Sands do not correlate well between the wells, but individual coals and groups of coals make excellent correlations. Seismic processing experiments show that resolution of the data improves when high frequencies are retained; in fact, the lower Wilcox "wipe-out" zone disappears.

On the reprocessed seismic data, fairly uniform cycles appear whose boundaries correlate with slightly thicker coals or groups of coals on the well logs. The log interval of each seismic cycle is about 300 ft (90 mi) and includes three or four stacked point-bar sands. An individual point-bar sand, and hence the producing reservoir sand, cannot be resolved on seismic data. It is thought the seismic cycles represent meander-belt cycles, each containing several point-bar sands.

A reprocessed dip line shows that the seismic cycle which includes the producing sand pinches out between the discovery well and the two dry holes. More seismic is necessary to define the lateral limits.

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Upper Cretaceous Tempestites in Mancos and Mesaverde Formations—A Model for Shallow-Shelf Sandstone Reservoirs

The sedimentologic features that characterize the pinchout of Mesaverde Group sandstones into the Mancos Shale are spectacularly exposed along the Book Cliffs in east-central Utah. We traced the upper portion of the Blackhawk Formation of the Mesaverde Group as it graded into Mancos Shale, and observed textural trends and sedimentary structures which match those that are observed in modern tempestites formed on siliciclastic shelves. The upper-most portion of the Mancos consists of upward coarsening sequences of mudrocks that exhibit large-scale scour and fill structures and slump features. Above the Mancos, sandstone units of the Blackhawk Formation commonly display sole marks within partial Bouma sequences, and sandstone units higher in the section consist of hummocky cross-strata sets grading up to asymmetrical ripple sets. These units represent tempestites that were deposited by wave-modulated, wind-driven currents generated by storms as they crossed the mud-dominated western shelf of the Cretaceous seaway. Tempestite sequences can be traced up depositional dip into tongues of prograding shoreface sandstones.

The moving of large quantities of sand and silt-sized siliciclastics out onto mud-dominated shelf environments appears to be a major process along margins of epicontinental seaways. We believe that these movements are storm-generated, and that sands, which later became petroleum reservoirs, were placed in shelf settings in the form of tempestites. In particular, many petroleum-bearing Cretaceous sandstones in Wyoming, Colorado, and Utah that have previously been interpreted as either deltaic-coastal bars or "shallow-water turbidites," are actually tempestites.

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Seasonal Growth Rates and Carbonate Production in *Halimeda opuntia* at Marquesas Keys, Florida

Rates of growth and carbonate production of the calcifying green alga, *Halimeda opuntia,* were measured from July 1982 to September 1983 at the Marquesas Keys, 29 km (18 mi) west of Key West, Florida. Seasonal fluctuations in growth rate were determined by collecting and analyzing whole colonies of algae that had been previously stained in situ with Alizarin Red-S. Weight increase of individual plants was calculated by recording weights of various *H. opuntia* colonies harvested at different times during the year. Growth was strongly seasonal with 80–90% of new plates being produced in summer months (May through October). From November through April, colonies appear to be in a semidormant state generating little new growth. Surprisingly, more than 90% of the new plates produced by parent plants were the offspring of only a few (usually less than 50) "dominant" plates.

Measured growth rates appear sufficient to explain the 12 m (6.6 ft) thick, 6 km (4 mi) wide, 16 km (10 mi) long, crossbedded *Halimeda* accumulation located west of the study area.

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Late Atokan Brachiopod Biostratigraphy, Bird Spring Group, Arrow Canyon, Clark County, Nevada

Pennsylvanian rocks at Arrow Canyon have been proposed as a stratotype for the base and top of the Pennsylvanian System and for the "Atokan" Series. Fusulinaceans and conodonts document an essentially continuous biostratigraphic succession, and detailed petrographic descriptions have been published. Systematic descriptions and local ranges for the extensive and biostratigraphically significant brachiopod fauna are, as yet, unpublished. This report on brachiopods from the Zone of *Fusulinella* is part of an ongoing investigation of the Arrow Canyon invertebrate fauna being conducted at the University of Illinois. Materials under study include about 1,000 weathered-free specimens, and silicified material etched from about 500 pounds of matrix. Twenty-eight taxa have been identified, most notably a new species of *Brasilioproductus* Mendes, a genus previously known only from the Amazon basin. Ranges of *Spiriferellina ceres, Antiquatonia hermosana, Neochonetes dominus, Cleiothyridina milleri,* and *Rhipidomella elyensis* are here extended into the late "Atokan." *Composita trinuclea,* characteristically Mississippian, also occurs. Biostratigraphic correlation with both the southern Rocky Mountain region and Ohio is strong. Midcontinental correlations are less firm, probably because Atokan rocks in that area are poorly fossiliferous.

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Diagenesis of Burbank Sandstone, North Burbank Field, Osage County, Oklahoma

The Pennsylvanian (Desmoinesian) Burbank sandstone in Tract 97 of Osage County, Oklahoma, is 2,845–2,945 ft (867–897 m) deep. Samples of the Burbank from cored intervals of five wells were analyzed to determine depositional environment, diagenetic alterations, and the effects of diagenesis on reservoir rock properties.

The Burbank sandstone consists of very fine to fine-grained lithic arenites deposited under fluvial-deltaic conditions. Though quartz dominates in the detrital fraction, rock fragments, primarily metamorphic, and feldspars constitute as much as one-third of the grains. Compaction, authigenesis, replacement, and dissolution have significantly altered the texture and composition of the Burbank sandstone. Compaction is relatively minor due to early cementation. However, multiple stages of authigenesis have given rise to abundant silica and carbonate cements and clay minerals, which together constitute approximately one-fourth of the bulk volume of the sandstone. Clay minerals, dominantly iron-rich chlorite with minor illite, occur as pore lining, pore filling, and replacement of silicate grains. Replacement of detrital particles by carbonate cement is ubiquitous; such replacement seems to be susceptible to dissolution. Dissolution of grains and particularly cement has yielded the present average porosity of 15%.

Hydrocarbon recovery from the Burbank sandstone is complicated by depositional changes and diagenesis. For a tertiary recovery program to be successful, the effects of cementation, dissolution, and authigenesis must be considered in the design.

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Review of Electrical Methods in a Multidisciplinary Exploration Program

As petroleum exploration enters a period of searching for increasingly subtle traps, a number of exploration companies have begun to reconsider electrical techniques as a supplement to ongoing seismic programs. Many domestic companies have either established in-house electrical research groups or have utilized the services of various electrical contractors. This renewed interest in electrical techniques warrants review of the major approaches used today in exploration.

Modern electrical techniques can be divided according to survey objective into three categories. The first and most controversial approach