Pennsylvanian, providing reservoirs in numerous oil fields such as Aneth and Cache-Ismay. Although these are generally considered to be randomly distributed stratigraphic traps, there is ample evidence that sedimentary growth of the bioherms was localized on very gentle, basement-controlled paleostructures. Although the reservoirs are generally too thin for recognition on present-day seismic sections, seismic mapping of paleostructure, not Laramide structure, is the key to further exploration of the lucrative basin.

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Mesozoic and Early Cenozoic Arc-Trench System of California—Do the Pieces Still Fit?

The Mesozoic and early Cenozoic arc-trench system of California has been interpreted to include the Franciscan Complex as a subduction complex, the Great Valley sequence as a fore-arc basin, and the Sierra Nevada batholith and volcanic rocks in the western states as the magmatic arc. The similar ages of these elements and the stacking sequence in the Franciscan Complex (youngest to the west) are consistent with this interpretation. However, some recent studies in paleomagnetics, radiometric dating, and sandstone petrology, particularly in the Franciscan Complex, suggest that a simple model of subduction and accretion does not explain many relations.

With the growing evidence for lateral translations of microplate along the Pacific margin during the Mesozoic and Cenozoic, some authors have attempted to explain Franciscan complexities by these large-scale lateral translations. Limestone and volcanic blocks in the Franciscan melange have been shown to be allochthonous, but there is yet no definitive evidence for large-scale translations of the melange as a whole. Several problems remain unsolved, including the relation between blueschist terranes, the large time delay between deposition of some sediments and their subsequent metamorphism to blueschist facies, the relation of sandstone provenance between the fore-arc basin and subjection complex, the distribution of sedimentary facies across the entire trench slope/fore-arc region, and the differing styles of deformation in the various Franciscan belts. Recent studies of modern and ancient arc-trench systems help explain some of these problems, but others remain enigmatic.

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Thermal Effects on Sedimentary Organic Matter and Recognition and Mapping of Subjacent Igneous Plutons, Ruby Range, Colorado

The Ruby Range igenous complex, west-central Colorado, is characterized by mid-Tertiary granodiorite plutons which intrude Paleozoic, Mesozoic, and Tertiary strata. Conventional contact metamorphism is limited to a mile-wide zone adjacent to the Ruby Range axis. Geochemical and related studies, including hydrocarbon levels and types, kerogen composition, visual kerogen, and vitrinite observations, on the organic matter in intruded sediments demonstrate that low-grade thermal metamorphic effects extend about 6 mi (9.6 km) from the Ruby Range intrusive axis. This is an unusually wide thermal aureole and indicates important heat sources in addition to the intrusions along the Ruby Range axis. Peripheral sills and laccoliths caused little thermal effect on the sediments. It is concluded that the thermal aureole adjacent to the Ruby Range is enlarged because of subjacent intrusions. Specifically, it is postulated that the White Rock pluton projects into the subsurface beneath the sedimentary cover. Recognition of organic matter metamorphism in the overlying sediments permits tracing the approximate margin of the pluton from its outcrop area in the northeast for a distance of about 10 mi (16 km) to the southwest along its subjacent trend. Relations between the trend of metamorphic isotherms and topography indicate that the pluton has a steep (stocklike) southeast margin. Significantly, the recently discovered molybdenum deposit beneath Mt. Emmons, near Crested Butte, Colorado, is located approximately along the projected trend of the subjacent extension of the White Rock pluton. Recognition of very low grades of thermal metamorphism of organic matter may also have application to the location and evaluation of geothermal reservoirs.

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Corporate Strategies Among Domestic Uranium Explorationists

Exploration by the uranium industry has responded to adverse market conditions in a uniform and predictable manner. Exploration personnel were reduced drastically, and even eliminated entirely in some places. Grass roots exploration has all but come to a halt, with selected properties being designated for drilling in the near future. Only those properties with relatively high grade, high tonnage potential will be designated for exploration. The grade cutoff may be as high as 0.50%, depending on distance from the processing mill and other economic factors. The goal of exploration, as well as the production phase of the industry, is to weather the economic storm and survive. Exploration efforts must be concentrated close to a mill, with most activities being conducted by a small number of people. The geologic targets, if previously unexplored, must bear close resemblance to ore bodies that have proved productive in the past. Diversification into other mineral ventures, such as base and precious metals, may also be required for survival.

Foreign countries with exploration interests in the United States are subject to the same pressures as domestic companies, but are able to weather the storm more effectively than domestic companies due to government backing or ownership of many foreign exploration companies.

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Mechanism and Kinetics of Sulfate Inhibition on Dolomitization of Calcium Carbonate

Calcite and aragonite transformation to dolomite has been accomplished in a few days in hydrothermal experiments using artificial seawater without sulfate and in $MgCl_2$ + $CaCl_2$ + NaCl solutions of seawater ionic strength, at 200° and 150°C. Calcium carbonate transformation to dolomite is retarded and frequently inhibited, depending on the concentration of SO_4^{2-} in solution. The mechanism of this reaction is being investigated. Preliminary results indicate that it is a surface-controlled mechanism.

These results explain: (1) the formation of either primary or replacement dolomite in organic-rich sediments, especially in sedimentary environments or rapid sedimentation, in which microbial sulfate reduction prevails, and diffusive communication of the interstitial water with seawater is precluded; (2) the observed large variations—from negative to strongly positive

$\delta^{13}C$ values (PDB)—of dolomites in the Monterey Formation, California, and in recent sediments in the Gulf of California, controlled by the CH_4/CO_2 ratio; and (3) the often observed similar oxygen isotope values of coexisting calcites and dolomites in limestones which were dolomitized by seawater mixed with large volumes of fresh water.

Thus, in low or sulfate-free environments, dolomitization of $CaCO_3$ and the formation of primary dolomite are limited by supply of alkalinity, calcite or aragonite, or dissolved Ca^{2+} or Mg^{2+}. Even in the absence of sulfate, dolomitization may be retarded or inhibited by the transformation of opal-A to opal-CT, a reaction which can compete with dolomite for available Mg^{2+}.

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Use of Vertical and Surface Seismic Profiles to Investigate Distribution of Aquifers in Madison Group and Red River Formation, Powder River Basin, Wyoming-Montana

Intensive energy development activity in the Powder River basin area of eastern Wyoming has placed heavy demands on the limited water resources of the state. Water cannot be obtained from streams, rivers, or shallow wells to support coal-slurry pipelines, coal gasification, shale retorting, or even in many places enlarged municipal water systems. The U.S. Geological Survey is, therefore, promoting the water resource potential of the Madison Group and Red River Formation. Such water is to be produced from depths of 2,500 to 7,500 ft (762 to 2,286 m) to supply some of the needs cited.

Because deep water wells are expensive, and Madison-Red River productivity varies drastically throughout the area, it is highly desirable to select drilling sites with a high probability of good water production. The exploration seismograph is a promising tool to aid in site selection. The object of the investigation was to determine under what conditions the exploration seismograph can be used to detect porosity development at depth in the horizons of interest, an application which also has obvious significance to the petroleum industry.

In-situ measurements of the acoustic properties of the Madison-Red River interval have been made using vertical seismic profiles in several wells. Surface seismic profiles were then run over the wells in which vertical seismic profiles had been made. The combination of these results, together with well log data and regional geologic subsurface studies, give one considerable insight into the problem of exploring for commercial quantities of water at depth.

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Multichannel Measurements Over a Possible Gas-Bearing Structure Near Cay Sal, Bahamas

Multichannel reflection measurements in water depths of 500 m reveal an asymmetric anticline 70 km southeast of Cay Sal Bank. This fold has an apparent width of 10 km. The northern flank has a maximum relief of 1 km, and the southern flank's maximum relief is 400 m. North of this structure, in Santaren Channel, coherent reflections occur throughout our 5-sec record. Depth at 5 sec is approximately 10 km. South of the anticline, reflections are discontinuous below 1 sec, and no coherent reflections can be seen below 2 sec. A strong reflection at 2.3 sec in Santaren Channel (approximately 3 km depth) probably marks a middle Cretaceous unconformity. Seismic units inferred to be youngest Cretaceous and Paleogene show maximum thinning over this fold. The Upper Cretaceous sequence shows maximum structural relief here. Amplitude anomalies occur on the crest. Reflections from the uppermost Cretaceous to Paleogene section are dim above reflections from inferred Upper Cretaceous units that contain several bright spots. Some flat reflections on the structure may stem from gas-liquid contacts.

Ten kilometers south of the asymmetric anticline, a tilted block that may be composed of platform carbonate rocks rises to within 0.3 sec of the sea floor. This block has an east-west dimension of more than 20 km and a maximum relief of 1.3 km. A Lower Cretaceous carbonate platform edge underlies 800 m of water and 1.5 km of sediment at the junction of Nicholas Channel and Florida Straits. In Florida Straits, a strong reflection correlates with the middle Cretaceous unconformity.

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Organic Geochemistry as a Geologic Tool

Recent advances in techniques for analyzing organic matter, together with improved understanding of compositional changes with changing physical conditions, have led to the development of methods with considerable potential for providing insight into geologic processes. The physical character and chemical composition of organic matter change with temperature and can be used like a thermometer that is still reading its maximum value. As organic matter is extremely sensitive to past thermal effects, it responds at temperatures much lower than those needed to produce the mineral changes characteristic of the lowest grade of metamorphism. If values for geothermal gradient are known the actual depths of burial can be estimated from values for vitrinite reflectance and elemental composition. Faults or unconformities commonly show clearly in vitrinite reflectance plots and it is possible to use this information to calculate the displacement of the fault or the amount of overburden removed. Vitrinite reflectance and electron spin resonance have the potential for showing past geothermal gradients. The amount and type of organic matter in a rock are strongly influenced by the depositional environment. An obvious example is the presence of wood indicating input from terrestrial sources. A variety of characteristic organic compounds (biological markers) have potential as environmental indicators. The role of organic matter in controlling conditions, especially Eh, is well known but often poorly documented, while the significance of organic matter in complexing and transporting trace elements in the subsurface is just starting to be investigated. Organic matter may also have an important role in recrystallization and diagenesis because of its adsorption on crystal surfaces. The wide range of compounds present in organic matter is controlled by depositional environment but subsequently modified by changes in temperature, pressure, Eh, and pH, and thus provide enormous potential for studying geologic processes.

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Geochemistry of a Marine Gas Hydrate Associated with a Bottom Simulating Reflector