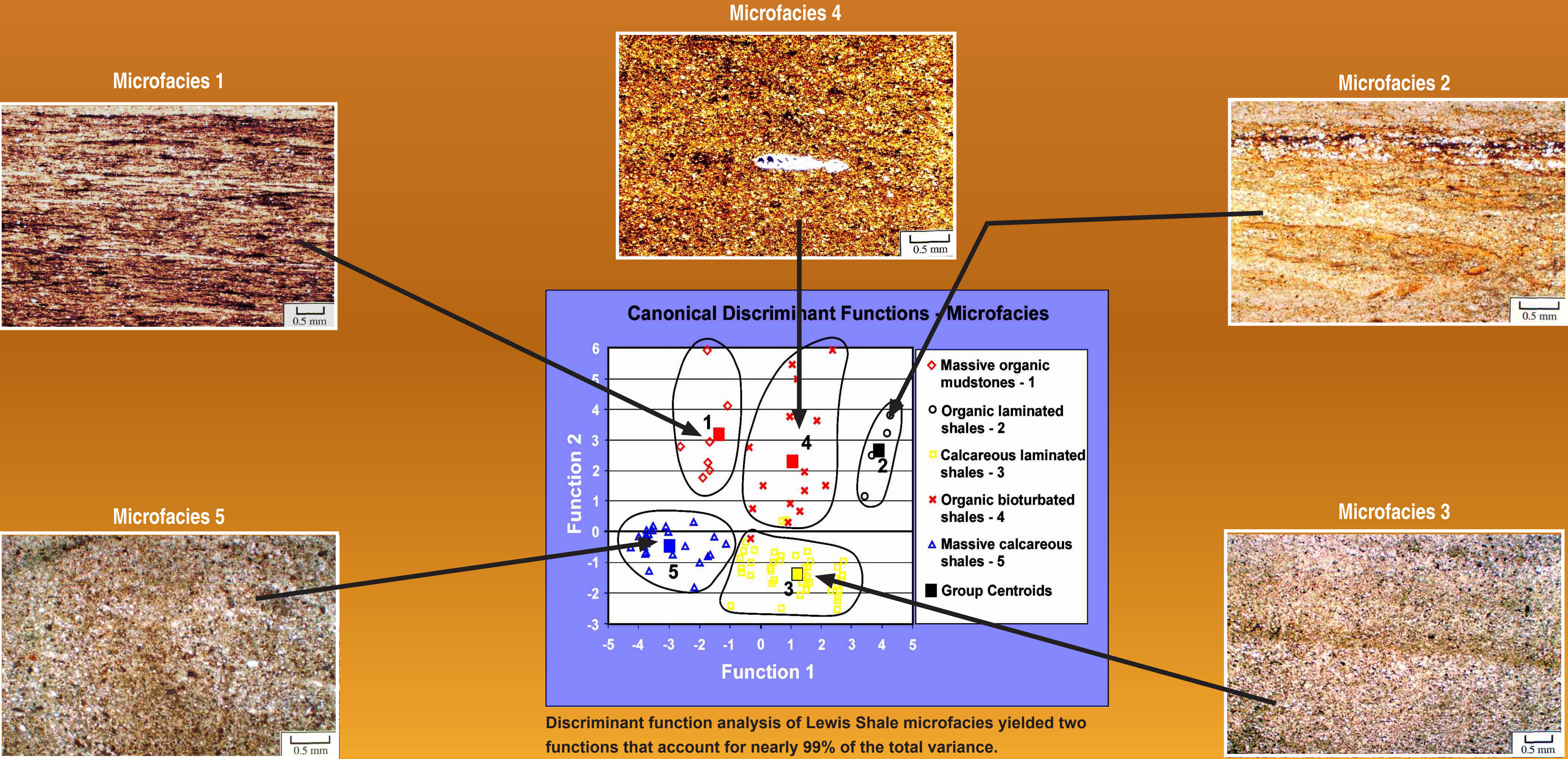


# Outcrop Analog Seal Data

Shale microfacies are recognizable in closely spaced shale samples from outcrops (Cretaceous, Wyoming). Each shale end-member type has distinctive fabrics, MICP character, and composition. Seal character varies in a predictable manner within a sequence stratigraphic framework. Well-laminated, clay- and organic-rich shales from uppermost transgressive units exhibit excellent seal potential.



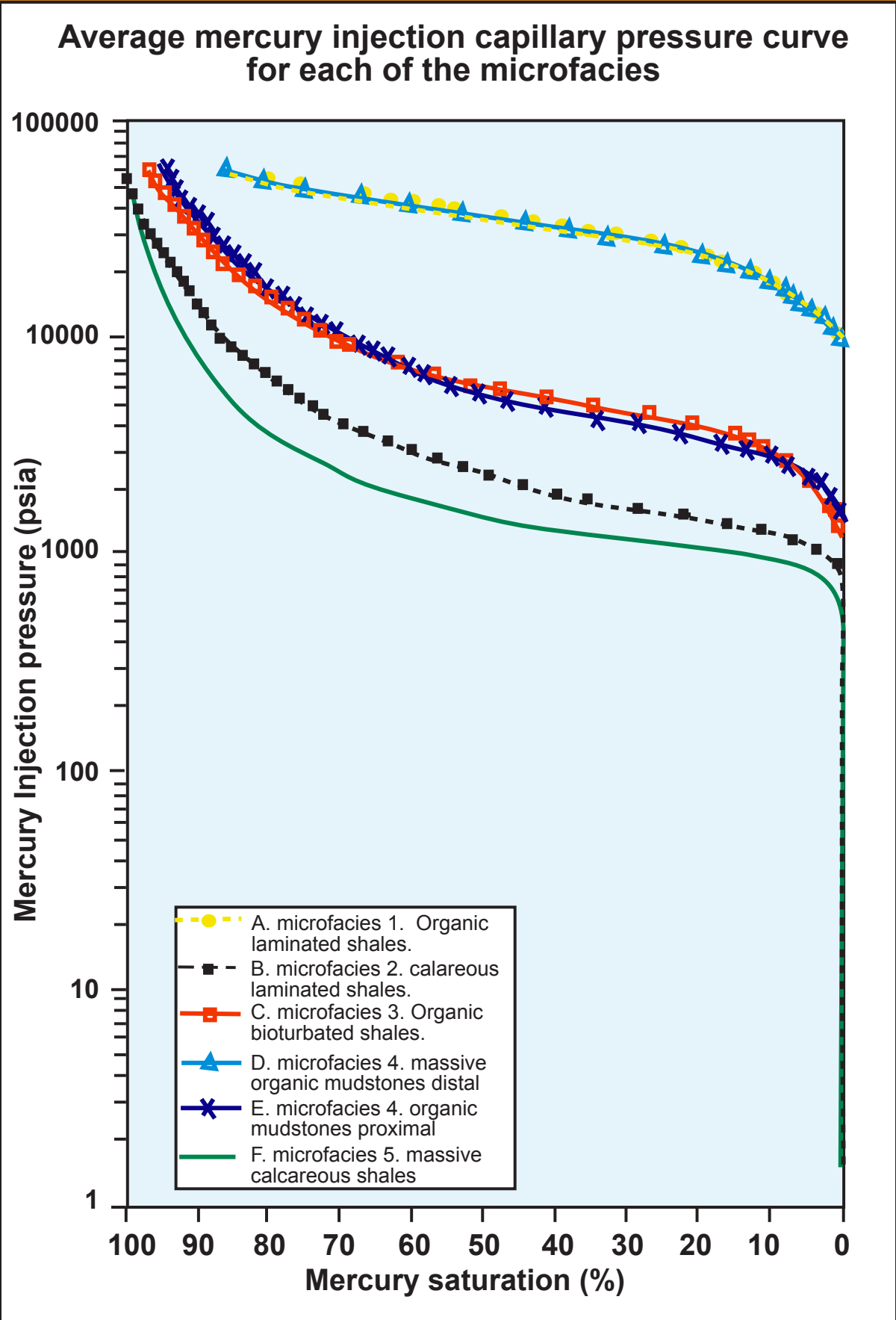
High resolution sequence stratigraphy reveals that this group of samples in this data set represent three of the six shale types that typify deepwater marine depositional settings. Shale type 2 occurs with 3rd- and 4th-order condensed sections and basal parts of transgressive stratal packages. Shale type 3 occurs mainly with silt- and sand-rich 4th-order lowstand units. Type 6 shales represent the most distal shale facies and record pelagic sedimentation with minimal bioturbation and slow sedimentation.

Microfacies	Description	Seal Character	Depositional System
Microfacies 1	Finely laminated, pyritic, black shales	Excellent	TST/CI
Microfacies 2	Moderately to very silty calcareous shales	Poor	HST
Microfacies 3	Moderately to very silty, mottled, calcareous shales	Moderate to poor	LST
Microfacies 4	Fossiliferous slightly to moderately silty claystones	Variable	TST/HST
Microfacies 5	Very silty shales and mottled argillaceous siltstones	Poor	HST/LST

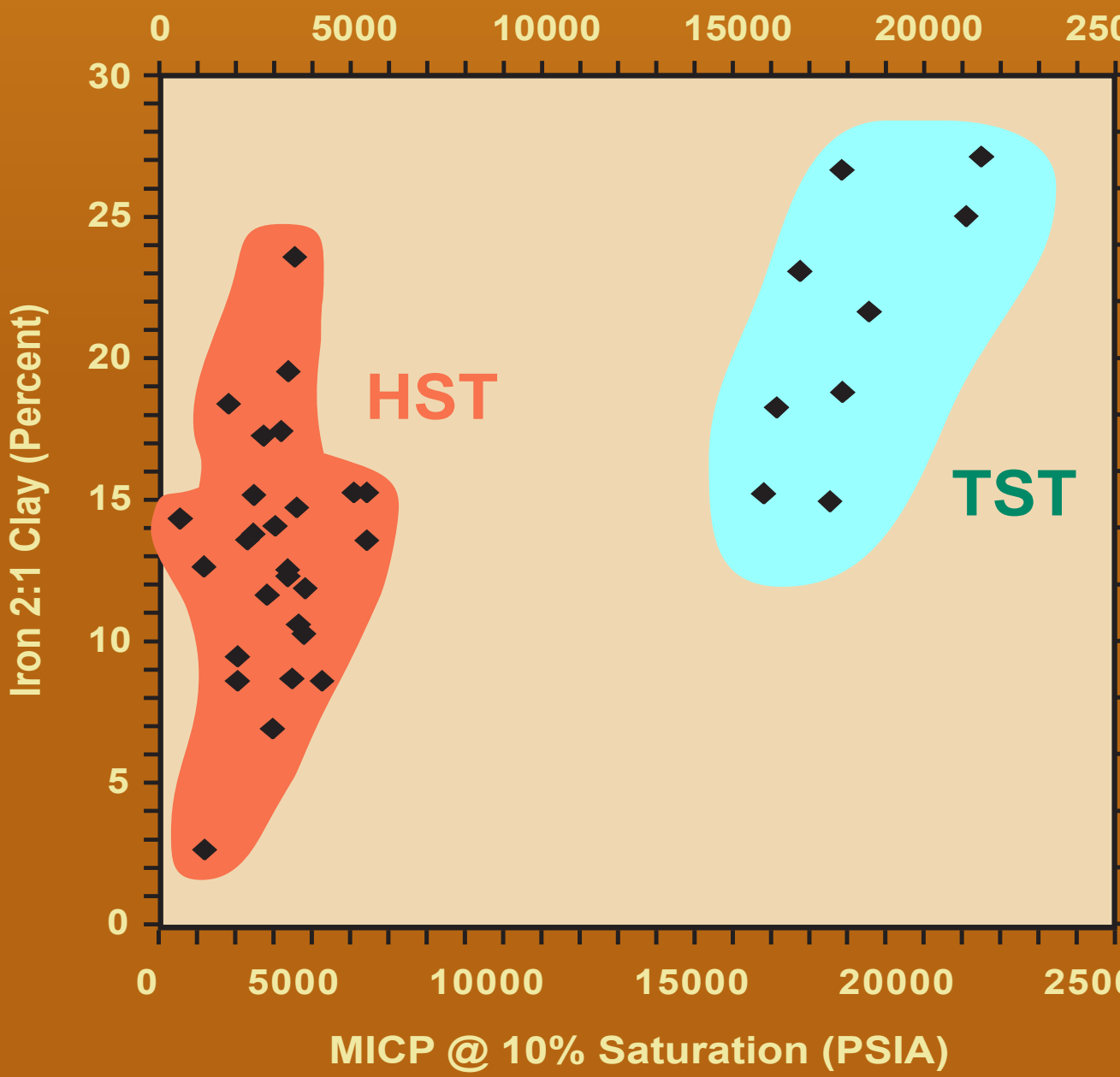
Table: Summary of shale attributes (potential seal)

MICP values and porosity are reduced significantly in the late TST relative to all parts of the HST interval. The reduced porosity in clay-rich TST shales is attributed improved organization of particles (well-developed laminar fabrics) as well as the precipitation of Fe-carbonate cements during early submarine diagenesis.

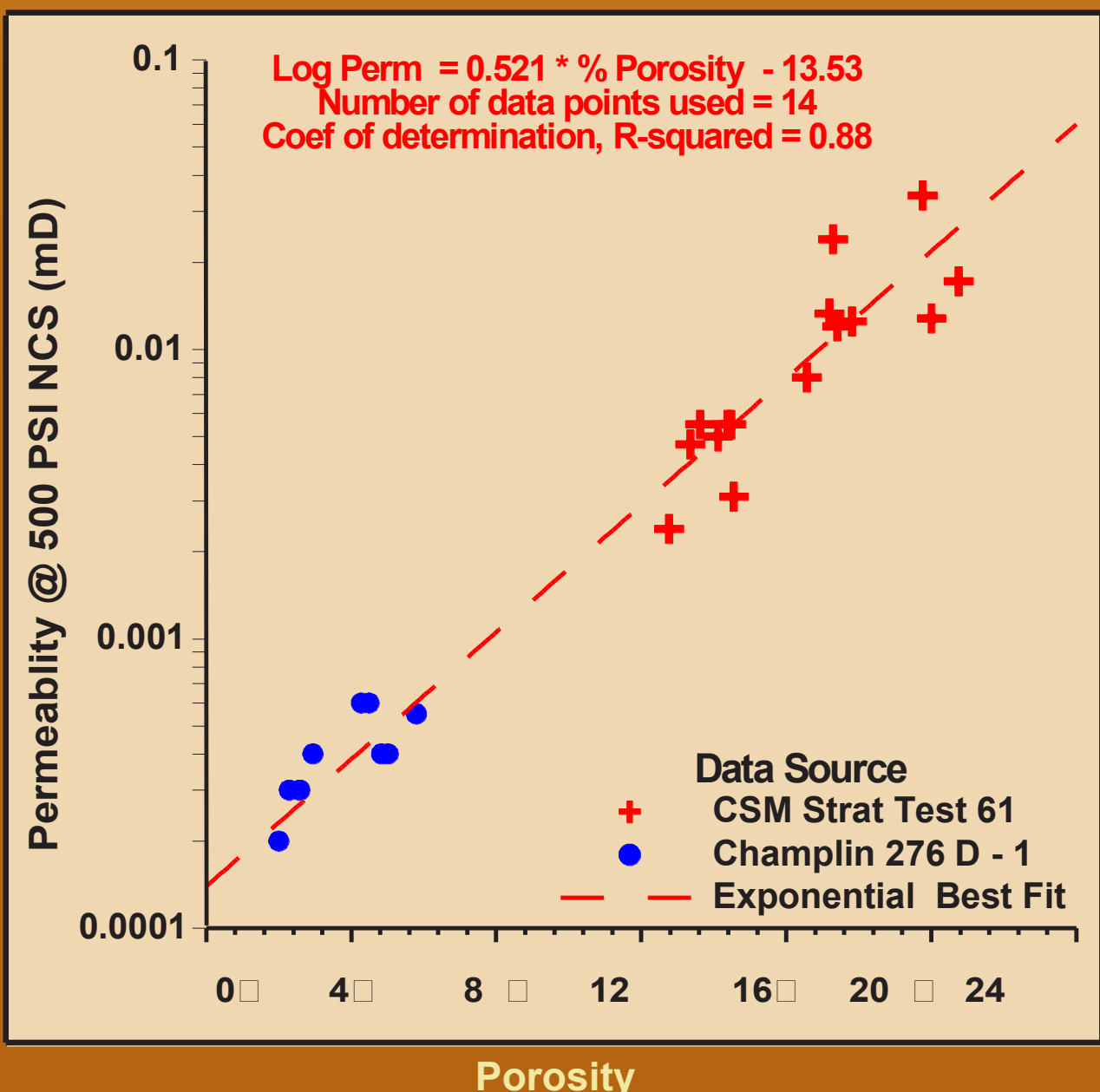
Additionally, there is a major difference in the permeability of TST and HST shales. Within the Lewis HST there is a weak trend of upward increasing permeability; this trend appears to correlate with a vertical increase in the content of detrital silt.



Distal marine (TST) shales (microfacies 1 and 4) exhibit the “best” seal character based on MICP analysis.



TST shales are enriched in iron-bearing clay minerals and pyrite and have strongly elevated MICP values relative to HST shales.



A strong correlation between subsurface and outcrop samples, along with evidence of comparable burial history (Tmax data), suggests that other factors (e.g., diagenetic processes) are responsible for differences in seal character.