tional-based cross-laminated sandstone increases in abundance upward.

Unit 6 (47 m) contains gradational-based cross-laminated sandstone, irregularly interbedded with gray mudstone and cross-laminated siltstone. The sandstone beds become thicker and more abundant upward.

Unit 7 is a channel cut into the top of unit 6. The minimum depth is 15 m, and minimum width 100 m. The lower 5 m of fill consists of graded siltstone-turbidite, and the upper part is identical with unit 6.

Unit 8 (15 m) consists of trough-cross-bedded and cross-laminated coarse sandstone, with few thin mudstone beds. The sandstone is of nearshore, possibly estuarine, origin.

The whole sequence indicates gradual basin filling. The turbidite-filled channel near the top is cut into "shelf-type" sediments, and probably acted as a passage for turbidity currents flowing farther into the basin. There is no evidence of slumping in the cyclothem, and the turbidity currents probably originated directly from rivers carrying at flood stage a high proportion of silt and mud in suspension into the basin.

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Distribution of Glauconite-Boron Association in Continental-Shelf Sediments

Glauconite occurs in the sediments from an area on the continental shelf off the Washington-Oregon coast. The mineral is forming apparently at the present time, although some of it may be derived from Tertiary sedimentary rocks exposed on the shelf.

The glauconite-rich sediment shows a linear correlation with boron, which averages 223 ppm. Boron and potassium indicate that the mineral is a mixed-layer montmorillonite-illite. The chemical composition of the sediment is nearly the same as that reported by other investigators for glauconite-rich sediment and sedimentary rocks.

Petrographic evidence indicates several modes of origin for the glauconite including the glauconitization of specific minerals, lithic fragments, fecal pellets, and clay material within shells.

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Shale Chemistry as an Environment Indicator

Approximately 1,000 shale samples were analyzed by X-ray-fluorescence spectrography for the elements Na, Mg, Al, Si, K, Ca, Fe, Rb, and Sr. Three quarters of the samples came from two completely cored sections of mainly Upper Cretaceous shale in eastern and central Saskatchewan; most of the remainder came from cored Jurassic and Triassic sections in western Queensland, Australia. Preliminary results indicate that diadochic substitution of minor elements in the clay minerals is controlled by the chemistry of the waters in which the clays were deposited. The Rb/K ratio in particular appears to be significantly higher for marine shale than for continental shale.

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Palynological Stratigraphy and Succession of Oklahoma Pennsylvanian Coal Seams

Palynomorphs occur abundantly in Pennsylvanian coals of Oklahoma and are usable as stratigraphic indices and indicators of ecological conditions which existed in the coal swamps during their accumulation. Climatic conditions during Pennsylvanian time in Oklahoma appear from several lines of evidence to have been remarkably uniform but certain genera and species of palynomorphs have restricted stratigraphic ranges which appear not to have been entirely ecologically controlled. Certain genera, *Knoxisporites, Densosporites, Savitrisporites*, and others, are more abundant in the Upper Mississippian strata than in Pennsylvanian and do not extend higher than the Morrow or Des Moines Series. The Missouri and Virgil Series are characterized by genera and species of saccate palynomorphs. Certain specific coals are characterized by suites of fossils, by paleoecological assemblages, and/or by stages of palynomorph succession. The last factor is based on at least three stages of palynomorph abundance which may be interpreted as representing stages in the paleoecological development of coal swamps. These successive abundance levels as high as the Mineral coal in the Des Moines Series are (1) *Laevigatosporites-Lycospora*, (2) *Calamospora-Florinites-Endosporites*, and (3) *Densosporites*. Above the Mineral coal the *Densosporites* stage is absent or is replaced by a stage dominated by saccate genera. In the Missouri and Virgil Series *Lycospora* is absent and *Laevigatosporites* commonly represents the first stage of palynological succession. All areal parts of most coal seams do not contain the complete series of stages or abundance of specific assemblages. There is evidence that this variation is a function of geographic distribution of the particular coal seam and its geomorphic development. When factors of succession are combined with stratigraphic ranges of palynomorphs, greater knowledge of Pennsylvanian coal-swamp ecology is attainable.

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Lacq Gas Field, France

The Lacq gas field, France's most important, was discovered in 1951 by geophysical methods. The field is just north of the major overthrust separating the southern edge of the Aquitaine basin from the Nord Pyrenees foredeep. Directly under the field is a paleo-high flanked by two strongly subsided basins: the Arzacq basin on the north and Upper Cretaceous flysch trough on the south.

The gas is trapped in a roughly elliptical anticlinal structure in which differential subsidence has played the major role.

The gas has a 15.4 percent H_2S content and occurs under strong pressure (9,700 psi at 13,200 ft) in uppermost Jurassic dolomitic strata, Purbeckian-Wealdian sandstone, and Neocomian limestone and dolomite.

Reservoirs characteristics of these rocks are poor (5 percent porosity; 0.1 md permeability at best) and production is possible only because of intense fracturing on the upper part of the structure.

Production of the field is presently 700 MMcf per day of raw gas and in place reserves are evaluated at 8.8 trillion cu ft.