9,000 feet. The oldest Upper Cretaceous rocks are Cenomanian in age (Goudkoff "H" zone), and these lie unconformably on quartz diorite, Sierra-type basement.

Exploration efforts in the initial stages were based on the drilling of what appeared to be structural anomalies. Well control since has indicated that structural closure is a minor contributing factor to gas accumulation. The bulk of the gas accumulation occurs in sand lenses along the flank of a gentle southeasterly plunging nose. Traps primarily are due to lateral and updip disappearance of these sands, and to less degree, to faulting. This lenticularity of sands has resulted in a high dry-hole ratio for normal field development.

C. L. Doyle, General Petroleum Corporation, Sacramento, California
Santa Fe Pool Development Santa Fe Springs Oil Field, California

Development of the Santa Fe pool was begun with the completion on February 2, 1956, of General Petroleum Corporation's Santa Fe 243 from intervals between 8,050 and 9,010 feet. The initial flow rate was 1187 B/D, 33.3° oil with 844 Mcf/D gas.

The pool underlies the Clark-Hathaway zone, the deepest previously known commercial zone in the field which was discovered and developed between 1928 and 1930. A number of sub-Clark-Hathaway tests have been drilled since 1930. Late discovery of the pool was a result of its small size and the fact that the accumulation is not coincident with the best structural location of the shallower zones.

The Santa Fe pool is of late Miocene age and composed of a series of relatively low-permeability sands with interbedded shales. Total sand in the section is 300–350 feet. Primary control of the accumulation is structural with the crest offset easterly from that of the shallower zones.

The pool has a productive area of about 100 acres. Water is present in members between the producing zones. Gas-bearing members are found at high structural position.

Development of the pool has been rapid, for in spite of its small size, ten operators hold productive land. Well spacing varies from less than an acre to 10 acres. Production practices have been highly competitive, with all sands of the pool open to production.

Archer H. Warne, Richfield Oil Corporation, Bakersfield, California
Structure of Wheeler Ridge Oil Field

Wheeler Ridge is a prominent topographic feature which stands out slightly from the southern margin of the San Joaquin Valley. This ridge is the surface expression of an anticline which contains nine or more oil-producing zones. The structure in all zones is that of an asymmetrical closed anticline, but the series of strata are separated into a hanging wall and a footwall group by a low-angle thrust fault. This thrust fault is nowhere exposed in outcrop, and it was long after discovery of the field that it became a known structural feature.

Maps and cross sections indicate that the movement on this fault was complex, and that, although the hanging wall and footwall anticlines are similar, they are genetically unrelated. Hanging wall structure therefore gave little clue, during early deeper exploration, to axial trends and the whereabouts of structural highs in the footwall block. Both structural blocks contain lesser faults, mainly of the thrust type. One of these is extensive enough to form an intermediate block containing several oil pools.

The Eocene rocks are cut by high-angle faults which cause anomalies in thickness and position of sands, and oil-water contact offsets.

Wheeler Ridge lies within the angle formed by the San Andreas and Garlock faults and is 12 miles north of their point of intersection. Also it lies on the probable extension of the steep buried White Wolf fault. Asymmetry of folds, multiple thrusting, and a component of strike-slip movement are effects to be expected in the area of the San Andreas-Garlock fault systems.

Donald B. McIntyre and John S. Shelton, Pomona College, Claremont, California
Preliminary Report on Tectonic History of Vizcaino Peninsula and San Benito Islands, Baja California, Mexico

Under the auspices of the Scripps Institution of Oceanography three visits have been made since April, 1955, to areas on the west coast of Baja California, 300–350 miles south of San Diego. Reconnaissance geologic maps have been prepared of the San Benito Islands and the nearby northwest part of the Vizcaino Peninsula.

Laboratory study of the rocks and fossils is not yet complete, but systematic examination of the areas shows the following.

1. Probably more than 10,000 feet of pre-Miocene chloritic sandstones, grits, and conglomerates occur in two series separated by faulting. A variety of intrusive and extrusive igneous rocks is confined to the older series, and probable Middle Cretaceous ammonites occur sparingly in the younger series.

2. These are unconformably overlain by more than 1,700 feet of highly fossiliferous middle Miocene siltstones, sandstones, and shales, locally of Monterey facies.

3. Unconformably on the Miocene are estimated 500+ feet of extremely fossiliferous Pliocene silts and sandstones.

4. Fossiliferous marine Pleistocene terrace deposits are faulted and gently tilted on the mainland. Emerged wave-cut benches are prominent on the islands.

5. The dominant structural pattern is a series of large northwest-trending faults separating the region into strips of older and younger rocks. Some faults have shear zones hundreds of feet wide containing a remarkable assemblage of more or less serpentinized basement rocks, most of which are not found in outcrops elsewhere. Four episodes of deformation can be differentiated; the earliest is pre-Miocene and the latest post-Pleistocene.

6. The San Benito Islands share in the northwest structural grain but lack the Miocene and younger rocks. Glaucophane schists, red cherts, graywackes, altered basic volcanics, and serpentine are highly sheared and suggest that these islands may be entirely within a large northwest-trending fault zone.

JOSEPH LIPSON, JACK EVERNDEN, AND GARNISS CURTIS, University of California, Berkeley, California
Potassium-Argon Dating of Sedimentary and Igneous Rocks

This laboratory has developed techniques for dating samples of low radiogenic argon content. Results of three principle lines of study utilizing these techniques will be reported. (1) Ages of a series of well classified glauconites from New Zealand ranging from the Cretaceous (55 million years) to the Miocene (20 million years). (2) Ages of two near surface igneous micas from Sutter Buttes, California, less than two million years in age. (3) Ages of a series of related plutonic igneous micas from the Sierra Nevada around 90 million years in age.

JACK W. KNIGHT, Petroleum Research Corporation, Denver, Colorado
Hydrodynamics—Practical Exploration Tool

Those effects of hydrodynamics which result in tilted oil pools have been known for some time, but the problem has been whether or not a practical application of these effects could be used in exploration. What is not commonly realized is that hydrodynamics plays a very important part in stratigraphic, fault, and unconformity oil accumulations which do not exhibit a noticeably tilted oil/water contact.

In tilted oil pools the tilt of the oil/water contact for a potentiometric surface increases as the gravity of the oil decreases. This tilt is accomplished, not by rapid movement of water through the aquifer past the oil/water interface, but rather by the pressure drop across the area of the oil accumulation due to extremely slow movement of the water through the pores of the aquifer.

Under static conditions, the size of an oil accumulation below a pinch-out or against a fault is dependent solely on the entry pressure of the barrier. If hydrodynamic conditions exist, however—and this appears to be almost universal—the size of the accumulation is increased or decreased from what would normally be expected, according to the direction of hydrodynamic force. This can result in very large oil accumulations or barren "traps" under what appear to be the same structural and stratigraphic conditions.

The practical application of hydrodynamics begins with the mapping of the potentiometric surface of the various reservoirs of interest. The map is then used in conjunction with the geology of the prospects to be evaluated and the gravity of the oil expected in the trap.

The application of hydrodynamics is developing into a very important exploration tool.

DON J. MILLER, U. S. Geological Survey, Menlo Park, California
Tertiary Sequence on Northeast Coast of Gulf of Alaska

Sedimentary rocks of Tertiary age exceeding 25,000 feet in composite thickness are intermittently exposed in a lowland and foothills belt 300 miles long and 2–40 miles wide on the northeast coast of the Gulf of Alaska. Three major subdivisions of the Tertiary sequence are recognized: (1) interbedded and intertonguing non-marine, brackish-water, and shallow-water marine strata that contain a tropical to warm-temperate flora and marine invertebrate fauna of late Eocene age and include the Stillwater, Kushtaka, and Tokun formations in the Katalla district and an unnamed formation in the Yakataga and Malaspina districts; (2) shallow- to deep-water marine strata that contain a warm-temperate to subtropical invertebrate fauna of Oligocene and early Miocene age and include the lower part of the Katalla formation in the Katalla district, the Poul Creek formation in the Yakataga district, and the basal part of the exposed Tertiary sequence in the Lituya district; (3) shallow-water marine strata, in part marine tillite, that contain a cool-temperate to sub-boreal invertebrate fauna of late Miocene and Pliocene age and include the upper part of the Katalla formation in the Katalla district, the Yakataga formation in the Yakataga and Malaspina districts, and the upper part of the Tertiary sequence in the Lituya district. Oil seeps and other indications of petroleum are associated mainly with the two lowest subdivisions of the Tertiary sequence.

Remains of marine mammals have been found in the upper part of the Poul Creek formation in association with Mollusca and Foraminifera that indicate correlation with the Blakeley formation