

THE UPPER DEVONIAN RHINESTREET SHALE: AN UNCONVENTIONAL RESERVOIR IN WESTERN NEW YORK STATE

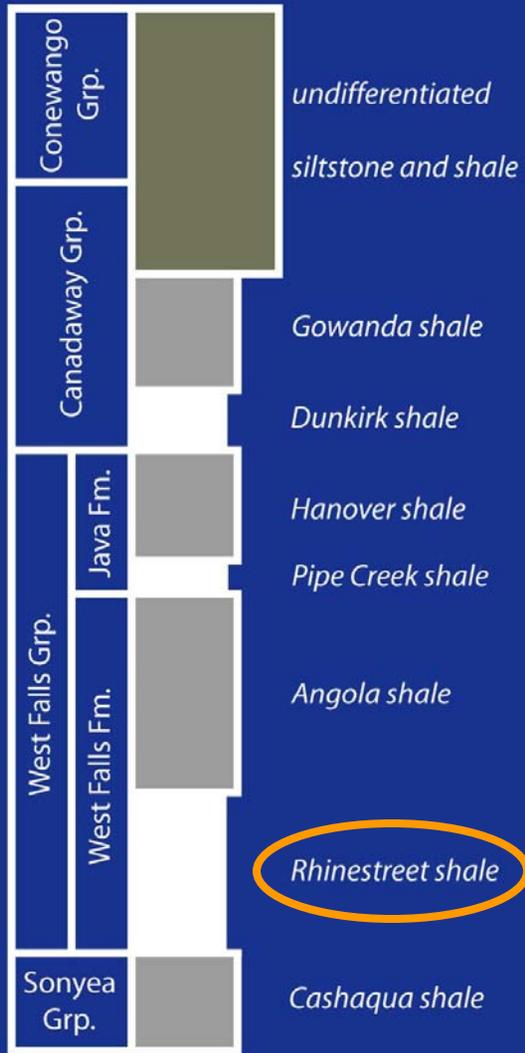
Gary G. Lash
Department of Geosciences
SUNY Fredonia
Fredonia, NY 14063

Why the Upper Devonian Rhinestreet black shale?

Why not the Middle Devonian Marcellus (Oatka Creek) black shale?

...the Rhinestreet is well exposed in western New York state, which allows for the integration of subsurface trends with knowledge gained from field studies...

Rhinestreet shale



not to scale



Eighteenmile Creek section - ~54 m (177 ft)





ENE joints

mode I cracks



NW joints

Alleghanian remote stress field



— ENE joints

mode I cracks

— NW joints

Alleghanian remote stress field

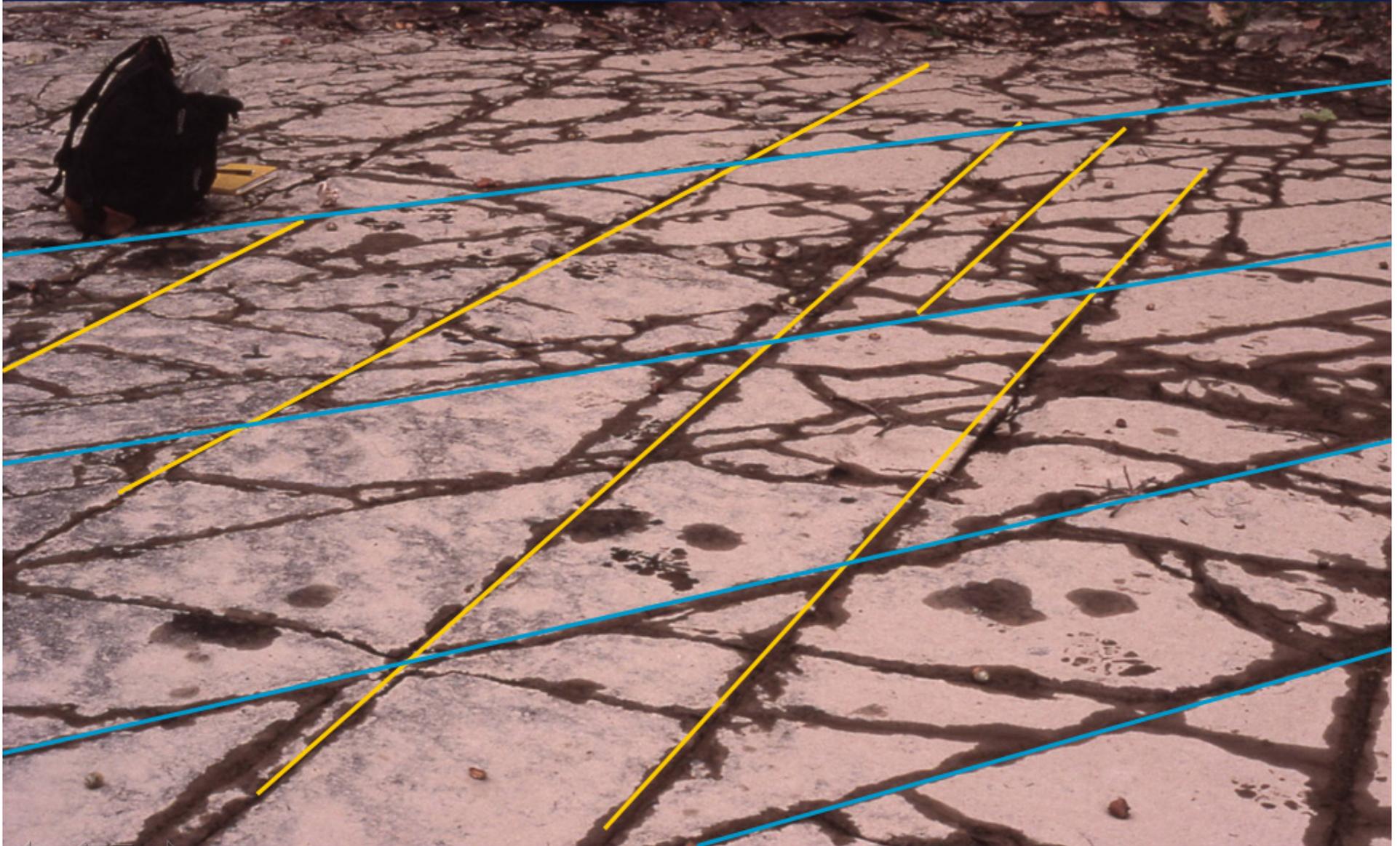


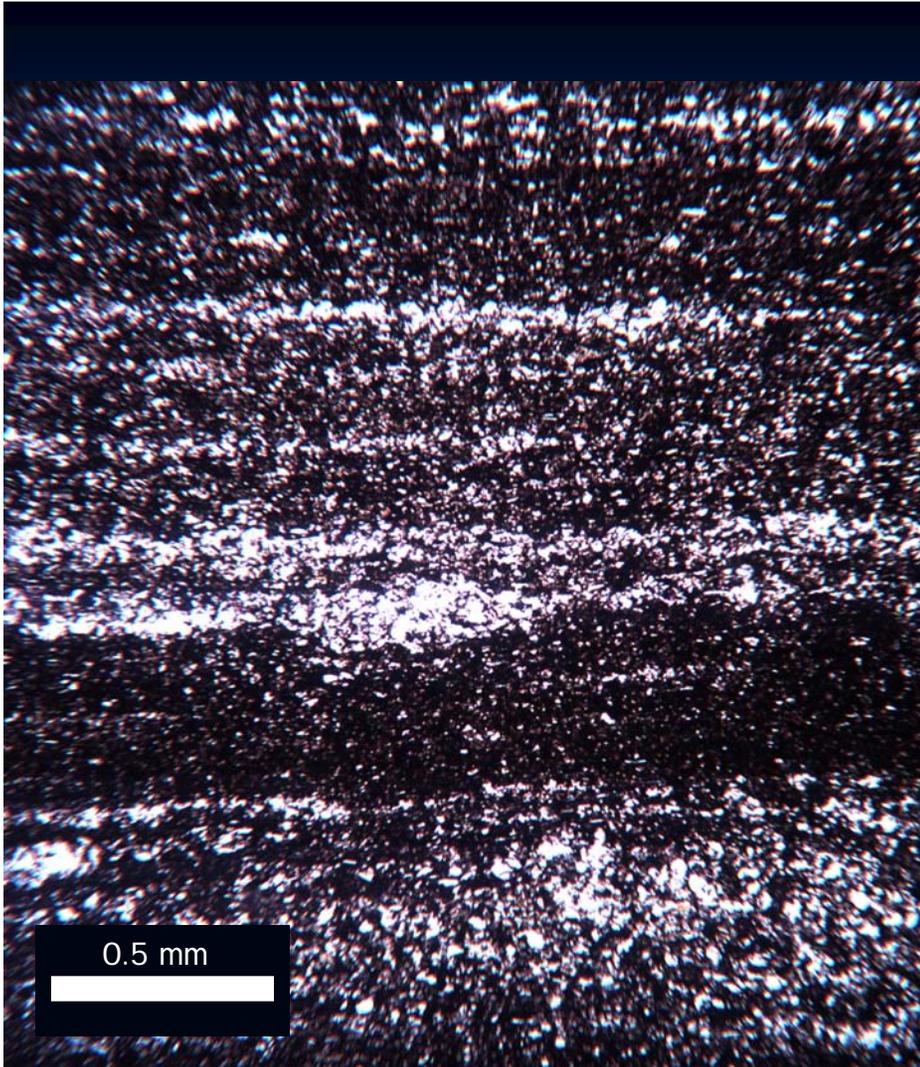
— ENE joints

mode I cracks

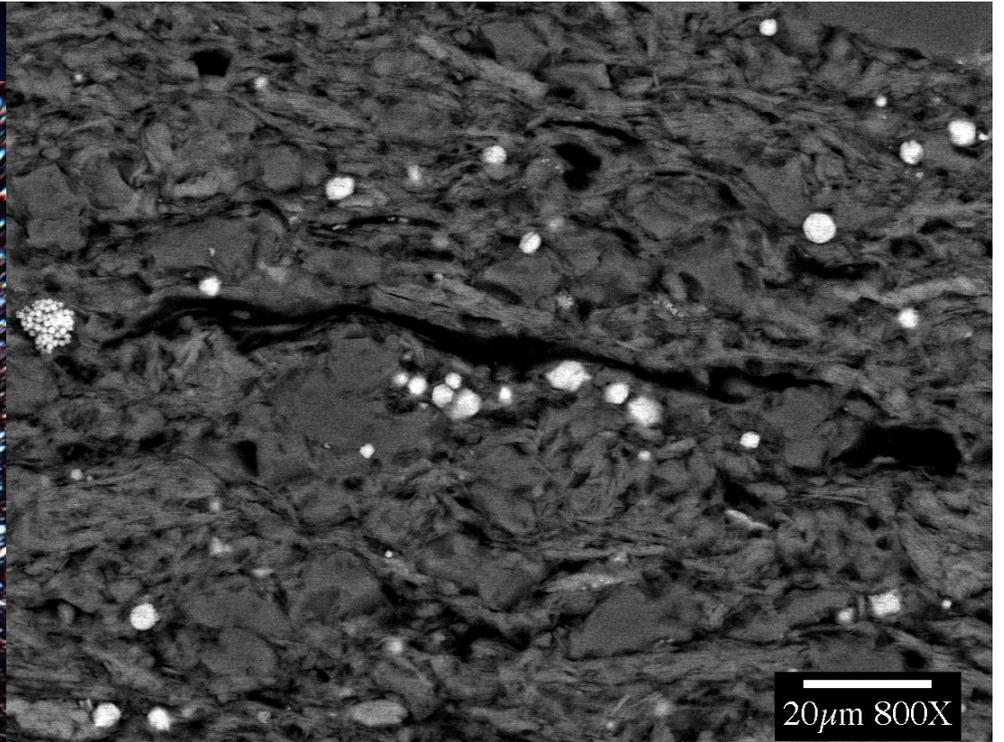
— NW joints

Alleghanian remote stress field

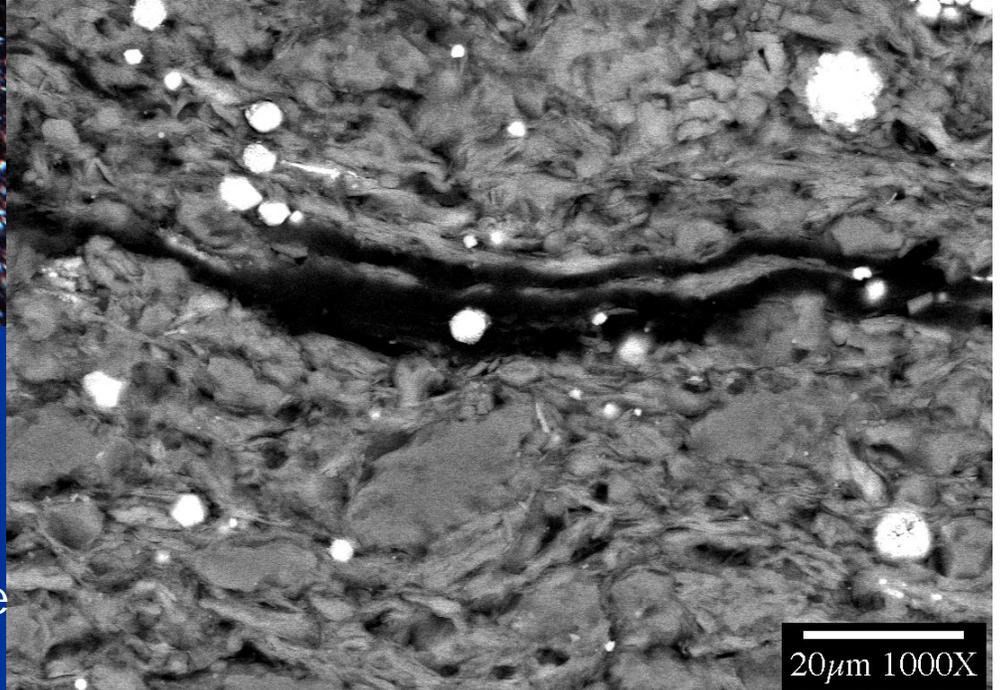




0.5 mm



20μm 800X



20μm 1000X

horizontal bitumen-filled
microcracks

concentrated of organic-rich clay laminae

Rhinestreet shale

general reservoir characteristics

Rhinestreet shale



Cashaqua shale

porosity = 5.3% (3.1-6.6%)

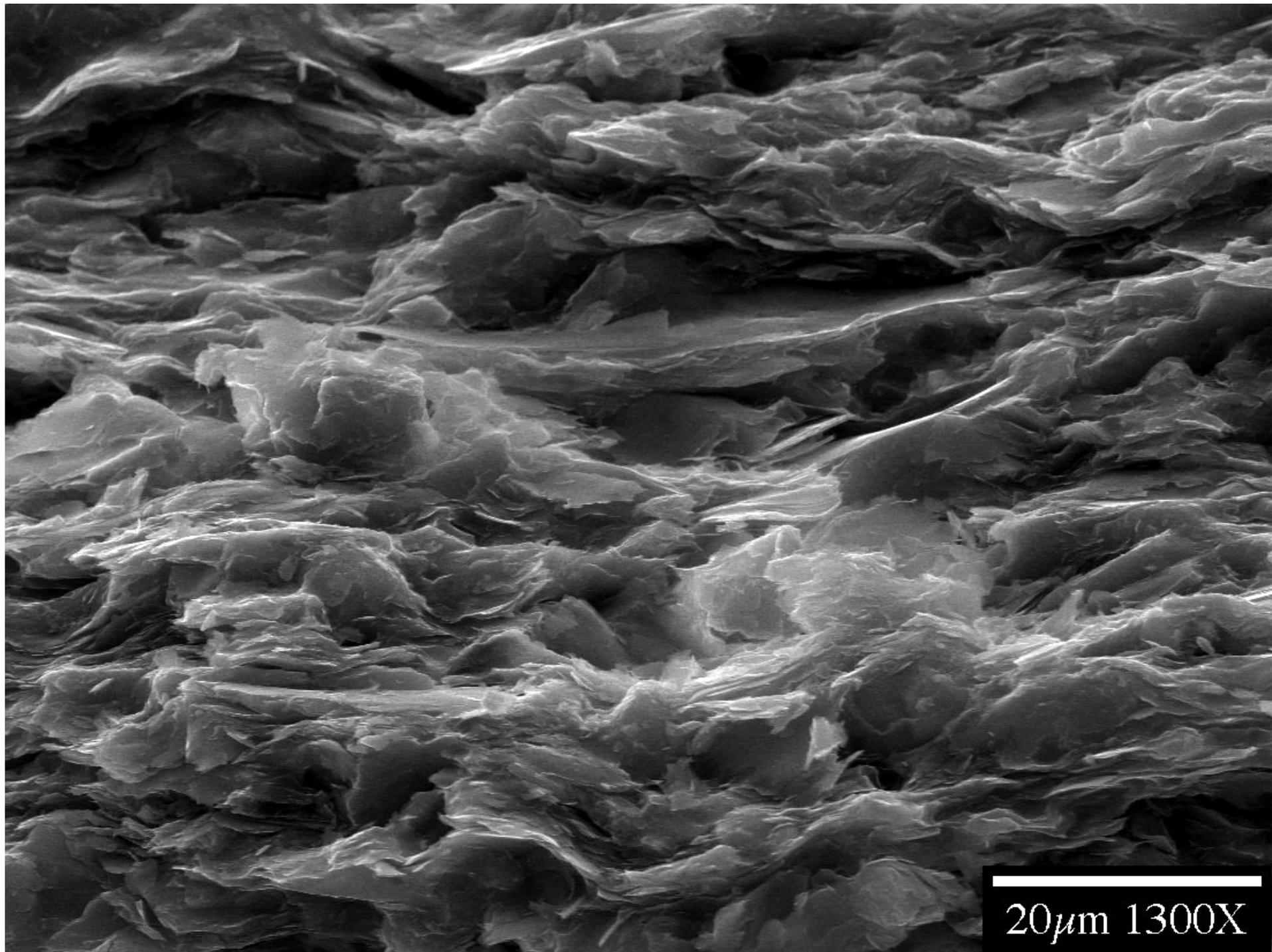
permeability = 10^{-20} m²

median pore throat diameter = 8 nm

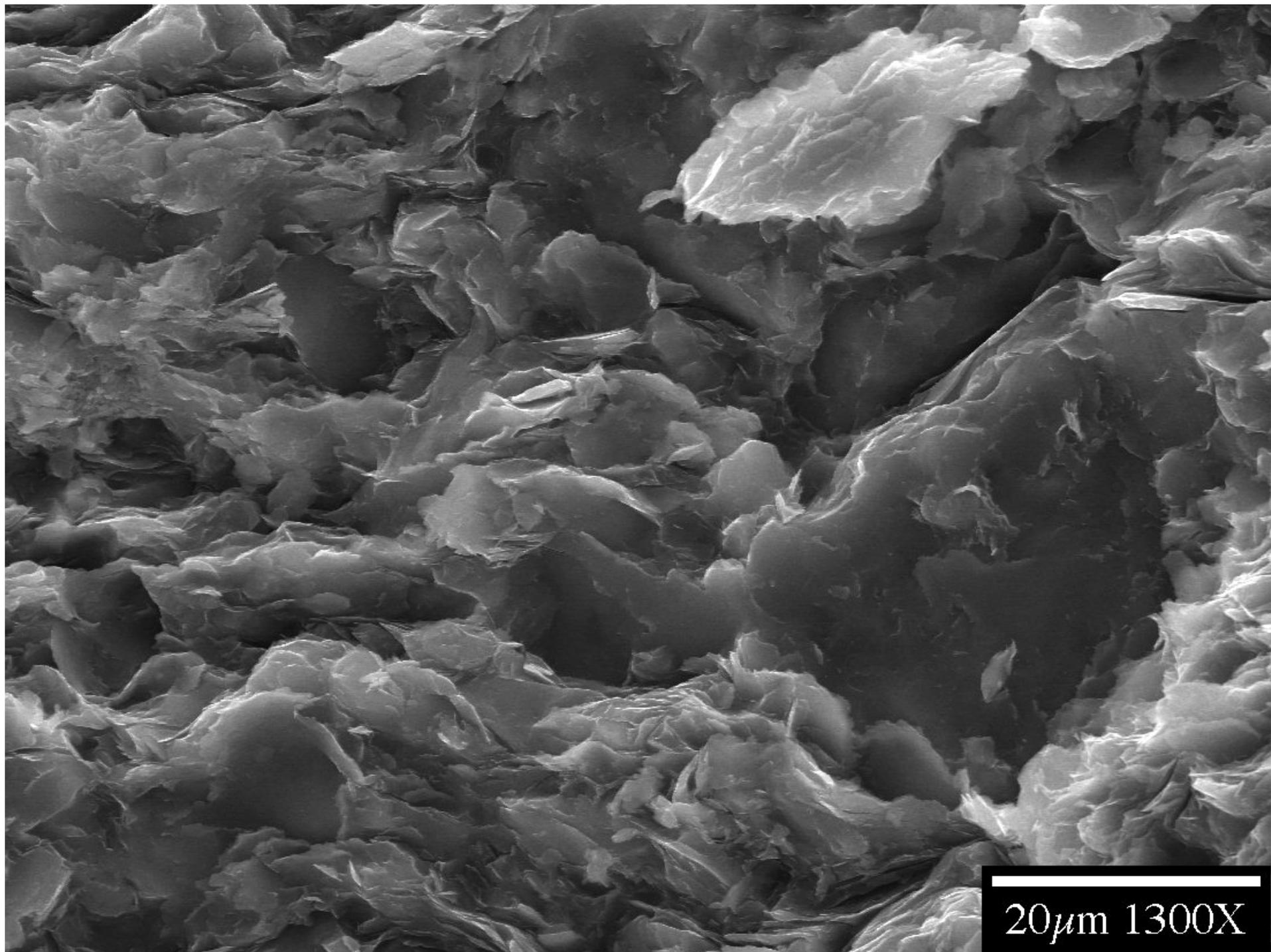
porosity = 8.5% (7.1-11.6%)

permeability = 10^{-18} m²

median pore throat diameter = 19.2 nm

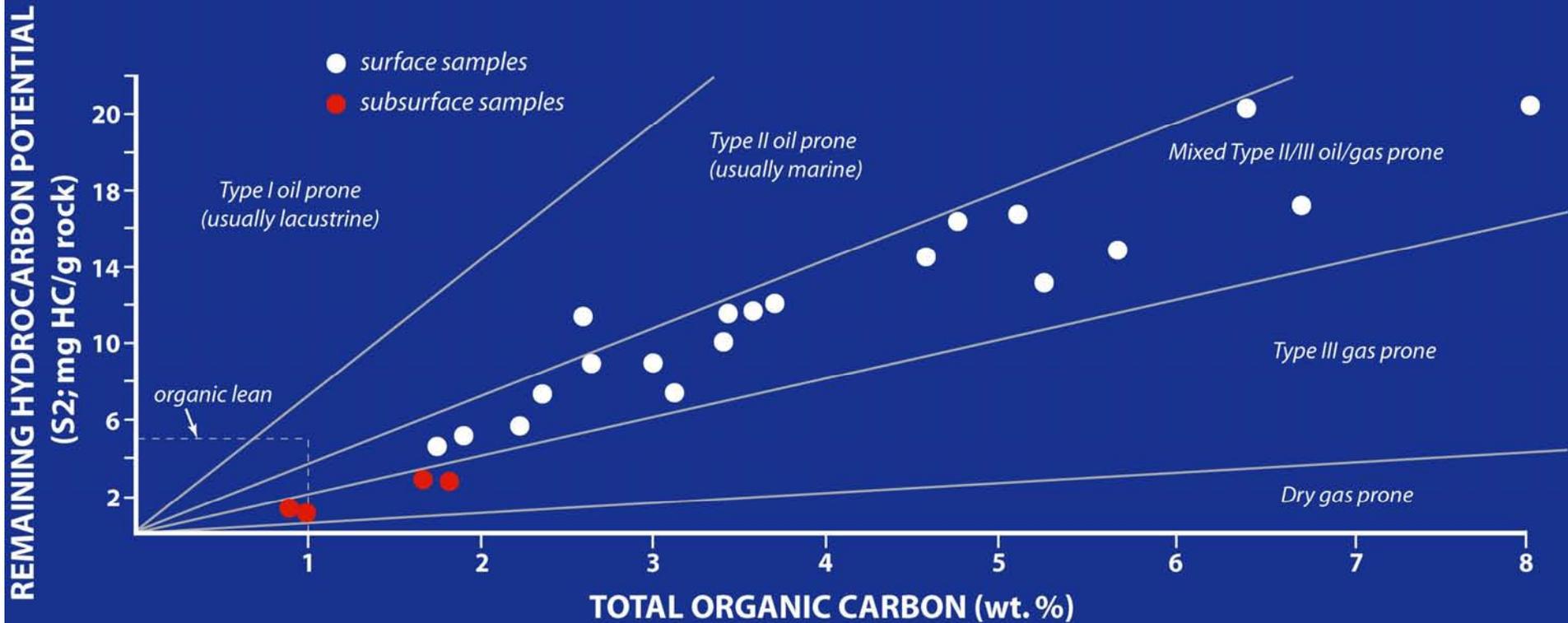


20 μm 1300X



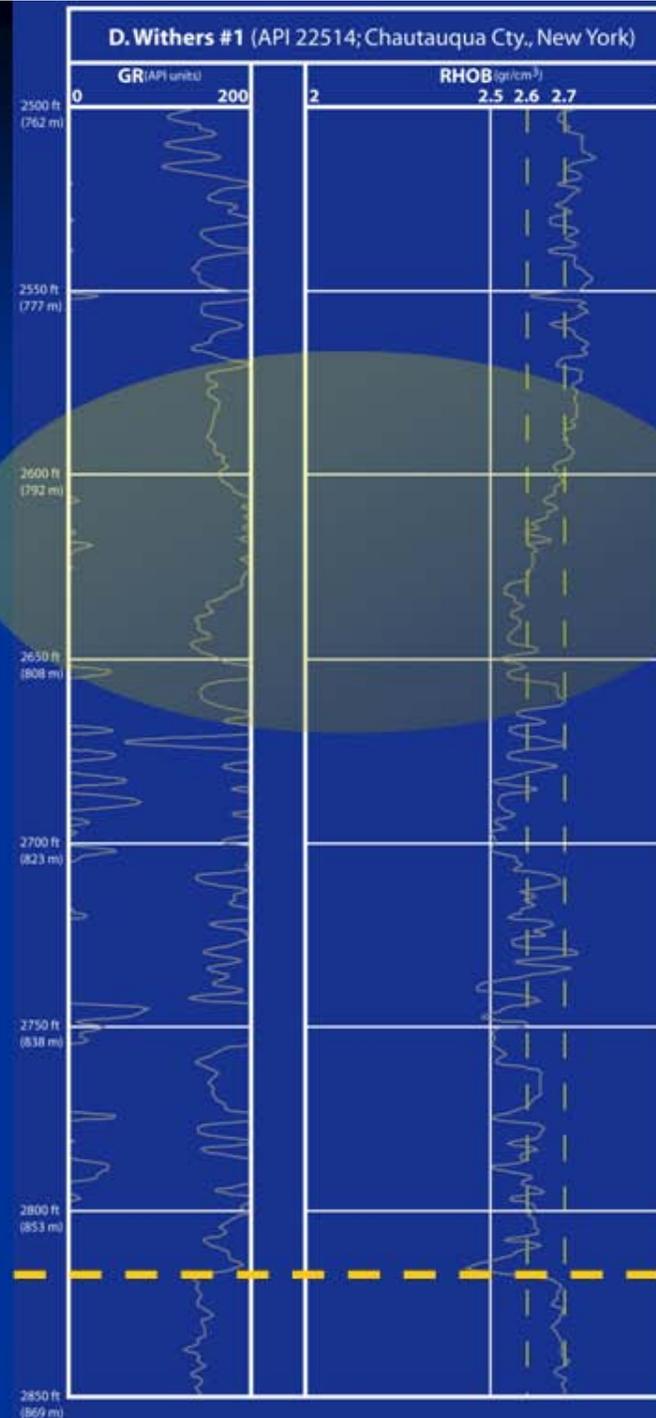
Rhinestreet shale

organic carbon content and type



Rhinestreet shale

subsurface thickness

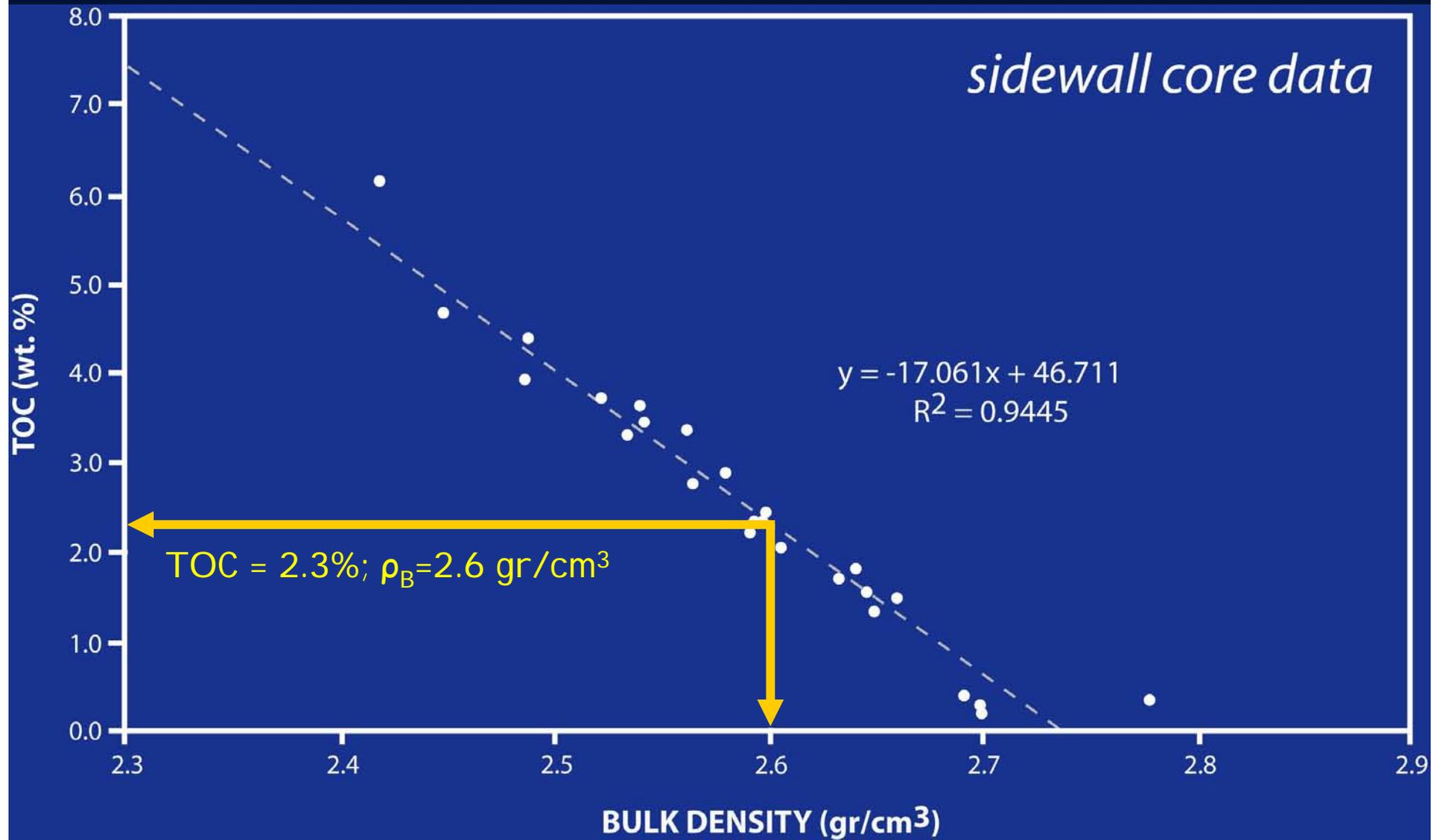


transitional
contact

Rhinestreet
shale

Cashaqua shale

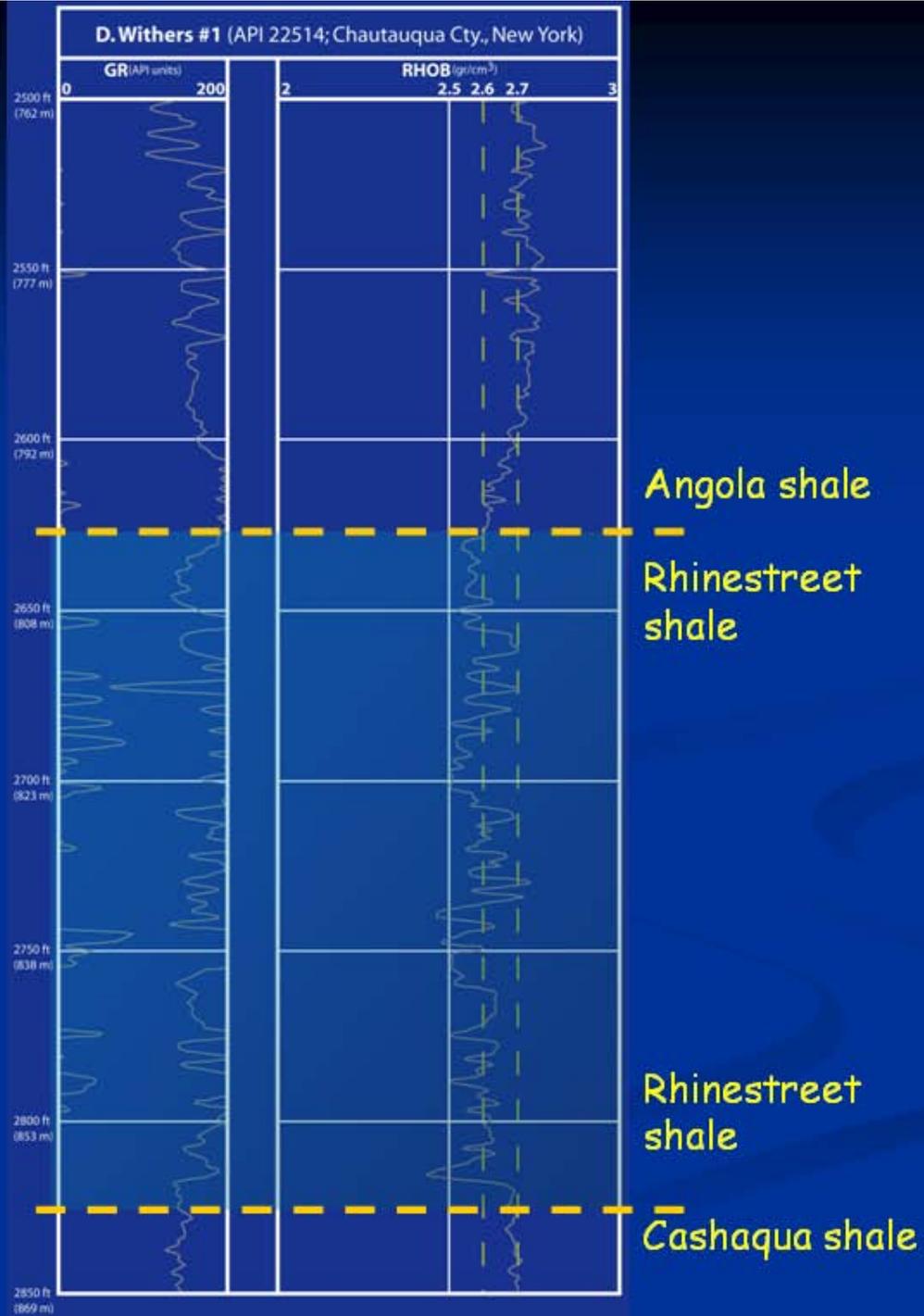
sidewall core data



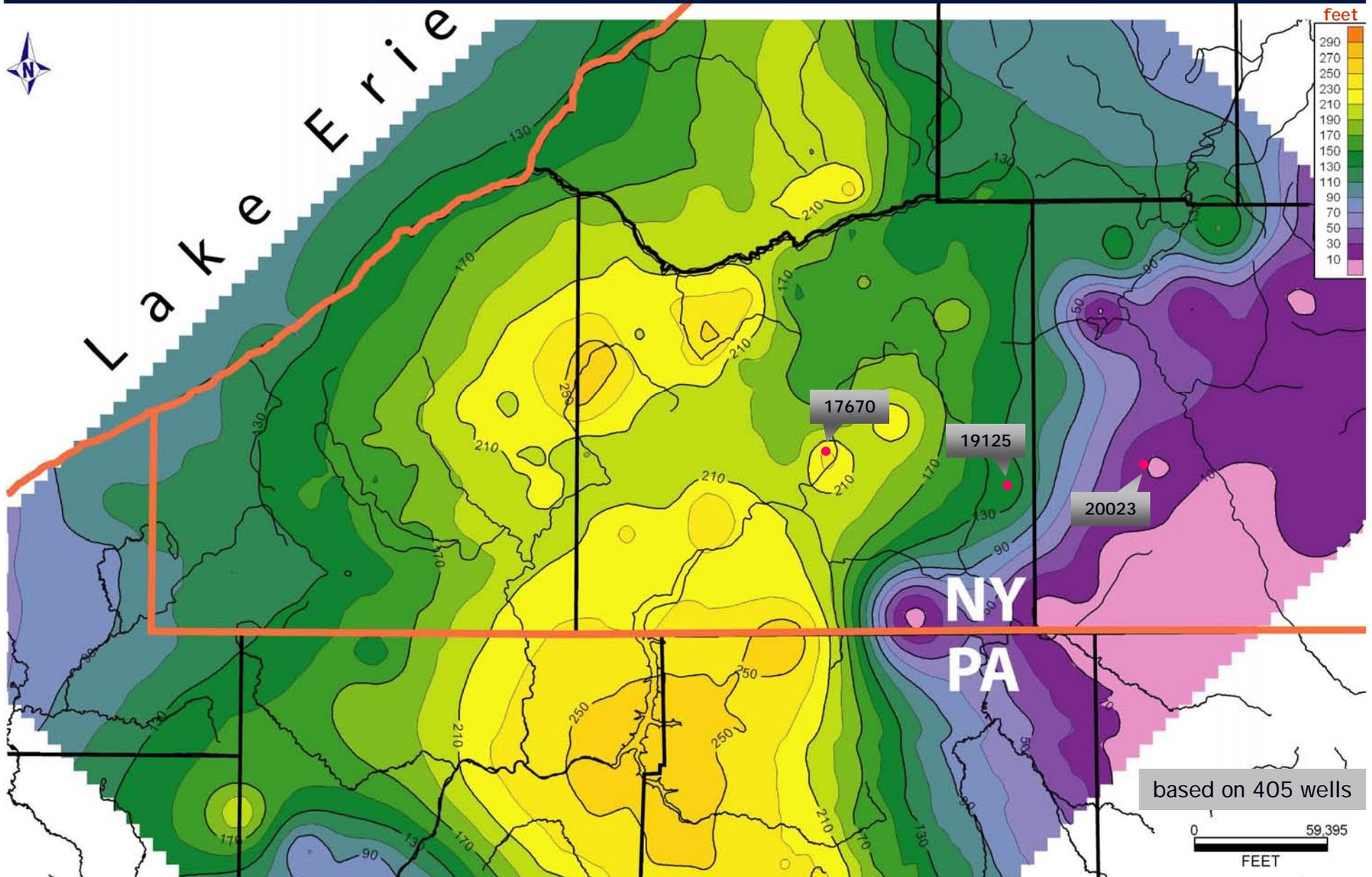
TOC = 2.3%; $\rho_B = 2.6 \text{ gr/cm}^3$

$y = -17.061x + 46.711$
 $R^2 = 0.9445$

subsurface thickness



RHI NESTREET THICKNESS (TOC \geq 2.3%)



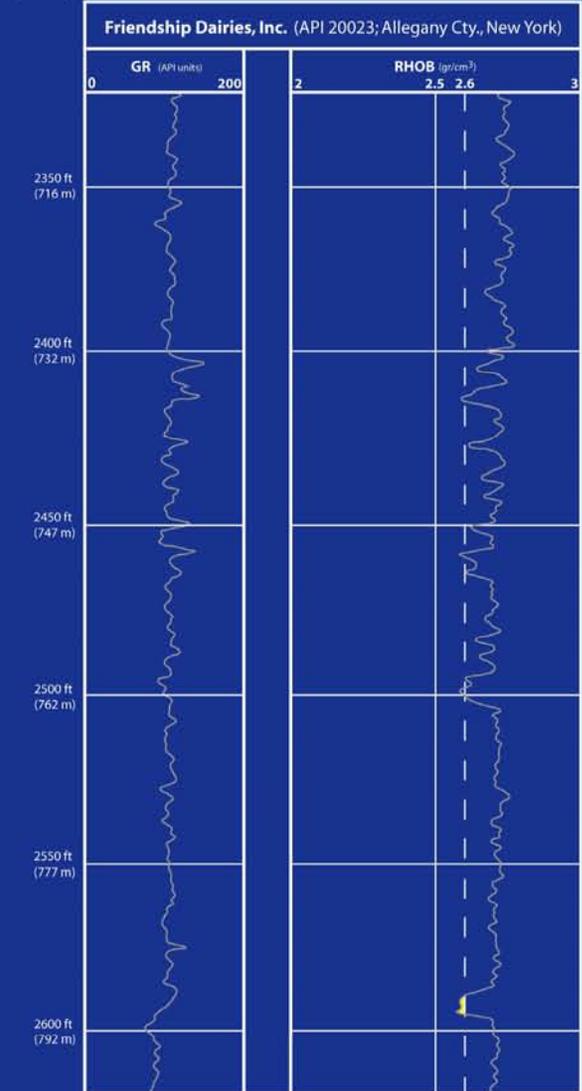
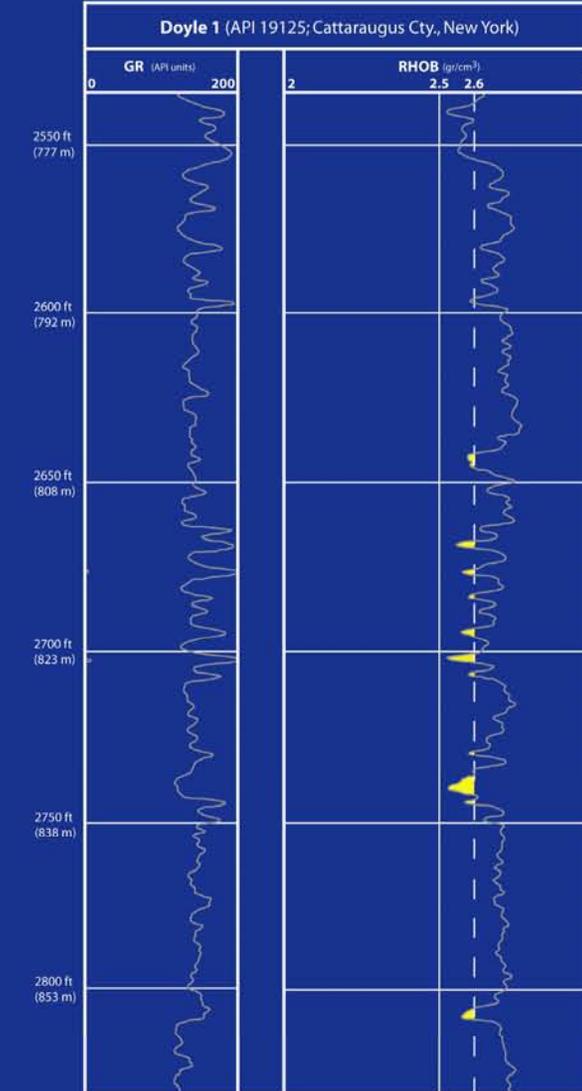
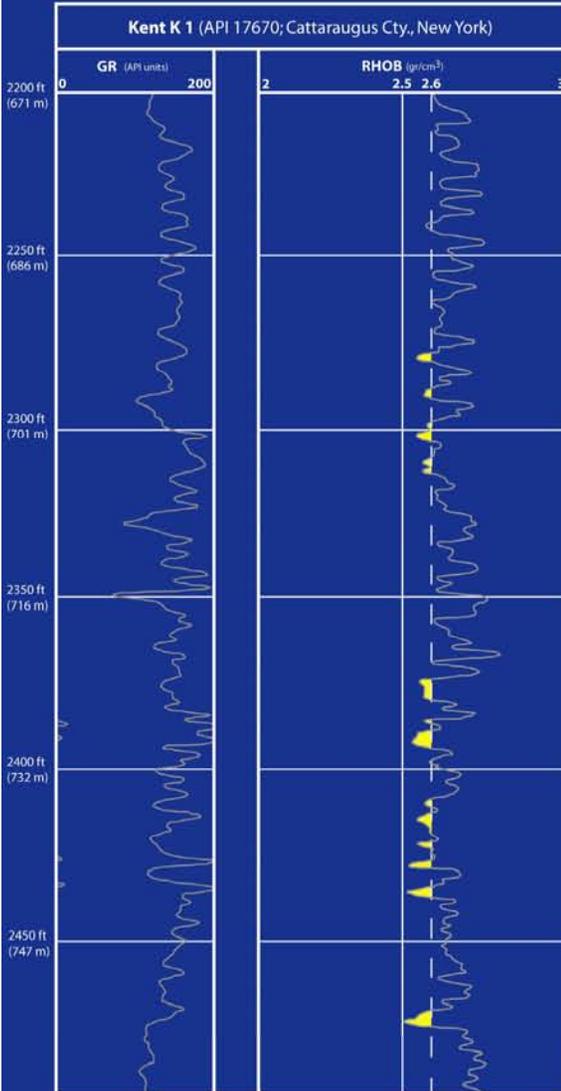
17670

15.19 Mi (24.4 Km)

19125

12.4 Mi (20 Km)

20023



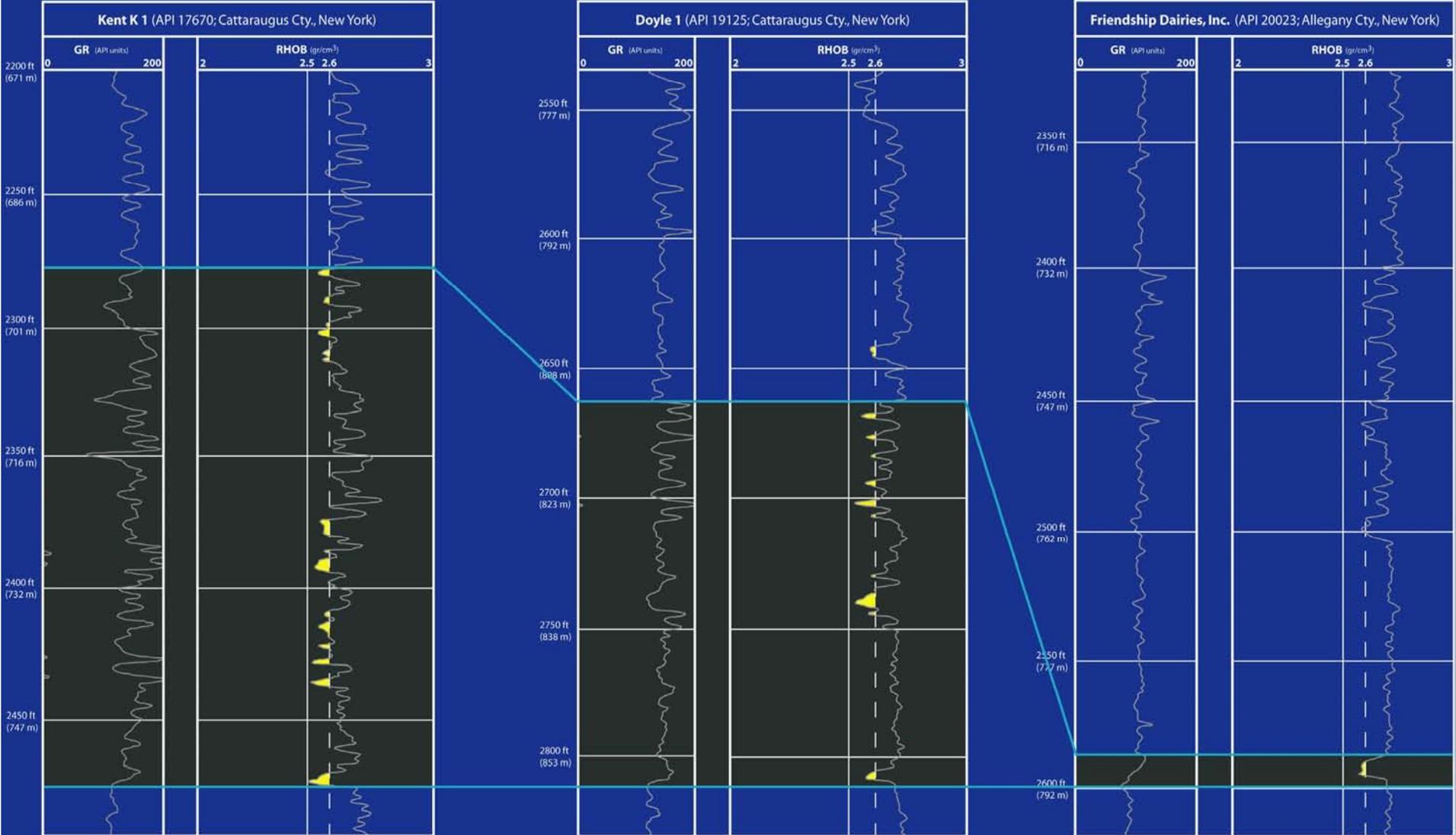
17670

19125

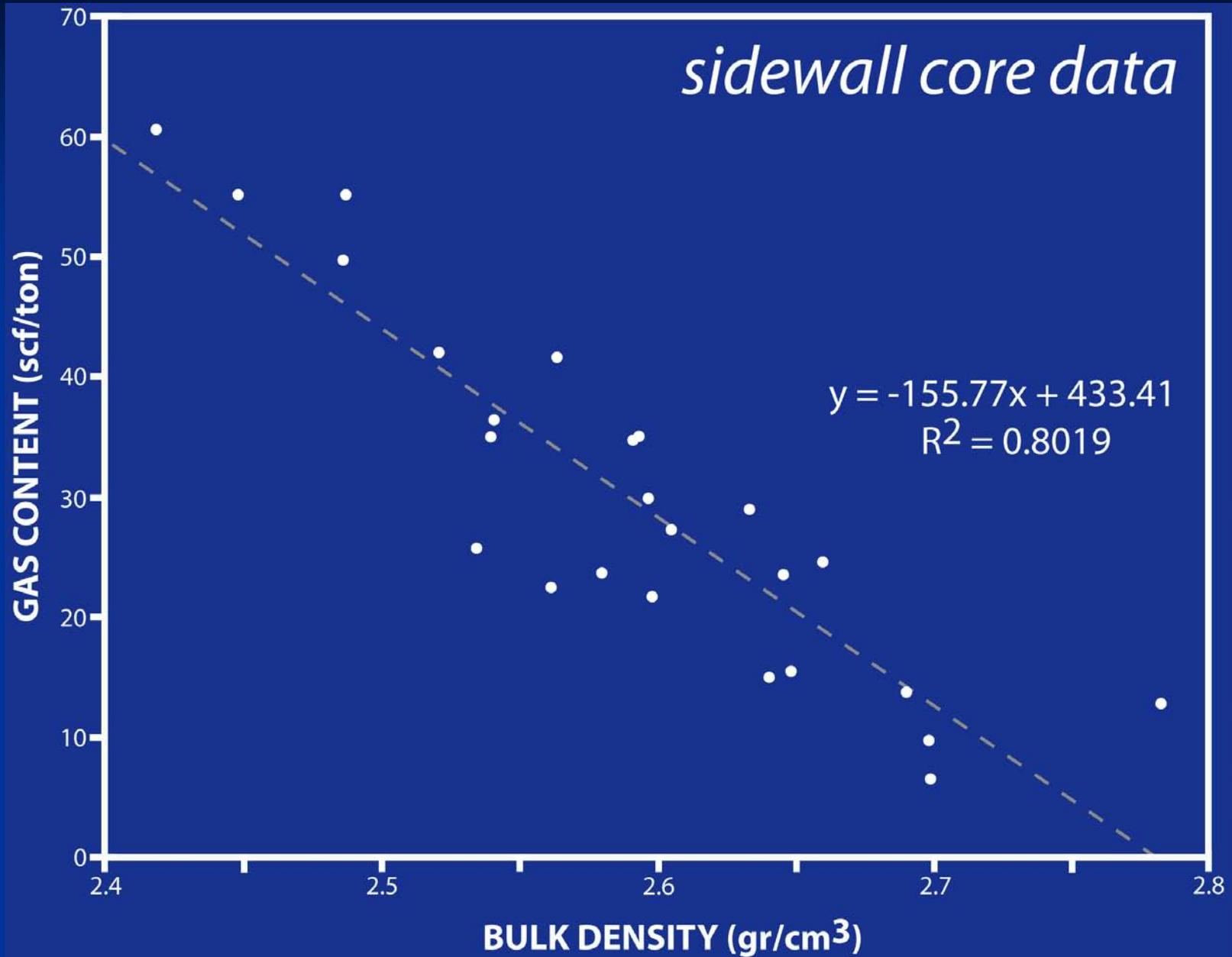
20023

15.19 Mi (24.4 Km)

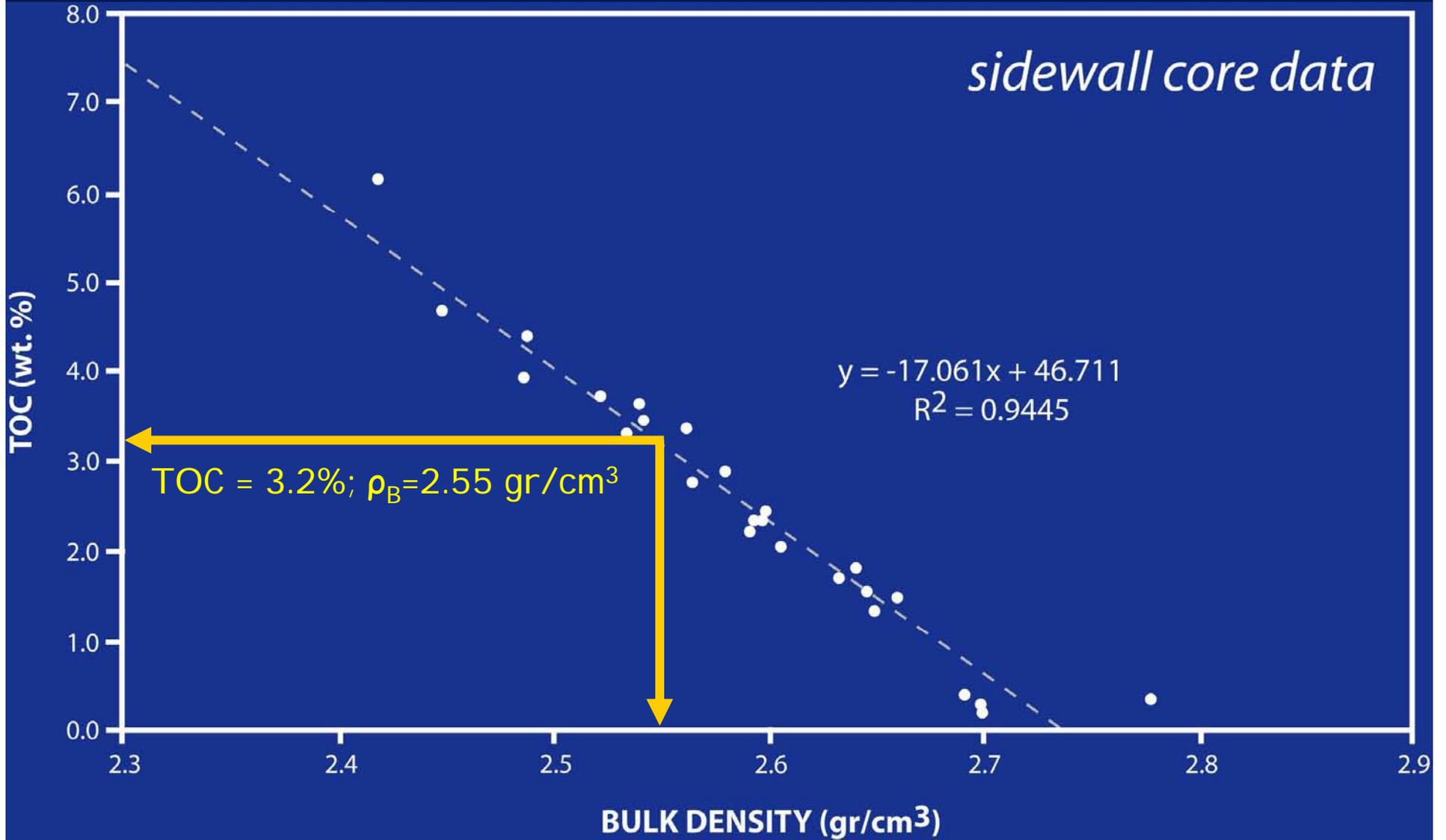
12.4 Mi (20 Km)



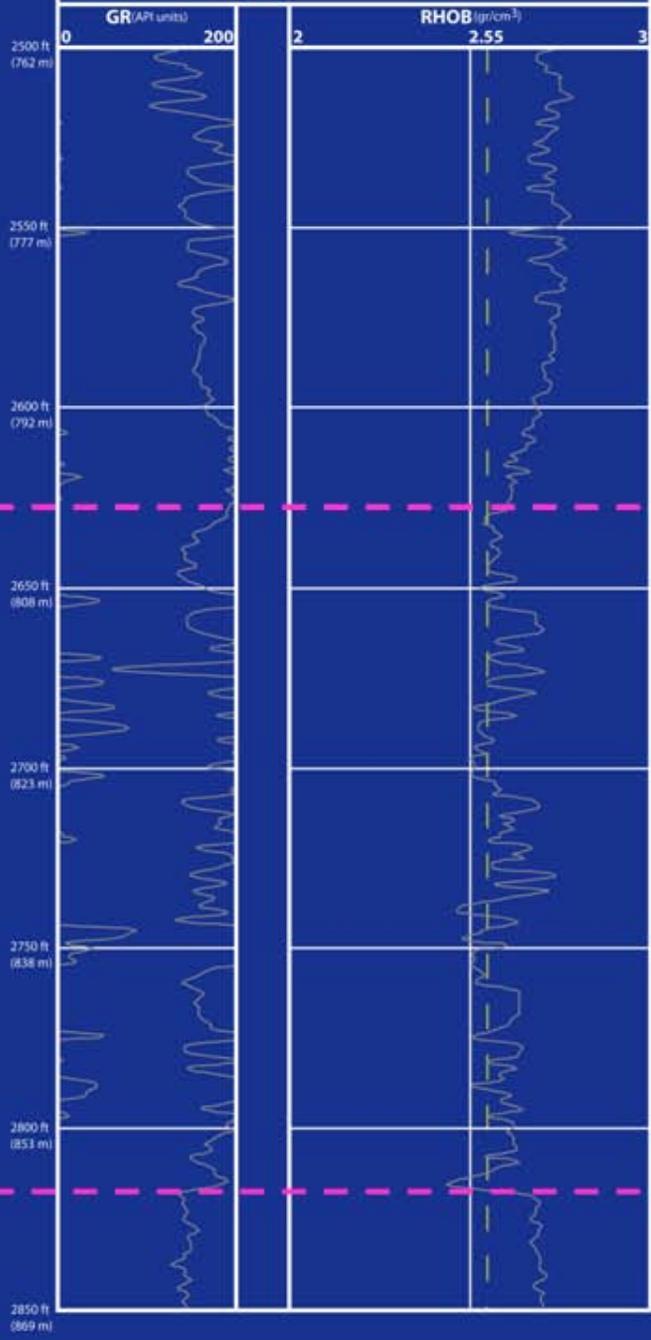
organic-rich interval thickness



organic-rich interval thickness



D. Withers #1 (API 22514; Chautauqua Cty., New York)



Angola shale

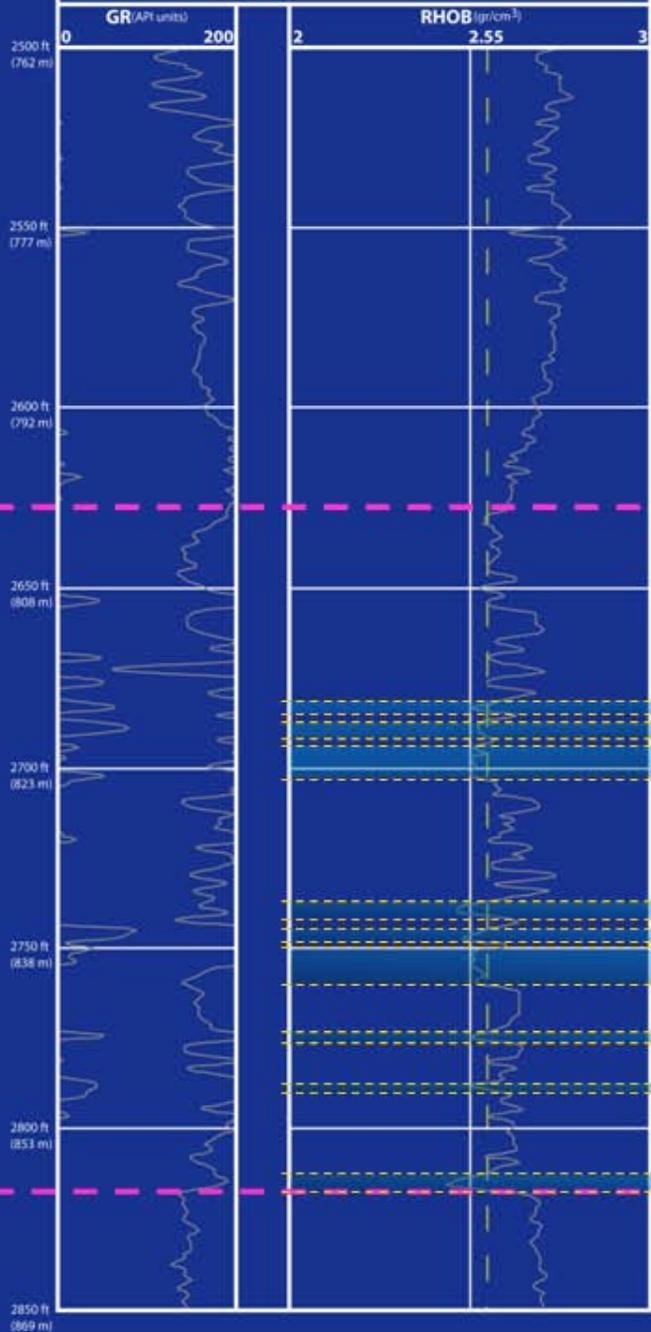
Rhinestreet shale

Rhinestreet shale

Cashaqua shale



D. Withers #1 (API 22514; Chautauqua Cty., New York)



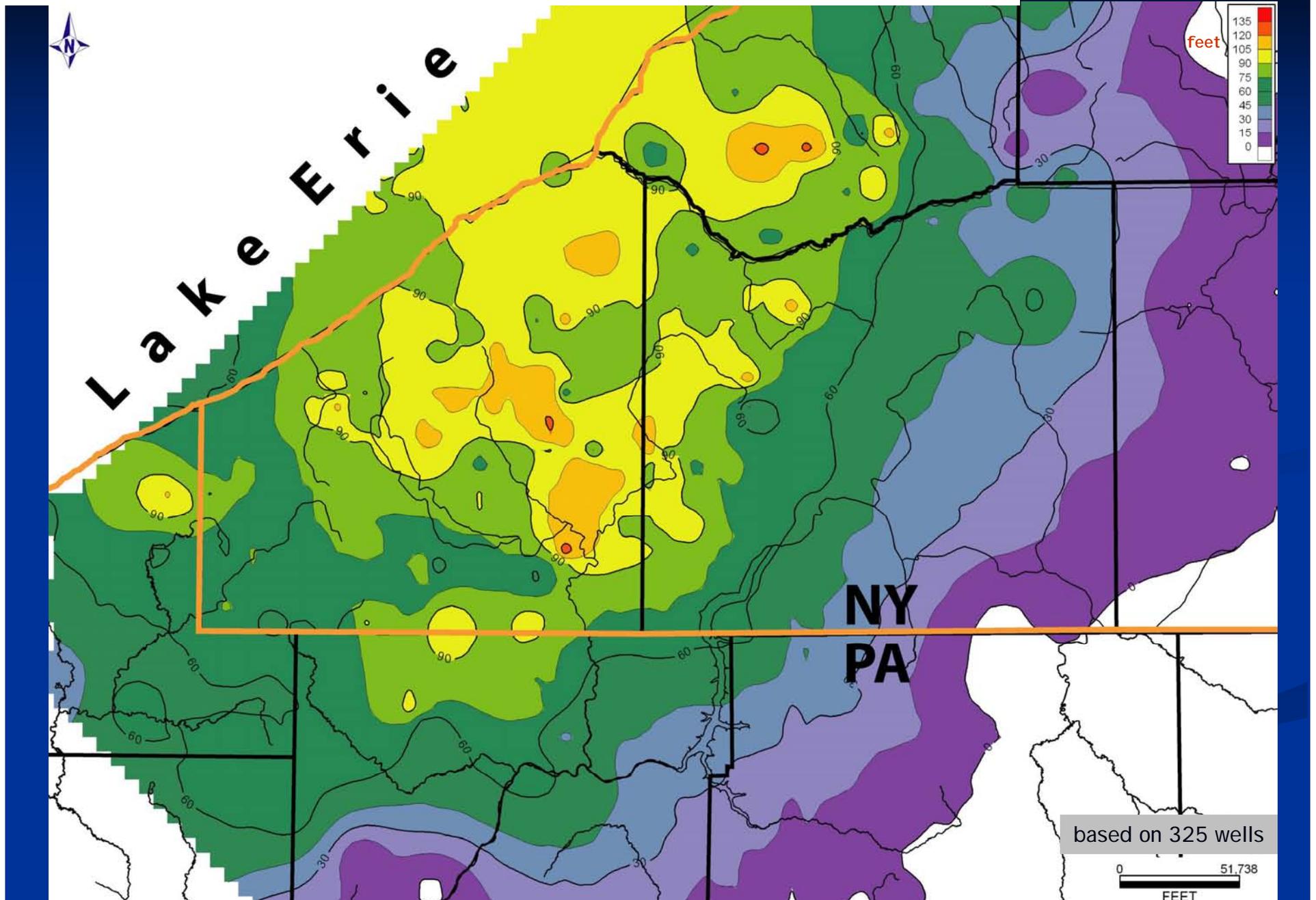
Angola shale
Rhinstreet shale

Rhinstreet shale
Cashaqua shale

TOC ≥ 3.2%
TOC ≥ 3.2%
TOC ≥ 3.2%
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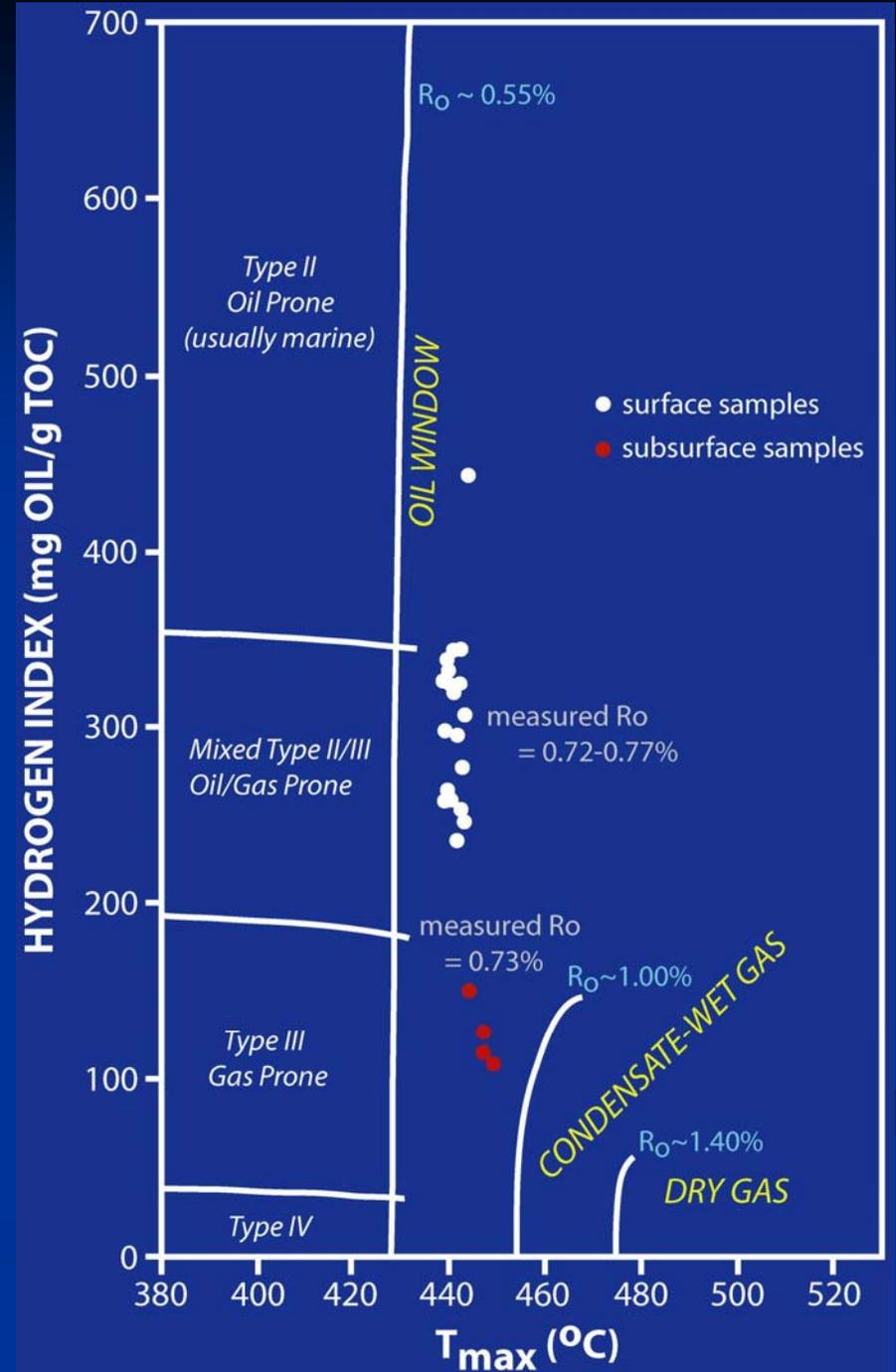
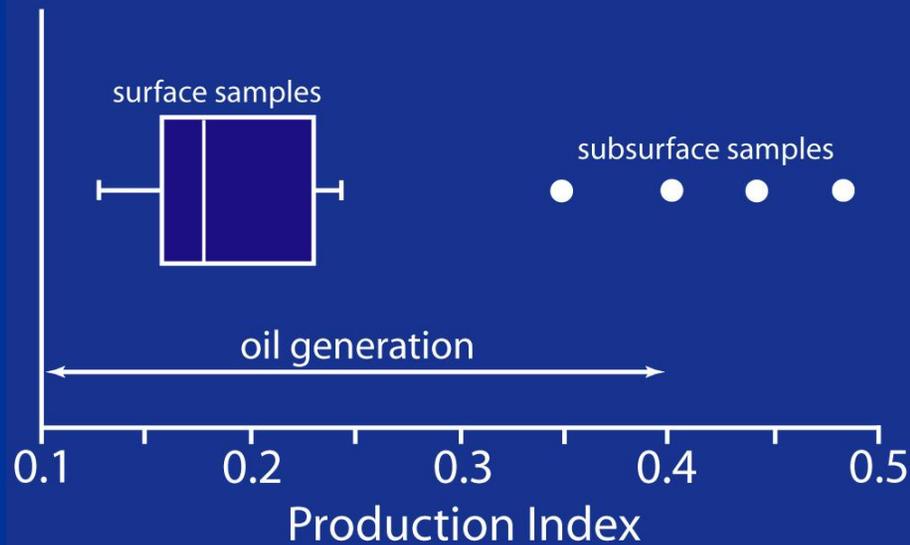
ORGANIC INTERVAL THICKNESS

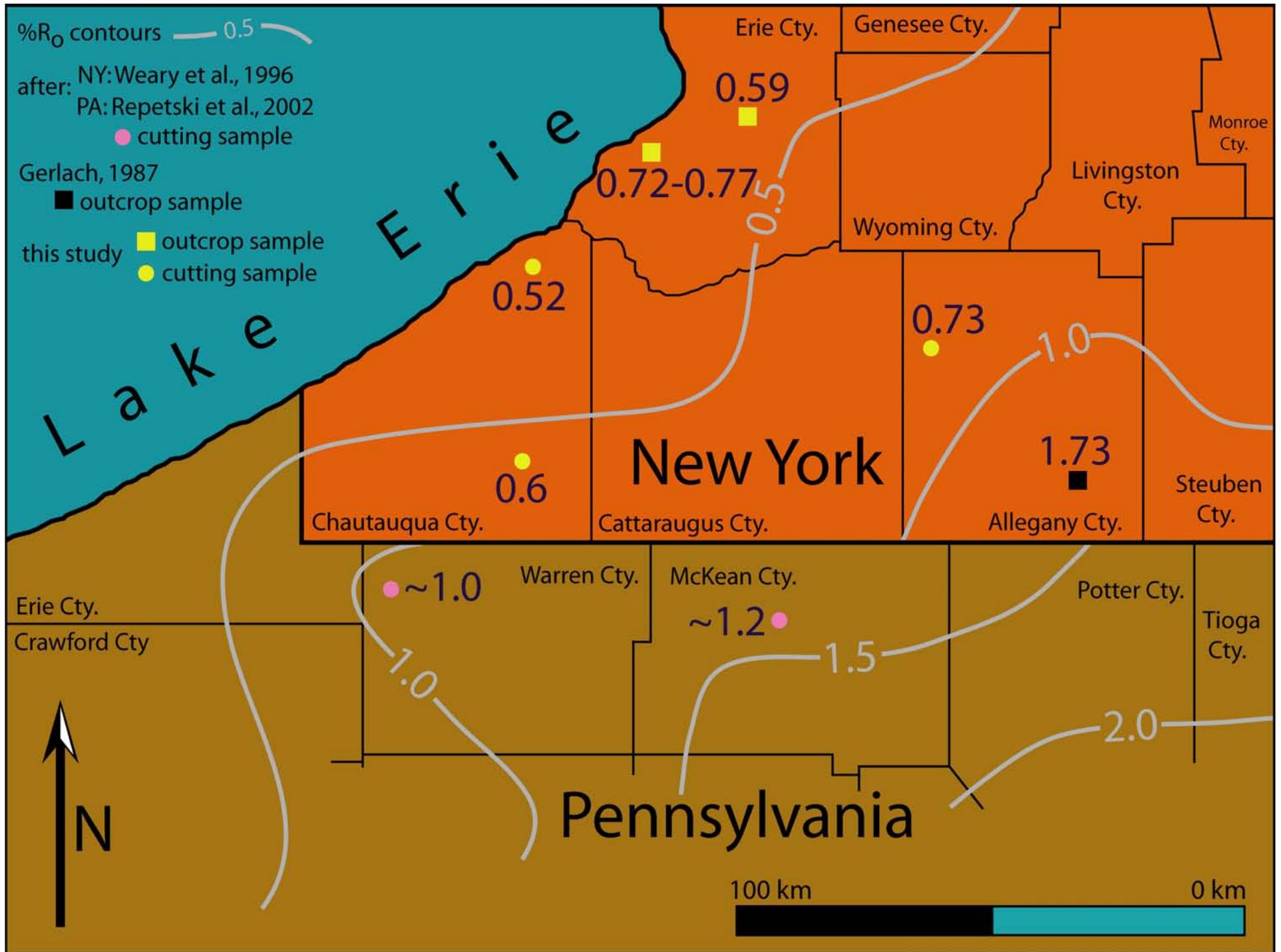
(TOC \geq 3.2%)

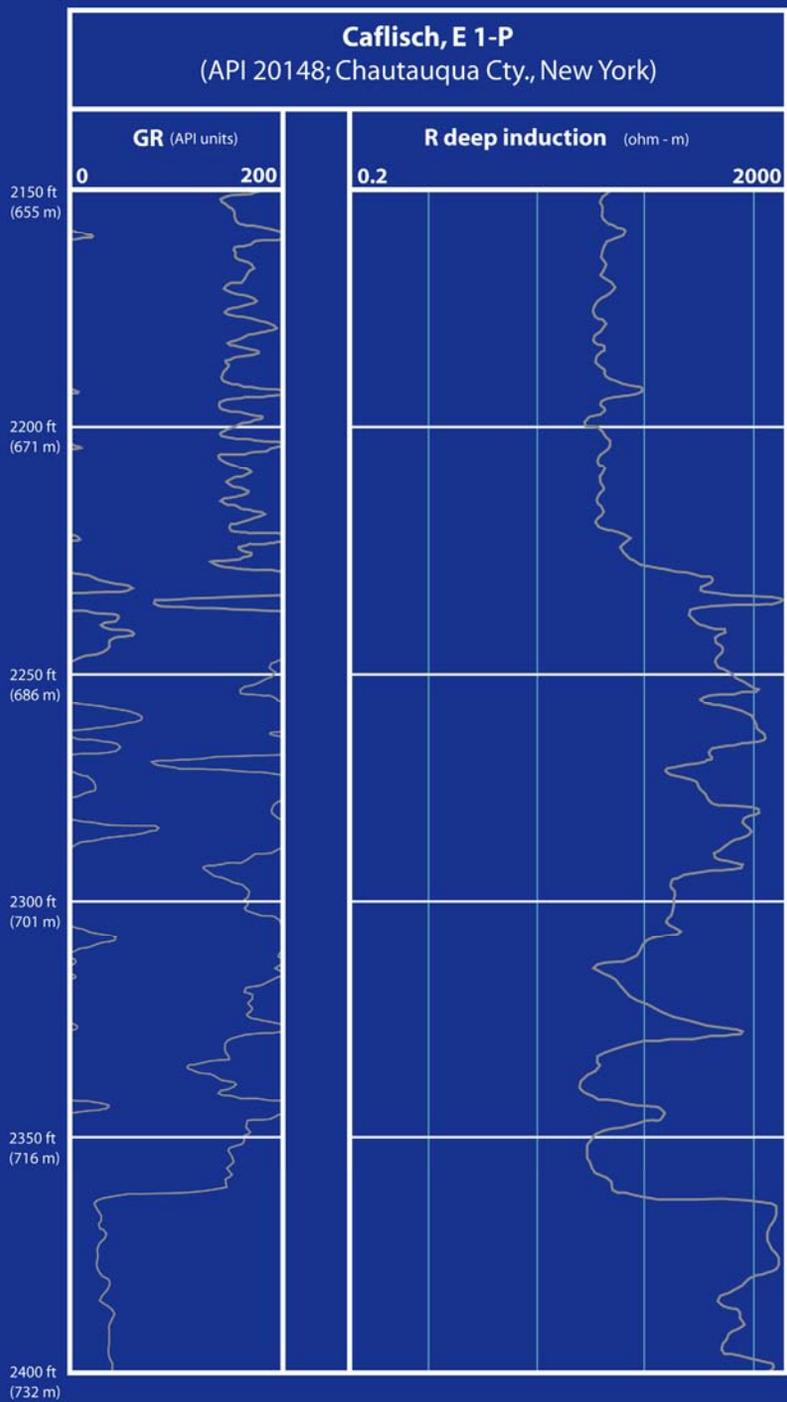


Rhinestreet shale

thermal maturity



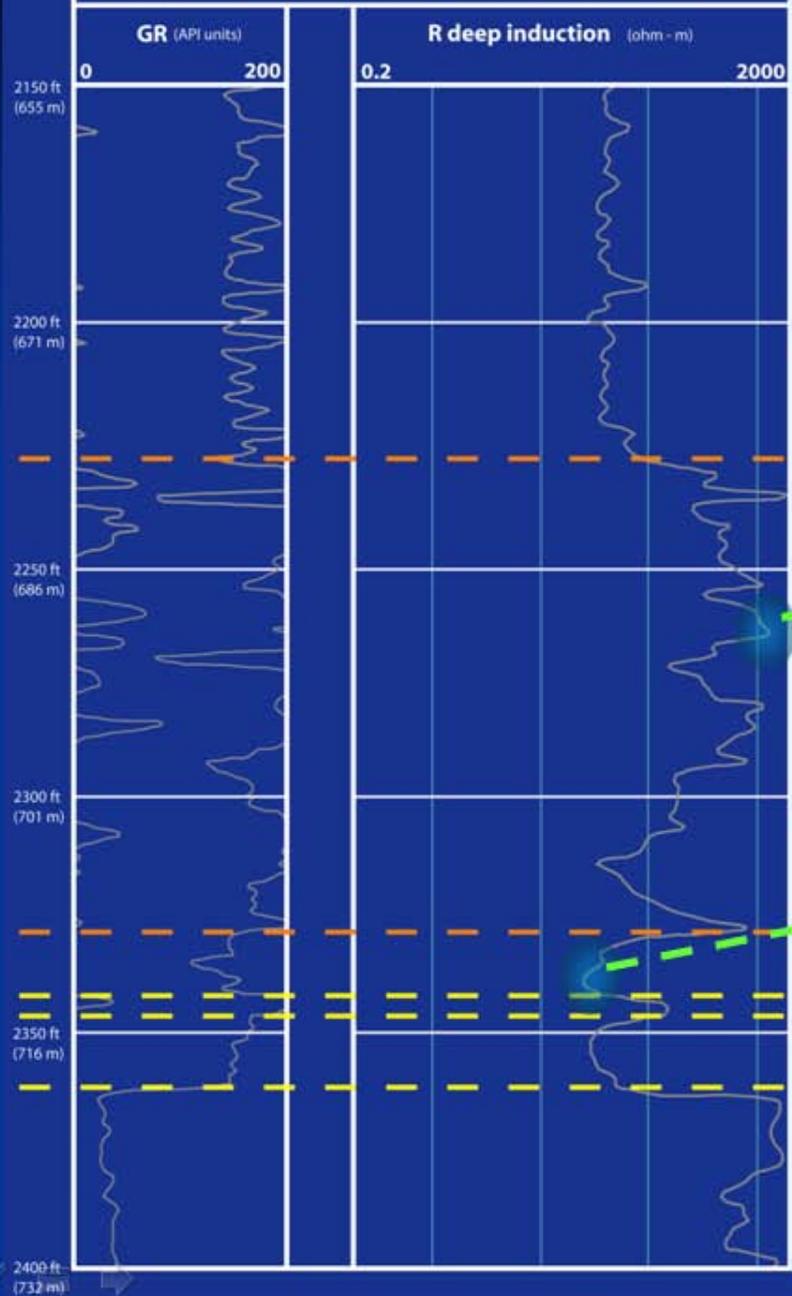




Resistivity – qualitative indicator of thermal maturity;

generation of hydrocarbons during compaction displaces pore water thereby increasing formation resistivity (Meissner 1978; Meyer and Nederlof, 1984; Mendelson and Toksöz, 1985; Schmoker and Hester, 1990; Morel, 1999).

Caflich, E 1-P
(API 20148; Chautauqua Cty., New York)



comparison of maximum resistivity of the Rhinestreet black shale with that of the organic-lean Cashaqua gray shale;

R_{rs} : maximum resistivity of the Rhinestreet shale

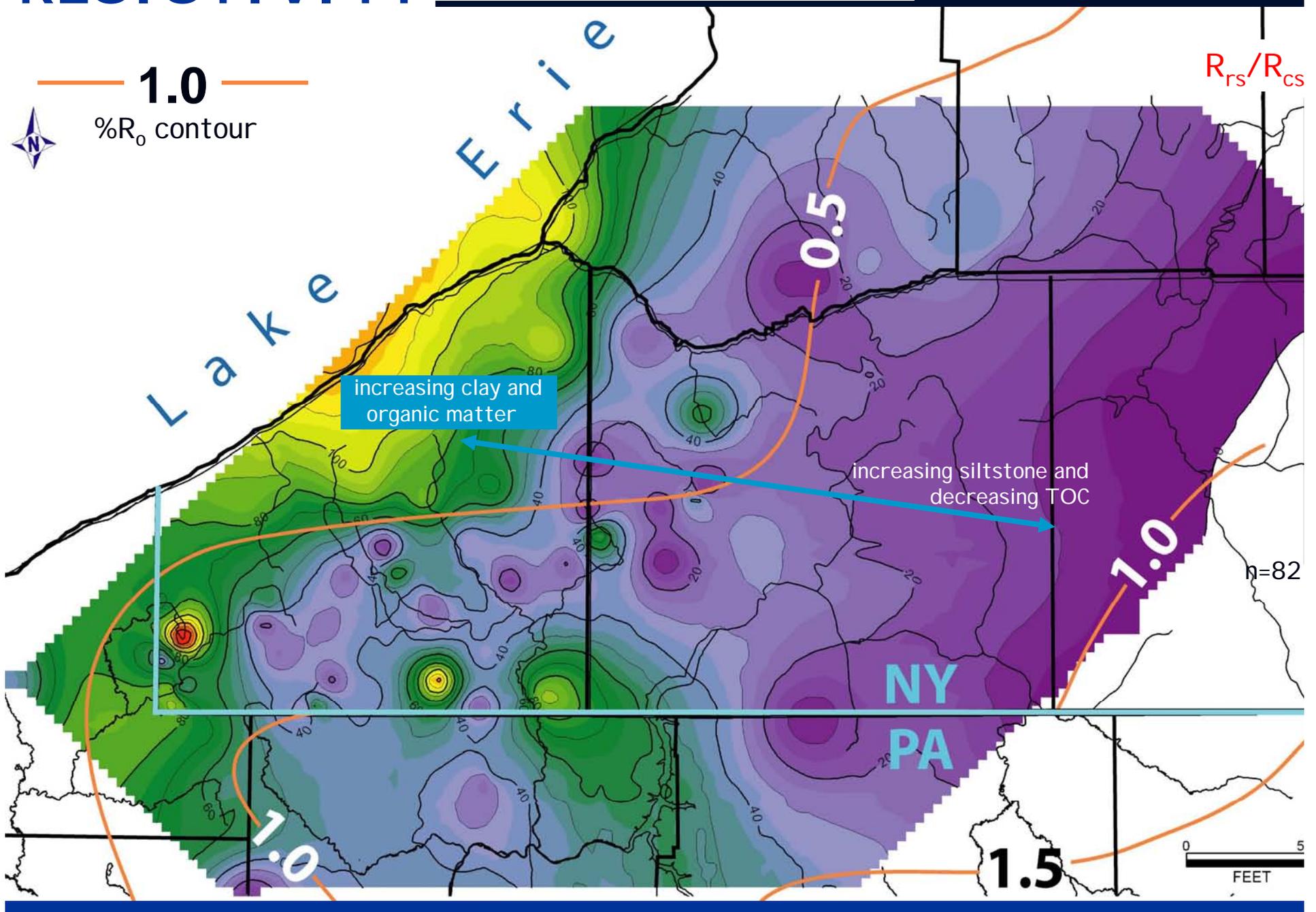
$$\frac{R_{rs}}{R_{cs}}$$

R_{cs} : resistivity of the Cashaqua shale

- Cashaqua shale
- Middlesex shale
- West River shale
- Tully limestone

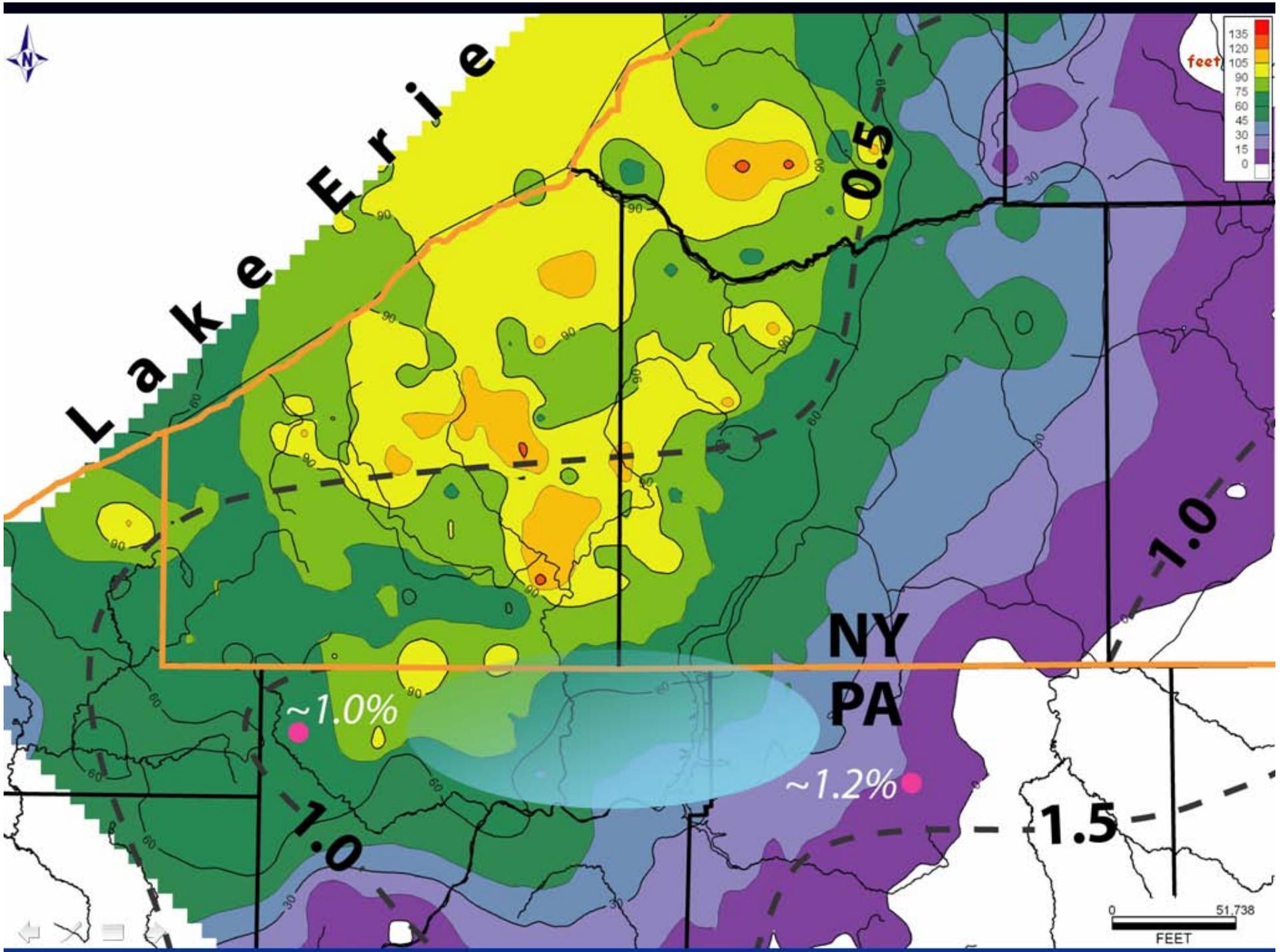
RESISTIVITY

Rhinestreet shale/Cashaqua shale

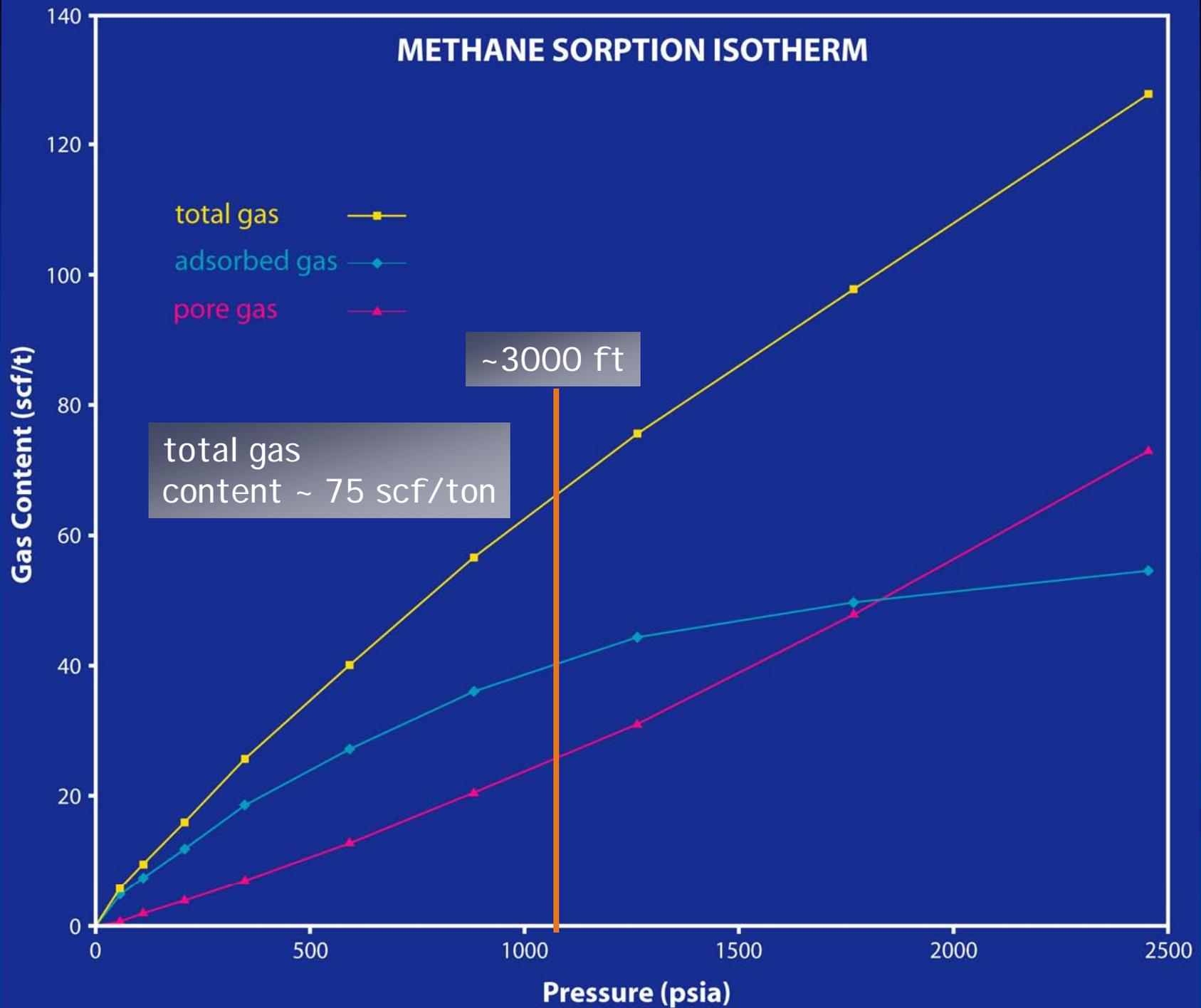


Conclusions

- the impermeable organic-rich, heavily fractured Upper Devonian Rhinestreet shale thins rapidly to the east as black shale quickly grades laterally into organic-lean gray shale and siltstone;
- the organic-rich interval (TOC \geq 3.2%; gas content \geq ~40 scf/ton) of the Rhinestreet shale is displaced somewhat to the west of the axis of maximum thickness of the unit;
- the bulk of the Rhinestreet shale appears to have been thermally matured to the oil window; it may have reached the gas window in eastern Warren and McKean counties though the organic richness is diminished;



METHANE SORPTION ISOTHERM

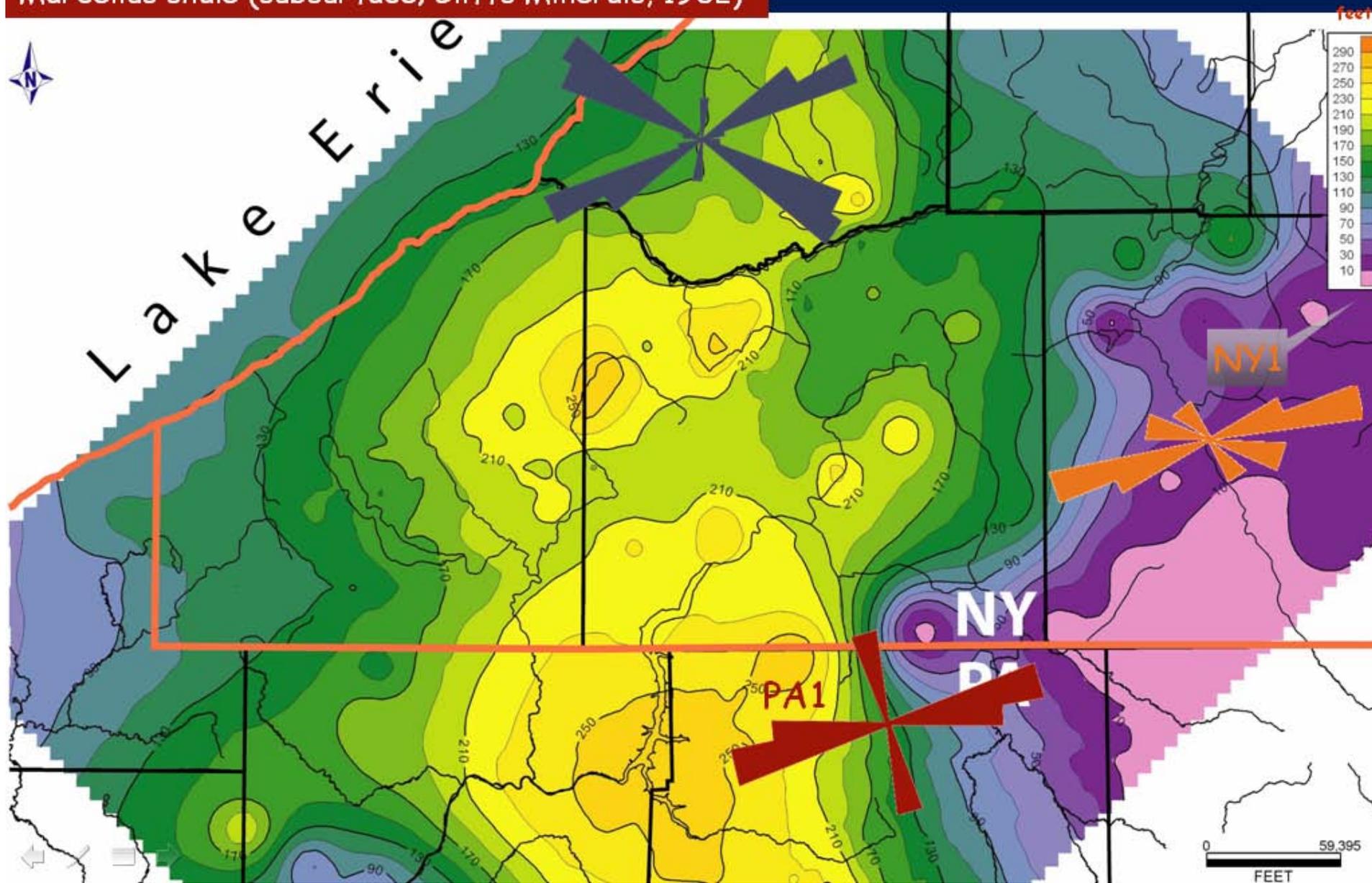


- production from this impermeable unit should utilize induced or natural fractures and should take advantage of the orientation of the contemporary maximum horizontal stress (S_H) and an ENE-trending joint set pervasive throughout the Rhinestreet;
- fracture trends (orientations and spacing data) can likely be extrapolated from the Rhinestreet and other exposed Upper Devonian black shale units studied in the field, down-section into the Marcellus (Oatka Creek) black shale;

Rhinestreet shale (outcrop data)

Rhinestreet shale (subsurface; Cliffs Minerals, 1982)

Marcellus shale (subsurface; Cliffs Minerals, 1982)



acknowledgements:

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Survey

Jim McDonald, Ohio Geological Survey



first gas well -Fredonia, NY