deposits in the surrounding basins. The great carbonate development of this interval extends into the area from the south and east and is of comparable magnitude. Within the clastic part of the basin the few wells penetrating this section have encountered well developed local sand and arkose deposits. The facies relationships here are the same as those in the Midland basin, with carbonate deposits averaging 800–1,200 feet thick and clastics ranging from 2,000 to 3,000 feet.

Pre-Pennsylvanian stratigraphy for the basinal area is comparatively simple. There is a basal sand of possible Cambrian age locally developed on the pre-Cambrian basement surface. In southeast Swisher County in the heart of the basin it reaches a thickness in excess of 200 feet. Here, it is a fine to coarse, porous sand, glauconitic in part. Above this the Ellenburger dolomite extends into the area from the east and southwest but is missing due to either erosion or non-deposition over the wide central part of the area along the axis of John E. Adam's "Texas Peninsula." From this Ellenburger remnant to Mississippian time there are no deposits present. The Mississippian consists of approximately 600 feet of carbonates near the south limits of the basin, thinning as it approaches an erosional edge along the south margin of the Amarillo Mountain structure. The relationship of the Osage, Meramec, and Chester shows that these rocks were eroded by early Pennsylvanian orogeny.

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Pennsylvanian of McAlester Basin, and Its Platform

The McAlester basin was a geosynclinal trough through the Atokan and Desmoinesian epochs. Later history is obscure and the trough seems not to have been geosynclinal. There was a narrow platform area in the Atokan, a moderate one in early Desmoinesian, and an extremely broad and stable platform during the remainder of Desmoinesian time. A few of the outstanding characteristics are the following.

Atoka basinal sediments are shallow-water, fine-grained clastics, with little preserved fossil life, virtually no coal, and rapid changes in grain size and thickness.

Atoka platform sediments are rich in carbonates, occur in a belt less than 100 miles wide, and reach maximum thickness of 350 feet.

Des Moines basinal sediments were deposited in swamps and in shallow marine water. Unlike those of some basinal sequences, the units have great continuity and relatively small lateral change in thickness and grain size.

Des Moines platform sediments are cyclical and have remarkable continuity of units, excepting most sandstones. Many of the coal beds and such thin units as the Doneley limestone, Tiawah limestone, and Verdigris limestone can be traced over much of the platform and some can be recognized far into the basinal area.

During the Upper Pennsylvanian the basin was only weakly geosynclinal, and its history is that of a dying paleogeographic element.

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Regional Stratigraphy and History of Ouachita Mountain Area

C. W. Tomlinson and the writer began a cooperative study of the Stanley-Jackfork-Johns Valley-Atoka stratigraphic sequence in the Ouachita province of southeastern Oklahoma in June, 1953. Although the work is still in progress, it is advanced enough to permit some conclusions.

Several members of the Stanley-Jackfork succession, which Harlton differentiated and named in Wildhorse Mountain and Prairie Mountain in the western Ouachitas, persist as far east as the Arkansas-Oklahoma line. Their recognition on the outcrop and on air photographs has made possible the differentiation of a large area of Atoka, and perhaps younger rocks, in a belt in the Kiamichi Range which has been mapped as Jackfork on the recent Oklahoma geologic map. Two unfaulted stratigraphic sections, showing the upper Stanley, a complete Jackfork sequence, and several thousand feet of overlying Atoka, have been discovered in the Kiamichi Range and have been described in detail. The Jackfork sandstone totals only 5,600 feet in the Kiamichi Range, which is considerably less than thicknesses ordinarily assigned to it. Work in the western Ouachitas has revealed that the lower part of the type Prairie Mountain formation, including the Prairie Hollow maroon shale, is equivalent to the upper part of the underlying Wildhorse Mountain formation at the type locality, and recognition of this duplication also reduces considerably the thickness assigned to the Jackfork in the western Ouachitas.

Several new occurrences of boulder-bearing Johns Valley shale are noted. In each outcrop the Johns Valley lies above a fossiliferous sandstone formerly included in the Jackfork, but correlated by Harlton with the Union Valley sandstone of the Arbuckle facies, and below another fossiliferous sandstone which was mapped as basal Atoka by Hendricks but which was correlated with the Barnett Hill by Harlton (Harlton regards the Barnett Hill as a split from the upper part of the Wapanucka or older reports). The boulder beds occupy persistent stratigraphic horizons within the Johns Valley and, whereas they contain numerous boulders foreign to the Ouachita province, they are indigeneous to the containing beds. Many of the rock fragments show evidence of profound chemical weathering prior to transportation and deposition, and they could hardly have been part of a friction carpet along a thrust sheet. The tentative conclusion is reached that the so-called Mississippi Caney boulders of the Johns Valley shale in Johns Valley are not erratics but are sideritic concretions which are in place in the lower part of the Johns Valley. A similar conclusion is reached concerning the "Caney boulders" at the bend in the Hairpin Curve on Oklahoma Highway No. 2 south of Wilburton. The logical conclusion is that the Jackfork sandstone must be Mississippian or older. This correlation of the lower part of the Johns Valley with the Mississippi Caney is based on the presence of the cephalopods *Cravenoceras choctawensis* and *Actinoceras* (*Rayonnoceras*) *vaughianum*, and the presence of abundant representatives of the pelecypod *Caneyella*, and on similar lithologic features.

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Geology of Keyes Field, Cimarron County, Oklahoma

The development of the Keyes field as a major gas reservoir in the lower Morrow sand has done much toward instigating the current wildcat play throughout the Hugoton Embayment, and Dalhart and Anadarko basins. This field, although discovered in 1943 by the Pure Oil Company, produced gas with a low 825 BTU, and development stagnated until a subsequent Coltexo discovery of high BTU gas in the upper Morrow (Purdy sand) incited major companies to exploit their leases. The exploitation of the Purdy sand for high BTU gas failed to develop substantial reserves; however, it did succeed in delineating the Keyes sand, although low BTU gas, as a major gas field.

The Keyes is considered to be a blanket clastic sand of Lower Pennsylvanian age, deposited on an erosional surface of late Mississippian time. Pre-Pennsylvanian structure and some later rejuvenation apparently are responsible for the accumulation, with porosity and permeability controlling local production. Stratigraphic conditions vary markedly throughout the columnar section, indicating numerous alternating shallow marine and continental environments of sedimentation. These abrupt facies changes may offer additional zones of production.

Though the Keyes sand is the major producer in the field, the Purdy (upper Morrow) and the Cherokee (lower Des Moines) have been proved for production in parts of the field.

To date, 107 wells have been completed in the Keyes sand, having a calculated reserve of 514,120,000,000 cubic feet of gas.

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Superposed Geologic Data as an Exploration Tool

The successful seeker for new petroleum reserves must be guided by careful and detailed analysis of geologic conditions in areas of known petroleum accumulation. Superposition of stratigraphic and structural features on a single map facilitates interpretation and analysis of the complex geologic framework associated with the accumulation of petroleum.

Areas of petroleum accumulation, outlined by drilling, can be defined by a series of superposed geologic situations. The superposed factors that define an area of petroleum accumulation will vary as the geologic framework changes; hence, the factors to be superposed must be chosen only after careful consideration and experiment. Extension of the superposed components beyond the area of known accumulation may reveal favorable areas for future exploration.

Some areas of proved petroleum accumulation in Kansas, Utah, and New Mexico seem to be definable by superposed geologic data. Projection of these superposed components reveals areas that may be favorable for the accumulation of petroleum.

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Caney and Related Problems of Southern Oklahoma

Lithologic monotony and peculiarity of rarely encountered marine faunas are characteristic of the Caney shale facies of Oklahoma. Detailed study of the goniatites and the conodonts (by far the most common among its fossils), provide important paleontologic control for stratigraphic division of the Caney group, which is based on detailed field work and on the recognition of lithologically different kinds of shale within the Caney "shale."

The lowest formation of the Caney group is the Ahlosa, recognized in the northern Arbuckle Mountains by its hard, but not siliceous, platy shale, and rarely encountered diminutive brachiopods of Salem (Spergen) age.

Most widespread and most familiar to fossil collectors is the next formation, the Delaware Creek, with locally abundant goniatites of distinct late Visean (P2) aspect.

The third formation is known in the Ardmore basin as the Goddard shale, and contains the characteristic lower Namurian (E and E2) goniatites and some latest Chester (Kinkaid) conodonts. Recent field evidence indicates that here belong the subsurface Goodwin sandstones, and the bryozoan-brachipod-molluscan-bearing sandstones exposed north of Milo, where several species of *Archimedes* have been encountered.

The lower two-thirds of the Springer are not represented by any sediments in the northern