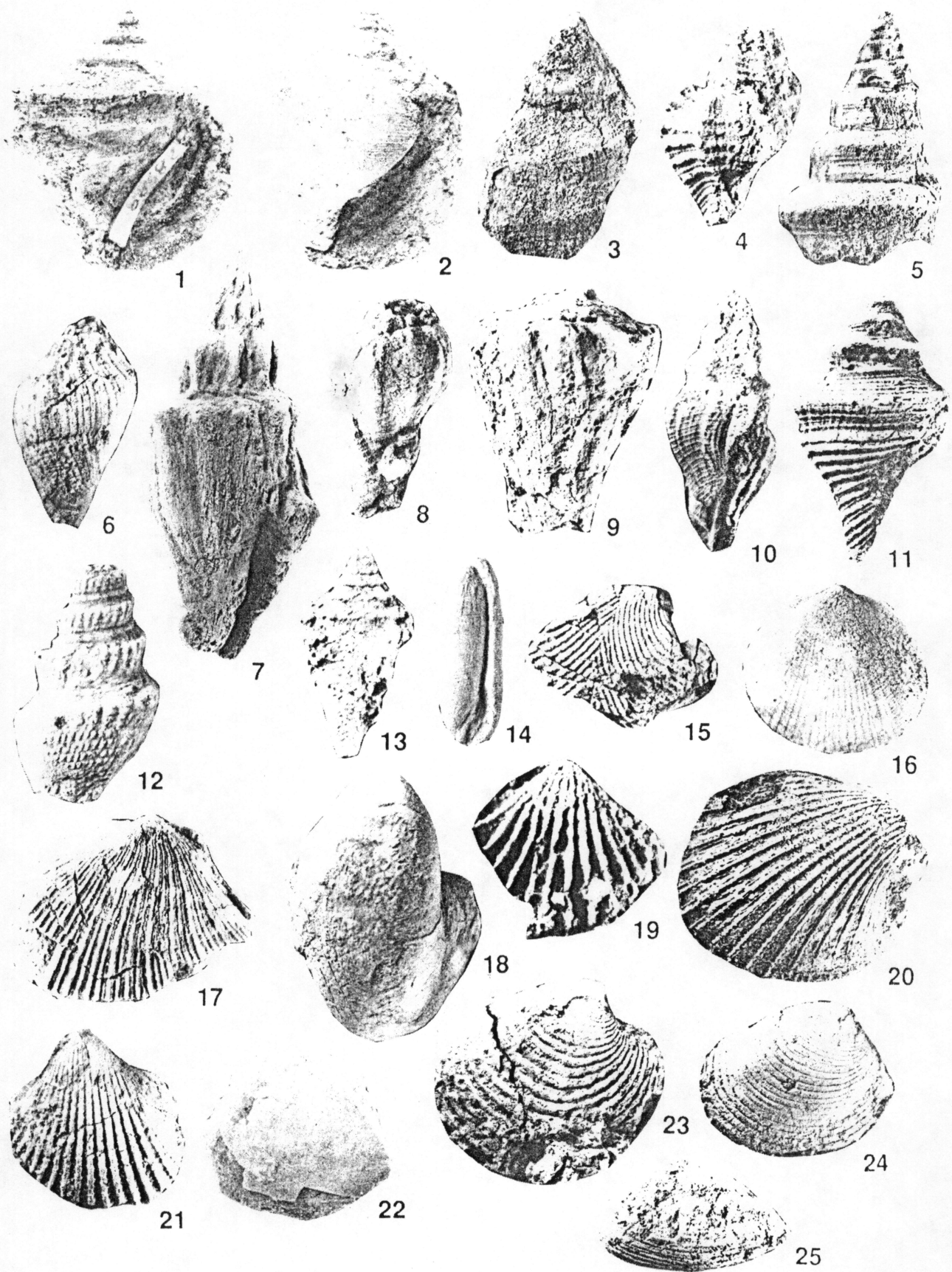


Plate 2

Figures 1-26. Maniobra Formation gastropods and bivalves identifiable as to species or subspecies. Figs. 1-15, gastropods. Figs. 16-26, bivalves.

1. *Galeodea* cf. *G. gallica* Wrigley, 1934, apertural view, x1.7, height 27.6 mm, width 24.7 mm, UCLA hypotype 28988, LACMIP loc. 23779 = CSUN loc. 662. LACMIP hypotype 8836
2. *Phalium* (*Semicassis*) *louella* Squires and Advocate, 1986, apertural view, x1.7, height 27.6 mm, width 22.3 mm, LACMIP holotype 7166, CSUN loc. 665. X
3. *Ficopsis remondii crescentensis*?, partial specimen, abapertural view?, x2.3, height 20 mm, width 15 mm, LACMIP hypotype 11467.
4. *Favartia* ? sp., abapertural view, x4.9, height 7.5 mm, width 5 mm, LACMIP hypotype 11468.
5. *Clavilithes tabulatus* (Dickerson, 1913), spire only, x1.5, height 31 mm, width 20 mm, LACMIP hypotype 11469, CSUN loc. 662.
6. *Calorebama dilleri lineata* (Gabb, 1864), abapertural view, x5, height 7.5 mm, width 4.5 mm, LACMIP hypotype 11470, CSUN loc. 674.
7. *Volutilithes orocopiaensis* Squires and Advocate, 1986, apertural view, x1.2, height 62 mm, width 26.7 mm, LACMIP holotype 7168, CSUN loc. 662. X
8. *Lyria andersoni* Waring, 1917, partial specimen, left side view, x1.7, height 23 mm, LACMIP hypotype 11471, CSUN loc. 675.
9. *Lyriscapa lajollaensis* (Hanna, 1927), left side view, x1.5, height 30 mm, LACMIP hypotype 11472, CSUN loc. 672.
10. *Pleurofusua fresnoensis* (Arnold, 1910), apertural view, x6, height 8 mm, width 3 mm, LACMIP hypotype 11473, CSUN loc. 662.
11. *Surculites mathewsonii* (Gabb, 1864), abapertural view, x1.7, height 30 mm, width 17 mm, LACMIP hypotype 11474, CSUN loc. 671.
12. *Domenginella* aff. *D. claytonensis* (Gabb, 1864), abapertural view, x4.5, height 9.5 mm, width 6 mm, LACMIP hypotype 11475, LACMIP loc. 23779 = CSUN loc. 662.
13. *Conus hornii umpquaensis* Turner, 1938, abapertural view, x6.5, height 6 mm, width 3 mm, LACMIP hypotype 11476, CSUN loc. 674.
14. *Cylichnina tantilla* (Anderson and Hanna, 1925), apertural view, x4, height 8.5 mm, width 3 mm, LACMIP hypotype 11477, LACMIP loc. 23779 = CSUN loc. 662.
15. *Acila* (*Trunacila*) *decisa* (Conrad, 1855), left valve, x5, length 7 mm, height 5 mm, LACMIP hypotype 11479, CSUN loc. 674.
16. *Glycymeris* (*Glycymerita*) *sagittata*? (Gabb, 1864), right? valve of a closed-valve specimen, , x3, length 11 mm, height 10 mm, LACMIP hypotype 11480, LACMIP loc. 23779 = CSUN loc. 662.
17. *Spondylus* cf. *S. carlosensis* Anderson, 1905, partial specimen, left valve, x3.8, length 11 mm, height 9 mm, LACMIP hypotype 11481, LACMIP loc. 23779 = CSUN loc. 662.
18. *Ostrea haley* Hertlein, 1933, left valve, x1.5, length 23 mm, height 38 mm, LACMIP hypotype 11482, LACMIP loc. 23779 = CSUN loc. 662.
19. *Glyptoactis* (*Claibornocardia*) *domenginica* (Vokes, 1939), left valve, x9, length 4 mm, height 4 mm, LACMIP hypotype 11483, CSUN loc. 674.
20. *Glyptoactis* n. sp.?, x2.5, right valve of a closed-valve specimen, length 17 mm, height 13 mm, LACMIP hypotype 11484, CSUN loc. 662.
21. *Acanthocardia* (*Schedocardia*) *brewerii* (Gabb, 1864), left valve, x2.3, length 14 mm, height 10 mm, LACMIP hypotype 11485, CSUN loc. 671.
22. *Glossus* (*Meiocardia*) *susukii* Squires and Advocate, 1986, left valve, x2, length 16.5 mm, height 16 mm, UCLA holotype 48427, LACMIP loc. 23779 = CSUN loc. 662. LACMIP holotype 10568
23. *Callista* (*Costacallista*) *hornii vokesi* Squires, 1987, left valve, x2.1, length 20 mm, height 18 mm, LACMIP hypotype 11486; CSUN loc. 675.
24. *Pitar* (*Lamelliconcha*) *joaquinensis* Vokes, 1939, right valve, x2.2, length 16 mm, height 14 mm, LACMIP hypotype 11487, CSUN loc. 674.
25. *Corbula* (*Caryocorbula*) cf. *C. (C.) dickersoni* Weaver and Palmer, 1922, left valve, x3.2, length 11 mm, height 7 mm, LACMIP hypotype 11488, CSUN loc. 676.



were collected from the Maniobra Formation. Forty-eight of these could be identified as to species or subspecies. These are one colonial coral, one solitary coral, one brachiopod, one polychaete worm, one scaphopod, 32 gastropods, and 11 bivalves, and they are listed in Table 1 and illustrated in Pls. 1 and 2. Two other bivalves, *Crassatella* sp. indet. and *Venericardia (Pacifcor)* sp. indet. were too poorly preserved to allow specific identification but were listed in Table 1. Seventeen other taxa were too poorly preserved for generic identification and include clusters of polychaete worm? tubes, two epitoniid? gastropods, a calyptraeid? gastropod, two ranellid? gastropods, an olivid? gastropod, a turrid gastropod (possibly *Apitoma*), one arcid bivalve, two ostreid bivalves, a fimbrid? bivalve, a pitarid bivalve, terebratulid bivalve tubes, a crab, a spatangoid? echinoid, and a shark tooth.

The identifications of all the species listed by Crowell and Susuki (1959, p. 588-589) have been changed during the course of this study. These changes are shown in Table 2. Their specimens of *Ectinochilus* sp. cf. *E. macilentus*, *Keilostoma* sp. cf. *K. californicum*, and *Macrocallista* sp. were examined and found to be too poorly preserved to make generic identifications.

THIS REPORT

CROWELL & SUSUKI (1959)

Gastropods

Amaurellina caleocia
Bittium cf. *B. preussi*
Calyptraea diegoana
Chedevillia saltonensis
Clavilithes tabulatus
Cylichnina tantilla
Ectinochilus (Vaderos) elongata
Galeodea cf. *G. gallica*
Homalopoma aff. *H. watti*
Lyria andersoni
Turritella andersoni
Turritella buwaldana
Turritella buwaldana
Turritella uvasana hendoni s.l.

Amaurellina sp.
B. sp. cf. *B. longissimum*
Calyptraea sp.
C. sp. cf. *C. stewarti*
C. sp. cf. *C. tabulatus*
Cylichnina? sp.
E. n. sp.
G. sp. cf. *G. sutterensis*
Homalopoma sp. cf. *H. watti*
Lyria sp.
T. andersoni lawsoni
T. sp. cf. *T. buwaldana*
Turritella buwaldana n. var.
T. uvasana n. var.

Bivalve

Acanthocardia (Schedocardia) brewerii

S. cf. *S. brewerii*

Table 2. Equivalency of taxa identified in this report versus those listed in Crowell and Susuki (1959, p. 588-589).

Two new species may be present in the Maniobra Formation fauna. Two specimens of the polychaete worm *Rotularia* n. sp.? have a bicostate keel and are unlike any other Eocene *Rotularia* from the Pacific coast of North America. More specimens are needed of the polychaete worm in order to prove that they may represent a new species. Many juvenile specimens of the bivalve *Glyptoactis* n. sp.? have tripartite ribbing over the entire shell rather than just on the anterior part of each valve as in other *Glyptoactis* from the Paleogene of North America. Adult specimens are needed of the bivalve *Glyptoactis* n. sp.? in order to prove that it is a new species.

A single juvenile specimen of a muricid gastropod was found in the Maniobra Formation and is tentatively identified as *Favartia*. If this identification is correct, then this specimen is the first occurrence of genus *Favartia* in the Paleogene of the Pacific coast of North America.

GEOLOGIC AGE

Advocate et al. (1988) reported that the Maniobra Formation is early Eocene in age based on mollusks, calcareous nannofossils, and planktonic foraminifera. The molluscan taxa in the Maniobra

Formation indicate the Pacific coast of North America provincial molluscan middle lower Eocene "Capay Stage," used in the restricted sense of Givens (1974). Taxa restricted to the "Capay Stage" were reported by Advocate et al. (1988) from the lower and middle parts of the formation. These taxa are *Turritella meganosensis protumescens*, *Turritella andersoni*, and *Ostrea haleyi*. Calcareous nannofossils indicative of CP9 to CP11 Zones (early Eocene) of Okada and Bukry (1980) and planktonic foraminifera indicative of P7 to P9 Zones (early Eocene) of Berggren et al. (1985) were reported by Advocate et al. (1988). No age-diagnostic fossils have been found in the upper 200 to 300 m of the Maniobra Formation.

The conclusion of Advocate et al. (1988) regarding the age of the Maniobra Formation using mollusks is confirmed in this present study. In addition, since their work was completed, an additional age-diagnostic molluscan species was found by the author in the submarine-canyon-fill deposits of the formation. *Turritella andersoni*, an index fossil of the "Capay Stage" (Squires, 1988) was found at numerous localities in the interval between 450 and 1,200 m above the base of the formation (Table 1; Fig. 2). It should be mentioned, however, that a few of the specimens of *T. andersoni* from the uppermost part of the formation do approach in morphology the upper lower to lower middle Eocene "Domengine Stage" *T. andersoni lawsoni*.

The presence of the bivalve *Spondylus* cf. *S. carlosensis* tentatively extends the geologic range of this species. Previously, it was confined to the "Domengine Stage" (Squires, 1987).

The bivalve *Glossus (Meiocardia) susukii* is the earliest reported species of *Meiocardia* on the Pacific coast of North and South America, and *Phalium (Semicassis) louella* is the earliest record of this genus/subgenus in North America (Squires and Advocate, 1986).

CORRELATION

As shown in Squires (1987, fig. 5; 1988, fig. 3) and Advocate et al. (1988), the Maniobra Formation is time correlative to the following "Capay Stage" (middle lower Eocene) strata on the Pacific coast of North America: Crescent Formation (in part), northwestern Washington (Snaveley, 1987); Lookingglass Formation, southwestern Oregon (Heller and Dickinson, 1985); Capay Formation, Sacramento basin, northern California (Cherven, 1983); upper Lodo Formation, central California (Poore, 1976); Uvas Conglomerate Member of the Tejon Formation, San Emigdio Mountains, south-central California (Nilsen, 1987); Juncal Formation?, Lockwood Valley area, southern California (Squires, 1988); lowermost part of the Juncal Formation, Santa Ynez Range, southern California (Thompson, 1988); lower part of the Juncal Formation, Pine Mountain and Whitaker Peak areas, southern California (Givens, 1974; Squires, 1987); and lowermost marine part of the Lajas Formation, Simi Valley, southern California (Squires, 1984). In addition, recent work indicates that the Maniobra Formation is also time correlative to a part of the Bateque Formation, Baja California Sur, Mexico (Squires and Demetron, in press), and to a part of the Tepetate Formation, Baja California Sur, Mexico (Squires and Demetron, in review).

Kirkpatrick (1958) hypothesized that 310 km of post-Eocene right slip on the San Andreas fault has separated the Maniobra Formation from similar-appearing Eocene rocks in the Lockwood Valley area (Fig. 1). Howell (1975a, b) hypothesized that a more compelling match would be Eocene rocks in the Whitaker Peak-Pine Mountain area (Fig. 1) and that about 260 km of right slip on the San Andreas fault system has separated these two areas. Many authors have iterated these hypotheses, and these authors are listed in Advocate et al. (1988).

A thorough discussion of the validity of the postulations of Kirkpatrick (1958) and Howell (1975a, b) is beyond the scope of this present report. It is important to note, however, that detailed lithostratigraphic, biostratigraphic, and depositional environment

studies of the Lockwood Valley area (Squires, 1988) and the easternmost Whitaker Peak area (Squires, 1987; Yamashiro, 1989) are now available for comparison with the Maniobra Formation. Although the Maniobra Formation is time correlative with the Eocene rocks in the Lockwood Valley area and some of the Eocene rocks in the Whitaker Peak area, the Maniobra Formation does not match the lithologies, the overall macrofossil taxonomic composition, or the depositional environments of these lower Eocene rocks. In addition, the Maniobra Formation is overlain by different formations than those found in the other two areas.

BIOGEOGRAPHY

The early Eocene was a time of widespread tropical to subtropical conditions and coincided with the peak warming interval of the Cenozoic. The early through middle Eocene was also a time of influx of many Old World mollusks and other invertebrates into the Pacific coast region of North America by way of Central America (Squires, 1984; Squires, 1987). The archeogastropod *Velates perversus* is a cosmopolitan species (Squires, 1987). The gastropod *Galeodea gallica* is an Anglo-Paris Basin species (Squires and Advocate, 1986).

Some of the Maniobra Formation mollusks show Old World affinities. These are the gastropods *Campanile dilloni*, *Chedevillia saltonensis*, *Eocypraea? maniobraensis*, *Clavilithes tabulatus*, *Lyriscapha lajollaensis*, and *Volutilithes orocopianensis*.

Many of the Maniobra Formation macrofossil species are ones that also are present in other early Eocene faunas from the Pacific coast of North America. The colonial coral *Astrocoenia dilloni*, the gastropods *Velates perversus*, *Turritella andersoni*, *T. buwaldana*, *Campanile dilloni*, *Calypptogena diegoana*, *Eocernina hannibali*, *Pachycrommium clarki*, *Amaurellina caleocia*, *Clavilithes tabulatus*, *Lyria andersoni*, *Lyriscapha lajollaensis*, *Pleurofusua fresnoensis*, *Surculites mathewsonii*, *Cylichnina tantilla*, and the bivalves *Acila (Truncacila) decisa*, *Ostrea haleyi*, *Glyptoactis (Claibornicardia) domingica*, *Acanthocardia (Schedocardia) brewerii*, and *Pitar (Lamelliconcha) joaquinensis* are all species that are widespread in lower Eocene strata of the Pacific coast of North America (Squires, 1984, 1987, 1988; Squires and Demetron, in press).

The presence of the brachiopod *Kingena? simiensis* in the Maniobra Formation extends the geographic range of this species. Previously, it was only known from Simi Valley, southern California (Hertlein and Grant, 1944). The presence of the gastropod *Ectinochilus (Vaderos) cf. E. (V.) elongata* tentatively extends the geographic range of this species. Previously, it was only known from the Cowlitz Formation of southwestern Washington (Weaver, 1943).

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LOCALITIES

All are CSUN localities and, unless otherwise noted, are in the United States Geological Survey Red Canyon, provisional edition, 1986, 7.5-minute topographic quadrangle, Riverside County, southern California.

662. 2,910 ft elevation along crest of small hill, 137 m (450 ft) south and 31 m (100 ft) west of the northeast corner of sec. 25,

T6S, R12E, Hayfield, provisional edition, 1987, 7.5-minute topographic quadrangle, Riverside County, southern California. This locality is the same as locality F of Crowell and Susuki (1959) = LACMIP loc. 23779 = UCLA loc. 3779.

665. 2,120 ft elevation along east side of small canyon, 861 m (2,825 ft) north and 709 m (2,325 ft) west of the southeast corner of sec. 30, T6S, R13E. = LACMIP locality 16335.

667. 2,040 ft elevation along east side of canyon, 183 m (600 ft) south and 213 m (700 ft) west of the northeast corner of sec. 31, T6S, R13E.

668. 2,000 ft elevation in stream bed, 421 m (1,380 ft) south and 198 m (650 ft) east of the northwest corner of sec. 31, T6S, R13E. = LACMIP loc. 16155.

669. 2,120 ft elevation along south side of stream, 152 m (500 ft) south and 198 m (650 ft) west of the northeast corner of sec. 36, T6S, R12E. = LACMIP loc. 16394.

670. 2,180 ft elevation at southeast end of butte, 274 m (900 ft) north and 808 m (2,650 ft) east of southwest corner of section 25, T6S, R12E.

671. 2,040 ft elevation in stream bed, 579 m (1,900 ft) north and 26 m (85 ft) west of the southeast corner of sec. 31, T6S, R13E. = LACMIP locality 16076.

672. 1,840 ft elevation in stream bed, 366 m (1,200 ft) north and 76 m (250 ft) west of the southeast corner of sec. 31, T6S, R13E. = LACMIP locality 16274.

673. 1,960 ft elevation in stream bed, 670 m (2,200 ft) north and 381 m (1,250 ft) west of the southeast corner of sec. 36, T6S, R12E.

674. 1,940 ft elevation along east side of stream bed, 579 m (1,900 ft) south and 472 m (1,550 ft) west of southeast corner of sec. 6, T7S, R13E. = LACMIP locality 16082.

675. 2,000 ft elevation along crest of small ridge, 594 m (1,950 ft) north and 701 m (2,300 ft) west of southeast corner of sec. 36, T6S, R12E. = LACMIP locality 16151.

676. 2,010 ft elevation along north side of stream bed, 671 m (2,200 ft) north and 786 m (2,580 ft) west of southeast corner of sec. 36, T6S, R12E. = LACMIP locality 16192.

677. 2,060 ft elevation, 411 m (1,350 ft) south and 518 m (1,700 ft) east of northwest corner of sec. 6, T6S, R12E.

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