[PS]Detailed Lithostratigraphic Characterization of the Monterey Formation at Chico Martinez Creek, California*

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Abstract

Chico Martinez Creek, located in the foothills of the Temblor Range, southwestern San Joaquin basin, has served as a stratigraphic reference section for the Miocene Monterey Formation for nearly 100 years because of its great thickness (>6,000 feet) and its close proximity to major oil fields. The Monterey succession includes the Gould, Devilwater, McDonald, and Antelope Shales. Much of the previous work from the 1930's to 1980's was proprietary and focused on identifying lithostratigraphic and biostratigraphic intervals for subsurface correlation in the western San Joaquin basin. In spite of numerous field guides with general or very localized descriptions, a continuous, detailed lithostratigraphic characterization of the section has not been published. To rectify this, percent lithology will be described in 5-foot increments through the entire Monterey and handheld spectral gamma-ray data will be acquired at 2-foot intervals. To obtain consistent, high-quality results through covered intervals, approximately 2500 stratigraphic feet of trenches were dug or reopened by backhoe. The gathered data will be compiled into a mudlog-type format consistent with presentation of subsurface logs to aid in basin-wide correlation. These data will be integrated with existing industry-provided biostratigraphy for the Chico Martinez Creek section to provide chronostratigraphic context. To refine age control across the poorly dated McDonald Shale, 33 dolostone beds were cored and analyzed to identify magnetic reversals in the Upper Miocene succession. Magnetostratigraphic and biostratigraphic data will provide additional age constraint, allow for more accurate determination of sediment and geochemical mass accumulation rates, and make chronostratigraphic correlation with other Neogene sections possible. Ultimately, this new detailed reference section will be of value to geoscientists working on the Monterey in the subsurface of the San Joaquin basin and throughout California.

Detailed Lithostratigraphic Characterization of the Monterey Formation at Chico Martinez Creek, California

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Abstract

Chico Martinez Creek, located in the foothills of the Temblor Range, southwestern San Joaquin basin, has served as a stratigraphic reference section for the Miocene Monterey Formation for nearly 100 years. Although this section is one of the thickest and most continuous surface accumulations (>6000') of the Monterey Formation in California, the academic literature provides only a brief one-page description of lithology. To rectify this, this study aims to provide a detailed lithostratigraphic characterization of the section by means of aquiring spectral gamma ray data and describing % lithology at the resolution of a detailed subsurface log across the section. These data were integrated with existing industry-provided micropaleontological data for the Chico Martinez section to provide chronostratigraphic context. To refine age control further, 33 dolostone beds were cored and analyzed to identify magnetic reversals in the Upper Miocene succession. Magnetostratigraphic and biostratigraphic data provide additional age constraint, allow for more accurate determination of sediment accumulation rates, and could potentially make chronostratigraphic correlation with other Neogene sections possible. Ultimately, this new detailed section will be correlated with proximal subsurface wells in the western San Joaquin basin to evaluate lateral variations in thickness.

Section of Monterey shale on Chico Martinez Creek in Temblor Range, 25 miles southeast of Kettleman Hills
(Measured by M. N. Bramlette)

Tulare formation:
Conglomerate and sandstone resting with angular discordance on the Monterey shale.

Monterey shale:
Unnamed member:
11. White to dove-colored diatomaceous shale,.. Feet 770
10. Diatomaceous shale with thin chert beds and zones of calcareous concretions..... 60
Unnamed member (?):
9. White to light-brown, porcelaneous shale with abundant diatom impressions; thin chert beds numerous; zones of calcareous concretions at intervals of 15 to 20 feet. This beds of fine-grained sandstone, some of which are calcareous, occur in and near the middle part of this unit..... 1,865
Unnamed member (?):
8. Light chocolate-brown, thin-bedded porcelaneous mudstone with diatom impressions and with thin chert beds; zones of calcareous concretions at intervals of 10 to 20 feet..... 1,015
Unnamed member (?):
7. Weathering, dove-colored, shaly shale with vague diatom impressions; zones of calcareous concretions at intervals of 10 to 20 feet..... 480
6. Dove-colored, hard to dove-colored shaly shale with vague diatom impressions; zone of calcareous concretions... 445
5. Thinly laminated shale, less siliceous than overlying shale; to diatom impressions; zones of calcareous concretions at intervals of 10 to 20 feet..... 400
4. Alternating zones of hard and soft slightly calcareous, shaly shale; numerous zones of calcareous concretions..... 705
Unnamed member (?):
3. Soft foraminiferal clayey shale with phosphatic nodules and stringers; zones of calcareous concretions at intervals of 10 to 20 feet..... 350
2. Brown mudstone; zones of calcareous concretions at intervals of 10 to 20 feet..... 840
Gould shale member:
1. Hard shaly shale interbedded with soft foraminiferal shale; few zones of calcareous concretions..... 265
Thickness of Monterey shale..... 7, 235

Figure 1: Bramlette's published description of the Monterey at Chico Martinez Creek (Woodring, Steward and Richards, 1940)

Field Location, Structure and Stratigraphy

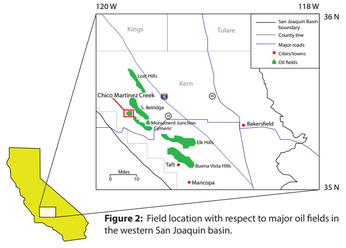

Figure 2: Field location with respect to major oil fields in the western San Joaquin basin.

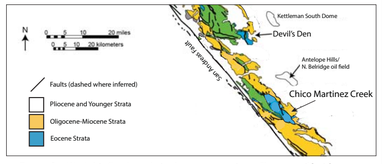

Figure 4a: West side San Joaquin basin outcrop geology. Figure modified from Johnson and Graham (2007).

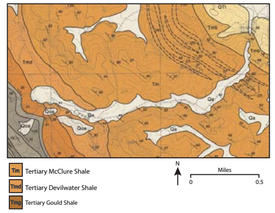

Figure 3: Structure map showing a shallow eastward dipping homoclinanal structure with no mapped major faults or unconformities (Dibblee, 2006).

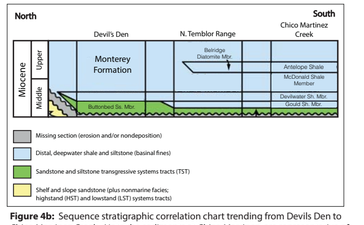

Figure 4b: Sequence stratigraphic correlation chart trending from Devils Den to Chico Martinez Creek. Note the sediments at Chico Martinez are representative of a distal deep basin which shoals northward. All Monterey members: Antelope Shale, McDonald Shale, Devilwater Shale and Gould Shale are present at this locality. Figure modified from Johnson and Graham (2007).

References

Dibblee, T. W., Jr., 2006, Geologic map of the Carneros Rocks and Belridge quadrangles, San Luis Obispo and Kern Counties, California: Dibblee Geological Foundation, Map DF-274 (Minch, J. A., ed.), scale 1:24,000.

Heitman, H. L., 1986, The Chico Martinez/Zemorra Creek surface section; A west side San Joaquin Valley reference section (unpublished industry report) 107p.

Johnson and Graham, 2007, Middle Tertiary stratigraphic sequences of the San Joaquin basin, California in Petroleum systems and geologic assessment of oil and gas in the San Joaquin basin province, California: U. S. Geological Survey Professional Paper, 18p, ch. 6.

Shell Data, 1935, unpublished

Woodring, W. P., Stewart, R., and Richards, R. W., 1940, Geology of the Kettleman Hills oil field: U. S. Geological Survey Professional Paper, n. 195, 178 p.

Methods

Percent lithology was described in 5' increments and handheld spectral gamma ray data was acquired at 2' intervals throughout the entire Monterey section. Due to poor outcrop exposure, approximately 2500 stratigraphic feet of trenches were dug or reopened to enhance to amount and quality of data collected. Micropaleontological data from previous proprietary studies conducted by Shell (1935) and Unocal (1985) were integrated into the measured section to provide age control. To further refine age control, 33 dolostone beds were cored and analyzed to identify magnetic reversals. Dolostone beds were projected into trenches 6 and 7 based on stratigraphic correlation between the beds cored in the creek and hill to the north and the trenches.

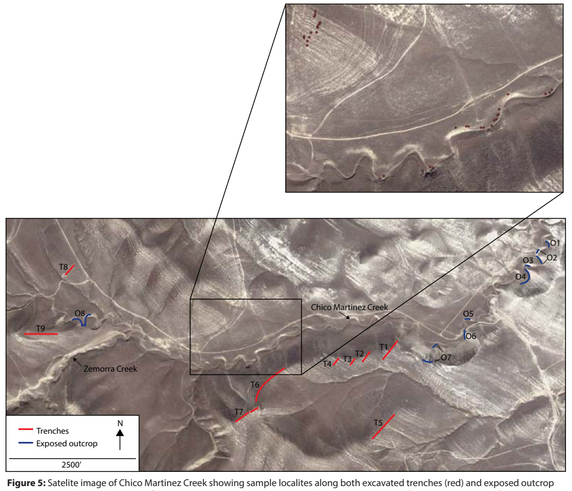

Figure 5: Satelite image of Chico Martinez Creek showing sample localites along both excavated trenches (red) and exposed outcrop along the creek (blue). The magnefied box along the creek and northern hill show the localities of the dolostone cored for magnetostratigraphy.

Future Work

The next phase in this project will involve an attempt to fill in the gaps of missing total gamma ray data by correlating with a nearby well, and lastly correlating the Chico Martinez Creek section to proximal wells, likely in the South Belridge and Monument Junction fields. Future work that lies outside of the scope of this project will involve extending of the magnetostratigraphic record upsection into the Antelope Shale and potentially conducting XRF (x-ray fluorescence) geochemical analysis on 30' interval samples collected along excavated trenches and exposed outcrop sections.

Acknowledgments

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Detailed Lithostratigraphy with Spectal Gamma Ray Data

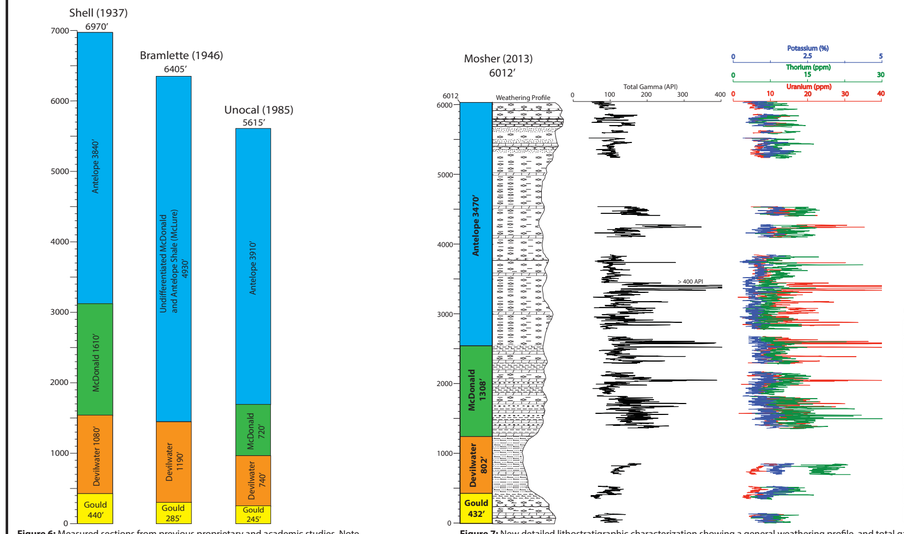

Figure 6: Measured sections from previous proprietary and academic studies. Note, Unocal (1985) and Bramlette (1946) measured along the creek exposures, while Shell (1935) measured along excavated trenches on the southern ridges lining the creek.

Figure 7: New detailed lithostratigraphic characterization showing a general weathering profile, and total gamma ray and spectral gamma ray data including potassium (%), thorium (ppm) and uranium (ppm), collected in 2' increments. More detailed lithologic data and descriptions are available in an industry standard subsurface mudlog format.

Chronostratigraphy

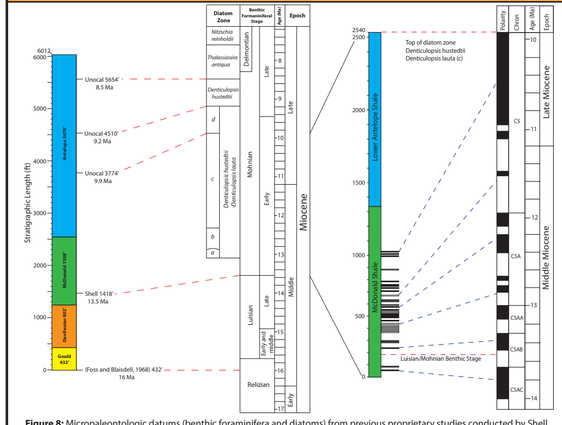

Figure 8: Micropaleontologic datums (benthic foraminifera and diatoms) from previous proprietary studies conducted by Shell (1935) and Unocal (1985) were successfully tied into the measured section. These datums allow for the correlation of paleomagnetic reversals to the geologic timescale and provide additional age constraint on the timing of deposition.

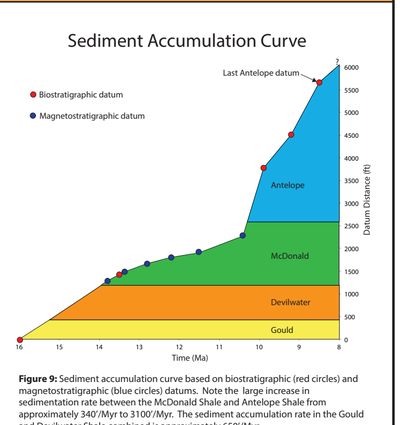

Figure 9: Sediment accumulation curve based on biostratigraphic (red circles) and magnetostratigraphic (blue circles) datums. Note the large increase in sedimentation rate between the McDonald Shale and Antelope Shale from approximately 340'/Myr to 3100'/Myr. The sediment accumulation rate in the Gould and Devilwater Shale combined is approximately 650'/Myr.