

restricted to the Ponta Grossa Formation, a potential source rock unit.

The subsurface distribution, the character and the stratigraphic limits of this formation are not precisely known yet.

Paleontological studies of the macrofauna from this formation indicated an Early Devonian age. Previous palynological analysis has been exclusively based on chitinozoans, spores, and the acritarchs of the leiofusidae group and the *Maranhites* genera.

Other microplankton have not been considered.

This paper intends to fill this lack in the palynological record of the Devonian for the Parana basin.

For this paper a wide range of surface samples and core samples from eight wells drilled by PAULIPETRO (a CESP-IPT joint venture) have been studied.

Microplankton from the Devonian of the Parana basin never before described are presented here, together with their biostratigraphical and paleoecological implications. Intra-basinal and inter-basinal correlations are also made.

From a total of 60 species identified until now, twenty forms having well-defined stratigraphic ranges and broad (intercontinental) geographic representation are described herein. This assemblage is marked by the presence and diversity of the Subgroups Polygonomorphitae and Pteromorphitae. The Subgroup Acanthomorphitae is also well represented.

The Emsian-Frasnian age previously established for the Ponta Grossa Formation through other palynological studies is further confirmed by the paleomicroplankton evidence. Moreover, the chronostratigraphic limits of these sediments may now be refined even further. Thus, despite the presence of long-ranging forms, other species, such as *Triangulina alargada*, which is restricted to the Emsian in the "La Vid" Formation in northern Spain, allow a better chronostratigraphic subdivision of the Ponta Grossa Formation.

The microplankton assemblage is very similar to others known from the Maranhão basin, Brazil; the province of Leon, Spain; and Ghana, Africa.

The abundance of forms of *Tasmanites* together with a large quantity and diversity of microplankton provides the basis for the paleoecologic interpretations.

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Effects of Depositional and Diagenetic History Upon the Reservoir Properties of Parkman Sandstone, Powder River Basin, Wyoming

The depositional system within which the Upper Cretaceous "Parkman Formation" (= Parkman Sandstone Member of the Mesaverde Formation) of the Wyoming part of the Powder River basin was formed, was delineated using a combination of outcrop data, subsurface core data, and geophysical well logs. The post-depositional history of these rocks was determined, semi-quantitative compositional analyses of authigenic components were made, and paragenetic sequences were established with the aid of scanning electron and transmission electron microscopy.

The Parkman Formation in the study area is composed of a progradational deltaic complex of interstratified sandstone, siltstone, and shale that overlies the extensive marine shelf deposits of the Steele Shale. Four distinct units within the Parkman have been delineated: (1) interbedded shale, siltstone, and very fine grained, well-sorted sandstone, which were deposited in prodeltaic environments; (2) coarsening-upward sequences of sandstone with lenticular siltstone beds and some shale interbeds, which were deposited in distributary mouth-delta front environ-

ments; (3) fine-grained, moderately sorted, horizontal to cross-bedded sandstones deposited in beach environments; and (4) dark lignitic shales, carbonaceous siltstones, and fining-upward sandstone sequences deposited in floodplain, swamp, and distributary channel environments.

The timing and intensities of diagenetic alterations have profound effects upon reservoir properties of the Parkman Sandstone in the Wyoming part of the Powder River basin. In the subsurface samples, major authigenic minerals observed in the Parkman Sandstone are clay minerals (chlorite, illite, montmorillonite, kaolinite), quartz, feldspar, calcite, dolomite, and iron-oxides, whereas in the surface samples there was no authigenic chlorite and only rare quartz overgrowths, but rather more kaolinite, calcite, and iron-oxide.

The generalized diagenetic sequence can be summarized as follows: (1) ductile grain deformation and original porosity reduction due to settling and mechanical compaction; (2) authigenic chlorite formation as grain coatings or pore linings; (3) authigenic quartz overgrowths from dissolution of silica grains, and clay diagenesis, as well as pressure solution; (4) authigenic feldspar overgrowths; (5) minor authigenic mineral deformation due to continued mechanical compaction; (6) authigenic feldspar alterations to clay minerals; (7) calcite cementation; (8) dolomitization; (9) calcite replacement of siliciclastic grains; and (10) iron-oxide development.

All of the authigenic minerals in the Parkman Sandstone, where they are abundant, reduce the effective primary porosity and permeability of potential reservoir sandstones prior to petroleum generation, migration, and accumulation. In the subsurface samples where authigenic chlorite occurs, the pore space was reduced by 5 to 10  $\mu$ . However, where chlorite is thin or absent, quartz overgrowths tend to grow larger to a maximum crystal diameter of 30 to 40  $\mu$ , filling most of the pore space. Therefore chlorite coatings actually prevent the porosity from being completely destroyed with quartz overgrowths. In surface samples, chlorite coatings have not been observed, but late-stage calcite cement replaced most of the siliciclastics and, along with iron-oxide cements, further reduced porosity and permeability.

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Experimental Low-Altitude Aeromagnetic Reconnaissance for Petroleum in Arctic National Wildlife Refuge, Alaska, Using Horizontal Gradients—A Progress Report

Variations in the earth's magnetic field arising from areally restricted increased amounts of shallow-buried magnetite over hydrocarbon deposits have been mapped in the Arctic National Wildlife Refuge and elsewhere in northern Alaska. The anomalies have been delineated with a low-flying (90 m; 295 ft) magnetic horizontal gradiometer mounted on a fixed-wing airplane. Limited data from stable carbon isotope and remanent magnetism measurements of rock cores from the Cape Simpson region strongly suggest that the magnetic anomalies result from the chemical reduction of iron oxides in the presence of seeping hydrocarbons. Relatively large magnetic contrast between typical sedimentary rocks and those locally enriched with this epigenetic magnetite results in distinctive high wave-number and low-amplitude total field anomalies. Magnetometers extended from each wingtip and in a tail stinger permit calculation of the resultant horizontal gradient vector relative to the flight path. This calculation provides data for the unmeasured area between adjacent flight lines spaced at 1.5 km (.9 mi), thereby allowing