PRELIMINARY RESULTS FROM COAL-BED METHANE DRILLING IN PANOLA COUNTY, TEXAS

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Figure 1. Title page.

INTRODUCTION - OUTLINE

* This is work in progress! Only preliminary data are presented

* Overview of NE TX/LA coal geology & drill site location

* Results: coal and gas physical characteristics & geochemistry

* Conclusions and where do we go from here?

•Acknowledgements: Phillips Coal, TXU Mining Company, and co-workers at TX A&M and USGS

Figure 2. Introduction and outline. In June, 1999, the U.S. Geological Survey (USGS) and Texas A&M University drilled two coal bed methane test holes in Panola County, Texas. The following diagrams provide some preliminary results from drilling and samples collected. The first hole (USGS-PA-1) contained no measurable gas. The second hole (USGS-PA-2), contained some coal gas, and is the focus of this presentation.

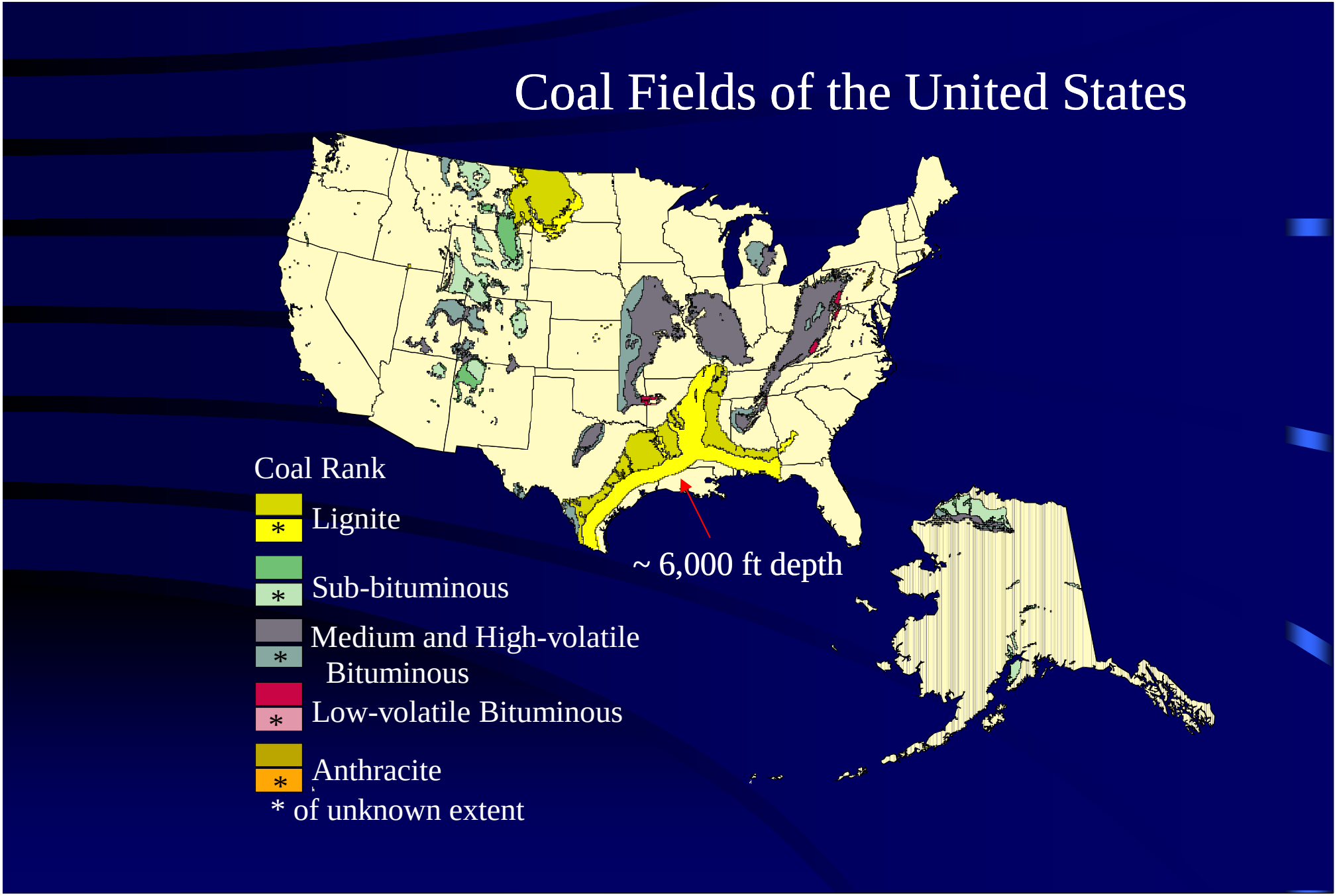


Figure 3. Coal field map of the United States. Note the relative size of the Gulf Coast coal region compared to other coal-bearing regions of the country. Also note that the Gulf coal-bearing strata dip southward into the Gulf of Mexico basin. An estimated 6,000 ft (1828 m) depth to top of the coal-bearing formations is shown.

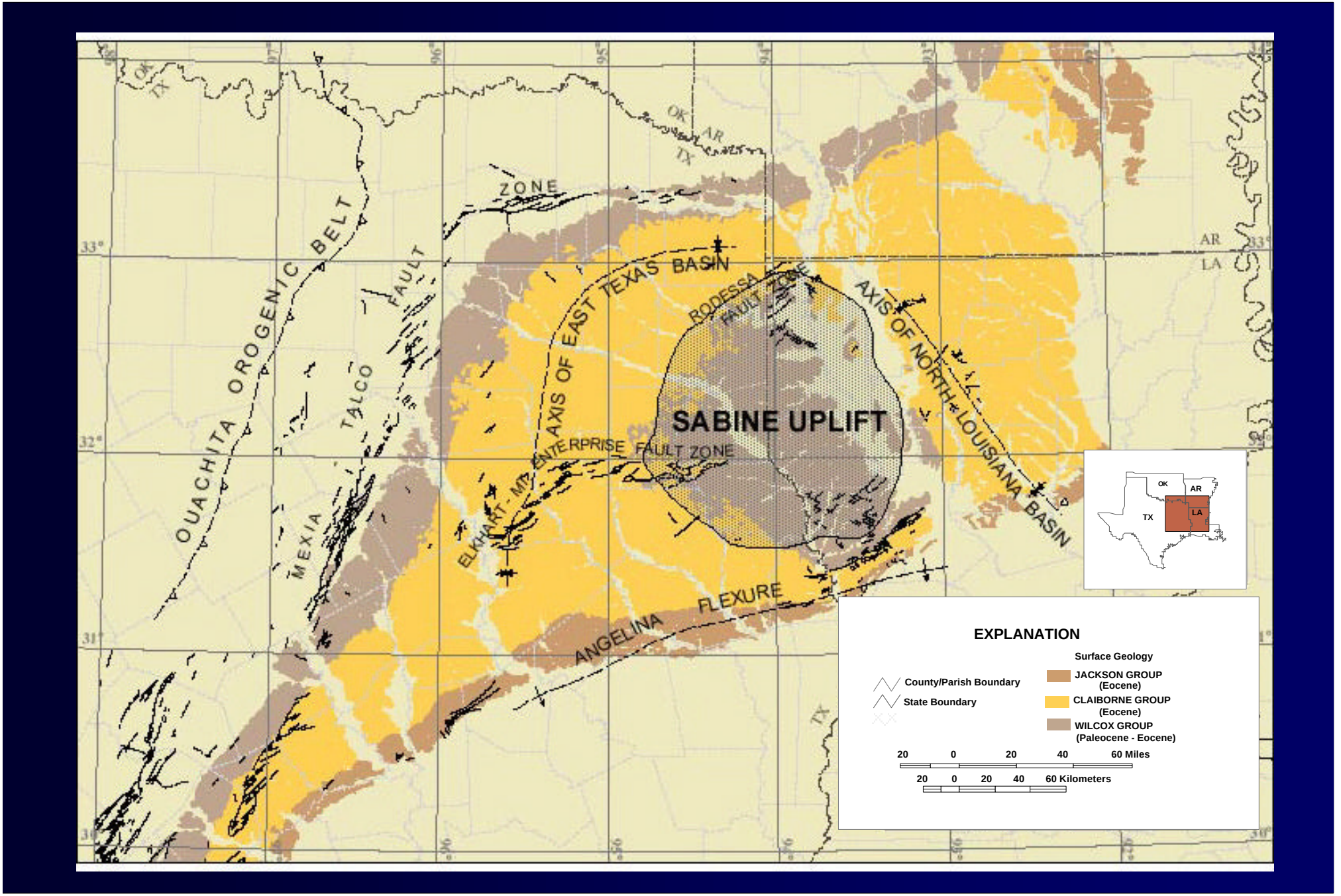


Figure 4. Generalized outcrop of coal-bearing units and major structural features in the Sabine Uplift area of Northeast Texas and Northwestern Louisiana.

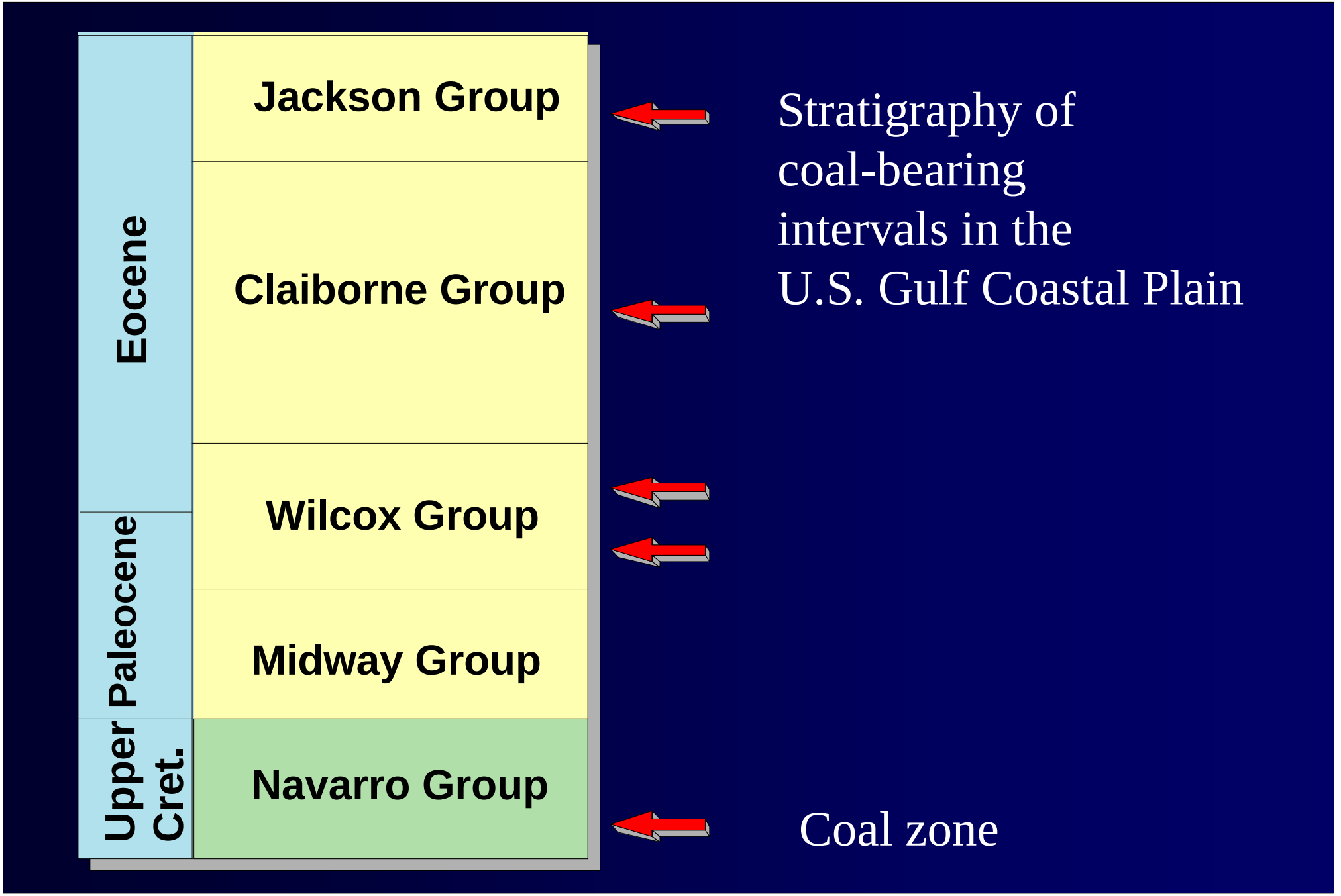


Figure 5. Stratigraphy of coal-bearing units in the Gulf Coastal area. Arrows indicate position of major coal zones. Most coal mine production is from the Wilcox Group.

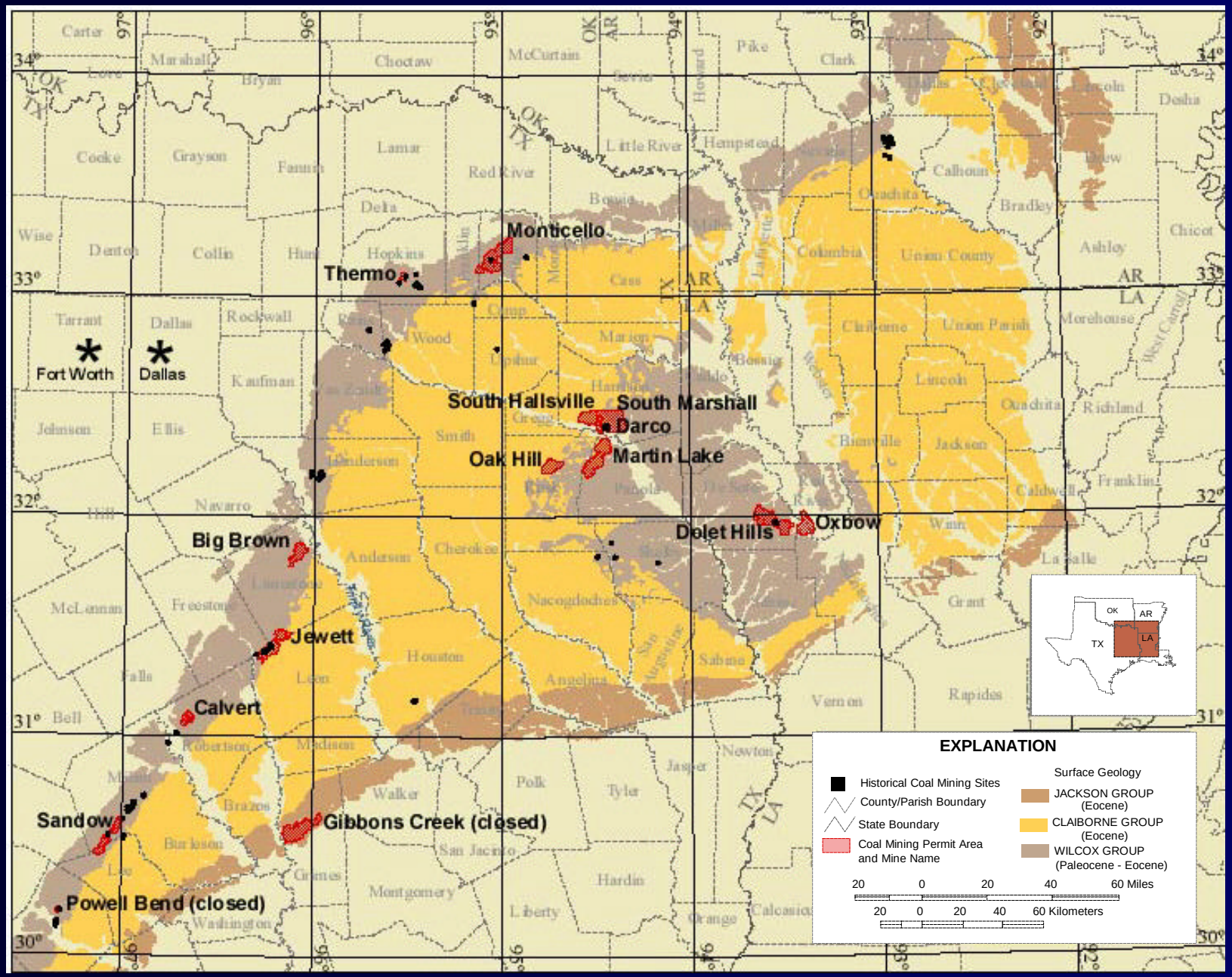


Figure 6. Generalized outcrop of coal-bearing units and location of current and historic coal mines in the Sabine Uplift area of Northeast Texas and Northwestern Louisiana. Coal beds cored from shallow drill holes (<150 ft or 46 m deep), near the Calvert and Jewett mines, showed no gas content when tested.

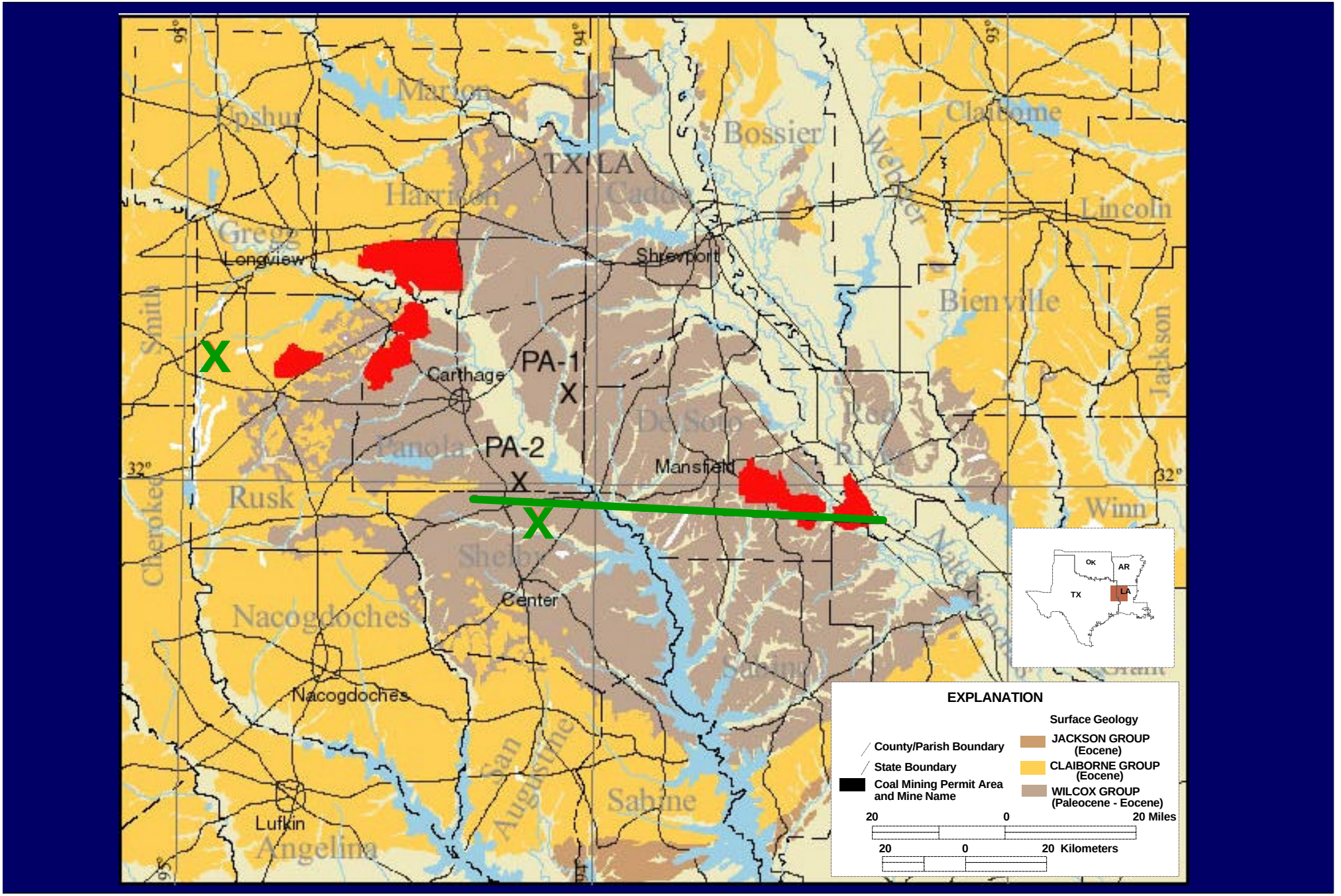


Figure 7. Close-up map of the Sabine Uplift area. Green "X" indicates location of stratigraphic control from drill holes. Green line is approximate line of section for cross section from Luppens (1987). Black "X" indicates location of 1999 USGS coal-bed methane test holes. Areas colored red are surface coal mine permits.

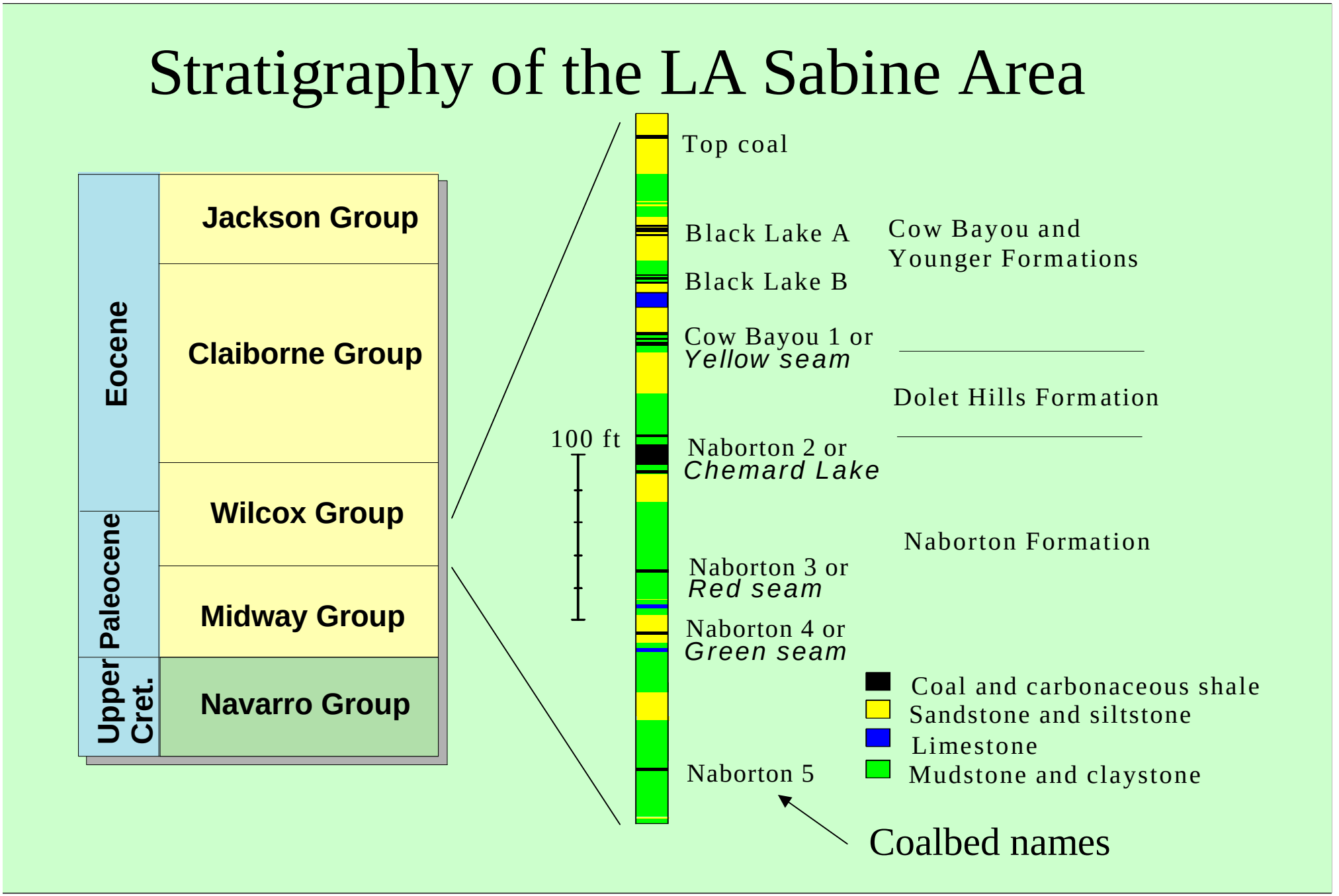


Figure 8. Detailed stratigraphy of the coal-bearing part of the Louisiana Sabine Uplift. Italicized coalbed names are from Williamson (1986).

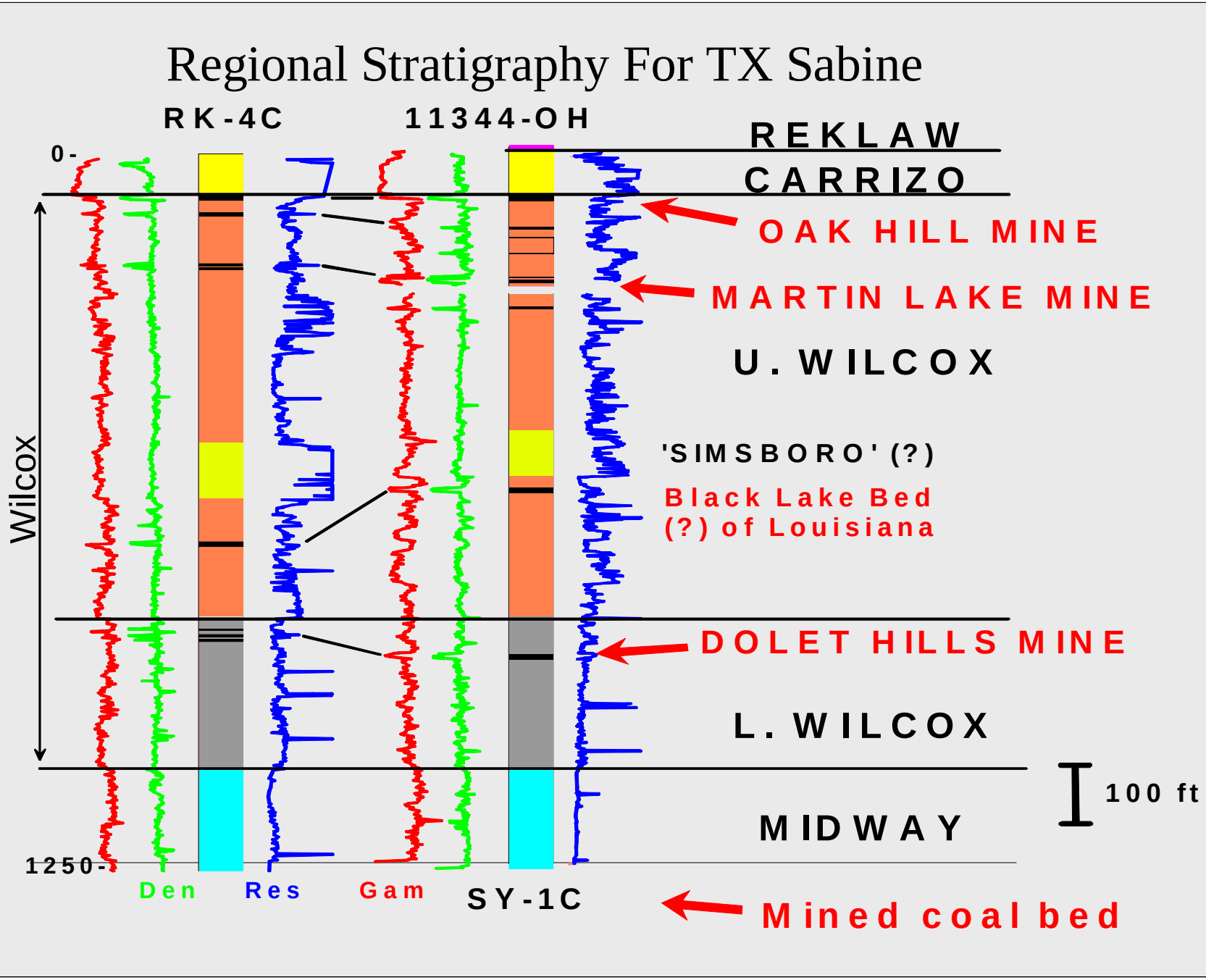


Figure 9. Composite boreholes showing regional correlation of the undivided Wilcox Group in the Texas part of the Sabine Uplift. Data modified from Oak Hill mine permits (1134-OH) and Kaiser (1990). Red arrows indicate stratigraphic position of coal beds mined at surface mines shown on figure 6.

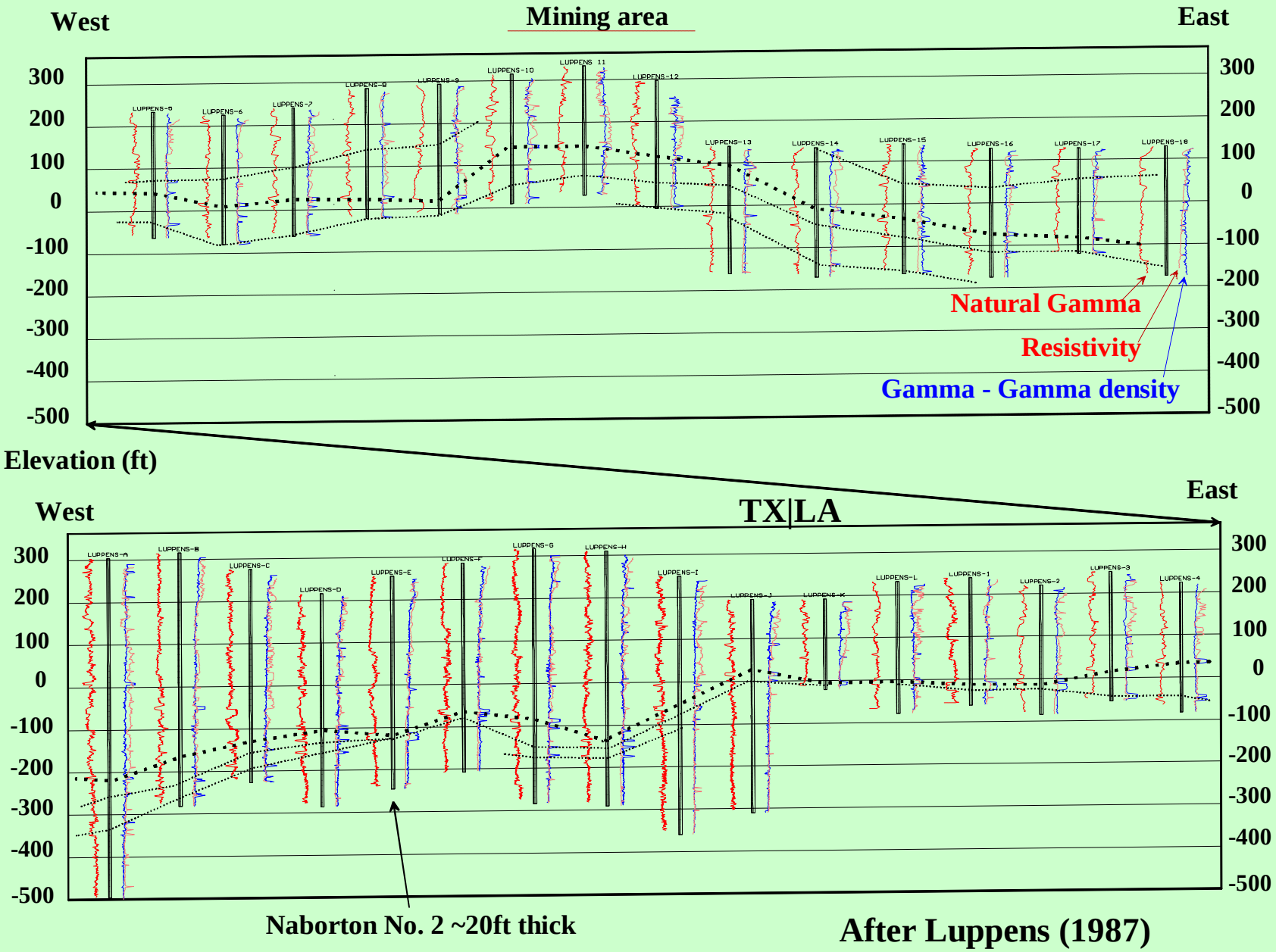


Figure 10. Regional cross section from Luppens (1987). Note that this is one cross section joined as indicated by the join line. Heavy black lines indicate stratigraphic position of the Naborton No. 2 or Chemard Lake coal zone. The arrow indicates an area where the Naborton No. 2 bed is about 20 ft (6 m) thick. Drill hole USGS-PA-2 was located in this area. Note the area where the coal is mined (upper section). Location of the line of section and mining area is shown on figure 7.

Figure 11. Photograph of Texas A&M drill rig on site at USGS-PA-2.

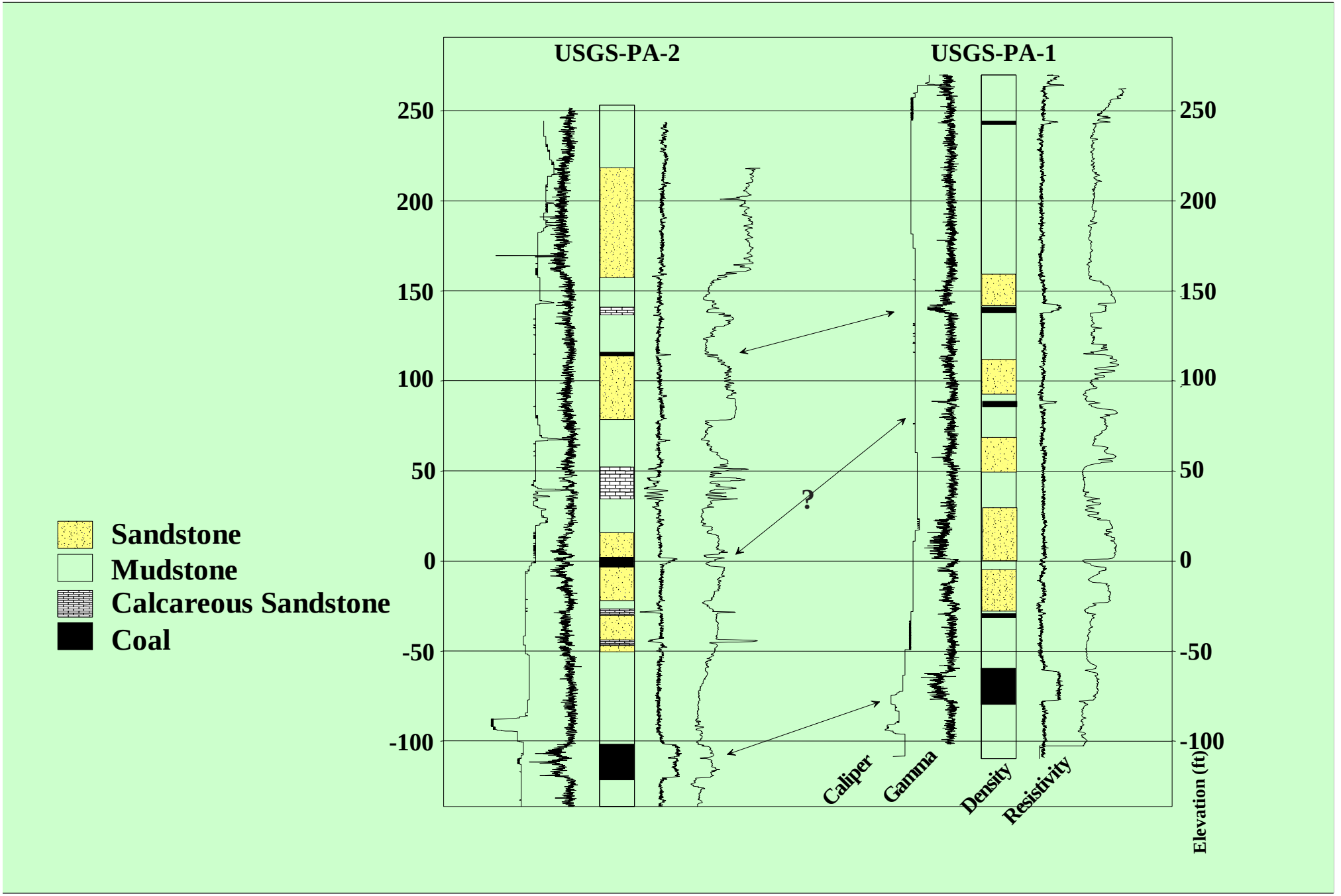


Figure 12. Generalized stratgraphic column and geophysical logs from USGS core holes in Panola County, Texas. Locations are shown on figure 7. Only USGS-PA-2 contained coal bed gas.

Figure 13. Coal core being measured and described prior to insertion into the desorption canisters at USGS-PA-1. Note clay parting in coal core on the left end of the core. The clay parting occurs at depth 331.2 – 331.35 ft (USGS-PA-1) or about 0.2 ft from the top of the coal bed in both USGS-PA-1 and PA-2.

Figure 14. Close-up of clay parting in USGS-PA-1. This is probably a volcanic ash or tonstein. The clay parting occurs at depth 331.2 – 331.35 ft (USGS-PA-1) or about 0.2 ft from the top of the coal bed in both USGS-PA-1 and PA-2. A similar ash parting occurs in the same position of the coal being mined at the Dolet Hills and Oxbow mines in Louisiana (fig. 6; also see Ruppert and Warwick, 1994). The occurrence of this ash layer supports Luppens (1987) regional correlation shown on figure 10.

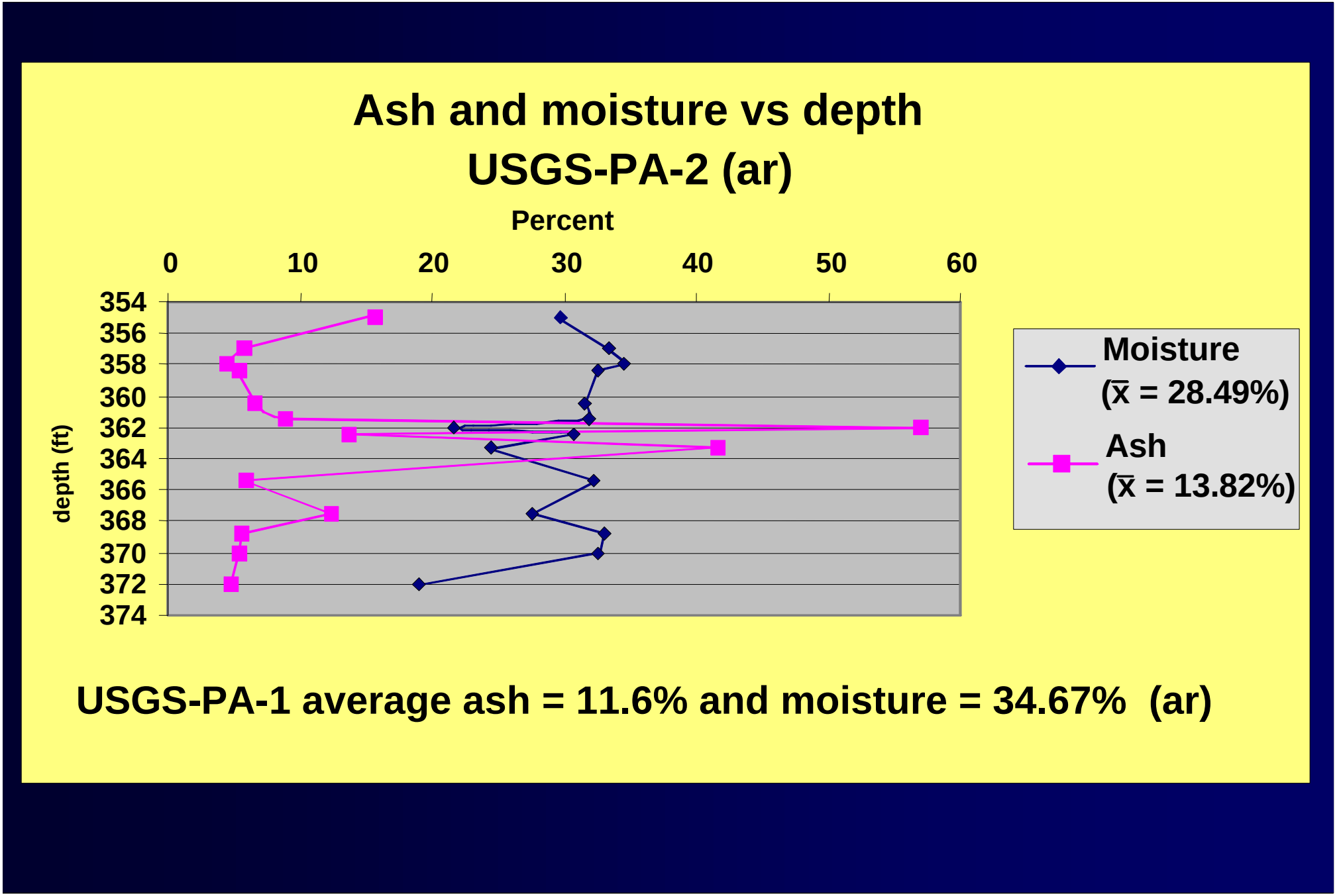


Figure 15. Plot of ash yield and moisture (as received basis, ar) for gas-bearing coal samples from USGA-PA-2. Note the high ash yield in the middle of the bed. Average ash and moisture values for the coal samples from USGA-PA-1 are given at the bottom of the illustration.

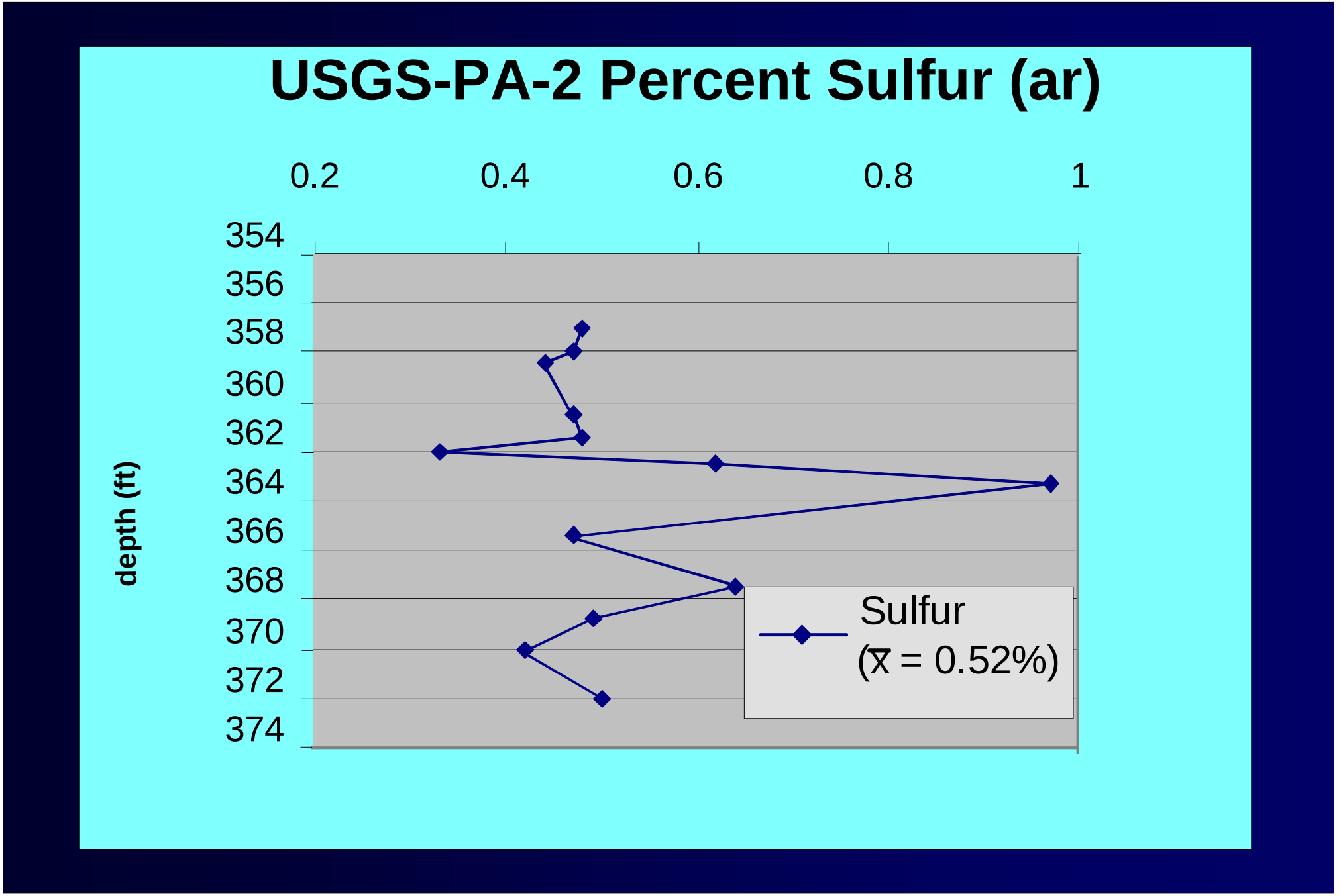


Figure 16. Plot of sulfur content (as received basis, ar) for gas-bearing coal samples from USGS-PA-2.

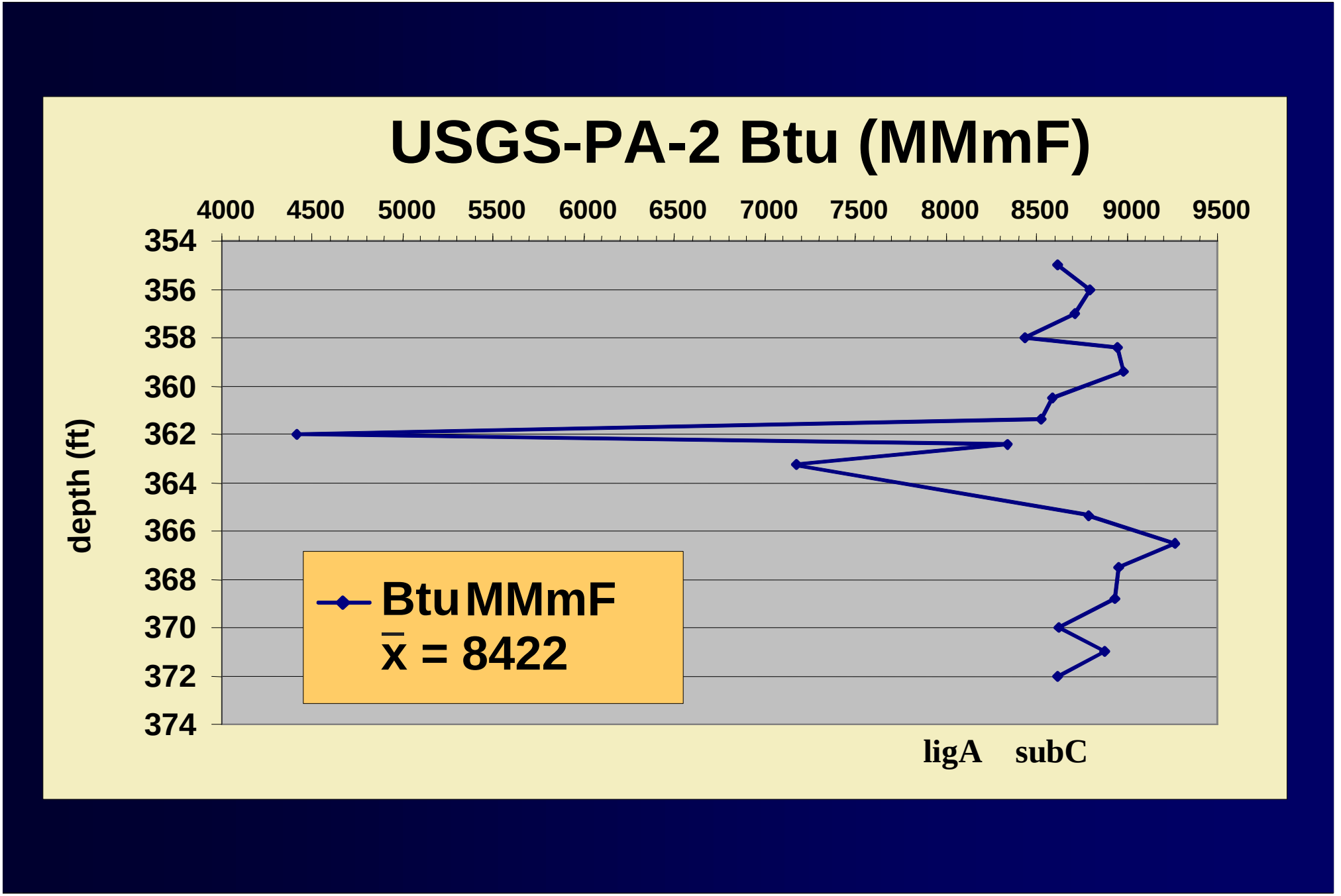


Figure 17. Plot of calorific values (Btu/lb on a moist, mineral matter free basis, MMmf) for gas-bearing coal samples from USGS-PA-2. Note most samples plot above 8300 Btu/lb, the boundary between lignite and sub-bituminous.

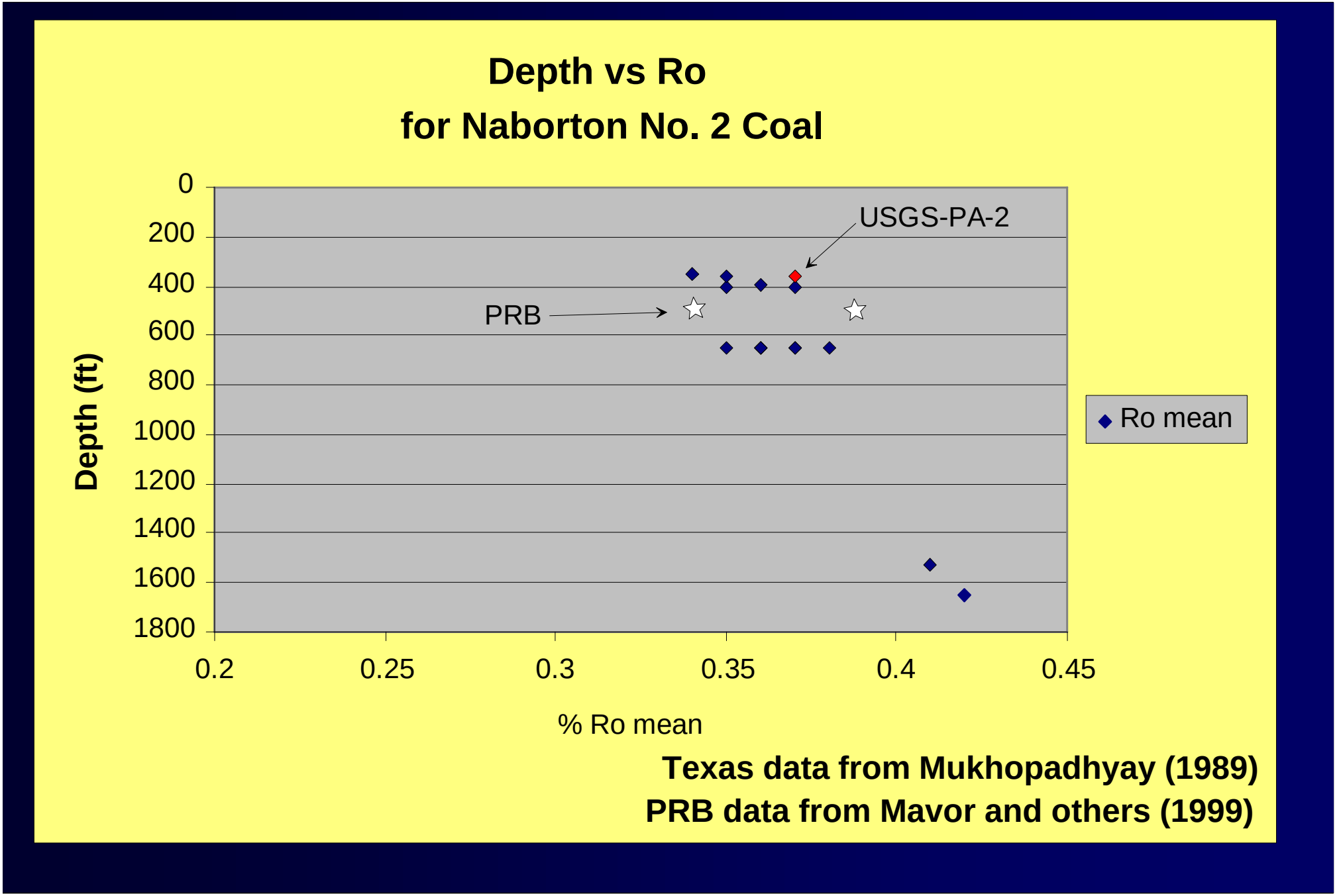


Figure 18. Plot of vitrinite reflectance data for the Naborton No. 2 (Chemard Lake) coal in Texas. Blue points from Mukhopadhy (1989). Red point is from USGS-PA-2. White stars are from Powder River basin (PRB) data (Mavor and others, 1999). The deep samples (>1400 ft) with high (>0.4%) Ro values indicate coal rank increase with depth.

Figure 19. Photograph showing constant temperature water baths used with the coal desorption canisters.

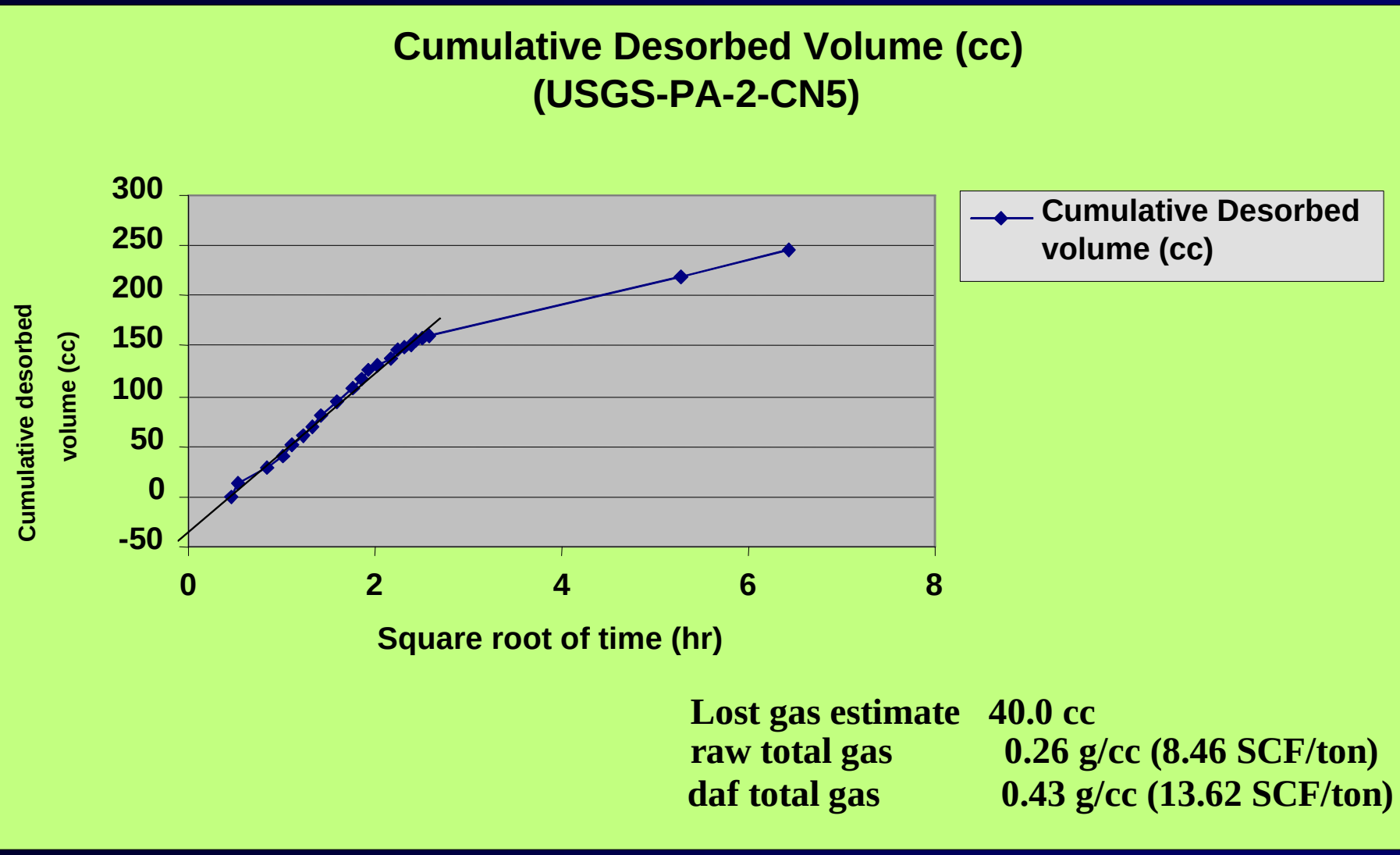


Figure 20. Example of one of the desorption plots from USGS-PA-2 (canister no. 5, which is about 5 ft (1.5 m) from the top of the coal bed; daf = dry, ash free basis).

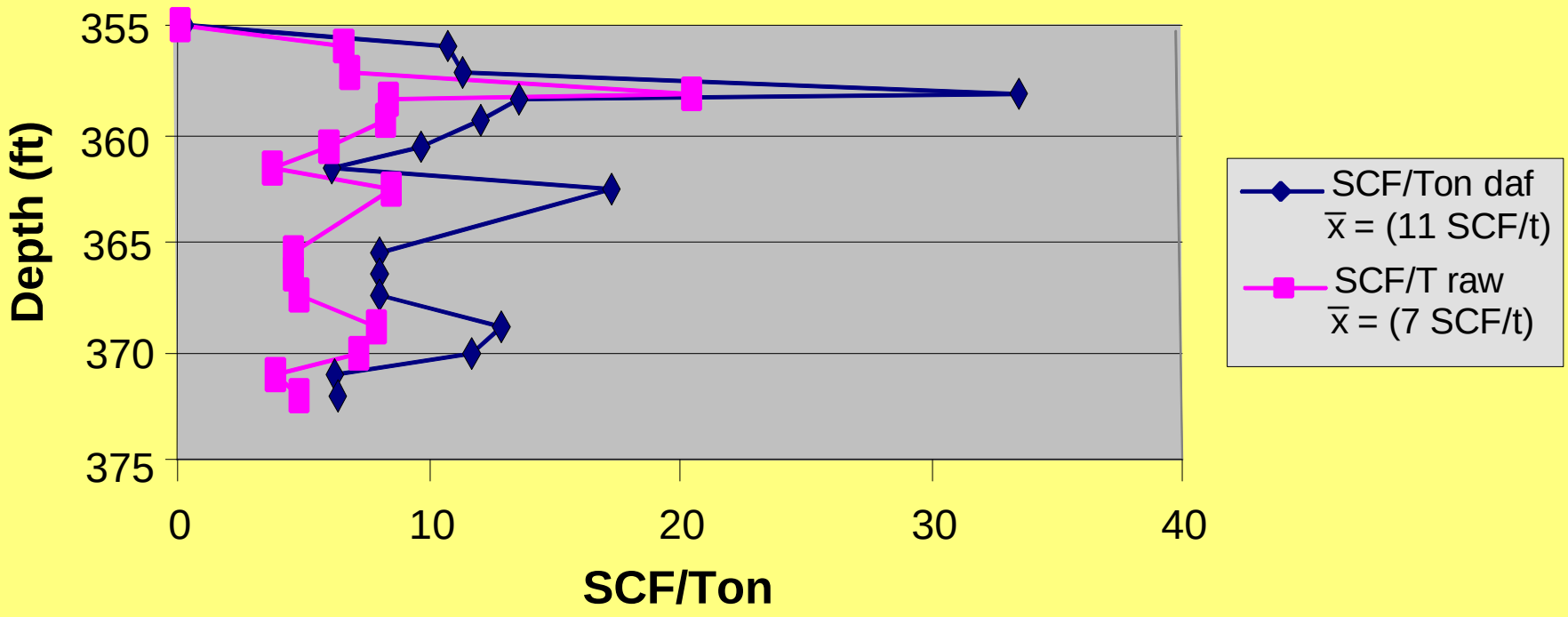


Figure 21. Results of all desorption tests on coal from USGS-PA-2. Note the higher gas content in the upper part of the coal bed. daf = dry, ash free basis.

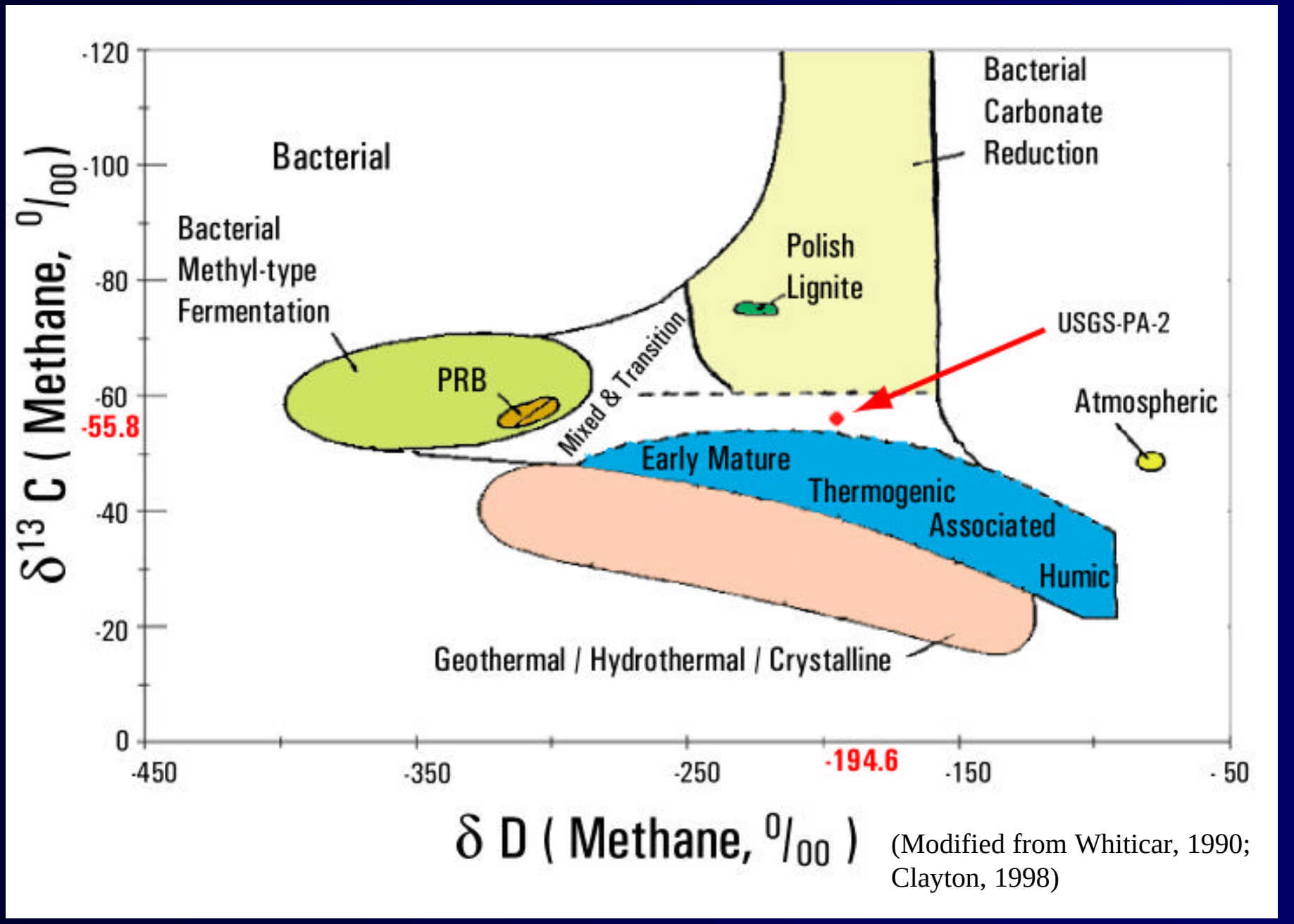


Figure 22. Isotopic composition of carbon (y axis) and hydrogen (x axis) for methane from a gas sample collected from one USGS-PA-2 coal sample. The values obtained from the sample are shown along the axes in red. Note that the gas sample plots in the mixed or transition zone between gases of biogenic and thermogenic origin and is different from Powder River basin (PRB) gases. Diagram after Clayton (1998).

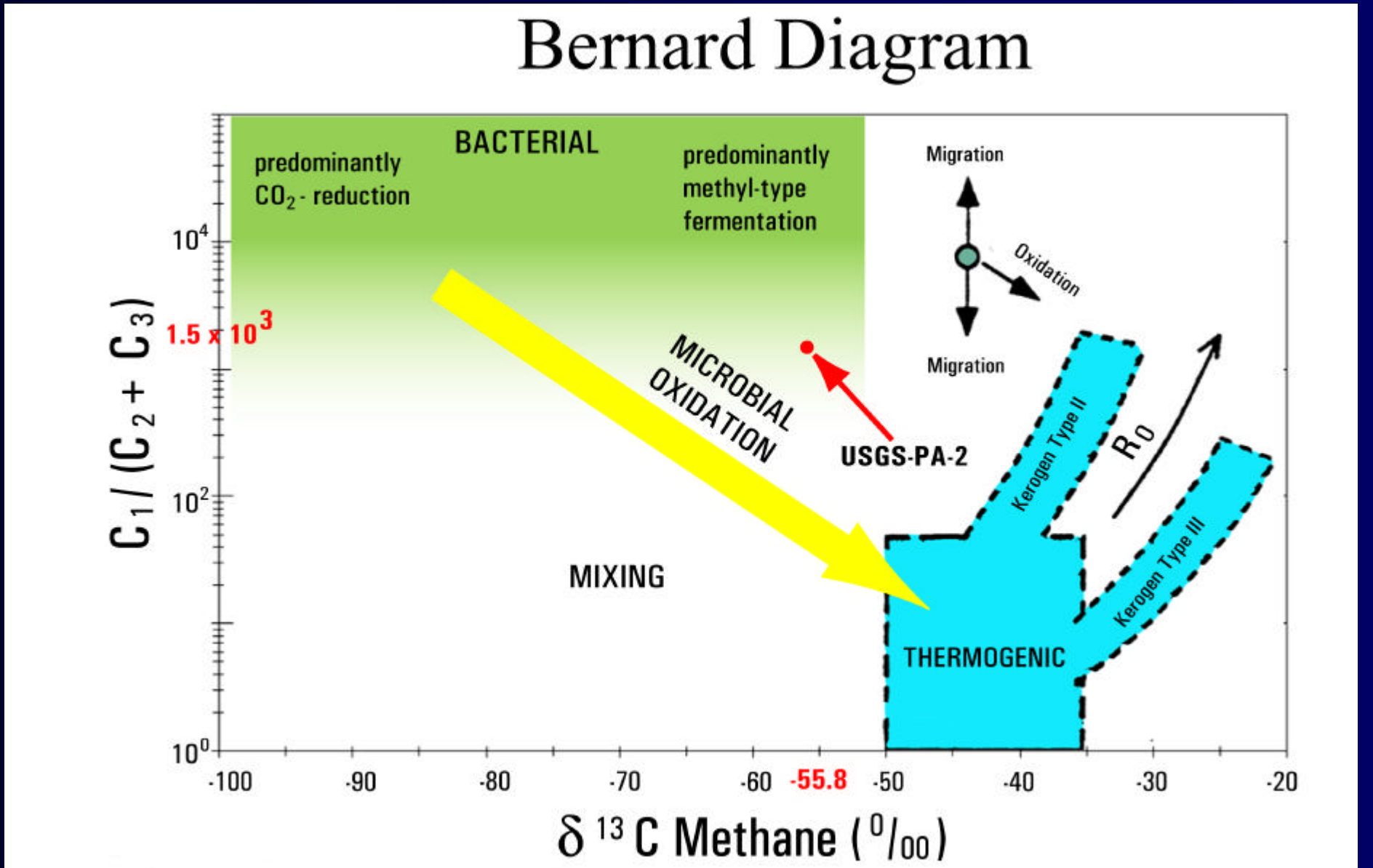


Diagram modified from Bernard and others (1978); Faber and Stahl (1984); and Whiticar (1994).

Figure 23. Bernard diagram for a gas sample collected from one USGS-PA-2 coal sample. The plot shows the molecular ratio of C_1, C_2 and C_3 (methane, ethane, and propane) and carbon isotopic composition in methane. The values obtained from the USGS-PA-2 sample are plotted along the axes in red. Note that the gas plots in the transition region of the diagram. The dryness of the gas indicates it is out of the thermal region. Diagram modified from Bernard and others (1978); Faber and Stahl (1984); and Whiticar (1994).

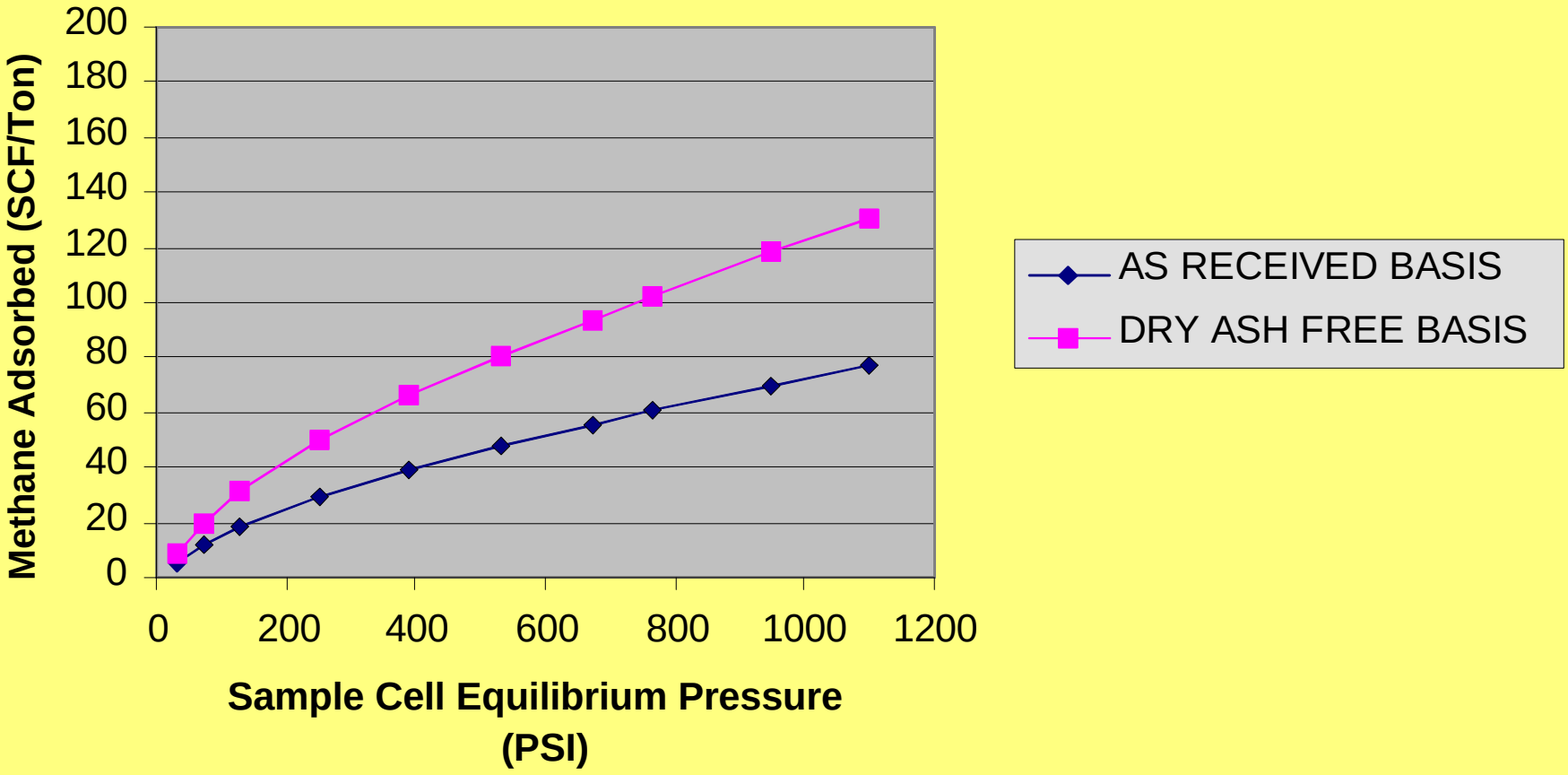


Figure 24. Example of a methane sorption isotherm for a sample from near the top of the gas-bearing interval sampled in USGS-PA-2. Note the difference between the as-received and dry, ash-free bases.

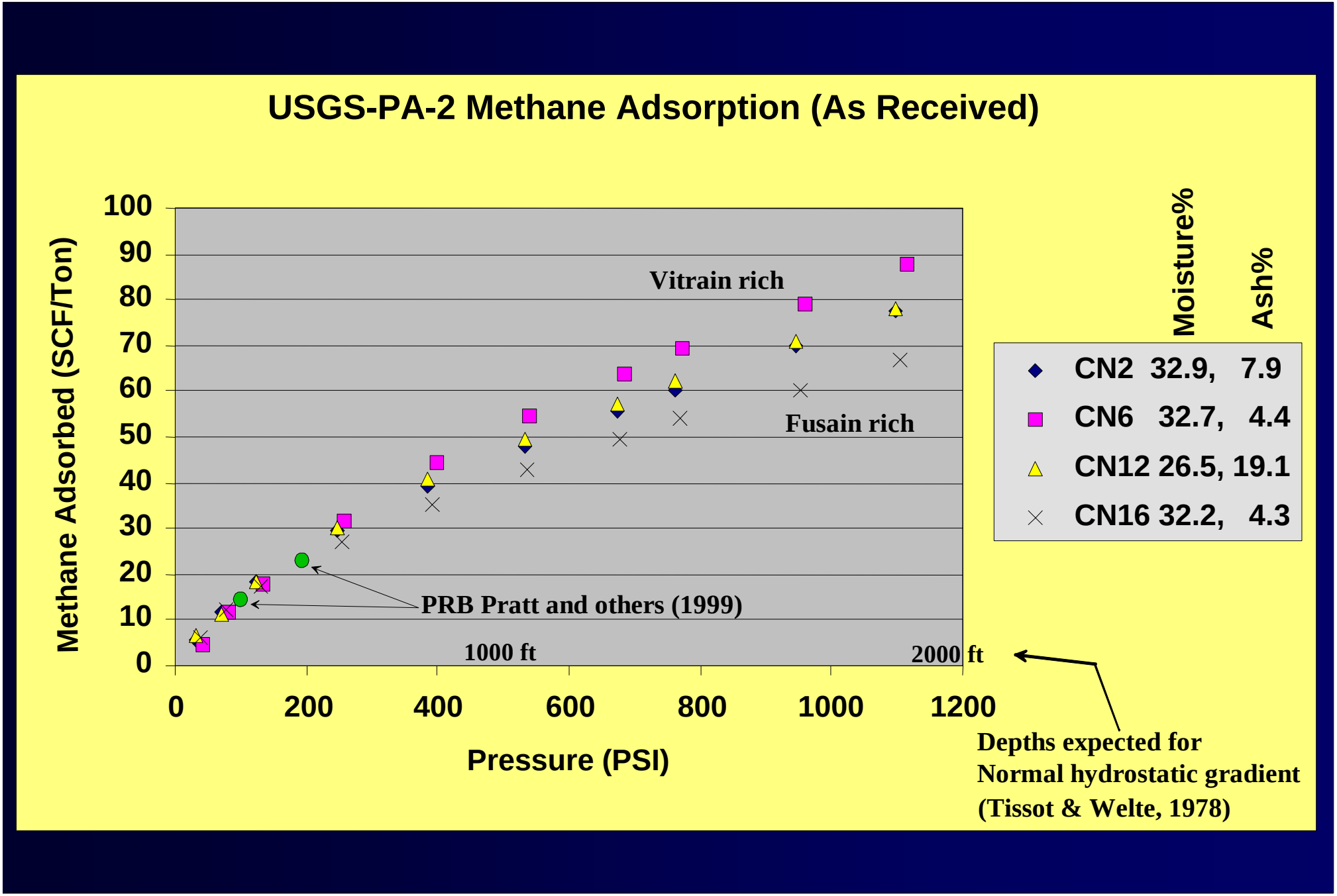


Figure 25. Plot of methane adsorption potential (as-received basis) for four samples from USGS-PA-2. The difference in adsorption potential may be associated with sample organic composition. Examination of sample CN16 in hand sample indicates it is fusain rich, and sample CN6 is vitrain rich. Expected depths are plotted above the corresponding pressures as derived from a normal hydrostatic gradient (from Tissot and Welte, 1978). Published adsorption values for Powder River basin (PRB) coals are plotted for comparison (green dots, data from Pratt and others, 1999). Sample number approximately indicates the depth in feet from the top of the coal.

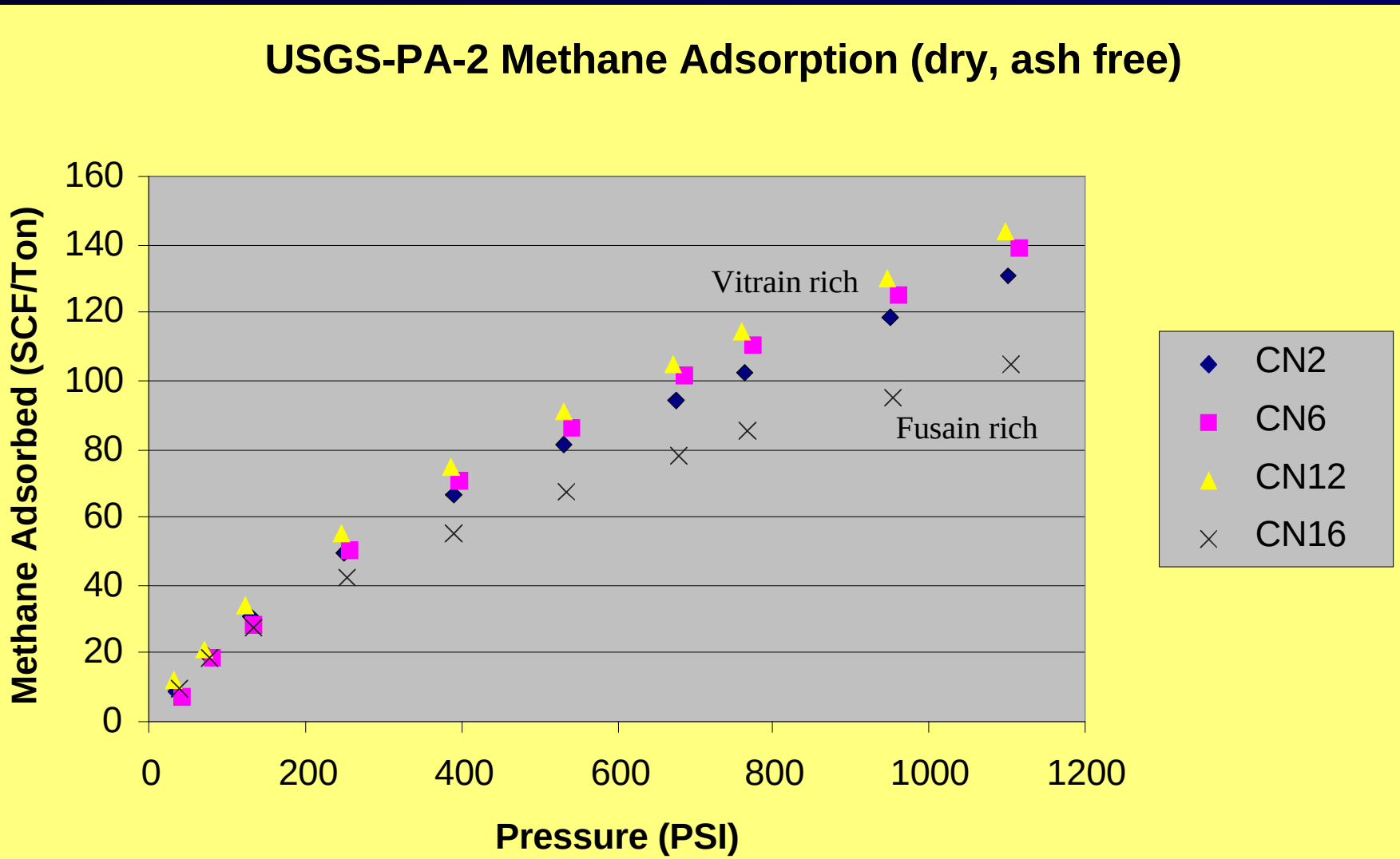


Figure 26. Plot of methane adsorption potential (dry, ash free basis) for four samples from USGS-PA-2 (same samples as shown on figure 25). Note that on a dry basis CN16 (fusain rich) and CN6 (vitrain rich) still diverge. Also note the effect of removing ash and moisture on the range of gas adsorbed. The grouping of samples CN2, CN6, and CN12 probably indicates that have these samples have similar organic compositions.

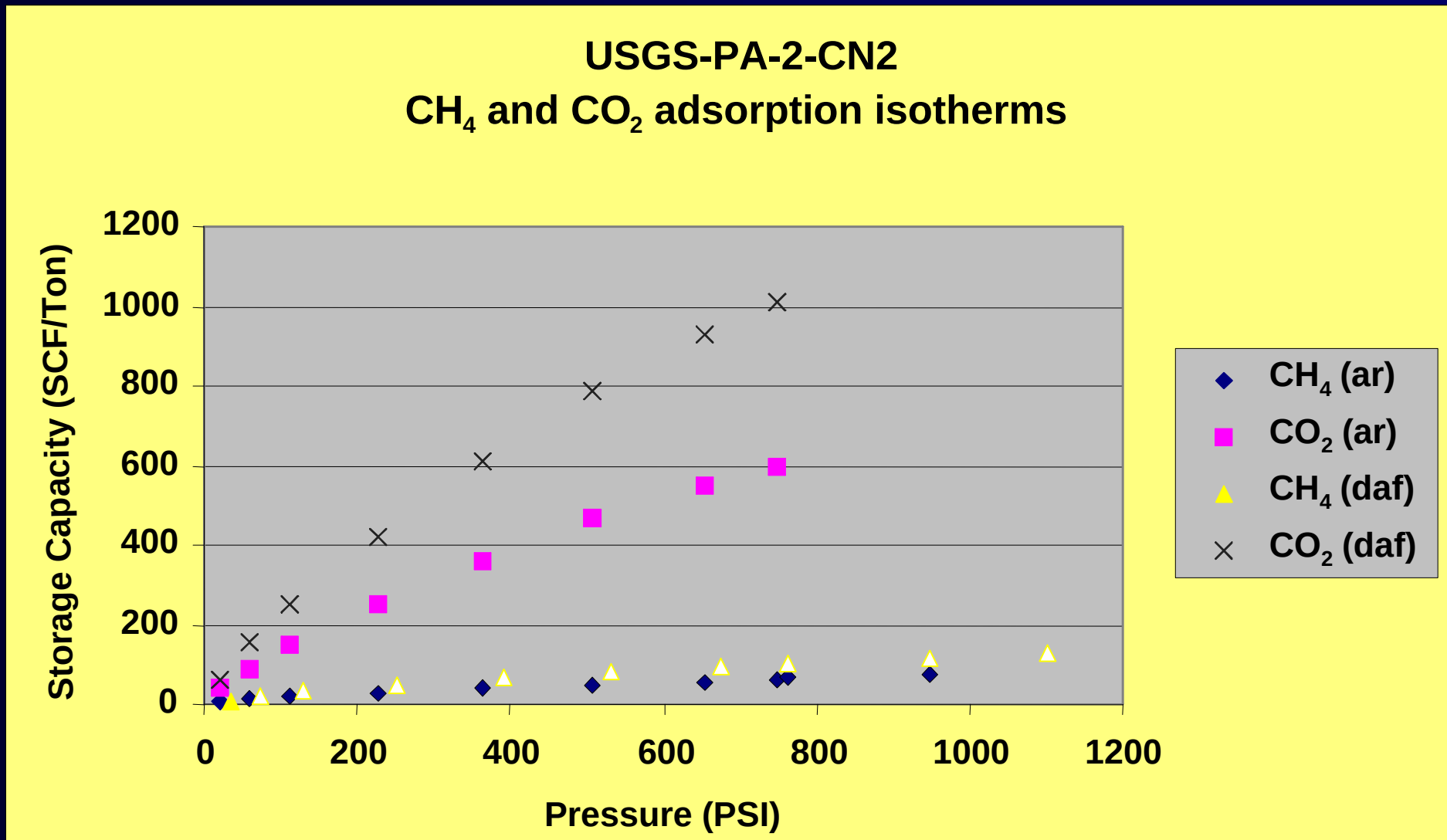
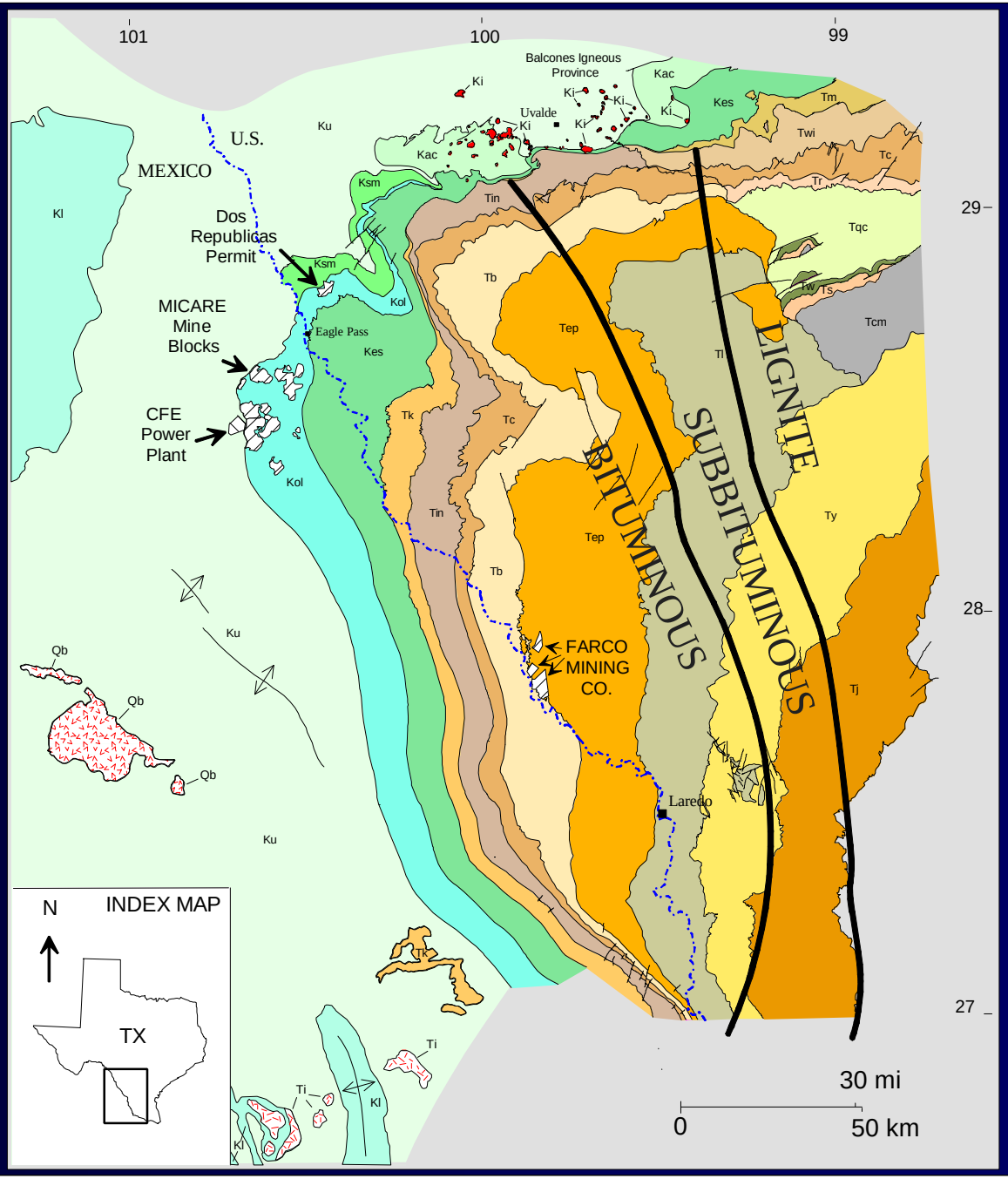


Figure 27. Comparison of methane and CO_2 adsorption isotherms on as-received (ar) and dry, ash-free (daf) basis for sample CN2. CO_2 adsorption characteristics are important for determining the CO_2 storage capacity for the coal.

Geology & Rank map of South Texas



(SanFilipo, 1999)

Figure 28. Geologic map lower Tertiary and Upper Cretaceous rocks in South Texas showing generalized rank boundaries. For explanation of map units see SanFilipo (1999). This area is currently undergoing exploration for coal bed gas. Note the anomalous increase in rank toward the southwest.

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Conclusions

- USGS-PA-1 and shallow (<150 ft) Wilcox coals had only traces of gas
- USGS-PA-2 had a show of gas (about 7 (ar) or 11 (daf) scf/ton)
- Isotopic signatures indicate the gas was generated in the transition zone between biogenic and thermogenic realms consistent with the approximate subbituminous rank of the coal
- Detailed coring and desorption/adsorption studies are needed to characterize the CBM production and CO_2 storage potential for the Gulf Coastal Plain Province
- Our data suggest that deeper Gulf Coastal Plain Wilcox and Upper Cretaceous coal beds warrant testing for commercial CBM accumulations

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Figure 29. Conclusions.

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Figure 30. References.