range from 300–750 MCF per acre foot and 400–750 barrels per acre foot. Reservoir engineering studies of the character and behavior of some Morrow sands indicate that they should be capable of permitting efficient "sweep out" under secondary recovery.

Subsurface geology and imaginative thinking are essential to the exploration approach of the Morrow. Gravity and seismic methods are being used with success. This area is in the early stages of development, and many reserves remain to be found.

GEORGE DOBERVICH, consultant, Amarillo, Texas
RICHARD L. PARKER, Petroleum Exploration, Inc., Amarillo, Texas

Morrowan Series of North Texas Panhandle

Morrowan sediments are recognized in the subsurface over most of the northern Texas panhandle. Morrowan terminology is based primarily on lithology and stratigraphic sequence with some faunal identification. The rocks are predominantly shales with less amounts of limestones and sandstones. The sandstones are of prime economic importance in the production of oil and gas distillate, and account for a greater part of the recent discoveries in the panhandle.

ABSTRACTS

PACIFIC SECTION MEETING, LOS ANGELES, NOVEMBER 7 8, 1957

R. J. BEAN AND R. C. SPIVEY, Shell Oil Company, Los Angeles, California

Geological and Geophysical Studies at Railroad Valley, Nevada

In Paleozoic time 20,000 feet of sediments accumulated in the Railroad Valley area. Limestone and dolomite make up about 85 per cent of these sediments, with 5–10 per cent sandstone and the rest shale. Fossils and lithologic characteristics indicate most or all of these sediments were deposited in shallow water, but subsidence of the area was nearly continuous, and all of the Paleozoic systems are represented in the sequence of beds.

In late Paleozoic or early Mesozoic time the area was uplifted and no seas are known to have covered it since that time. Erosion produced a surface with slight to moderate relief, and beds ranging in age from Devonian to Permian were exposed. On these upper Paleozoic strata Tertiary lake and stream sediments and volcanic materials were deposited in thicknesses ranging up to 15,000 feet. These Tertiary beds can be subdivided into four groups which can be recognized in wells in Railroad Valley and in several nearby mountain ranges. Some diastrophism occurred in early and middle Tertiary time, resulting in several widespread unconformities, but the diastrophism which produced the present basin-and-range topography occurred after deposition of all of these Tertiary beds.

Seismic and gravity surveys were used to delineate structural features in the sediments beneath the valley. Both methods show that Railroad Valley is an asymmetrical basin with the greatest depths on the east. The gravity survey shows a major border fault probably is present on the east flank of the basin, and a series of horsts and grabens parallel the mountain on the west side of the valley. Seismic reflections outlined several structural highs which were tested; one of these produced oil in the Eagle Springs field.

Seismic reflections are not of the best quality in the valley, but the most numerous, reliable, and continuous reflections originate from within Tertiary and Quaternary clastic deposits. Reflections from greater depths are fragmentary, but often are useful. In some instances, the unconformity at the top of the Tertiary volcanics could be mapped. Reflections could not be obtained on the fan deposits at the edge of the valleys, where major border faults probably occur. In these regions gravity data were used to trace the faults, obtain estimates of their dips, and to outline the structure of the Paleozoic surface. Estimates of depth to Paleozoic rock in several basins along the axis of the valley could also be made from gravity data; these depths range from 7,000 to 15,000 feet.

F. G. STEHLI, Pan American Petroleum Corporation, Tulsa, Oklahoma
C. R. ALLEN AND L. T. SILVER, California Institute of Technology, Pasadena

The west side of Baja California between 30° and 32° North exhibits a terrane of deformed pre-batholithic eugeosynclinal rocks, abundant batholithic and smaller intrusive bodies, and a coastal zone of relatively undeformed post-batholithic sediments.

The pre-batholithic section of great but unknown thickness consists of basic and intermediate volcanic pyroclastics and flows, graywackes, and rare carbonates. It has been intensely folded and faulted, and near contacts with plutonic intrusives is mildly to strongly metamorphosed. A persistent limestone zone has been a useful stratigraphic unit in regional study. Numerous fossils taken from this zone and from other horizons indicate Albian age.

Plutonic rocks of considerable variety intrude the eugeosynclinal terrane but occur most com-

monly away from the coast. Absolute age determinations by both Larsen and isotope dilution techniques have confirmed previous regional correlation of the batholith of Baja California with the Southern California batholith.

Relatively undeformed post-batholithic rocks along the Pacific Coast lie across beveled erosion surfaces on both pre-batholithic and plutonic rocks, clearly establishing the age relations. Abundant fossils indicate that the oldest exposed sediments in this sequence are of Maestrichtian age.

A close point of correlation has been established between the relative and absolute time scales. The absolute age of the intrusive rocks, $115(\pm 10)\times 10^6$ years, falls in the interval of time bracketed by the Albian below and the Maestrichtian above. The chronological and geological relations of the Baja California rocks to those of adjacent regions are considered.

DONALD A. HENDRICKSEN, Richfield Oil Corporation, Ojai, California

Fillmore Oil Field, Ventura County, California

The Fillmore field is a relatively minor Ventura basin oil field located west of and adjacent to the city of Fillmore. It is one of several recent discoveries in the Santa Clara Valley area between the Oak Ridge fault on the south and the San Cayetano fault on the north.

The Fillmore field is an excellent example of multiple-zone primary stratigraphic trap accumulation, independent of local structural closure. Two middle Pico (Pliocene) sand zones have produced to date. Closure in both zones is effected by rather abrupt updip pinch-out on a low southeastward-dipping homocline.

The Spalding pool was discovered by Standard Oil Company in April, 1954, and development of the field has been continuous and orderly since then. The Perkins pool, slightly shallower but more limited in areal extent, was discovered by Humble Oil and Refining Company in January, 1957. Both zones have short oil columns, small free gas caps, level water tables, and relatively narrow productive areas elongate essentially parallel with the regional northeasterly strike.

At present the field is 3 miles long and has maximum width of 3,200 feet, with a proved productive area of approximately 800 acres. Average well depth is a little more than 14,000 feet, and gravity of the oil is 27°–35° API. Cumulative production to August 1, 1957, was 2,387,000 barrels, and average production as of that date was 7,984 B/D from 22 wells.

The productive limits of the two known pools have been fairly well established except at the east end of the field, where development is continuing at present. Future expansion of the field depends on its easterly extent and possible discovery of additional Pliocene sand pinch-out traps.

TOD P. HARDING, Humble Oil and Refining Company, Chico, California

Llano Seco and Perkins Lake Gas Fields, Butte and Tehama Counties, California

The Perkins Lake and Llano Seco gas fields are in the north point of the Sacramento Valley 12 and 16 miles, respectively, southwest of the city of Chico.

The Llano Seco field was discovered in November, 1954. Production is from the Upper Cretaceous Estes and Sannar sands at a depth of approximately 3,300 feet. Structurally, the field is on a broad, symmetrical north-trending anticline.

The larger Perkins Lake field, discovered in September, 1955, produces from the lower Eocene "Perkins Lake" sand at depths ranging from 3,365 to 3,505 feet. The structure is an elongate, northeast-trending anticline.

Stratigraphically, the two fields are quite dissimilar. The Llano Seco field has an almost normal sequence of lower Eocene and Upper Cretaceous beds, whereas the Perkins Lake field, being in an Eocene erosional gorge, has a lower Eocene section which is greatly thickened at the expense of the Upper Cretaceous section. The pronounced unconformity at the base of the Eocene is found 1,300–1,800 feet lower at Perkins Lake than at Llano Seco, whereas within the Cretaceous the two fields are nearly flat structurally.

HAROLD L. FOTHERGILL, Union Oil Company, Orcutt, California

Oil Creek Field, San Mateo County, California

The Oil Creek field is in the southeast corner of San Mateo County, in the Santa Cruz Mountains. The discovery well was the Union-Richfield's Costa No. 1, completed in October, 1955, from the interval 2,055–2,206 feet, with production from the Butano sandstone of Eocene age. The initial production on the pump was 100 B/D, 10% cut, 43.2°, 45 MCF. As of September 1, 1957, the well had produced an approximate total of 25,775 barrels net oil and has a present daily rate of 30 barrels net oil.

The surface structure is anticlinal and was delineated in the field by close coordination of surface mapping and paleontological control. The subsurface structure is that of a faulted anticline or a bowing against a fault.

The stratigraphic section in the field consists of the San Lorenzo and Butano formations.