

Geomorphology of Gypsum in Soils

- NCSS Gypsum Geomorphology Workgroup

NCSS National Work planning Conference

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“Gypsum” is really $\text{Gyp}\Sigma$

gypsum & other co-occurring salts of equal or greater solubility (e.g. halite).

Why? :

- 1) Common to encounter other salts.
- 2) Presence of other salts alters behavior of gypsum (analytical response).

Workgroup Charges:

1. Investigate relationships of forms of gypsum on landforms / geomorphic surfaces.
(*What?*)
2. Investigate and document occurrences of gypsum on landforms / geomorphic surfaces.
(*Where?*)
3. Investigate pedogenic and geomorphic transport processes of gypsum. (*When, How?*)

lenticular selenite crystals



**gypsum / ca-carb.
coats**



Schoeneberger

Talos soil (Btky 60 cm)

WSMR, NM

bundle (needle) gypsum (typically upper 3-25cm profile)



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Elcor soil on structural bench

Culberson Co., TX



Landform: *sabkha* - A flat area of both sedimentation and erosion formed under semiarid or arid conditions in interior areas (e.g. on basin floors slightly above playa lake beds (e.g. playa step), or along coastal areas ...

Parker Lake

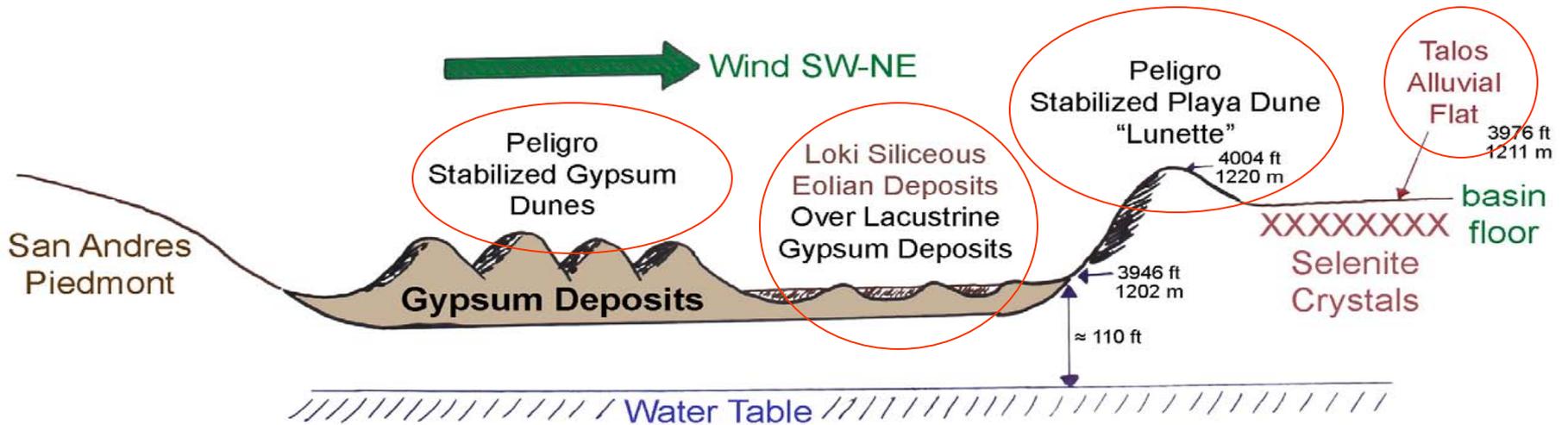


Wind SW-NE



Water Table ↓

Wind SW-NE



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- 1) Investigate relationships of forms of gypsum on landforms / geomorphic surfaces. (*What?*)
- 2) Investigate and document occurrences of gypsum on landforms / geomorphic surfaces. (*Where?*)
- 3) **Investigate pedogenic and geomorphic transport processes of gypsum.**
(*When, How?*)

Conventional geomorphic processes and subsequent landforms apply to hypergypsic settings.

Ex. Eolian (erosion, transport , & deposition)

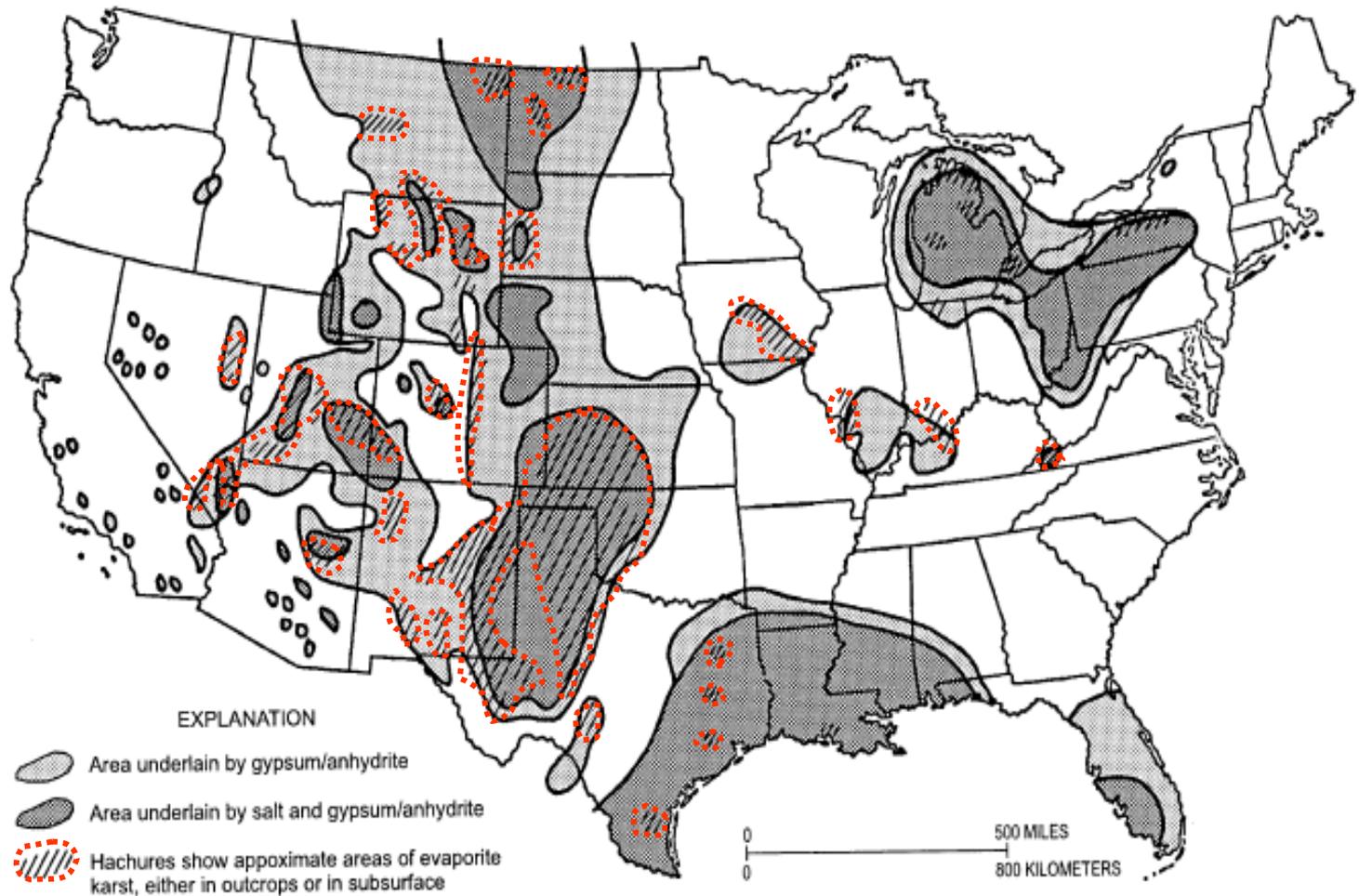


However: Gypsum particles are more fragile than siliceous particles (e.g. quartz), and therefore more subject to abrasion and dissolution / re-precipitation

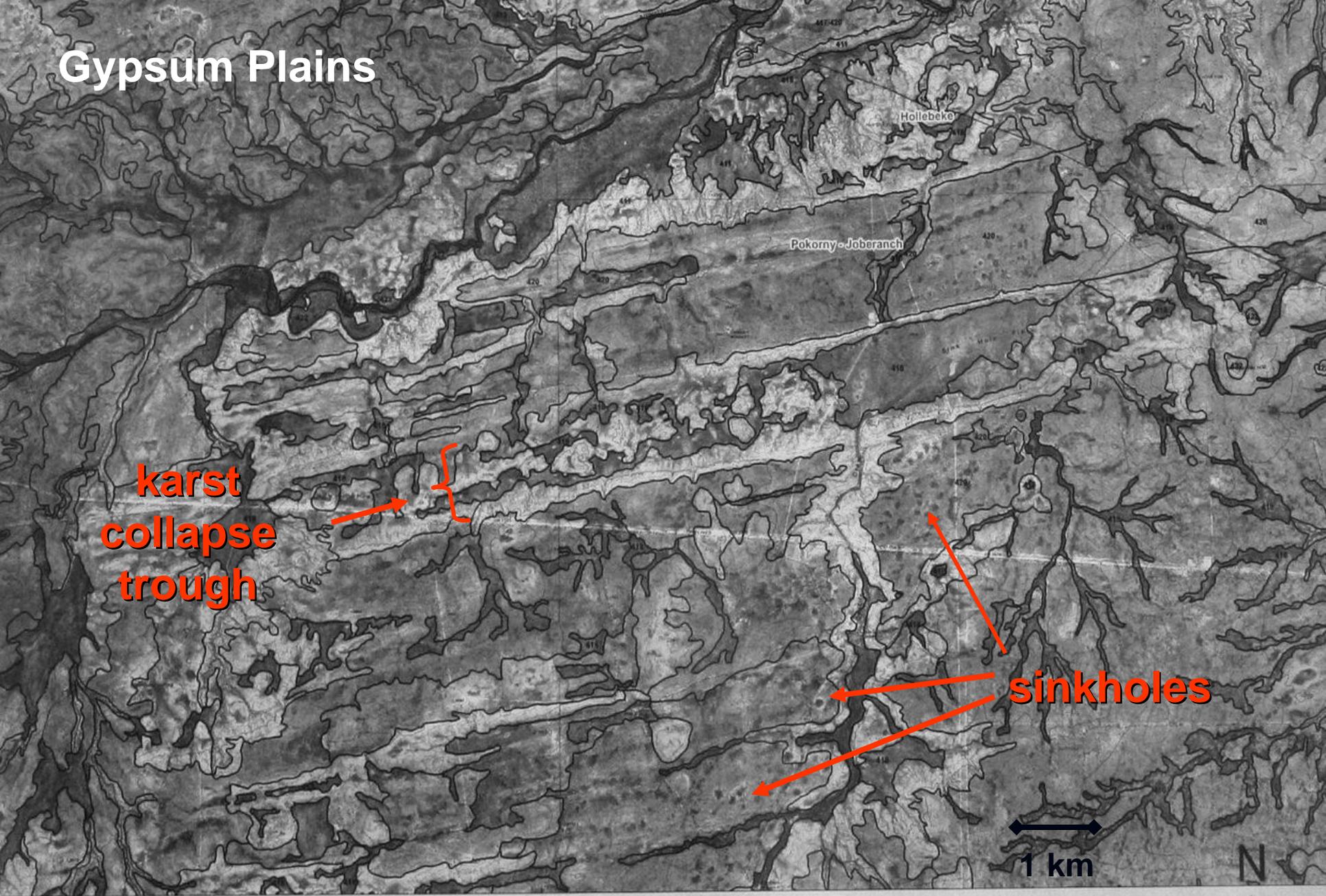
Workgroup Charges: – *cont'd*

- 4) **Identify and document relationships of gypsum dissolution and ground subsidence to gypsum origins, forms and locations in landforms. (*Applications / Soil Interpretations*)**
- 5) Investigate relationships of gypsum to other salts and metals. (*Other soluble salts*)
- 6) Identify and compare existing occurrence models of gypsum with patterns and processes in current soil survey areas.
(*Conceptual & Predictive models*)

Ex. Estimated evaporite karst in the US



Gypsum Plains



karst
collapse
trough

sinkholes

1 km

gypsum karst landscape

Culberson Co., TX

Workgroup Charges: – *cont'd*

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(*Applications / Soil Interpretations*)
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(*Conceptual & Predictive models*)

Na salt & gypsum rich soil area within a gypsum-rich soil (Gyp Σ)



alluvial flat on relict pluvial lakebed on semi-bolson floor

Workgroup Charges: – *cont'd*

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(*Applications / Soil Interpretations*)
- Investigate relationships of gypsum to other salts and metals. (*Other soluble salts*)
- **Identify and compare existing “occurrence” models of gypsum with patterns and processes in current soil survey areas.**
(*Conceptual & Predictive models*)

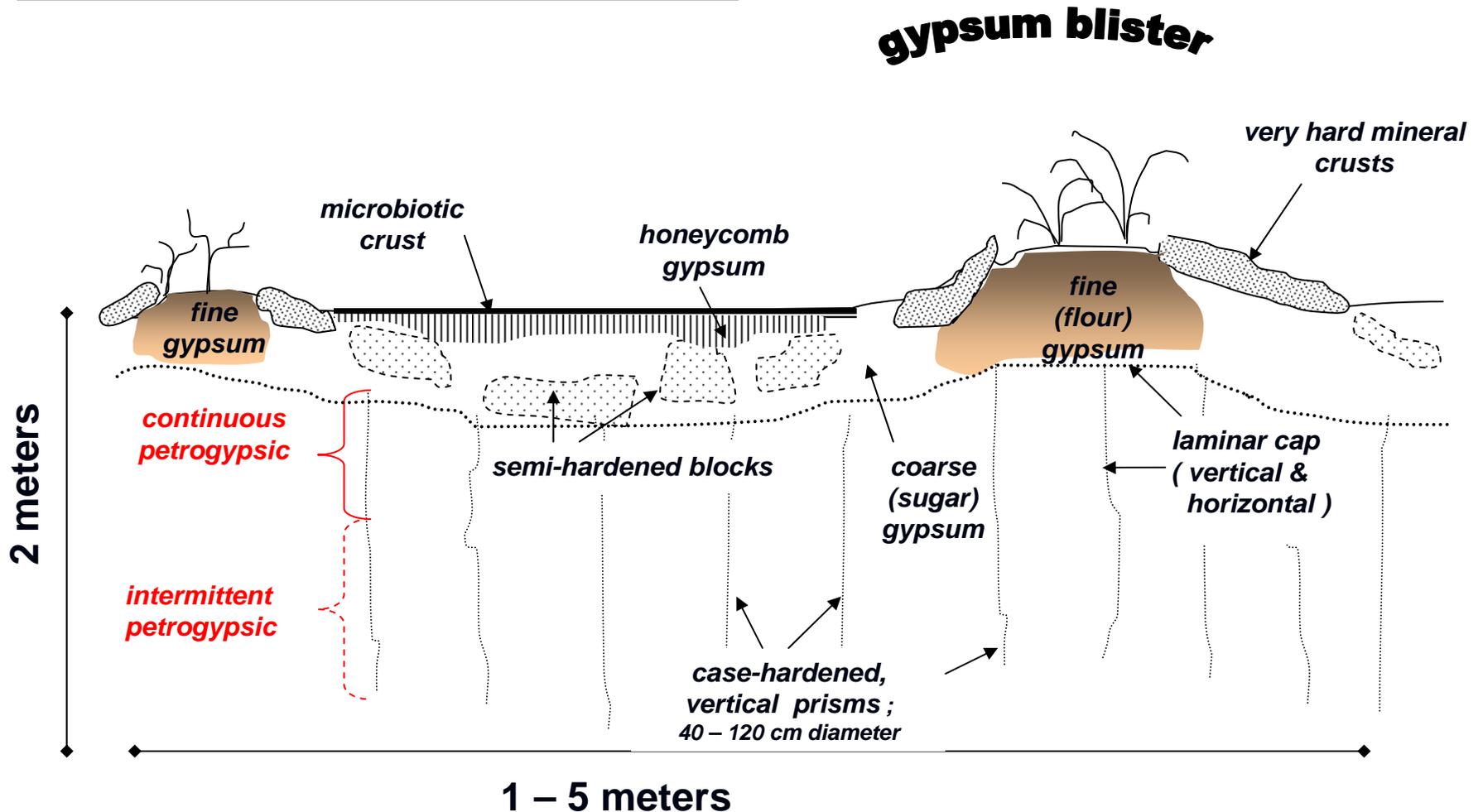
gypsum blister (microhigh)

Hermes soil

WSMR, NM



Conceptual models

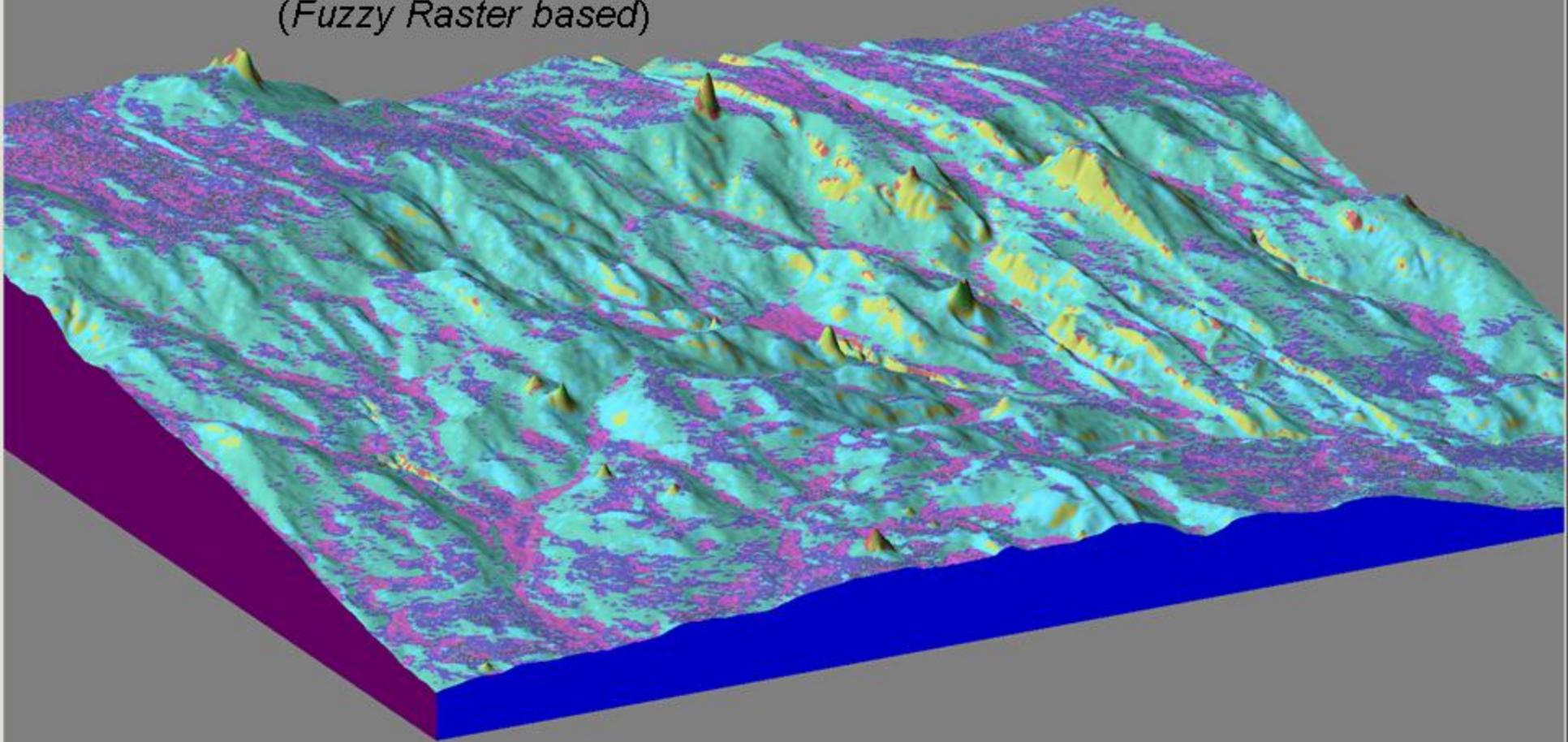


Stylized schematic of cyclic, highly gypsiferous soils and gypsum blisters.

Current Projects

- **Ongoing soil surveys in gypseous areas.**
(*Culberson & Hudspeth Co's., TX ; White Sands Missile Range, NM*)
- **Develop models of gypsum & soluble salt occurrence and distribution across landscapes.** (*fuzzy raster based inference model, conventional*)
- **GPR & EMI field investigations of gypsum regolith.** (*bedrock and petrogypsic layers*)

Predicted Soil & Landform distribution (Fuzzy Raster based)



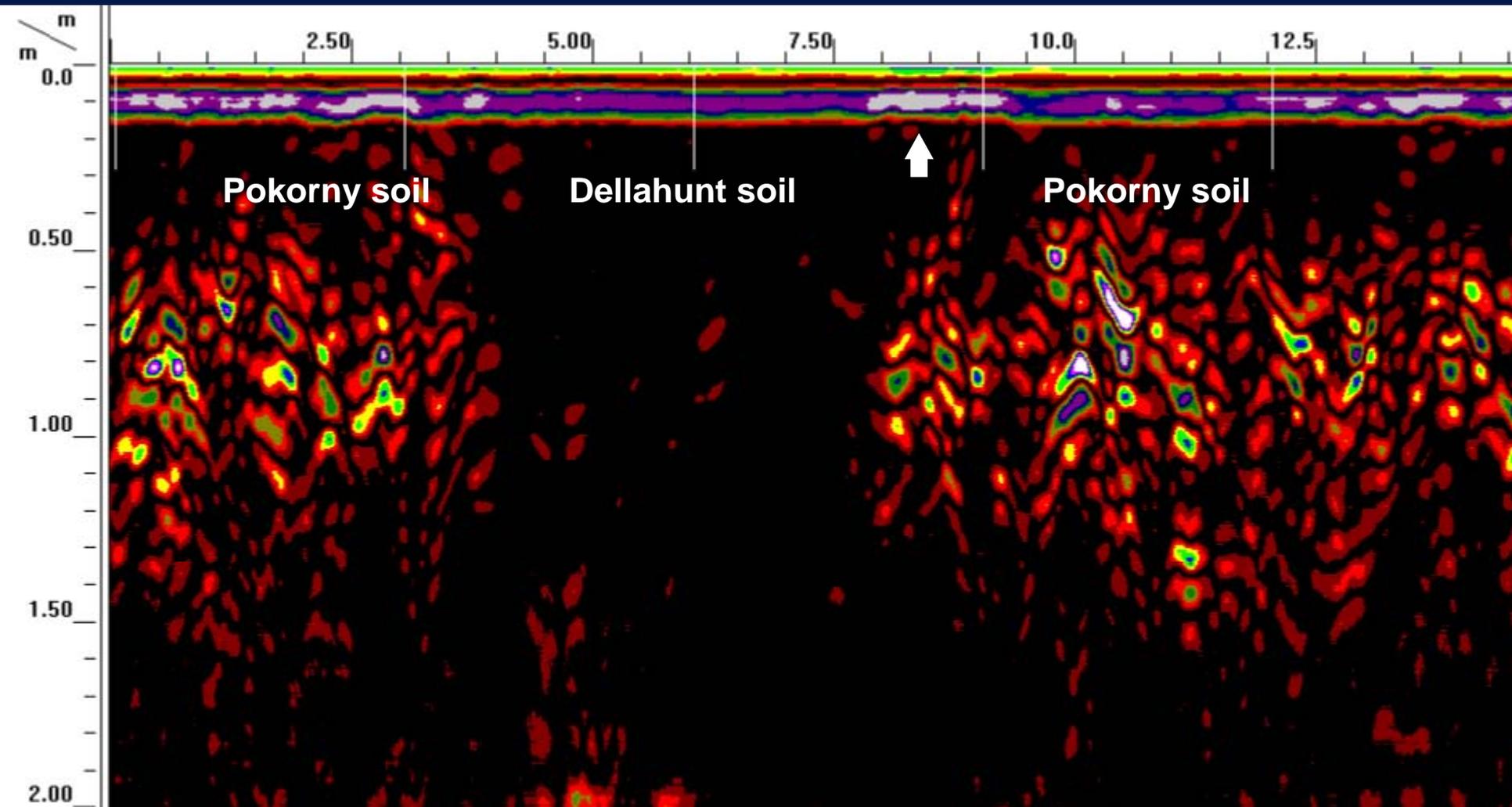
Seven L Peak Quadrangle, Culberson CO., TX

Purple = Dillyhunt **Light Blue** = Hollebeke **Yellow** = Elcor
Pale Green = Cavewell **Darkest Blue** = Pokorny **Red** = Bissett

GPR & EMI detection of:

- Gypsum & other soluble salts (e.g. Na materials).
- Soil type distributions (patterns) in gypsum karst.
- Detecting internal structures within gypsum bedrock.

GPR Traverse : soil type distribution across gypsum karst.



J. Doolittle

Water Tank Site, Culberson Co., TX.

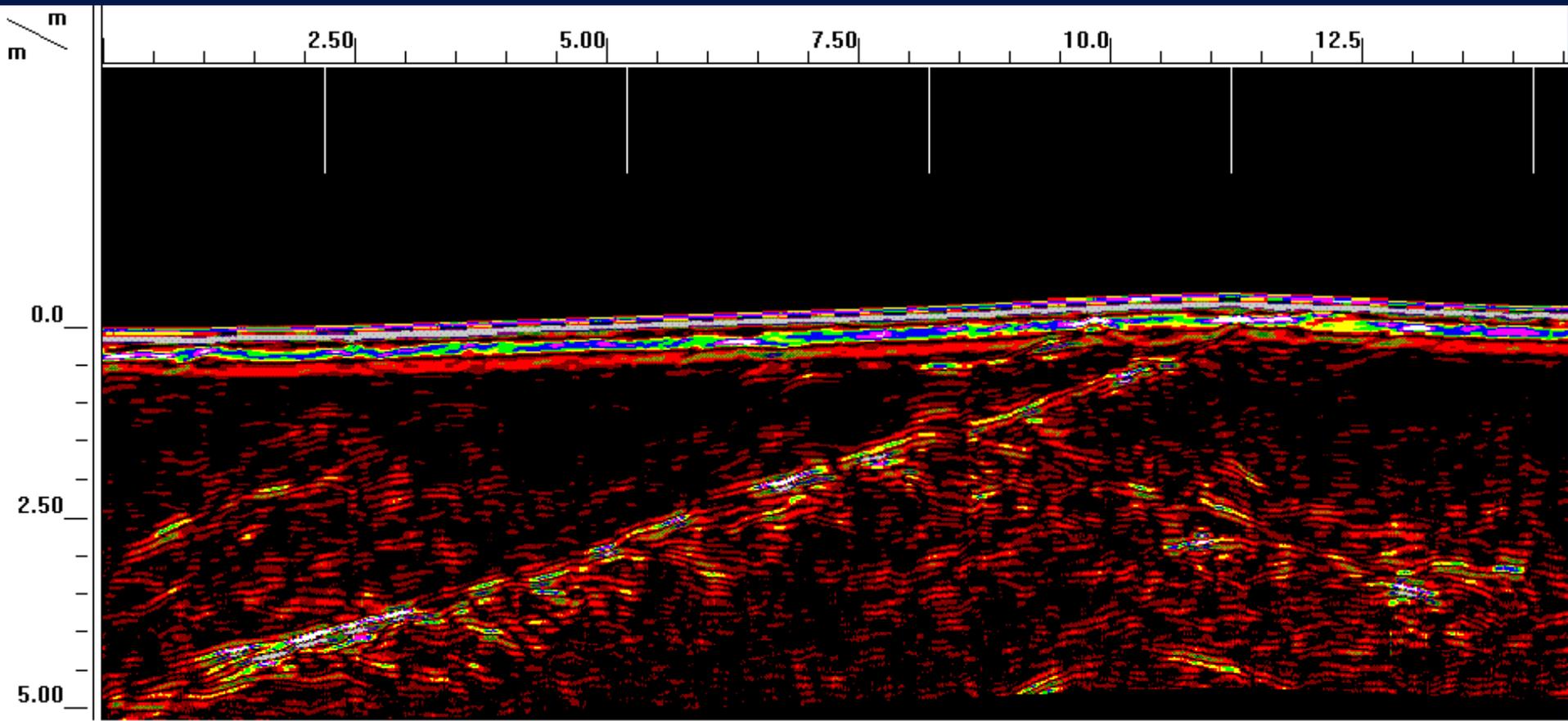
A white-out area occurs between the 3 and 9 meter distance marks and indicates an area of higher attenuation caused by clays and silts.

Pokorny

Joberanch



GPR Record : internal structures within gypsum bedrock.

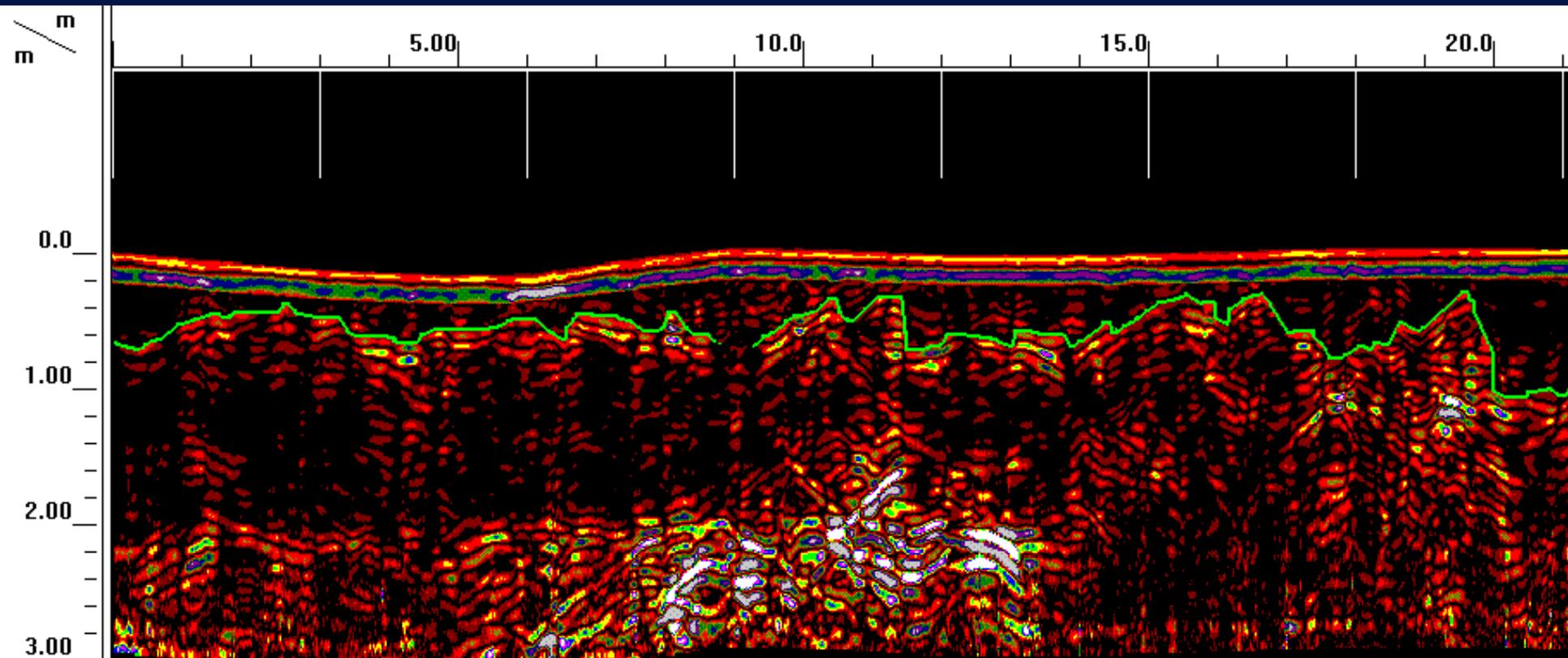


J. Doolittle

Alligator Draw Site, Culberson Co. TX.

An inclined vein of selenite gypsum within the rock gypsum bedrock.

GPR Record : depth to bedrock (rock gypsum)

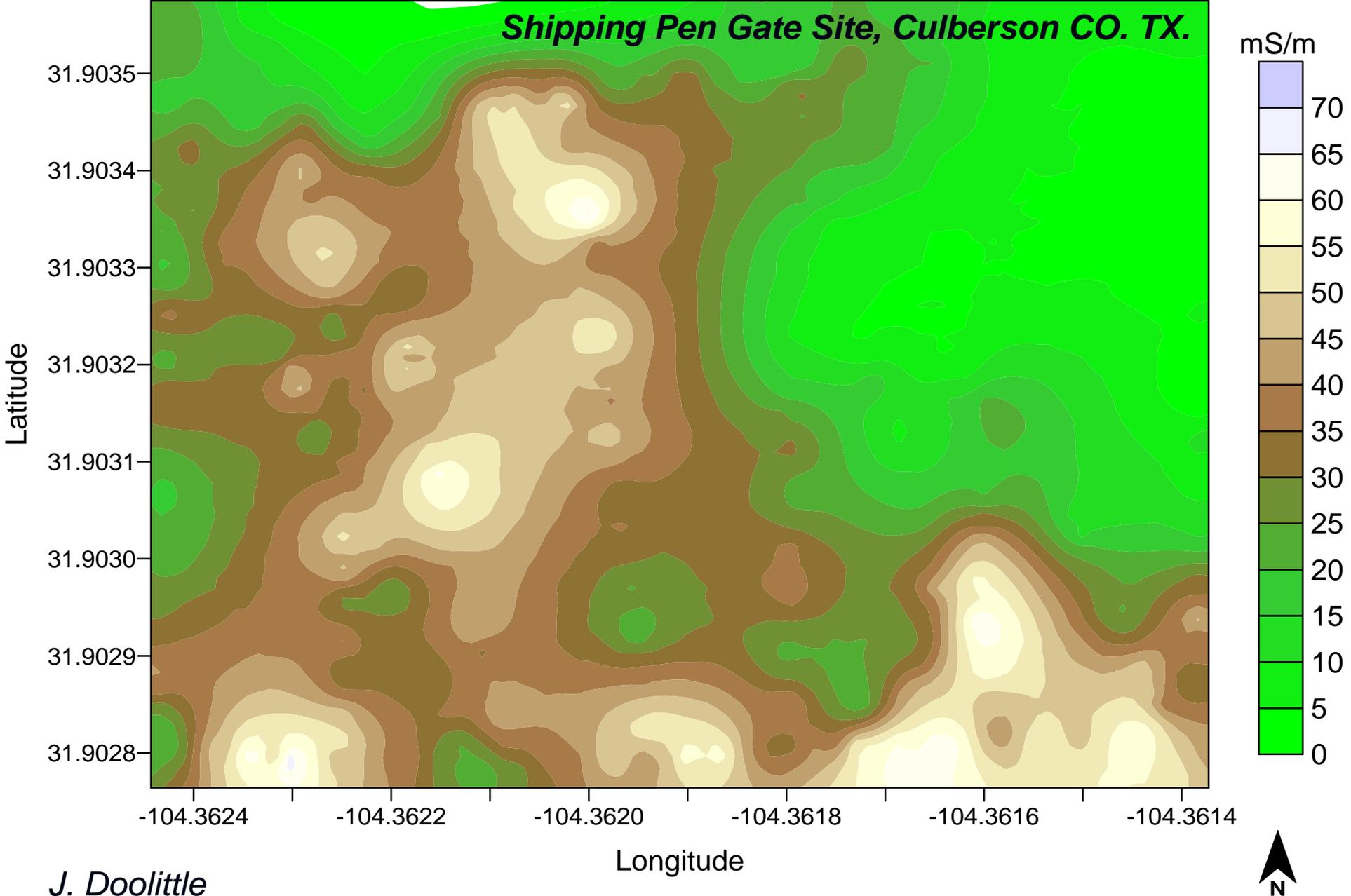


J. Doolittle

Radio Tower Site, Culberson Co., TX.

Interpreted depth (green line) to unweathered rock gypsum bedrock along a radar traverse.

Shipping Pen Gate Site, Culberson CO. TX.



J. Doolittle

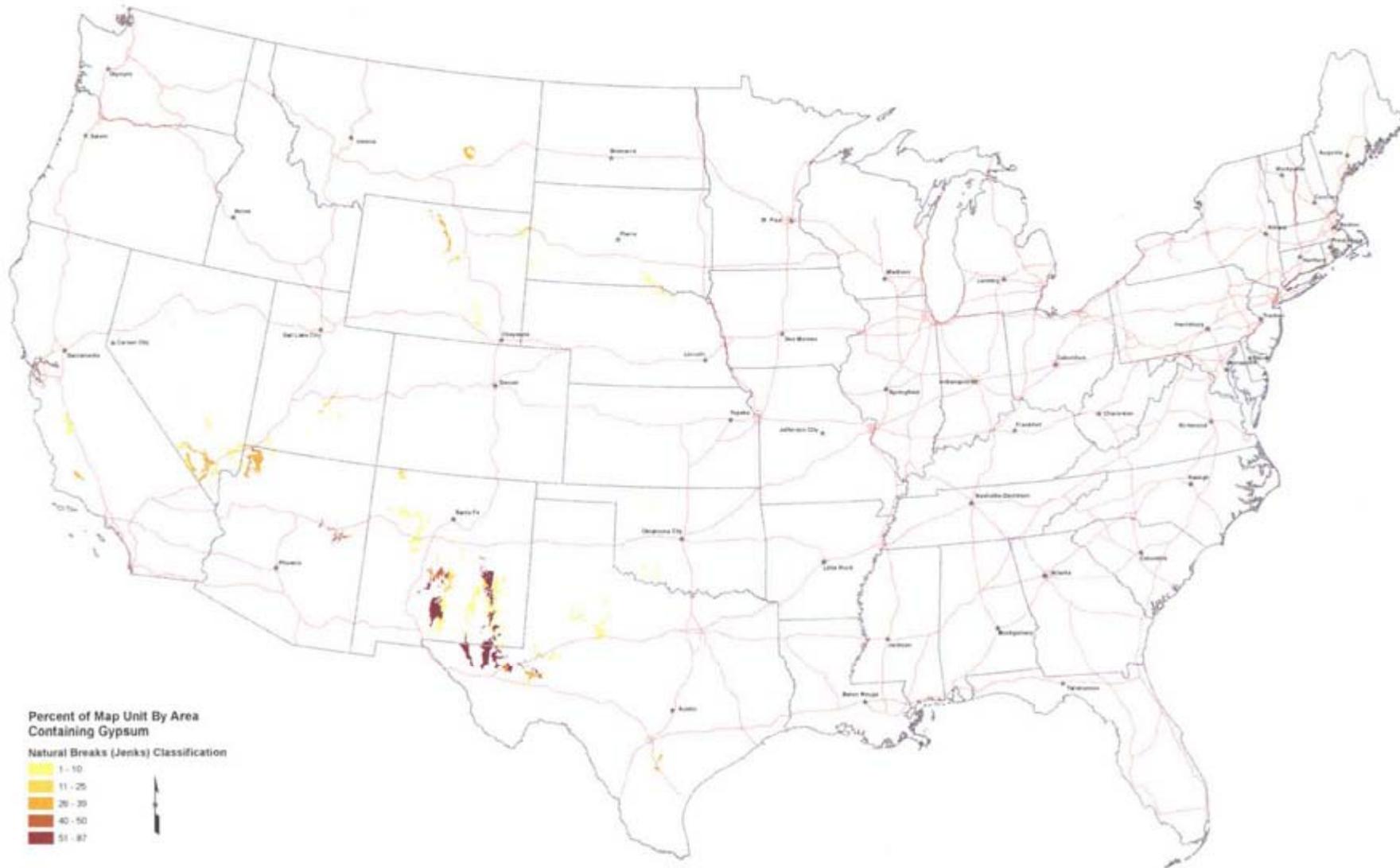
Spatial ECa patterns measured via EM38 meter (vertical dipole orientation)

Other Projects – *cont'd*

- **Hydropedology / Water behavior.**
(e.g. In situ Ksat investigations) - *WSMR*
- **Specimen identification and morphology of gypsum forms.** (*national*)
- **Assess the aerial distribution of gypsum.**
(*national*)

Hydraulic properties - hypergypsic (gypseous) materials

- In situ K_{sat} determinations support behavior consistent with “apparent field texture” (*i.e. sandy textures have high K_{sat} values*).



AREA (ACRES) BY LEGEND CLASS

| | |
|---------|-----------|
| 1 - 10 | 397,220 |
| 11 - 25 | 763,491 |
| 26 - 39 | 771,804 |
| 40 - 50 | 269,325 |
| 51 - 87 | 1,828,475 |

Source: Soil Survey Staff, 2005. All soil data from digital general soil map of U.S. Department of Agriculture, National Resources Conservation Service, Lincoln, Nebraska. Atlas Expert/Atlas Data preparation: NACRS/abcm.

Map Revised
September 18, 2008

Soil Gypsum Map of the Conterminous United States

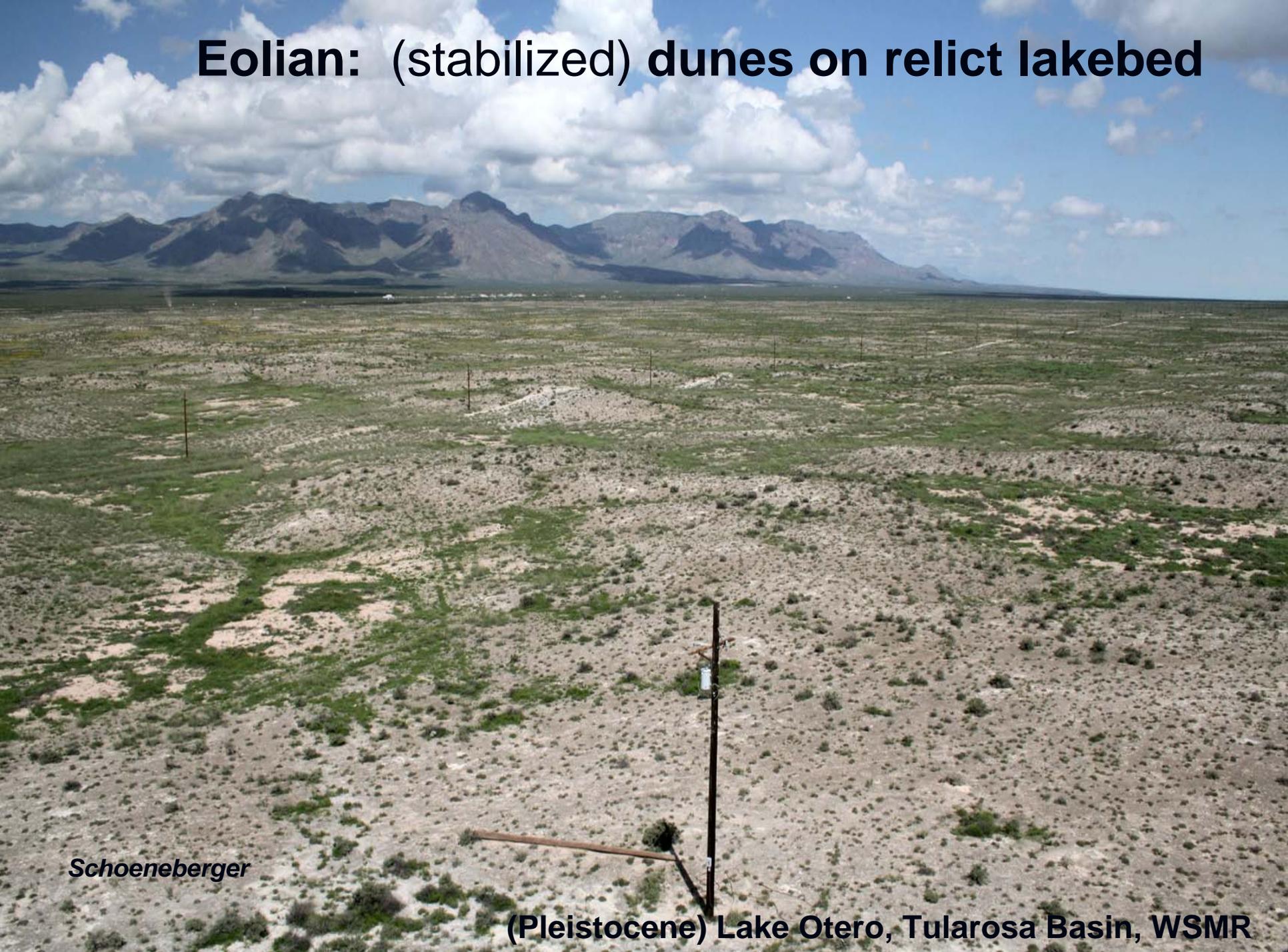


High Gypsum Soils

(hypergypsic / gypseous)

- In arid environments, hypergypsic materials can function primarily as harder sediments:
 - Karst
 - Eolian
 - Alluvial
 - Lacustrine
 - Mass Wasting (*colluvium (?)*, salt glacier; Chile, IRAN)
- In subhumid or wetter environments, gypsic materials function largely in response to water dynamics (hydropedology):
 - Vertical and lateral “chromatography”

Eolian: (stabilized) dunes on relict lakebed



Schoeneberger

(Pleistocene) Lake Otero, Tularosa Basin, WSMR

Fluvial: alluvial gypsum in inset fanhead trench



Hillslope processes: gypsum colluvium / residuum over varved rock gypsum bedrock.



Low to Moderate Gypsum (gypsiferous soils)

- In all environments, gypsic materials function largely in response to water dynamics (hydropedology):

vertical and lateral “chromatography”
(e.g. idealized horizon sequences :)

arid semi-arid & subhumid soils

recharge sites

Bk

By

Bz

H₂O

Flow



discharge sites

Bz

By

Bk