rents; (4) specific water masses; (5) conditions of preservation; (6) presence and strength of upwelling onto shelves and under boundary currents; (7) eutrophic conditions; and (8) tectonic events (isolating radiolarian populations).

These biologic indicators and their related forms are useful in determining similar parameters in the fossil record. Studies of radiolarians from Neogene Deep Sea Drilling Project and onshore samples indicate: (1) relative distance from continents; (2) relative paleodepths; (3) strengths and directions of paleocurrents; (4) presence and degree of paleo-upwellings; (5) origin, development, and presence of paleowater masses; (6) paleoeutrophic conditions; and (7) paleotectonic activity. These biologic indicators may provide a framework for paleo-oceanographic interpretations of Mesozoic and perhaps even Paleozoic radiolarian-bearing sediments.

SPLETTSTOESSER, JOHN F., Univ. Minnesota, St. Paul, Minn.

Coal in Antarctica

Coal has been reported from numerous locations in Antarctica beginning about 70 years ago. Only since about 1960, however, have data become available on petrologic and analytic studies. Nearly all Antarctic coal deposits are in the Transantarctic Mountains of East Antarctica, that portion of the continent lying mostly south of Africa, Asia, and Australia. All appear to be of Permian age, and most have been altered by contact thermal metamorphism; they range in rank from low-volatile bituminous to semianthracite. The coal beds generally lack marine deposits and underclay. In addition to those in the Transantarctic Mountains, coal deposits have been reported from the Prince Charles Mountains. Coals in the Prince Charles Mountains mostly are unaffected by thermal metamorphism and have a rank of high-volatile bituminous. Most coal deposits in Antarctica have very limited horizontal extent; beds range to 3 or 4 m in thickness, but are generally thinner. Except for some deposits in the coastal parts of the Transantarctic Mountains and those in the Prince Charles Mountains, coal is found mainly in the interior of the continent. The location of most coal poses a major transportation problem for potential mines. Some coal could possibly be mined and used locally as an energy source for heating or power production. Another potential problem, yet to be resolved, is the matter of territorial claims, which might dictate the ownership of mineral deposits.

STAHL, W. J., E. FABER, Federal Inst. or Geosciences and Natural Resources, Hannover, Germany, and B. D. CAREY, and D. L. KIRKSEY

Origin of Gases Adsorbed in Near-Surface Sediment Identified by Carbon Isotopes

No abstract available.

STAHL, WOLFGANG J., E. FABER, Federal Inst. Geosciences and Natural Resources, Hannover, Germany, and B. D. CAREY, Tenneco Oil Co., Houston, Tex.

Carbon Isotopes—New Tool in Hydrocarbon Correlation and Exploration

The recently developed isotopic type-curve technique is based on the $^{13}C/^{12}C$ ratios of saturates, aromatics, heterocyclics, asphaltenes, and kerogen. This technique has been applied to problems of correlation of oil with oil and oil with source rocks, and has also been used to identify bacterial degradation in crude oils. Correlation of gas with source rock is essentially related to the determination of the carbon isotope ratio of methane. The ratio links the gas to the type and maturity of its organic source material. This technique was applied to head space analyses of canned drillhole samples. The type and maturity of source rocks can be evaluated as shown by isotope-depth profiles from different basins. Migration of gaseous hydrocarbons from deep sources to higher strata becomes evident.

STANLEY, DANIEL JEAN, Smithsonian Inst., Washington, D.C., and R. JOHN KNIGHT, Petro-Canada Exploration Inc., Calgary, Alta.

"Giant" Mudflow Deposits in Submarine Trenches; Hellenic Basins and Slopes in Eastern Mediterranean

Mud rather than sand is the predominant sediment type in submarine trenches, and most studies attribute fine-grained layers to pelagic and hemipelagic mechanisms or to turbidity-current and slump emplacement. Analysis of 28 piston cores in the eastern Hellenic Trench (eastern Ionian basin) in the eastern Mediterranean Sea sheds light on thick muds that form a major component of late Pleistocene–Holocene trench lithofacies. Several 600-cm-long core sections consist entirely of clayey silt that in X-radiographs appears structureless or displays vague lamination or subtle graded bedding. Size analysis reveals an upward increase in the relative percentage of the clay fraction. The sand-size fraction, generally less than 2%, includes planktonic and benthonic forams, shell fragments, and terrigenous components (light and heavy minerals, mica and plant debris). Carbonate content ranges from 20 to 40%, and that of organic matter from 3 to 5%. A 3.5-kHz subbottom survey of the region reveals discontinuous, acoustically transparent layers in trench basins and locally on slopes and depressions that bound the Hellenic Trench. A mudflow–turbidity-current origin is proposed, and is substantiated by radiocarbon dates showing rapid emplacement.

It would appear that "giant" mudflow deposits of this type are a particularly characteristic component of the typical trench lithofacies. Transport in many cases involved displacement of 1 cu km (e.g., a 10-m-thick layer covering 100 sq km). However, it should be noted that comparable or even greater volumes of mud have been displaced by single-event processes such as turbidity currents in almost all large basins of the Mediterranean such as the Algéro-Balearic, Ligurian, and Tyrrhenian basins on the west and the Ionian, Sea of Crete, and Herodotus basins in the eastern Mediterranean. The marked thickness of mudflow deposits in the Hellenic Trench and other trenches primarily reflects ponding in structurally mobile and topographically restricted de-

pressions rather than a transport process unique to the trench environment.

STANLEY, KENNETH O., and GUNTER FAURE, Ohio State Univ., Columbus, Ohio

Isotopic Composition and Sources of Strontium in Sandstone Cements in High Plains Sequence of Wyoming and Nebraska

The $^{87}Sr/^{86}Sr$ ratios of sandstone cements reflect the isotopic composition of strontium released into the pore fluid by different rock and mineral constituents. However, little is known about the extent to which the isotopic compositions of strontium in cements reflect local or regional variations in sandstone compositions. The $^{87}Sr/^{86}Sr$ ratios of sandstone cements permit identification of the major sources of strontium in the pore fluid and indicate the dimensions of the aquifer system within which the pore fluid was isotopically homogenized. Since the abundances of radiogenic ^{87}Sr is continually increasing by decay of ^{87}Rb, isotopic compositions of strontium may also suggest the sequence and time of cement formation in sandstones that contain detrital mineral and rock grains having high Rb/Sr ratios.

After removing the calcite, montmorillonite, or zeolite cements, sandstones from the Arikaree and Ogallala Groups of the High Plains sequence (Oligocene to Pliocene) have $^{87}Sr/^{86}Sr$ ratios ranging from 0.7065 for plagioclase arenite to 0.7491 for arkosic arenite; rhyolitic vitric ash samples have intermediate ratios of 0.7093 and 0.7133. In contrast to the detrital fractions of the sandstones, the cements contain strontium that is isotopically homogeneous over distances of 70 km or more. Calcite and montmorillonite cements from the Arikaree Group (Oligocene-Miocene) have an $^{87}Sr/^{86}Sr$ ratio of 0.7103, whereas calcite and clinoptilolite from the Ogallala Group (Miocene-Pliocene) yield 0.7112. The ratio of the cements suggests that the pore waters were homogeneous on a regional basis and were not locally controlled. The slight difference in the isotopic composition of strontium in the cements of the Arikaree and Ogallala Groups may have resulted either from decay of ^{87}Rb during the time interval of about 20 m.y. between lithogenesis of the Arikaree and Ogallala Groups or from differences in their mineral compositions. A quantitative model for mixing of different isotopic varieties of strontium indicates that Precambrian plagioclase, Paleozoic marine carbonate rocks, and Tertiary volcanic ash were the dominant sources of strontium in the pore solution and that Precambrian K-feldspar was the principal contributor of radiogenic ^{87}Sr.

STAUB, JAMES R., and JOHN C. FERM, Uni. South Carolina, Columbia, S.C.

Estuarine–Coastal Plain Coal Deposition in Southern West Virginia; Pennsylvanian Beckley Seam

Current studies of the Beckley (Pennsylvanian) seam in an area 60 by 30 km in southern West Virginia indicate that the Beckley was formed in a back-barrier depositional setting. Examination of about 1,800 core records as well as underground workings shows that the Beckley stratigraphic position is characterized by linear northeast-southwest-trending orthoquartzitic sandstone bodies about 1,500 m wide representing stranded barriers on a prograding coastal plain. Areas between the barrier sandstones are about 15 km wide and are occupied by coal and shale of estuarine and tidal-creek origin. The thick bodies of coal, which are relatively small (4.8 by 9.6 km or less), are located on the flanks of the barrier and thin toward the shaly central part of the interbarrier area. Adjacent to the barriers, the coal is split by small linear tongues of sandstone produced by erosion of the barrier. Where the coal adjoins estuarine and tidal-creek sediments, it interfingers and thins into shale and sandy shale. Within the interbarrier areas, the thickest coal is near the headward parts of the tidal creeks; closer to the major estuary the coal bodies are thinner and smaller in areal extent. Knowledge gained from exploration and mining of the Beckley seam should aid in searching for and developing coals in similar depositional settings.

STAUFFER, K. W., and R. ARAUJO, Chevron Venezuela, Maracaibo, Venezuela

Geochemical Evaluation of Ensenada de la Vela Basin, Offshore Falcon State, Venezuela

Maturation mapping in the Tertiary La Vela basin, based on bottom-hole temperatures of 12 wells, indicates that only the Paleogene Guarabal Formation and the lowermost part of the Miocene Agua Clara Formation reached temperatures adequate for the generation of oil.

Plotting of temperature contours on cross sections of the basin and on isopach maps delimited the extent of the potential oil-forming units. Flows of oil in drill-stem tests came from wells on a basement horst adjacent to a deeply buried "pod" of Guarabal Formation, which was suggested as the local source rock.

Later geochemical analyses of samples from three wells confirmed this model by showing that the Miocene Agua Clara Formation was immature and contained insufficient amounts of organic matter to be an oil source. Furthermore, it was confirmed that the "pod" of Paleogene Guarabal Formation was mature, and contained up to 6% total organic carbon as well as predominantly oil-prone kerogen.

Accurate location of the oil-generating beds in the La Vela basin was thus made possible by geochemical mapping, and should help focus exploratory drilling on those traps most likely to contain oil accumulations.

STEGE, BRUCE R., NICHOLAS E. PINGITORE, JR., and PHILIP C. GOODELL, Univ. Texas, El Paso, Tex.

Carbonate Geology of Peña Blanca Uranium District, Chihuahua, Mexico

The Peña Blanca Range of central Chihuahua is the site of Mexico's largest uranium deposit. The exposure at Peña Blanca consists of Tertiary silicic pyroclastics overlying middle Cretaceous (Albian and Cenomanian) limestones. The uranium is present predominantly in the basal unit of the pyroclastics, at or near the contact with the limestones. The limestones make up a large