centages—is developed by examples to show how map patterns are in part controlled by the ways in which the mapped data are expressed.

KVENVOLDEN, KEITH A., Socony Mobil Oil Company, Dallas, Tex.

NORMAL PARAFFIN HYDROCARBONS IN RECENT SEDIMENTS FROM SAN FRANCISCO BAY, CALIFORNIA

Post-Pleistocene sediments of San Francisco Bay, California, have been analyzed for the presence of normal paraffin hydrocarbons. Gas-liquid chromatography was used to examine sediment extracts for normal paraffins containing 8 through 13 carbon atoms per molecule (intermediate molecular weights). Liquid-solid chromatography, infrared and mass spectrometry were used to determine in sediment extracts normal paraffins containing more than 18 carbon atoms per molecule (high molecular weights). Knowledge of normal paraffins in recently deposited sediments may be useful in explaining the origin of crude oils.

The results of analyses of sediments of San Francisco Bay show that normal paraffins containing 8 through 13 carbon atoms are probably absent, or each is present in a concentration less than one part per million dried sediment. Concentrations from 3 to 6 parts per million dried sediment were determined for the normal paraffins containing more than 18 carbon atoms per molecule. Among the normal paraffins containing 23–35 carbon atoms per molecule, the relative number of molecules having an odd number of carbon atoms is greater than the relative number of molecules having an even number of carbon atoms.

Normal paraffins of intermediate and high molecular weights are present in most crude oils, but only normal paraffins of high molecular weights were detected in the sediments of San Francisco Bay. In the sediments the normal paraffins containing 23–35 carbon atoms per molecule show a predominance of odd-carbon-number molecules. In crude oils the normal paraffins in the same weight range are distributed so that odd-carbon-number molecules and even-carbon-number molecules are present in about equal amounts.

If the sediments of San Francisco Bay are to yield crude oil, changes probably should take place in the molecular distribution of the normal paraffins already present. The ratio of odd- to even-numbered normal paraffins should be reduced so that the odd- and even-numbered molecules are about equally abundant. Also, normal paraffins of intermediate molecular weights probably should be added to these sediments. The additional normal paraffins may be derived from other organic materials dispersed in the sediments.

LIAN, HAROLD M., Union Oil Company of California, Anchorage, Alaska
SIMONSON, RUSSELL R., The Ohio Oil Company, Los Angeles, Calif.

COOK INLET BASIN—STRUCTURE, STRATIGRAPHY, EXPLORATION TECHNIQUES, LOGISTICS, DISCOVERIES

Exploratory objectives in the Cook Inlet Basin are confined largely to the Kenai Formation, a 15,000–20,000-foot series of non-marine, coal-bearing sediments of Eocene or younger Tertiary age, underlain by marine Mesozoic sediments. The Kenai Formation on the Kenai Peninsula is divisible into an upper sand member, a middle siltstone and coal member, and a lower sand member. The gas fields on the Kenai Peninsula occur in the upper member; Swanson River oil production is from the lower member. The Kenai beds have been gently to moderately folded and locally faulted.

Exploration techniques consist of surface mapping, gravity and airborne magnetometer surveying, and reflection seismic shooting. Marine reflection shooting and gas exploder-sparker surveys have been used to explore Cook Inlet. Some structural leads can be obtained by field mapping but seismic work is needed to confirm closure. To date only structures defined by seismic methods have been drilled.

The Swanson River oil field is producing in excess of 28,000 barrels per day from the Hemlock zone, a series of sands and conglomerates near the base of the Kenai Formation. The structure is a large, faulted anticline.

Five gas fields have been discovered—the Kenai, Swanson River, West Fork, Falls Creek, and Sterling fields. Gas from the Kenai field is being delivered to Soldotna and Anchorage; the other fields are shut in although some gas from the Swanson River gas field is used in oil-field operations.

The gas consists of 99% methane and is believed to have originated within the Kenai Formation. There is insufficient evidence to determine whether the oil originated in the Kenai Formation or in underlying Mesozoic shales.

Seismic crews cost between $60,000 and $85,000 per month. Costs of deep exploratory wells on the Kenai Peninsula vary between $20 and $50 a foot, exclusive of road costs. Completed oil wells in Swanson River cost nearly $400,000. Road costs range from $10,000 to $50,000 per mile.

An increase in the tempo of exploratory drilling in 1962 is indicated.

LOHMAN, KENNETH E., U. S. Geological Survey, Washington, D. C.

STRATIGRAPHIC AND PALEOECOLOGIC SIGNIFICANCE OF TERTIARY DIATOMS OF CALIFORNIA AND NEVADA

Many areas of both California and the Great Basin contain diatom-bearing sediments which range in age from Late Cretaceous to Recent. The diatom assemblages in these rocks contain both short-ranging species that are useful for stratigraphic correlation and others, still represented in living assemblages elsewhere, that are useful for paleoecologic interpretations. Although thousands of square miles of diatom-bearing sediments have been mapped by petroleum geologists and have been penetrated and cored during drilling operations, the diatoms have been neglected as a stratigraphic and paleoecological tool. Some of the reasons most often presented for this lack of attention are claims that Foraminifera are easier to work with, are better known, and that laboratory manipulation of them is easier and more suited to assembly-line methods. This is true in part only, as assembly-line methods have been developed for handling large numbers of samples of diatomaceous sediments. Furthermore, diatoms are commonly found in sediments that are completely barren of Foraminifera or other fossils.

The present interest in palynology by the oil companies indicates that new techniques are no longer viewed with disfavor. As far as the necessary laboratory preparation and study are concerned, diatom samples can be prepared and significant species identified at least as expeditiously as samples containing pollen and spores.

Distinctive diatom assemblages are known from the Moreno Shale of Late Cretaceous and Paleocene (?) age and from many sedimentary formations in Eocene, Oligocene, Miocene, Pliocene, and Pleistocene rocks in California from the San Francisco Bay area southward. These assemblages from rocks of Cretaceous through Miocene age are virtually all marine. Pliocene rocks in different localities contain either marine or non-marine diatom assemblages. Pleistocene assemblages are dominantly non-marine.

Extensive areas of Miocene, Pliocene, and Pleistocene sediments in Nevada also contain distinctive non-marine diatom assemblages. In that region, diatoms, more commonly than otherwise, are the only fossils present. Here also the diatoms can provide much needed paleoecological information, as the Cenozoic lake basins varied greatly in depth, temperature, salinity, pH, and other factors of paleoecological importance.

MENARD, H. W., Scripps Institution of Oceanography, University of California, La Jolla, Calif.

GEOLOGIC HISTORY OF PACIFIC BASIN

The oldest fossils in the Pacific Basin are only of Middle Cretaceous age. They consist of coral reefs on the tops of extinct volcanoes which have more than 2 miles of local relief. Consequently, the basin must have existed long enough for the accumulation of an ocean more than 2 miles deep prior to Cretaceous time. In all probability the basin is of the greatest antiquity.

Fossils occur on enough atolls and guyots to permit the construction of a geological history of the Pacific during the last 100 million years. Vulcanism was widespread and volcanic islands were relatively common during early Tertiary time. Shortly after they reached full development, the volcanoes began to subside and an area of several million square miles in the central western Pacific apparently sank as a unit.

Tectonic events of the first magnitude have occurred in the eastern and southern Pacific but their geologic history is little known. Present seismicity and high heat flow suggest that the events may be continuing at present. Vertical displacements of 1 to 2 miles, and horizontal displacements of 200 to 400 miles have torn the sea floor into distinct blocks.

Unconsolidated sediment has filled the basin to a depth of only about 1,000 feet. Most of the sediment has been deposited very slowly by the accumulation of pelagic organic remains and continental dust. In a few places, notably off the United States, Canada, New Zealand, and Japan, turbidity currents are separated from the open basin by sediment traps in the form of island arcs and trenches.

MERRIAM, DANIEL F., HAMBLETON, WILLIAM W., AND COLE, VIRGIL B., State Geological Survey of Kansas, Lawrence, Kans.

PRECAMBRIAN BASEMENT ROCK TYPES IN MID-CONTINENT REGION

Recent compilation of data by the Kansas Geological Society's Basement Rocks Committee regarding the Precambrian in part of the Mid-Continent provides a framework in which to analyze further this rock complex. In Kansas alone, more than 2,100 wells are known to have penetrated the Precambrian, and approximately 50–60 tests a year are drilled into the basement. Studies are now in progress to attempt to determine detailed spatial relationships of these rocks and their intricate geologic history.

By using only preliminary information, it is possible to differentiate general categories of rock types at the Precambrian surface, which in Kansas is buried beneath Paleozoic rocks at depths from 500 to 9,000 feet. Rocdk types recognized include granite, granodiorite, syenite, diabase, rhyolite, and metasediments; the interrelations of these are exceedingly complex.

Sediments, chiefly alternating silicate-cemented sandstone and indurated shale, have been described from Missouri and may be abundant elsewhere. Outliers of schist capped by resistant quartzite form buried hills in central Kansas.

Diabase and related types of mafic rocks are found; syenite may be in the form of intrusive plugs. Extrusive rocks are represented by the rhyolite and associated suites. Granite of various kinds is by far the most extensively recorded rock type in the Mid-Continent; granodiorite has very limited distribution. In many areas, the deeply weathered and perhaps even reworked pre-Reagan (or Lamotte) basement rock constitutes "granite wash" assumed here to be Precambrian.

Geographic distribution of different rock types is suggestive of pre-Paleozoic structure. A wide band of metasediments through central Missouri, northeastern Kansas, northeastern Nebraska, and southeastern South Dakota forms a large arc convex southwest perhaps outlining the southwestern flank of the old Wisconsin Highlands. Present dip of the metasediments in west-central Missouri is known to be southwestward. Outside the belt of metasediments are igneous rocks and some metasediment outliers.

Potassium-argon ages determined by J. L. Kulp on five samples from Barton, Rush, and Morris Counties, Kansas, yielded dates of 1,165 to 1,460 million years, comparable with ages elsewhere in the central United States.

MERRILL, WILLIAM M., Department of Geology, Syracuse University, Syracuse, N. Y.

DISTRIBUTION OF LATE CRETACEOUS AND EARLY TERTIARY NON-MARINE STRATA IN WEST-CENTRAL ALBERTA

Investigation of Late Cretaceous and Tertiary non-marine strata of west-central Alberta has been undertaken for the Research Council of Alberta to solve problems of origin, correlation and age, structure, and nomenclature. Sediments are exposed in or underlie a belt extending from the Foothills northeast to the line Drumheller-Edmonton-Whitecourt and from Calgary-Drumheller northwest to the Athabasca River. Units of immediate concern include Edmonton, Brazeau, Paskapoo, and Saunders. Abundant well records afford an opportunity for correlation between northeastern and southwestern outcrop belts, as well as to study regional and local sedimentary patterns.

Purpose of this paper is to present the results of preliminary subsurface studies of regional relationships among the non-marine strata that are exposed in various areas. On the northeast, formations include the Belly River, Bearpaw (marine), Edmonton (all Cretaceous) and lower Paskapoo (Tertiary). The part of the section commonly recognized as Cretaceous is approximately 2,600 feet thick. Except for the marine Bearpaw, the units are almost entirely non-marine, composed of lenticular shales, siltstones, sandstones, and coal beds. Similar rocks, assigned to the Paskapoo, overlie the Edmonton.

In the subsurface, near Lacombe and not far west of Edmonton, the Bearpaw passes into terrestrial beds, so that non-marine units are not so easily separated. Southwestward, the entire sequence becomes coarser (sandstones more abundant, and coarser-grained), and thickens markedly on the order of 20 feet per mile, across the strike and toward the Foothills. Equivalent units in and near the Foothills include those called the Brazeau, Saunders, and Paskapoo, but published correlations are open to question.