TENNANT BROOKS, OTTO HACKEL, ROBERT L. JOHNSTON, HORACE HARRINGTON, ADDISON CATE, JOHN WELLS, and PAUL MCGOVNEY.
Southern San Joaquin Valley Cross Section.

The correlation section extends from outcrop in Pyramid Hills, Sec. 16, T. 28 S., R. 29 E., M.D.B.&M., west through the Round Mountain, Kern River, Fruitvale, Gosford, Ten Section, Coles Levee, Elk Hills, and Cymric oil fields to an outcrop section in the vicinity of Zemorra Creek in Sec. 9, T. 29 S., R. 20 E., M.D.B.&M. The section illustrates the correlation of the various surface and subsurface lithologic units with the recognized time-stratigraphic units across the valley.

JOHN C. WELLS, Standard Oil Company of California, Elk Hills.
Geology of Elk Hills, Kern County.

The Shallow zone at Elk Hills was discovered in 1919; the Stevens zone was discovered by Standard in 1941. In 1944, the Navy and Standard lands were joined in a unit with the Standard as operator, and Congress authorized drilling of undeveloped parts of the Reserve to increase the production from 15,000 to 65,000 barrels per day. At the end of the war, production was cut back to the former figure which has subsequently been reduced to a current production of about 5,000 barrels per day from the Shallow zone and 3,000 barrels per day from the Stevens. Since the war, exploratory and development programs have been carried on.

The present known stratigraphic column at Elk Hills extends from the Pleistocene Tulare formation to the lower Miocene Vaqueros. Shallow-zone production is established in sands near the base of the Pliocene San Joaquin and in the upper 600 feet of the Pliocene Etchegoin formations. Stevens zone production is established in sands and fractured shale in the upper Miocene McLure formation. No commercial production has been established below the Stevens, but formation tests of the lower Miocene Carneros sand have shown the presence of gas and some oil.

The Shallow-zone structure is a broad faulted anticline similar to the surface structure. At the top of the Stevens, however, the structure consists of three *en échelon* folds, the larger eastern fold being fairly symmetrical and the two western structures asymmetrical with nearly vertical northern flanks. Evidence indicates at least three periods of structural movement during and since upper Miocene time.

ROBERT E. TREFZGER, United States Bureau of Reclamation, Santa Barbara.
Geology of Tecolote Tunnel.

The Tecolote Tunnel, one of the essential features of the Bureau of Reclamation's Cachuma Project, is located in the southeast part of Santa Barbara County, California. The tunnel, now under construction through the Santa Ynez Mountains, connects Cachuma Reservoir in the Santa Ynez Valley with the narrow coastal plain in the Santa Barbara region.

Rocks penetrated have a stratigraphic thickness of more than 10,000 feet, range from upper Miocene to middle Eocene age, and include the following formations: Monterey, Rincon, Vaqueros, Sespe, Alegria, "Coldwater" (Sacate), Cozy Dell, Matilija, Anita (Juncal), and possibly Jalama (Upper Cretaceous age).

Three major structural units are found along the tunnel line: (1) the south limb of a major east-west-trending anticline, cut off on the north side by the Santa Ynez fault; (2) a much broken, moderately sheared and deformed, homoclinal sequence which is bounded on the south by the Santa Ynez fault and on the north by a minor fault zone; and (3) a minor northwest plunging syncline.

Regularly spaced samples of rock in the tunnel have been and are being taken for the purpose of lithologic, paleontologic, and porosity-permeability studies. Preliminary work on the microfossils from these samples reveals a prolific Miocene fauna but a rather sparse yield from the Eocene.

Parts of the tunnel have been logged by using conventional radioactivity (gamma ray) logging equipment with lead shields spaced normal to the ionization chamber. Favorable correlations are found between the log and lithologic units.

Uncemented sands, washed and blown into the tunnel by formational water and gas, have caused much delay in progressing through the Santa Ynez fault zone. Large flows of water, more than 4 million gallons per day, from fractured parts of the Cozy Dell formation have also impeded progress. Very minor traces of petroleum have been observed in both of these sections of the tunnel.

CHARLES W. PORTER, Pacific Western Oil Corporation, Bakersfield.
Geology of the Belgian Anticline Field, McKittrick Area.

The Texas Company completed "Westpet" No. 1, a 77 location in Sec. 29, T. 30 S., R. 22 E., M.D.B.&M., on October 22, 1946, for the first deep-zone production on the Belgian anticline. This discovery well was completed from the top 30 feet of the Oceanic sand, Refugian (Oligocene) in age, penetrated at 5,143 feet. The initial flow test produced gas and condensate at 140 barrels per day rate, 72° gravity, 16/64-inch bean, and 2,230 MCF gas. Six feet of *Phacoides* oil sand, at 4,955–4,961 feet, was left behind the pipe.

Since this discovery, 5 years of exploration drilling by The Texas Company, Pacific Western Oil Corporation, Tide Water Associated Oil Company, Trico Oil and Gas, and The Ohio Oil Company have resulted in drilling 42 test wells and three non-productive redrill holes to evaluate approximately 1,530 acres. As of September 15, 1951, there were 25 wells producing either gas or light-gravity oil, 15 dry holes, and one abandoned producer. This low exploration and development ratio of 5:3 reflects the complexity of the geology and structure of the Belgian Anticline field.

The structure, essentially, is a southeast-plunging anticline. The north flank has been shoved over by a series of northwest-southeast-trending south-dipping thrust faults. This asymmetric fold has been broken into a complex fault block pattern by the combination of both high-angle thrusts and normal cross faults. Three principal unconformities truncate the structure from east to west: one at the base of the Miocene (lower Zemorrian-Salt Creek shale), another at the base of the Saucesian, and the third at the base of the middle Miocene (Gould shale).

Production has been established from the Eocene Point of Rocks sand, the only blanket sand across the structure, the Oligocene Oceanic sand, the major productive sand of the field, and from the Miocene lower Zemorrian *Phacoides* sand, the uppermost productive zone. Production from the Oceanic sand has been established from drill depths ranging from 4,480 to 6,055 feet. The Carneros sand and the fractured upper Miocene shale as yet have not been productive.

CURTIS H. JOHNSON, General Petroleum Corporation, Los Angeles.
Case History of Helm Oil Field, Fresno County.

A seismic map prepared by Western Geophysical Company for General Petroleum Corporation, preceding the discovery of the Helm oil field in Fresno County, California, by the Amerada Oil Company in October, 1941, is compared with a recent structure map based on the results of drilling, and good agreement is seen.

Structure and stratigraphy now known from drilling are compared with reflection-seismograph cross sections obtained by the General Petroleum Corporation and conclusions are drawn about the optimum seismic field and interpretative techniques in this type of area.

The local results of a gravity-meter survey by the Brown Geophysical Company for the Seaboard Oil Company are shown and interpreted, though neither the Amerada nor the General Petroleum Company used gravity results as a guide in seismic programs.

L. F. MALARIN, Standard Oil Company of California, Bakersfield.
Durham Gas Field.

A geological-geophysical case history. Structure of the Durham gas field as determined from seismograph data and as verified by subsequent drilling.

K. E. BURG, Geophysical Service, Inc., Dallas, Texas.
Exploration Problems of the Williston Basin.

The various types of structures to be encountered in the Williston basin and the application of the seismograph and other geophysical tools to the location of these structures are discussed.

Specific examples in the form of seismograph record cross sections show the ability of the reflection seismographs to locate these structures. Many of the unique problems encountered in the area are illustrated and suggested solutions outlined.

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