phase of the delta, is a complex of various lithologies which is divided into 4 major facies: coastal swamp, fluvial estuary, barrier island, and neritic marine. The fluvial estuary is open landward to a major distributary channel and exhibits high-energy, fluviatile bed forms. The barrier island sandstone body shows a N65°E orientation and separates 2 major facies—the coastal swamp/fluvial estuary facies on the northwest and the neritic marine on the southeast. *Ophiomorpha* burrows, indicators of littoral and shallow neritic environments, are common throughout the barrier-island sandstone. Unit E represents the destructional phase of the delta with initial deposition of marine black shale capping the complex of deltaic sediments of unit D. A grain-size increase upward through unit E, to fine-grained sandstone, culminates in the development of linear, offshore sandstone bars in the upper part of the interval. The sandstones have been bioturbated thoroughly by detritus feeders. Paleorelief, caused by the underlying stratigraphy of unit D, influenced the distribution of the unit E sandstone. Paleotopographic depressions found over the previous positions of both the subshoreface facies of the barrier-island sandstone and the coastal swamp facies, received the thickest offshore sandstone bar development, whereas paleotopographic ridges, specifically above the barrier-island sandstone, received the thinnest offshore bar development. No significant paleorelief was present at the end of the deposition of unit E and the beginning of the deposition of the upper shale member of the Mancos Shale.

The zircon:tourmaline ratio, determined by heavy-mineral analysis of the sandstones, can be used to differentiate fluvial and marine sandstones. Because zircon (Sp. G. 4.7) and tourmaline (Sp. G. 3.1–3.3) have widely different specific gravities, their relative abundances can be used as sensitive indicators of depositional environments. This sorting is related to the particular energy regime which existed at the time of deposition. Ratios greater than 1:1 are representative of high-energy fluvial sandstones, and ratios less than 1:1 are representative of low-energy marine sandstones. The marine environment can be subdivided further between shallow neritic (barrier islands, offshore bar, and shoreface environments) and deeper neritic with the shallow neritic having abundant heavy minerals and the deeper neritic having rare heavy minerals.

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Geology of Felder Uranium Deposit, Live Oak County, Texas

The Felder ore deposit is a 5 million-lb uranium deposit in the South Texas coastal plain. It occurs in the basal sandstone of an Oakville Formation (Miocene) alluvial system. The host sandstone is a carbonate-rich arkose which contains virtually no carbonaceous debris and has been reduced by the local introduction of hydrogen sulfide. The ore lies well within the reduced zone and occurs as coffinite and uraninite that fill interstices and coat and replace grains.

The overall geometric configuration of the ore is that of a winged, crescentic ore roll. Weak mineralization extends the wings of the ore roll and gives greater expression to the roll character. Departures from the shape are controlled by discontinuities in bedding and by proximity of the ore to the surface. Associated with the uranium is a broad halo of anomalous molybdenum.

Subsidiary mineralized trends suggest a preexisting updip position for the main roll. Oxidation from the surface largely destroyed this previous roll by solubilization of uranium. Uranium subsequently migrated into favorably reduced sandstone and reprecipitated at the present roll position.

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Characteristics of Tidal Sedimentation in Phosphoria (Permian) Strata at Cottonwood Creek Field, Big Horn Basin, Wyoming

Phosphoria reservoir rocks at Cottonwood Creek field, in the Big Horn basin, exhibit many characteristics of sediments deposited by a confined current, such as those in channels in modern carbonate tidal flats. Such physical properties, observed in thin sections and hand samples, are marked in contrast to the appearance of the nonporous carbonate facies of the Phosphoria. Nonporous strata, updip and laterally adjacent to this large stratigraphic oil accumulation, have properties common to sediments of interchannel and supratidal environments observed in modern tidal flats. These observations, in conjunction with the problem of anhydrite pore-filling and fracture distribution, help to explain the distribution of the reservoir and trap at Cottonwood Creek field, and may have application in exploration elsewhere in this province.

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Reevaluation of Unconformity Criteria in Carbonate Successions

Studies of modern carbonate sediments during the past 15 years have resulted in 4 revelations that should modify traditional stratigraphic concepts and definitions relating to unconformities: (1) brief subaerial exposure and attendant cementation of scattered small tracts, such as sand bars and tidal flats, are normal and continuing aspects of shallow-water carbonate deposition; (2) submarine cementation of carbonate sediments is a widespread, ongoing process; (3) submarine erosion and transportation of contemporaneously cemented fragments also are taking place constantly within the carbonate depositional realm; and (4) some features formerly thought to represent "soil" or vadose origin are essentially indistinguishable from marine-organic structure, or products or submarine cementation.

By analogy, these same concepts probably apply to ancient carbonate rocks. Consequently many of the traditionally accepted criteria for outcrop and core recognition of unconformities are invalid or tenuous at best.

A new definition of "unconformity" is needed. "Missing section" is not satisfactory as a definitive criterion because an apparent hiatus in fact may be only a function of unrecognized lithofacies or biofacies patterns, depending on the magnitude of the interval involved. Clearly, the really important connotation of "unconformity" is that an area of regional extent was eroded, and the new definition should reflect both qualities: erosion and extent. Along the same line, a useful classification of nongradational stratigraphic boundaries can be constructed, based on the same two criteria.

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Reevaluation of Use of Glauconite for Radiometric Stratigraphic Dating

Glauconite is a potassium- and rubidium-bearing clay mineral that forms at the seawater-sediment interface in marine environments. As such, it should be useful in the determination of absolute ages of sedimentation of sedimentary zones.

K/Ar and Rb/Sr ages from glauconites are about 10–20% lower than the age of sedimentation where external controls on the ages are available. Previous studies have indicated that these low ages are not attributable to normal diffusion loss of Ar from glauconite crystallites.

The possibilities of argon loss from "open" potassium sites, such as on crystal surfaces and from expanded layers, was investigated by acid dissolution techniques. These studies show that potassium is removed from glauconites with low expandabilities at 3 different rates. The highest dissolution rate corresponds to cation exchange and comprises 5–10% of the total potassium. About 5% of the total potassium is removed at a much slower rate than that of cation exchange, but at an order of magnitude faster than most of the potassium.

The amount of potassium in "open" sites, interpreted to be subject to argon loss, was compared with the difference between radiometric age and stratigraphic age for some samples. It appears that low radiometric ages from glauconites can be explained largely by the presence of potassium in sites where argon is readily lost, although such factors as late epigenetic gain of potassium by glauconite may contribute to their low radiometric ages.

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GEOCHEMISTRY OF SOME LOWER EOCENE SANDSTONES IN ROCKY MOUNTAIN REGION

The lower Eocene sandstones in the Rocky Mountain region were studied to determine the geochemical setting for the valuable uranium and other mineral deposits they contain. Three pairs of samples were collected from each of 2 sections in 18 different basins and each sample was analyzed for chemical and mineral constituents. The resultant data on 216 samples have been treated statistically. The samples range from arkosic wackes derived from the crystalline cores of mountain ranges to quartz and carbonate arenites derived from the reworking of Mesozoic and Paleozoic strata. The average composition of the 216 samples, expressed as the geometric mean (geometric deviation follows in parentheses), is [in percent]: SiO_2 72.9 (1.2), Al_2O_3 6.6 (1.9), total iron as Fe_2O_3 1.2 (2.1), MgO 0.6 (3.0), CaO 2.4 (4.3), Na_2O 0.5 (4.6), K_2O 1.4 (2.3), H_2O^+ 1.4 (1.6), TiO_2 0.2 (1.9), P_2O_5 0.05 (2.6), MnO 0.06 (2.1), CO_2 0.7 (12.6); [in ppm] B 13 (2), Ba 415 (2), Co 4 (2), Cr 13 (3), Cu 8 (2), Ga 9 (2), La 12 (2), Ni 9 (2), Pb 8 (2), Sr 138 (3), V 24 (2), Y 10 (2), and Zr 113 (2). Compared with the average composition of sandstone as estimated by Pettijohn, these figures are high for Sr, V, La, Y, Ni, and Co, and low for Fe_2O_3, MgO, Na_2O, TiO_2 P_2O_5, MnO, Zr, and possibly B. Geometric mean values for each of the individual sections show considerable variation from the overall mean.

Analysis of variance data suggests that for most constituents the greatest percentage of variance occurs between pairs of samples. This variance also includes that resulting from analytical errors and sample inhomogeneity. For most constituents, significant variance exists between sections; Al_2O_3, K_2O, Na_2O, Ba, Cr, and Ga also show significant variance between basins, suggesting that these data are most useful for plotting regional trends.

Factor analysis of correlation coefficients was used to determine 3 principal geochemical groupings of constituents—quartz, carbonate, and feldspar. Among the minor elements, Cr, Ni, Co, Cu, and V tend to correlate with each other and with iron. Ba correlates best with Al_2O_3 and K_2O; Sr with CaO and plagioclase; Ga with Al_2O_3 and Na_2O. Zr tends to correlate with TiO_2; B with quartz; and MnO with CaO.

Similar statistical methods were applied to 4 separate color subsets of the 216 samples—identified as predominantly red, orange, yellow, or green. The subset of 11 green samples, which were yellowish green to greenish gray to olive gray, differs significantly from the other color subsets and the whole. The green subset shows higher concentrations of nearly every constituent except SiO_2, 14–15 Å clays, kaolin, quartz, potassium feldspar, and calcite. They are enriched especially in Co, Cr, Cu, Ni, Sr, V, Ga, and mica.

Individual stratigraphic sections that show high concentrations of some minor elements include the Patmos Head area of Utah, which is enriched in Cr, Cu, V, Ni, Pb, and TiO_2, and the Oregon Buttes area of Wyoming, which is enriched in MnO, Sr, Co, Cr, V, and Ni.

21ST ANNUAL MEETING OF GULF COAST ASSOCIATION OF GEOLOGICAL SOCIETIES and GULF COAST SECTION OF SEPM

New Orleans, Louisiana October 13–15, 1971

The New Orleans Geological Society invites you to come to New Orleans, "Where The Action Is," for the 21st Annual Meeting of the Gulf Coast Association of Geological Societies and Gulf Coast Section of SEPM.

Headquarters for all the action will be the complete convention facilities of the Jung Hotel, with additional housing available in other outstanding downtown and French Quarter hotels. Present plans include:

Technical sessions.—An outstanding program, geared to the oil finder and built around the theme "Where The Action Is," is being assembled. Included will be papers on all the currently active exploration areas from South Texas to peninsular Florida.

Field trips.—1. Pre-convention trip (Oct. 10–13) to the southern coastal waters and barrier reef of British Honduras, to study carbonate sedimentation, reef development, and mixed carbonate-clastic sequences. Cost of $190 includes transportation from New Orleans, meals, housing, boats, and guidebook.

2. Pre-convention trip (Oct. 11–13) to eastern Mississippi and western Alabama, to study the stratigraphy, paleontology, and environments of deposition of classical Gulf Coast Tertiary outcrops. Cost is approximately $40 for transportation, lodging, and guidebook (meals not included).

3. Post-convention trip (Oct. 16) to Bayou Lafourche and Grand Isle, Louisiana, to study barrier islands and ancient deltas of the Mississippi River delta complex. Cost of $35 includes lunch, guidebook, plane, and bus.

4. Post-convention trip (Oct. 16–17) via airplane and boat to the lower Mississippi delta Venice, Louisiana (Head of Passes), and the mouth of South Pass to study delta processes, sediments, and structures. Cost