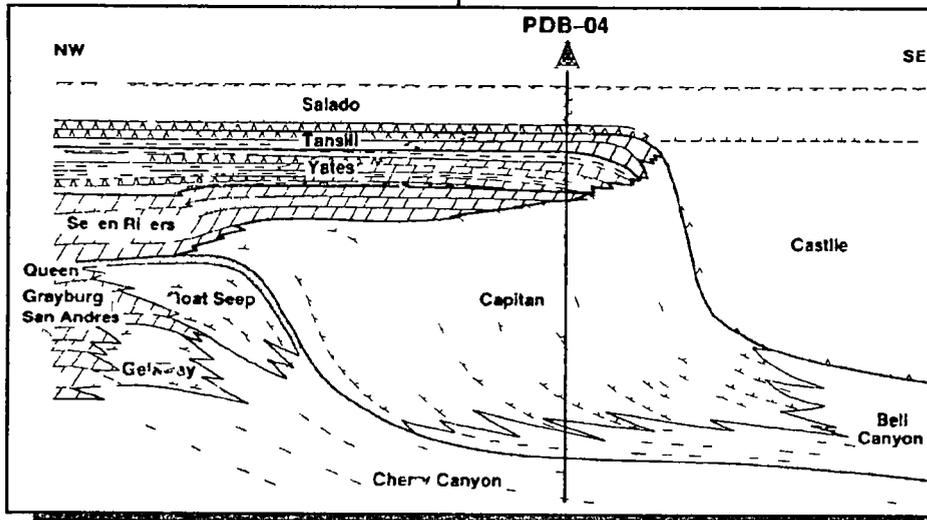
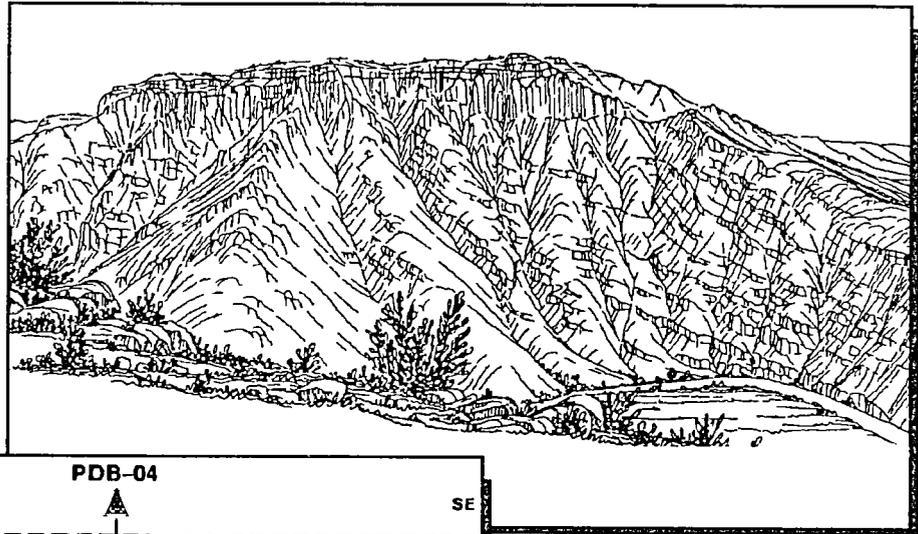


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Subsurface and Outcrop Examination of the Capitan Shelf Margin, Northern Delaware Basin



SEPM Core Workshop No 13
San Antonio, April 23, 1989

OCD Case# 15307
Oasis Water Solutions LLC
September 17 2015
Ex# 14

Subsurface and Outcrop Examination of the Capitan Shelf Margin, Northern Delaware Basin

Organized and Edited

By

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and

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SEPM Core Workshop No 13
San Antonio, April 23, 1989

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THE ROLE OF HYDROGEN SULFIDE IN THE EVOLUTION OF
CAVES IN THE GUADALUPE MOUNTAINS OF SOUTHEASTERN NEW MEXICO

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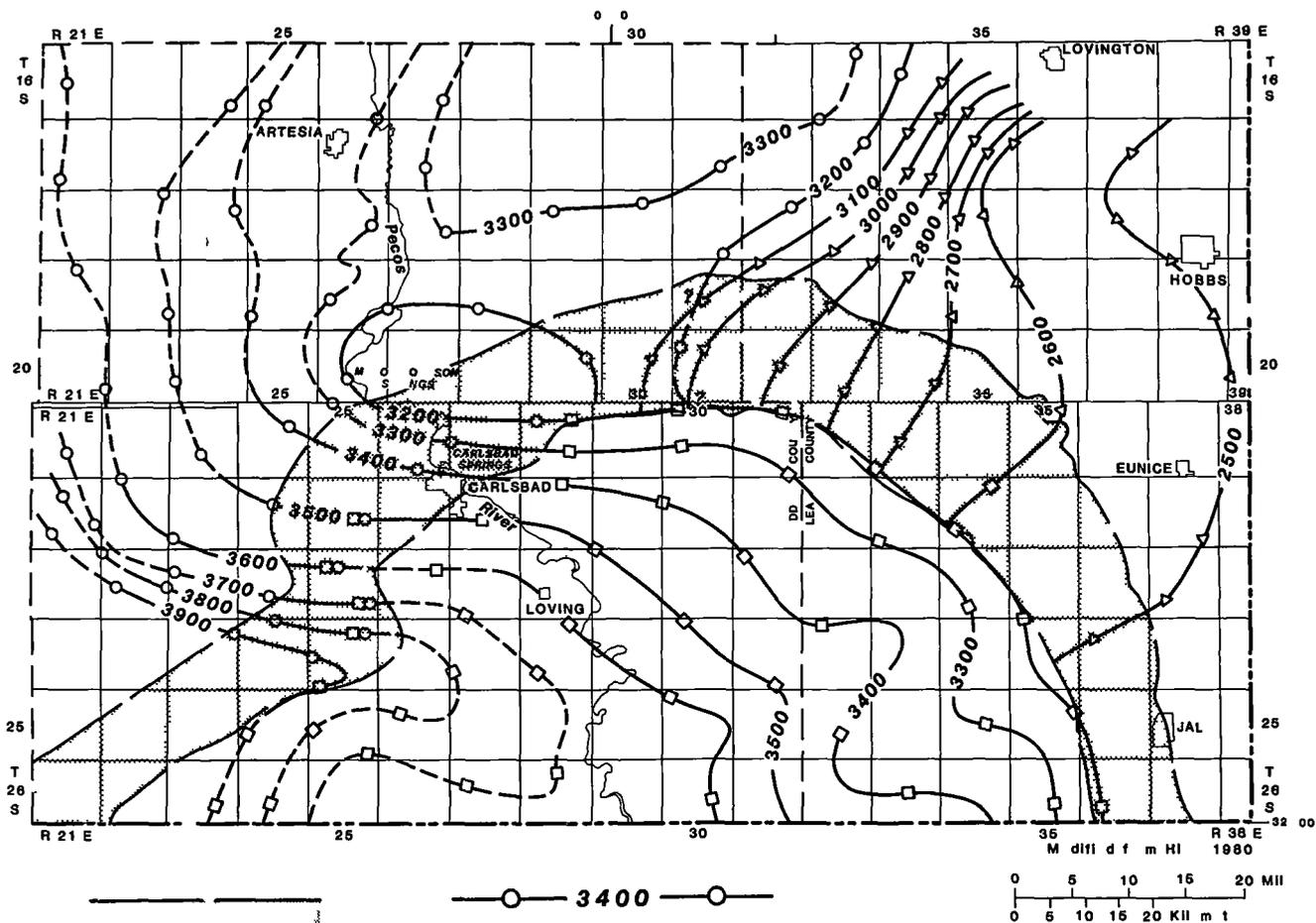
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Part of the Permian Capitan Reef Complex is exposed in the Guadalupe Mountains of southeastern New Mexico and western Texas (Fig 1) The reef complex includes the Capitan Limestone and the carbonate backreef beds of the Artesia Group that comprise a lithosome called the Capitan aquifer (Hiss, 1976) This lithosome contains well-developed solution openings that range from microscopic to voids the size of Carlsbad Cavern This solution porosity was once thought to be caused by weak carbonic acid in the phreatic zone within the Capitan aquifer (Bretz, 1949) During the last 15 years, however, workers have obtained evidence indicating that sulfuric acid may be a major cause of carbonate dissolution (Egemeier, 1973, Jagnow, 1977, Palmer et al, 1977, Maslyn, 1979, Davis, 1980 Kirkland, 1982, and Hill, 1987) Sulfuric acid is generated when oxygen (O_2) is introduced into solutions containing dissolved hydrogen sulfide (H_2S) gas (Hill, 1987)

Hydrogen sulfide is common in subsurface formations in southeastern New Mexico (Bjorklund and Motts, 1959, Hinds and Cunningham, 1970, pp 4 and 7) In southeastern New Mexico and elsewhere along the subsurface trend of the Capitan reef, H_2S is present in accumulations of oil and gas and in associated saline water (Schram, 1956a, p 103, and 1956b, p 307, Wilson, 1956, p 179 and Roswell Geological Society Symposium Committee, 1956a, p 181, and 1956b, p 291)

Hydrogen sulfide results from the metabolic reduction of sulfate by bacteria in the presence of hydrocarbons (Feely and Kulp, 1957 Davis and Kirkland, 1970) This process also causes the fractionation of sulfur isotopes ^{32}S and ^{34}S , resulting in enrichment of ^{32}S in the more mobile phase each time metabolic reduction or oxidation occur Because of this enrichment in ^{32}S sulfur that has been metabolized has a distinct isotopic signature that allows it to be distinguished from nonmetabolized, primary sulfur compounds (Kirkland, 1982, Hill, 1987)

The concept of solution by sulfuric acid within the Capitan aquifer is supported by an abundance of secondary gypsum that is enriched in ^{32}S in caves of the Guadalupe Mountains (Kirkland, 1982, Hill, 1987) Gypsum is precipitated when limestone is dissolved by sulfuric acid and the resulting solution becomes supersaturated with gypsum (Hill, 1987, pp 71-72) Gypsum is present in these caves as massive deposits on the floors of large rooms,



Approximate position of Capitan aquifer

Potentiometric contours for formations of Permian Ochoan, Guadalupian, or Leonardian age. Values of hydraulic head are expressed as water with a specific gravity of 1.00. Contours are dashes wherever data are few or of doubtful reliability. Contour interval 100 feet. Datum is sea level. The contours represent a generalized regional hydraulic head considered to be representative of shelf and basin aquifers during 1960-70. Similarly, contours for the Capitan aquifer are an interpretation of the hydraulic head representative of the later part of 1972.

○ — 3400 — ○

Hydraulic head measured in shelf aquifer system where the hydraulic connection with the Capitan aquifer is minimal

□ — 3400 — □

Hydraulic head measured in basin aquifer system where the hydraulic connection with the Capitan aquifer is minimal

△ — 3400 — △

Hydraulic head measured in the Capitan and shelf aquifer systems where the hydraulic connection between the two aquifer systems is substantial

Figure 3 Potentiometric surface of the Capitan aquifer and associated deposits