Permian Salt Dissolution in Silo Field*

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Abstract

Within Silo Field, a Permian salt edge exists. This salt edge was believed to be the cause of faulting and fracturing within the Niobrara Formation but studies have shown that this is not the case. Using a 3-D seismic survey encompassing approximately 30 square miles, the nature of the salt edge was examined. The irregular shape of the salt edge suggests that it was caused by dissolution rather than deposition. Dissolution occurred during the Late Jurassic and Early Cretaceous. Two of the proposed mechanisms for salt dissolution include compaction-driven water migration in the Lyons Formation and basement tectonics. Based on the seismic patterns observed, basement tectonics was the likely control on the location of the salt edge but further analysis is required to determine the role played by the Lyons Formation. The Permian salt also has an effect on the overall structure of Silo Field. The field exhibits a structural monocline in all of the strata overlying the Permian salt. Differential compaction over the salt edge creates the monocline. However, basement structure also has some control on the structural monocline. The lack of salt and timing of dissolution caused a thickened Dakota-Sundance interval in the southwestern part of the survey area. It is possible that this thickened section is the cause for high water production from the Niobrara in Silo Field. Understanding the nature of the Permian salt edge in Silo Field could have implications for understanding Permian salt dissolution and its impact in other Rocky Mountain fields.

References Cited

Malesardi, T., 2012, Petroleum Geology of Silo Field, Laramie County, WY: Colorado School of Mines, Master's Thesis.

Merin, I.S., and W.R. Moore, 1986, Application of Landsat imagery to oil exploration in Niobrara Formation, Denver basin, Wyoming: American Association of Petroleum Geologists Bulletin, v. 70, p. 351-359.

Oldham, D.W., 1996, Permian salt in the northern Denver basin; controls on occurrence and relationship to oil and gas production from Cretaceous reservoirs, in M.W. Longman and M.D. Sonnenfeld, (eds.), Paleozoic systems of the Rocky Mountain region: Society for Sedimentary Geology, Rocky Mountain Section, p. 335-354.

Sonnenberg,, S.A., 2011, The Niobrara Petroleum System, A Major Tight Resource Play in the Rocky Mountain Region: Search and Discovery Article 10355 (2011), Web Assessed August 9, 2014. http://www.searchanddiscovery.com/documents/2011/10355sonnenberg/ndx_sonnenberg.pdf.

Svoboda, J.O., 1995, Is Permian salt dissolution the primary mechanism for fracture genesis at Silo Field, Wyoming? in R.R. Ray, S. Sonnenberg, M. Wilson, S. Zinke, M. Longman, M. Holm, and M. Crouch, (eds.), High-definition seismic; 2-D, 2-D swath, and 3-D case histories: Rocky Mountain Association of Geologists, Denver, CO., p. 79-85.

Weimer, R.J., 1983. Relation of unconformities, tectonics and sea level changes, Cretaceous of the Denver basin and adjacent areas: in M.W. Reynolds and E.D. Dolly, (Eds.), Mesozoic Paleogeography of West-Central United States, Rocky Mountain Section SEPM, pp. 359-376.

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Outline

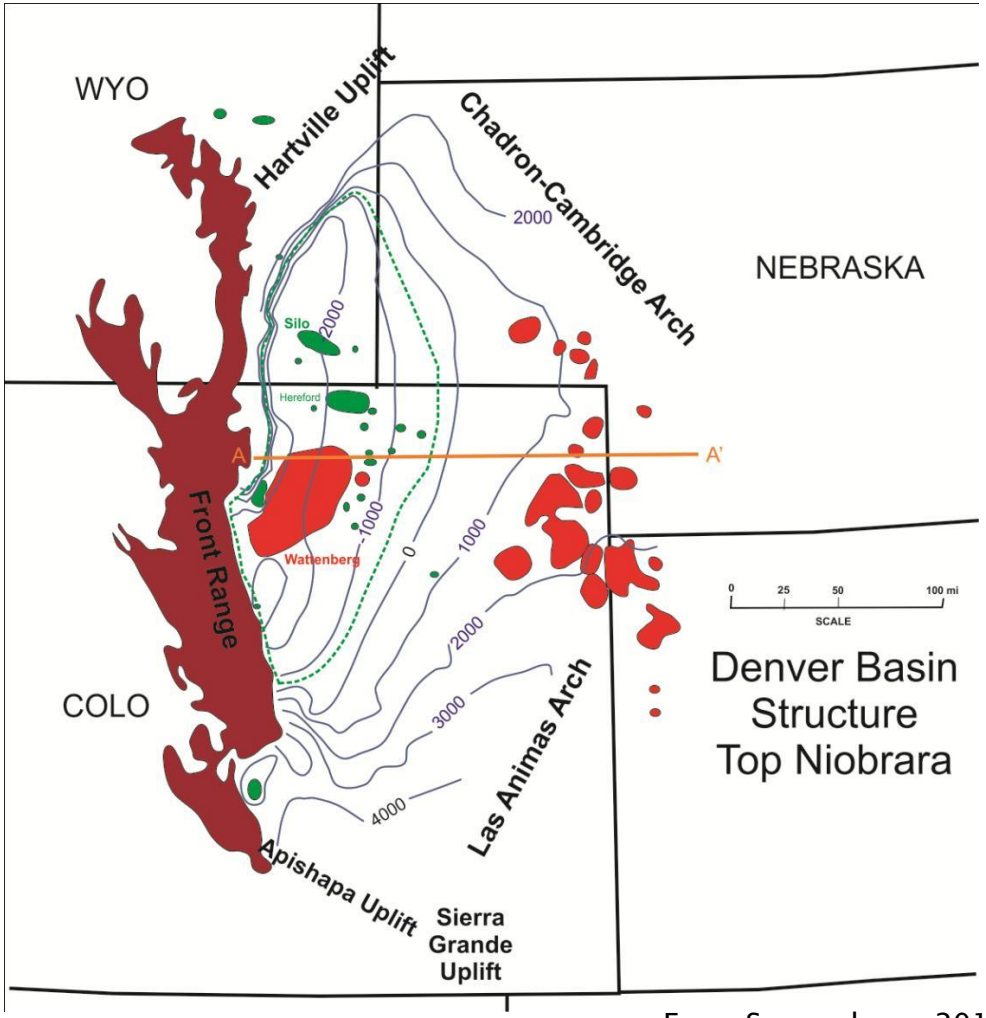
- Introduction
- Seismic Data
- Permian Salt Deposition
- Permian Salt Dissolution
- Structure and Dissolution
- Conclusions

Introduction

- Part of thesis work on Niobrara Formation in Silo Field
  - Examine nature of salt edge in Silo field
  - Depositional or dissolutional?
- Determined by Svoboda (1995) to not be cause for Niobrara fracturing

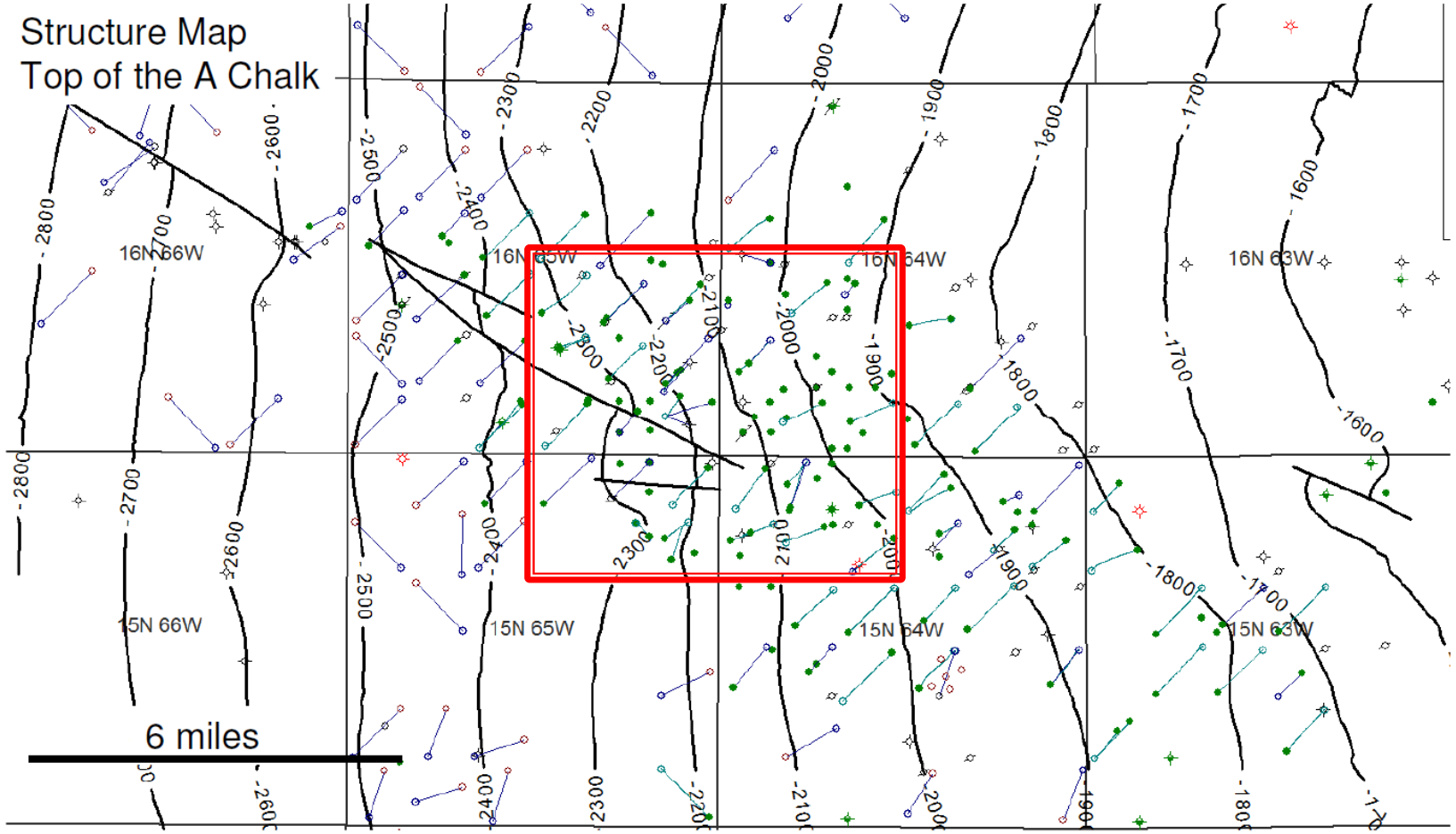
Silo Field

- Discovered 1981
- Horizontal drilling commenced 1990
- Produced 11.4 MMBO to date
- Structural monocline with no apparent structural closure
- Niobrara depth from 7100-8800'
- Production heavily influenced by fractures



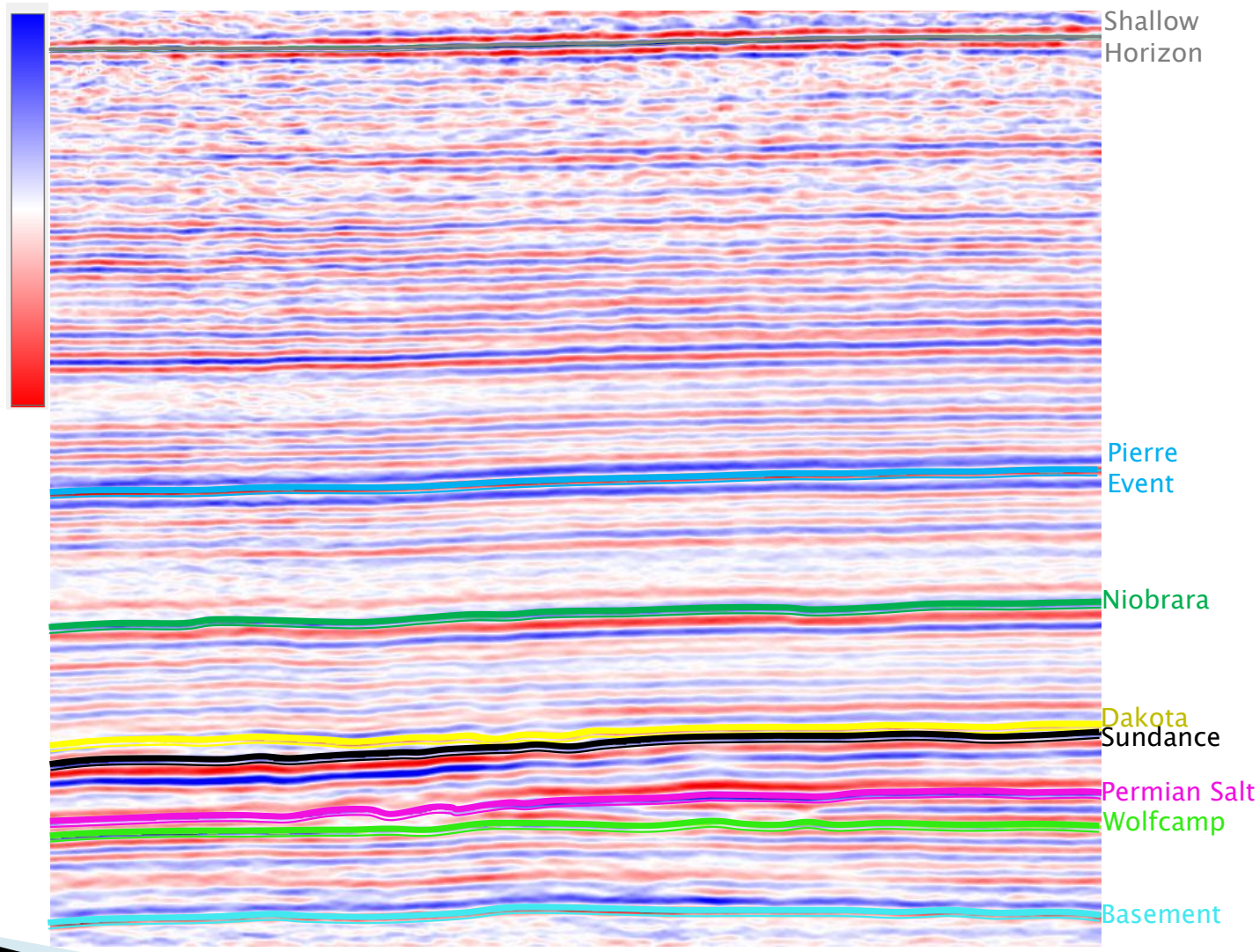
From Sonnenberg, 2011

Seismic Data



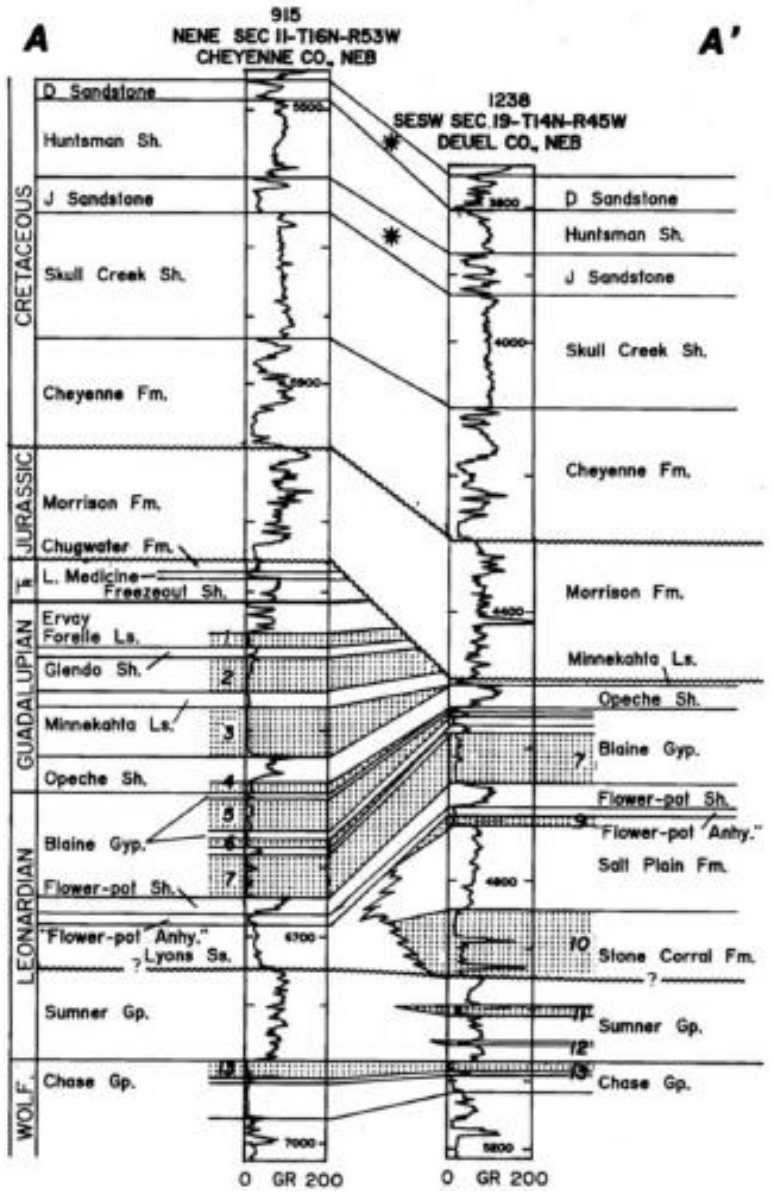
Modified from Malesardi, 2012

Horizons


Shallow Horizon
Pierre Event
Niobrara
Dakota
Sundance
Permian Salt
Wolfcamp
Basement

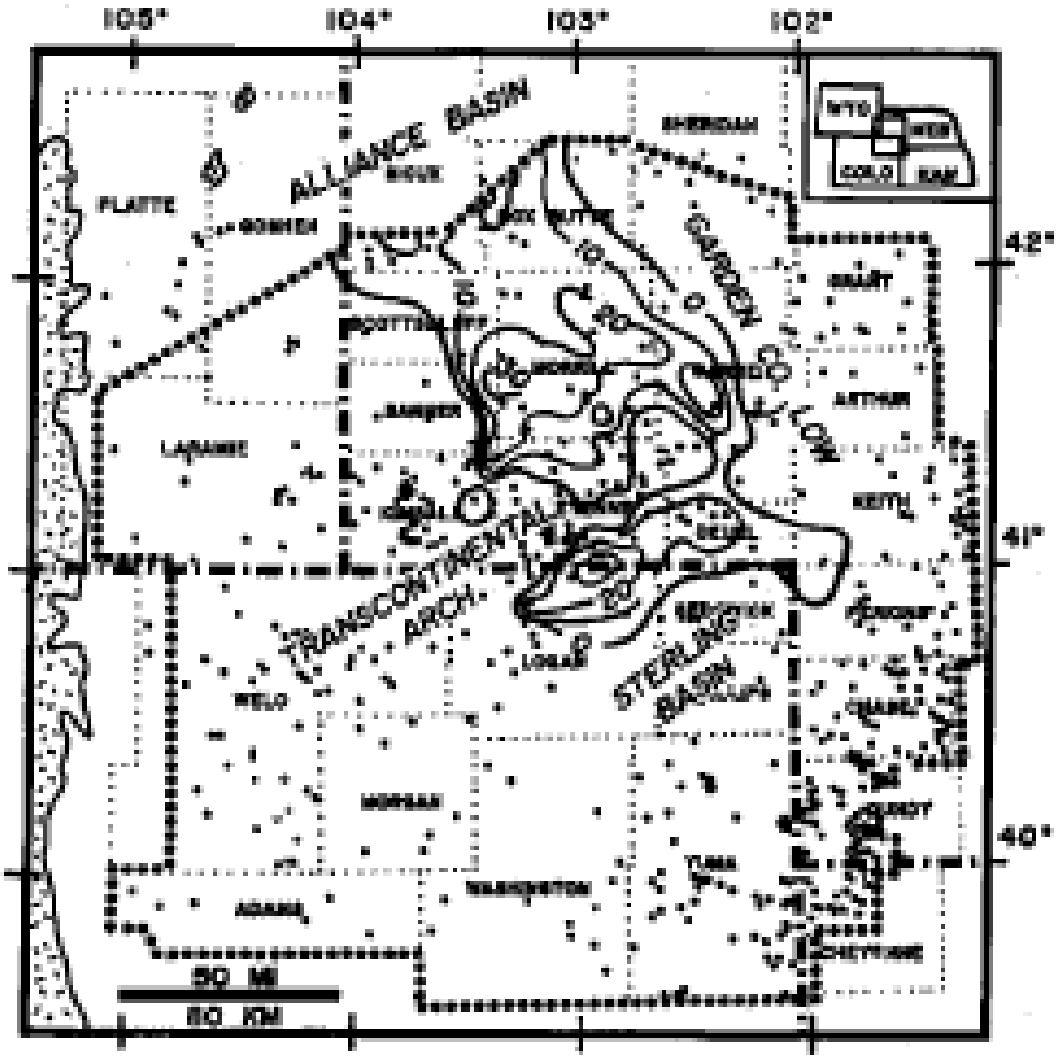
Permian Salt Deposition

- Deposited in the Alliance Evaporite Basin
  - Multiple salts from Wolfcampian-Guadalupian in Denver Basin



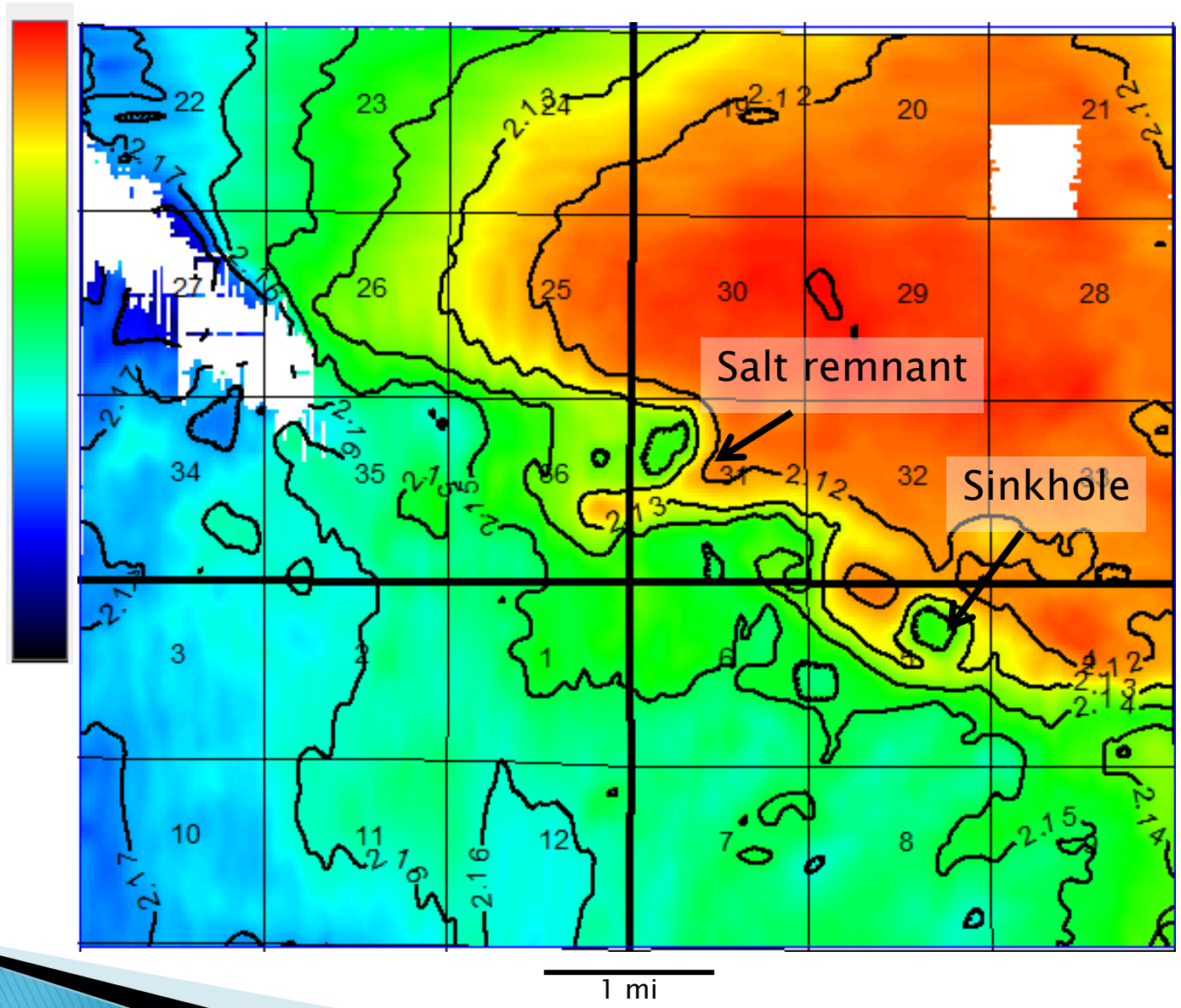
Oldham, 1996

Permian Salt Deposition

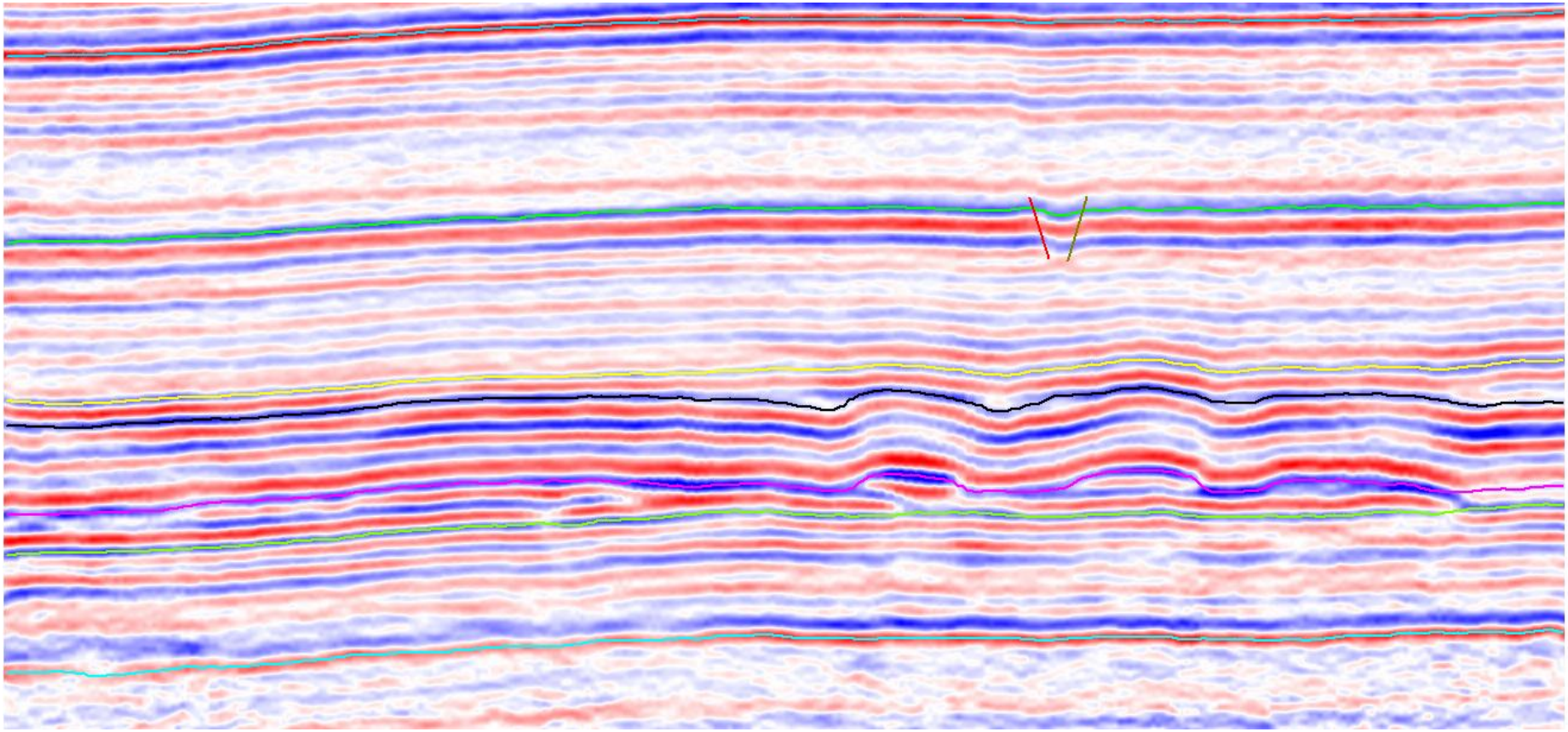


Oldham, 1996

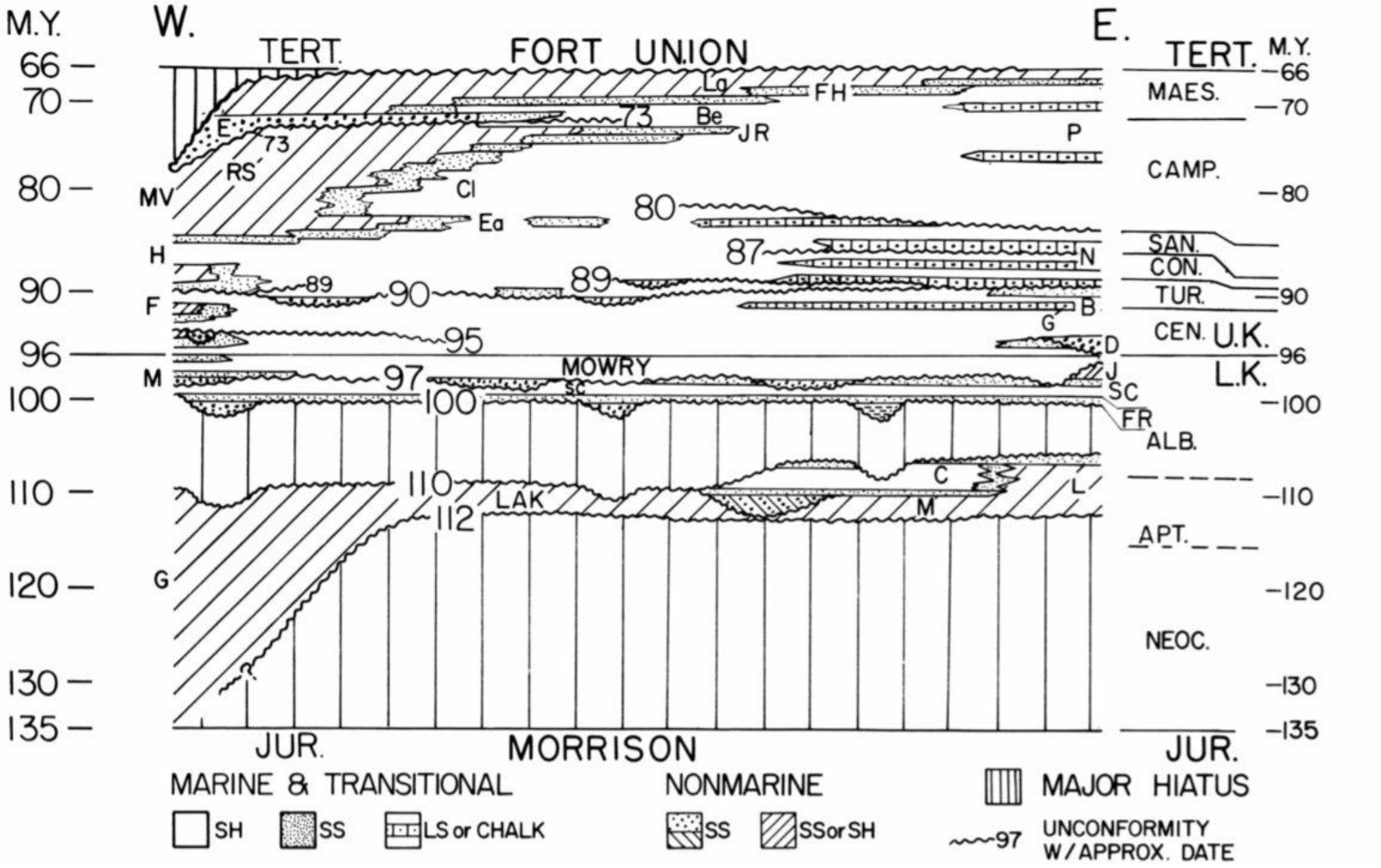
Permian Salt Structure



Permian Salt Dissolution

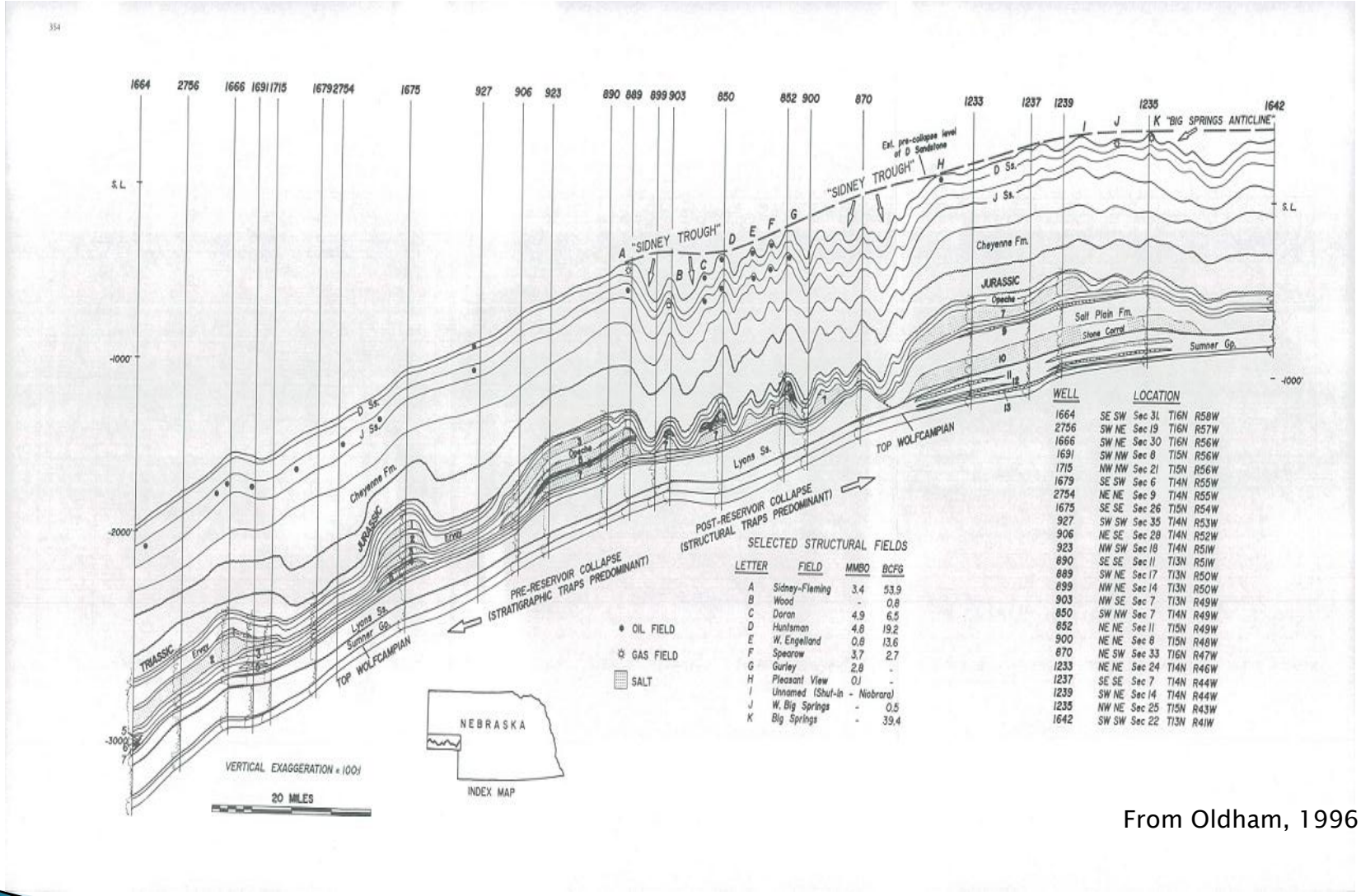


Permian Salt Dissolution



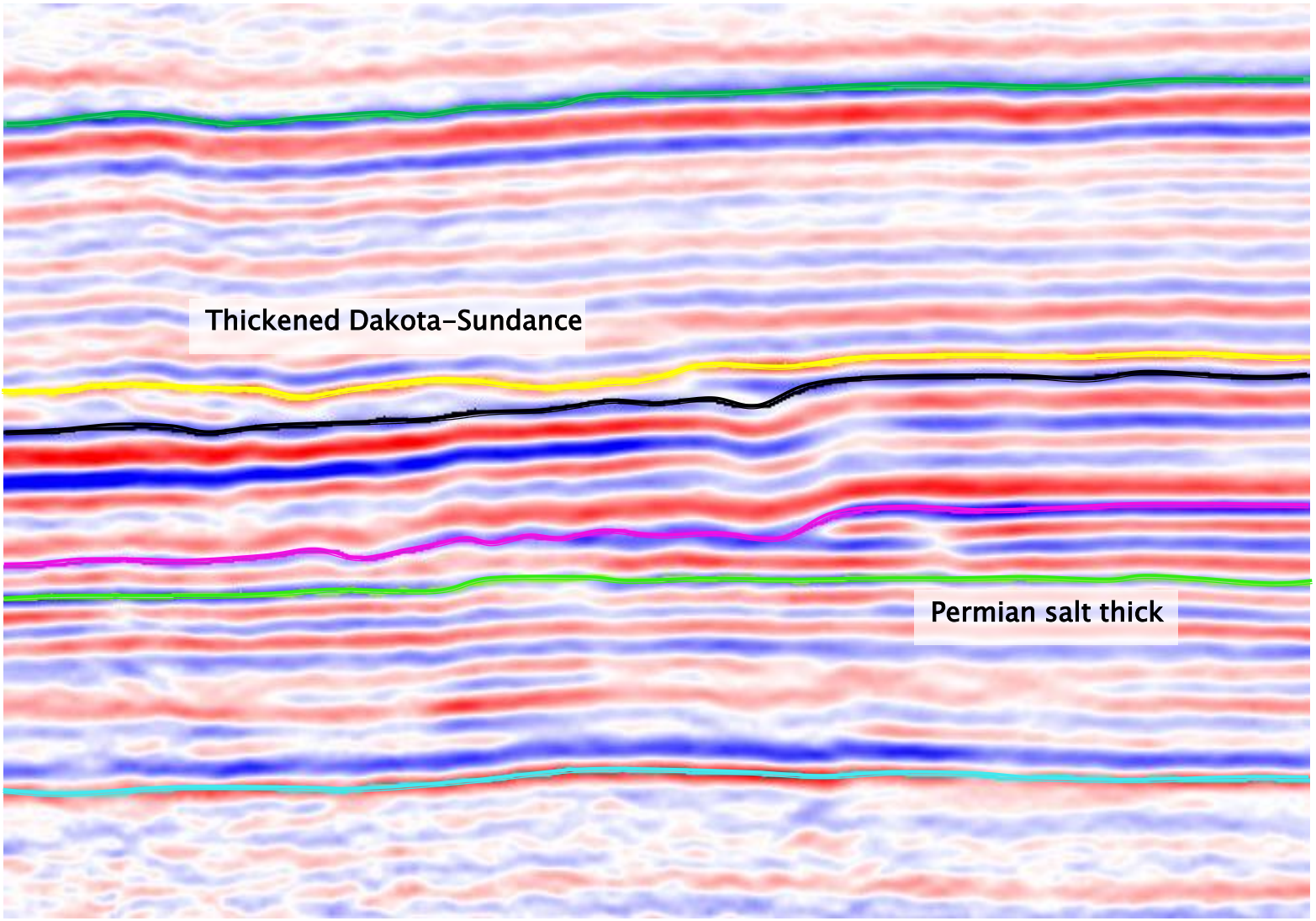
Weimer, 1983

Permian Salt Dissolution



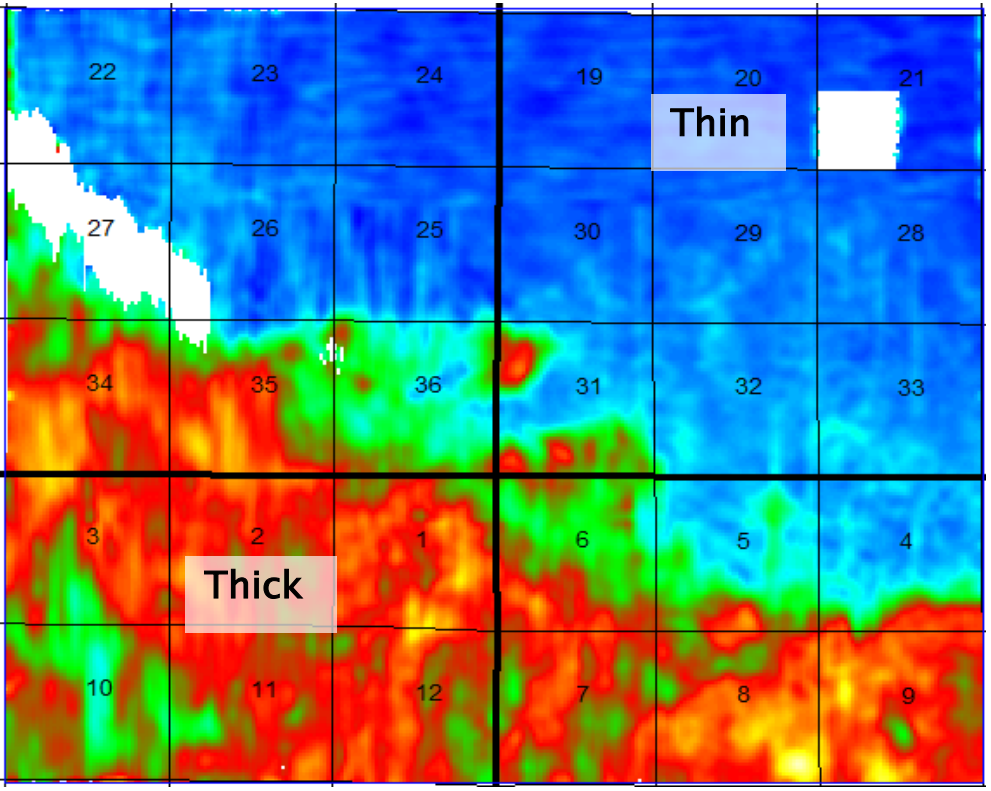
From Oldham, 1996

Permian Salt Dissolution

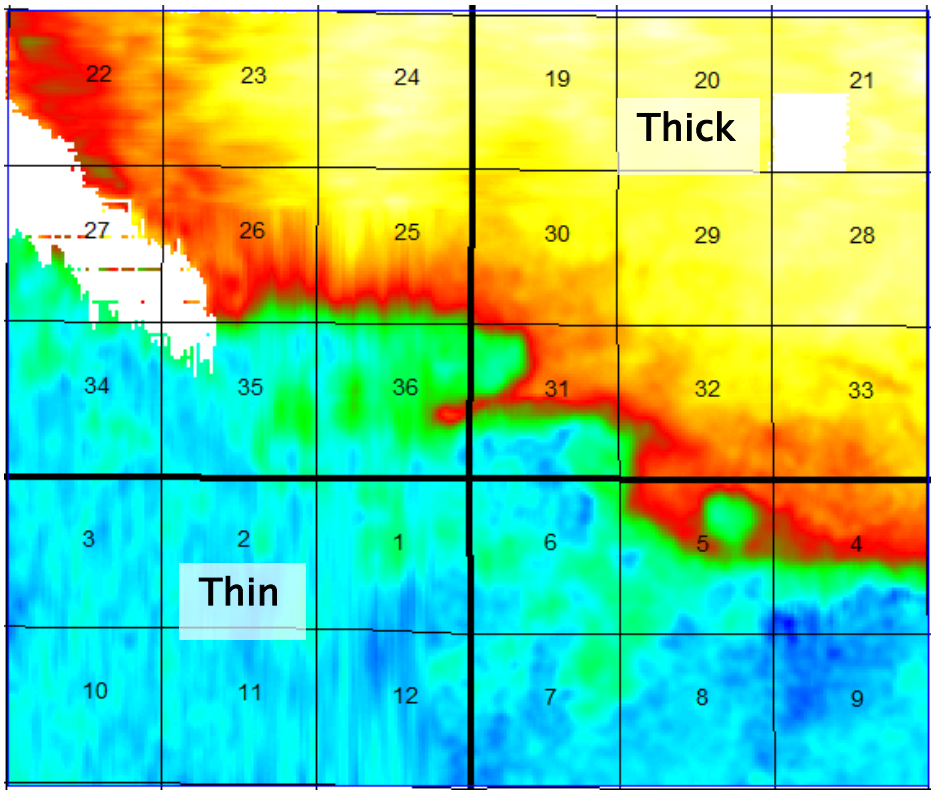


Permian Salt Dissolution

Dakota- Sundance Isochron

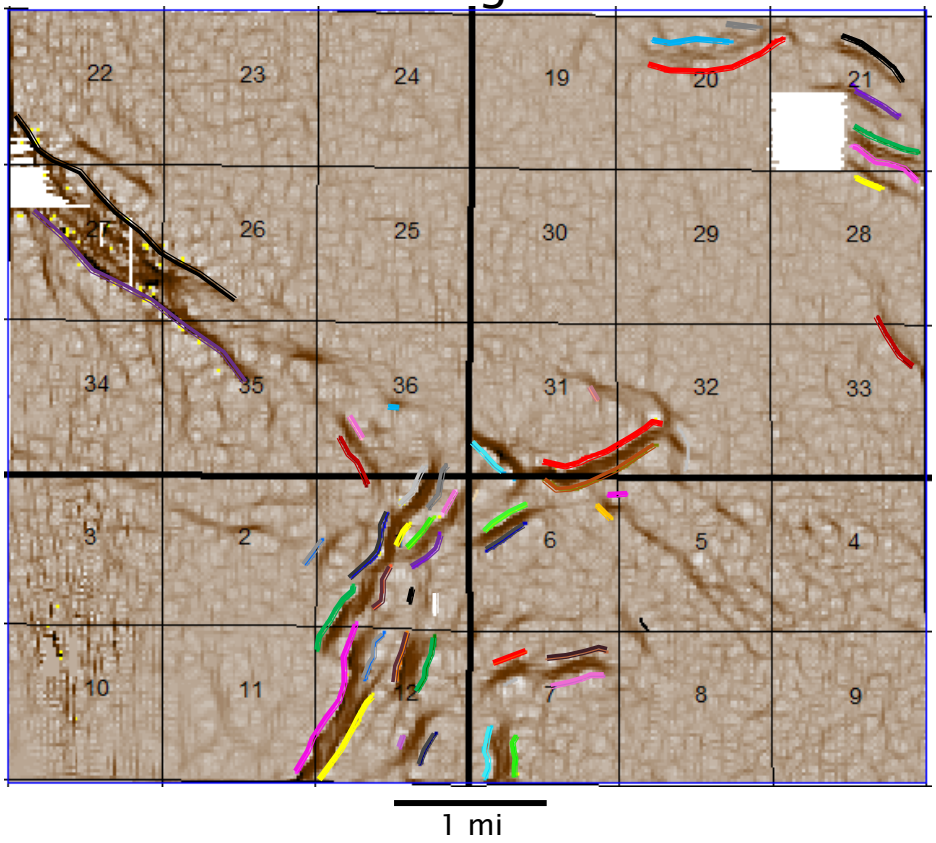


Permian Salt-Wolfcamp Isochron

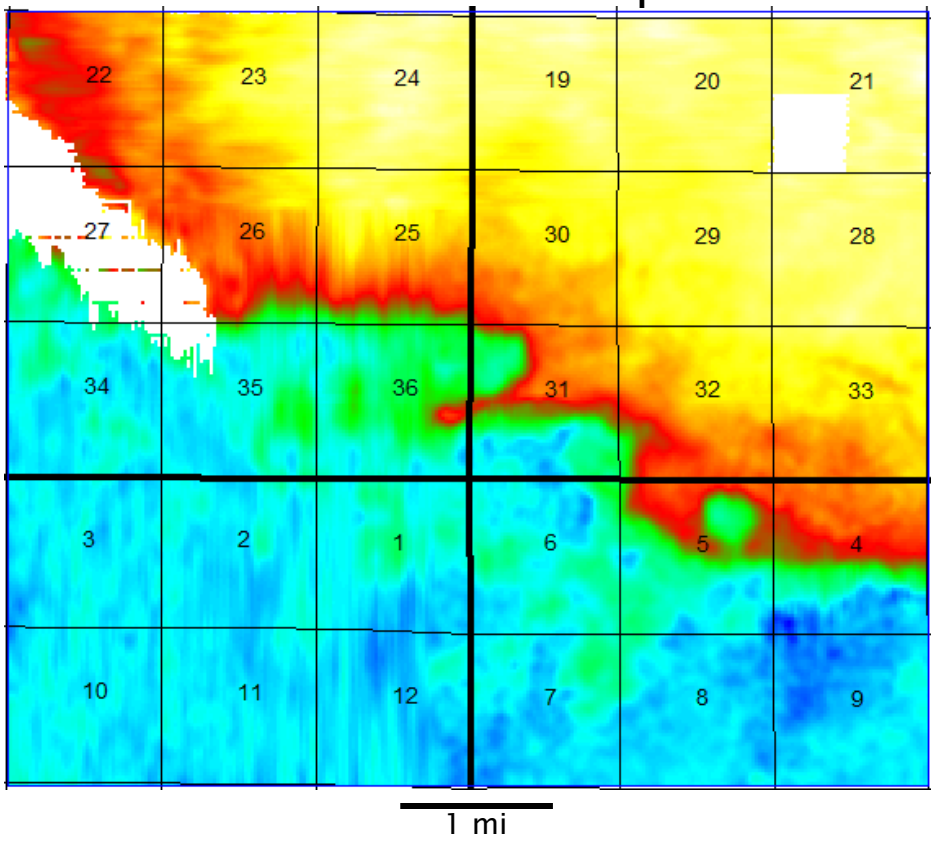


Permian Salt Dissolution

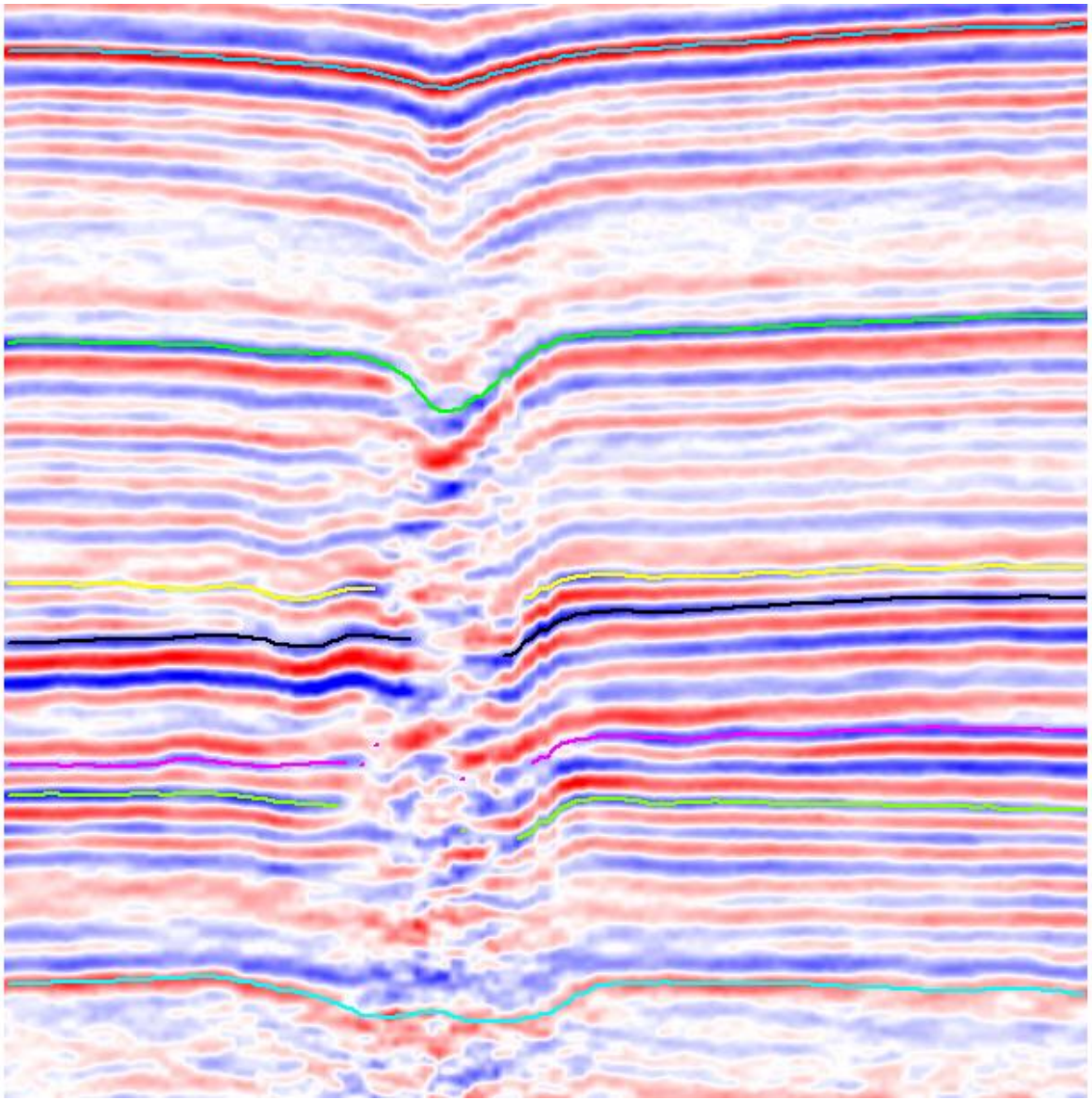
Niobrara Most Negative Curvature



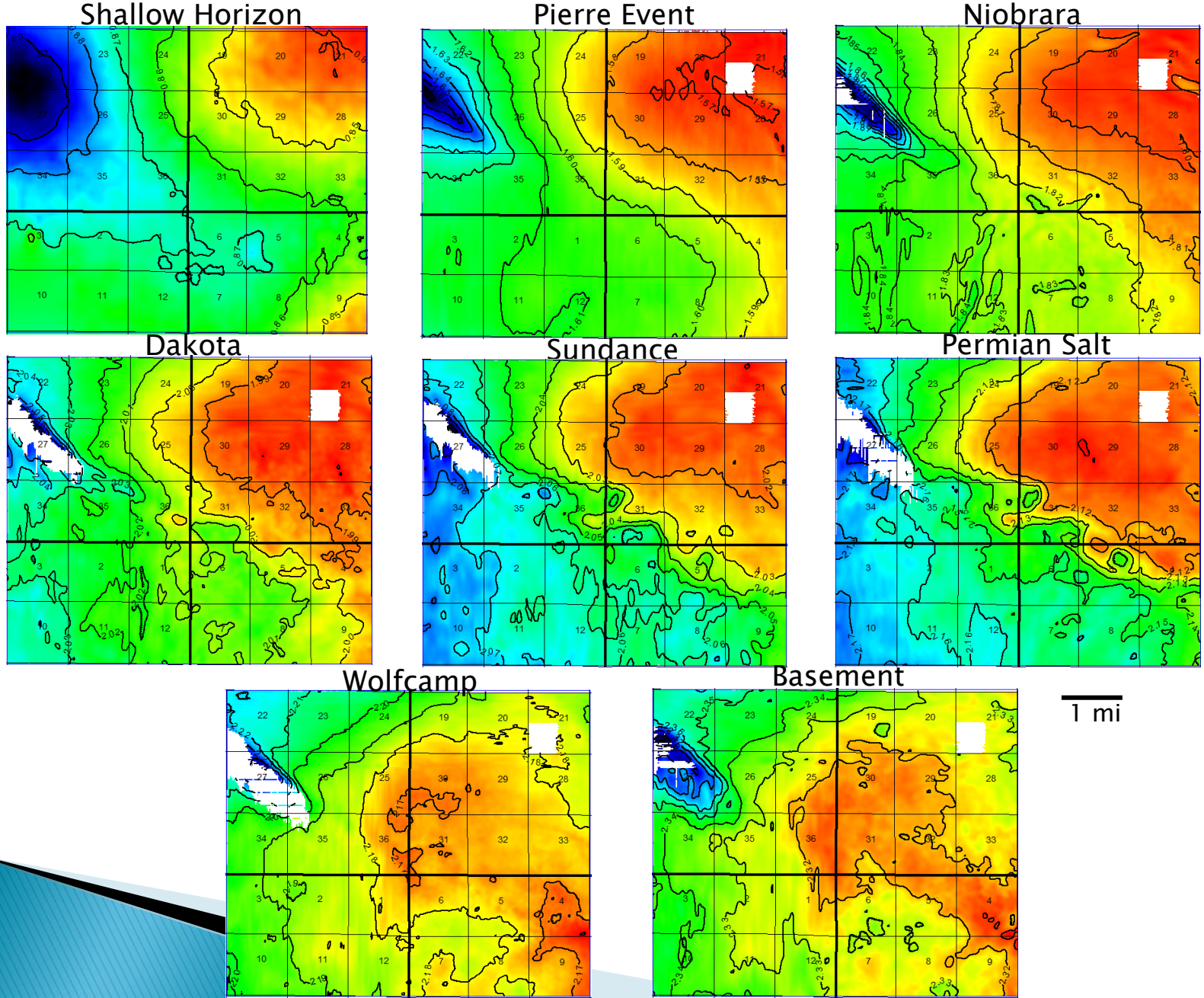
Permian Salt-Wolfcamp Isochron



Wrench Faults

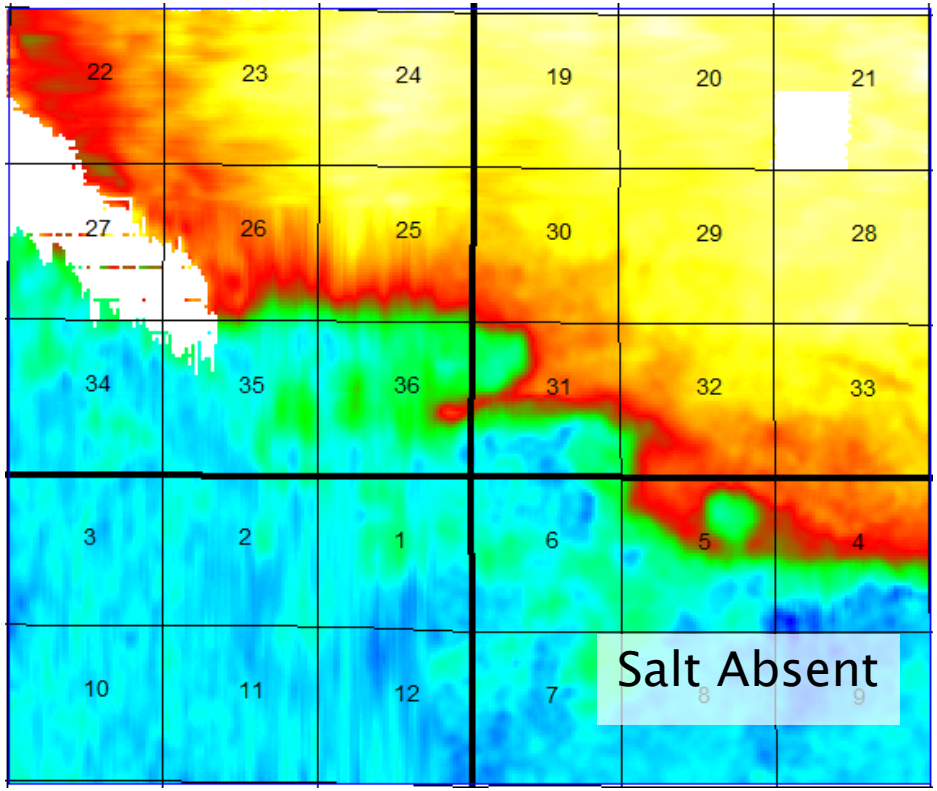


Structure and Dissolution

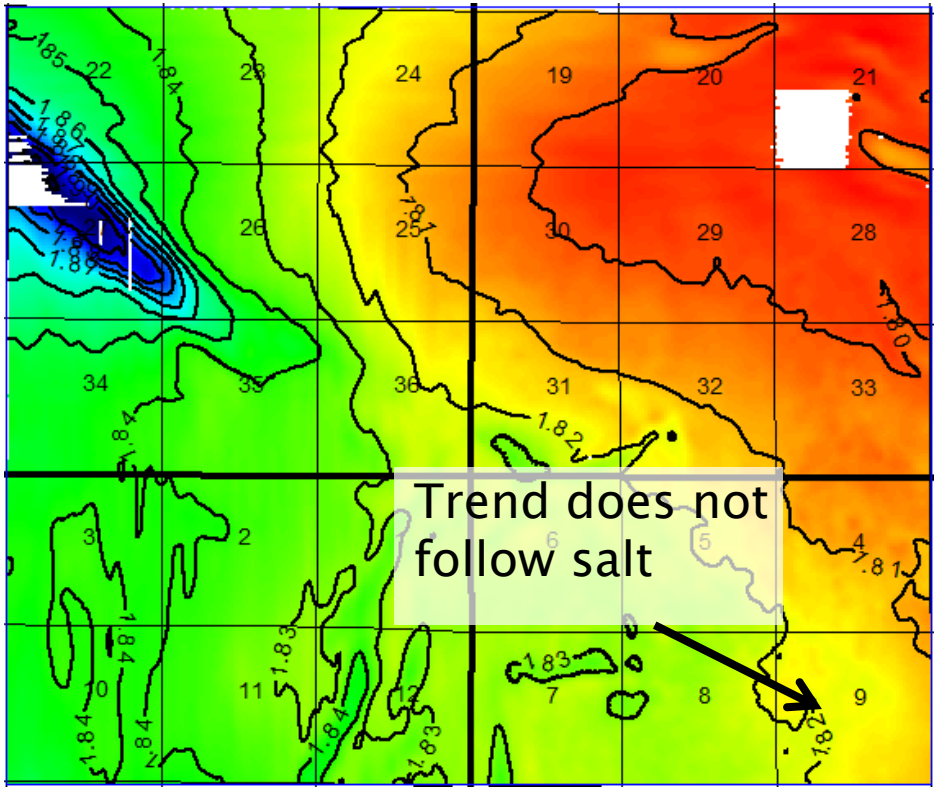


Permian Salt and Structure

Permian Salt-Wolfcamp Isochron



Niobrara Time-Structure



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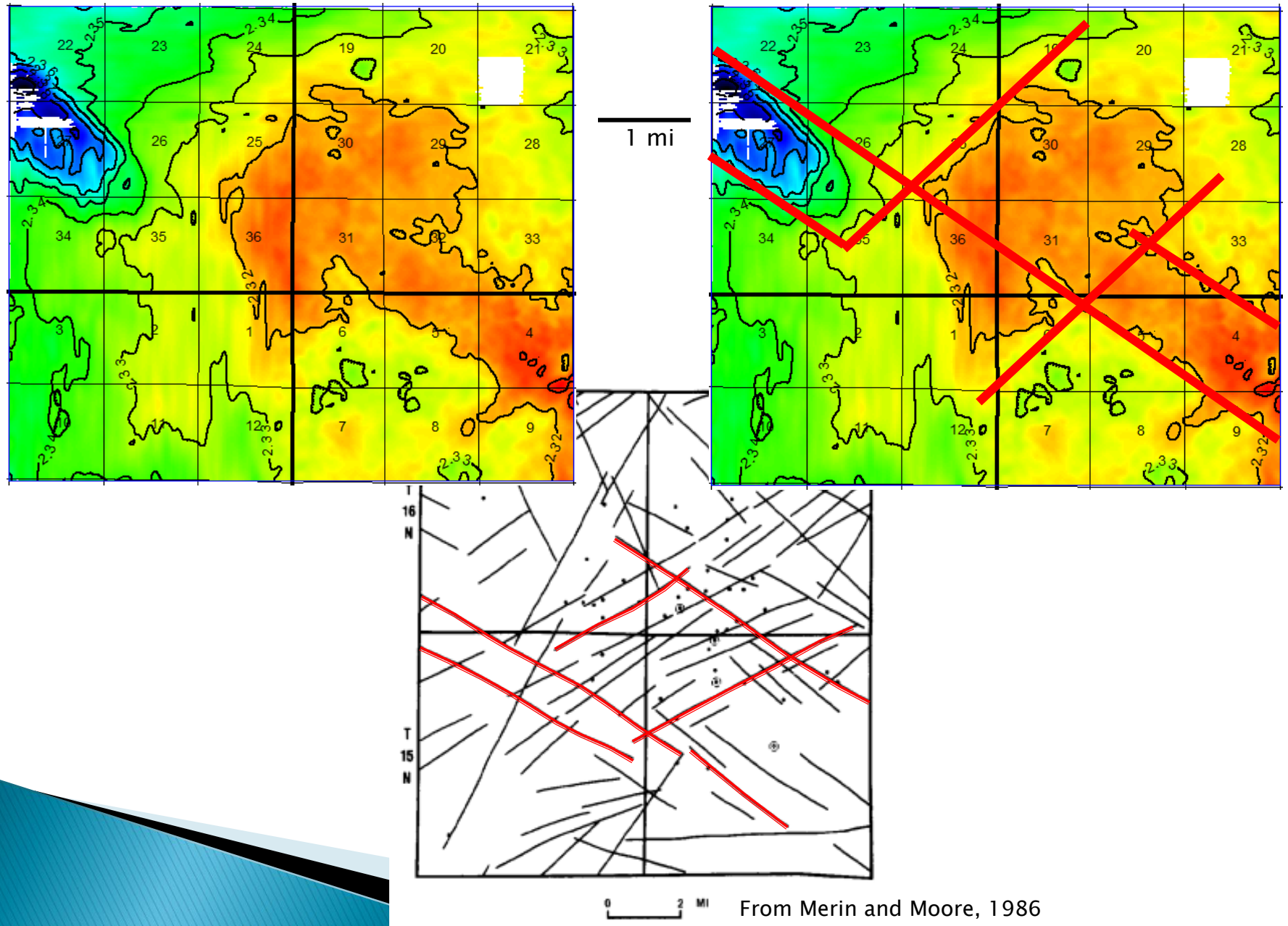
Basement Faults



From Merin and Moore, 1986

Conclusions

- Permian salt edge is dissolutional
  - Dissolution occurred in Late Jurassic–Early Cretaceous
- Dissolution caused thickening of Dakota–Sundance interval
- Basement structure controlled dissolution
  - Lyons Formation may have played a role
- Salt edge partially responsible for structure in Silo Field