a now-eroded, oblong reef rim probably existed. Within the reefs, 7 forereef, 2 reef-core, and 12 backreef subtypes can be distinguished. Transgressions and regressions of the sea resulted in cyclic sedimentation on the flat, widespread shelf-lagoon. Locally the transgressive cycles start with black marls, whereas the regressive cycles terminate with laminites and erosion features. The topmost parts of the subsiding reefs are built of convex limestone caps (Iberg facies), tens of meters thick; there is no backreef lagoon facies. Two facies subtypes can be recognized within these very fossiliferous limestone caps—biodetrital limestones with a high original interframe porosity, and micritic limestones with "stromatactis" (so-called still-water bioherms).

The interreef basins between the isolated reef complexes are characterized by black bituminous shale (so-called "Flinz" facies). Also in the geosynclinal trough, dark, pelagic shales are present. Limestone turbidites are continuous from the outer forereef flanks into the adjacent deeper basins.

Dolomitization occurs mainly in the fine-grained bank types and the micritic backreef subtypes, whereas the reef-core and the sparry-cemented, forereef subtypes are less dolomitized. The dolomitization is preponderantly epigenetic (bound to joints, faults, bedding planes, or schistosity planes). No economic discoveries of oil or gas have been made in the Devonian carbonate complexes in central Europe. Origin and source of asphaltite in the isolated small Iberg-Winterberg reef, Harz Mountains, are still unresolved.

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WIDTH-THICKNESS RELATIONS FOR FLUVIAL AND SHORELINE SAND BODIES

The relation between the width and thickness measurements of 2 different types of sand bodies were studied. The measurements were gathered from more than 100 literature sources.

The reduced regression line through the width-thickness data for shoreline sand bodies is significantly different from a similar line determined for fluvial sand bodies. The lines are almost parallel with the shoreline sand line, a fact which shows that shoreline sands have a greater width than fluvial sands for any stated thickness. Both populations may be fit by bivariate log-normal distributions and both result in nearly linear relations between the mean, median, and modal widths and the thickness.

Equations are presented for determining the relative frequency function of the width for any thickness of sand found in a well. Therefore, the probability that the width is greater or less than a stated value, or the probability that the width lies within a particular range, can be determined if one knows only the maximum thickness of the cross section being studied and the type of sand body. The possible error resulting from using a thickness other than the maximum is small when the thickness used is 80 ft or more for a fluvial sand body and 50 ft or more for a shoreline sand body.

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REMOTE SENSING FOR PETROLEUM

Remote sensing techniques in the exploration for petroleum have not moved from the small-scale, limited-study-area, experimental state to full-scale, large-area, operational status. Remote sensing techniques will have come to maturity when total basin surveys for known and potential hydrocarbon anomalies are commonplace. As with much of petroleum exploration, remote sensing is primarily an indirect technique limited to the development of drillable petroleum prospects. Remote sensing techniques include spectroscopic analysis, which offers the potential for airborne geochemical surveys. Research toward the latter objective is still in early phases.

The most commonly used wavelengths are the visible part of the spectrum (0.3–0.7μ), infrared film emulsions (0.3–1.1μ), and thermal infrared (8–14μ). Equipment and materials covering these spectral bands are the best developed and the most widely available.

Exploration in areas of consistently poor illumination because of meteorologic conditions will bring about increased use of the longer wavelength (microwave) equipment. Cloud penetration is a function of wavelength; passive microwave radiometers, side-looking radar, and scatterometers possess this capability. Currently, airborne microwave instrumentation is not widely available, but indications are that it will come into wider use.

Educational opportunities to orient exploration personnel to the uses and limitations of this new tool appear adequate. In addition to the proliferation of short courses on remote sensing at numerous universities, industry-sponsored seminars have been conducted.

Service companies prepared to perform multisensor data collecting on a global scale are now operational. They offer, on a contract basis, sophisticated equipment in advanced aircraft, with or without interpretation packages. In addition to petroleum companies, their clientele includes mining companies, widely diversified agricultural interests, and domestic and foreign government agencies.

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APPLICATION OF STABLE OXYGEN AND CARBON ISOTOPE TECHNIQUES TO STUDIES OF DIAGENESIS

Oxygen and carbon-isotope techniques are well established in classical paleotemperature work, in the fields of igneous and metamorphic petrology, and in certain phases of organic geochemistry. However, there is a wealth of fundamental data on the isotopic behavior of sedimentary rock-forming mineral systems (carbonates, silicates, sulfates, and their interaction with various fluids) that await systematic exploitation by geochemists interested in low-temperature diagenesis of sedimentary rocks. One example of specific isotopic studies involves early dolomitization.

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MARKOV CHAIN ANALYSIS OF CARBONATE ROCKS: APPLICATIONS, LIMITATIONS, AND IMPLICATIONS AS EXEMPLIFIED BY PENNSYLVANIAN CARBONATES IN SOUTHERN NEVADA

Markov chain analysis is a simple, powerful, mathematical tool for testing the presence, absence, and length of "memory" in a sequence of events. Use of this method on the Pennsylvanian carbonates of southern Nevada revealed the presence of a "memory" ($X^2 = 32.55$ with 15 df) in the thick basinal interval of the Bird Spring Group of the Arrow Canyon Mountains and a relative lack of memory ($X^2 = 20.5$ with 15 df) in the thinner, age-equivalent, shelf deposits of the Callville Limestone on Frenchman Mountain.

Covered intervals have little effect in situations