

Sequence Stratigraphy, Depositional Settings, and Production Trends of the Middle and Upper Pennsylvanian Cleveland and Marmaton Tight-Gas Sandstones, Northwest Anadarko Basin*

Tucker F. Hentz¹ and William A. Ambrose¹

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Abstract

Although gas production from the low-permeability (tight) Cleveland and Marmaton Formations in the northwest Anadarko Basin started in the mid-1950's, the sequence-stratigraphic and depositional settings of their reservoir sandstones in the primary producing area are poorly known. Analysis of closely spaced log sections of approximately 800 wells and ~250 ft (~75 m) of 5 conventional cores in these stratigraphically adjacent units indicates that they compose a succession of highstand deltaic and lowstand incised-valley-fill deposits with strong tidal signatures that accumulated on a broad shelf or ramp.

The Cleveland section in the producing area, 100–300 ft (30–92 m) thick, includes six fourth-order, westerly sourced deltaic highstand systems tracts that become more limestone rich upsection as the unit grades into overlying Kansas City Formation carbonates. A prominent, 40-to-80-ft-thick (12-to-24-m) lowstand incised-valley system occurs in the middle Cleveland, consisting dominantly of fine-grained estuarine sandstones exhibiting abundant draped ripples and flaser bedding. Fluvial sandstones bearing abundant shale clasts occur locally at the base. The valley-fill sandstones and the underlying highstand deltaic topset beds into which the valley system locally incises compose the primary reservoir zone in the Cleveland. The underlying Marmaton succession (80–550 ft [24–170 m] thick) comprises a highstand progradational sequence set of three southeasterly sourced deltaic successions showing no evidence of valley incision. The primary reservoir zone, the Hepler sandstone, comprises the topset beds of the uppermost sequence and overlying beds of the unusually sandy and thick (140 ft [43 m]) transgressive systems tract.

Hydrocarbon production from the Cleveland Formation, the primary producer of the two units (1.1 Tcf and 37.3 MMbbl as of June 2010), is controlled mostly by the occurrence of the sandstone-rich, west- to east-southeast-trending incised-valley system close to the structural updip limit of the unit's sandstone facies. Small southeast-plunging anticlines, such as the Perryton anticline in central Ochiltree County, are also sites of hydrocarbon accumulation, but they are developed only locally. Marmaton production (14.0 MMcf and 1.5 MMbbl as of June 2010) also appears to be controlled largely by sandstone distribution, most likely at the updip limits of elongate tidal sandstone bodies.

References

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- Hentz, T.F., 1994, Sequence stratigraphy of the Upper Pennsylvanian Cleveland Formation; a major tight-gas sandstone, western Anadarko Basin, Texas Panhandle: AAPG Bulletin, v. 78/4, p. 569-595.

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Acknowledgments

Jones Energy, Ltd.

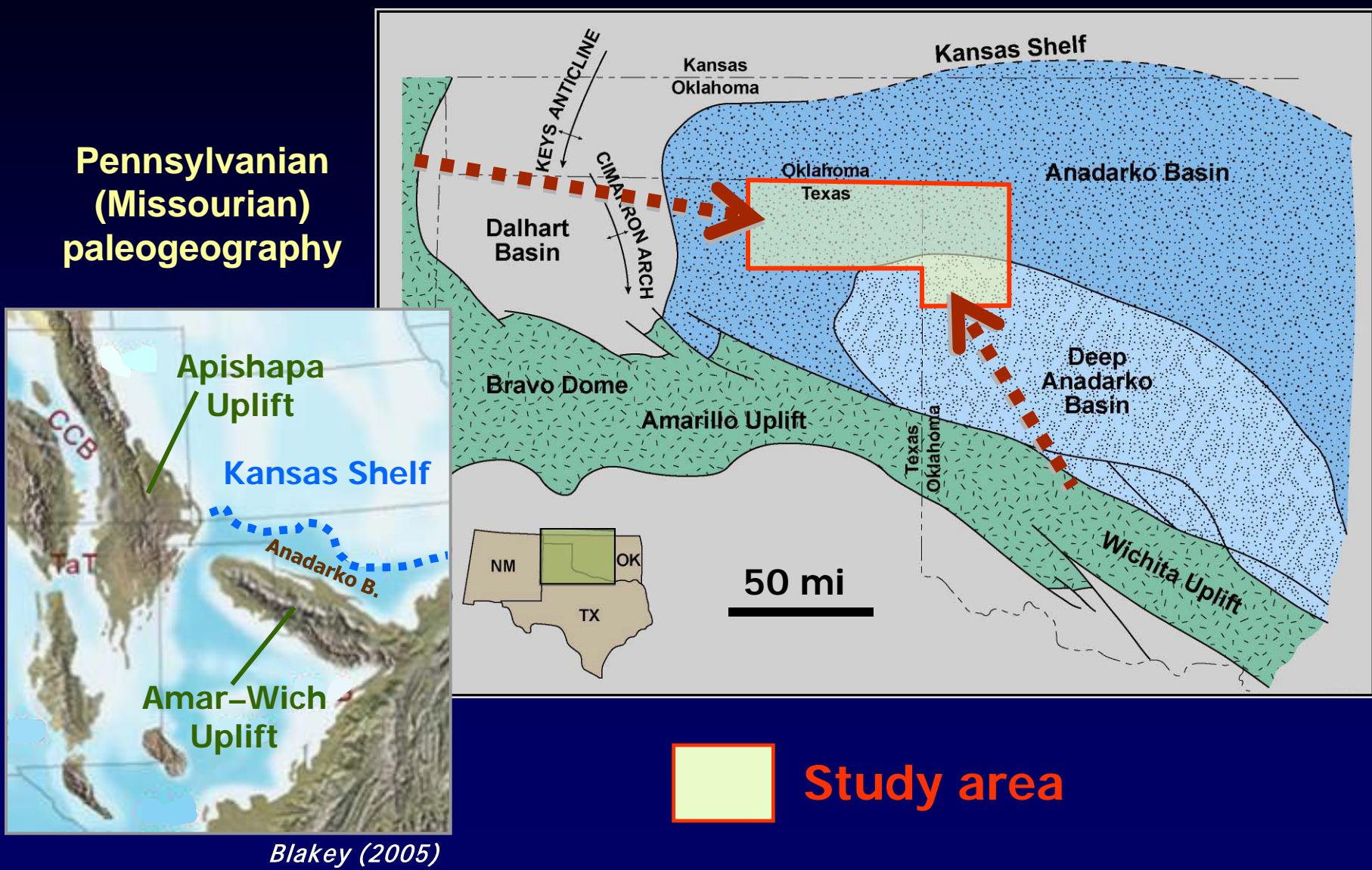


State of Texas Advanced Resource Recovery

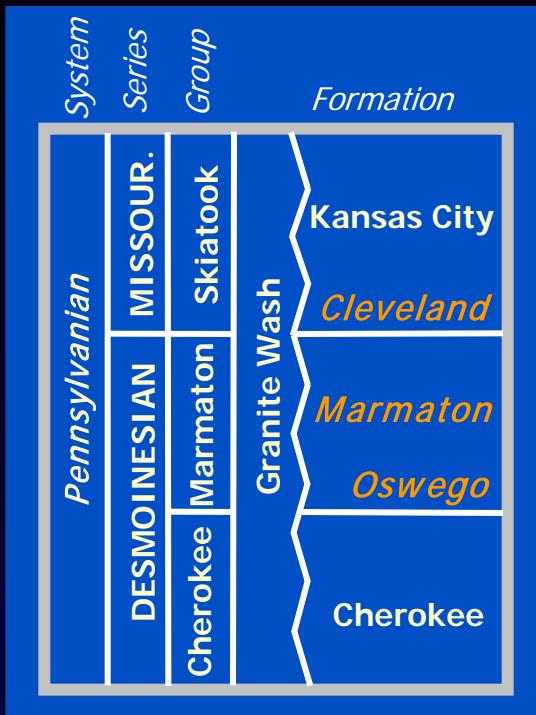
Focus

- Sequence-stratigraphic framework of Cleveland and Marmaton reservoirs
- Sandstone distribution and depositional settings (1,127 well logs, 7 cores)
- Shelf topography
- Production trends related to systems tracts and structure

Anadarko Basin and Source Areas



Type Logs



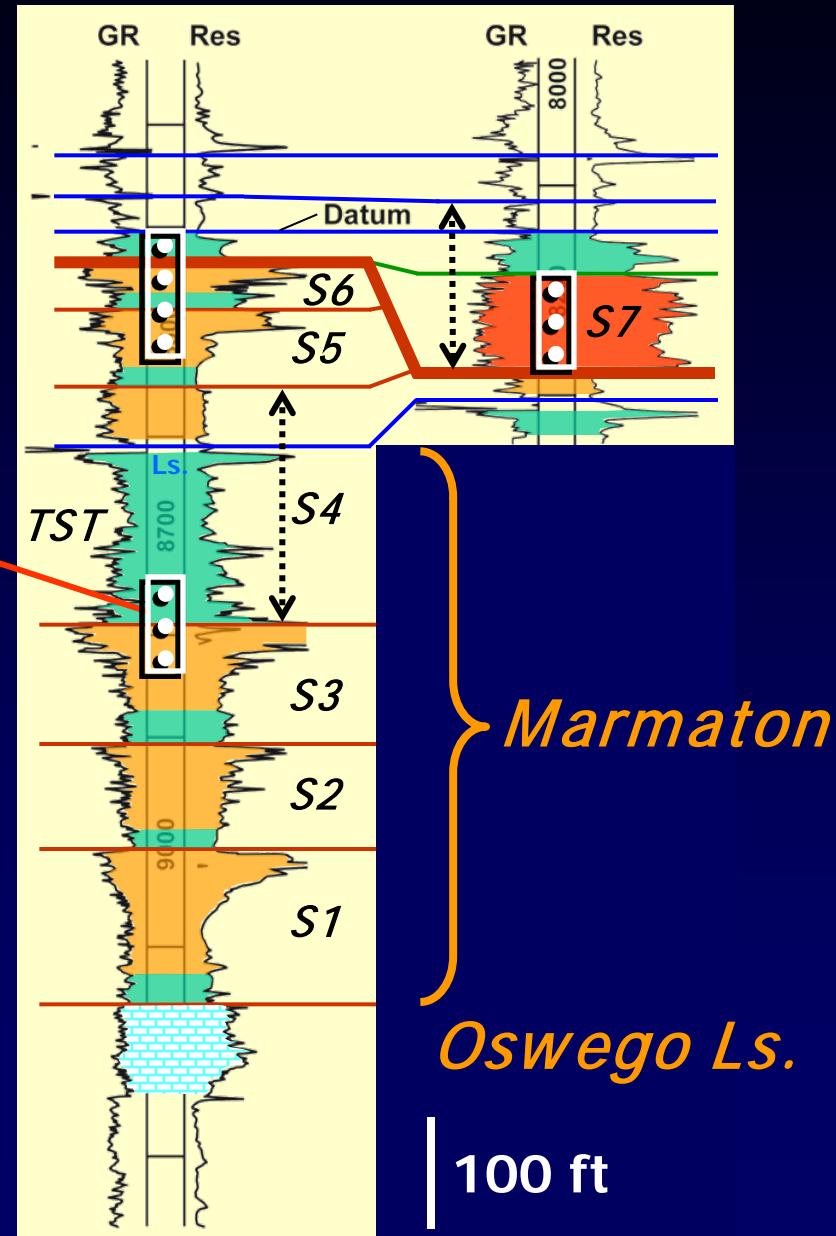
Cleveland {
Hepler Ss

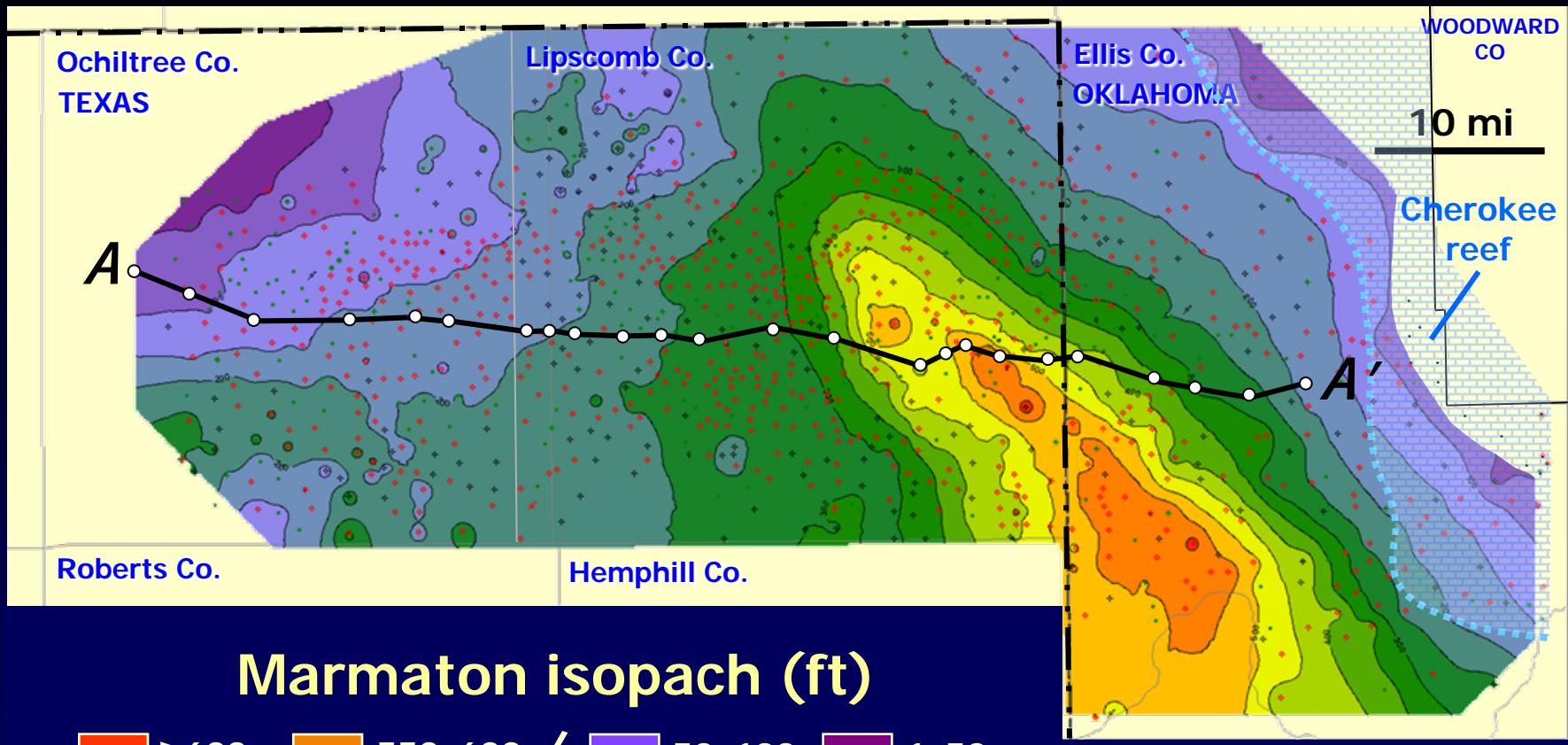
Systems tracts

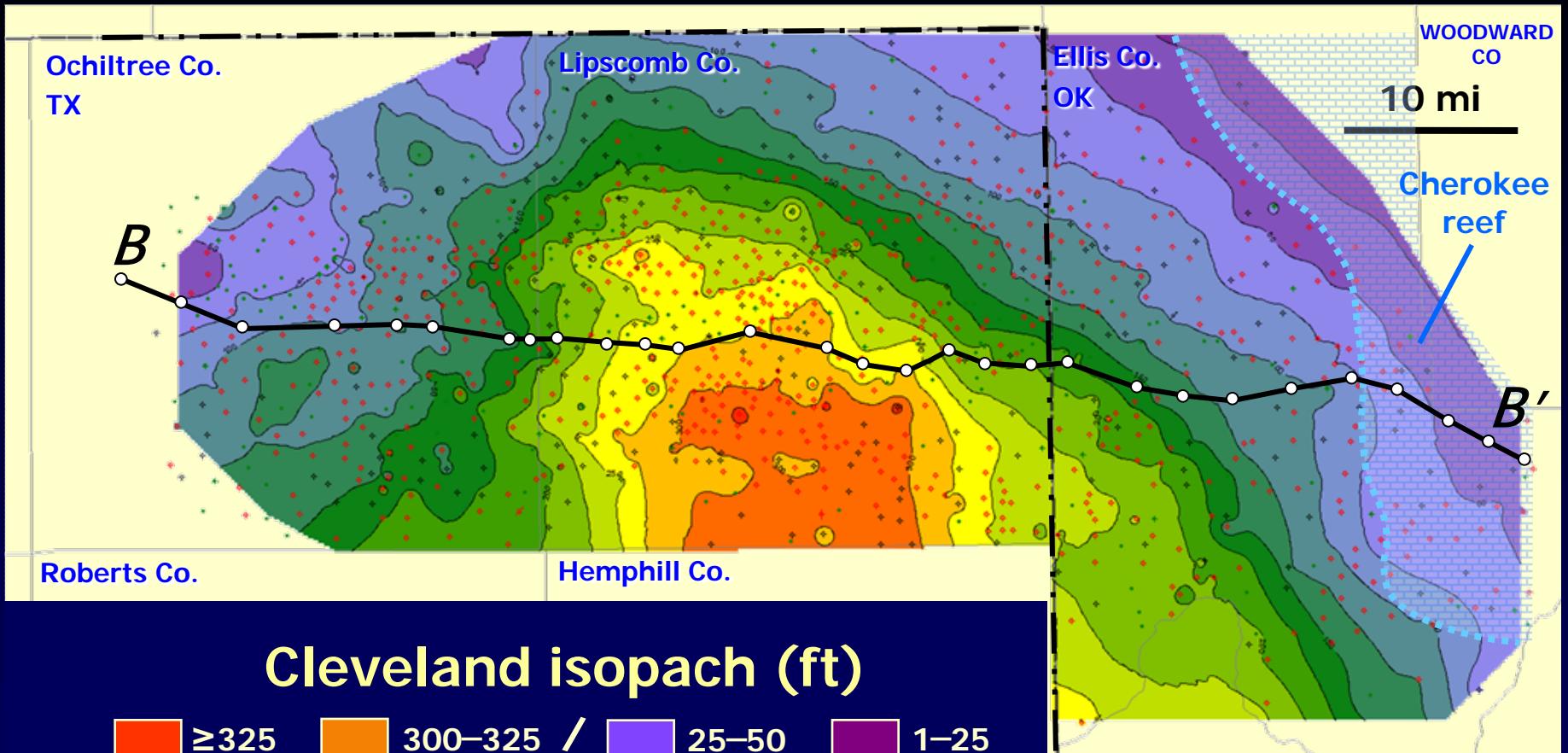
Lowstand:
incised-valley fill

Highstand

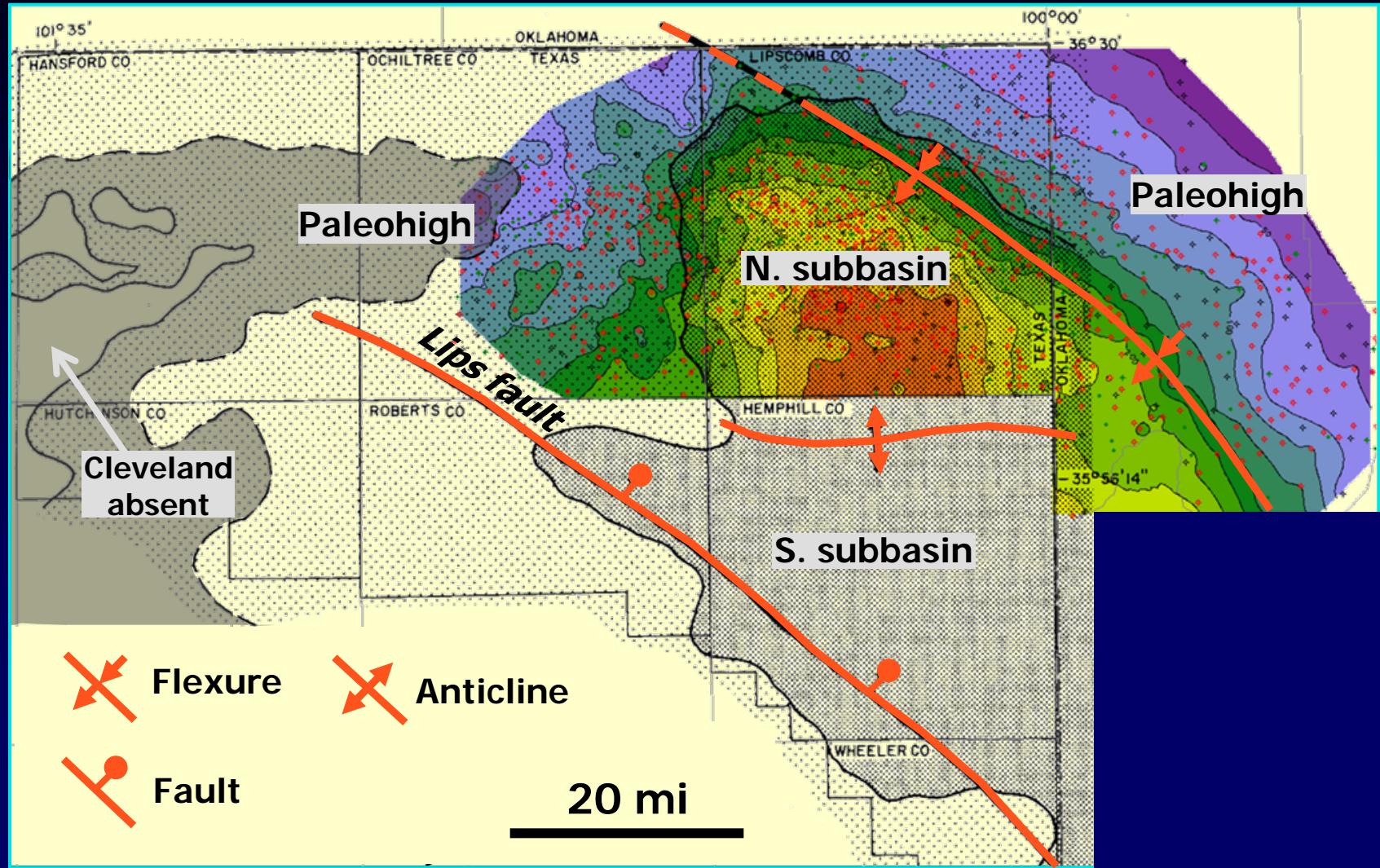
Transgressive





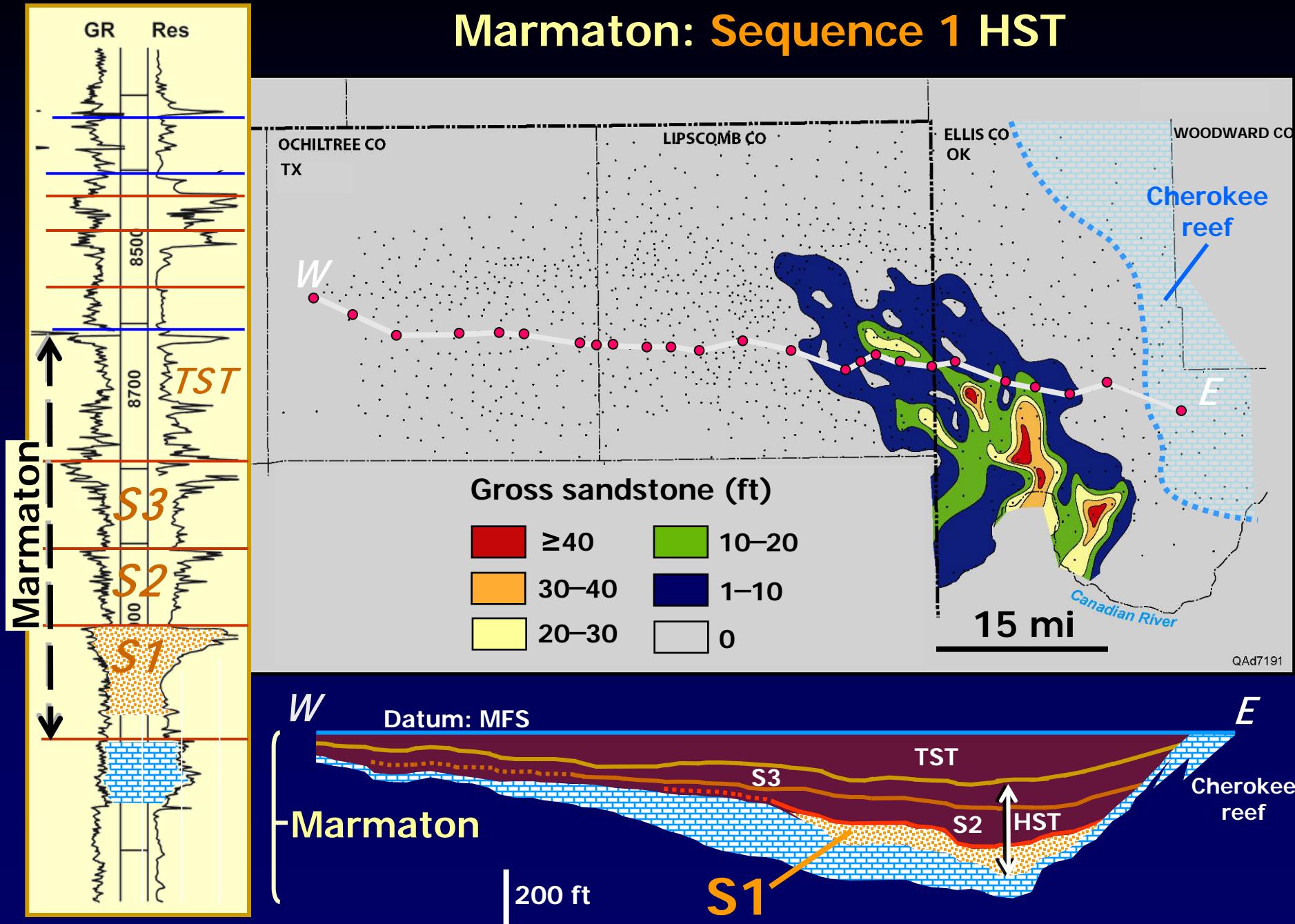


Cleveland Shelf Setting

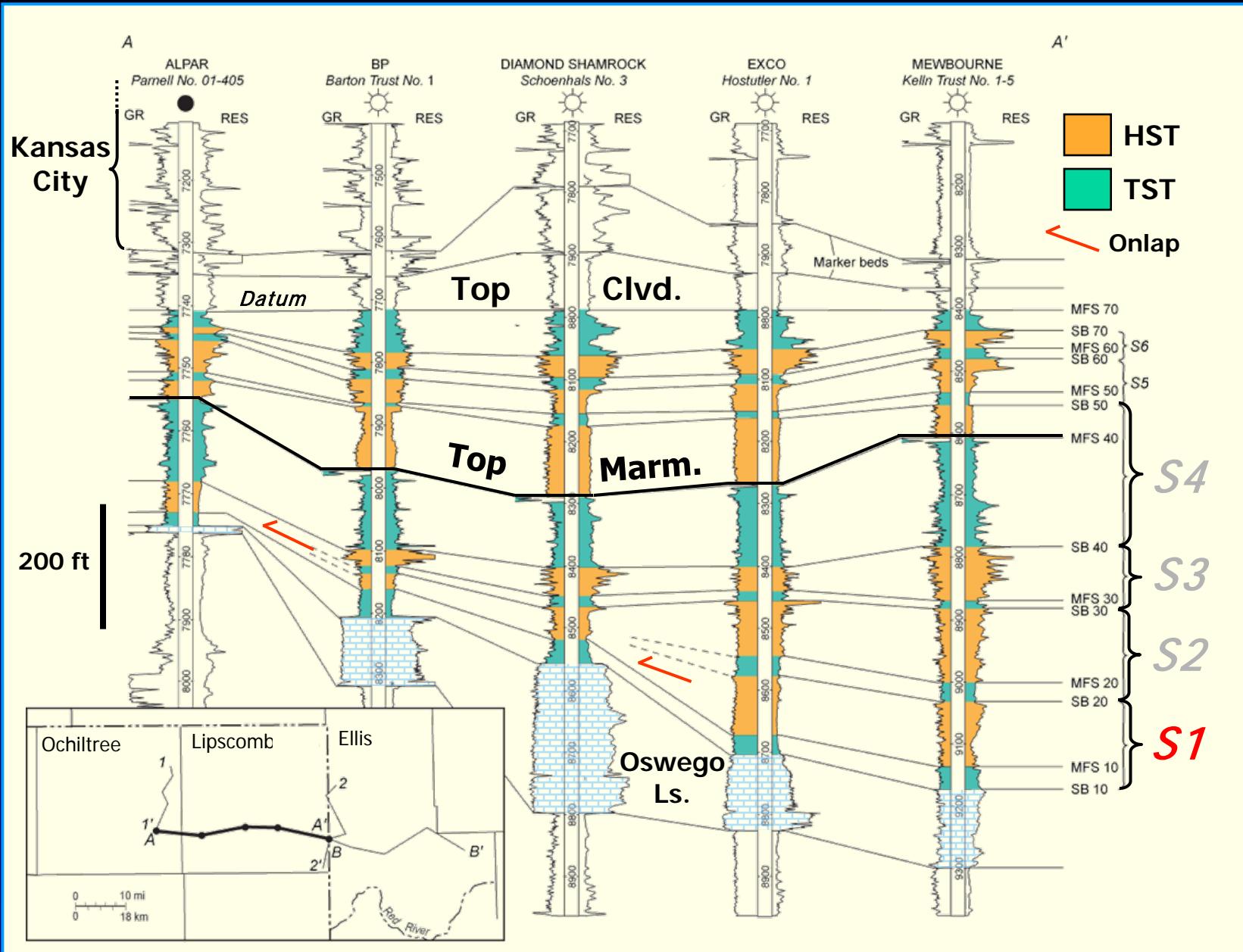


Henz (1994)

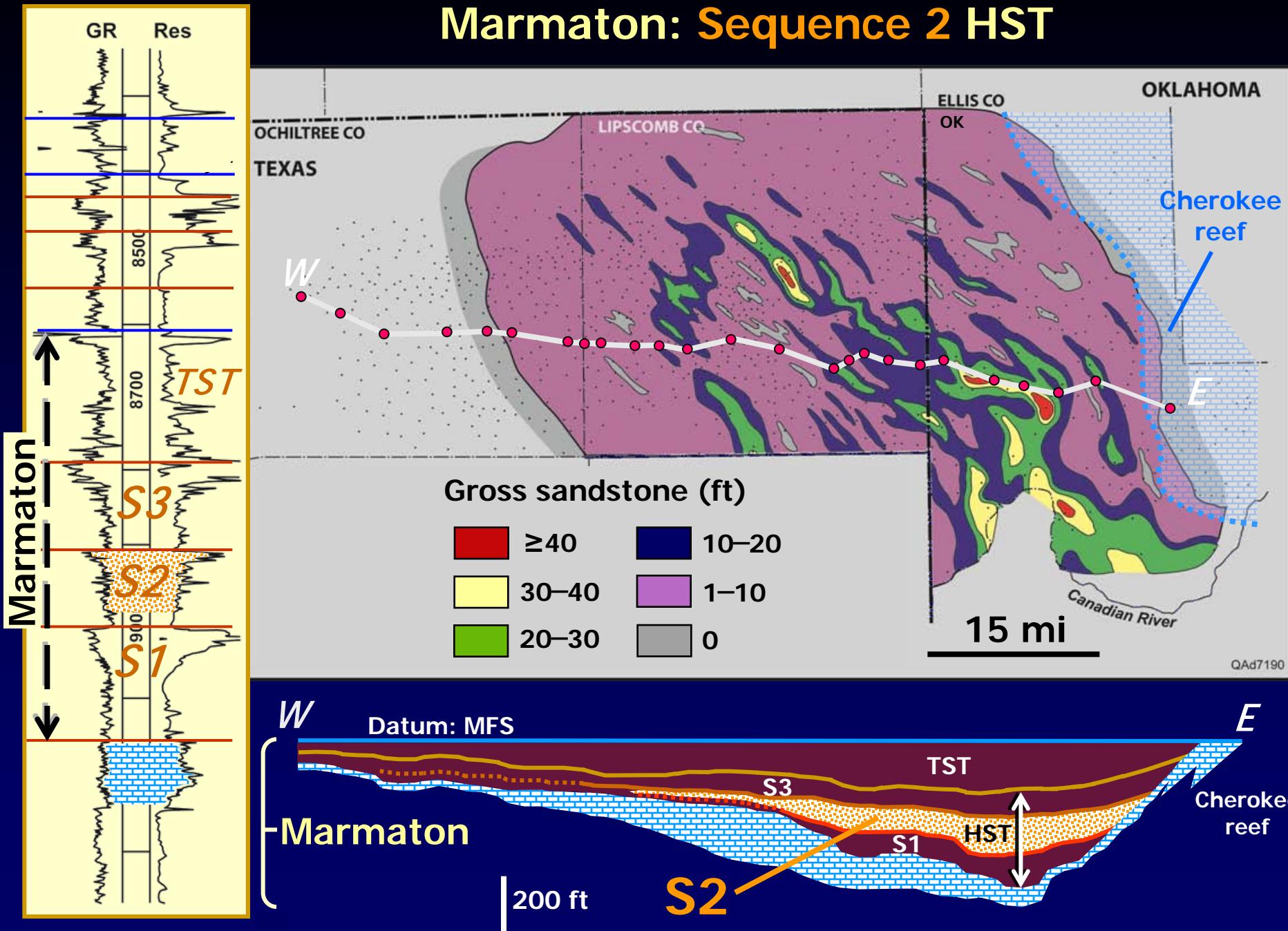
Marmaton: Sequence 1 HST



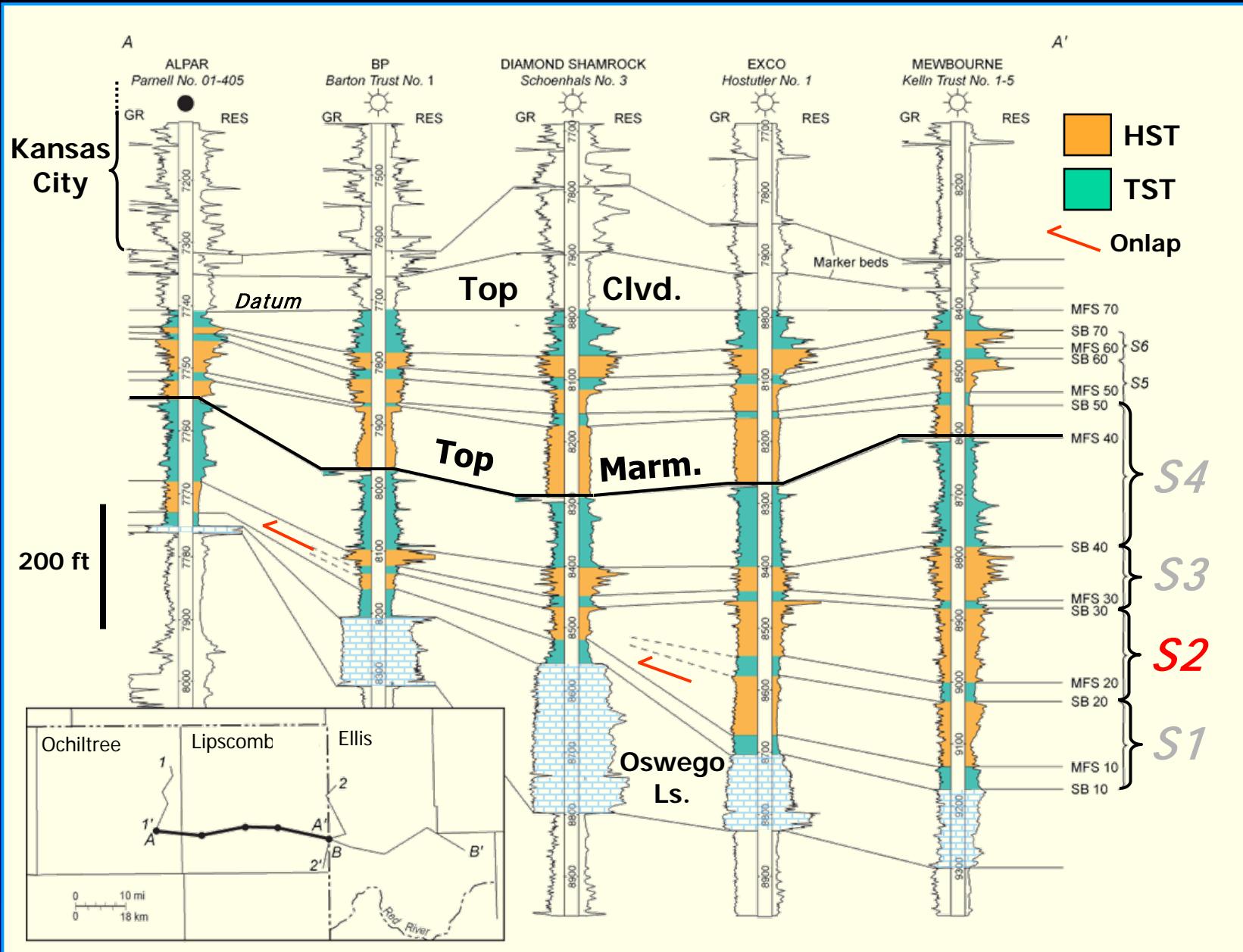
Marmaton: S1 HST



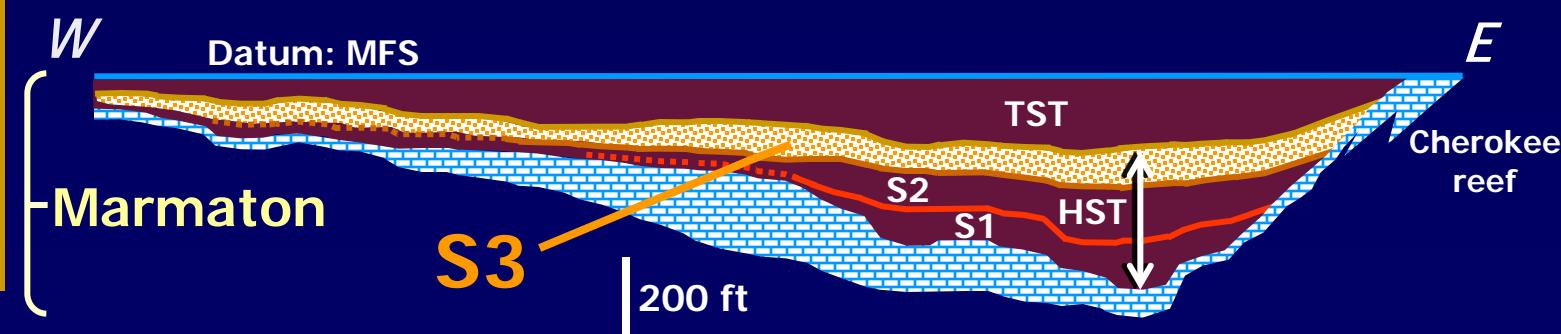
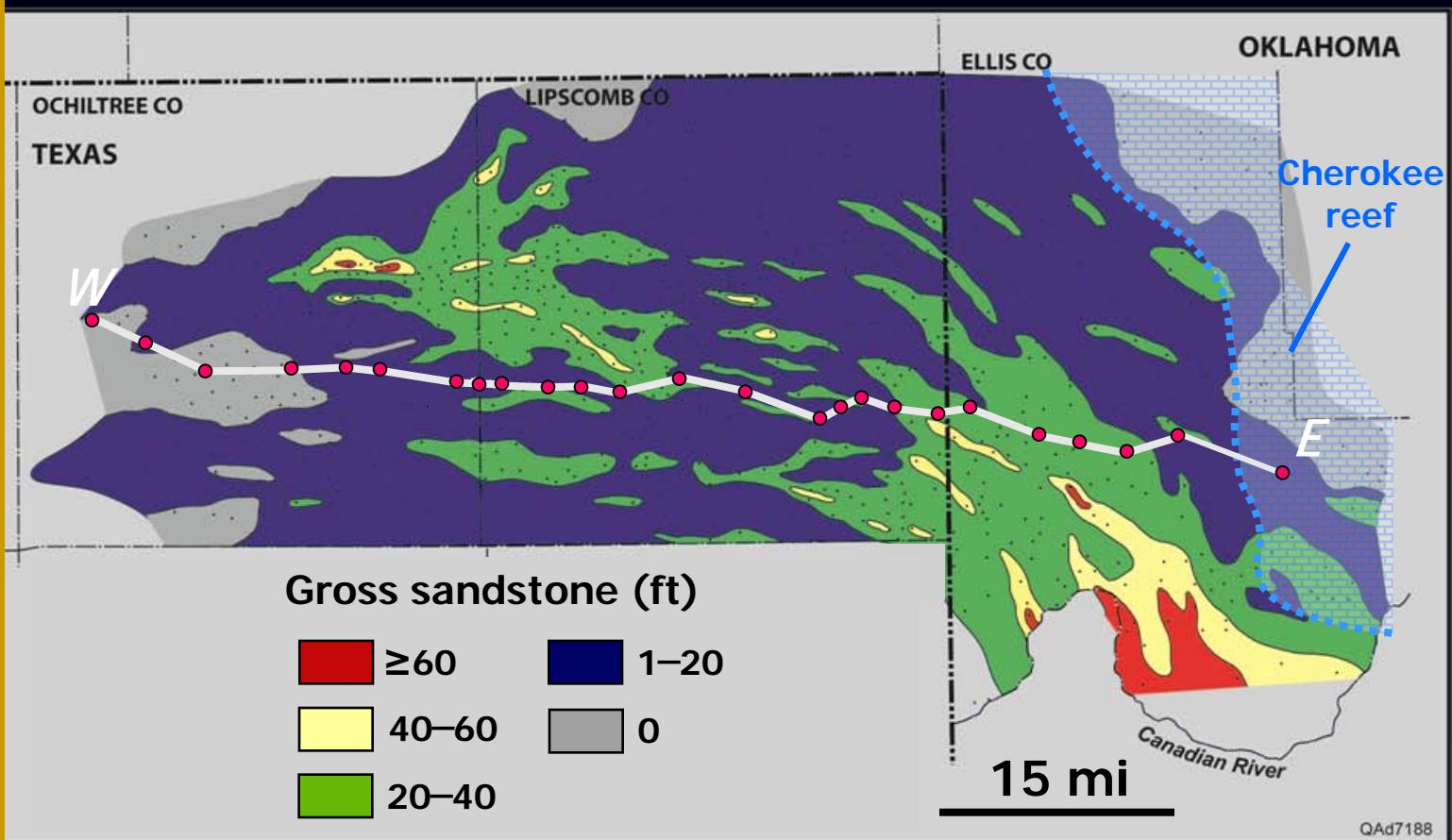
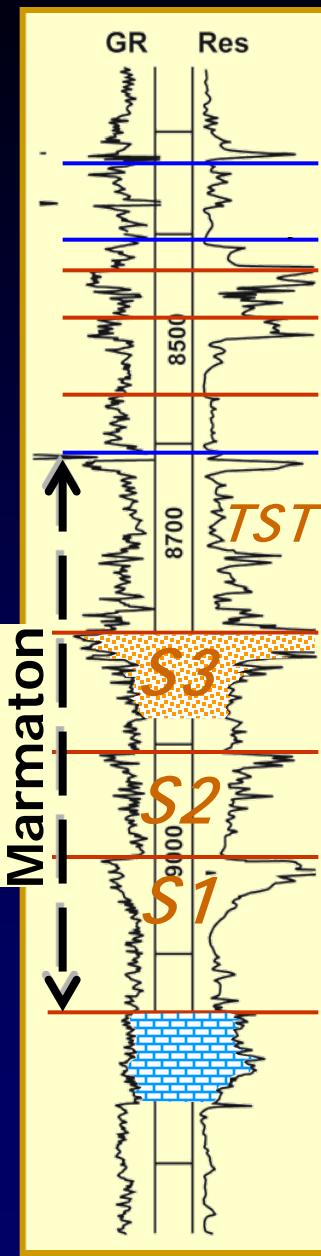
Marmaton: Sequence 2 HST



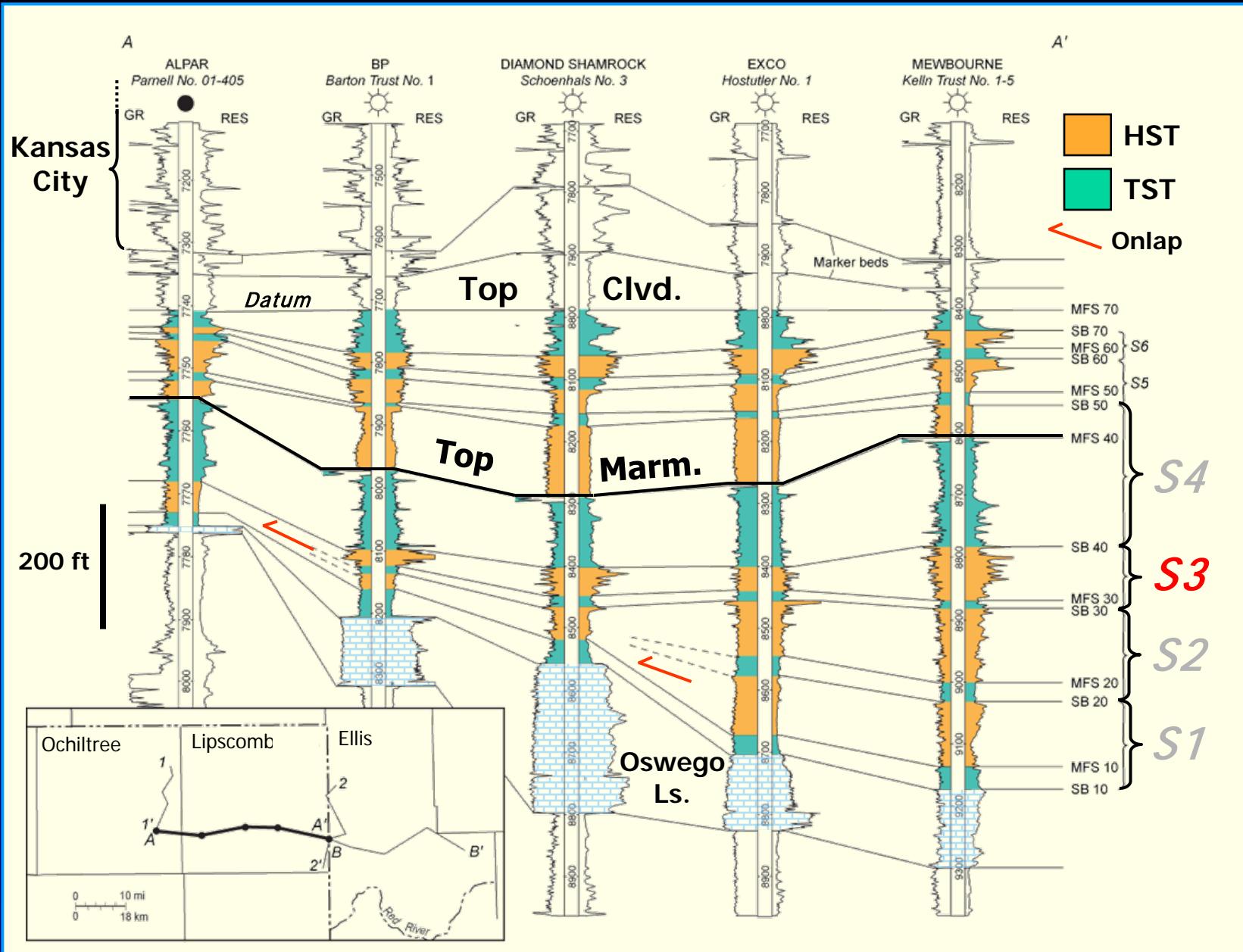
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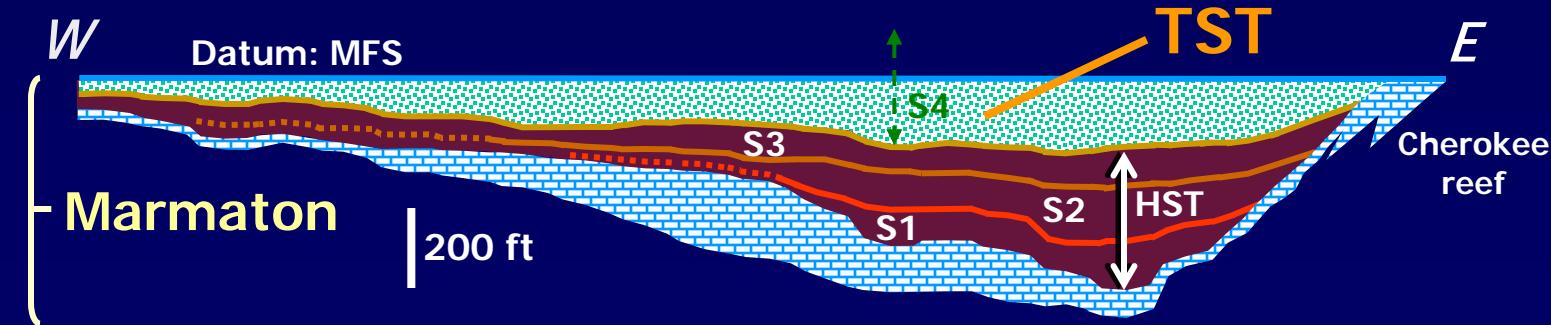
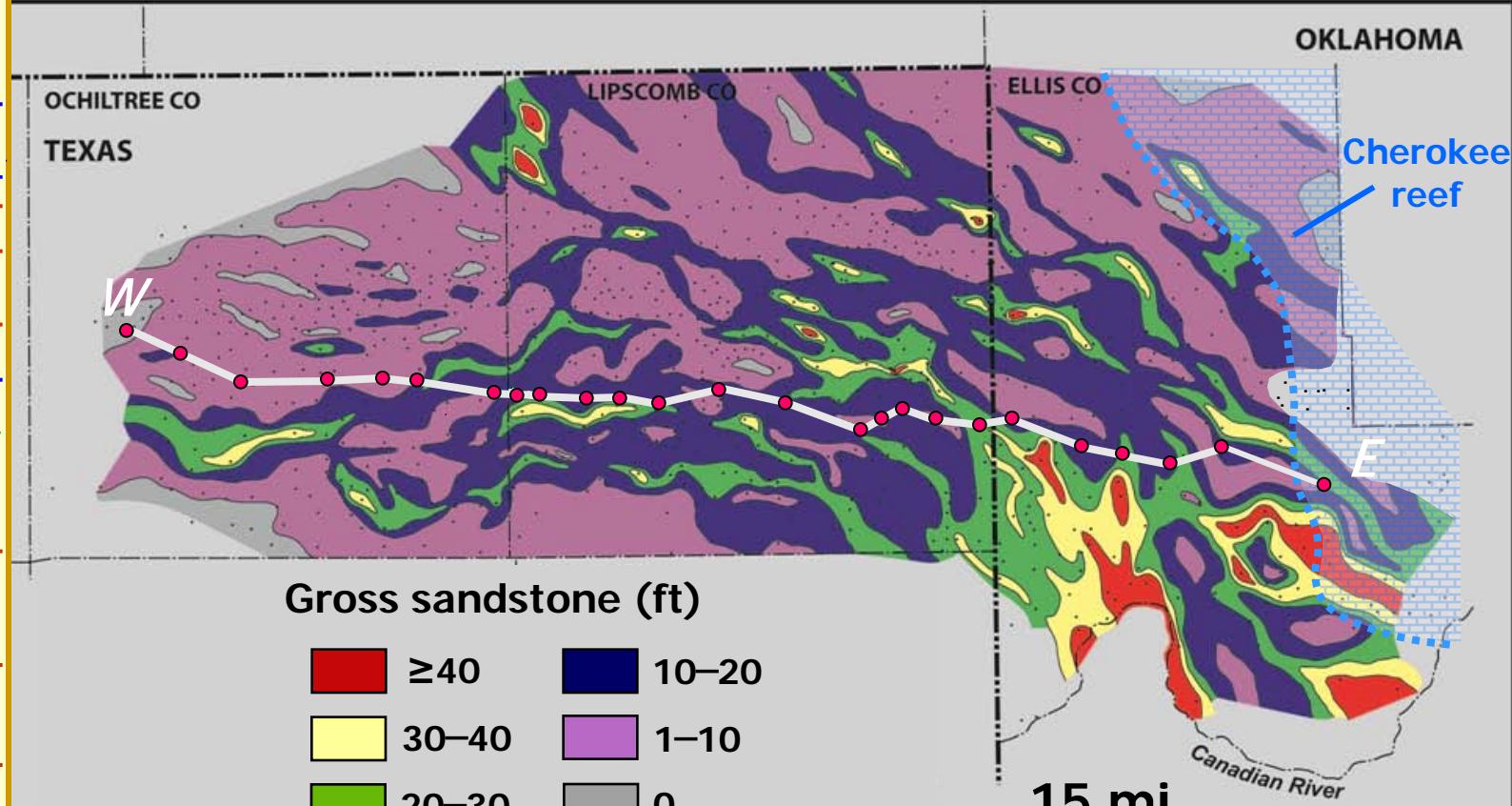
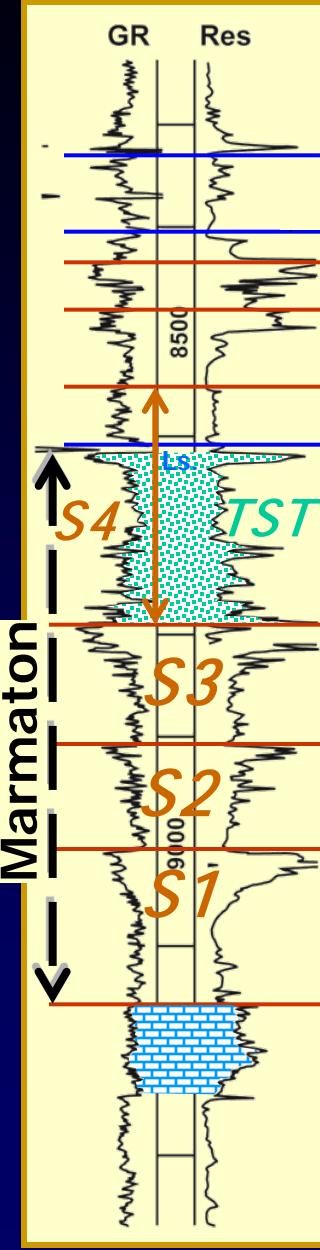
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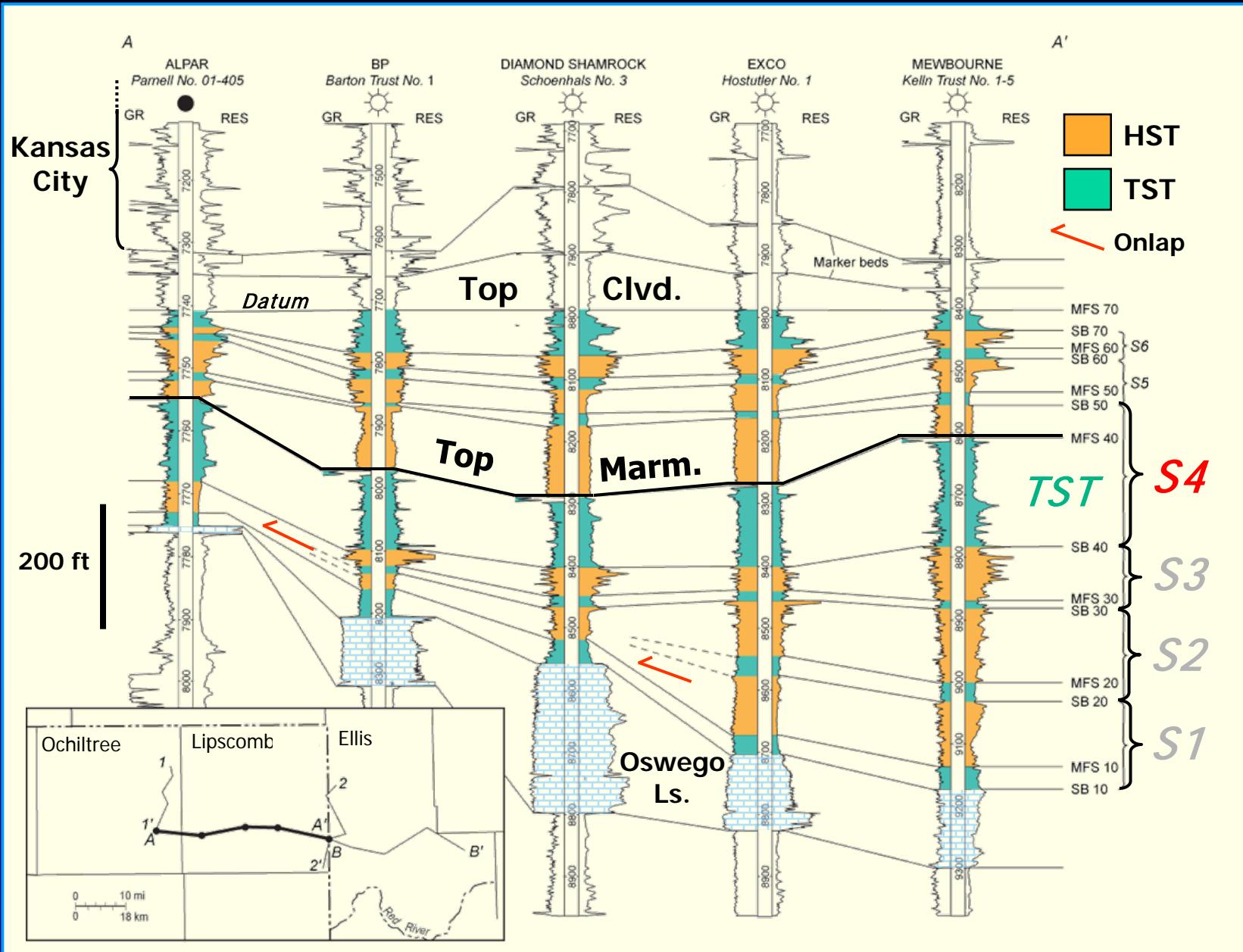
Marmaton: S3 HST



Marmaton: Sequence 4 TST

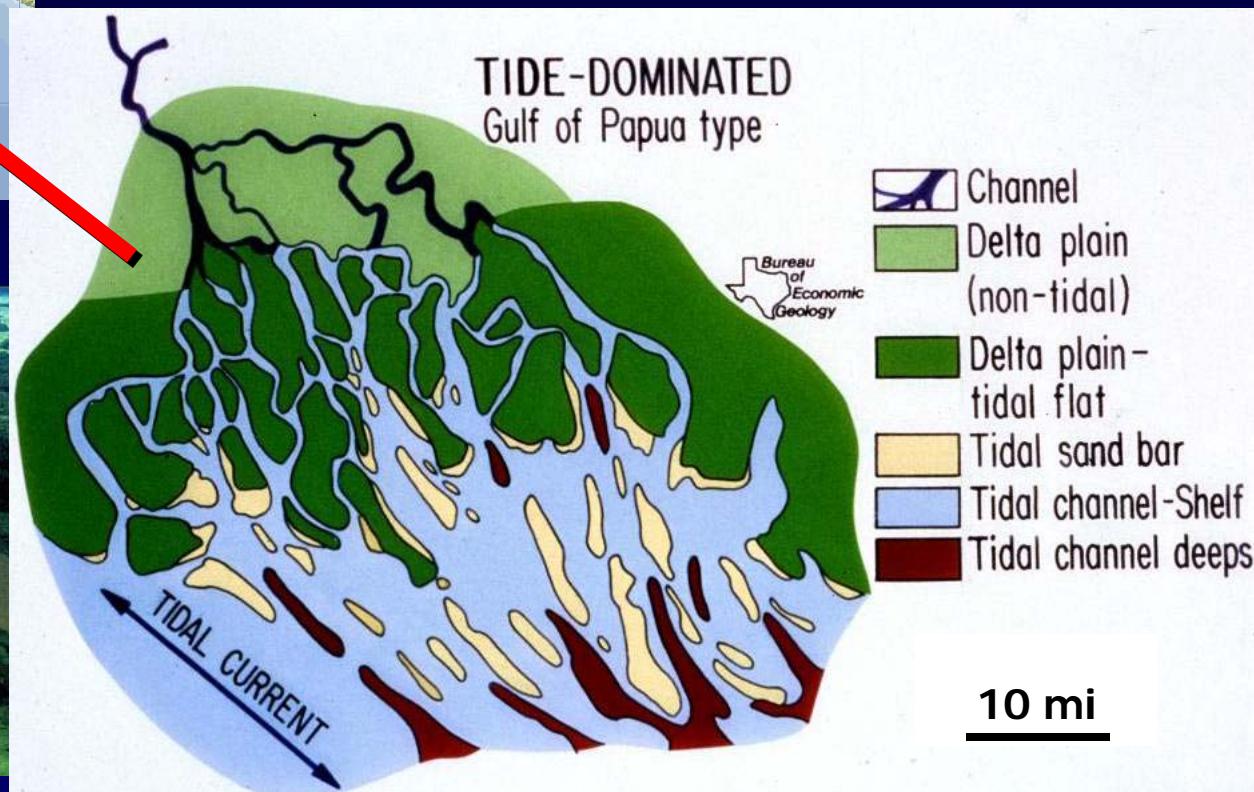


Marmaton: S4 TST



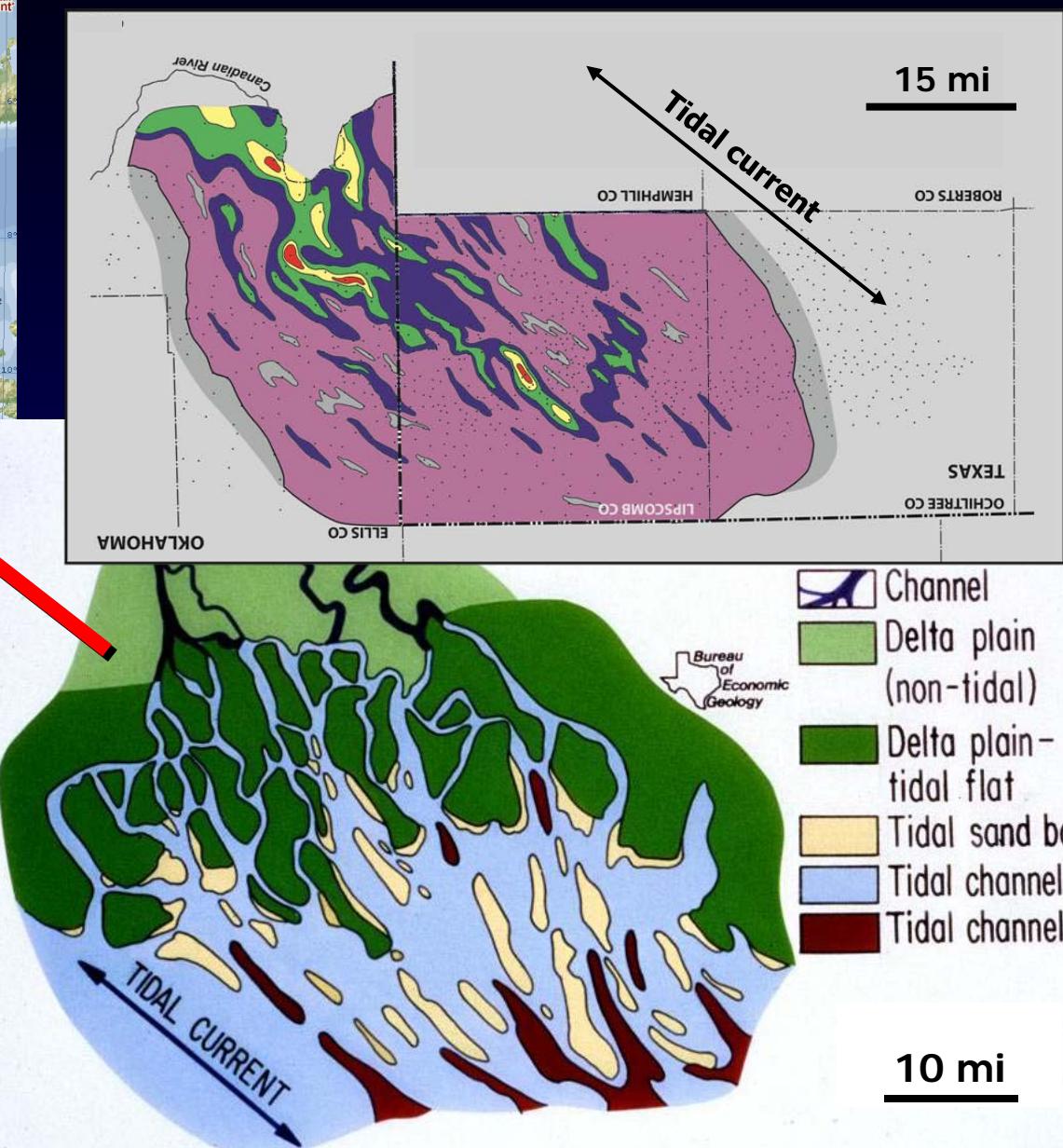
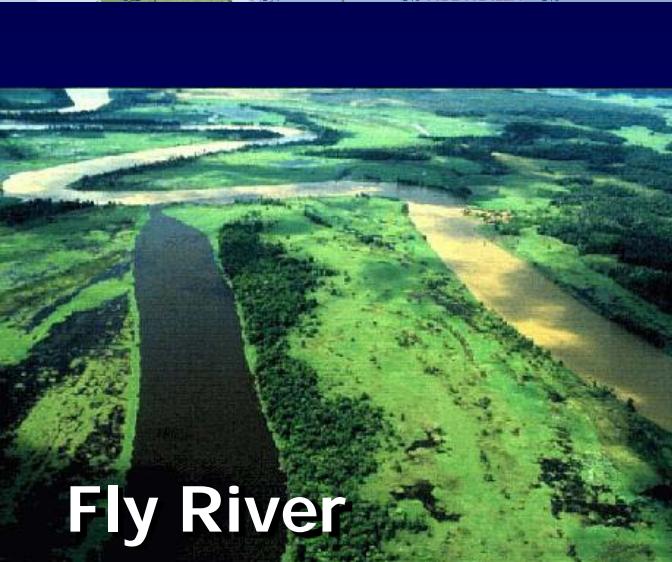
Gulf of Papua

- Tide dominated (3- to 5.5-m range)

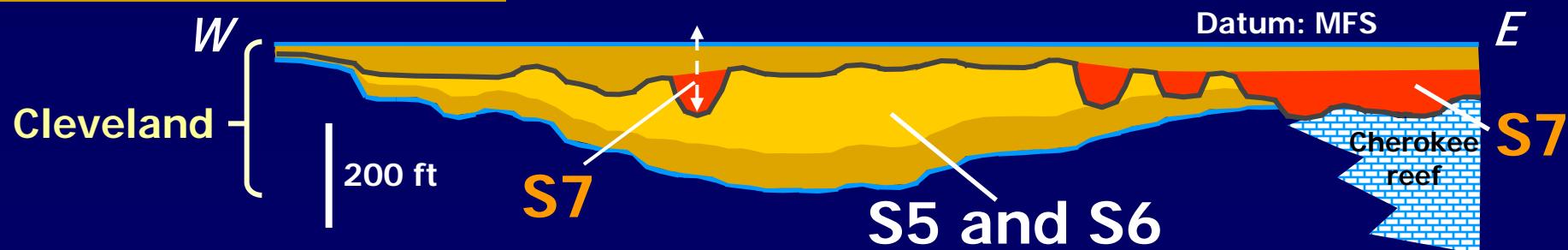
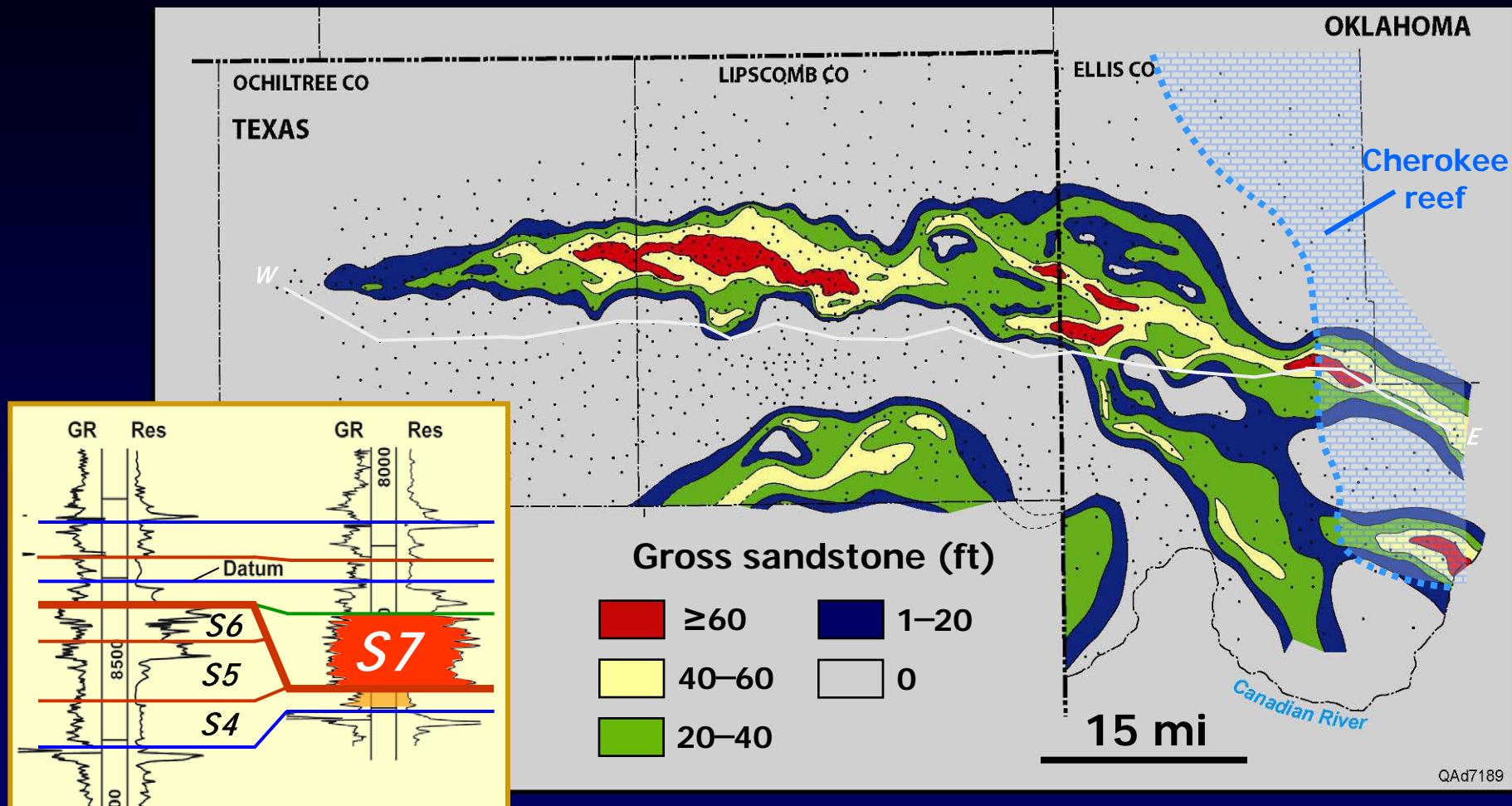


Gulf of Papua

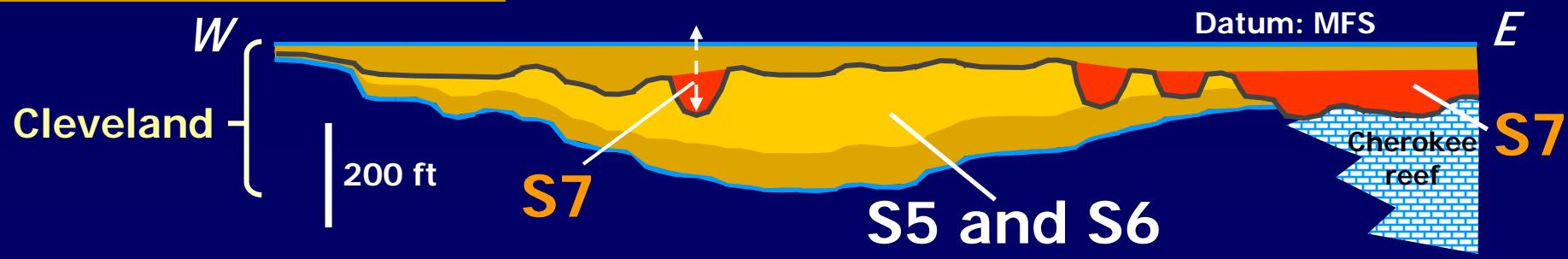
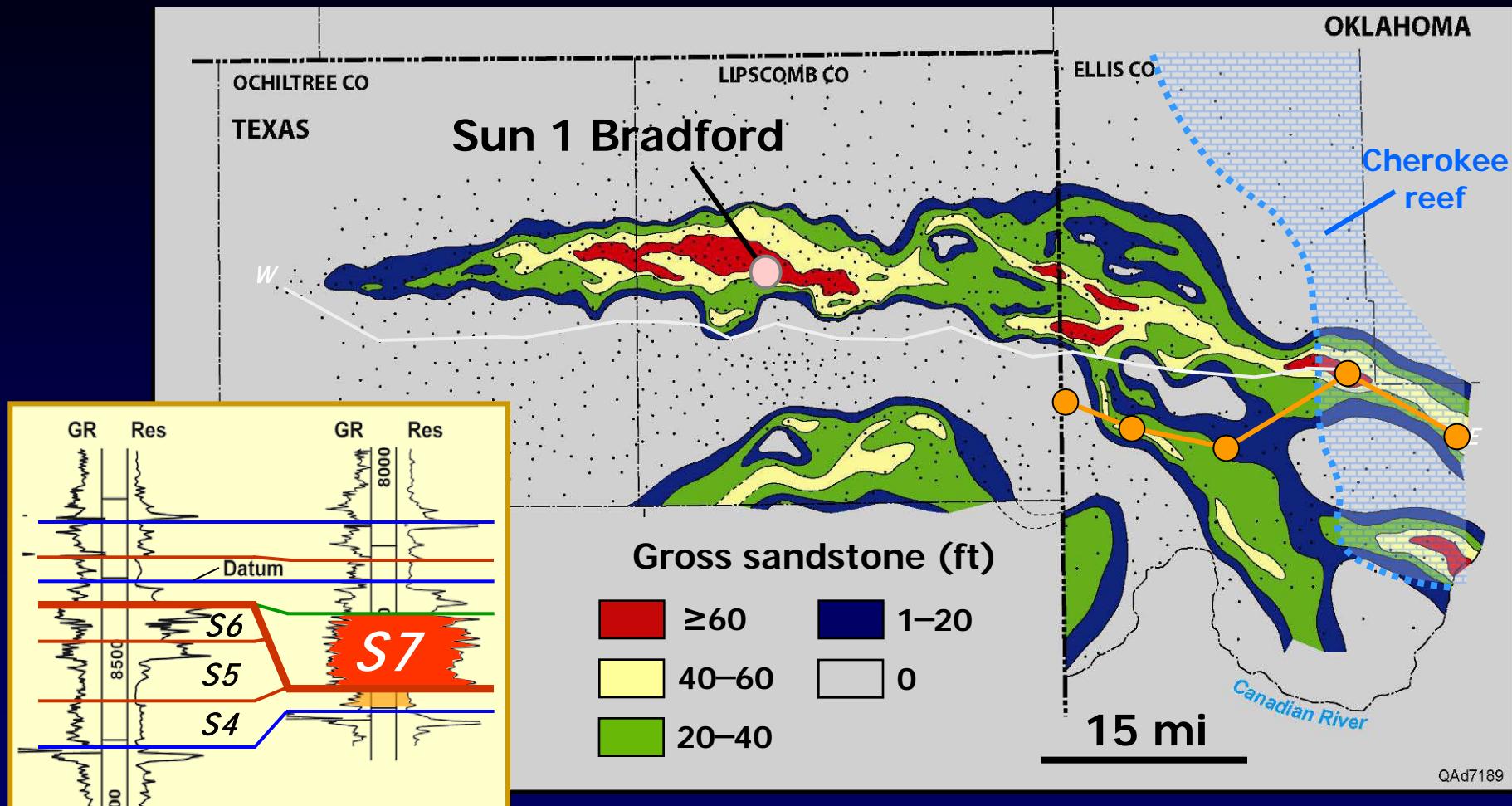
- Tide dominated (3- to 5.5-m range)



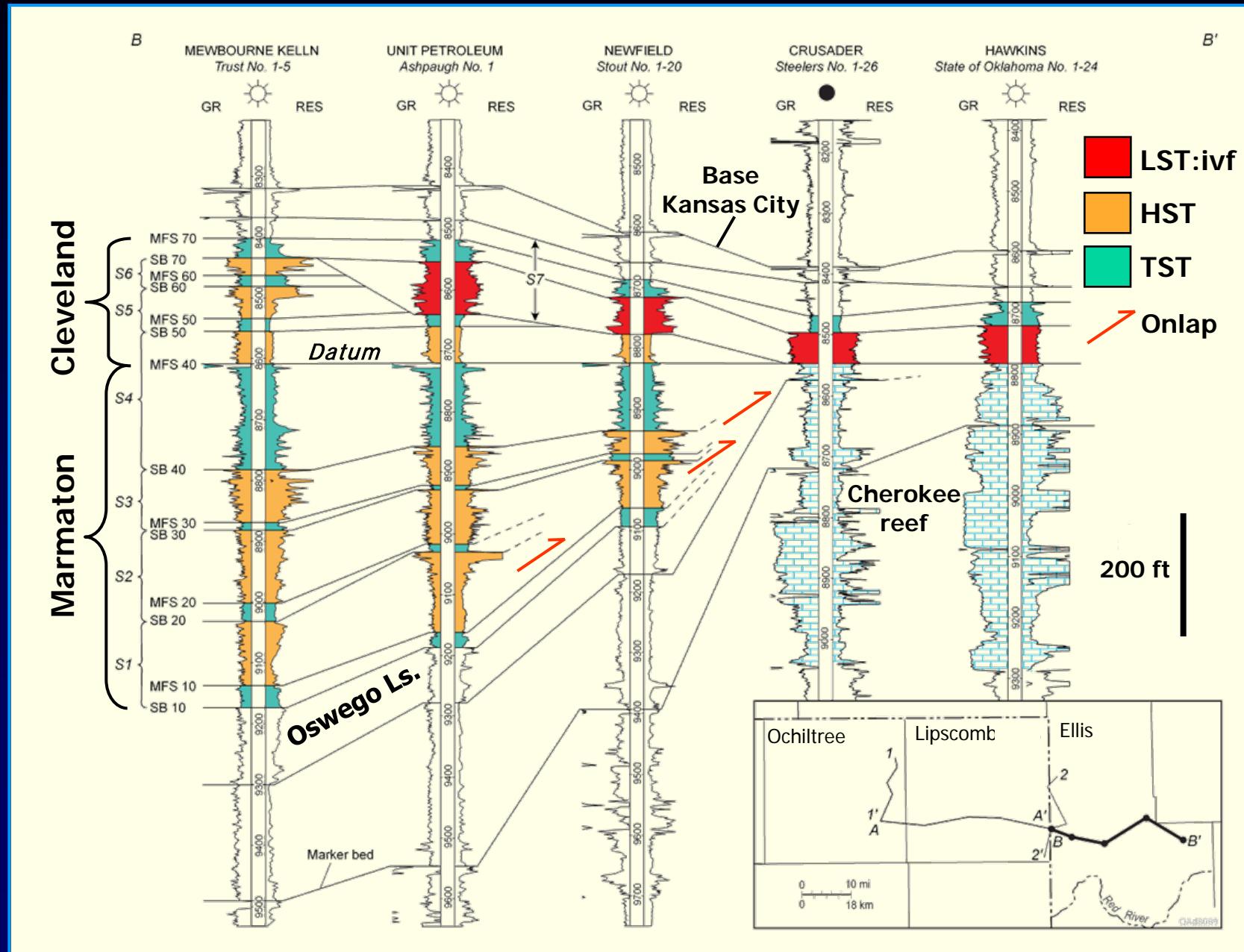
Cleveland: Sequence 7 LST Incised-Valley Fill



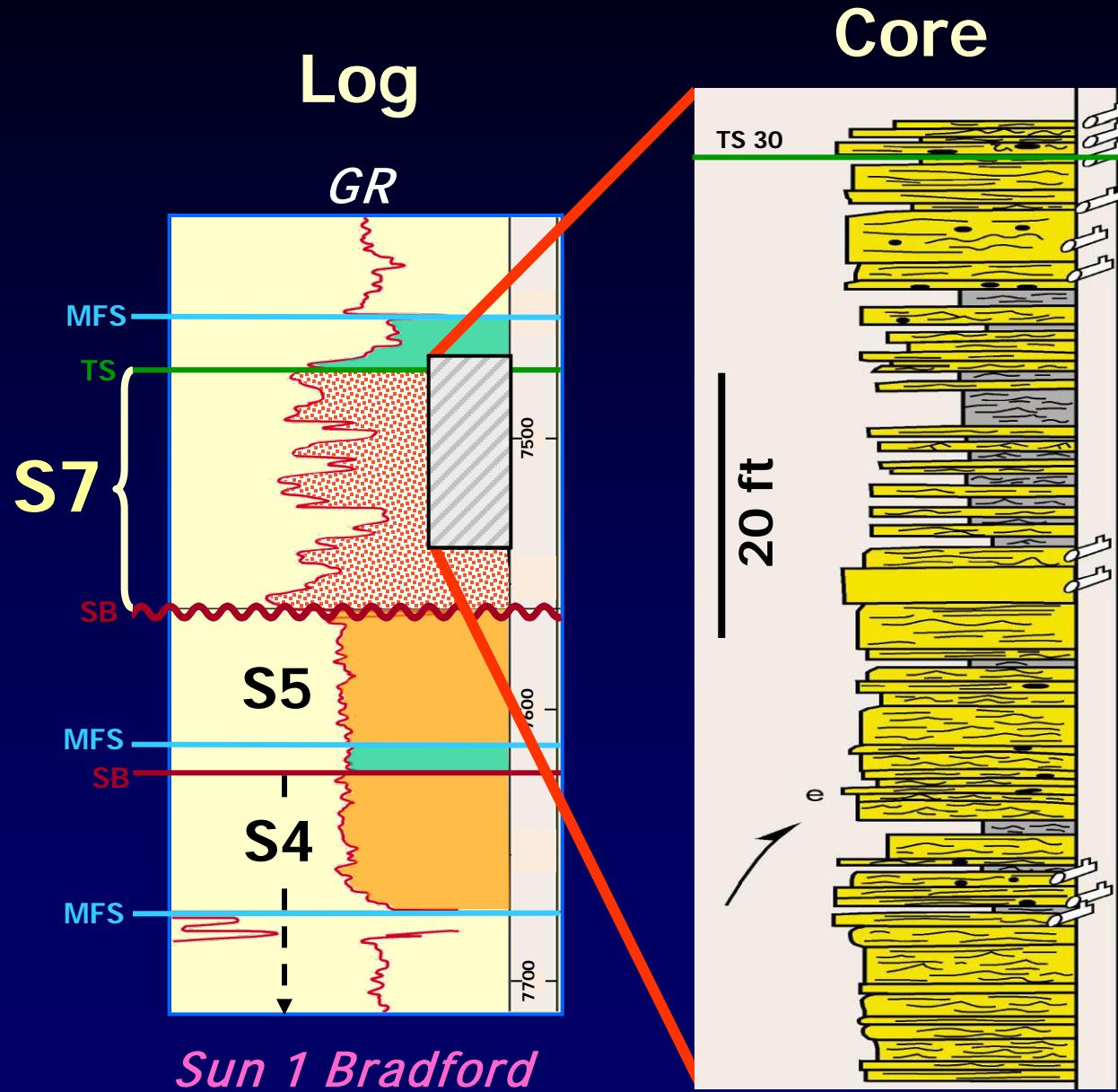
Cleveland: Sequence 7 LST Incised-Valley Fill



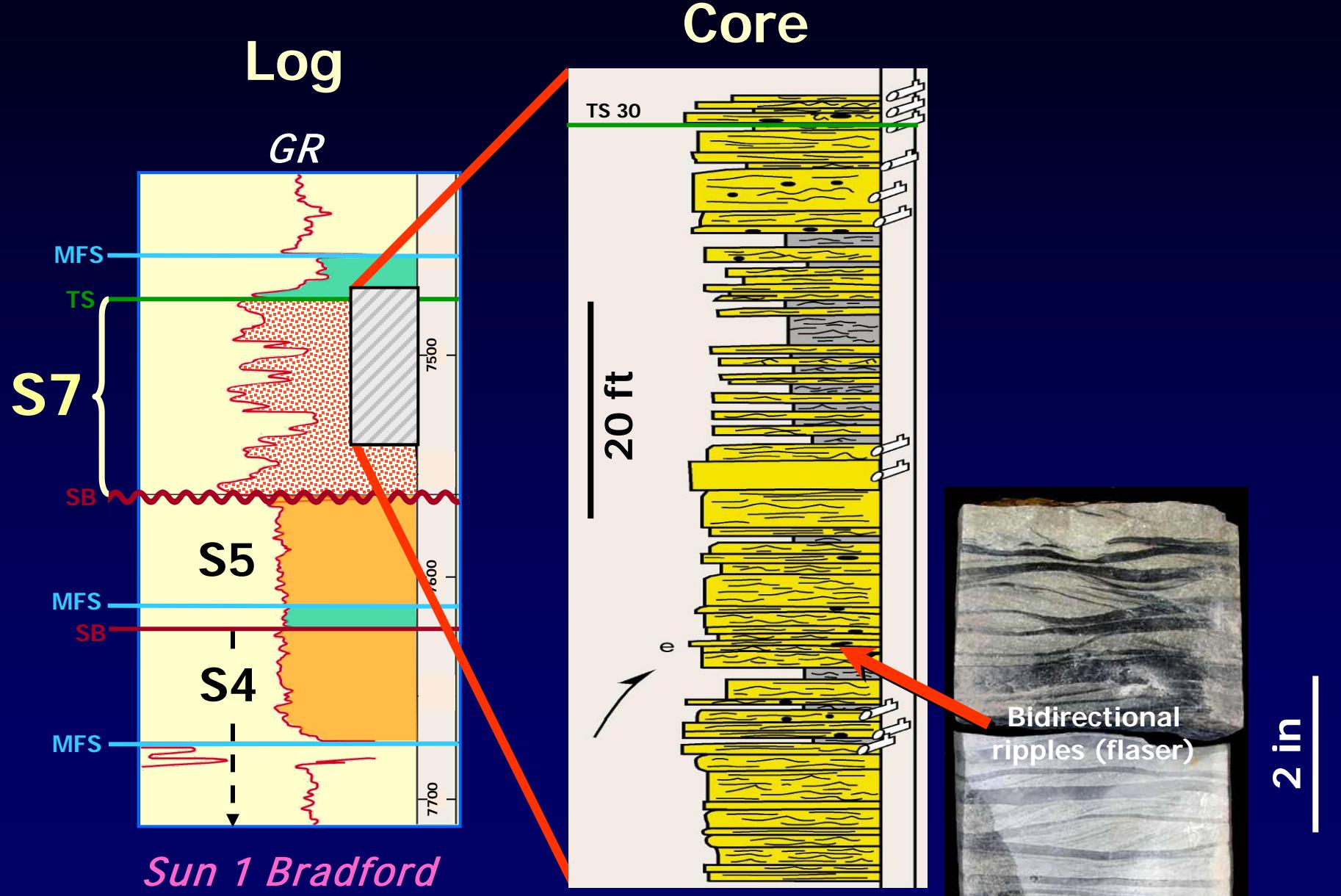
Cleveland S7 LST (IVF) at the Cherokee Reef



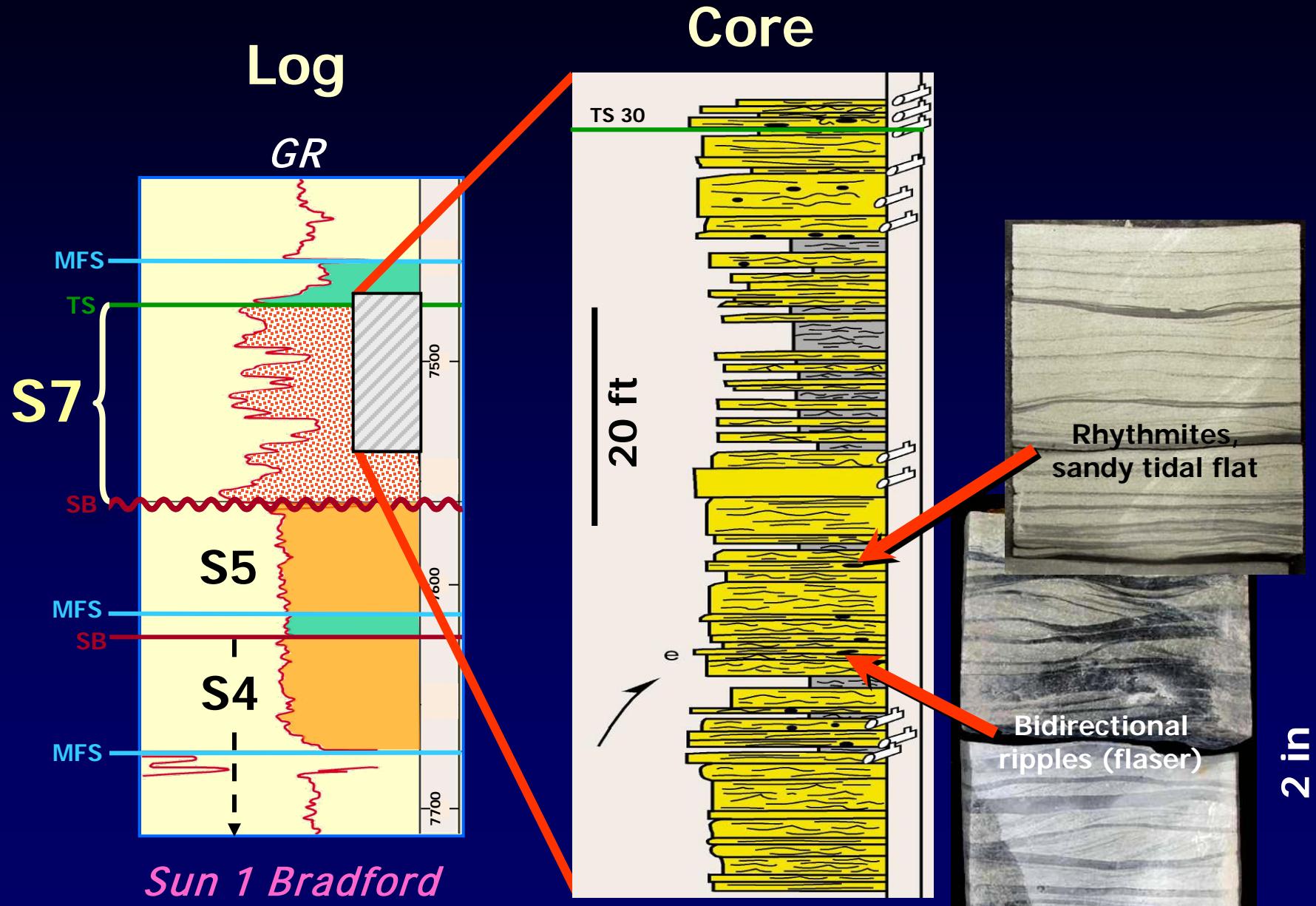
Incised-Valley Fill: Tidally Influenced Estuarine



Incised-Valley Fill: Tidally Influenced Estuarine

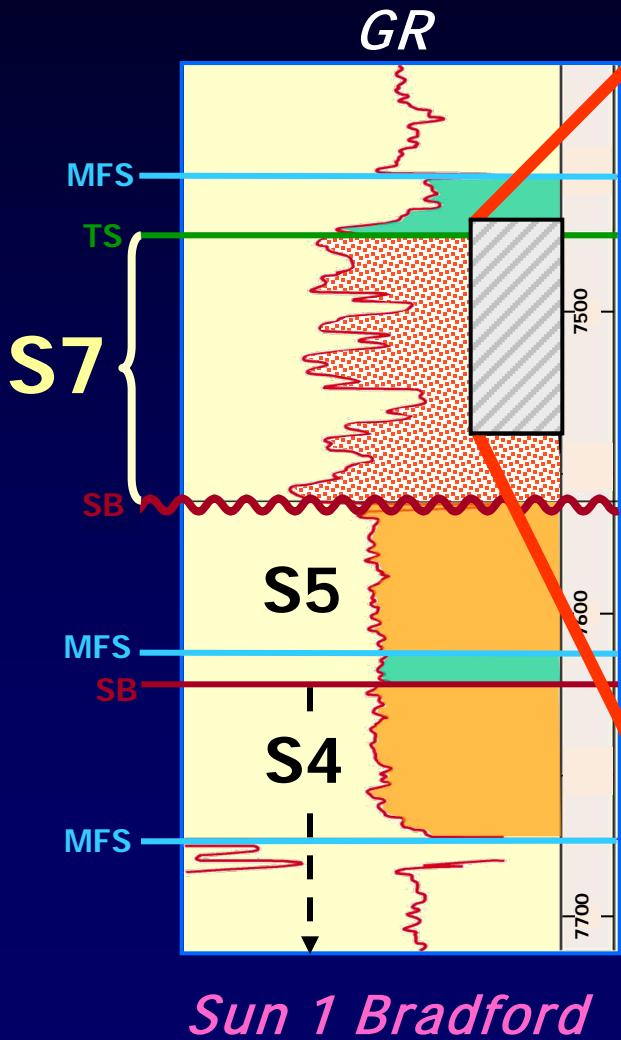


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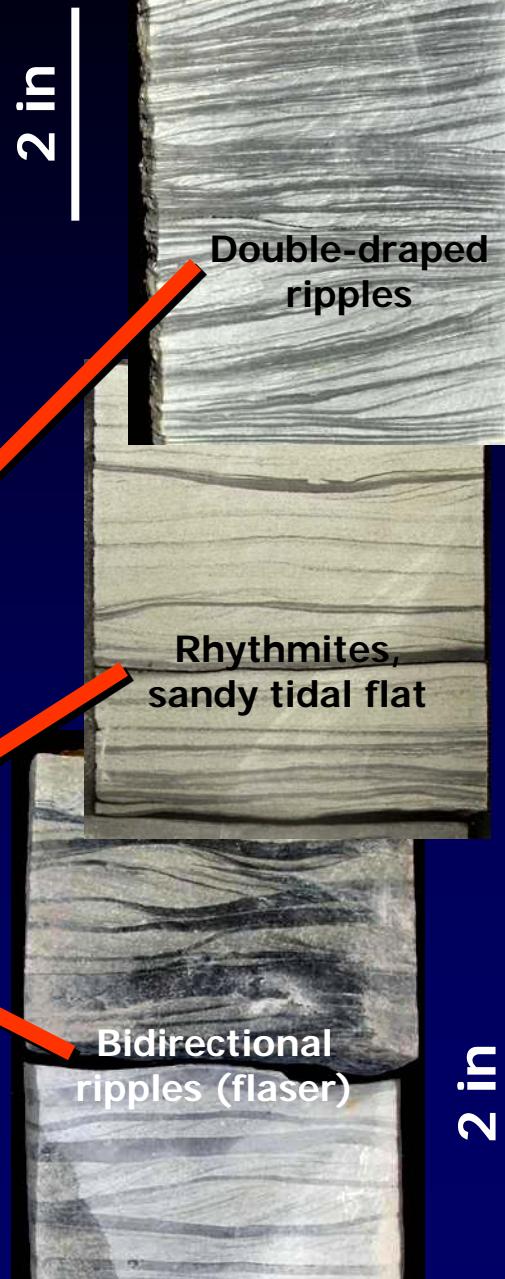
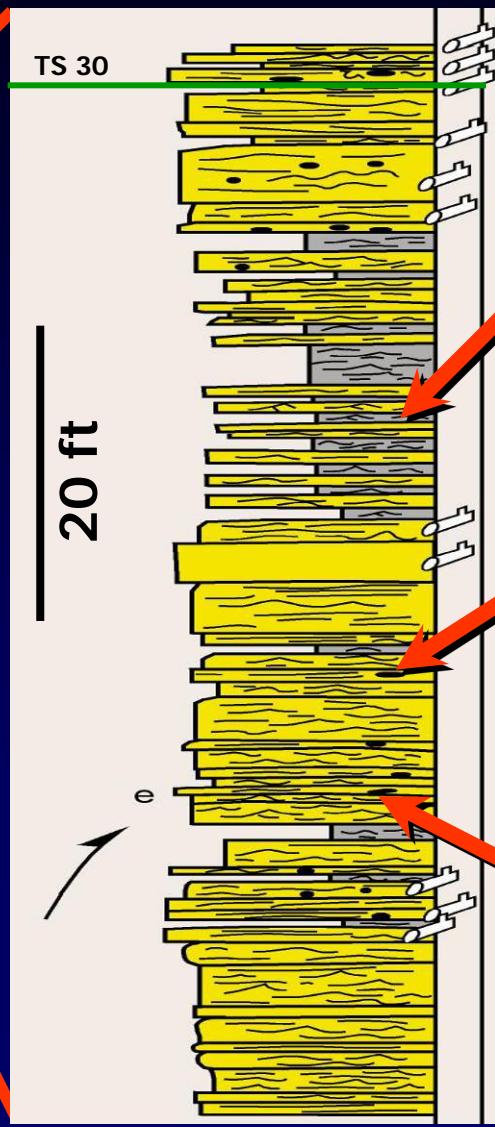


Incised-Valley Fill: Tidally Influenced Estuarine

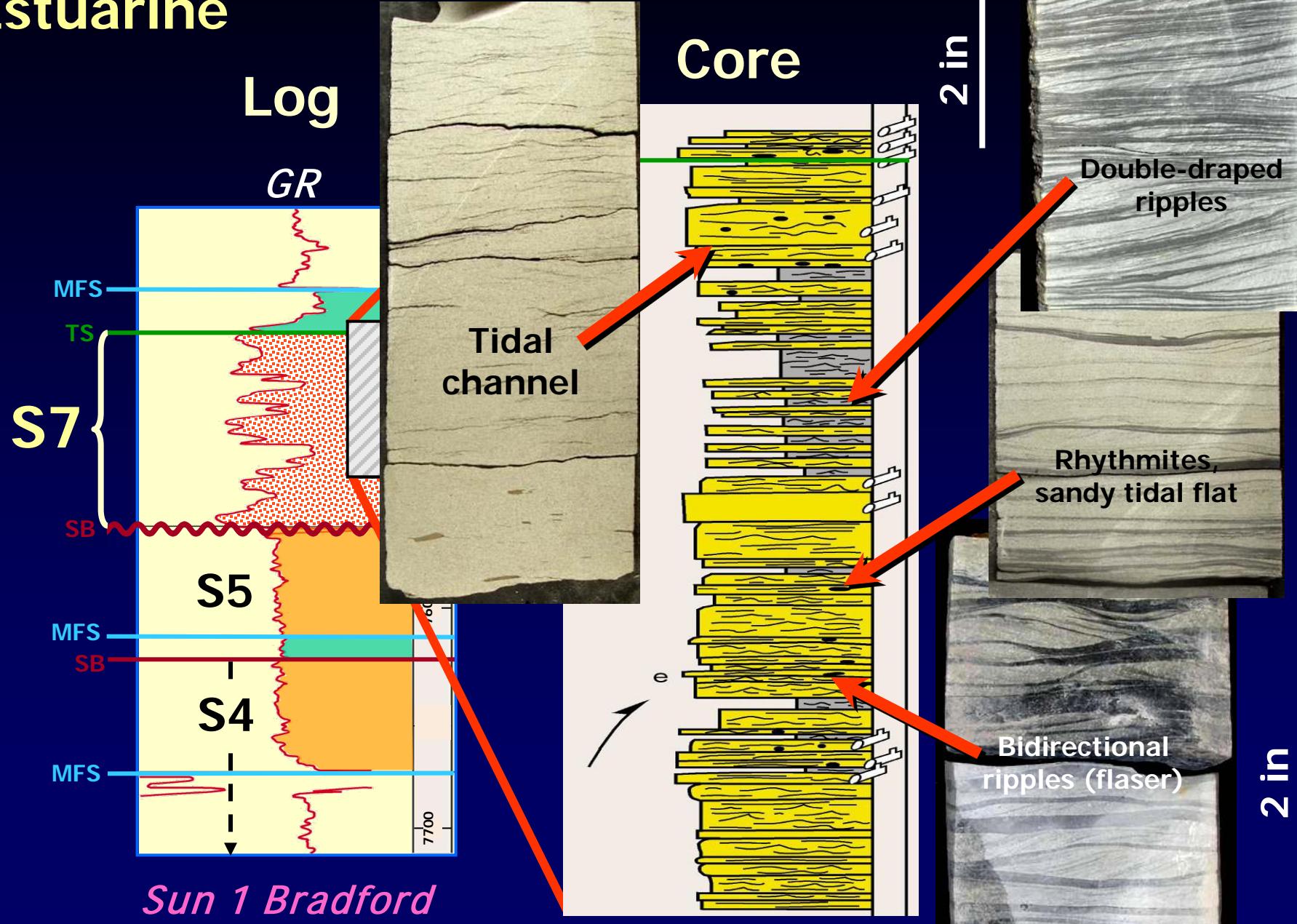
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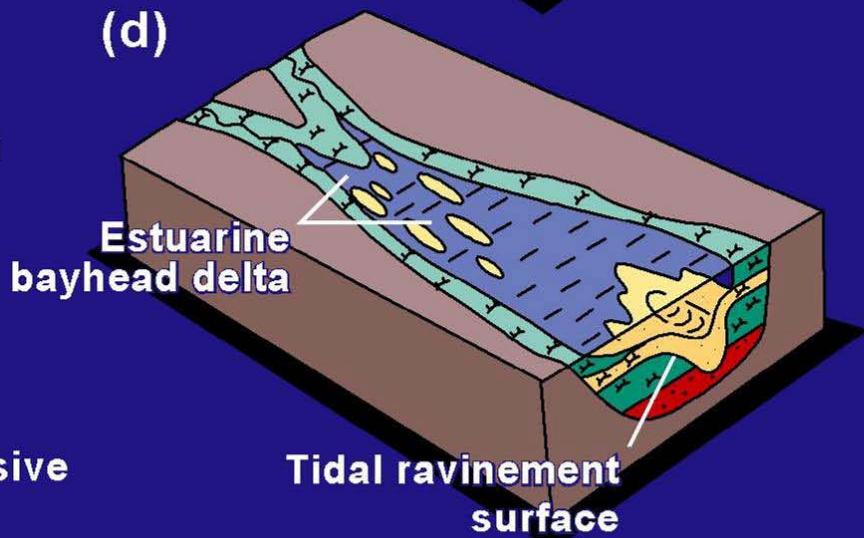
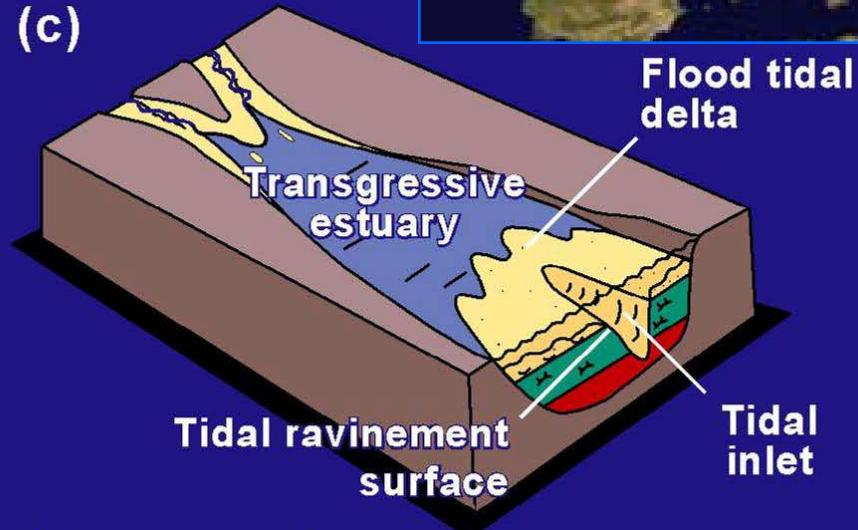
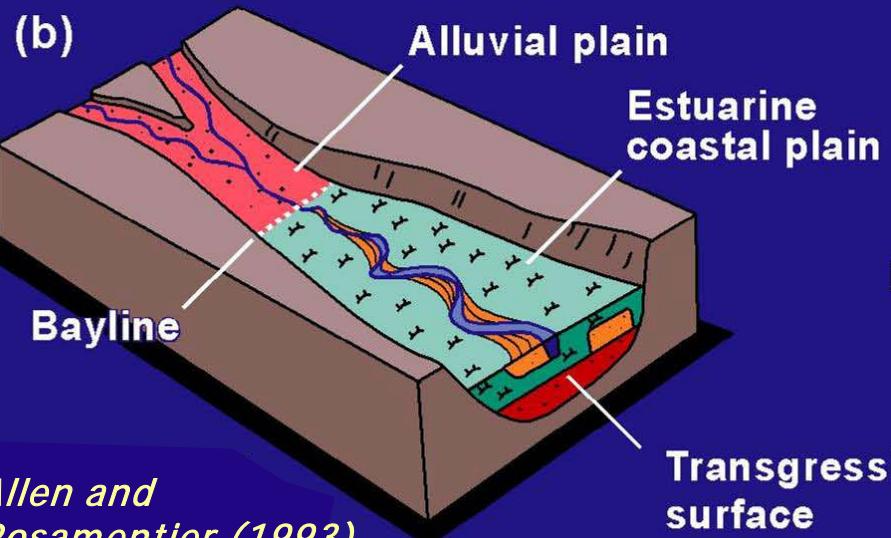
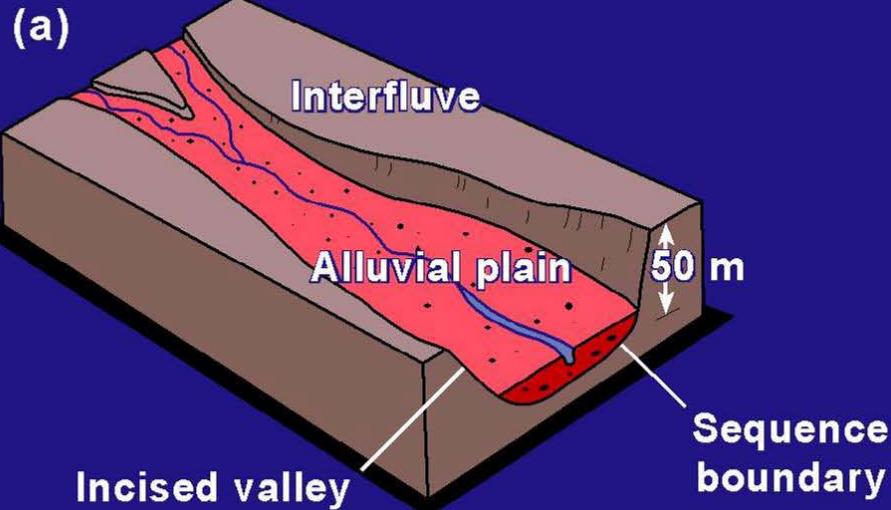
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Incised-Valley Fill: Tidally Influenced Estuarine

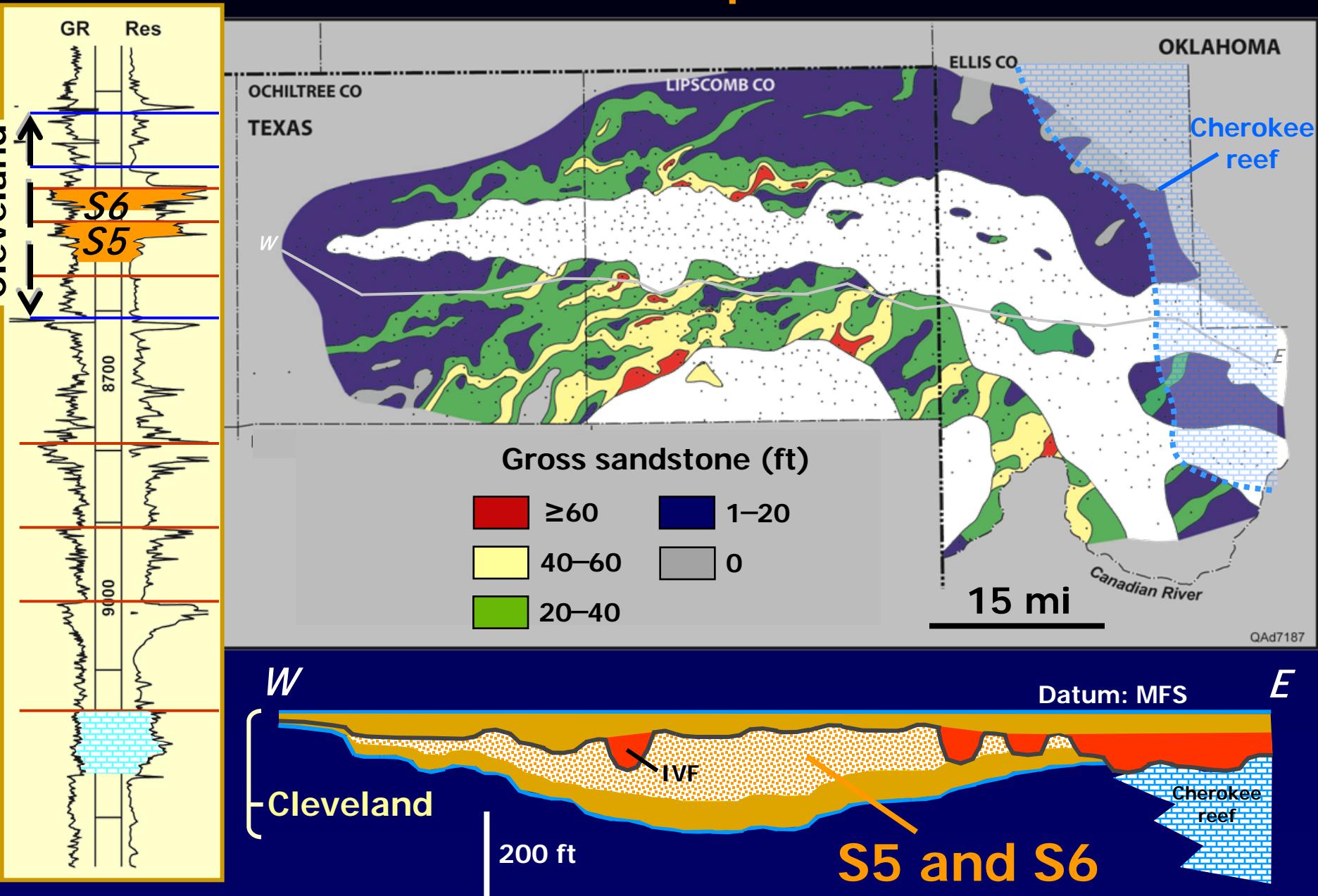


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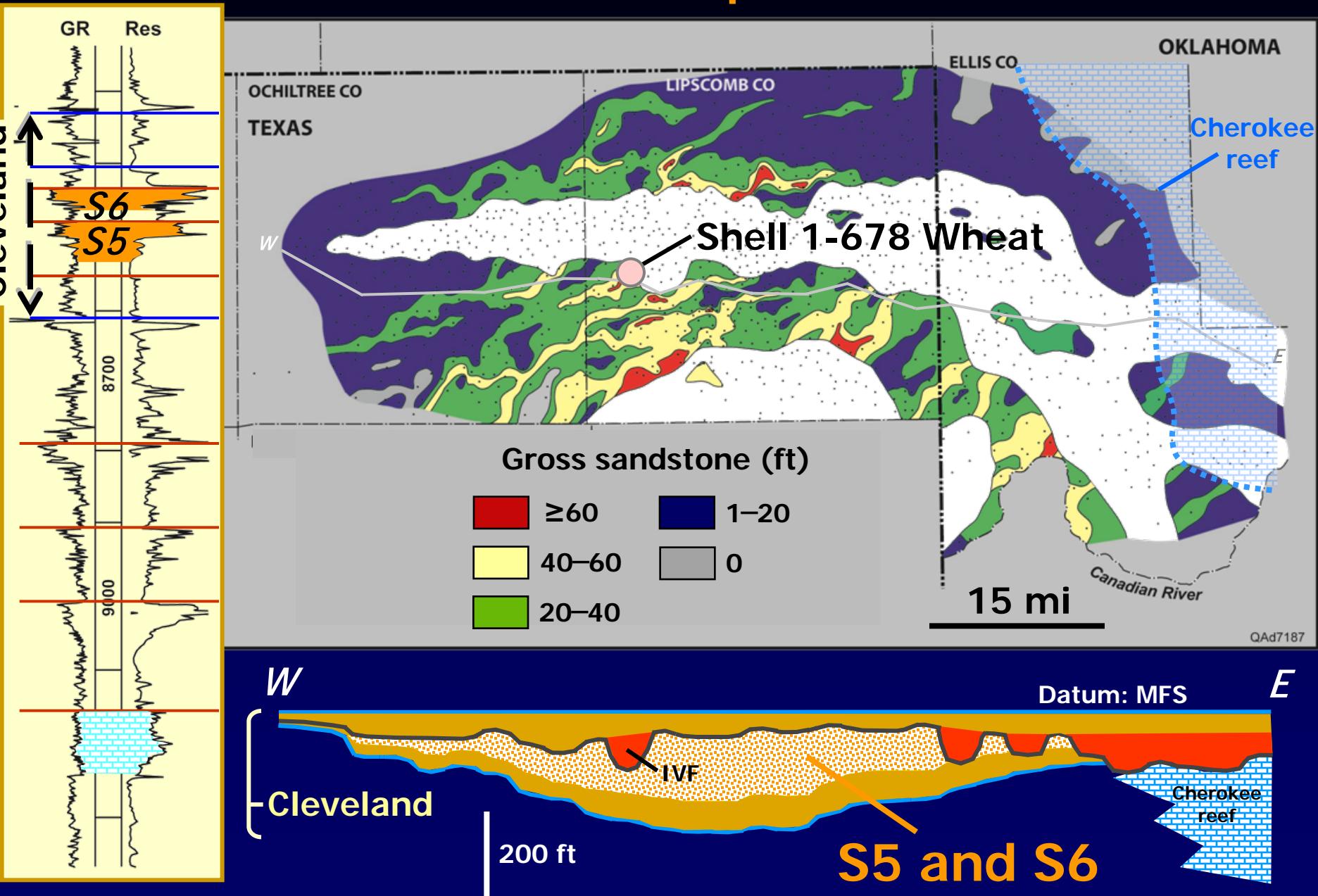


Allen and
Posamentier (1993)

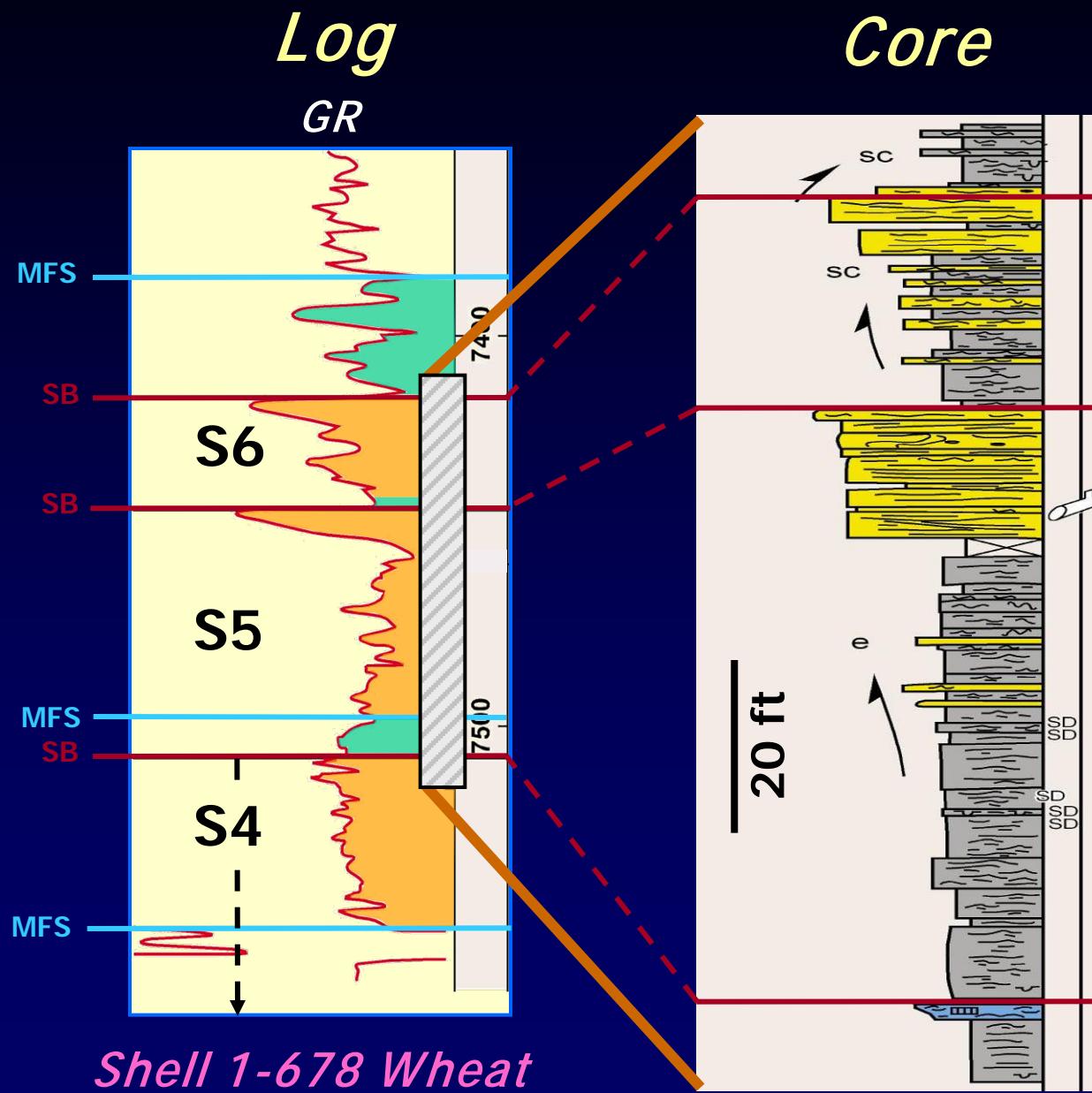
Cleveland: Sequences 5 and 6 HST



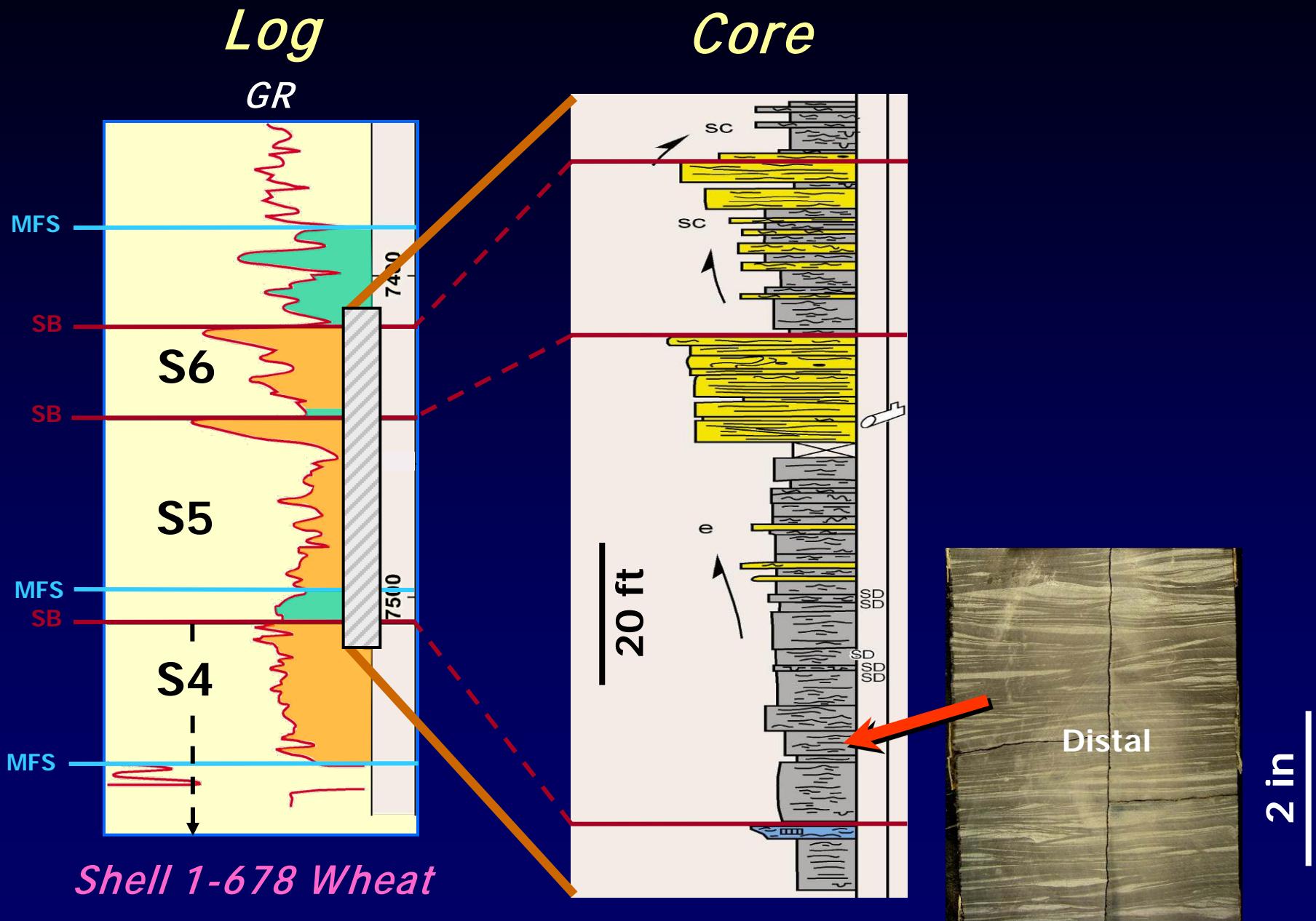
Cleveland: Sequences 5 and 6 HST



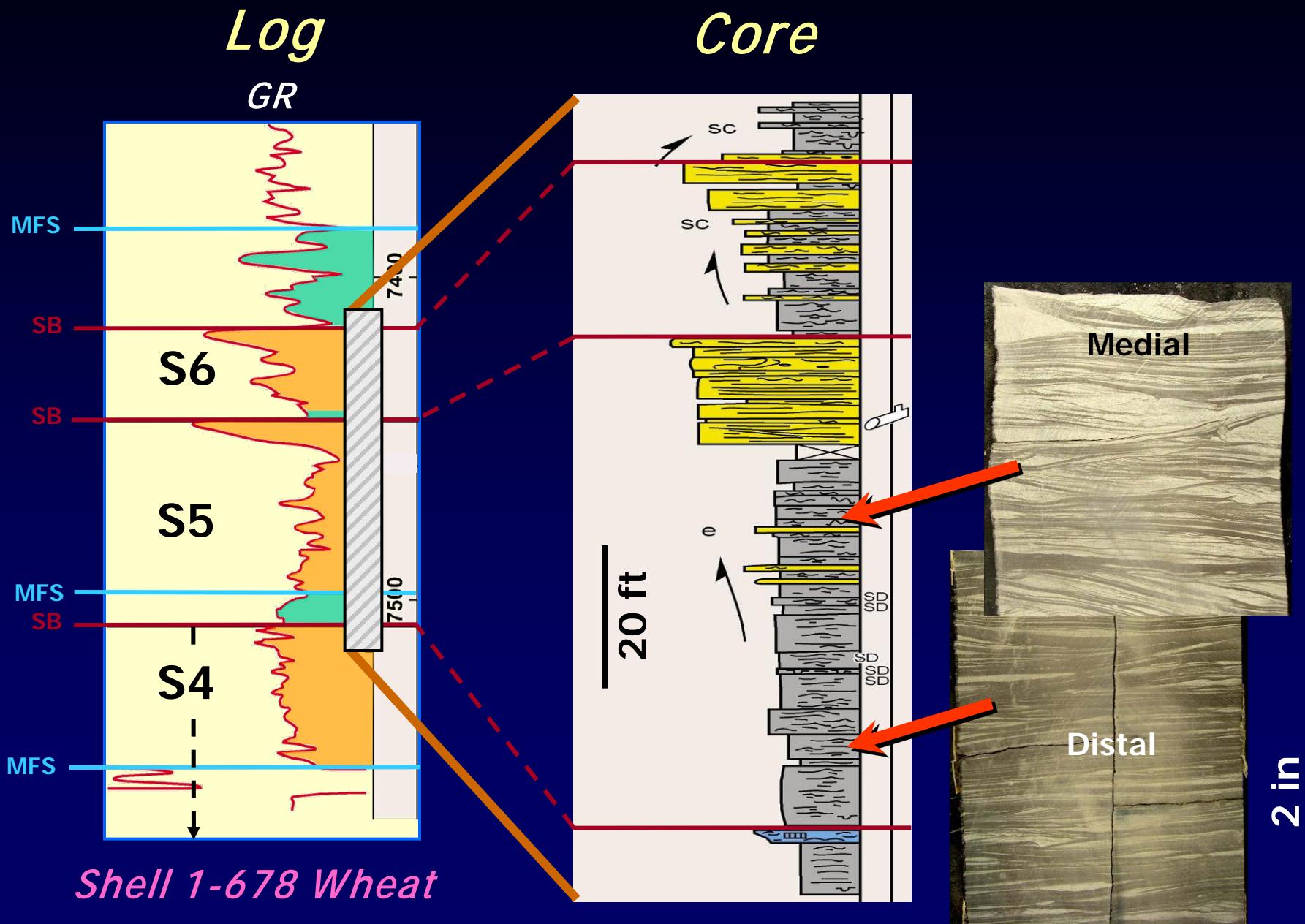
Highstand: Tidal Shelf



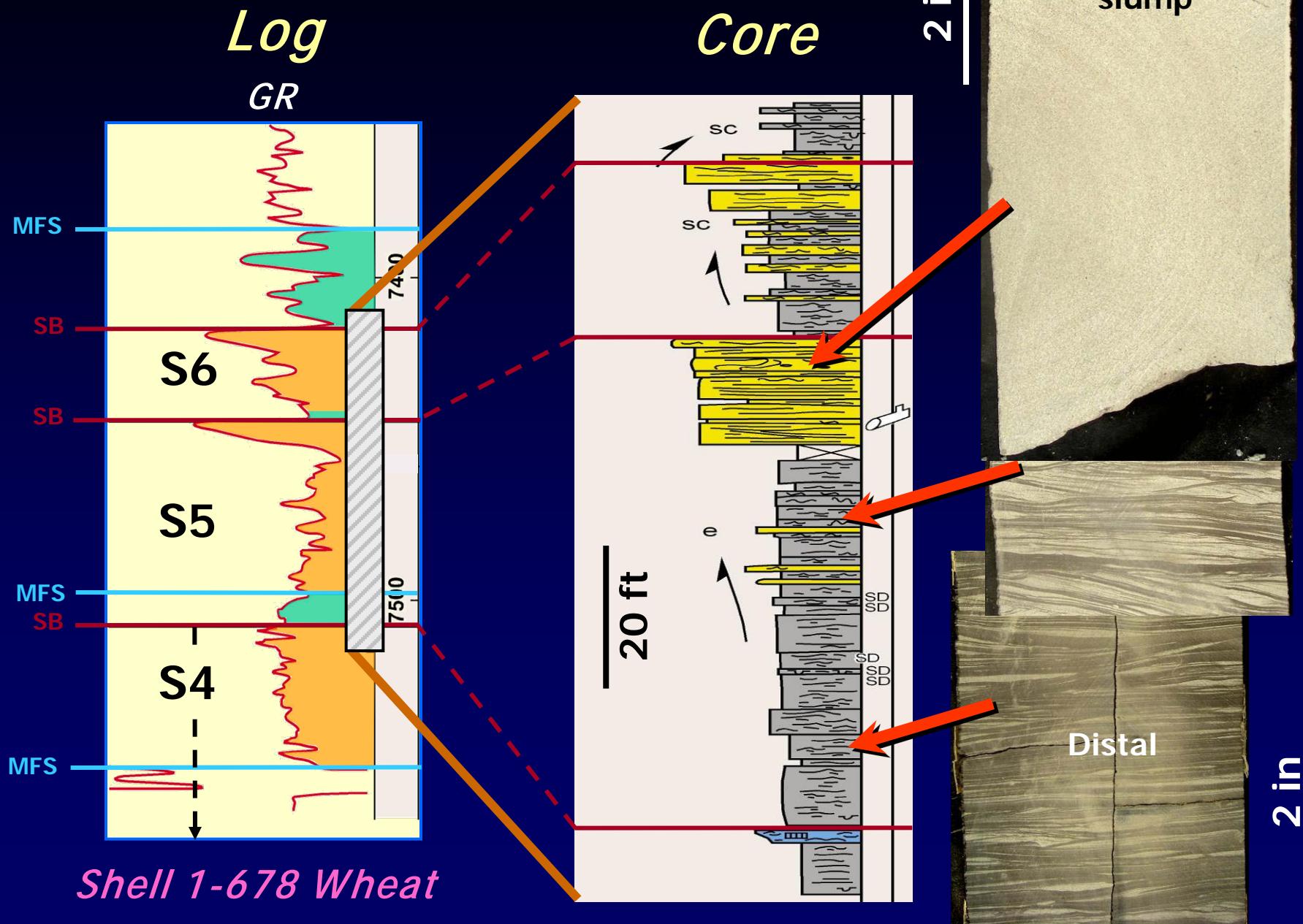
Highstand: Tidal Shelf



Highstand: Tidal Shelf

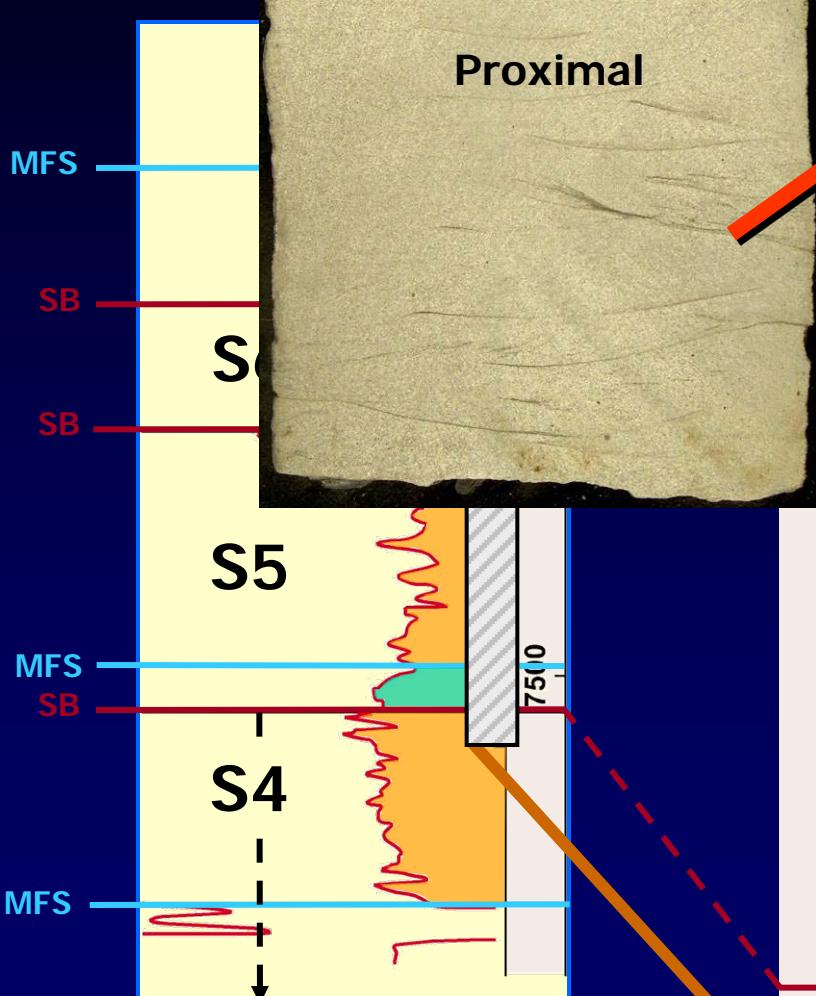


Highstand: Tidal Shelf

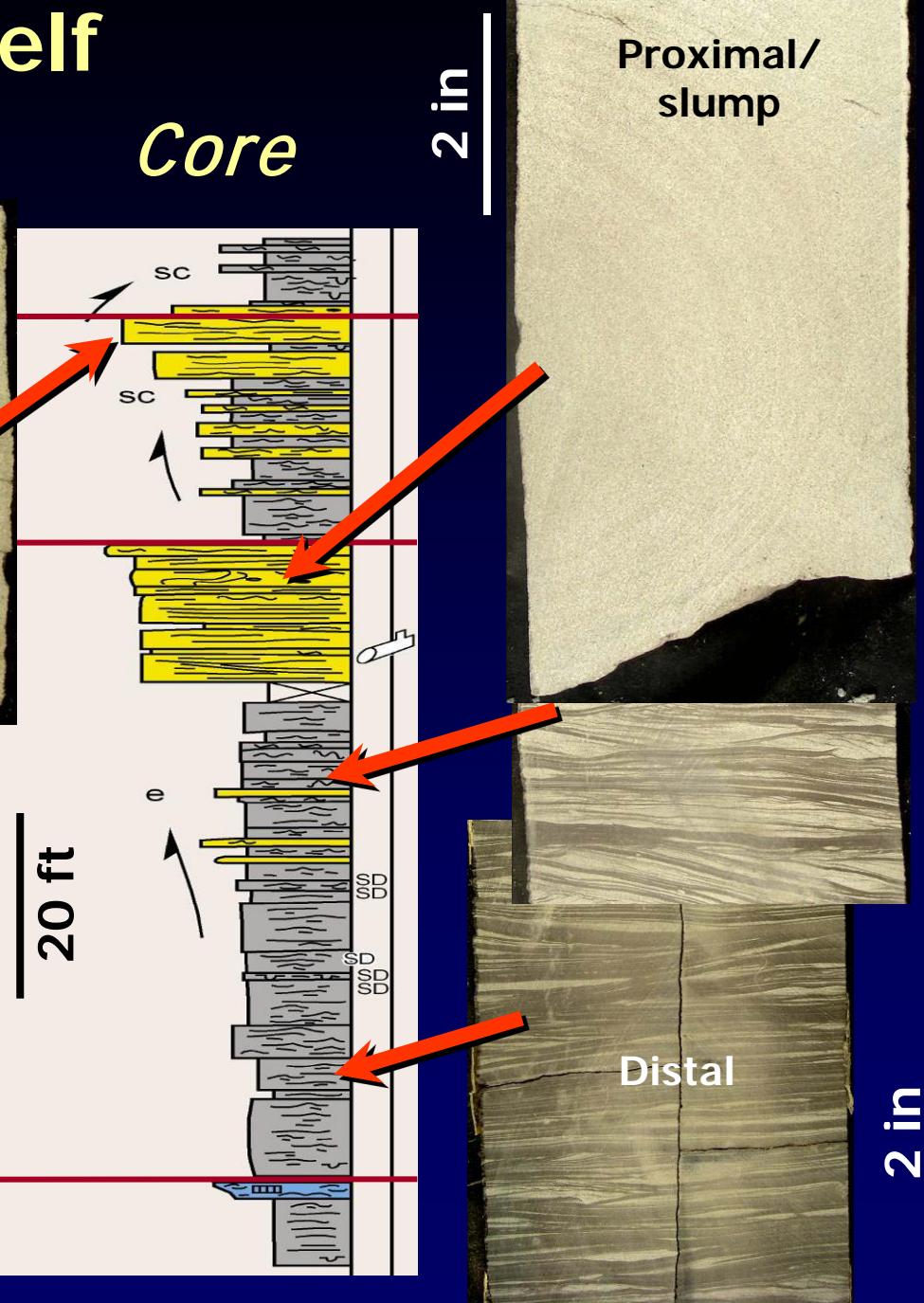


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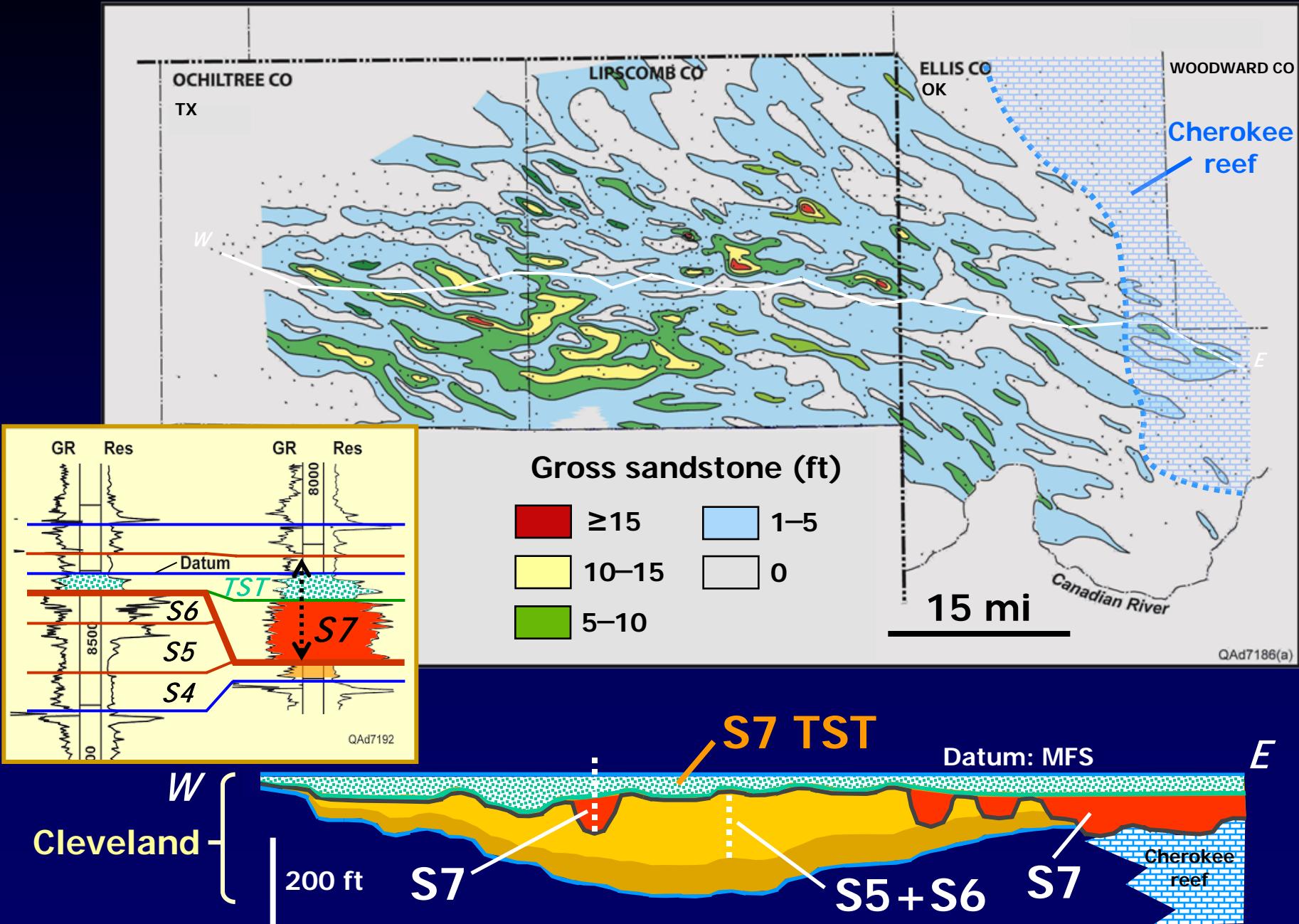
Log



Core

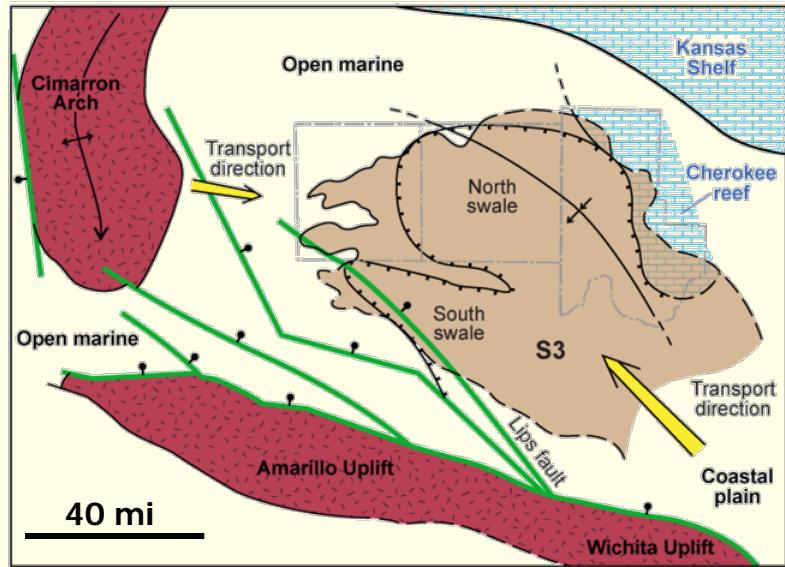


Cleveland: Sequence 7 TST

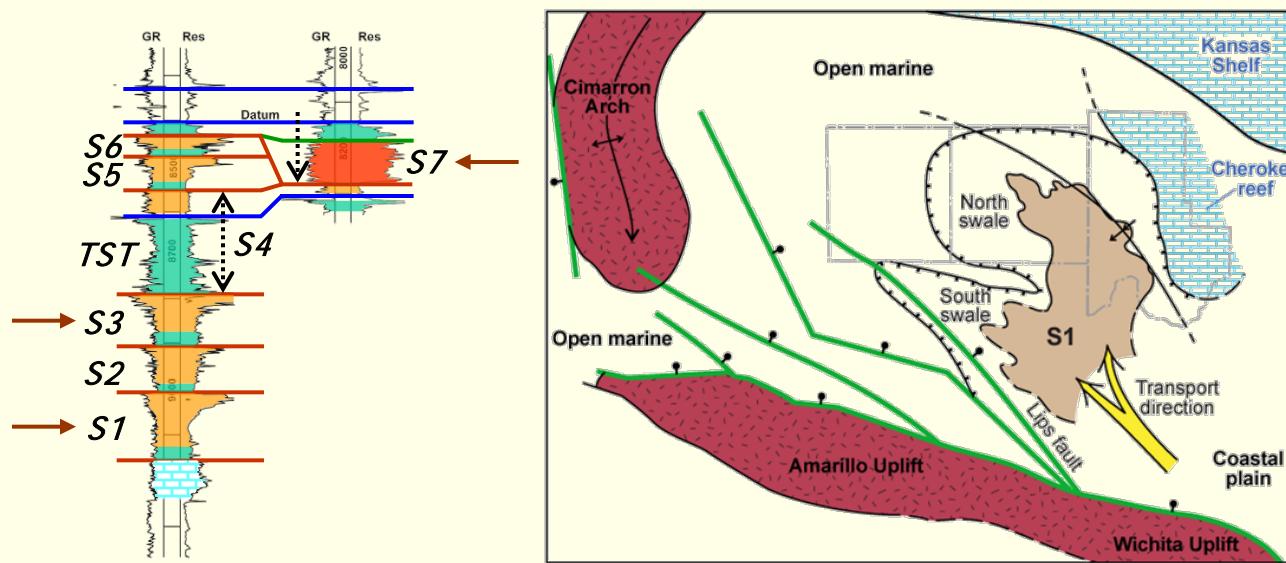
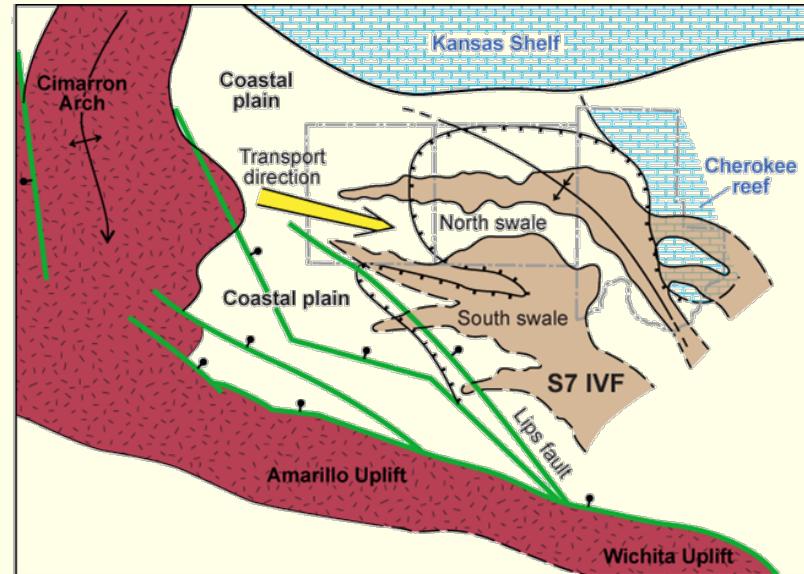


Complex Shelf Topography

Time 2: Marm. S3



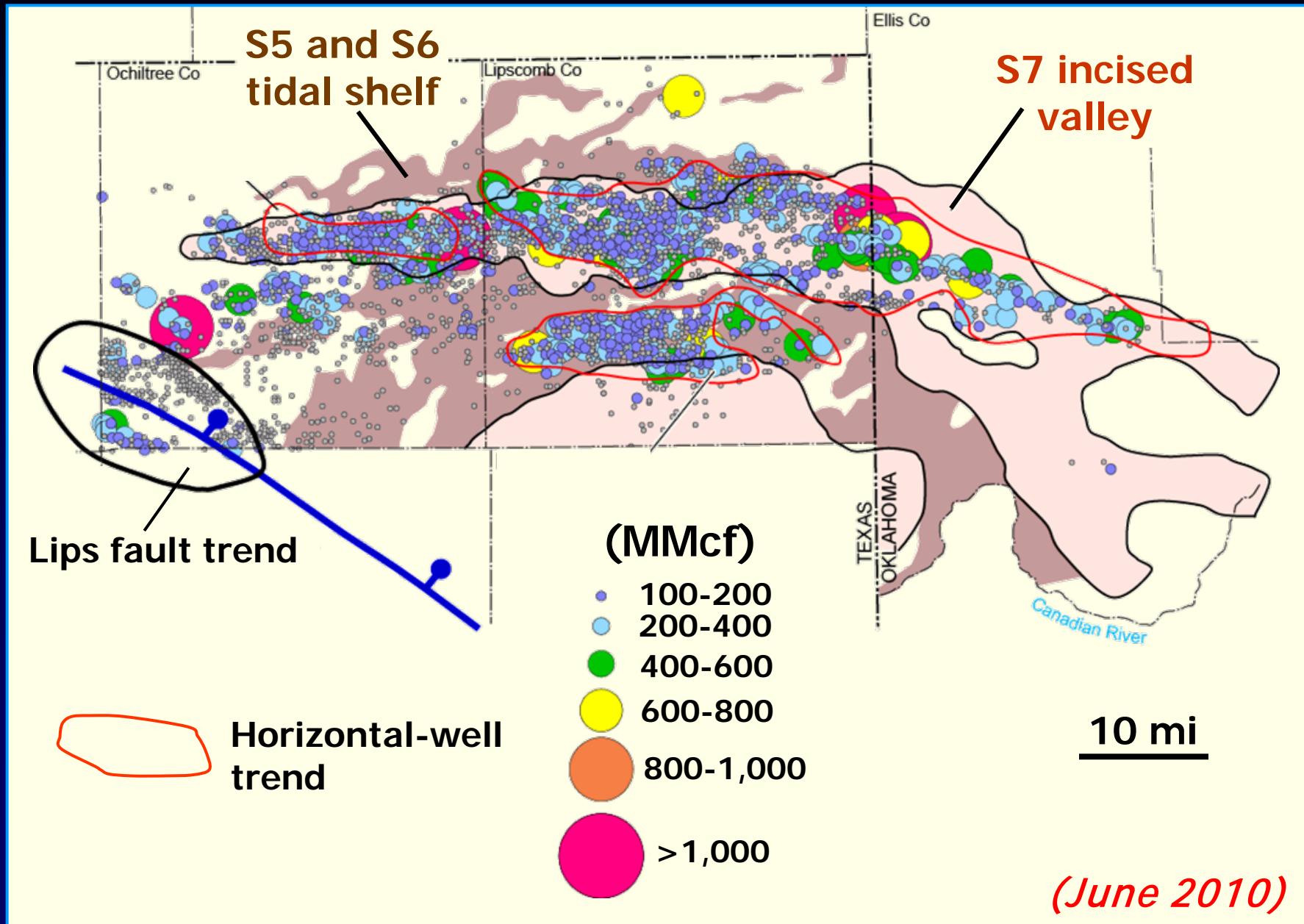
Time 3: Clvd S7 IVF



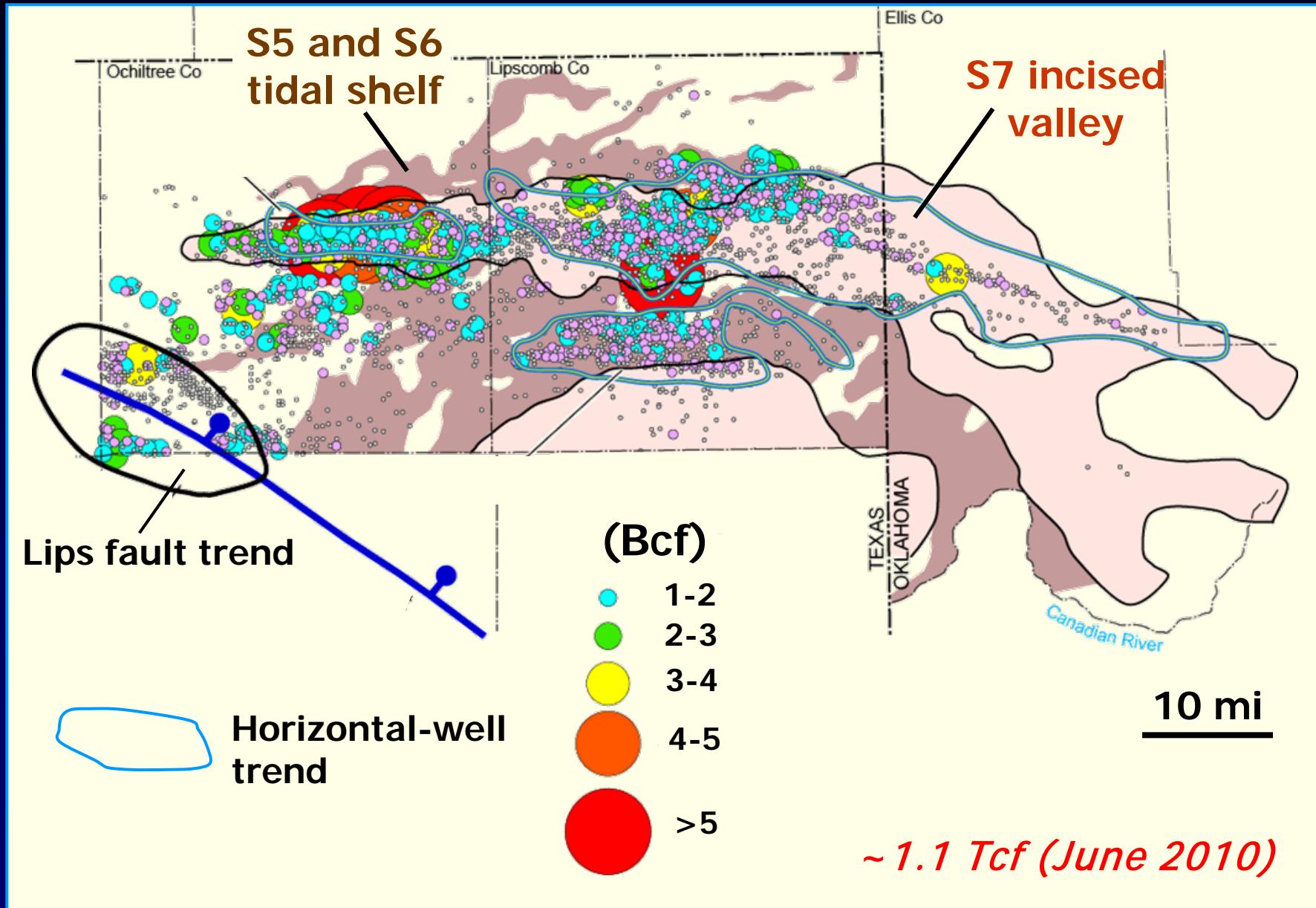
*Time 1:
Marm. S1*

- Fault
- Arch
- Flexure
- Shelf depression

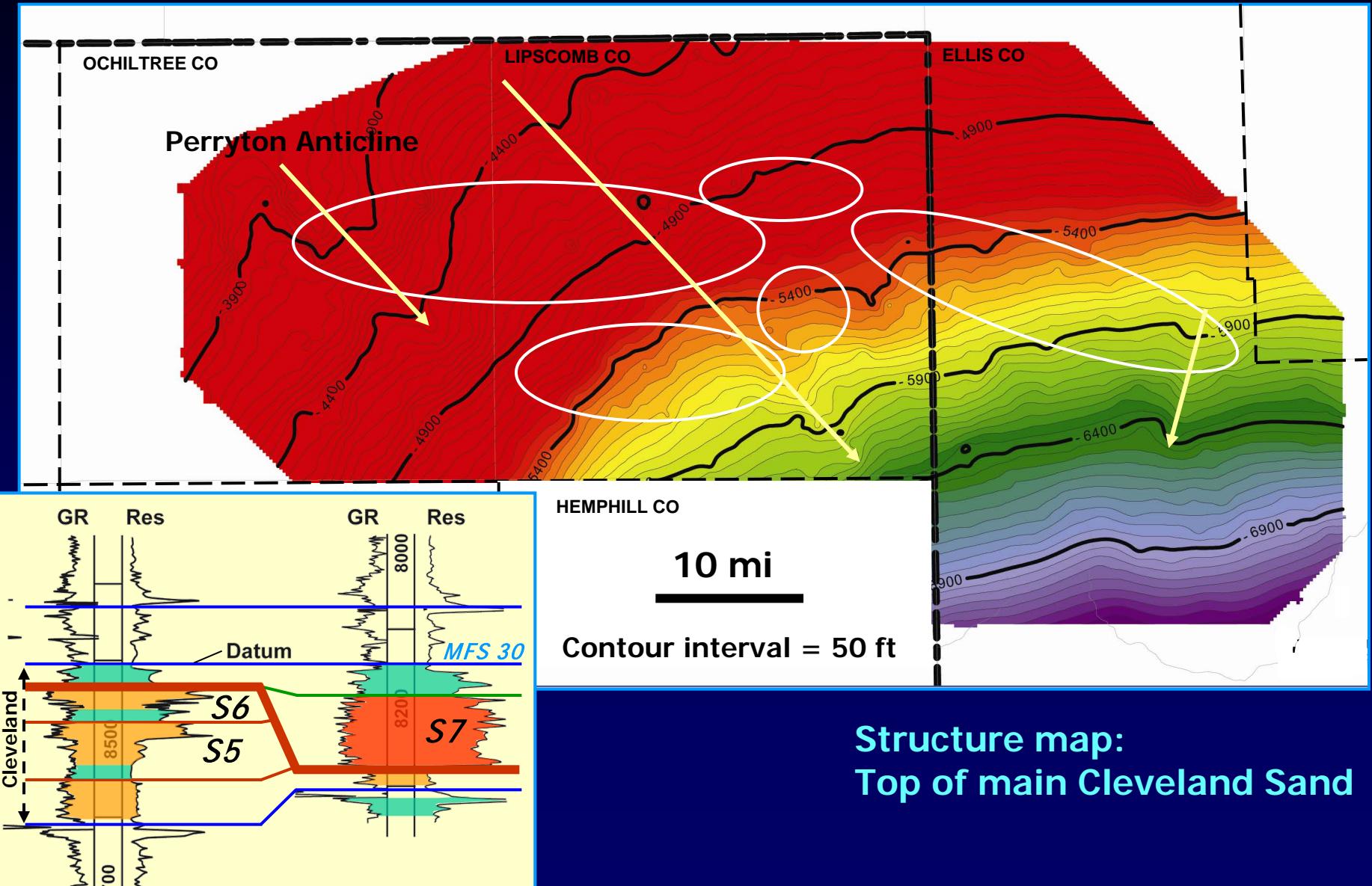
First Year's Cleveland Gas Production



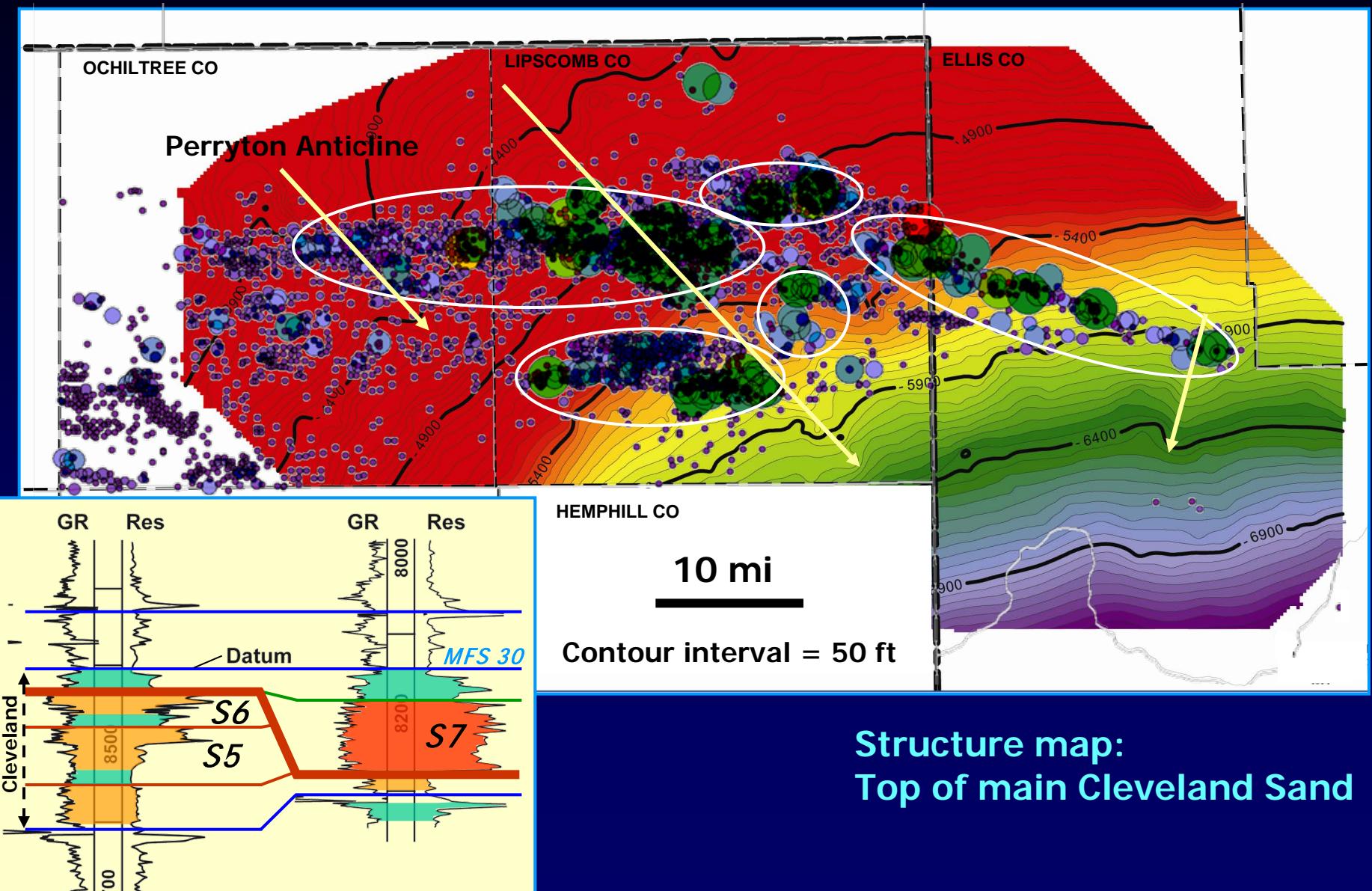
Cumulative Cleveland Gas Production



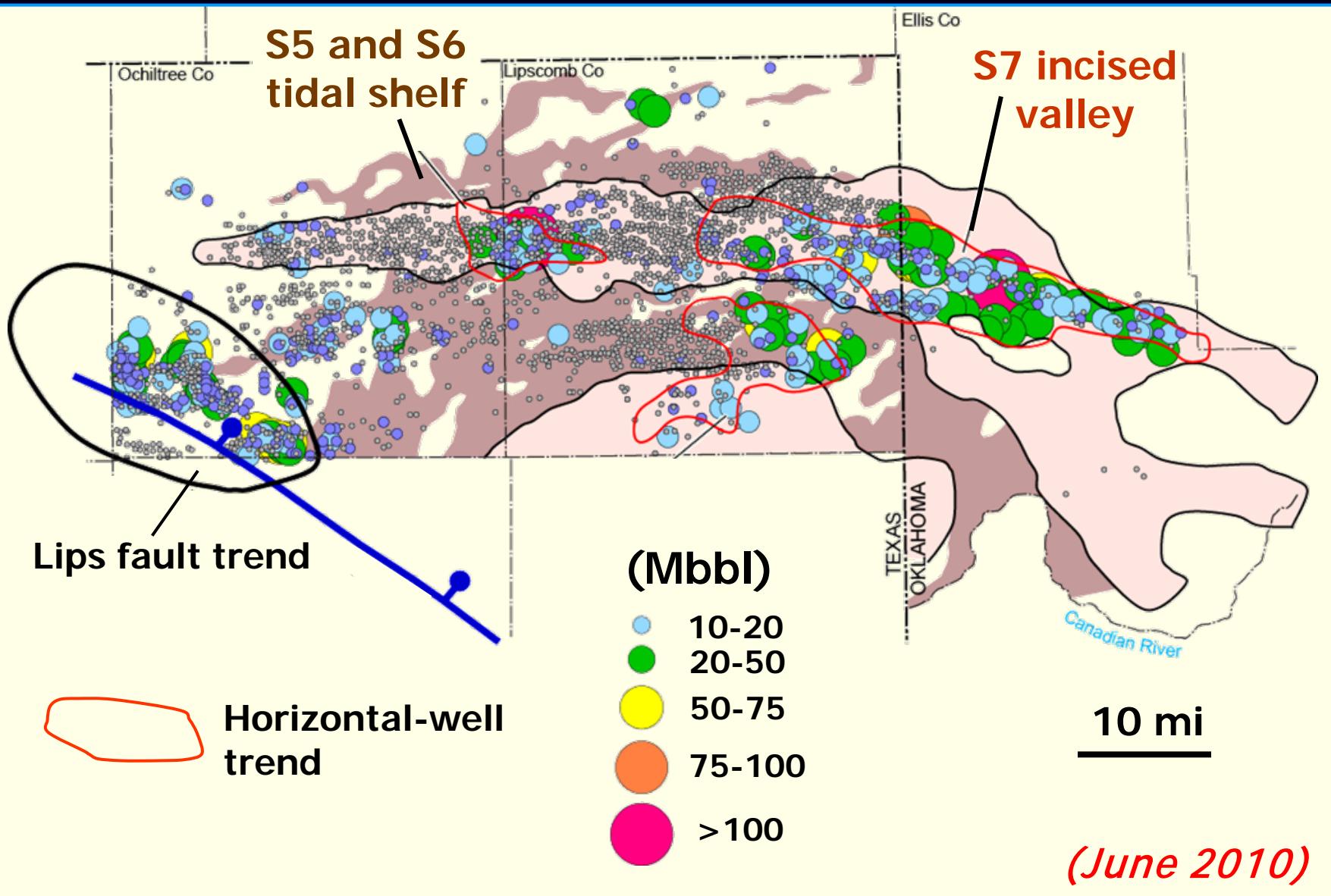
Structural Control on Cleveland Gas Production



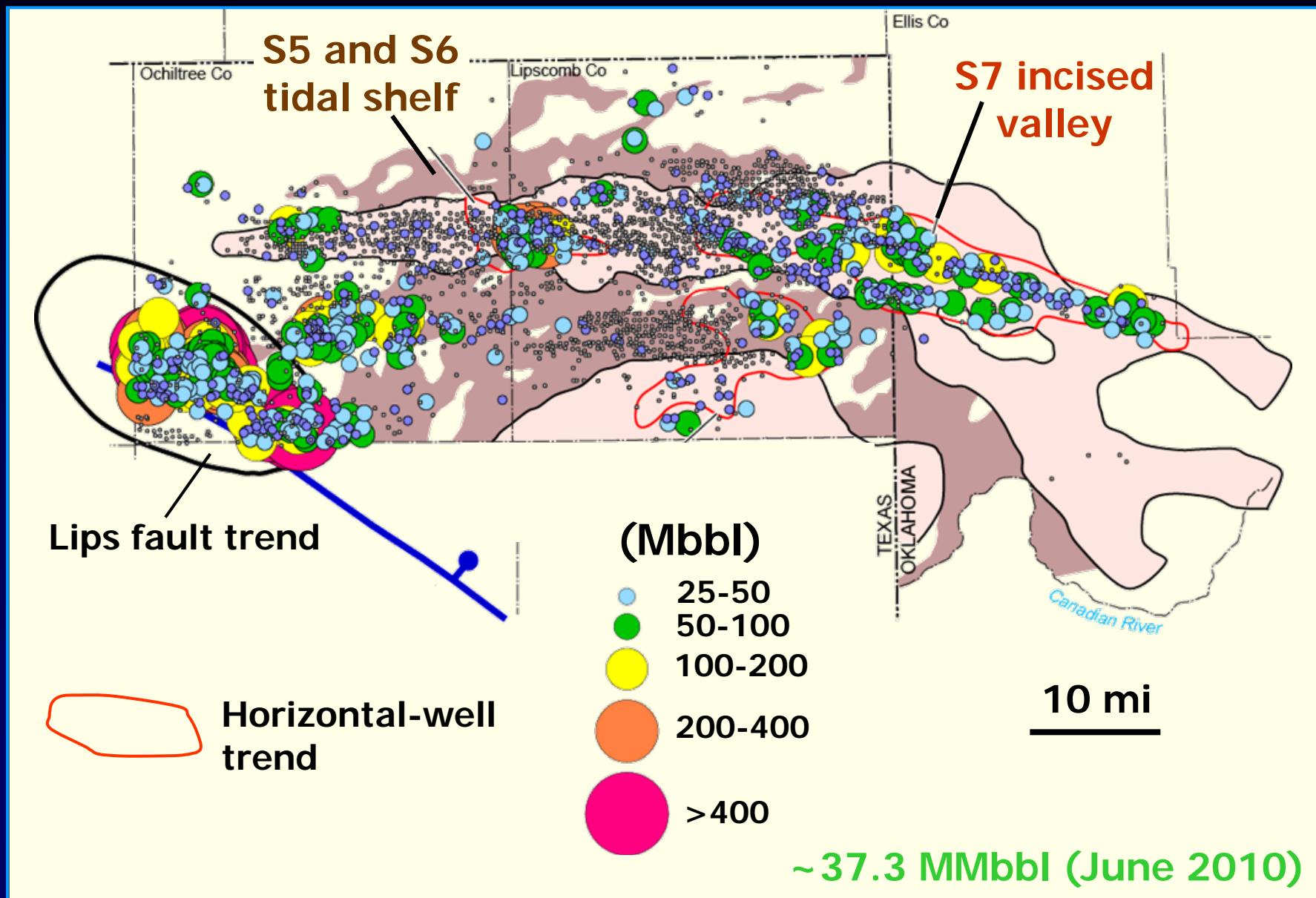
Structural Control on Cleveland Gas Production



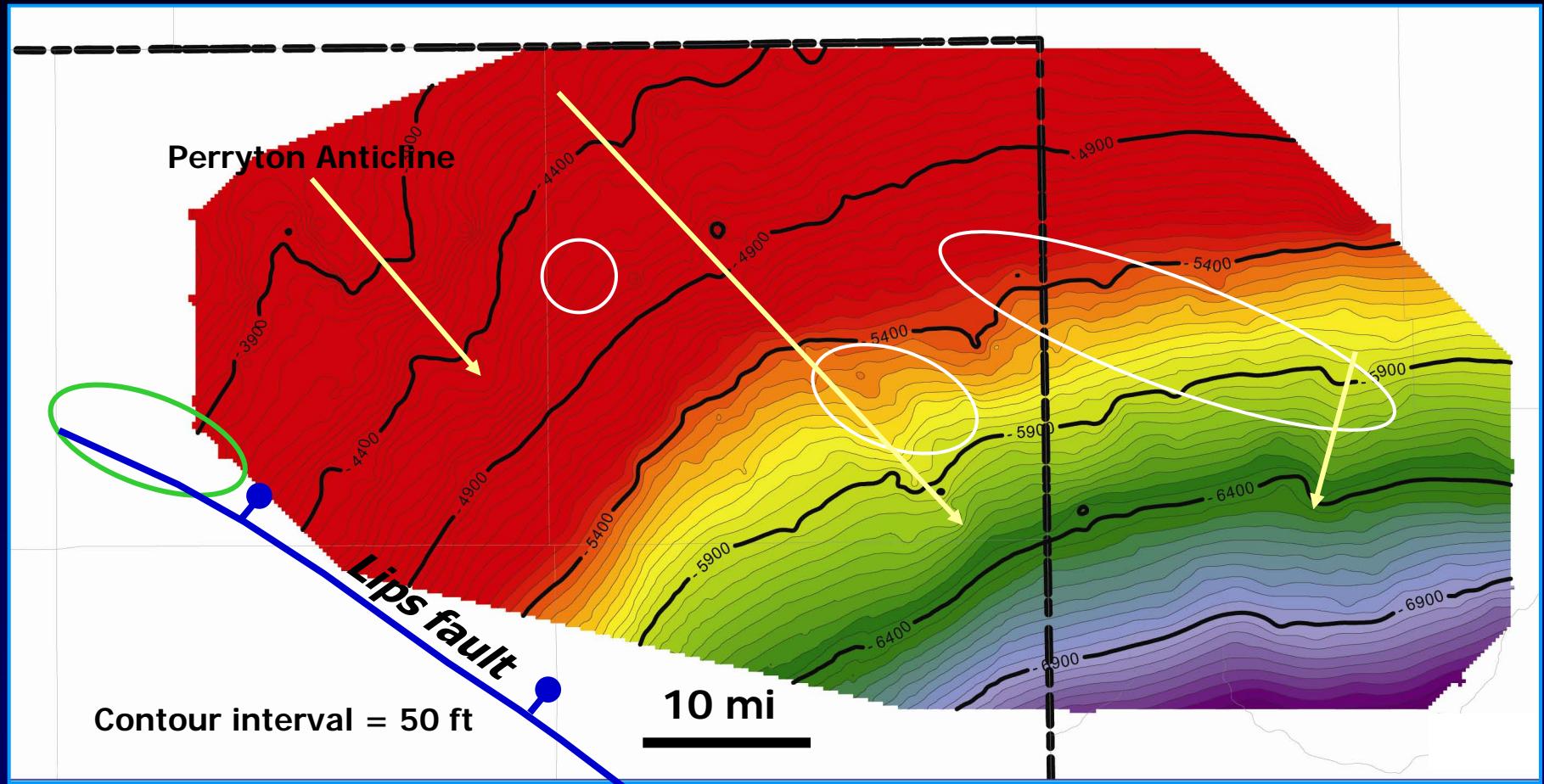
First Year's Cleveland Oil Production



Cumulative Cleveland Oil Production

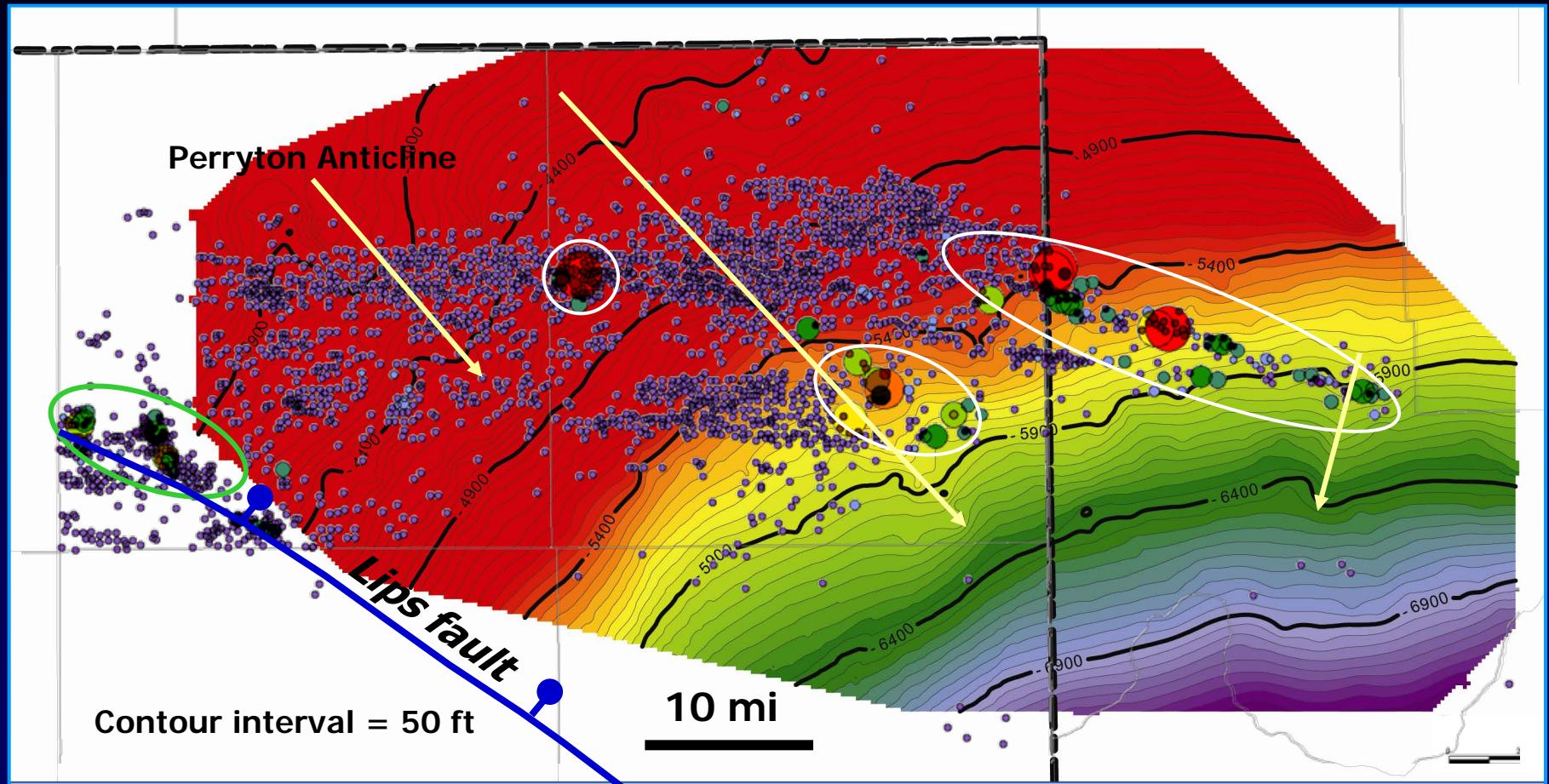


Structural Control on Cleveland Oil Production



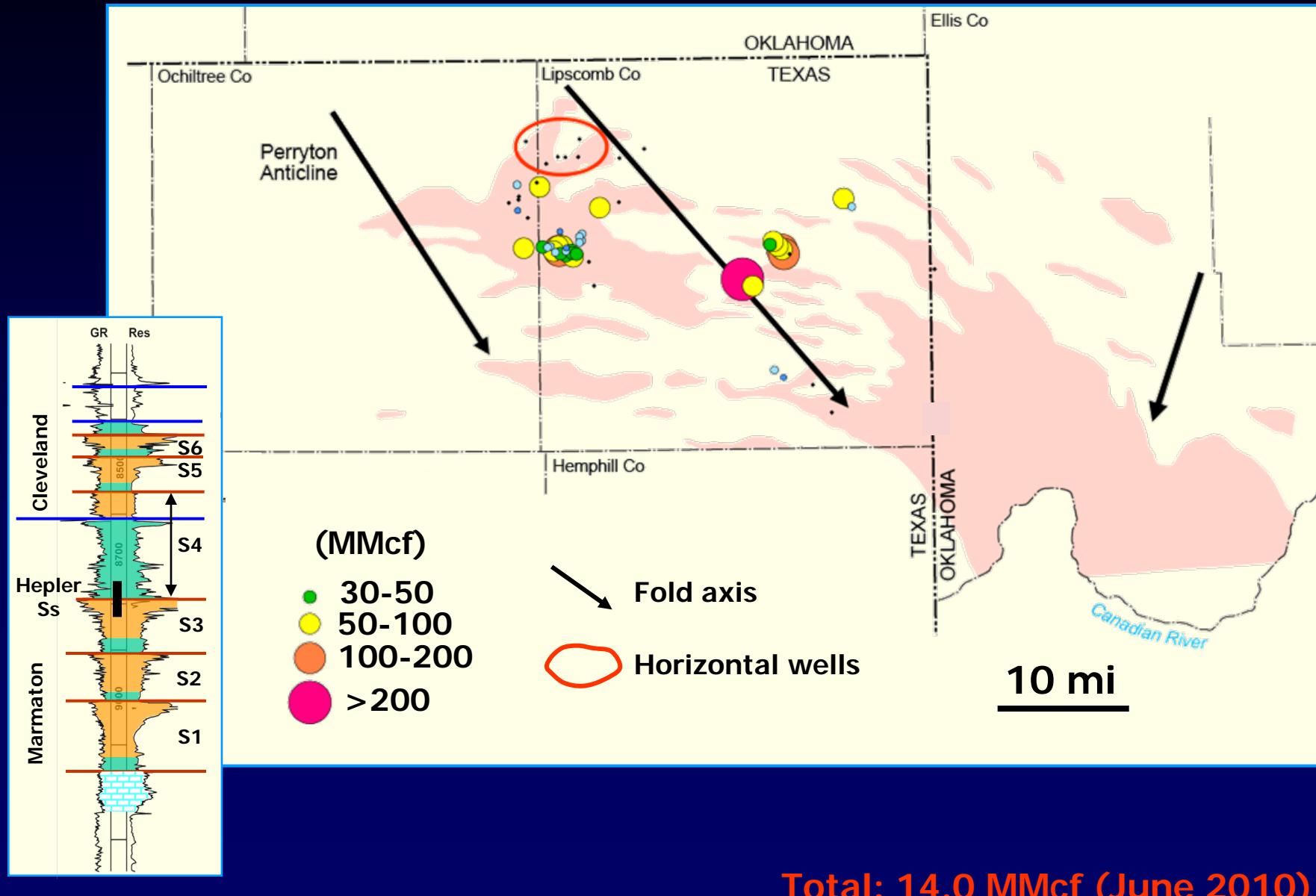
Structure map:
Top of main Cleveland Sand

Structural Control on Cleveland Oil Production

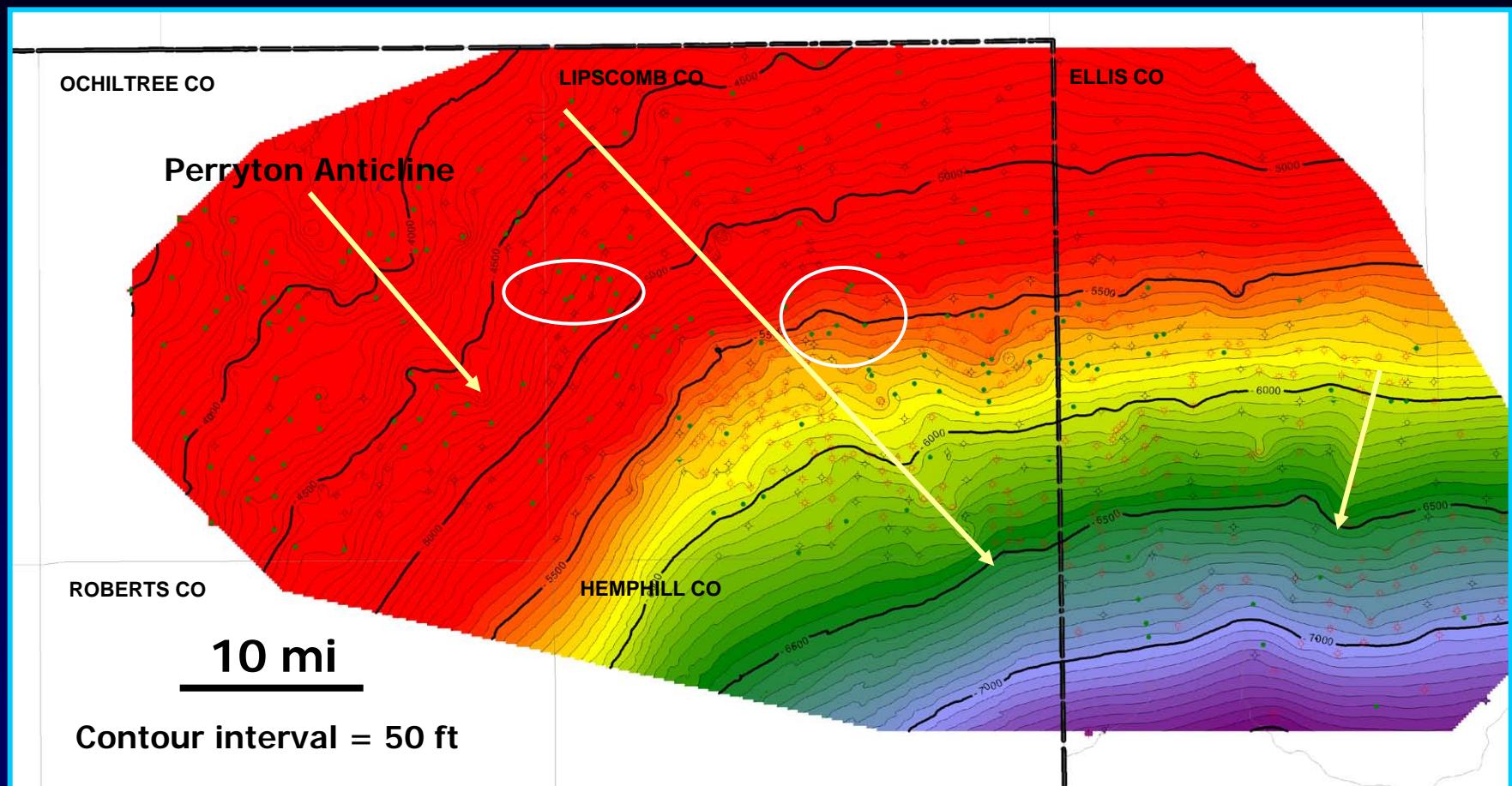


Structure map:
Top of main Cleveland Sand

First Year's Marmaton Gas Production (Hepler Ss)

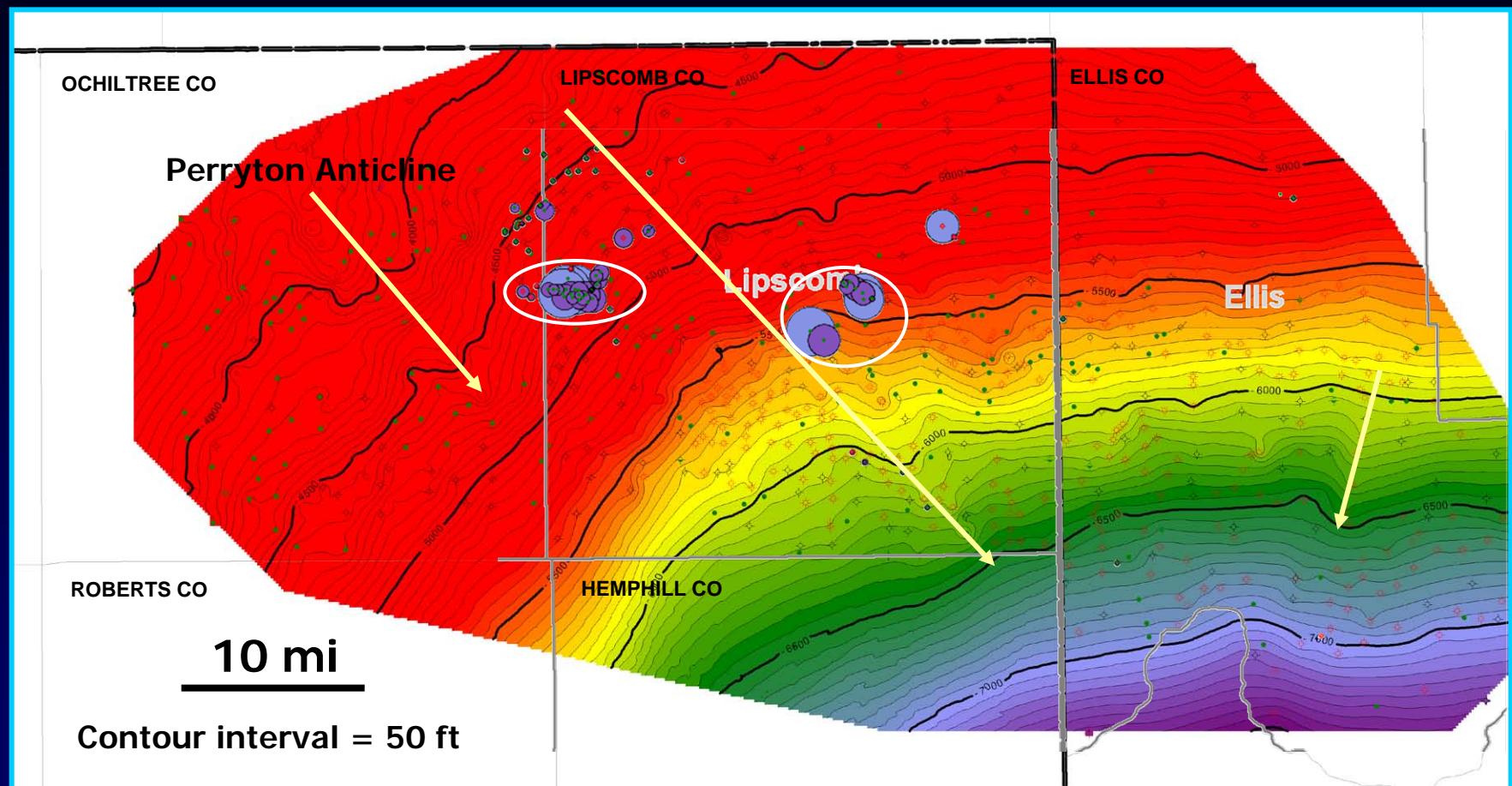


Structural Control on Marmaton Gas Production



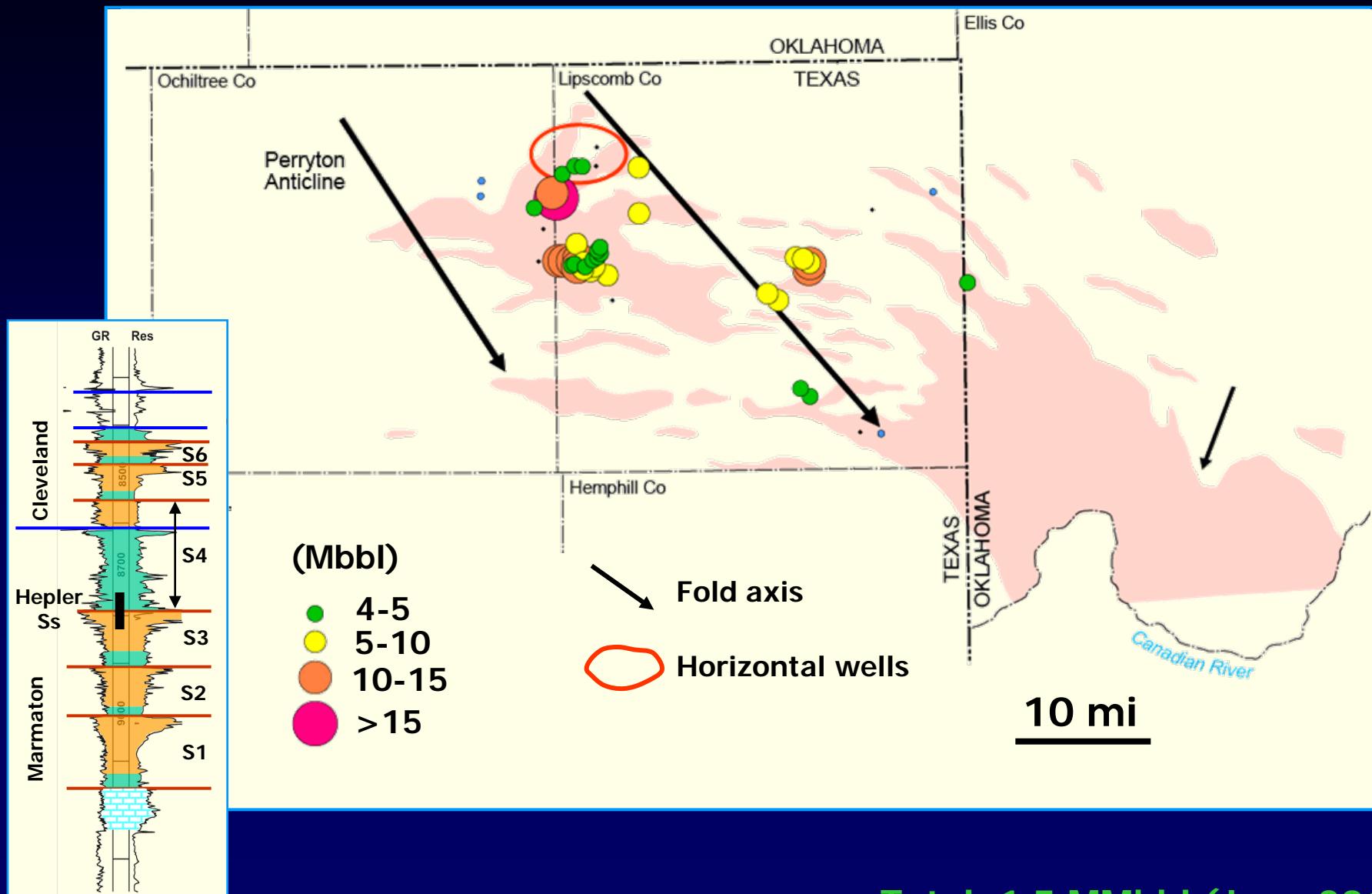
Structure map:
Top of Marmaton Group

Structural Control on Marmaton Gas Production

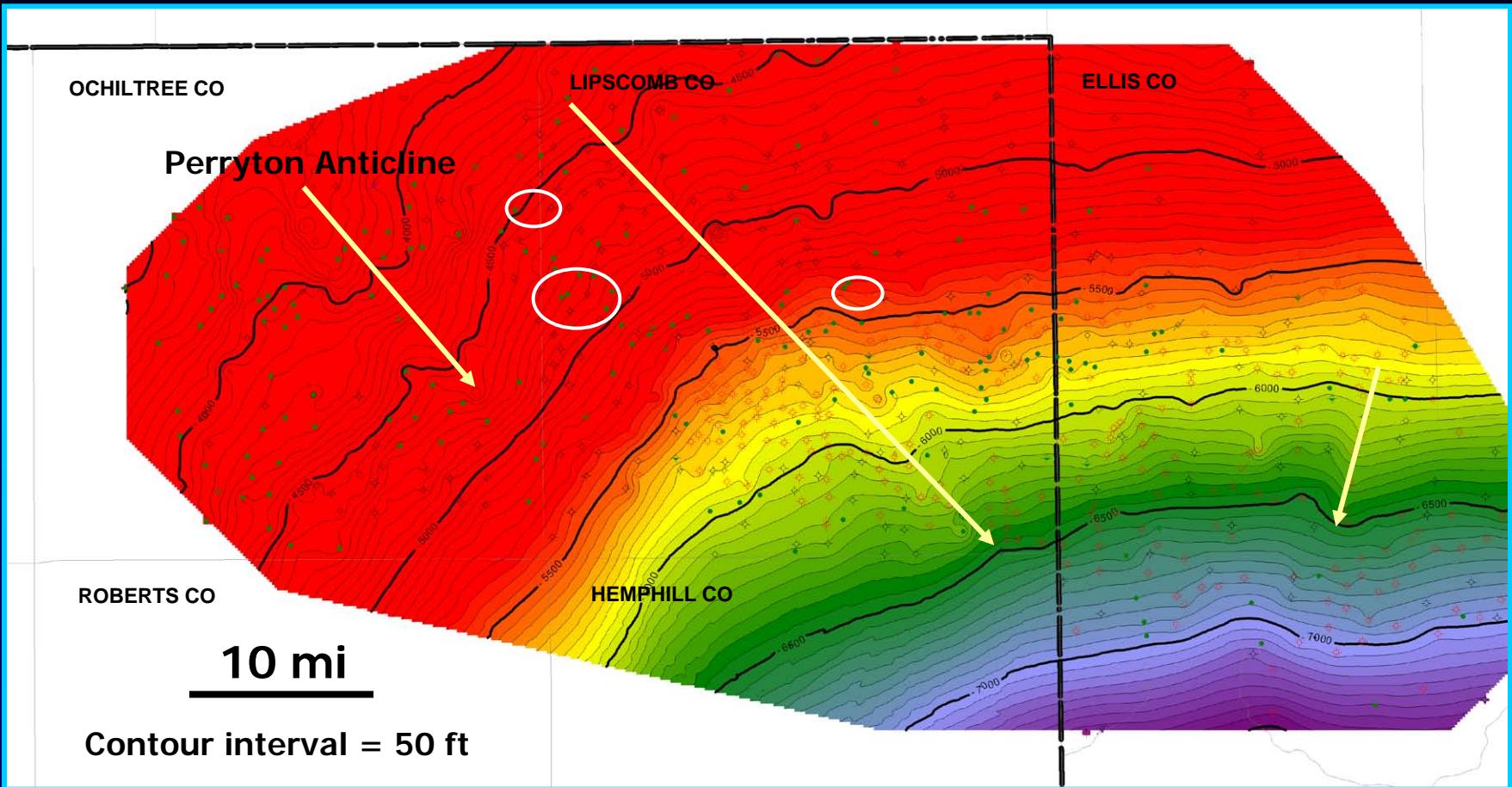


Structure map:
Top of Marmaton Group

First Year's Marmaton Oil Production (Hepler Ss)

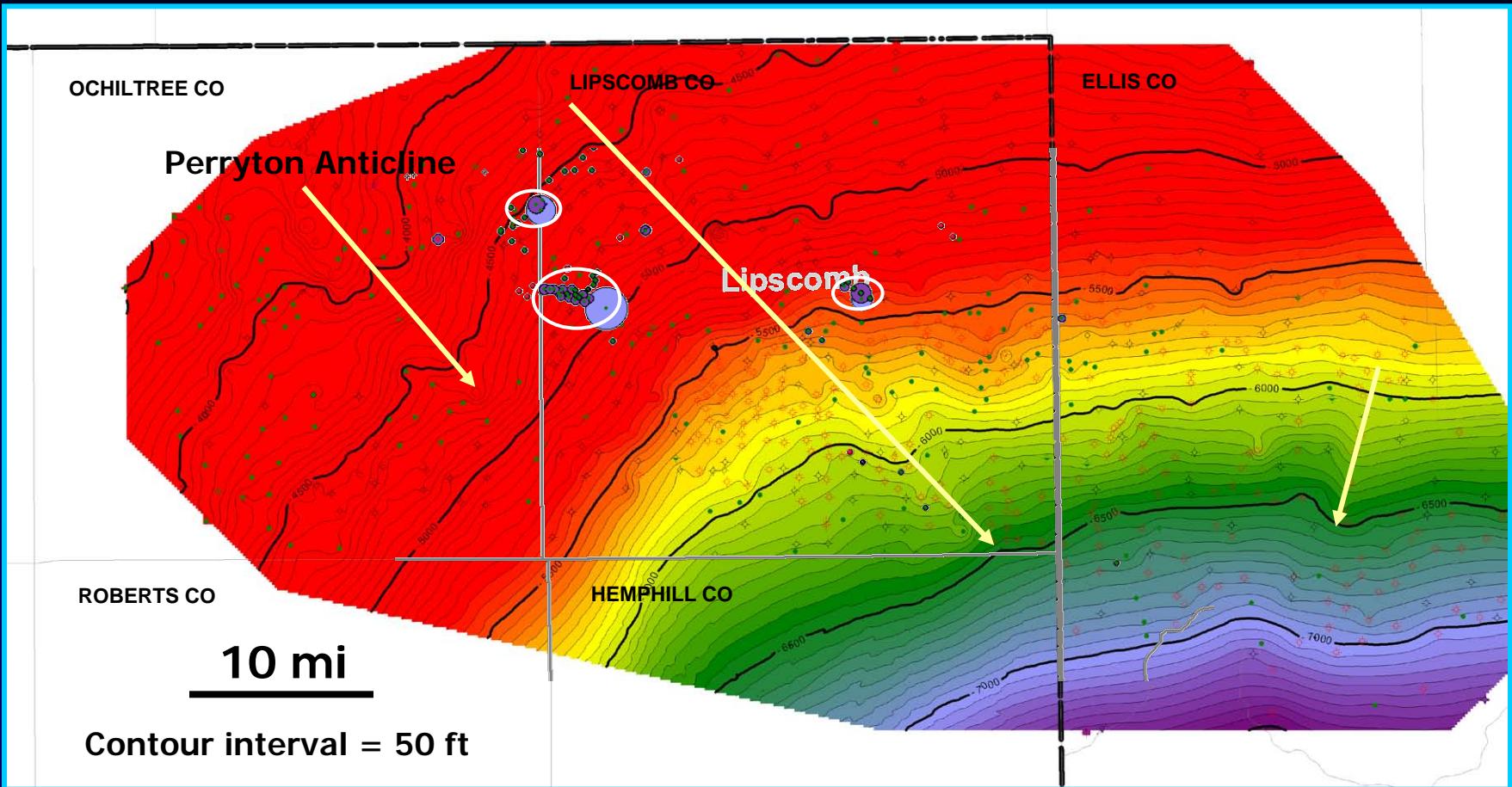


Structural Control on Marmaton Oil Production



Structure map:
Top of main Marmaton Group

Structural Control on Marmaton Oil Production



Structure map:
Top of main Marmaton Group

Summary

- Cleveland/Marmaton:
highstand, prominent lowstand IVF recording infilling and overtopping of shelf swale
- Irregular shelf (or ramp) topography
- Tidally influenced delta, shelf, and IVF systems dominate
- Controls on hydrocarbons accumulation:
 - (1) incised-valley-fill deposits
 - (2) upstructure pinch out, subtle anticlines

**See upcoming BEG Report of Investigations No. 275 for all details.
To be published in summer 2011.**

