some intercalated thin turbidites and enterolithic slump folds, whereas coarse turbidites were funneled into the deep basin plain. These hydrocarbon-saturated turbidite sandstones are derived from fluvial systems draining crystalline hinterland.

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Hydrocarbon Occurrences in Nonmarine, Pre-Salt Sequence of Cabinda, Angola

The nonmarine, pre-salt sequence of offshore Cabinda, Angola, is a prolific hydrocarbon producer. Thick, organic-rich, lacustrine shale was the source of the oil trapped in four distinct, nonmarine, reservoir rocks.

Subsidence followed by the formation of deep grabens introduced the Early Cretaceous rifting of the South Atlantic. The resultant basins of west Africa were filled with up to 2,500 m of nonmarine deposits. Aptian salt overlies the nonmarine deposits. Pre-rift and syn-rift strata are distinguishable in the pre-salt sequence and are separated by major unconformities. Hydrocarbons occur in both the pre-rift and the syn-rift strata.

The mostly clastic, pre-rift strata rest unconformably on metamorphic basement and were deposited in fluvial-lacustrine environments prior to active rift faulting. Today, the pre-rift strata are in tilted fault blocks dipping 20° or more. The Lucula Formation, a fine-grained sandstone in the pre-rift strata within these blocks, is one of the major productive reservoirs of West Africa.

The syn-rift strata, which unconformably overlie the pre-rift rocks, gradually filled the deep graben lakes produced by initial rift faulting. Organic-rich dolomitic shale, the source rock for both pre- and syn-rift reservoirs, grades upward into shallow-lacustrine green shale and carbonate rocks. The shallow-water, nonmarine carbonate rocks are important reservoirs. Final rifting caused gradual westward tilting and erosion of the syn-rift topography. Nonmarine carbonate rock and sand unconformably filled the resultant surface. Along the eastern margin of this basin fill, carbonate reservoirs produce oil.

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Tidal-Current Sand Waves in Vineyard Sound, Massachusetts

Response of bed forms to tides and storms was studied for 8 months on Middle Ground Shoal, Vineyard Sound, Massachusetts, which has a nearly bi-directional tidal ellipse parallel with the shoal axis. Bed forms are on three scales: sand waves (H, one to several m; λ, 20 to 200 m), megaripples (H, up to 1 m; λ, 1 to 20 m) and ripples ($H < 10$ cm; $\lambda < 1$ m). Ripples are superimposed on both sand waves and megaripples; megaripples are commonly superimpsed on large sand waves. Four transponder-navigated surveys with $\pm$ 1 m accuracy were made with 200-kHz narrow-beam echo sounding and side-scan sonar. Successive charts of sand-wave crest positions were inter-compared to measure sand-wave migration. One wave at the edge of the sand-wave field was studied during several deployments of a tetrapod instrumented with four acoustic-travel-time velocity sensors at 30, 50, 100, and 300 cm from the bed, a bottom camera, and a 4-mHz sonic profiler to record bed heights. Sand waves show a slight upslope component of migration. Flood and ebb waves are separated by a 100 to 200-m belt of symmetrical waves at the shoal axis; some crests are continuous across the entire shoal. Flood or ebb migration ranged from 2 to 28 m during the 8-month period, but certain segments of waves migrated much more than other segments. Superimposed megaripples, which migrate too rapidly for survey-to-survey correlation, were monitored by divers using a staked and measured line over a sand wave; these forms, with H up to 1 m and λ up to 20 m, migrated a full wavelength in up to several weeks.

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Rb-Sr Dating of Diagenesis—Epigenesis in Mesozoic Rocks, San Juan Basin, New Mexico

The Rb-Sr radiometric age determination method has been applied to problems of dating diagenesis-epigenesis in the southern San Juan basin, New Mexico. Nonmarine and marine units of the Morrison Formation (Late Jurassic) and Dakota and Mancos formations (Cretaceous) have been examined. Clay minerals from the $-2\ \mu$ fraction, when carefully characterized by X-ray and SEM techniques, are especially useful if maintained at low oxidation potential conditions since the time of the last diagenetic or epigenetic effect on the rocks. Montmorillonites, illites, and mixed layer montmorillonite-illite from the Westwater Canyon and Brushy Basin Members of the Morrison Formation yield a composite date of $130-140\pm15$ m.y.B.P., although the errors for individual units are larger. Chlorite-rich fractions penecontemporaneous with uranium mineralization in the Grants Mineral Belt yield dates of 139 ± 10 m.y.B.P. for early epigenesis and, where remobilization has occurred, dates commonly cluster about $110-120$ m.y.B.P. Dates on the Dakota Formation (93 ± 8 m.y.B.P.) and Mancos Formation (83 ± 7 m.y.B.P.) are consistent with K-Ar dates reported for these units. In general, low CEC clay minerals formed during or slightly later than sedimentation yield the most useful information; an exception is kaolinite-rich material which may prove to be more useful in determining the age of source area material.

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Geochronologic Evidence for Paleozoic Plutonic Activity in Florida Mountains, New Mexico

Plutonic rocks of the Florida Mountains, New Mexico, have been mapped both as Precambrian and as Mesozoic. Corbitt and Woodward demonstrated that the Floridas are bisected by the southern Cordilleran thrust belt, and Brookins reported Precambrian Rb-Sr dates from south of the thrust for granitic rocks while alkali granites-syenites from north of the thrust yielded scat-