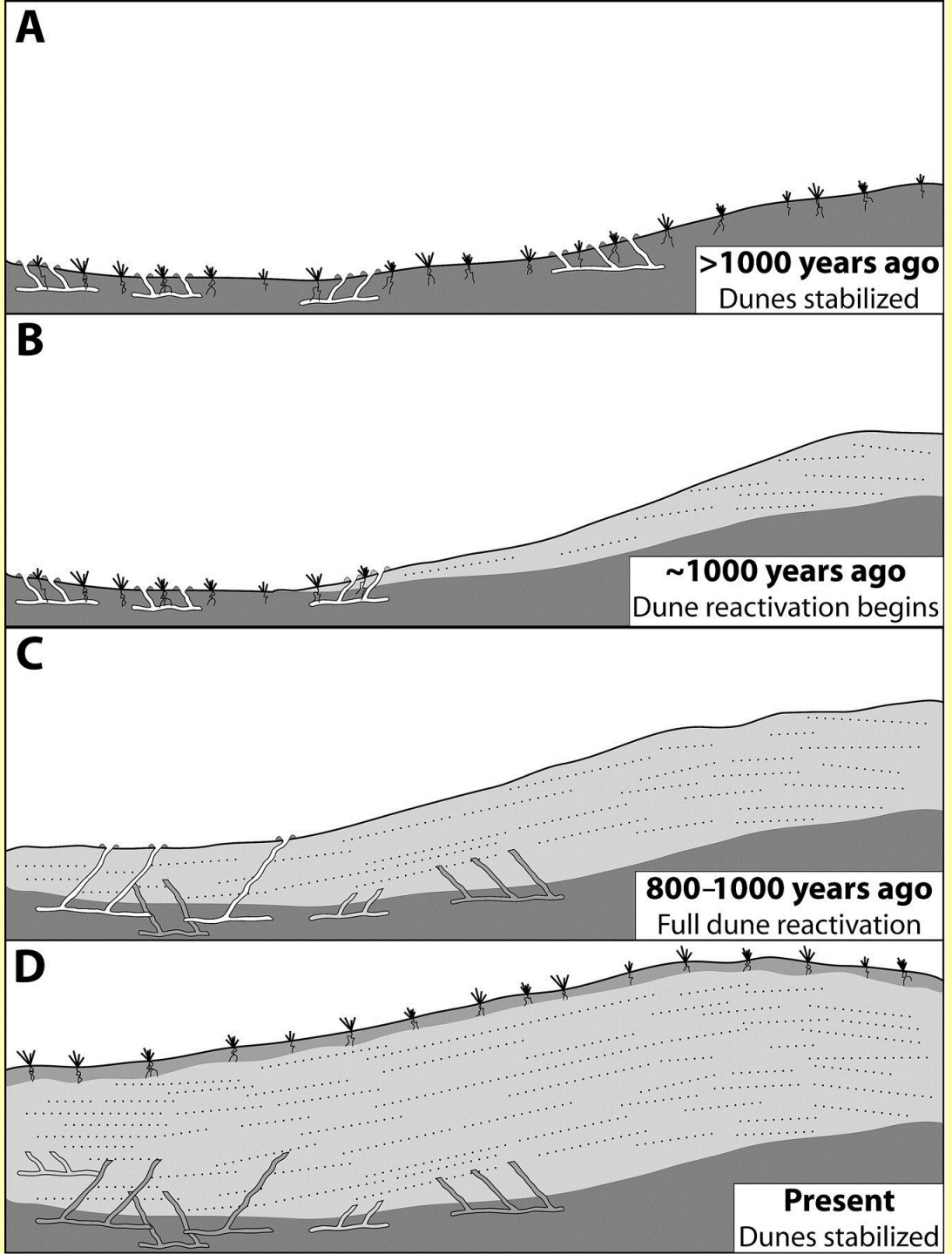



modern soil
800-year-old dune sand
buried soil

Gopher burrows at contact between paleosol (gray) and 800-year-old dune sand.

Becky Schmeisser
Ph.D. UNL, 2009

As active dunes spread over the landscape, gopher populations crashed.



Blast deposits and ash are about 1.5 feet deep at this site.

Snowpack

Original soil

Analogy

Mount Saint Helens, WA, May 18, 1980

Blast deposits and ash are about 1.5 feet deep at this site.

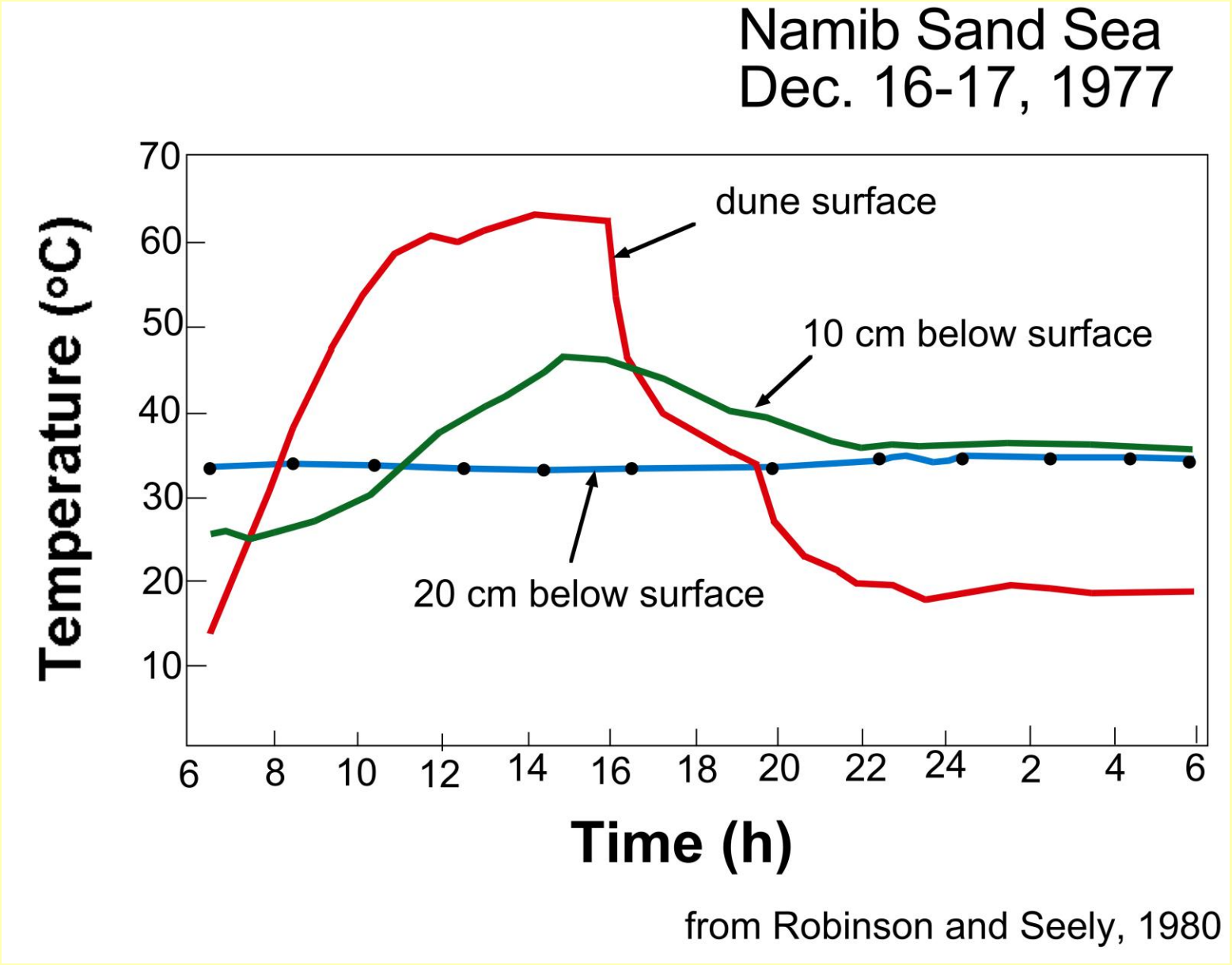
Snowpack

To be back-filled

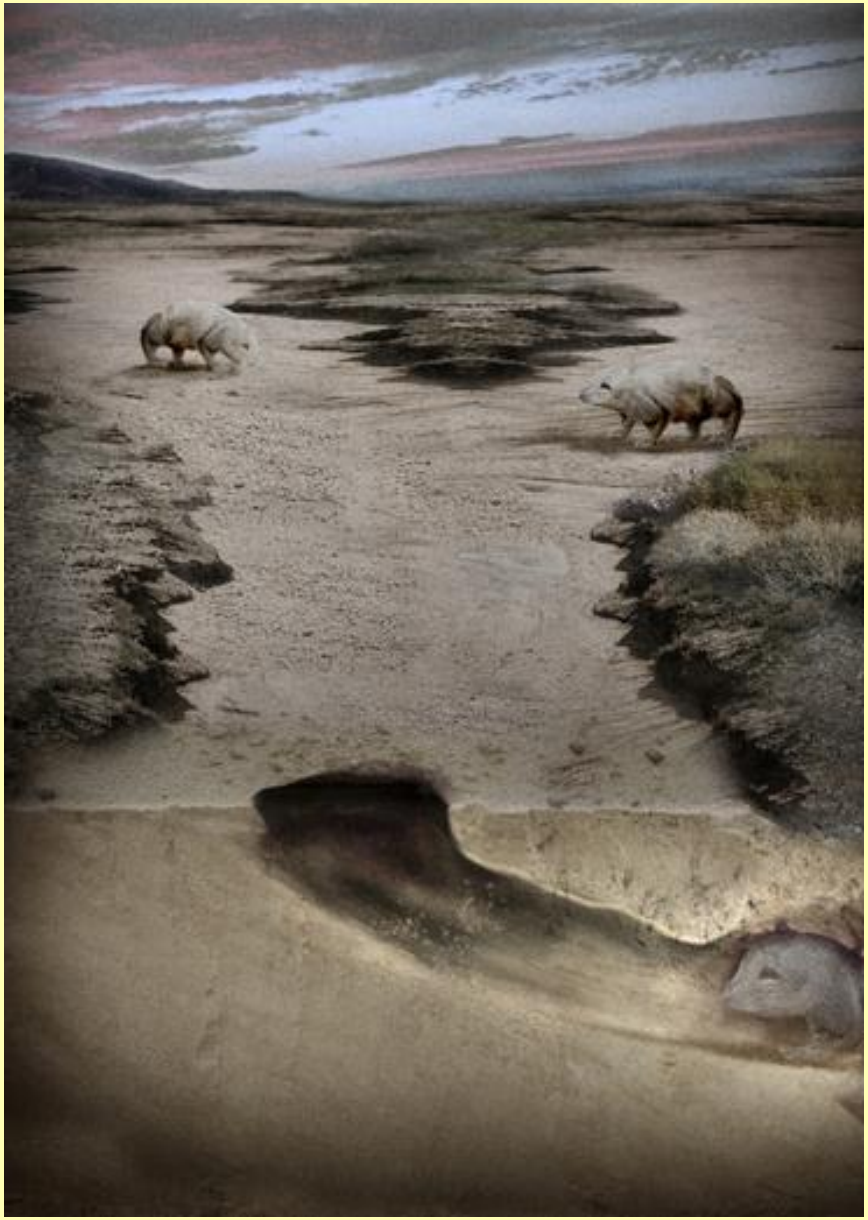
Original soil

Mount Saint Helens,
May 18, 1980

Why burrow in desert sand?

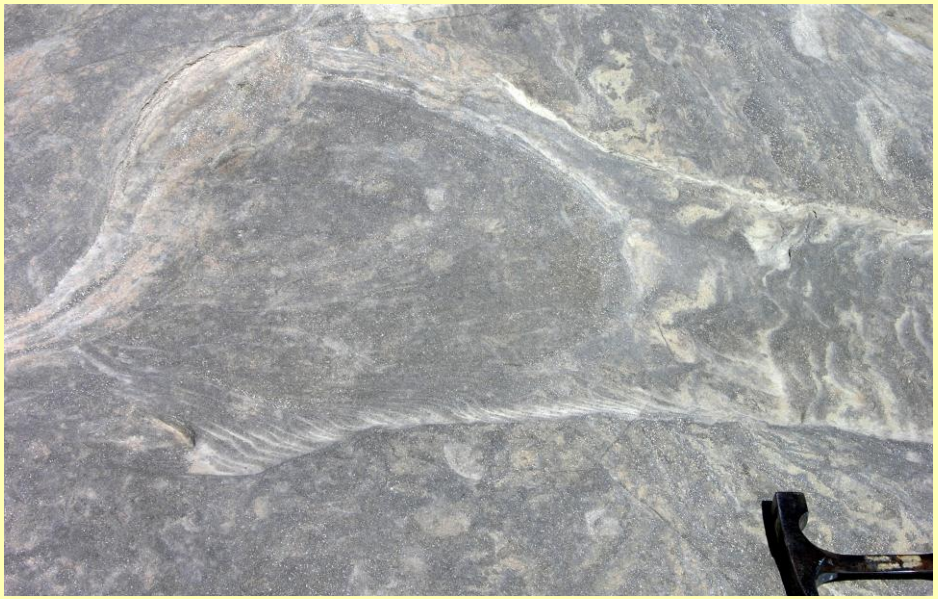


Large tetrapod burrows from the Middle Triassic of Argentina: a behavioural adaptation to seasonal semi-arid climate?



Lethaia
pages no-no, 22 OCT 2012 DOI: 10.1111/j.1502-3931.2012.00329.x
http://onlinelibrary.wiley.com/doi/10.1111/j.1502-3931.2012.00329.x/full#f9

Back to Utah's Jurassic rocks (briefly)



Jurassic burrows dug by a badger-sized, dune-dwelling reptile

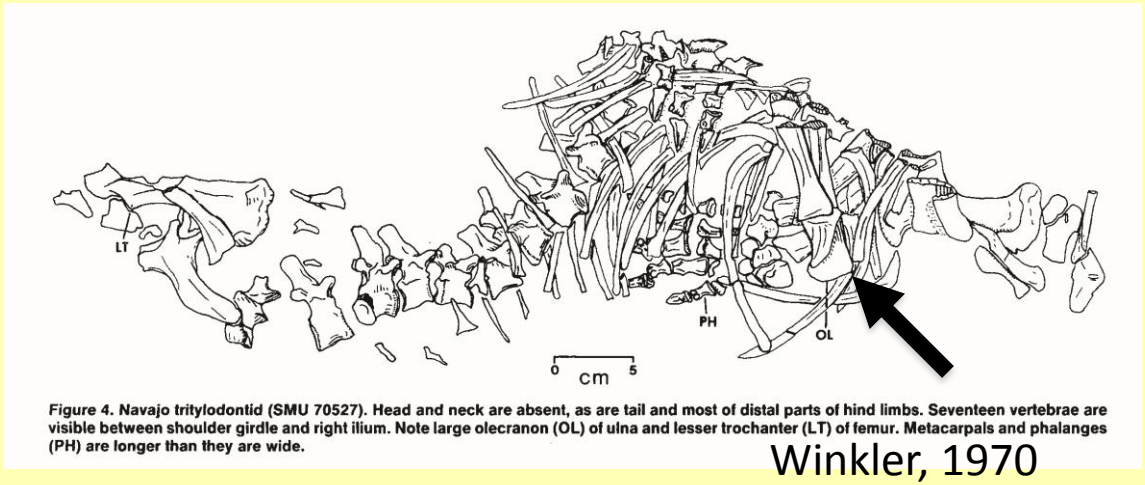
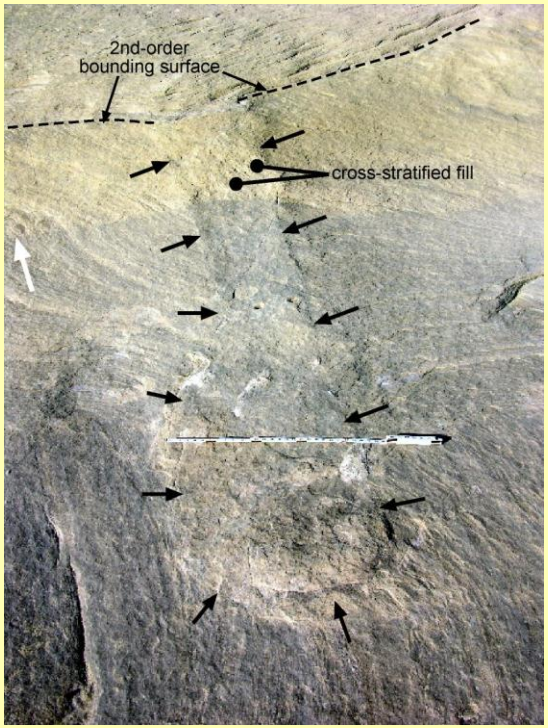


Figure 4. Navajo tritylodontid (SMU 70527). Head and neck are absent, as are tail and most of distal parts of hind limbs. Seventeen vertebrae are visible between shoulder girdle and right ilium. Note large olecranon (OL) of ulna and lesser trochanter (LT) of femur. Metacarpals and phalanges (PH) are longer than they are wide.

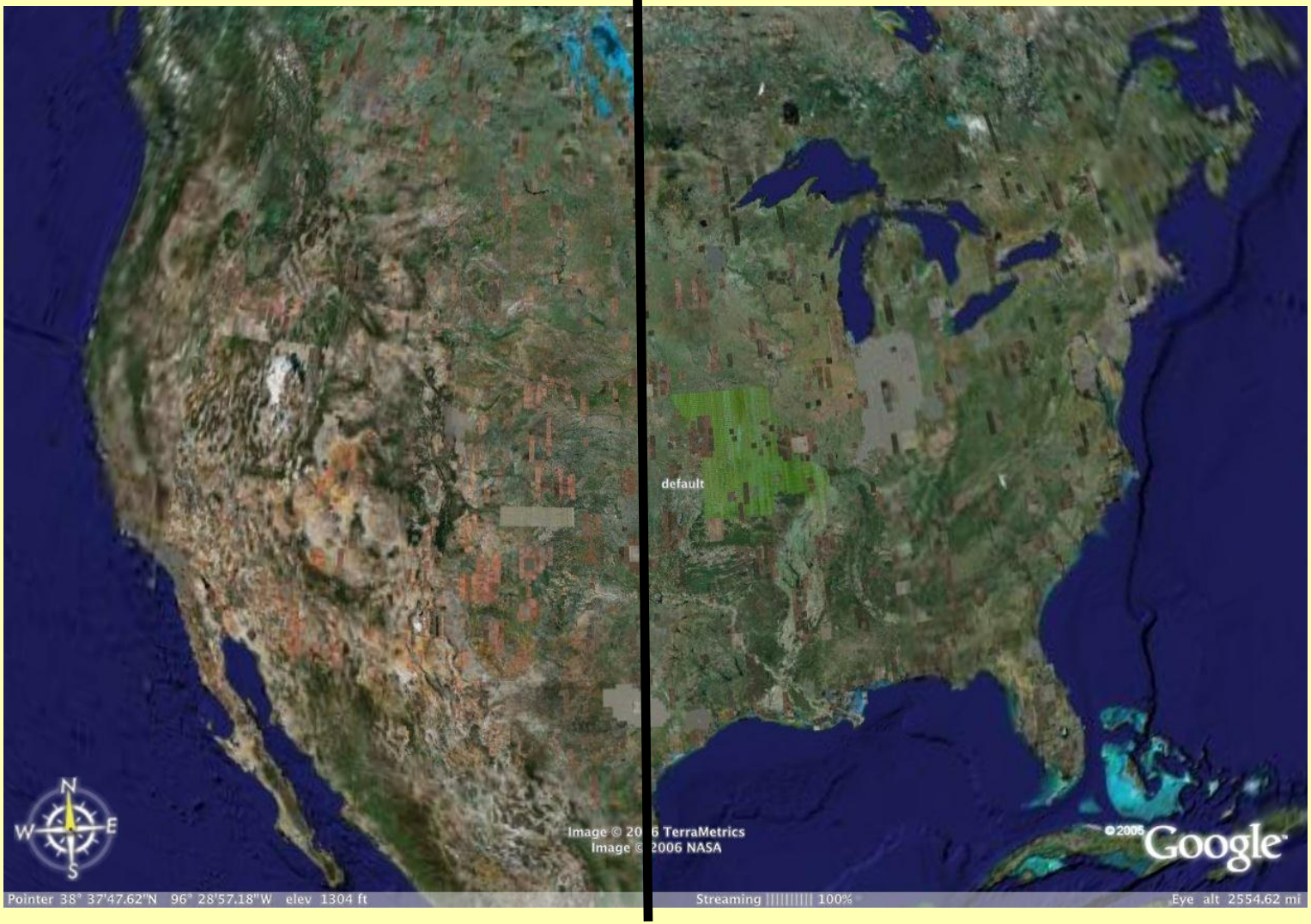
Winkler, 1970



Nebraska is a long way from a source of moisture, but…..

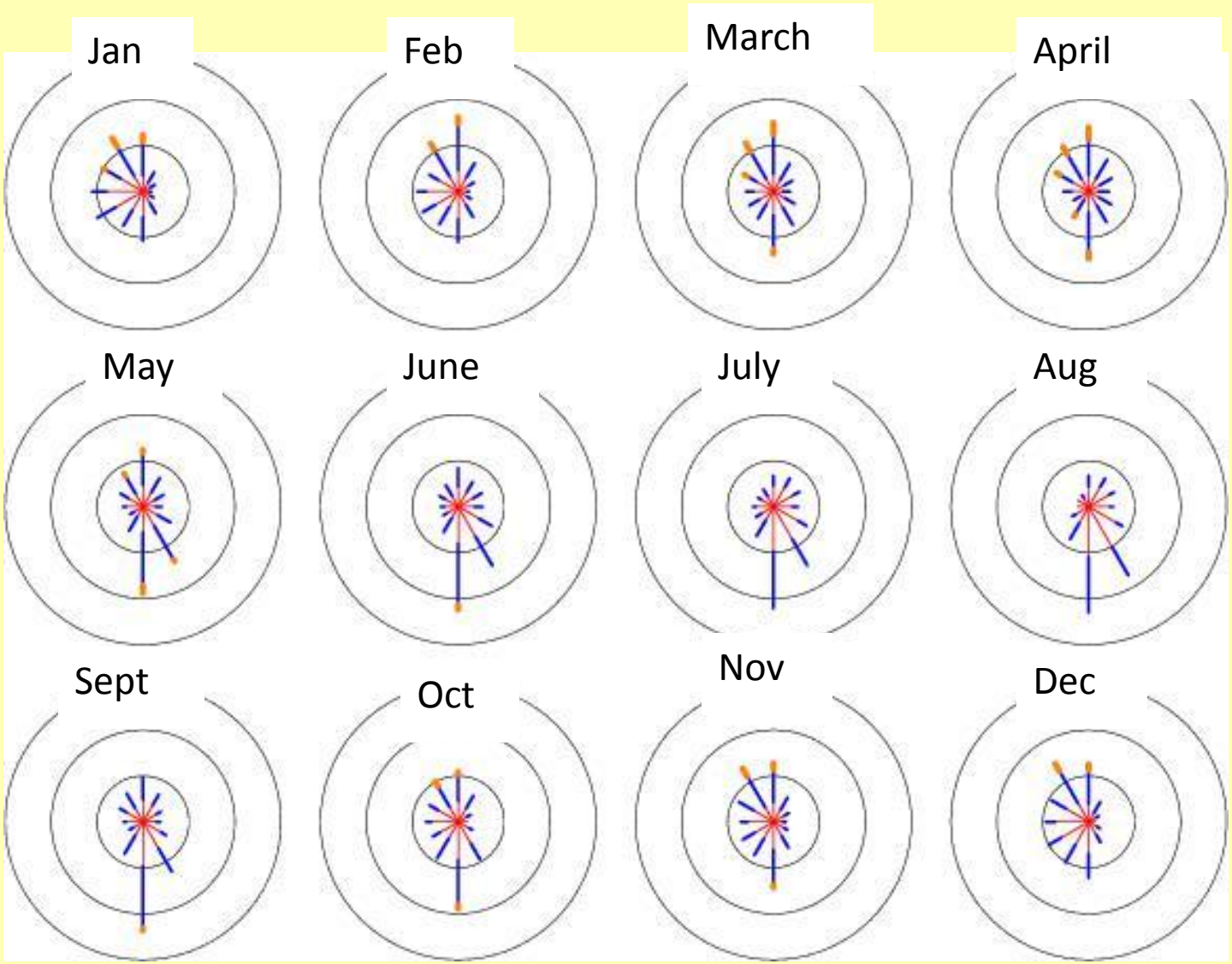
…..circulation around the Bermuda High brings moist air to Nebraska during the growing season.

98th meridian

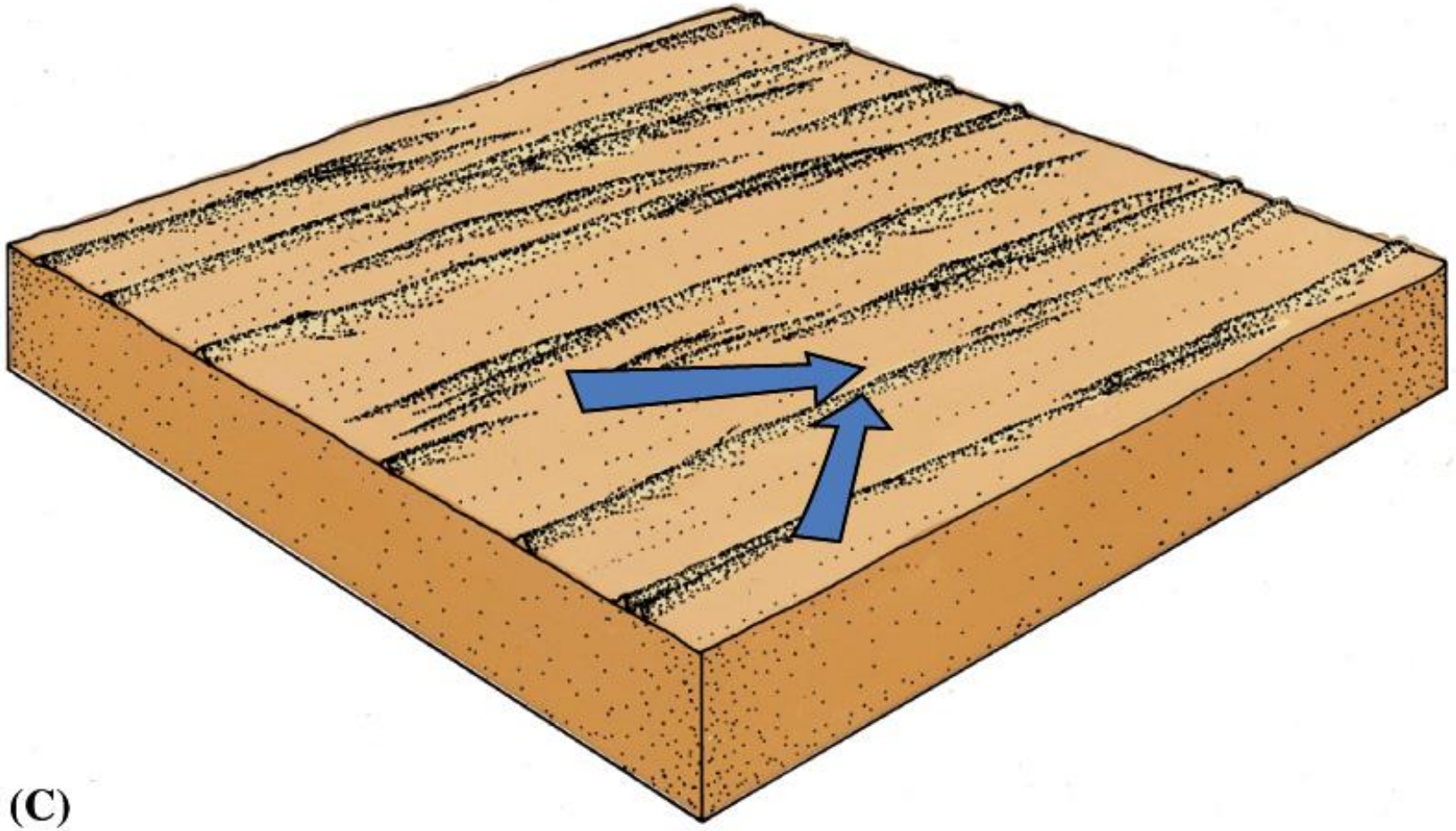


Nearly all of the precipitation in the Sand Hills comes from Gulf of Mexico; winds from south bring the moisture in May-July.

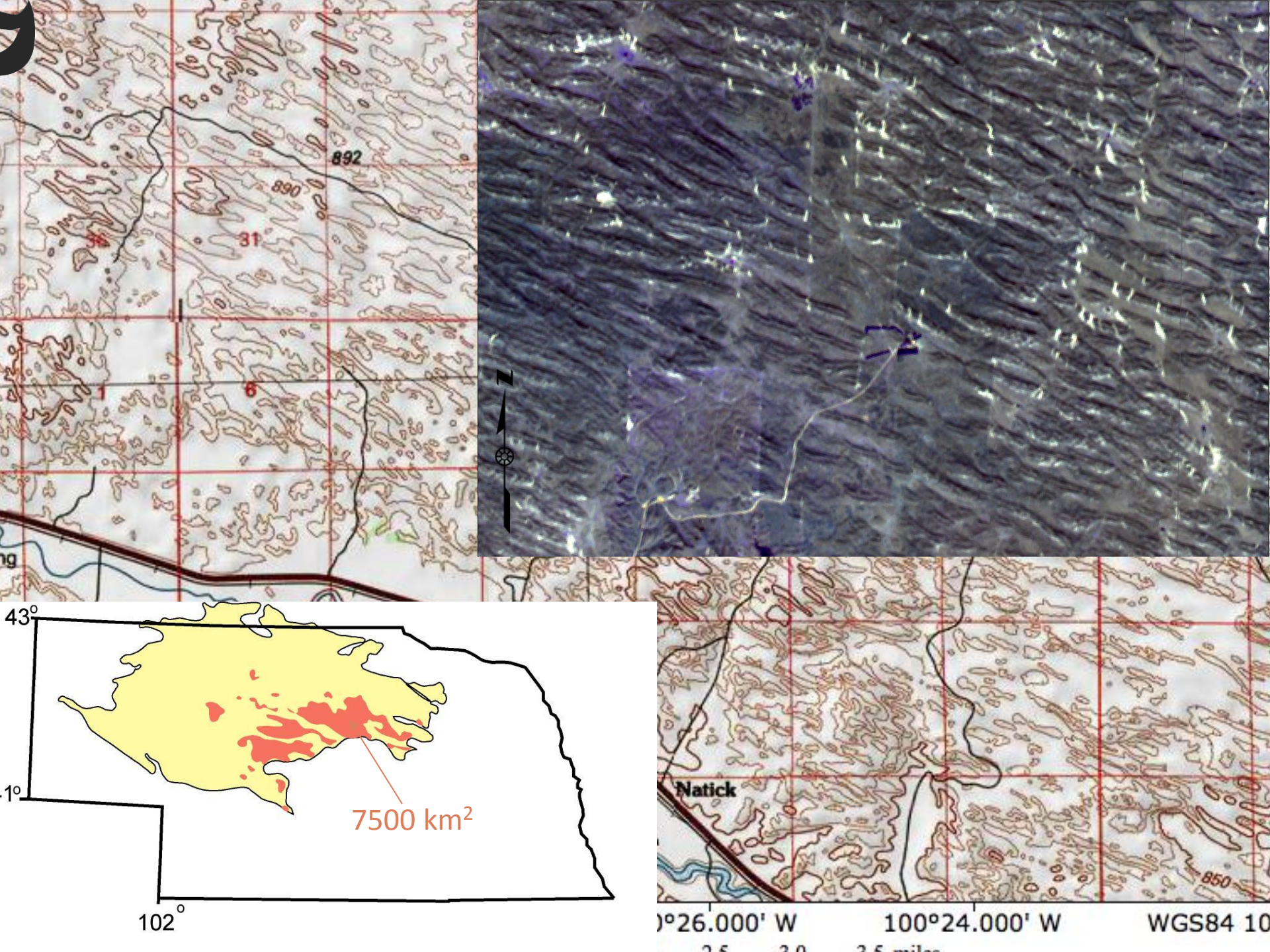
Grand Island Monthly Wind Roses, 1972-1997 lines point upwind



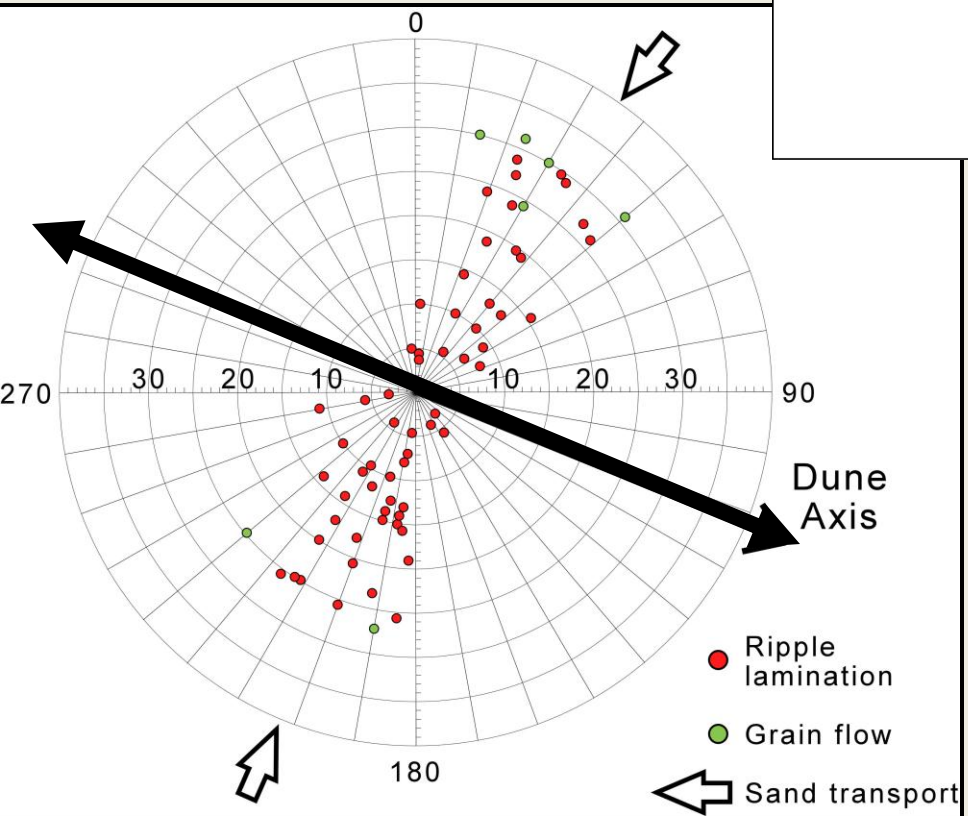
0.1-5 m/s **5.1-10 m/s** 10.1-15 m/s

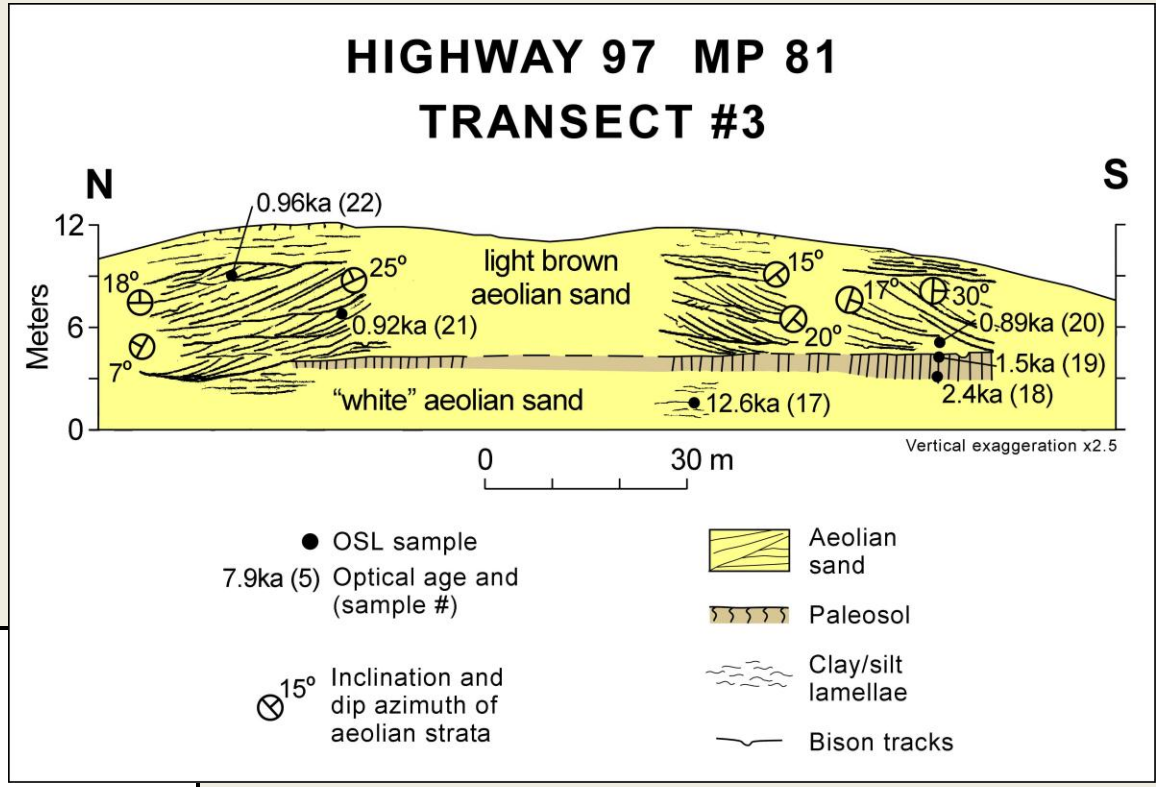


Linear dunes form in areas with two wind directions that diverge by more than 90^{o}.


892
890
36
31
1
6
43°
102°
7500 km²
Natick
850
°26.000' W
100°24.000' W
WGS84 10

The linear dunes in the Sand Hills were shaped by bimodal winds of subequal strength.





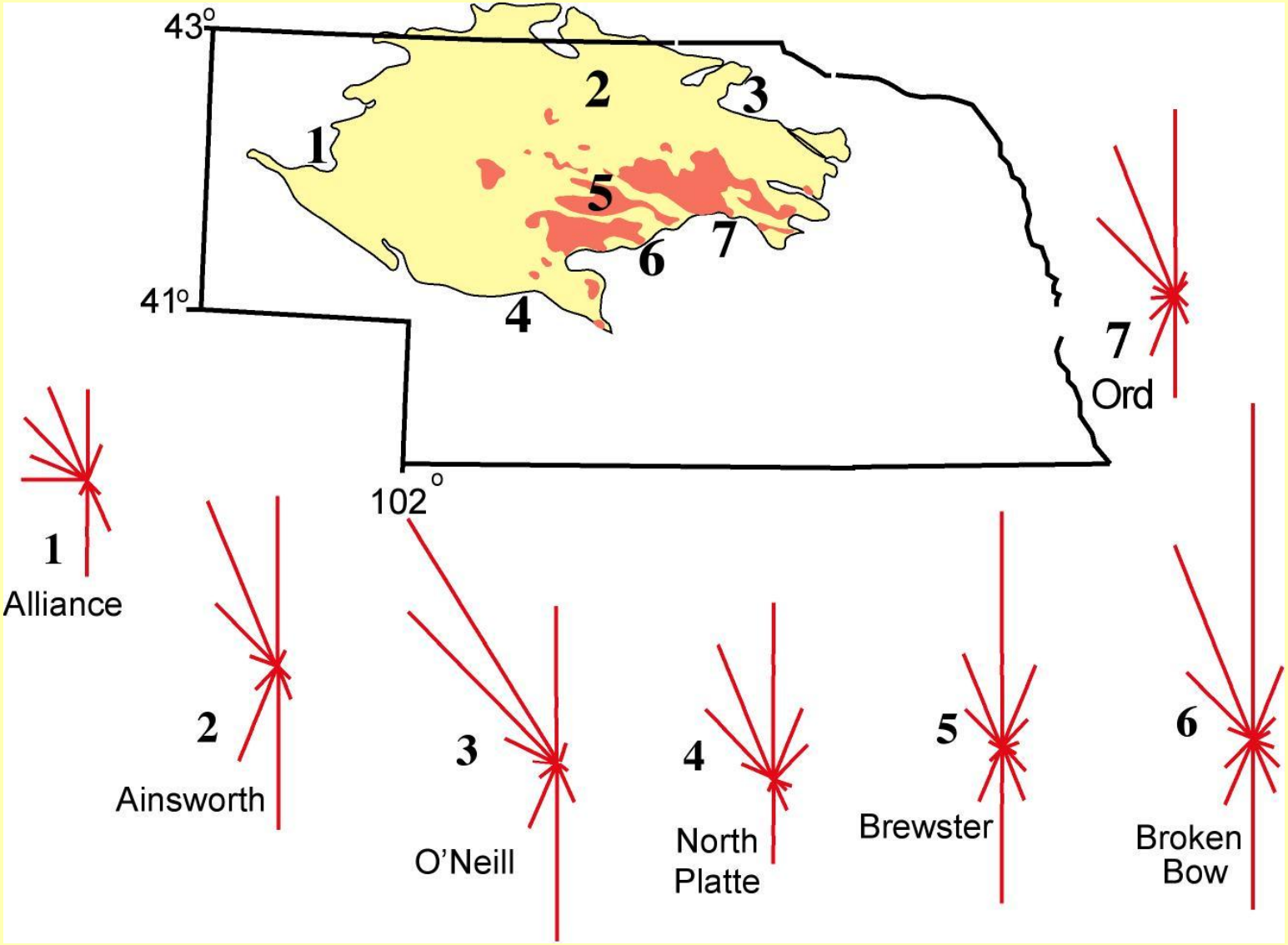
If sand were free to migrate today, what would dune orientation be?

Fryberger Method for Calculating Sand Drift

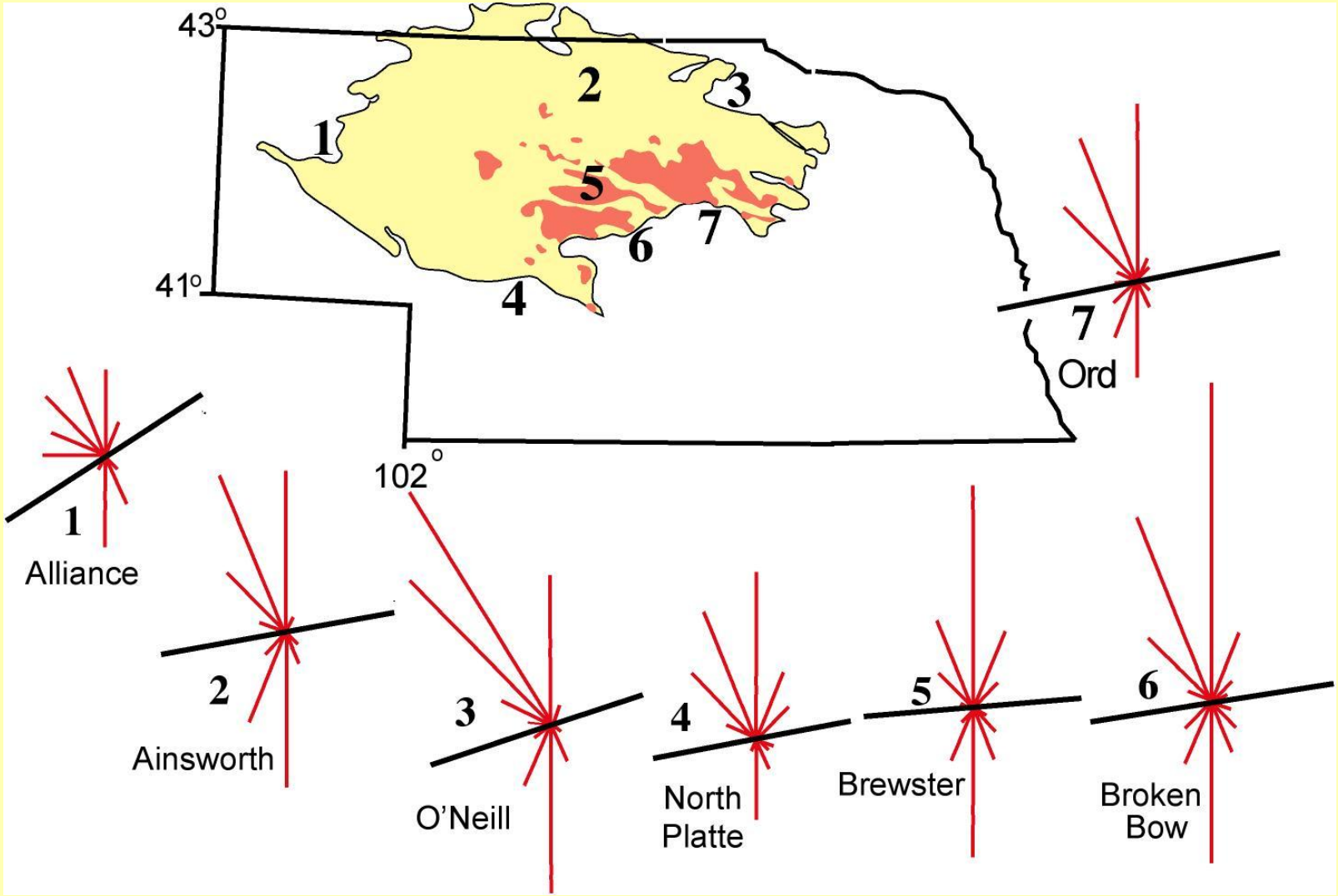
$$Q \propto V^2 (V-V_t)\, t$$

Q= annual rate of sand drift
t = time the wind blows (as percentage)
V = wind velocity
V_t = threshold velocity for sand movement ≈12 knots (measured at 10 m height)

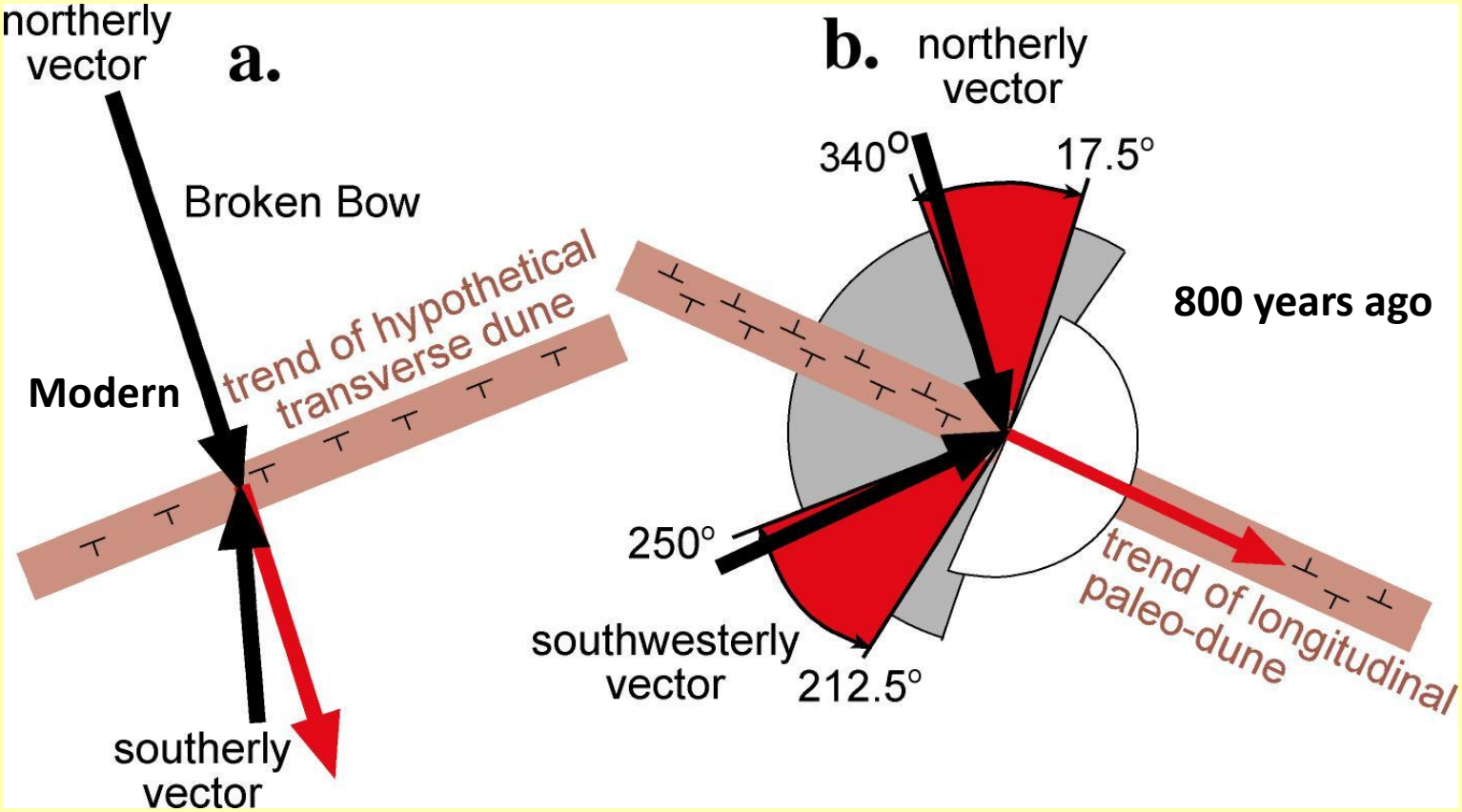
from Fryberger, S.G., 1979, Dune forms and wind regime *in* McKee, E.D. (ed.) ***A Study of Global Sand Seas***: U.S.G.S. Professional Paper 1052, p. 137-169

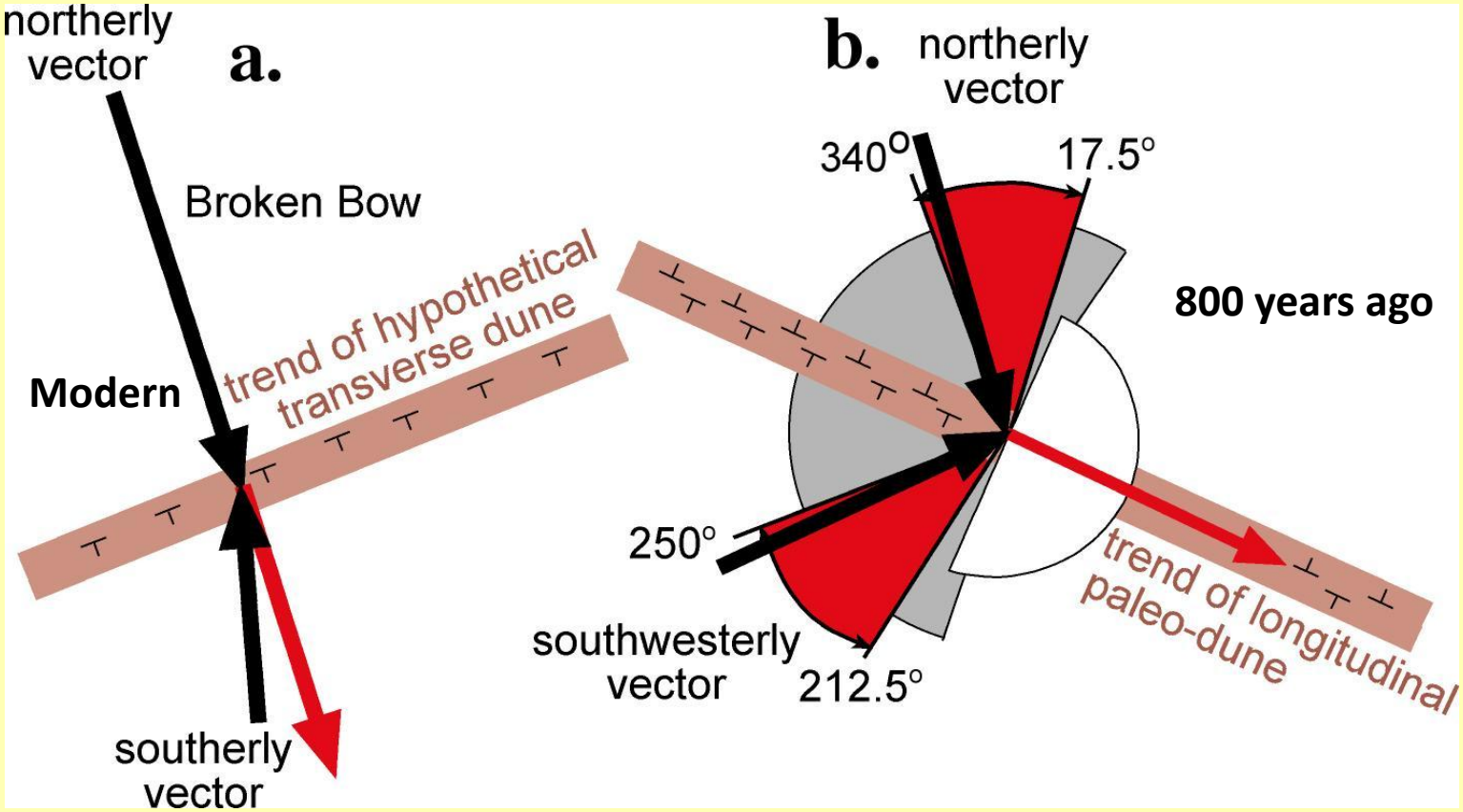


Sand drift roses, modern winds; red lines point upwind



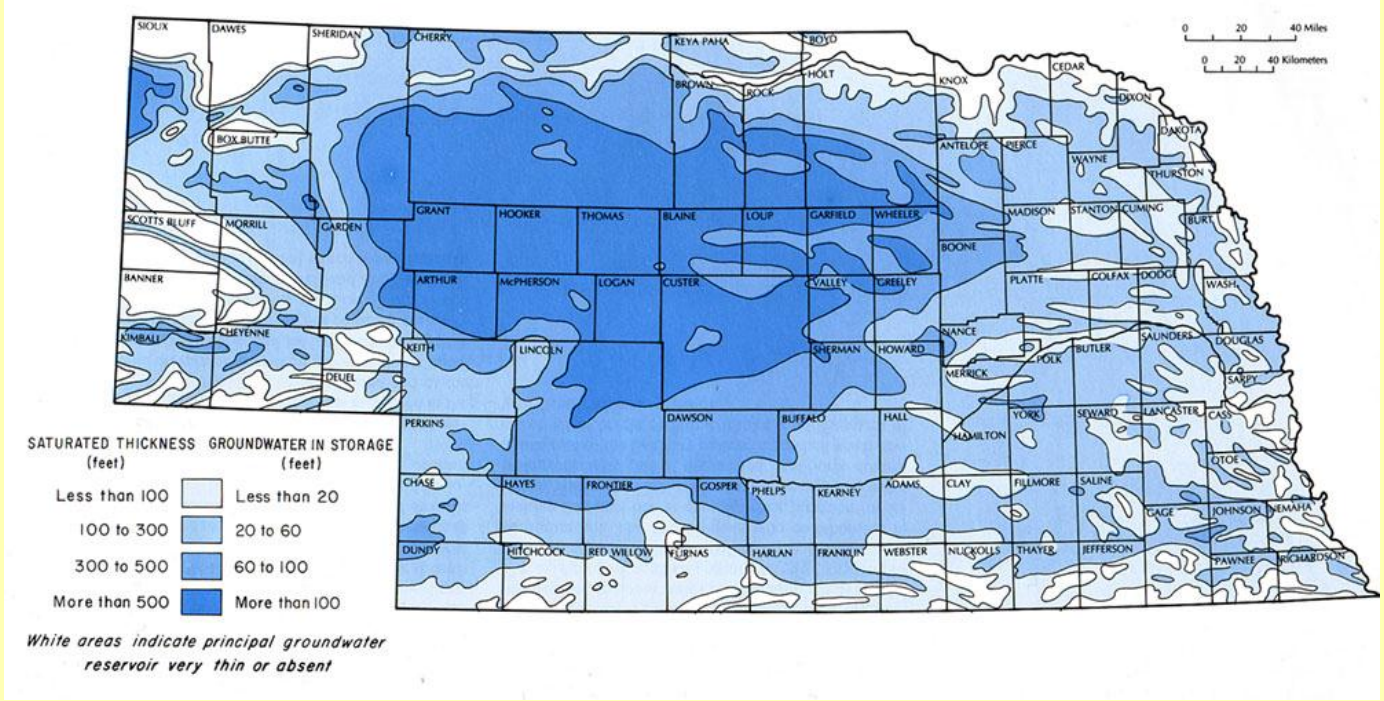
Black lines--calculated orientations of dune crests


northerly
vector
a.
Broken Bow
Modern
trend of hypothetical
transverse dune
southerly
vector
b.
northerly
vector
340°
17.5°
800 years ago
250°
southwesterly
vector
212.5°
trend of longitudinal
paleo-dune



Conclusion: During major droughts, Spring-Summer winds shifted to southwest, cutting off moisture from Gulf

Sridhar, V., D.B. Loope, J.A. Mason, J.B. Swinehart, R.J. Oglesby and C.M. Rowe (2006). Large Wind Shift on the Great Plains During the Medieval Warm Period, *Science, Vol. 313. no. 5785, pp. 345 – 347*



About 65% of the groundwater in storage in the High Plains Aquifer lies beneath Nebraska.
Note that much of Nebraska's groundwater is under the Sand Hills.

The steady-flowing Loup meets the dry Platte at Columbus