PALEOECOLOGY AND POROSITY TRENDS OF ABNORMALLY HIGH PRESSURED SANDS AND SHALES

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ABSTRACT

Paleoecology provides a practical basis for predicting the occurrence of abnormally high pressures in the subsurface of the south Texas and Louisiana Gulf Coast. By comparing detailed logs (Figs. 1 and 2) showing the biostratigraphy and paleoecology (including frequency distribution of microfossils) with seismic data and wireline logs, drilling programs can be evaluated and drill-site sample examination can be planned to reduce problems associated with unexpected penetration of abnormally high pressured sandstones and shale.

In the Gulf Coast region the depositional environment often associated with abnormally high formation pressure in wellbores is one of continuous sedimentation of a *deltaic* sequence (Fig. 3); no major erosional unconformities interupt the depositional sequence. Such deposits, generally encountered down-dip, consist of interbedded brackish- and shallow-marine strata indicative of deposition in inner-to-middle neritic depths of water. In the Rio Grande area, formations of Paleocene and Early Eocene age have abnormally high formation pressures also related to sandstones, interpreted as *offshore bars,* as well as deltaic deposits, (Figs. 4 and 5).

Shale diapirs occur commonly in upper Eocene and younger formations but are rare to absent in Paleocene and lower Eocene beds. These structures, always abnormally high pressured, consist of deeper marine, outer neritic to bathyal shales.

An abrupt regressive sedimentary cycle occurs frequently above high-pressure zones, but the paleocological evidence for this may be so subtle as to be difficult to detect. The sandstones and shales of this study have no apparent surface communication, and the high-pressured facies seemingly preserved the porosity of the enclosed strata. Porosity trend plots from acoustical and core data indicate an "arrested" compaction of sands and shales (Figs. 6 and 7). The general compaction trend of reduced porosity with depth of burial seems to be reversed in abnormally high-pressured facies.

Increase in the contacts between quartz grains and pressure solution along the contacts were observed (Figs. 8 and 9) in the high-pressure zones. The increased grain contacts are cyclic in occurrence and seem to be related to alternating paleoecologic cycles.

Paleoecology and abnormally high pressures may play a more important role in the understanding of sandstone diagenesis than has previously been recognized.

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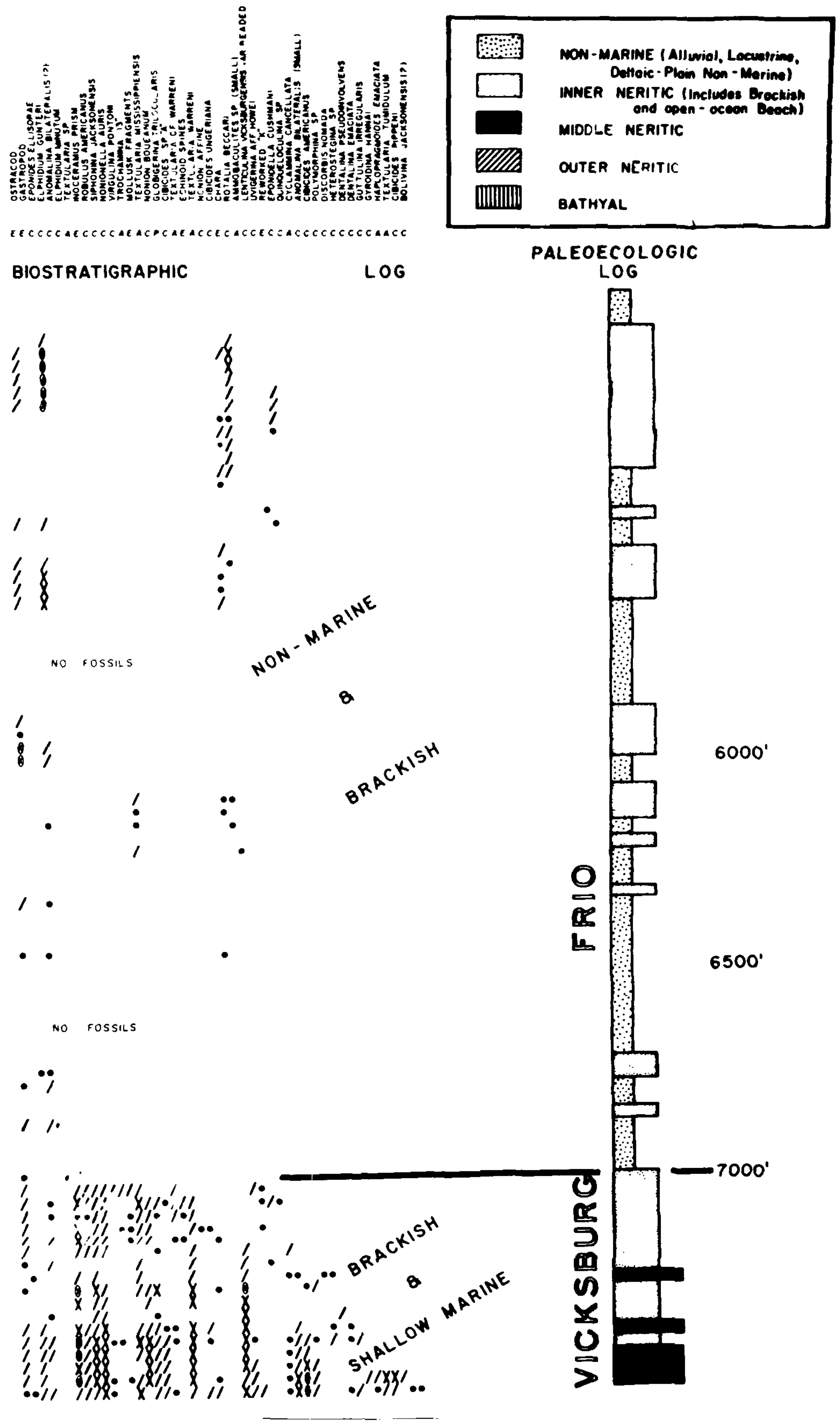

FIGURE 1 — A Biostratigraphic Log and Paleoecology Log of the subsurface Oligocene in Refugio County, Texas.

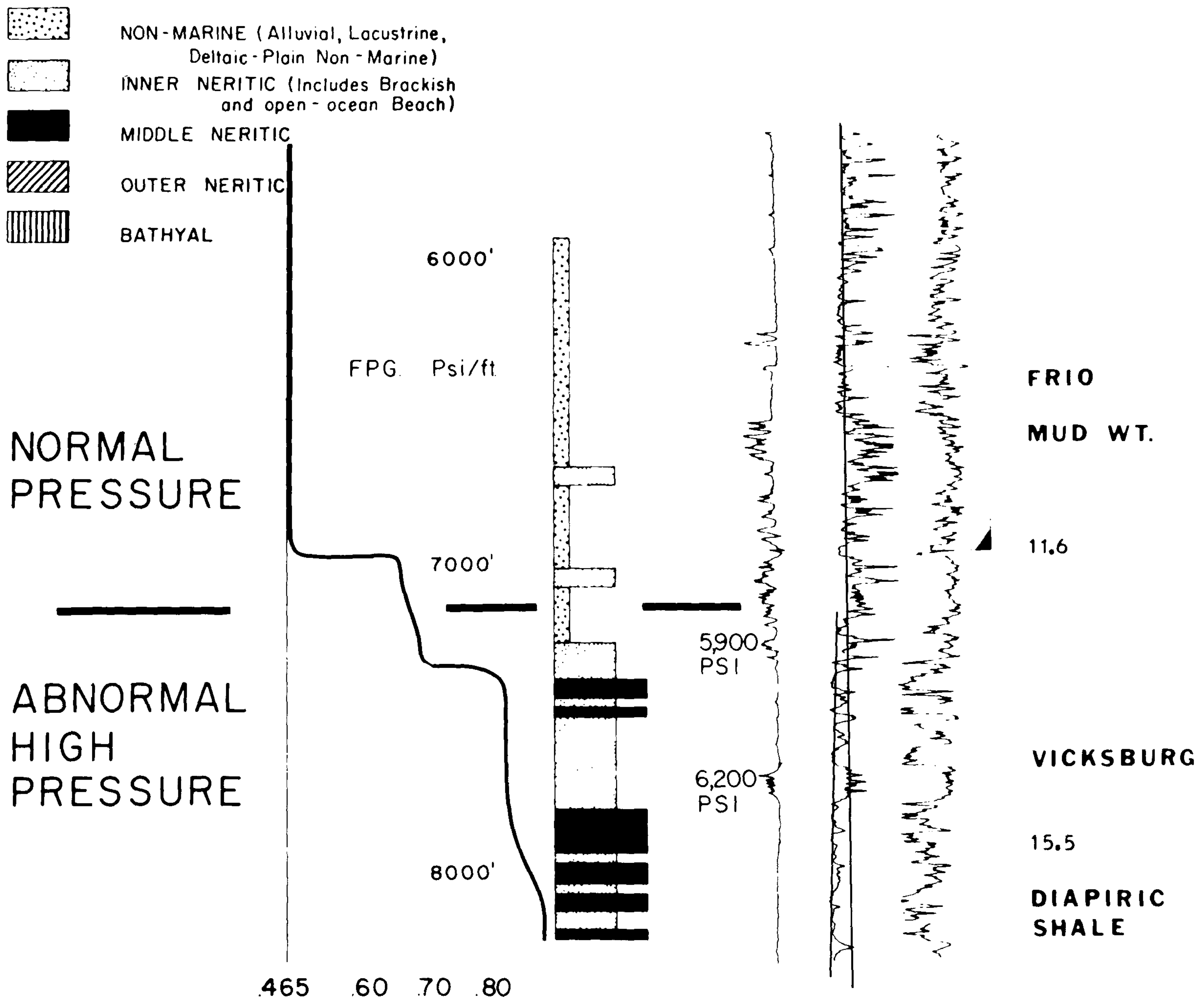

FIGURE 2 — Paleoecologic Log and I.E.S. Log with shale resistivity "Trend" line with the estimated Fluid pressure gradient curve (FPG); subsurface Oligocene, Nueces County, Texas.

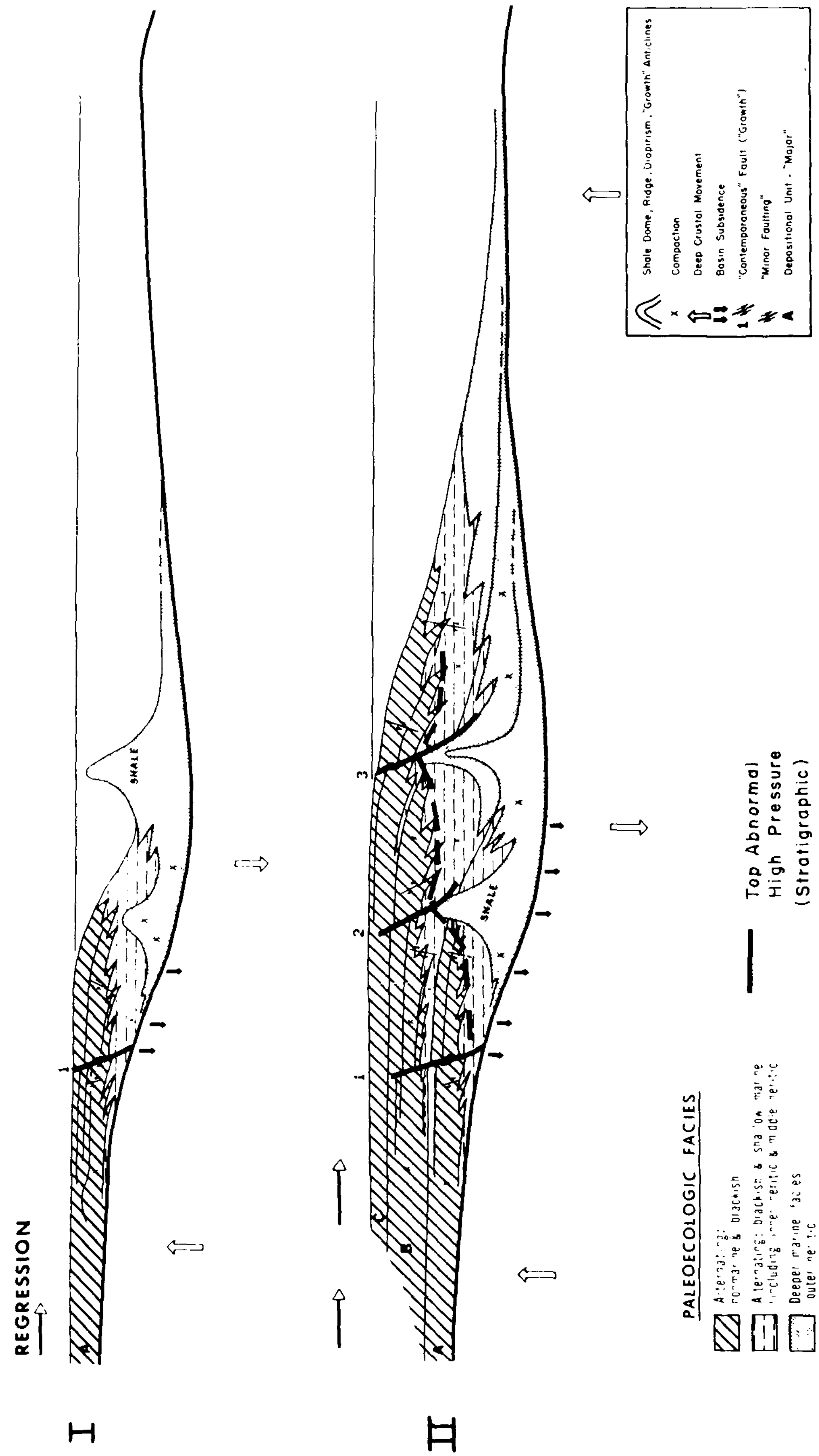

FIGURE 3 — Depositional scheme for prograding sedimentation (mainly deltaic) showing general position on top of abnormal high-pressure zone.

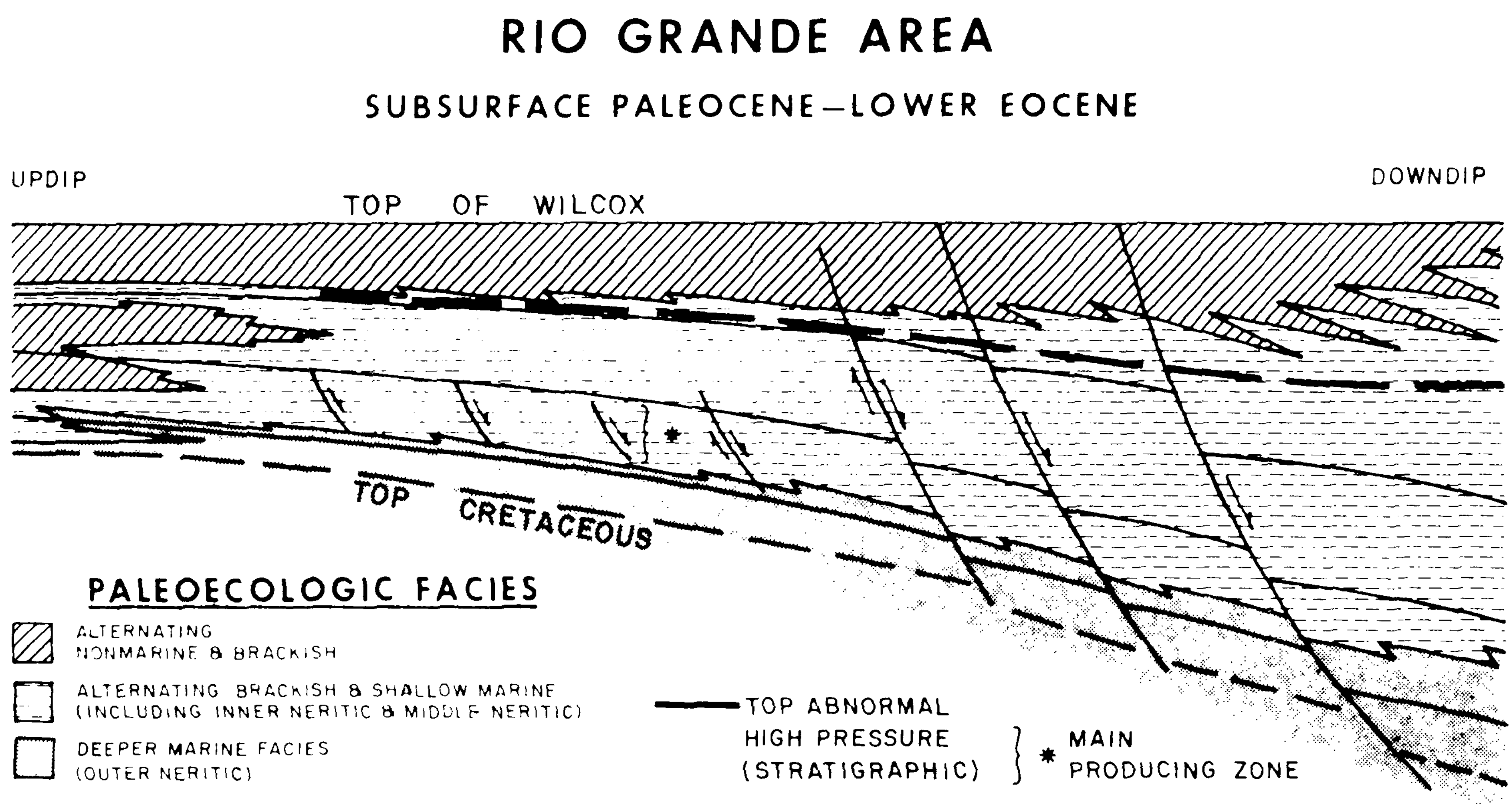

FIGURE 4 — Generalized paleoecologic setting of subsurface Paleocene-Lower Eocene Wilcox formation, Rio Grande Area. Cross section scheme datum is the top of Wilcox. *Note main producing zone.* (See Figure 5 for detailed view of Bar sands.)

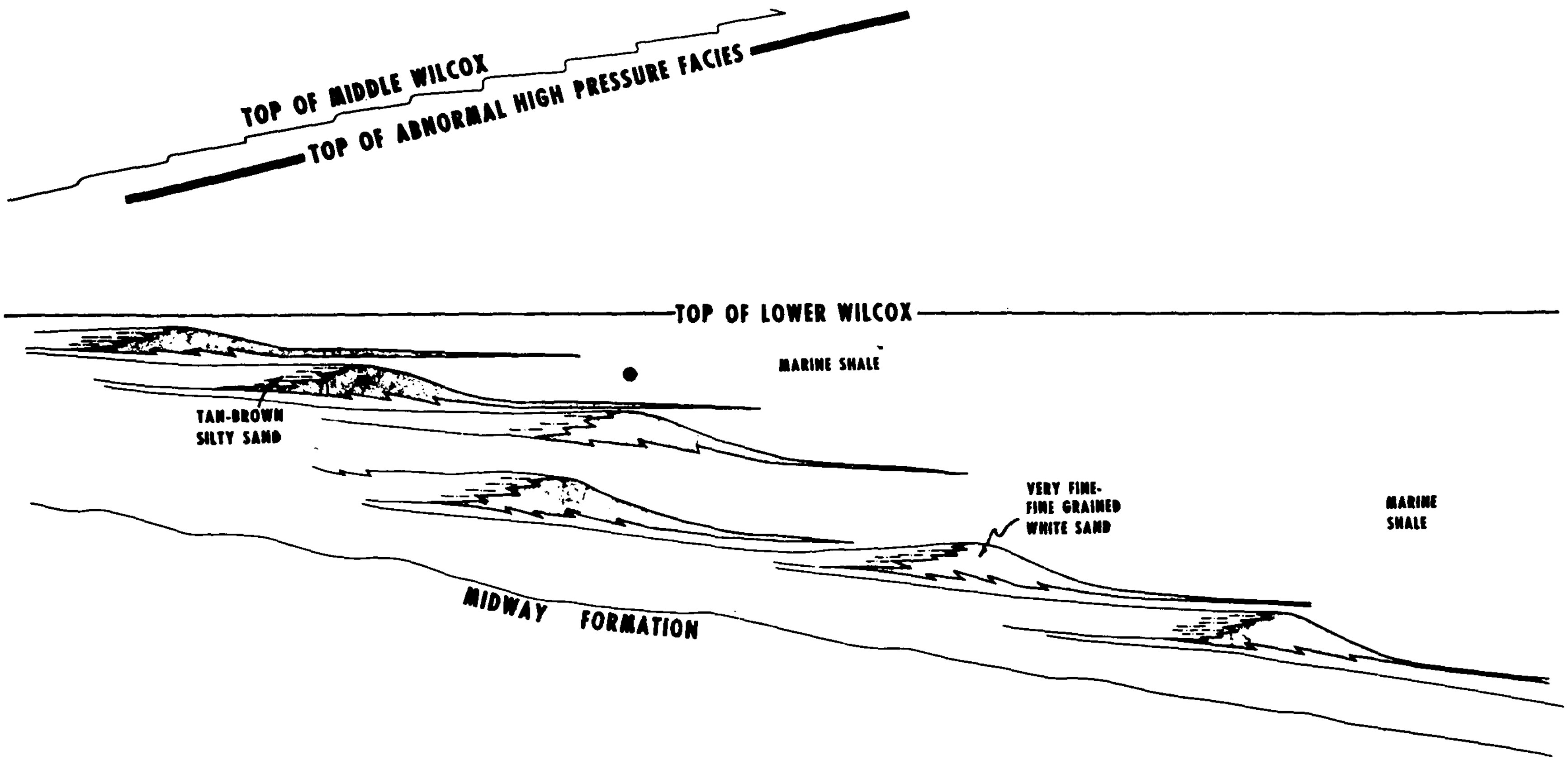

FIGURE 5 — Bar sands of the subsurface Wilcox formation in the Rio Grande Area of South Texas, within the main producing zone (See Figure 4).

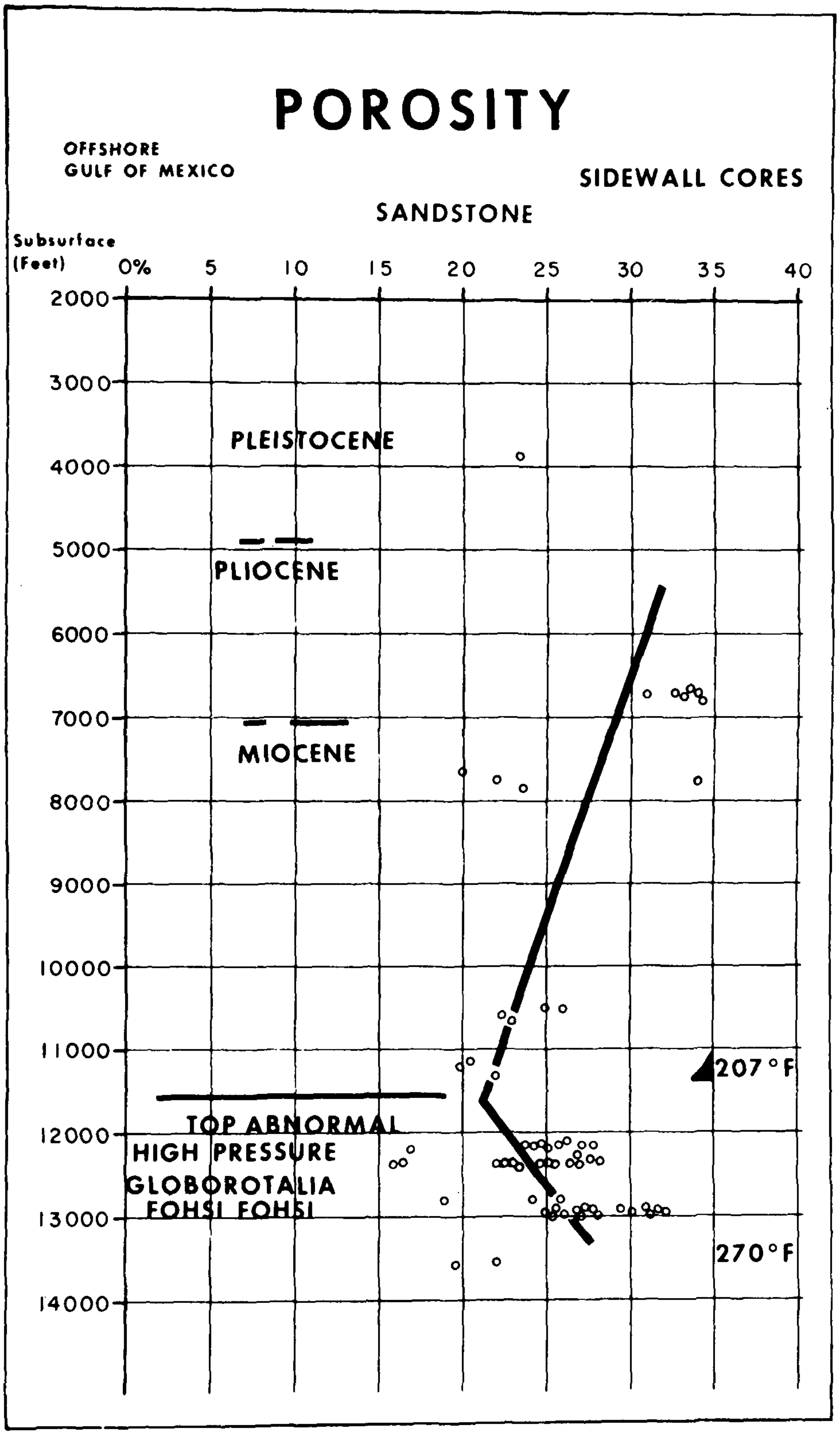

FIGURE 6 — Porosity of sands (from sidewall cores) of an offshore Gulf of Mexico wellbore. Note the porosity values in the abnormal high-pressure zone compared to the normal pressure zones.

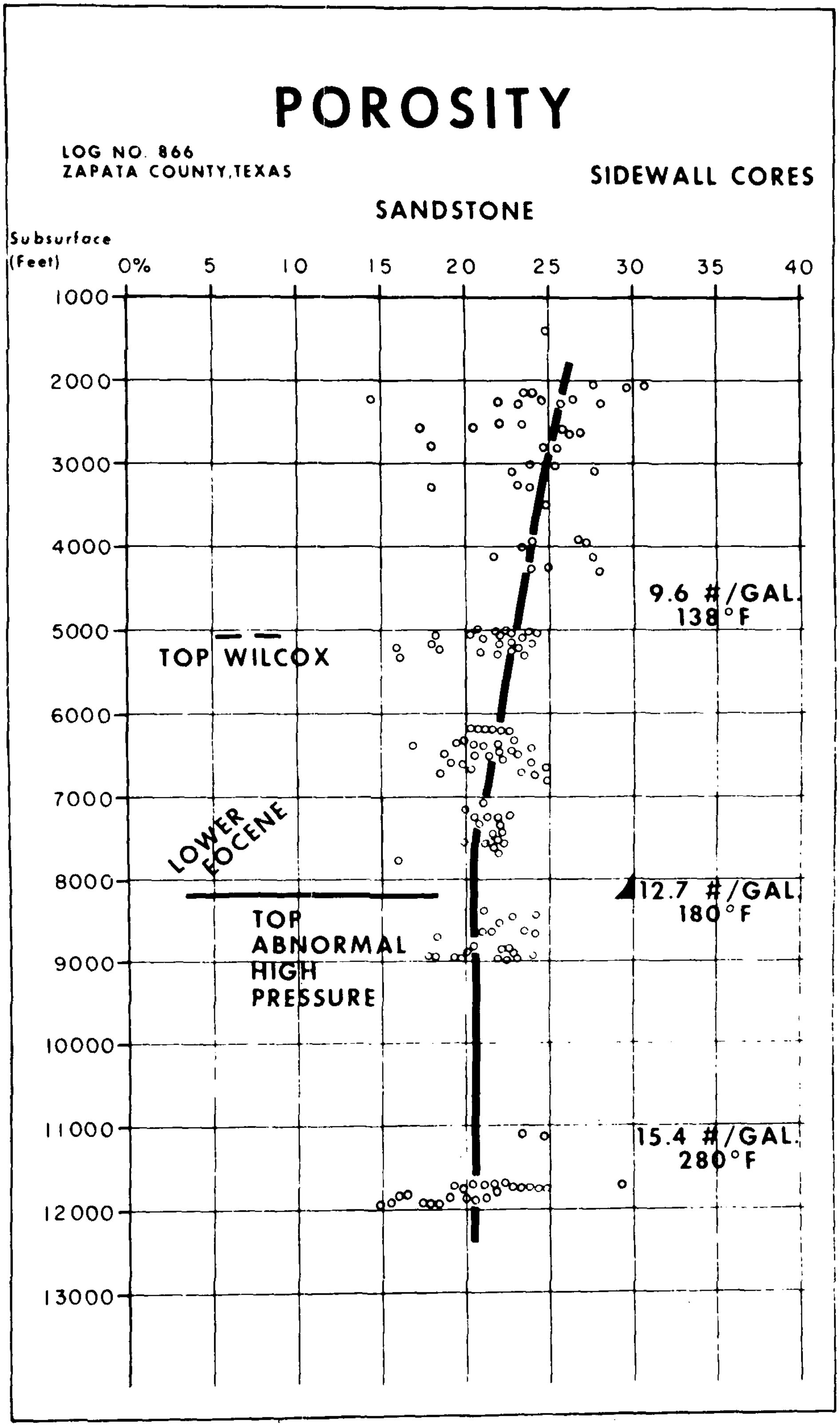

FIGURE 7 — Porosity of sands (from sidewall cores) of a wellbore in Zapata County, Texas. Note the values of porosity in the abnormal high-pressure zone and the departure of these values from the "trend."

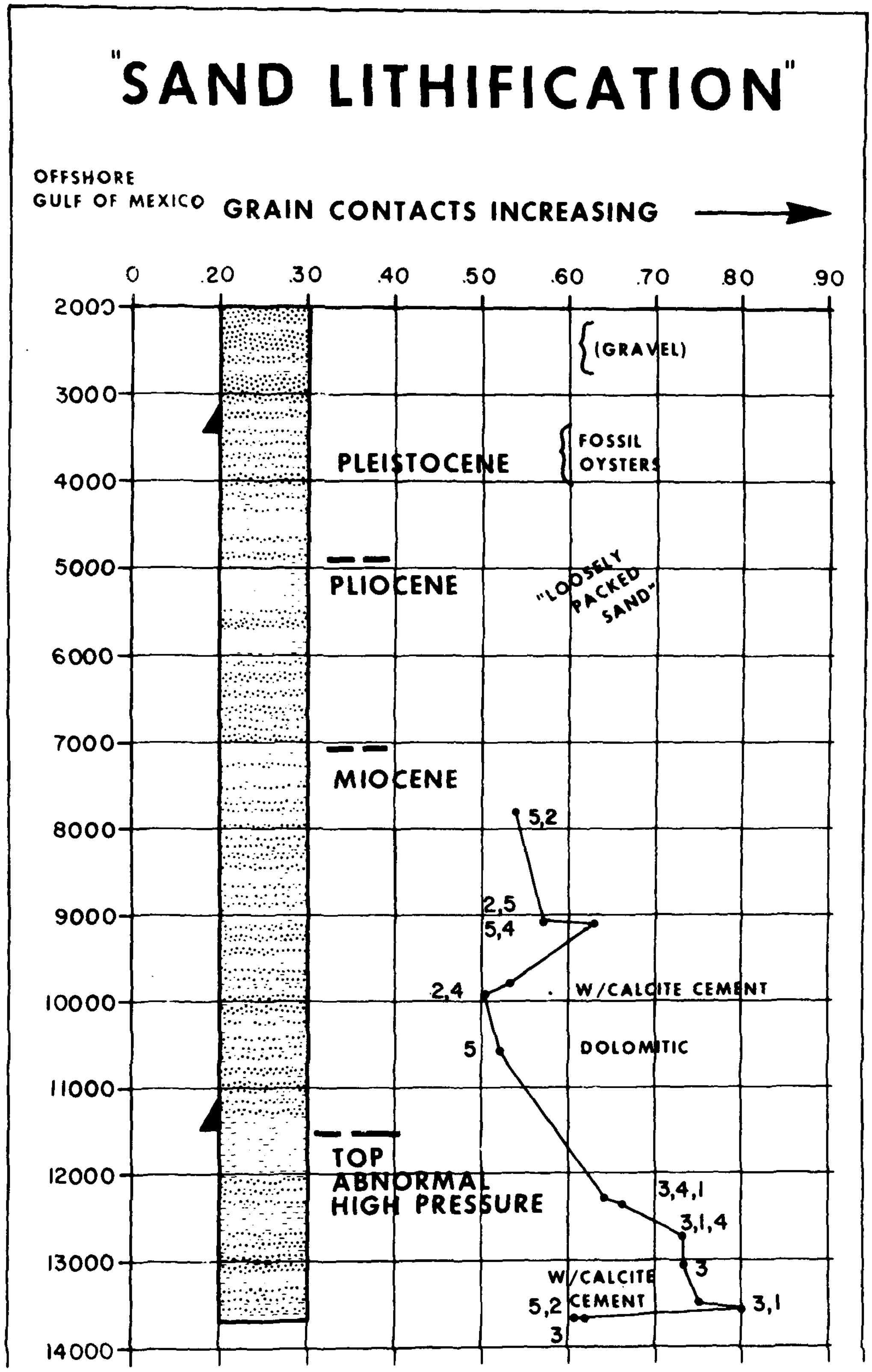

FIGURE 8 — Sand lithification plot prepared from petrographic thin sections of subsurface sands offshore Gulf of Mexico.

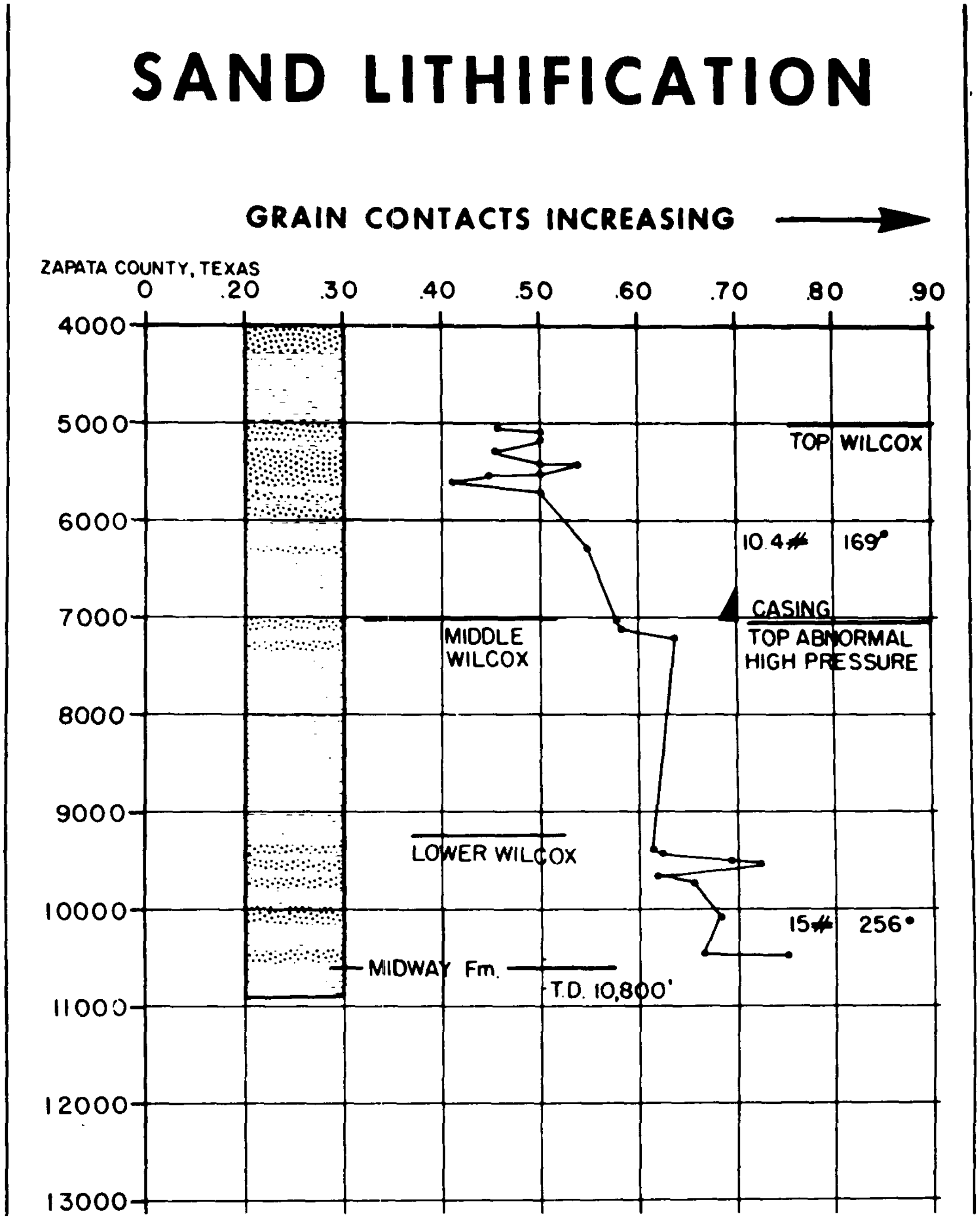

FIGURE 9 — Sand "Lithification" Plot prepared from petrographic thin section of subsurface sands in the Laredo, Texas area.