STRUCTURE CONTOURS ON TOP OF THE VEDDER SAND, SOUTHEASTERN SAN JOAQUIN VALLEY, CALIFORNIA

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ILLUSTRATIONS

Structure contours on top of the

Vedder sand, southeastern San Joaquin Valley, California

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Abstract

The Vedder sand (Miocene) is one of the principal oil sands of the southeastern San Joaquin Valley. Oil accumulation in this sand is controlled by structural traps, with stratigraphic traps playing a very minor role. Near the east border of the map area the traps are principally formed by normal strike faults. In the western and southern parts of the map area anticlinal folding is the dominant structural feature controlling the accumulation of oil. Cumulative production from the Vedder sand to January 1, 1965, is approximately 400 million barrels of oil.

Introduction

Discovery of oil in the Vedder sand of Diepenbrock (1933) of early Miocene (Zemorrian) age was made in July 1926 when Shell Oil Co. found the Mount Poso field (pl. 1) by completing their well Vedder 1 in sec. 9, T. 27 S., R. 28 E., Mt. Diablo meridian, Kern County, Calif. The discovery well was drilled to a depth of 3,130 feet into granitic basement rocks; it was then plugged back to 1,979 feet and completed for an initial production of 300 barrels of 15.5° API gravity oil per day from approximately 85 feet of medium- to coarse-grained sandstone with intercalated hard thin calcareous shell beds. This important discovery, in a previously nonproductive sand and in a type of structural trap (fault trap) from which there had been no prior commercial production on the east side of the San Joaquin Valley (fig. 1), stimulated search for similar accumulations elsewhere.

Some of the knowledge gained from 36 years of exploration of the Vedder sand, including the location of most oil fields producing from this unit and the generalized regional structure of the east side of the southern San Joaquin Valley, is depicted by structure contours on top of the sand (pl. 1). North of the active White Wolf fault structure contours are shown on plate 1 at intervals of 200 and 400 feet on top of the Vedder sand, as picked from electric logs. South of the White Wolf fault, the contour datum is the "Z_1" electric log marker, which is believed to approximate closely the stratigraphic position of the top of the Vedder sand of the Round Mountain-Mount Poso area. In areas where a 200-foot contour interval is used, adequate structural control permits a relatively close interpretation of the structure. In part of the Maricopa basin (fig. 1), the inadequate amount of subsurface information on the structural complexities permits only a generalized interpretation of the structure with contours at 400-foot intervals. The deeper part of the Maricopa basin is not contoured because no wells there have reached the Vedder sand.

Appreciation is expressed for the many courtesies, suggestions, and assistance generously extended by the various oil companies operating in the area. Published structural information (fig. 2), especially that of

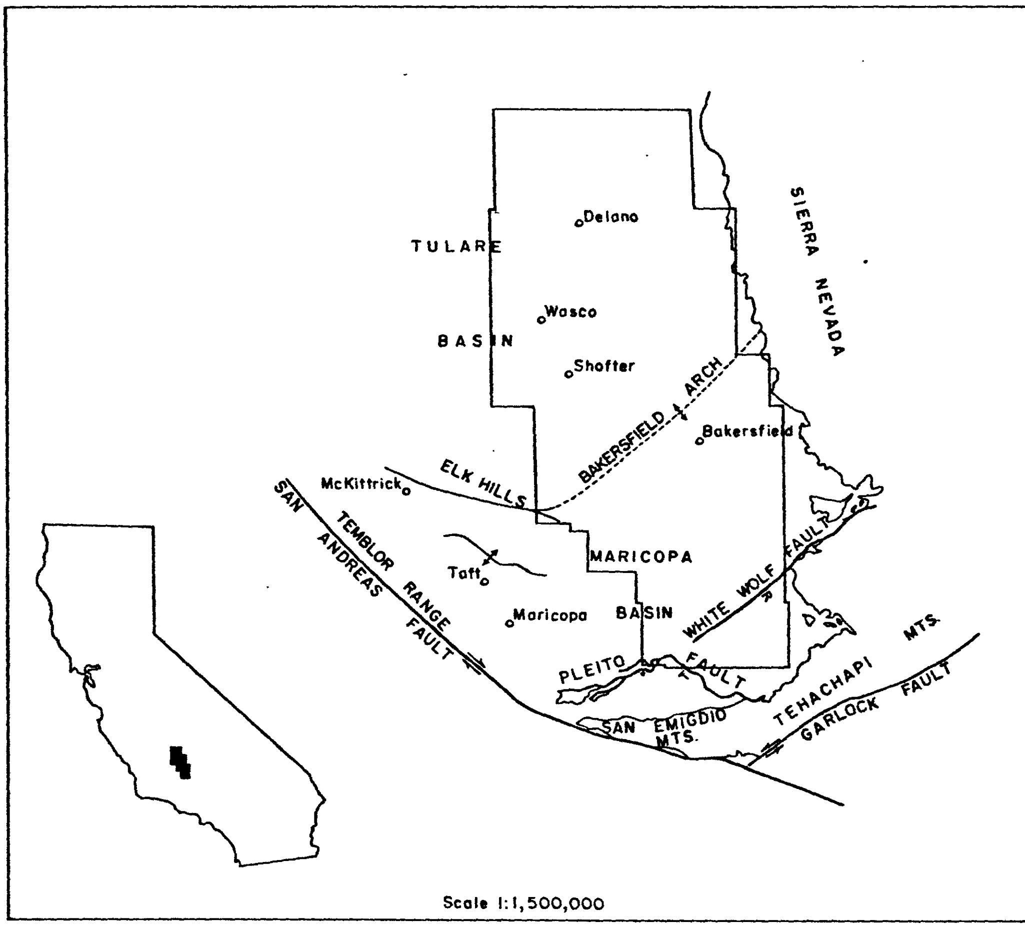

FIGURE I. Geologic index map of the southern San Joaquin Valley.

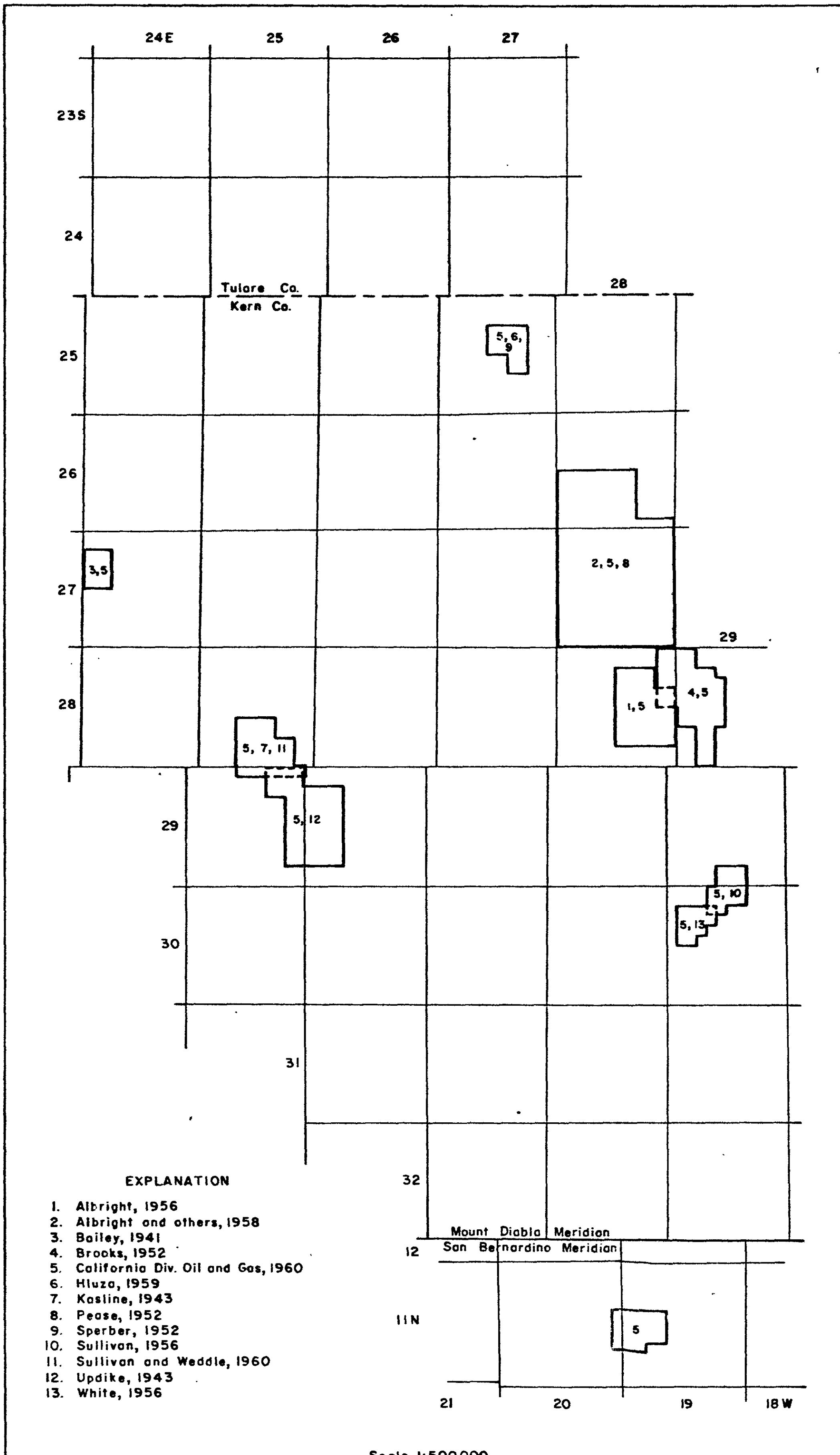

FIGURE 2.—Index map to references consulted in compilation of structure contours.

the California Division of Oil and Gas, was freely used. Detailed structural data on the various individual productive areas within the map area are available in the selected references, especially in that of the California Division of Oil and Gas (1960).

Description of the Vedder sand

In the discovery area, the productive sand was given the local name of Vedder zone by Wilhelm and Saunders (1927, p. 8-9). In January 1933, Shell Oil Co. found a second, lower productive sand in their well Vedder 6, also in sec. 9, T. 27 S., R. 28 E. This second sand, nearly 200 feet thick, is separated from the overlying productive sand by interbedded less permeable clayey fine oily sands and barren silts 40 to 60 feet thick. Diepenbrock (1933, p. 18, pl. 2) extended the informal name Vedder sand to include all strata in the discovery area between the top of the upper productive zone and the underlying continental Walker Formation of Wilhelm and Saunders (1927). He designated the two productive zones the upper and lower Vedder zones, separated by the intervening Vedder silt. Subsequent study of the interval included in the Vedder sand by Diepenbrock has shown that it may be further subdivided in the eastern part of the map area, from top to bottom, into the upper, lower, third, and fourth Vedder sands, with intervening brown organic siltstone and impermeable "gritstone" (Albright, Hluza, and Sullivan, 1958, p. 7, 13, 16). All these sands are productive, although not necessarily in the same well.

In the discovery well, the Vedder sand consists of 750 feet of fine- to coarse-grained interbedded sands and siltstones. These sands and siltstones are of Zemorrian age and are unconformably overlain by a basal grit bed, 10 to 15 feet thick, of Saucesian age consisting of fine- to coarse-grained sand with black chert granules and quartz pebbles in a clayey silt matrix (Diepenbrock, 1933, p. 15; Hackel and Krammes, 1958, p. 2). Elsewhere, the Vedder sand ranges in thickness from 0 feet at its featheredge to more than 2,000 feet near the southern end of the valley.

Figure 3, a diagrammatic section along part of line A-A' from the North Coles Levee area, T. 30 S., R. 25 E., eastward into the discovery area, T. 27 S., R. 28 E., shows the subdivisions of the Vedder sand in and near the discovery area and the general westerly increase in thickness of the entire unit. It also shows the gross change in lithology, as reflected by electric logs of wells in the North Coles Levee and the discovery areas.

Although the Vedder sand of Diepenbrock is widely recognized as a distinct stratigraphic unit by the California petroleum industry, no formal type section for the unit has ever been designated or described. Over much of the east side of the San Joaquin Valley the Vedder sand is characterized by thick clean medium- to coarse-grained well-sorted weakly calcareous permeable sandstone and interbedded brown organic siltstone. The clean sandstone and organic siltstone grade westward into less permeable siliceous well-cemented fine-grained silty sandstone and siltstone in the deeper part of the valley. Because of the decrease in permeability toward the center of the valley and the increase in the depth of wells required to reach the sand, the Vedder sand has not been as thoroughly tested in this part of the basin as it has nearer the east side.

Prominent beds of grit mark the base of the Vedder sand (Hackel and Krammes, 1958, p. 2). Other grits occur at the top and are overlain by thin fine- to coarse-grained sandstone with a matrix of clayey silt in most areas. Lenticular beds of grit are also common within the Vedder sand.

Stratigraphic relationships

Continental rocks of Eocene to Miocene age crop out along the southern border of the San Joaquin Valley and along the east side of the valley (Repenning, 1960, figs. 6, 7, 8). These deposits, which Stock (1920, p. 269) called Tecuya Beds near the southern end of the valley and Wilhelm and Saunders (1927, p. 9) named Walker Formation in the Mount Poso area, consist of tan to red coarse-grained sandstone and granitic conglomerate, with interbedded red and green shale in some areas. Northward and westward, toward the central part of the valley, subsurface exploration shows that the continental beds intertongue with nearshore marine and shale units of contemporaneous age (Repenning, 1960,p. 28-37). The first of the marine Miocene units to be deposited was the Vedder sand, embracing all marine strata of Zemorrian age on the east side of the valley.

The Vedder sand is not recognized in the main area of the Edison field in the east-central part of T. 30 S., R. 29 E. In this area, the Vedder probably wedged out against a basement high that was present during early and middle Miocene time, as progressively younger beds overlap pre-existing beds and in turn wedge out against the basement complex toward the central part of the main area. The Vedder sand rests upon basement rocks from the vicinity of the Edison field south to the Tejon Hills field in T. 11 S., R. 18 W., San Bernardino meridian. Beds of Refugian (late Oligocene) age underlie the Vedder sand in the western and southern parts of the map area. These beds pinch out in an easterly direction so that northwest of the Edison field the Vedder sand rests upon beds of Domengine to Tejon (middle to late Eocene) age in a belt roughly paralleling the east side of the valley (Clark, 1941, p. 947). Farther updip, the Vedder sand either rests upon continental beds assigned to the Walker Formation or it grades into the Walker so that no marine Vedder sand is recognized in the outcrop (Hackel and Krammes, 1958, p. 2). In the area between the Tejon Hills and Wheeler Ridge fields, the Vedder sand grades southward into the continental Tecuya Beds of Stock (1920).

Stratigraphic correlations

The southwest to northeast stratigraphic relationships of the Vedder sand and other stratigraphic units in the contoured area are shown graphically by the section along A-A' (fig. 3). A correlation chart prepared by Church and others (1957) shows the relationship of the Vedder sand with other stratigraphic units in the area and the equivalent units on the west side of the San Joaquin Valley. Repenning (1960, fig. 3) shows the relationship of the Vedder sand to the early Miocene part of the Vaqueros Sandstone and the early and middle Miocene Temblor Formation in the northern San Joaquin Valley. The Vedder sand essentially correlates with the Vaqueros Sandstone in the northern part of the valley as it does with the Vaqueros Sandstone and the basal part of the Rincon Shale of early Miocene age in the Ventura basin, in the western Santa Ynez Mountains and along the adjacent south coast, and in the eastern Los Angeles basin. Characteristic microfossils of the Vedder sand include *Bulimina carnerosensis*, *Cibicides pseudoungerianus* var. *evolutus*, *Eponides kleinpelli*, *Nonion incisum* var. *kernensis*, *N. umbilicatulum*, *Pseudoglandulina* cf. *conica*, *Siphogenerina multicostata*, *S. nodifera*, *S. smithi*, and *Uvigerina gallowayi*. The lower limit of the Vedder sand can locally be determined by the *Nonion affinis* faunule.

Regional structure

The regional geologic structure of the Vedder sand is illustrated by the subsurface contours (pl. 1) and by the section along line A-A' (fig. 4). They show the progressively increasing depth and thickness of the Vedder sand from east to west, the influence of the Bakersfield arch on the regional structure, and the concentration of faults near the east side.

The dominant structural feature of the east side of the San Joaquin Valley is that of a faulted regional homocline, formed by the westward tilting of the Sierra Nevada block. Some warping of the Sierra Nevada block during Cenozoic time is reflected in the sedimentary rocks by such features as the Bakersfield arch. This arch, which plunges westward through the central part of the contoured area, forms the eastern portion of a continuous structural uplift extending across the entire southern San Joaquin Valley. The uplift effectively subdivides the San Joaquin Valley into two distinct subbasins (fig. 1), the elongate Tulare basin to the northwest and the oval Maricopa basin to the southeast (Hoots and others, 1954, p. 116).

Along the east side of the map area (pl. 1), especially near the east end of the Bakersfield arch, the regional homocline is broken by a conjugate system of normal faults and some reverse faults, with displacements ranging from a few feet to several hundred feet (Nugent, 1942, p. 900). Faults of northwesterly strike are more numerous than those of northeasterly trend. Westward, toward the deeper part of the basin, the intensity of faulting decreases and anticlinal folds are the dominant structural feature modifying the regional homocline. In the Tulare basin these anticlinal folds are aligned in a northwesterly direction, nearly parallel to the regional trend of the San Joaquin Valley (Hoots and others, 1954, p. 116).

In the Maricopa basin, numerous strike and oblique faults and some dip faults, both normal and reverse, are present along the eastern and southern borders, with resulting complex structure in this area. Some of the dip faults along the east border extend southwest into the deeper part of the basin. One of these faults, the White Wolf fault, near the southern end of the valley, apparently displaces the Vedder sand vertically in excess of 10,000 feet (Church and others, 1958). The principal anticlinal folds, such as Wheeler Ridge, are aligned in a more westerly direction than those in the Tulare basin, approaching parallelism with the regional strike of formations along the southern end of the valley (Hoots and others, 1954, p. 116). Although no wells have reached the Vedder sand in the deeper part of the Maricopa basin, the maximum depth to this sand is probably in excess of 25,000 feet as illustrated by de Laveaga (1952, p. 102-103).

Oil accumulation in the Vedder sand

Oil accumulation in the Vedder sand is controlled by structural traps, with stratigraphic traps playing a very minor role. Near the east border of the map area, these structural traps are principally formed by normal strike faults (Nugent, 1942, p. 900). In the western and southern parts of the map area, anticlinal folding is the dominant structural feature controlling the accumulation of oil in the Vedder sand.

The Vedder sand is one of the most productive oil sands in the eastern part of the valley and is an important sand in other areas. Cumulative production from this unit in the Baker, Dominion, Dorsey, Granite Canyon, Mount Poso, and West Mount Poso areas of the Mount Poso field, the Coffee Canyon, Pyramid, Sharktooth, Alma, and Round Mountain areas of the Round Mountain field, and the Wheeler Ridge, Tejon Hills, North Tejon, Edison, Greeley, Rio Bravo, Strand, Jasmin, Shafter, and Dyer Creek fields to January 1, 1965 is approximately 400 million barrels of oil. Production from the "A-2" sand in the Wasco field, although classified as Vedder production by the California Division of Oil and Gas (1960, p. 282-283), is not included as the "A-2" sand is stratigraphically higher than the Vedder sand (Bailey, 1941, p. 67, pl. 3; Hawley, 1952, p. 125). The Dyer Creek and Shafter fields are now abandoned.

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