Reinterpretation of Tulare Depositional Environments and Reservoir Distribution, a Case for Two Depositional Sources in North Midway Sunset Oil Field, San Joaquin Basin, California*

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Abstract

The Midway Sunset (MWSS) Oil Field is a prolific field in the western San Joaquin Basin that has produced over 3 BBO since its discovery in 1909. Early production was mainly in the Miocene Potter turbidite sand. The Plio-Pleistocene Tulare was developed as a secondary reservoir starting in the early 1980s. The Tulare represents a variety of depositional environments, reservoir qualities and productivity. It has been targeted for development by various operators in North MWSS, yet little has been published about this unit, and what publications exist are at a regional scale compared to detailed, production-scale mapping presented here.

Previous regional interpretations of the North MWSS depositional environment for the Tulare assume a single depositional source from the Temblor Range, gradually changing in depositional environment from a bajada/alluvial system to fluvial systems, then into a lacustrine environment, from west to east respectively (Nielson, 1989). Recent regional mapping of the Tulare at North MWSS shows an abrupt unconformity that puts the reservoir sands laterally adjacent to a shale interval. In light of this data, I present a new depositional model that has two sources. One from a bajada/alluvial system flowing west-to-east which ends at a sinuous unconformity. The geometry of the unconformity is likely controlled by the Midway Syncline and the Globe Anticline. The second depositional source on the eastern portion of the field flows from north-to-south in a pro-delta system in a lacustrine environment. This presents a different distribution of sand and possible reservoirs for economic production in the Tulare. The different orientations and changes in depositional environment explain the previously inexplicable differences in oil production by areal extent. It also brings up questions of the uplift history in North Midway Tulare, not previously explored.

The Tulare represents a variety of depositional environments, reservoir qualities and production potential. Its heavy biodegraded oil (8-12 API) that requires tight well spacing, down to ¾ acre well spacing in heterogeneous alluvial fans or very thin-bedded lacustrine settings. This localized variation warrants different development strategies and will lead to varying production results. Mapping these environments at a local level could lead to more appropriate strategies and predictions for oil production in the Tulare.

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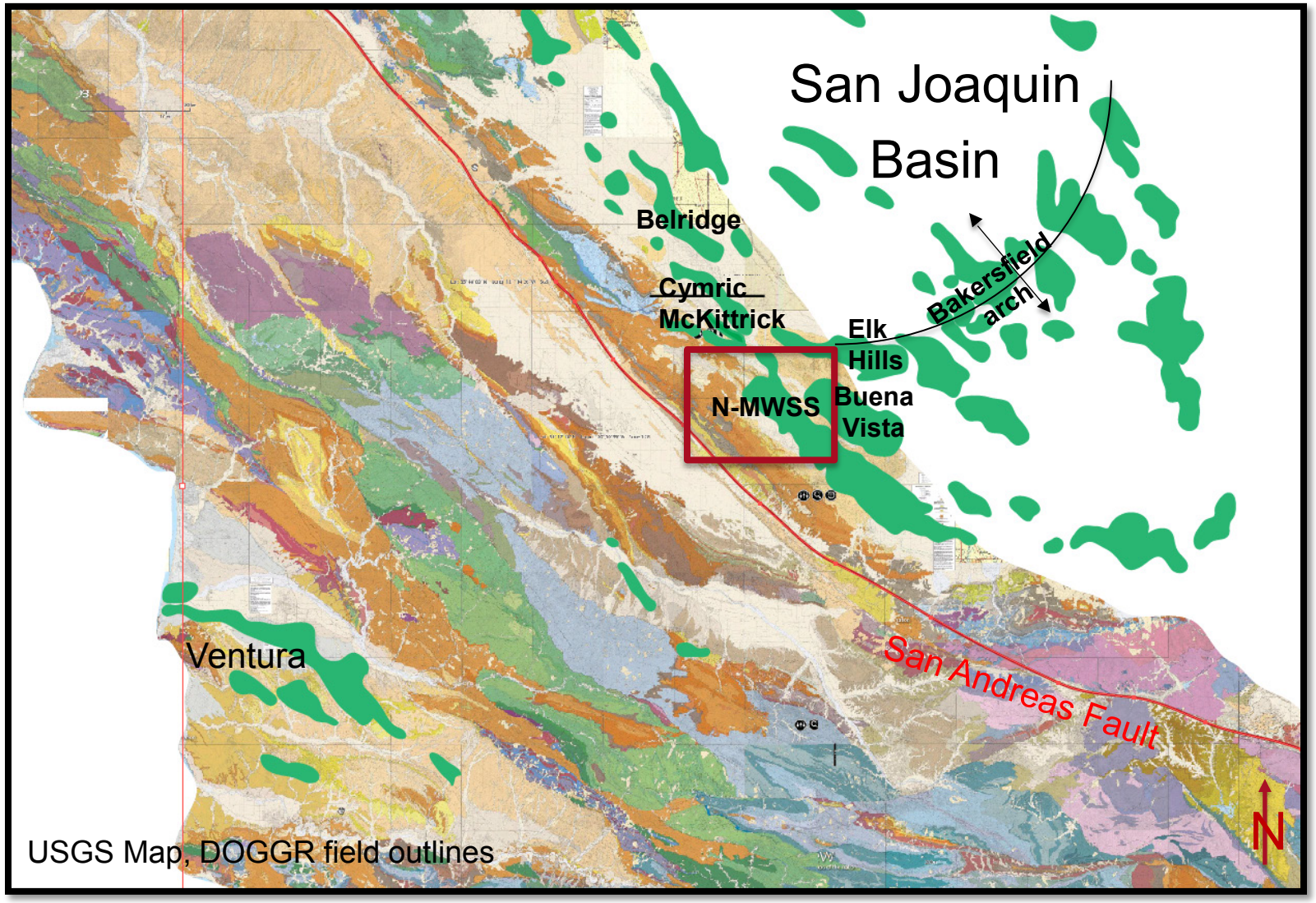
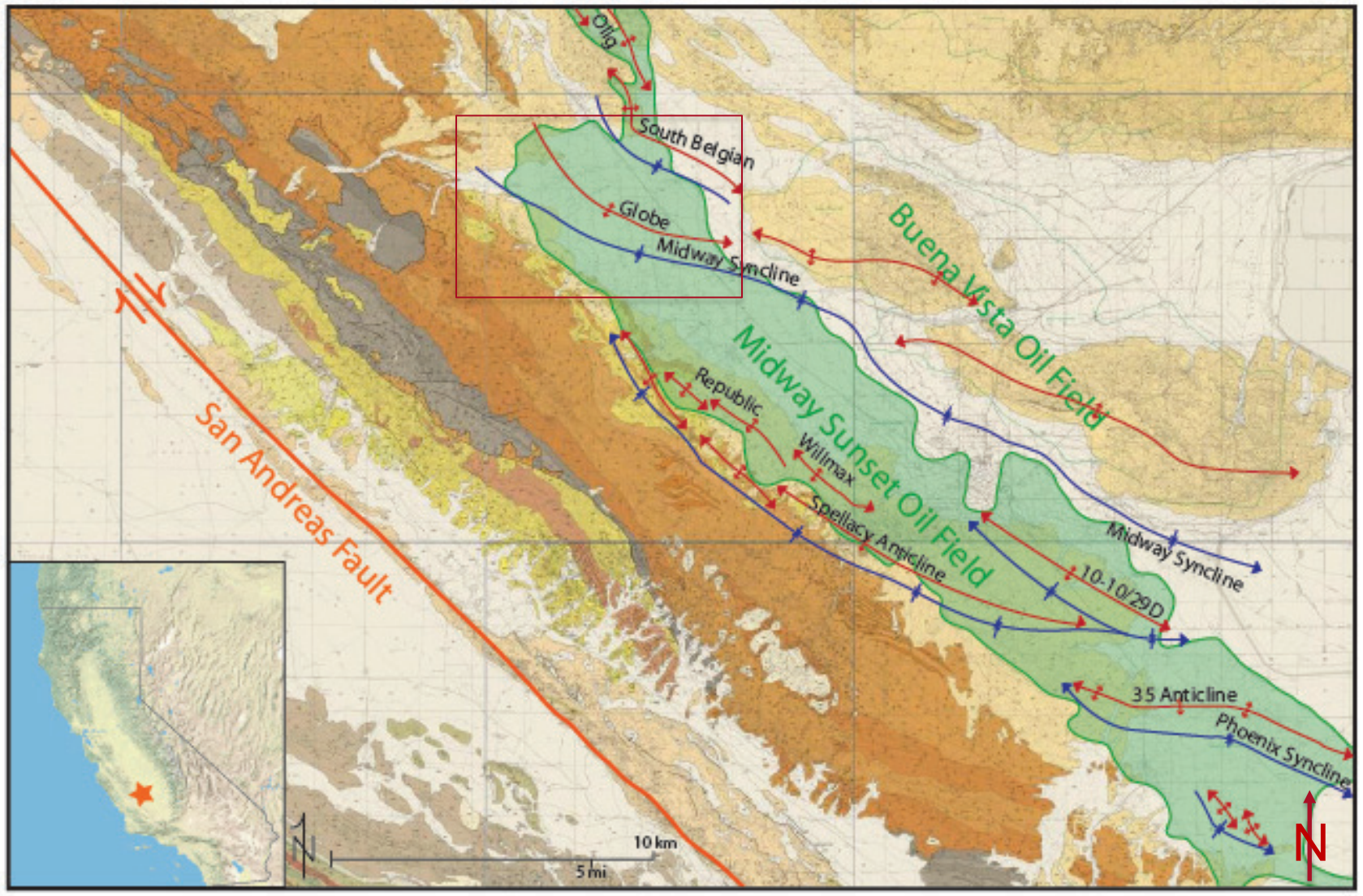
Outline

1. Regional tectonic setting
2. Identification of unconformity
3. Tulare depositional environments in North Midway-Sunset (N-MWSS)
4. Conclusion and implications

N-MWSS is on the western margin of the San Joaquin Basin



Tectonically active region with broad folds



Modified from USGS Dibble Maps, Tor Nielson folds

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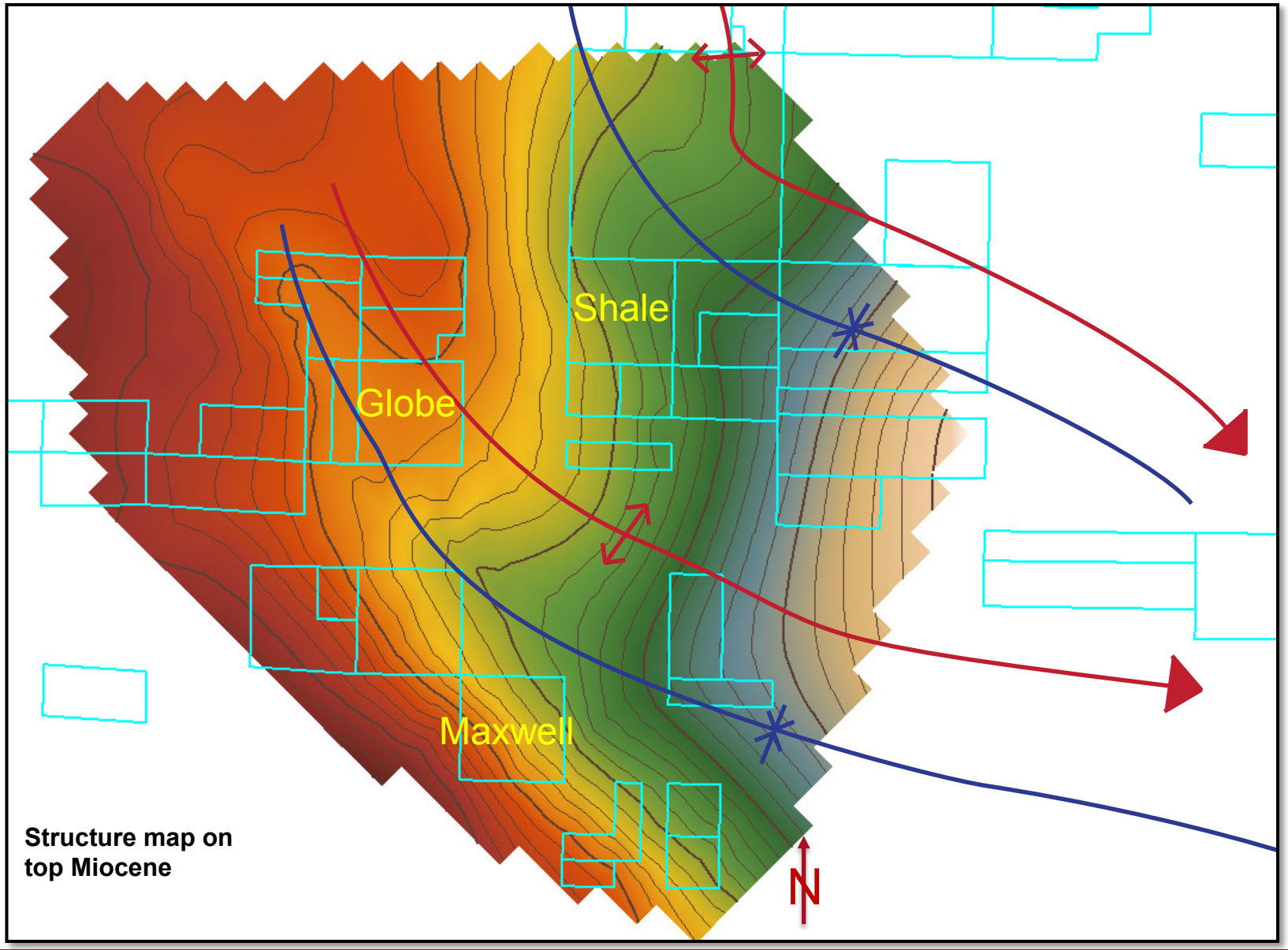
Basin filled in with Tulare Formation

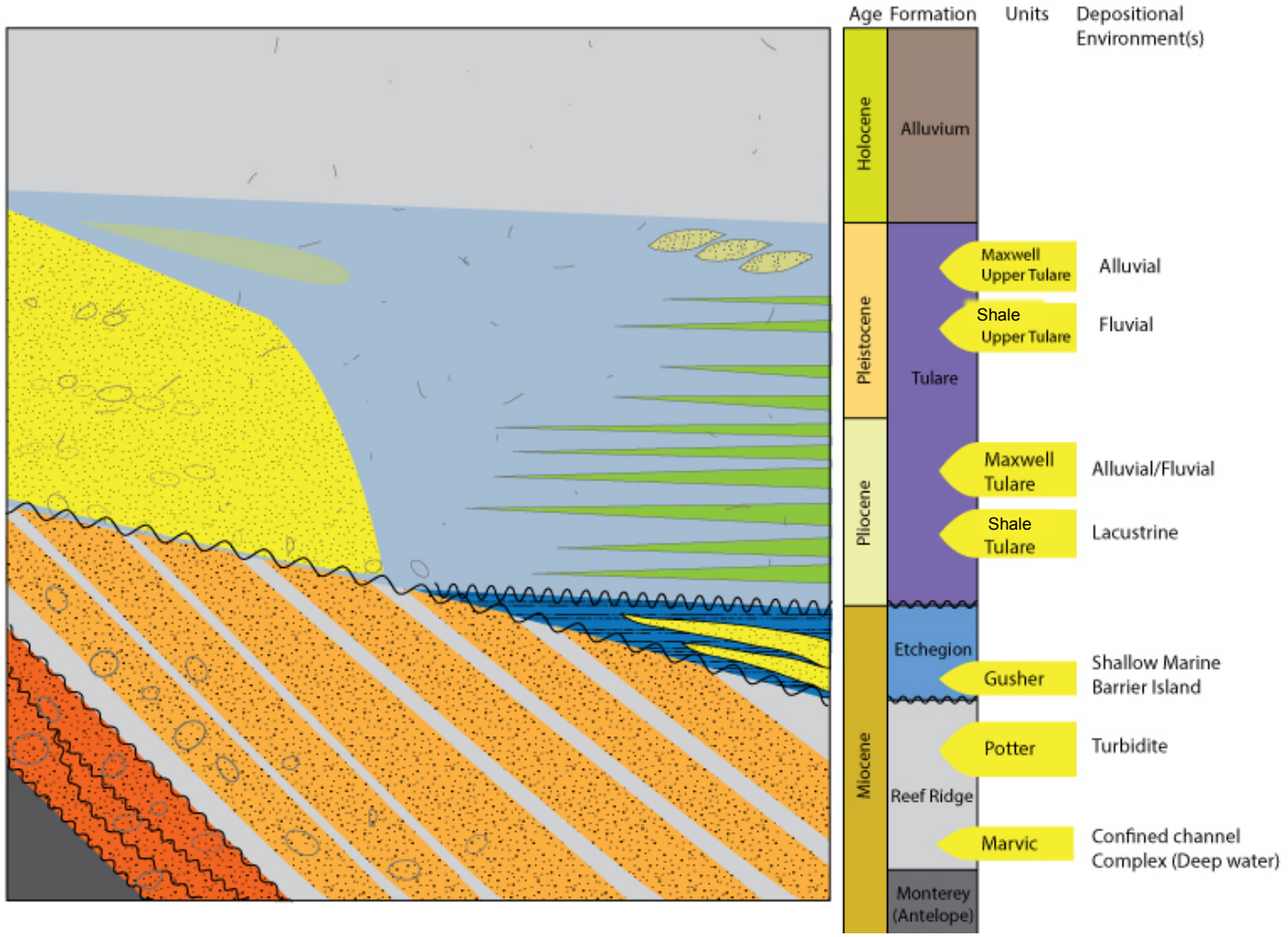


Structure map on
top Miocene

Tulare Formation

- The Tulare Formation is defined as any rock Pilo-Pleistocene in age
- Due to active tectonics, the Tulare Formation includes varied rock types with quick changes in depositional environment
- Various rock types filled in the basin created by en-echelon folding

Stratigraphic column



Tulare development

History

- As Potter production declined, Tulare was developed as a secondary reservoir.
- The Tulare was developed starting in the 1980's and accelerated in the 2000's, inspiring more geologic studies.

Question

- Why does the Tulare within North MWSS produce so differently between leases?

Challenges

- Postage stamp mentality on leases and data coverage

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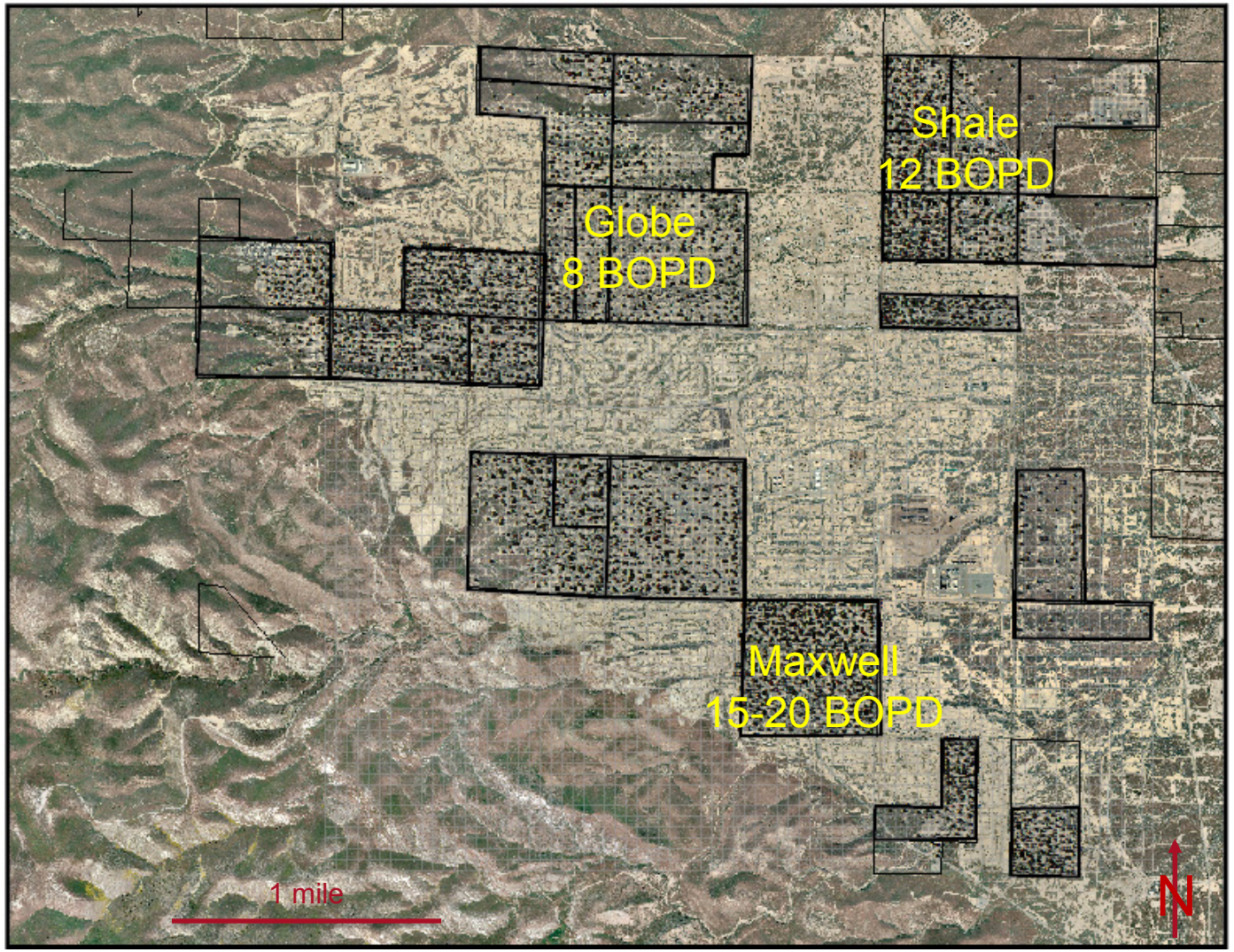
Tulare production by lease is variable



Variety in depositional environments: Tulare N-MWSS

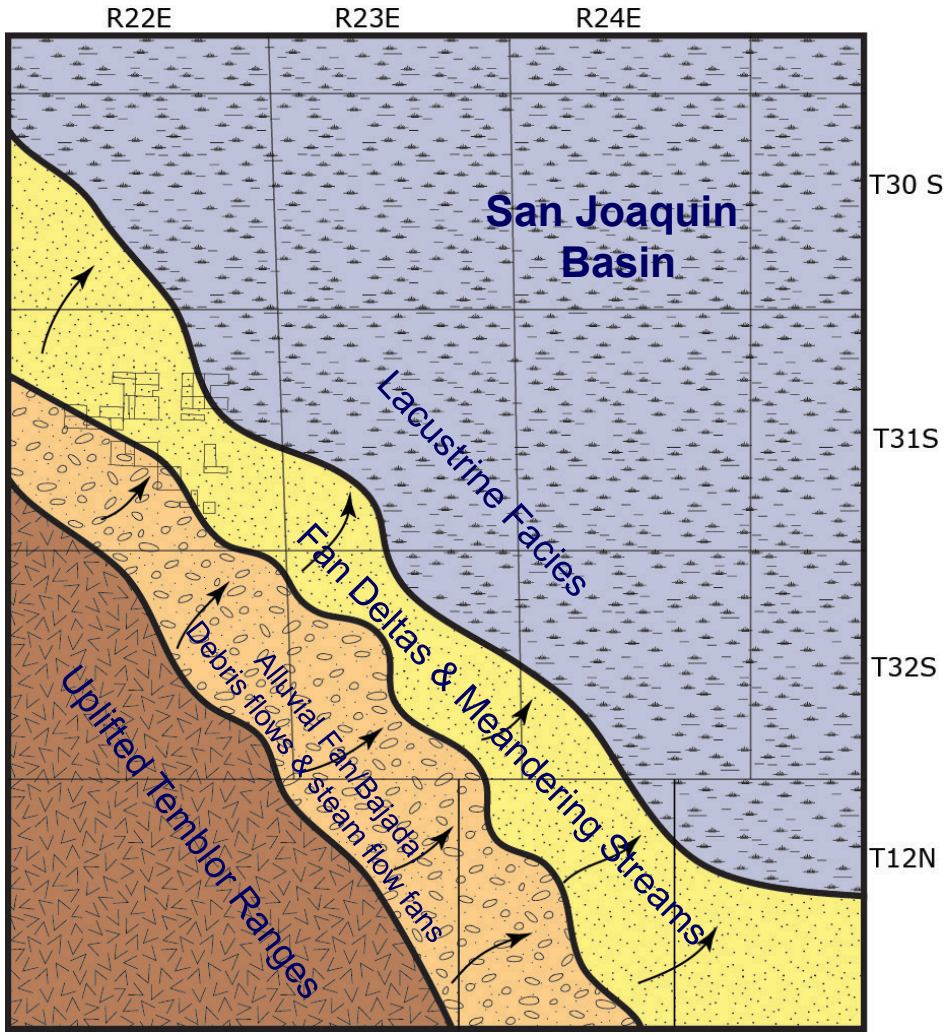
- Tulare cores show internal and lateral heterogeneity

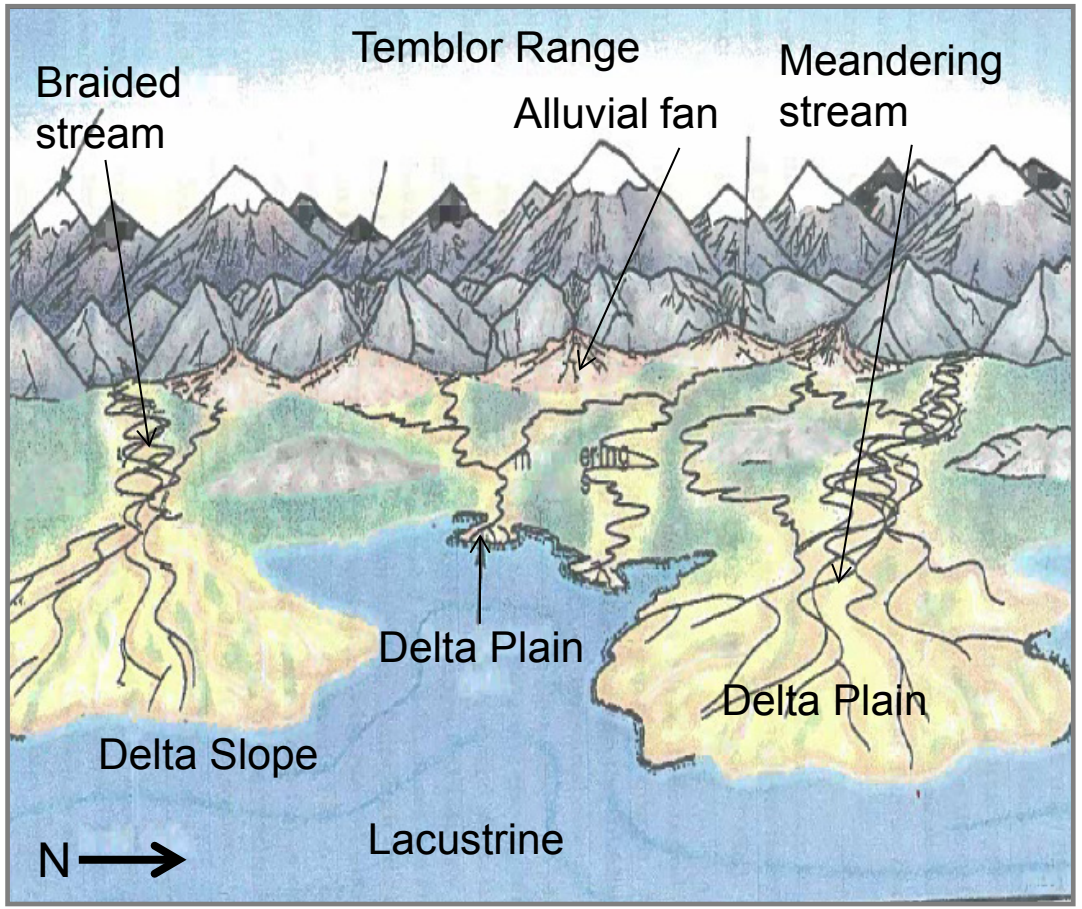
Alluvial Fan

Braided System

Lacustrine Margin

A San Joaquin Basin scale model for Tulare



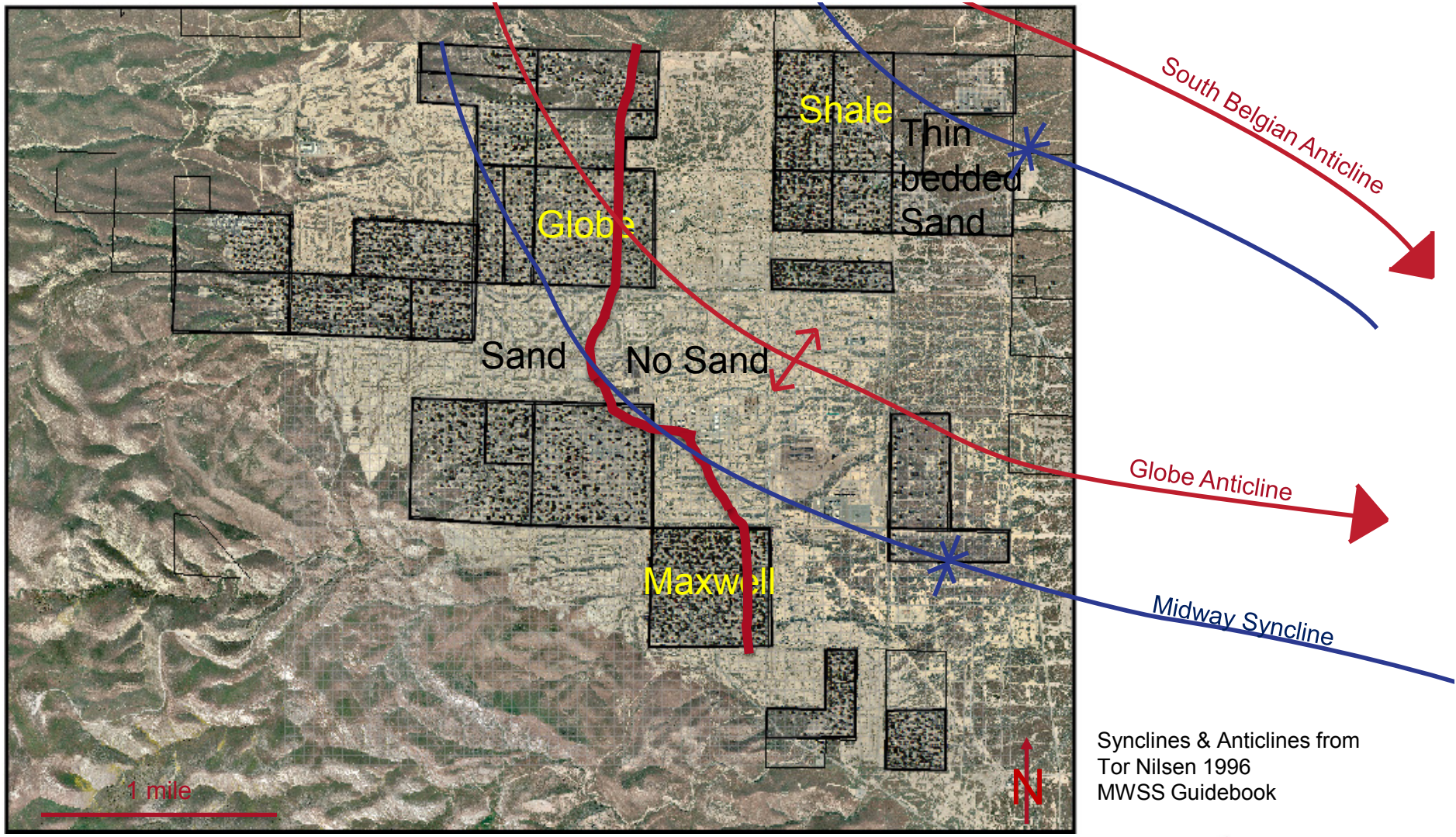


After McPherson, 1989

Finding the ‘Sand-edge line’- is it a new unconformity?

The new observation of a sub-vertical unconformity is incongruent with previous regional models

Scale of mapping was key to the interpretation



Synclines & Anticlines from
Tor Nilsen 1996
MWSS Guidebook

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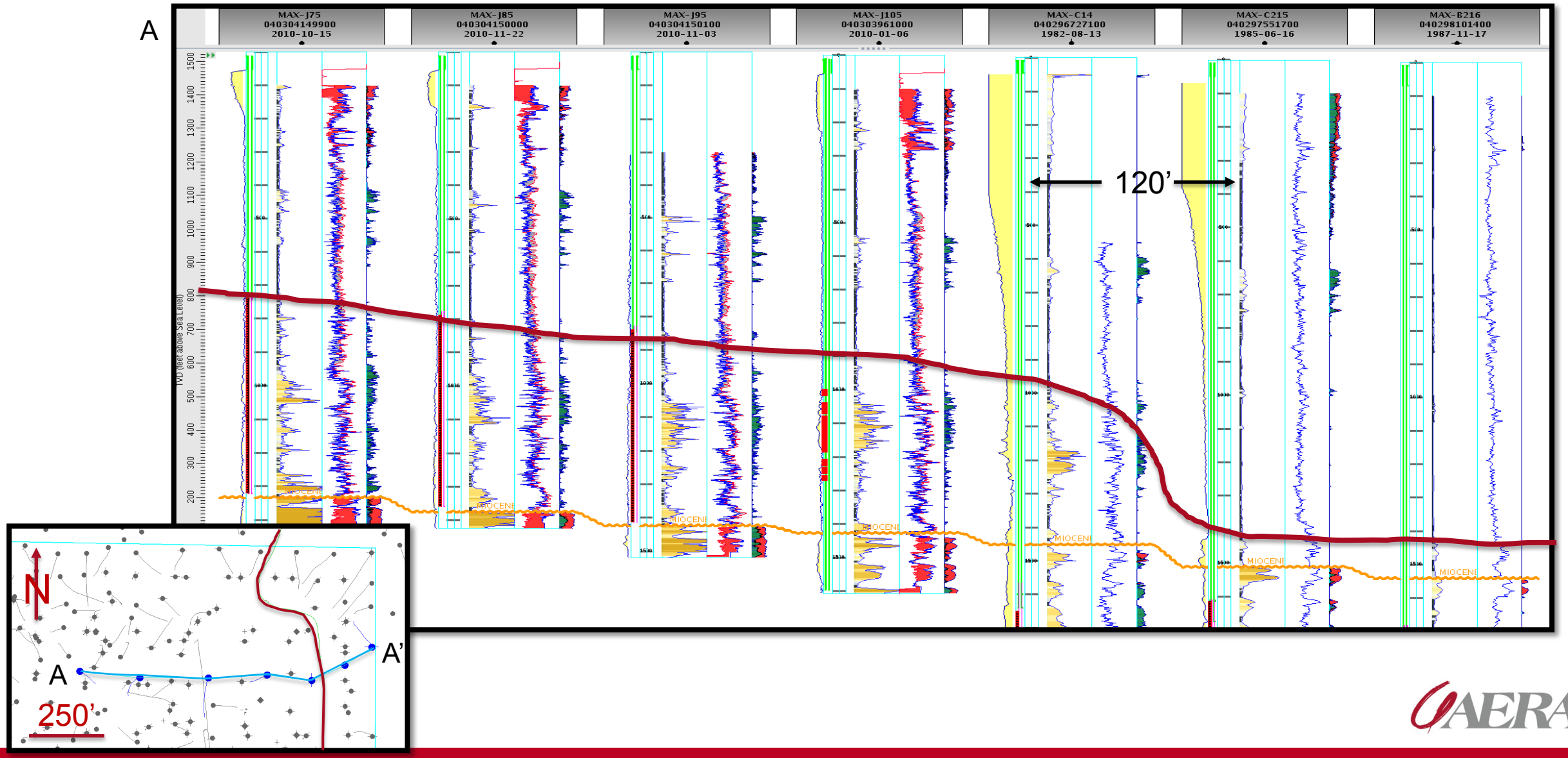
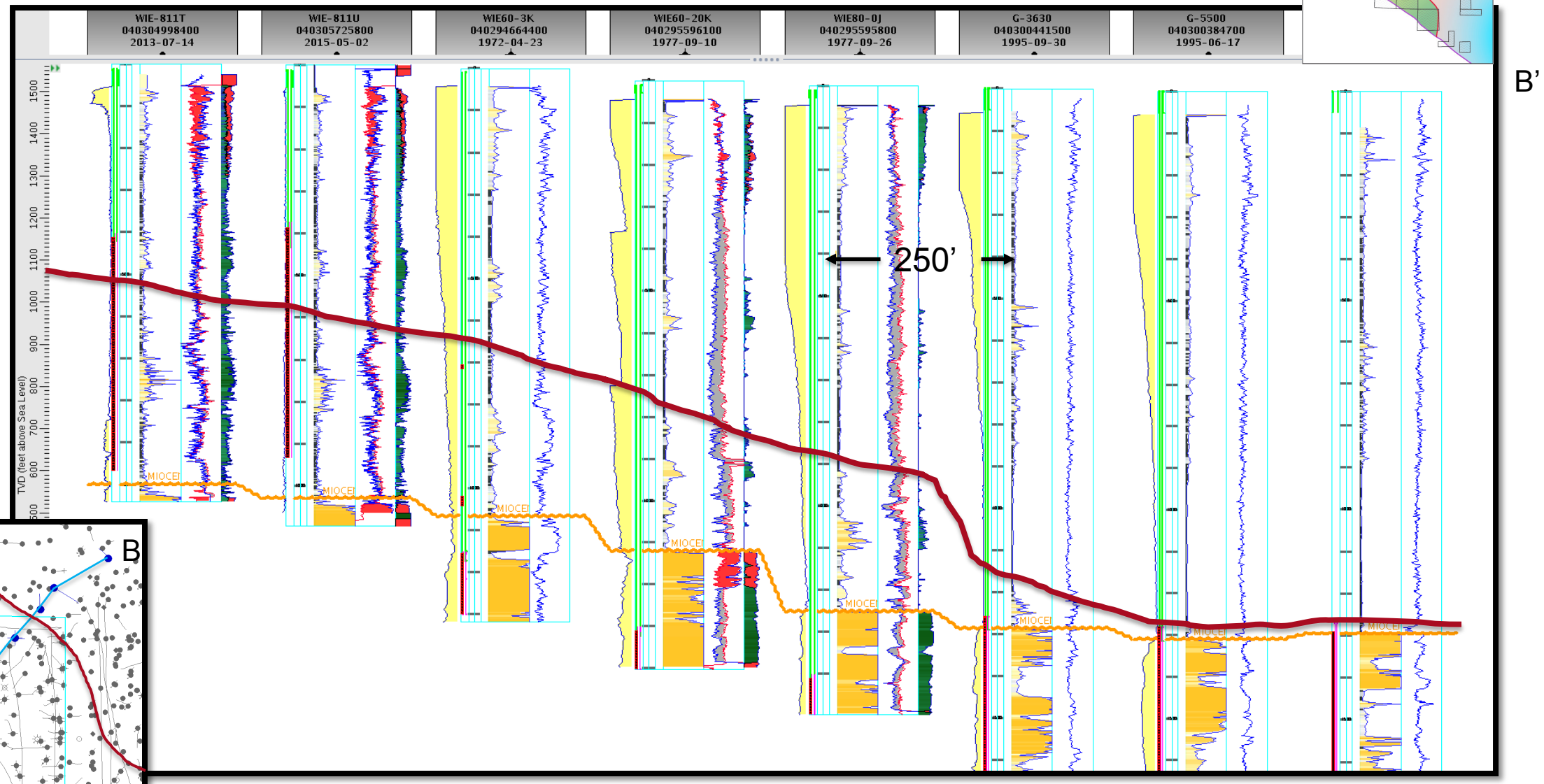
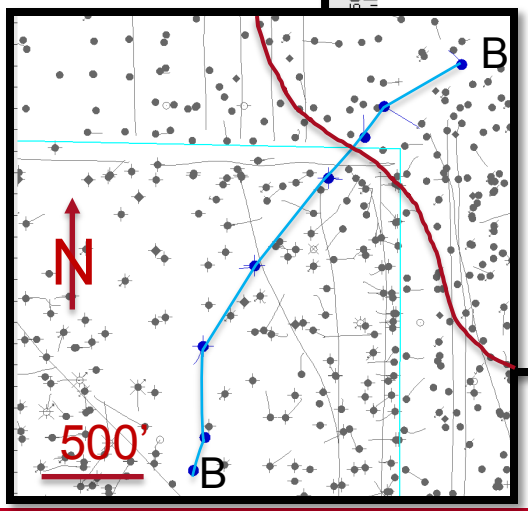
Unconformity at Maxwell

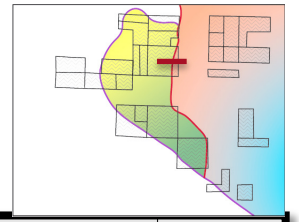


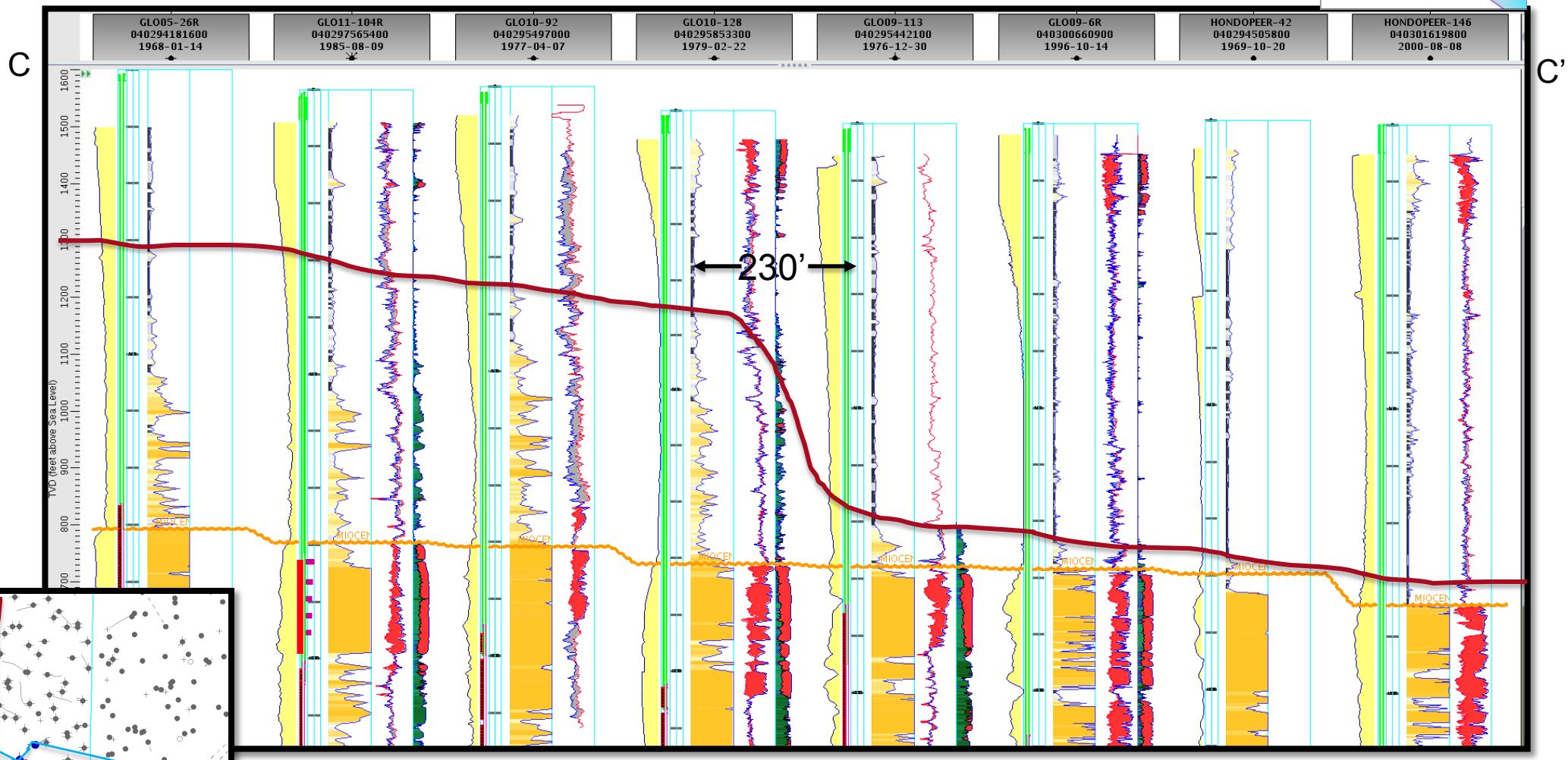
Unconformity at Weir

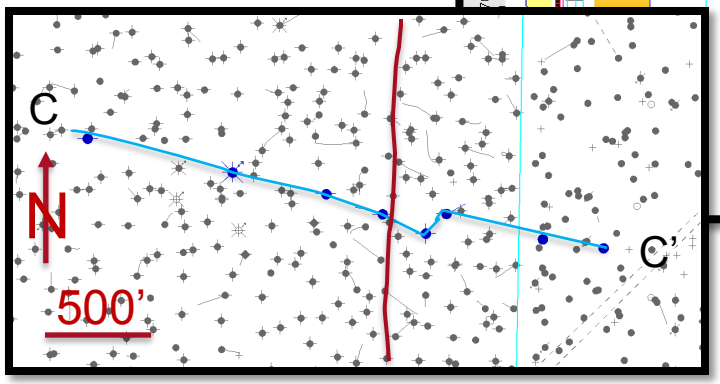




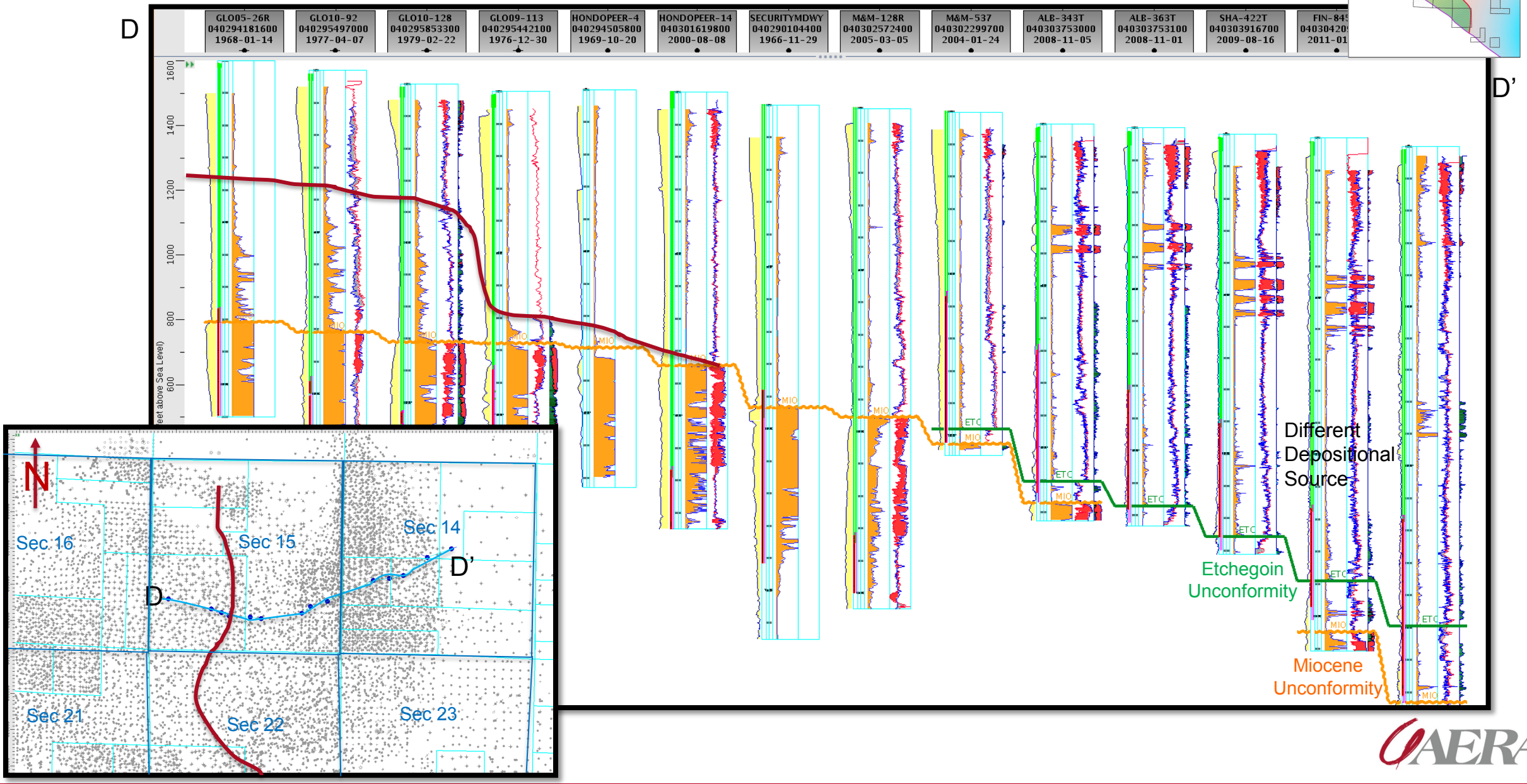
Unconformity at Globe



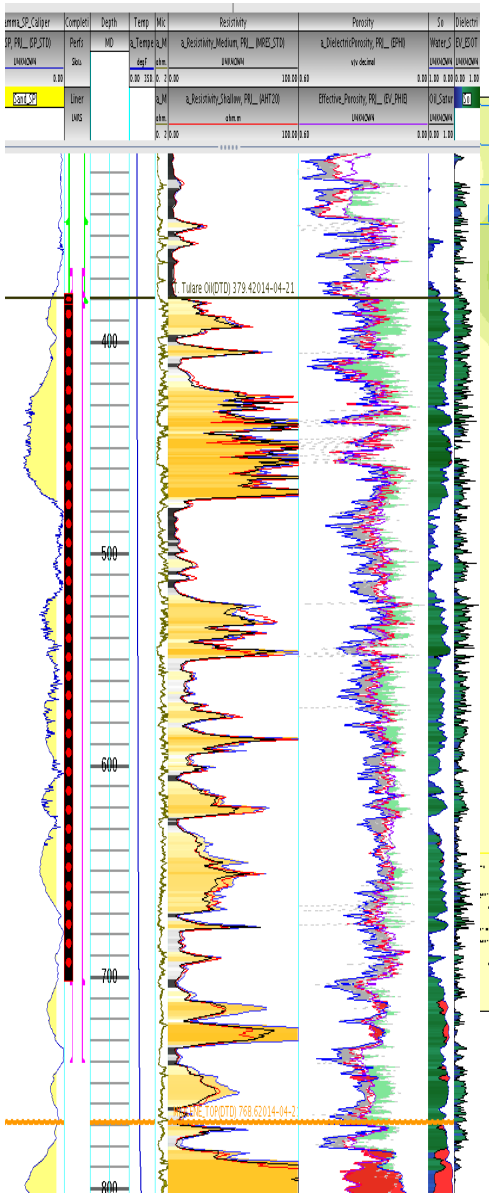


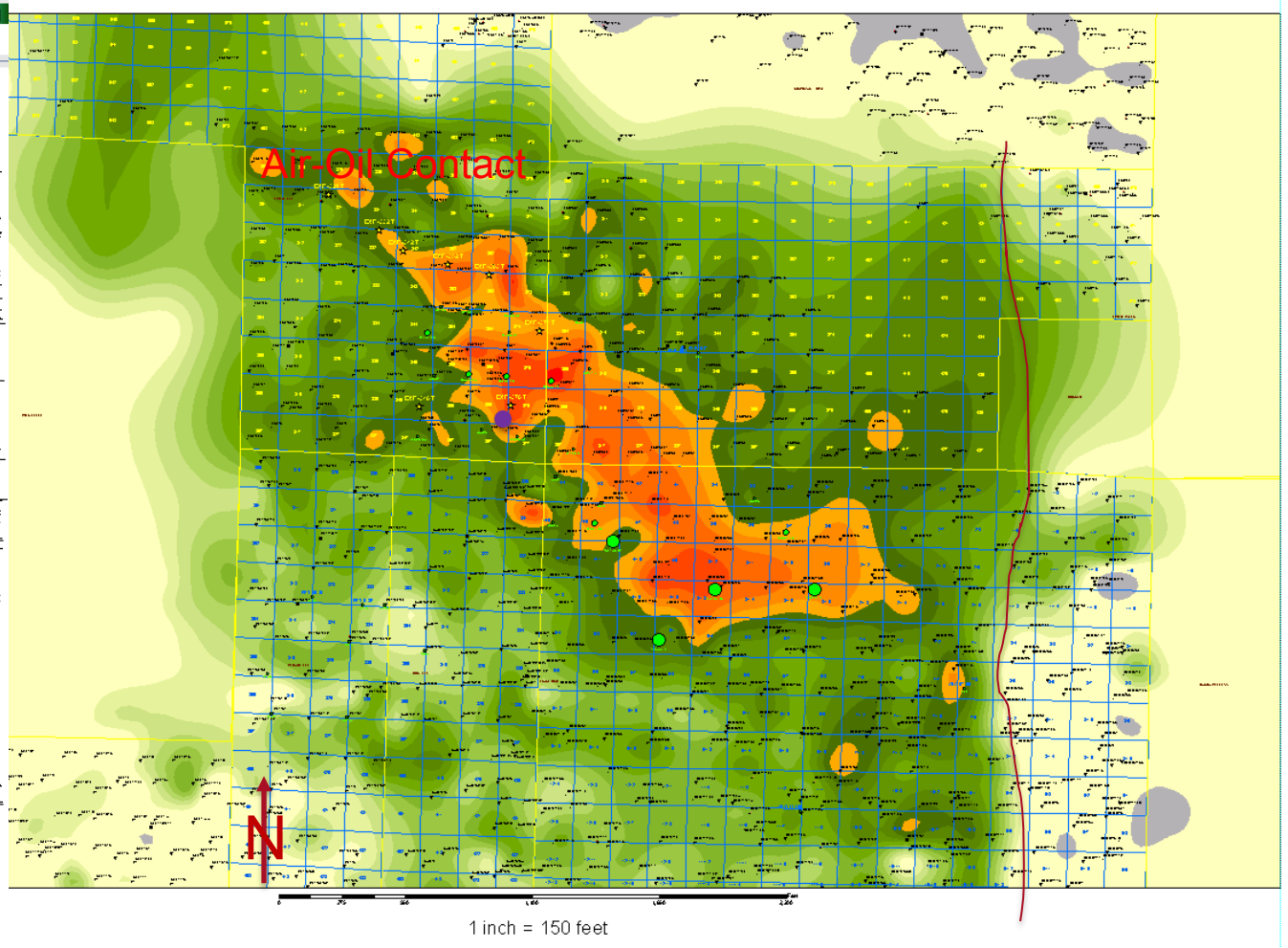


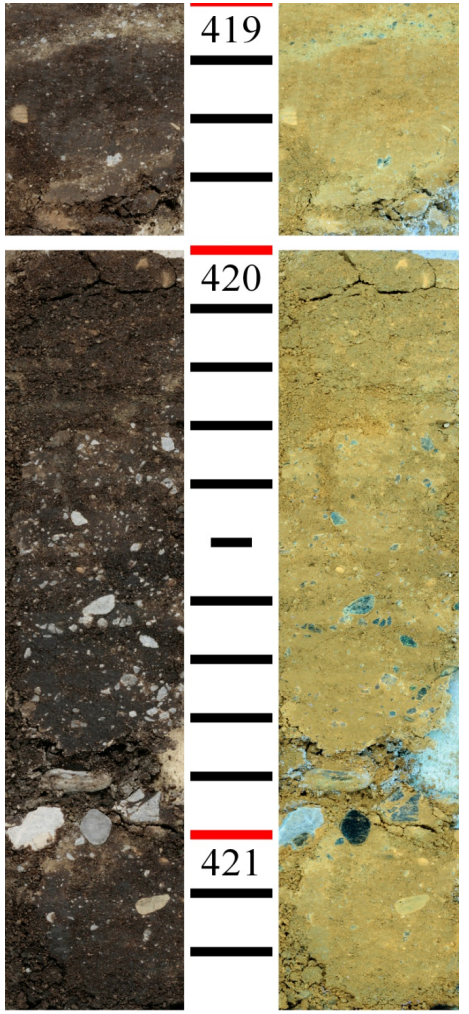
North Midway-Sunset cross-section



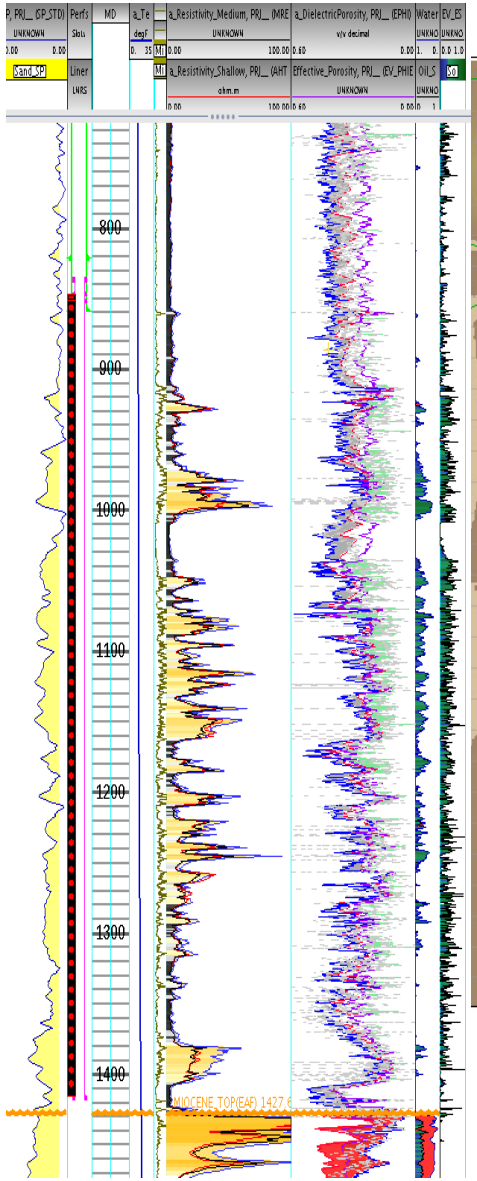
Globe Aera Tulare- net pay

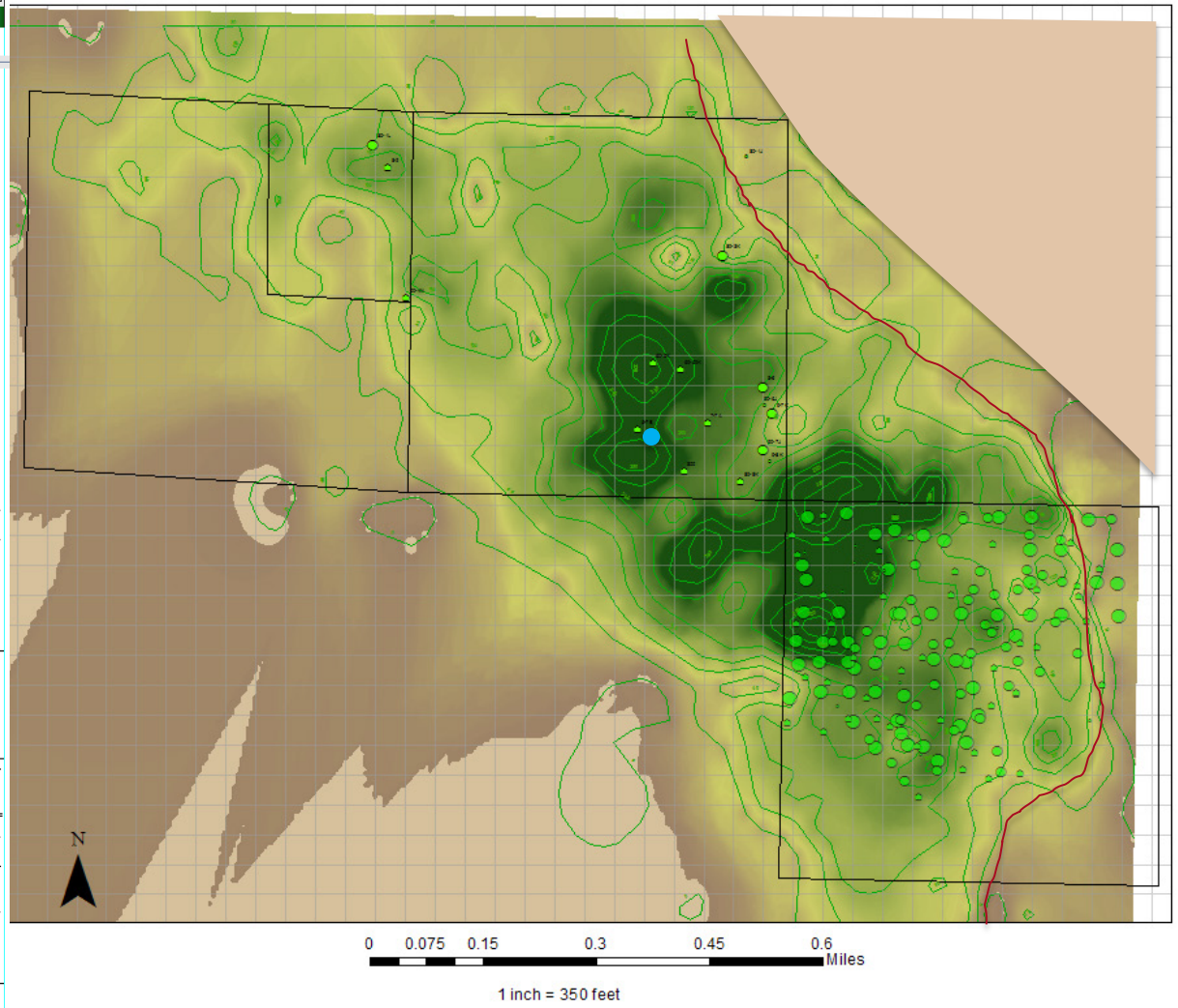




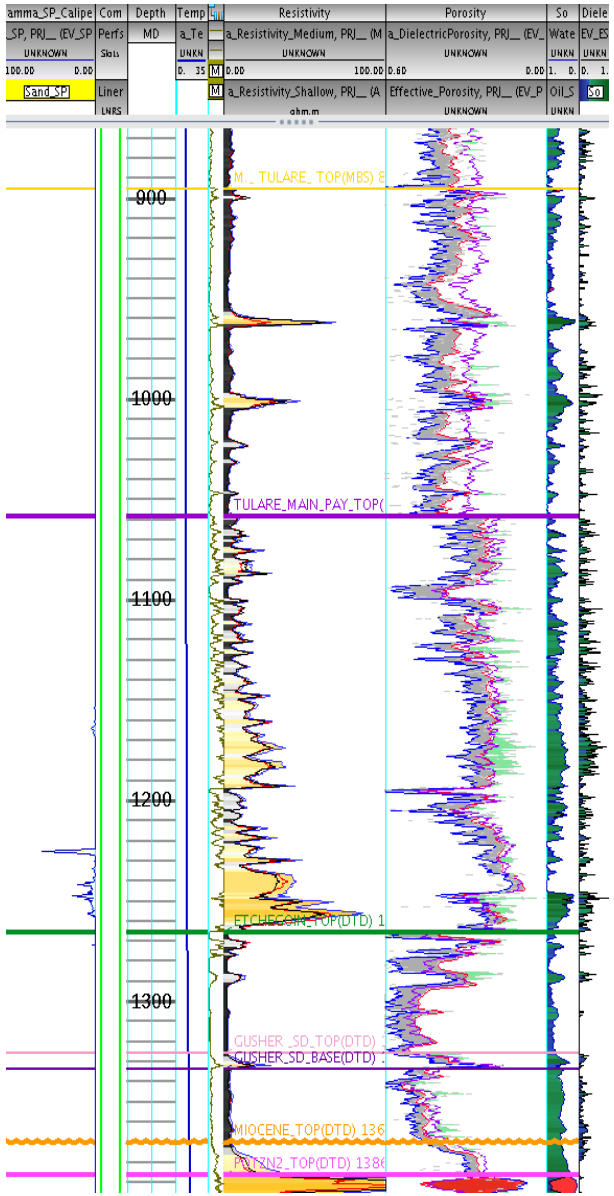


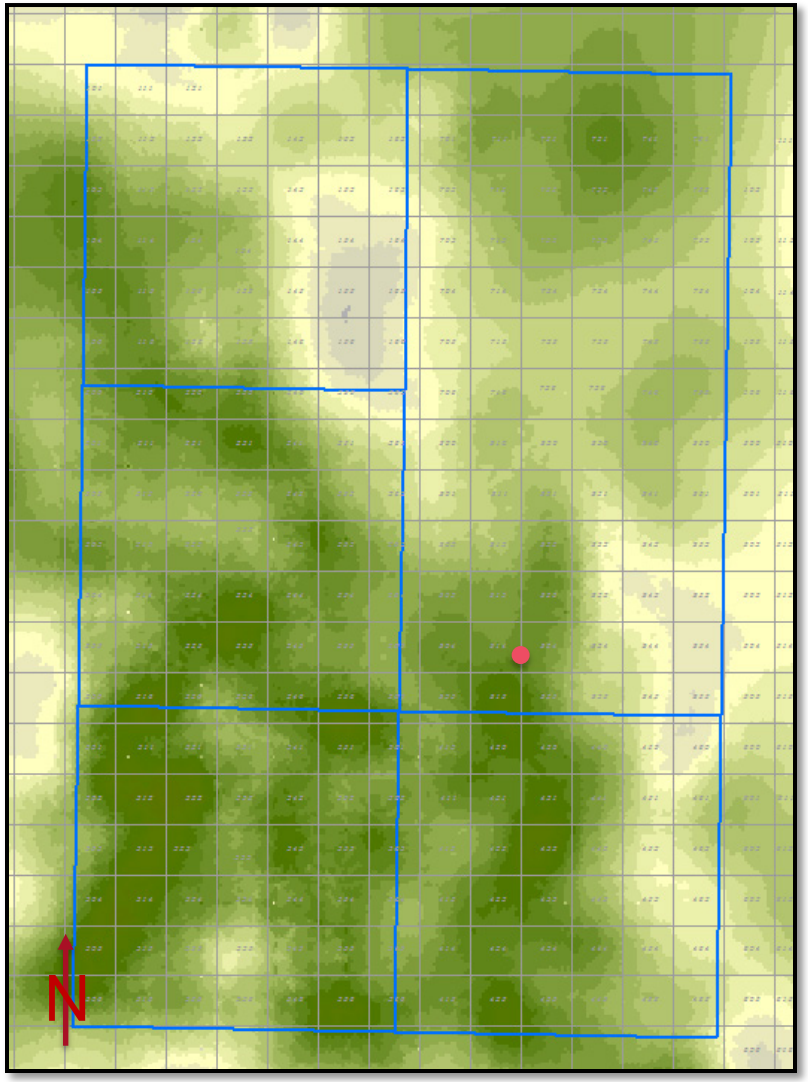
Maxwell/WWG Tulare- net pay

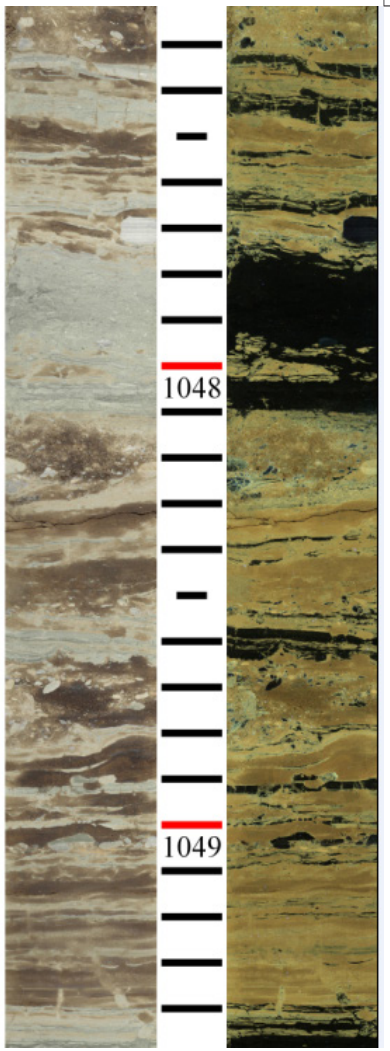


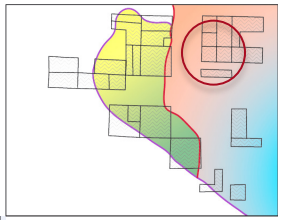


Shale Aera Tulare- net pay









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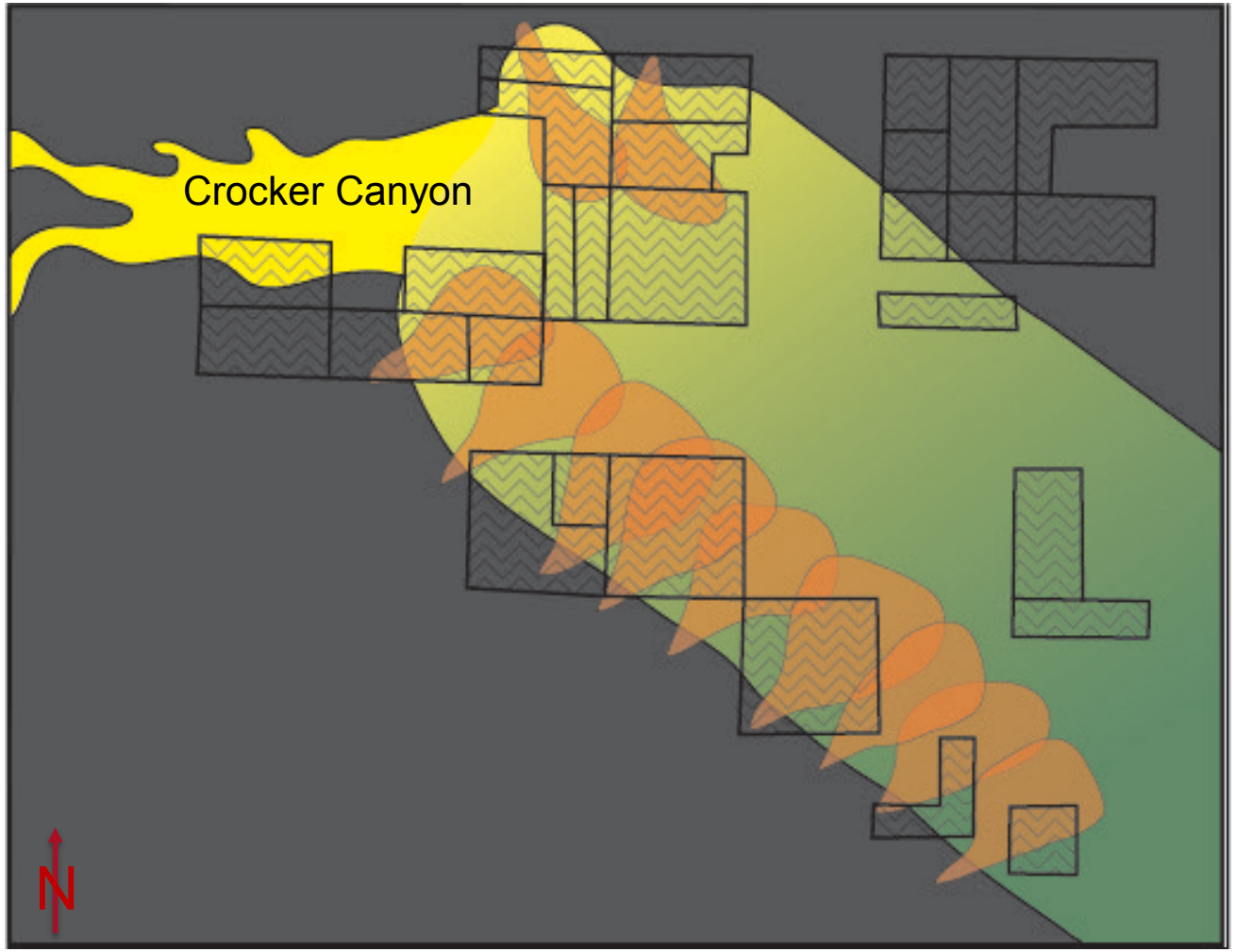
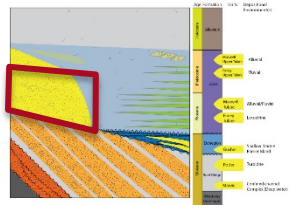
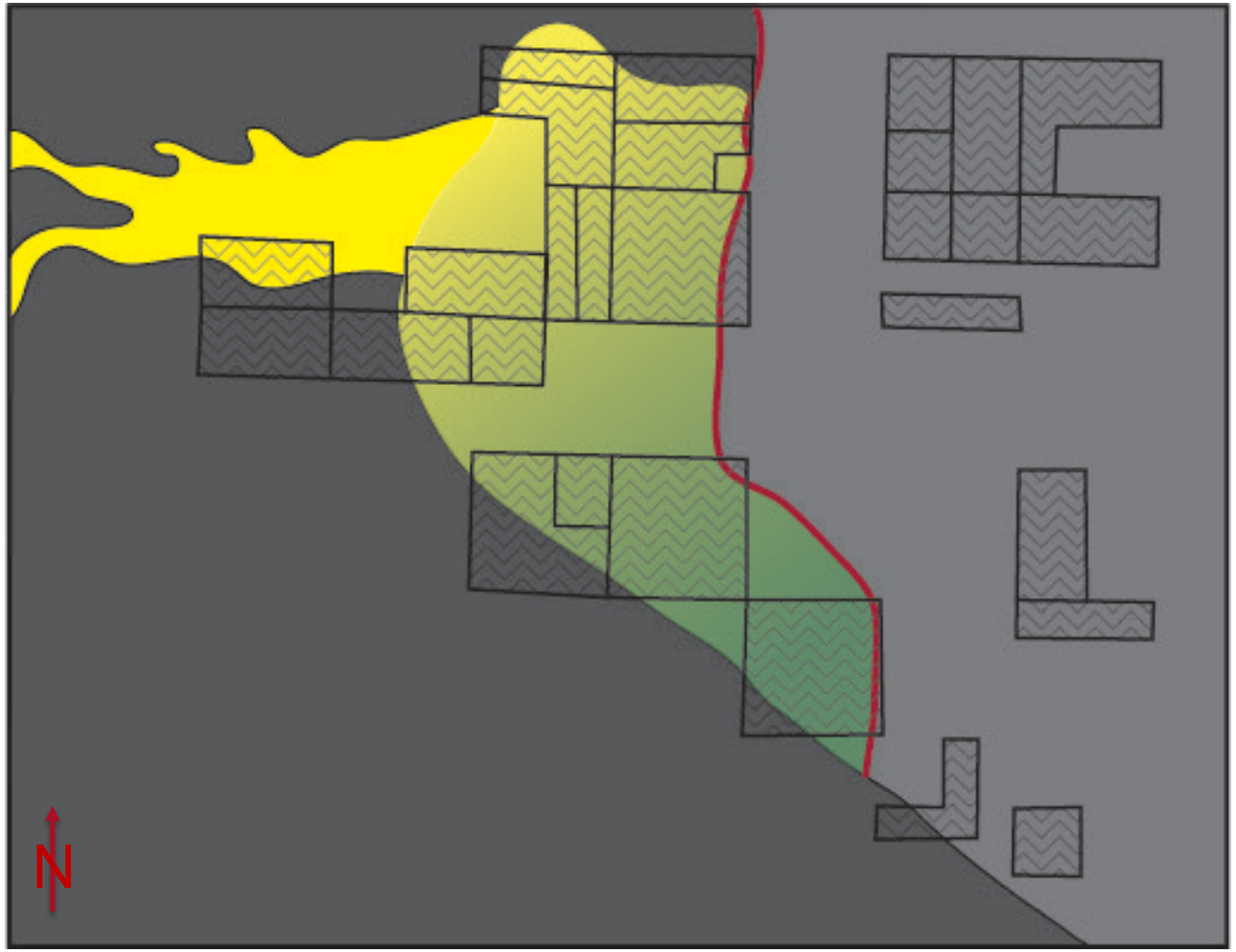
Time 1- Braided fluvial deposition



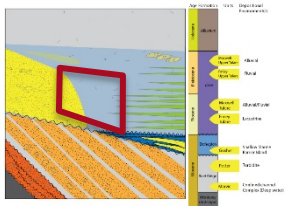
Lower Tulare



Time 2- Erosional unconformity

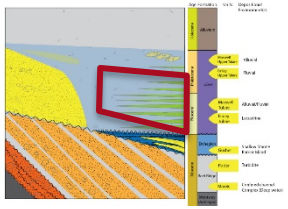


Lower Tulare

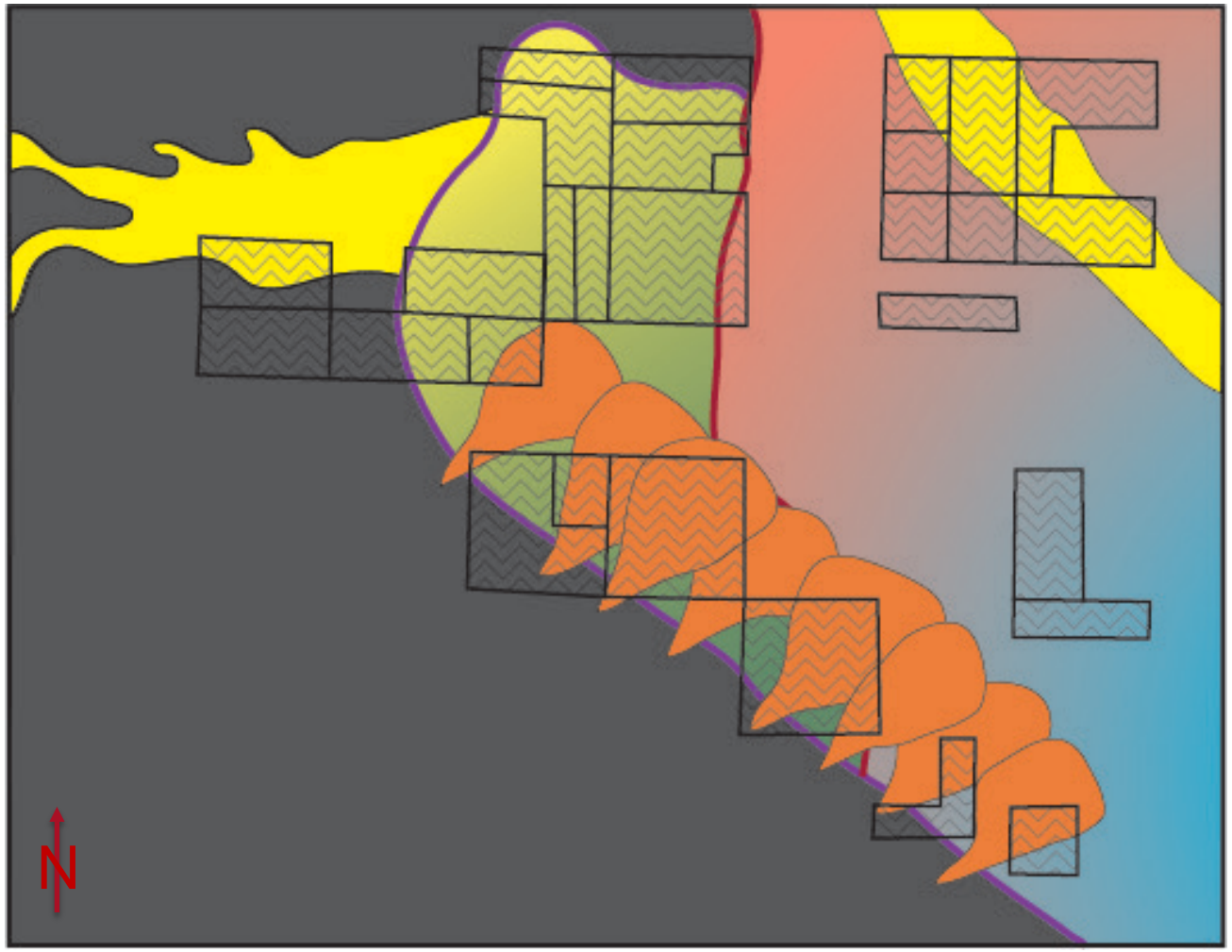


Time 3- Lacustrine pro-delta

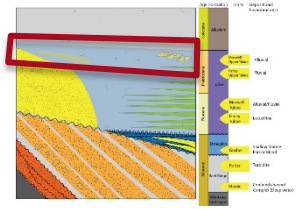
Lower Tulare



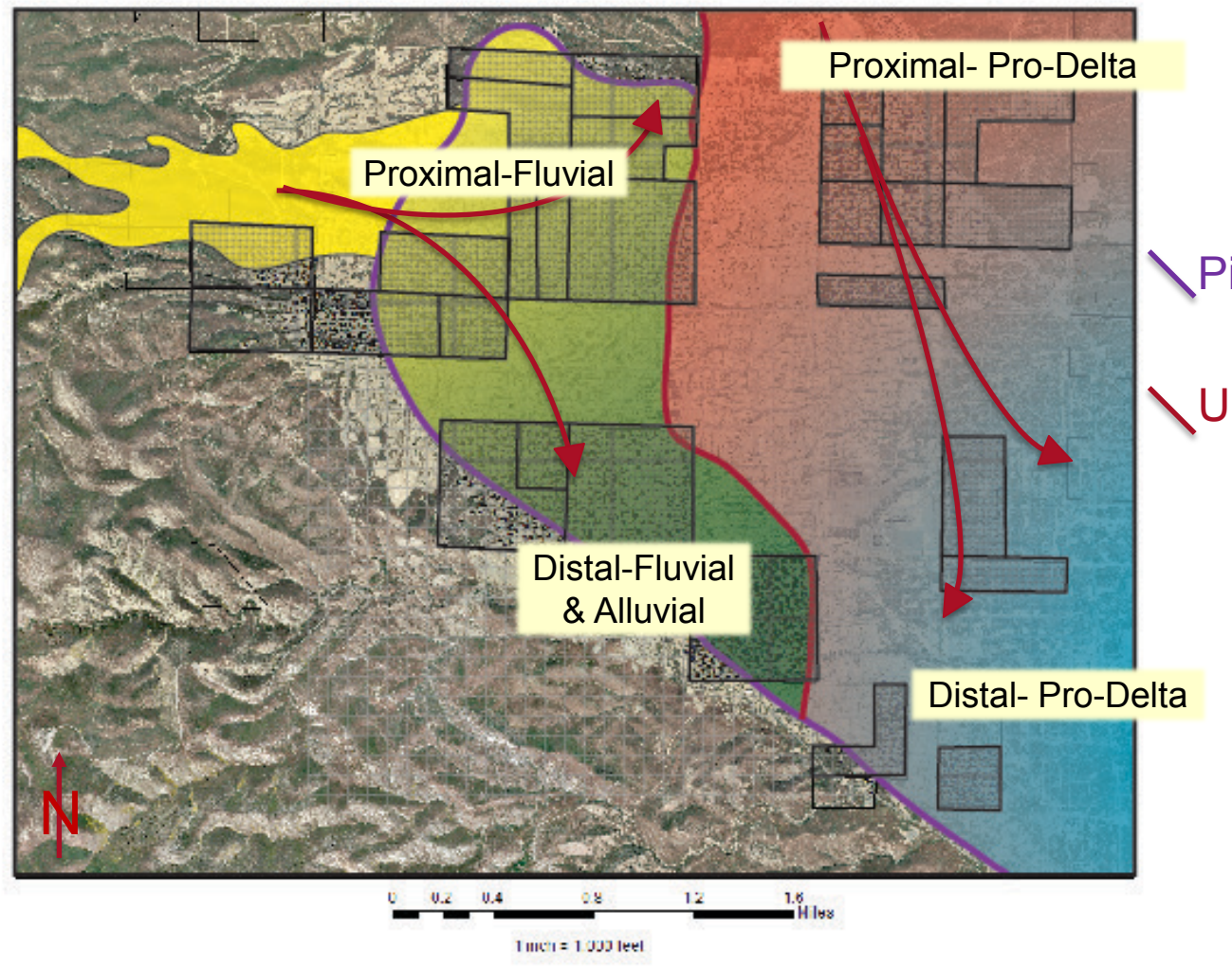
Time 4- Upper Tulare alluvial and braided fluvial

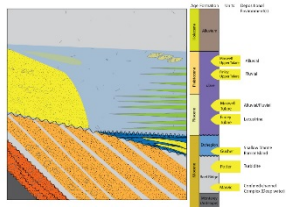


Upper Tulare



Two depositional source model for N-MWSS





Pinch out or outcrop

Unconformity

Conclusions & implications

- This proposed new depositional model for N-MWSS Tulare has implications for distribution of reservoirs
  - This model implies two separate provenances, one from west to east sourcing from Crocker Canyon (fluvial) and the Temblor Ranges (Alluvial)
  - A second, newly proposed, provenance sourcing from Cymric- McKittrick flowing north to south into N-MWSS

- For reservoir quaintly, OOIP evaluations and depositional environment:
  - “The Tulare is not the Tulare is not the Tulare” the depositional environment and quality of the reservoir varies over short distances requiring detailed correlation when projecting core data
  - Evaluations should be localized to an appropriate scale

What causes the unconformity?

Potential forcing event that could cause the localized unconformity

- Potter continuity demonstrates that it's not a fault
- Could be a stranded terrace from environmental change during the Plio-Pleistocene transition to a dryer climate
- Likely a pulse of regional uplift
  - May be associated with transpressional motion on San Andreas Fault strike-slip system around 5 Ma when the Big Bend was captured

Acknowledgements

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- Cynthia Huggins
- Don Deininger
- Chad Severson
- Ricardo Rojas
- Juan Pablo Gomez Alvarez
- David Miner

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Questions & discussion

- What do you think the Tulare Unconformity is?