STATE OF NEW MEXICO
ENERGY, MINERALS AND NATURAL RESOURCES DEPARTMENT
OIL CONSERVATION COMMISSION

APPLICATION OF GOODNIGHT MIDSTREAM PERMIAN LLC FOR APPROVAL OF A SALTWATER DISPOSAL WELL, LEA COUNTY, NEW MEXICO. **COMM. CASE NO. 24123**

APPLICATIONS OF GOODNIGHT MIDSTREAM PERMIAN LLC FOR APPROVAL OF SALTWATER DISPOSAL WELLS, LEA COUNTY, NEW MEXICO. **DIV. CASE NOS. 23614-23617**

APPLICATION OF GOODNIGHT MIDSTREAM PERMIAN, LLC TO AMEND ORDER NO. R-22026/SWD-2403 TO INCREASE THE APPROVED INJECTION RATE IN ITS ANDRE DAWSON SWD #1, LEA COUNTY, NEW MEXICO. **DIV. CASE NO. 23775**

APPLICATIONS OF EMPIRE NEW MEXICO LLC TO REVOKE INJECTION AUTHORITY, LEA COUNTY, NEW MEXICO. **DIV. CASE NOS. 24018-24020, 24025**

EMPIRE
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Part 2 of 6 - Exhibit B & B-1 thru B-26

Direct Testimony and Exhibits

August 26, 2024

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SELF-AFFIRMED STATEMENT OF ROBERT F. LINDSAY

1. My name is Robert Forrest Lindsay. I am over eighteen years of age and have personal knowledge of the facts herein. I am a geologist with 47 years of experience in the petroleum industry, having worked for Gulf (1976-1985), Chevron (1985-2001), ChevronTexaco (2001-2002), Saudi Aramco (2002-2015), and Lindsay Consulting (2016-Present). My expertise is in reservoir characterization.

2. I hold a Bachelor of Science degree in Geology from Weber State College (June, 1974), a Master of Science degree in Geology from Brigham Young University (December, 1976), and Doctor of Philosophy degree in Geology from the University of Aberdeen, Scotland (July, 2014).

3. I worked on Eunice Monument complex of unitized oil fields for Chevron from 1988 to 2002. I retired from Chevron in 2002. While working for Saudi Aramco (2002-2015), I used the 14-man year data base that I built on Eunice Monument unitized oil fields, other oil fields, and mountain range outcrops to complete a PhD degree (2014) on the Grayburg Formation.

4. I am a member of the following: 1) American Association of Petroleum Geologists (AAPG); 2) Society for Sedimentary Geology (SEPM); 3) Secretary (2023-Present) Midland chapter Society of Independent Professional Earth Scientists (SIPES, #3605); 4) Past-president and honorary life member of the West Texas Geological Society (WTGS); 5) Past-president and honorary life member of the

EXHIBIT B

Permian Basin Section–SEPM (PBS-SEPM); 5) President-Elect American Association of Petroleum Geologists Southwest Section (2026), and 7) Texas Board of Professional Geoscientists #1386.

5. I served my country in U.S. Army Special Forces as a medical specialist.

A. THE PROPOSED SWD WELLS WOULD INJECT INTO SAN ANDRES FORMATION WHICH CONTAINS A RESIDUAL OIL ZONE

6. While describing cores and characterizing Grayburg and San Andres reservoirs at Eunice Monument South Unit (EMSU), Eunice Monument South Unit Expansion Area B (EMSUB), and Arrowhead Grayburg Unit (AGU), located on the northwest corner of the Central Basin Platform (CBP), **it was discovered that the San Andres contains a residual oil zone (ROZ):**

- Upper San Andres reservoir at EMSU contains oil saturated porosity down section to depths of -719 ft (subsea) to -750 ft (subsea) and potentially deeper and is a residual oil zone (ROZ). Lower San Andres may also be a residual oil zone (ROZ).
- Grayburg reservoir at EMSU had initial water-free oil production to a depth of -350 ft (subsea), mixed oil and water production from -350 ft to -540 ft (subsea). Beneath -540 ft only water is produced.
- The unitized interval for EMSU is from -100 ft in the Grayburg Formation to the base of the San Andres Formation.

The attached exhibits illustrate and confirm the points made above. A description of the exhibits is as follows:

Exhibit B-1 shows that in the Late Eocene to Early Miocene the Southern Rocky Mountain Epeirogen uplifted western North America. Uplift was via a series of igneous intrusive bodies that formed the Trans-Pecos Magmatic Province. West of the Permian Basin this huge land mass recharged hot, high pressure, high volume meteoric water into the subsurface. Recharging meteoric water had an enormous head of energy and swept mobile oil out of structural closures to create residual oil zones (ROZ's). Middle Miocene to Late Miocene Rio Grande rifting down faulted and destroyed the large recharge area leaving small, isolated mountain ranges to recharge cool, low pressure, low volume meteoric water into the subsurface. This allowed some ROZ's to completely or partially re-saturate with mobile oil.

Exhibit B-2. Left figure is a map of the regional San Andres porosity fairways. These are porous pathways recharging meteoric water took when entering the Permian Basin as it recharged off the Southern Rocky Mountain Epeirogen. Right figure is a fracture halo, where a series of fractures surround a fault. Deep-seated differential block faulting folded overlying Permian dolostone strata and created a fracture halo without having a fault present. Meteoric water and later undersaturated fluid flow solution-widened fractures.

Exhibit B-3. Index map of New Mexico part of the Delaware Basin, Northwest Shelf, and Central Basin Platform (CBP). Positions of EMSUB, EMSU, and AGU are shown along the northwest corner of the

CBP. Down-dip limits of Goat Seep and Capitan aquifers are shown. Both aquifers are a source of low-salinity (<10,000 ppm) water. Goat Seep Aquifer is 1.5 to 2 miles down-dip of the west unit boundary of EMSU and is the source of edge water entry into the Grayburg reservoir. Capitan aquifer is not in fluid communication with EMSU. Pecos River, far to the west, is not in fluid communication with EMSU.

Exhibit B-4. Left: Index map of EMSUB, EMSU, and AGU unitized oil fields. Right: EMSU-329 to EMSU-458 serve as the principle cross section through the Grayburg reservoir. All cross sections will be along this line, including seismic data. Some cross sections will extend farther up-dip and down-dip.

Exhibit B-5. Reservoir-scale sequence stratigraphic model of Grayburg reservoir architecture, composed of individual cycles of dolostone and interbedded siliciclastic strata. West side of EMSU contains good to excellent reservoir potential. Whereas the east side contains fair to good reservoir potential. Up-dip the stratigraphic trap (right) is non-reservoir. Red = Dolograinstone. Orange = Grain-dominated dolo-packstone. Light blue = Mud-dominated dolopackstone. Light gray = Dolowackestone. Green = Fusulinid dolostone. Yellow = Dolomitic sandstone. Up-dip individual cycles act as flow units. Down-dip cycles tend to stack to form thick flow units. Note the presence of a subtle anticline during Grayburg time.

Exhibit B-6. Dip-oriented structural cross section through EMSU. Note double humped shape of the asymmetric anticline. The structure flattens up-dip (right) into the non-porous lateral stratigraphic trap and steepens to 5° down-dip (left) into the Delaware basin. Historically, water-free oil production was from top of Grayburg reservoir unit boundary at -100 ft (subsea) down section to -350 ft (subsea). Farther down section mixed oil and water production were from -350 ft to -540 ft (subsea). Beneath -540 ft (subsea) only water was produced. **San Andres reservoir contains a residual oil zone (ROZ) that extends down section to -719 ft to -750 ft (subsea) and potentially deeper.**

Exhibit B-7. EMSU-679 San Andres core containing good porosity, permeability, and oil saturation from 4239 to 4249 ft (-643 to -653 ft). Foot by foot porosity (Por), permeability (K), oil saturation (So), and water saturation (Sw) data are from core analysis. Core is from 95 ft to 105 ft beneath top of the San Andres. For complete review of EMSU-679 core photographs in plain light and UV light see Plate B-1 pdf.

Exhibit B-8. EMSU-679 San Andres residual oil zone (ROZ) photomicrograph of porous, oil-stained, grain-dominated dolopackstone from 4280.85 ft (-685 ft). Porosity = 14.9%. Permeability = 19 mD. Oil saturation = 38.4%. Water saturation = 28.4%. Blue = porosity. Thin section is from 97 ft beneath top of the San Andres. Injection of high salinity produced water, most likely containing Ca, Na, K, Ba ions, into **San Andres residual oil zone (ROZ) porosity containing sulfate will mix and precipitate cement (scale) in the porosity and reduce future ROZ productivity potential.** Photomicrograph was taken at 40X magnification.

Exhibit B-9. EMSU R.R. Bell #4 San Andres core containing fair to good porosity, low permeability, and fair to good oil saturation. Core photograph is from the base of the cored interval from 3996 to 4002 ft (-445 to -451 ft). Well location was adjacent to the up-dip stratigraphic trap where porosity, permeability, and oil saturation decreased. Missing core in core photograph was crushed to calculate oil (So) and water (Sw) saturations. Core is from 113 ft to 119 ft beneath top of the San Andres. For a complete review of EMSU R.R. Bell #4 core photographs in plain light and UV light see Plate B-2 pdf.

Plate B-1. EMSU-679 basal Grayburg and upper San Andres well log, core description, and core photographs (Plain light and UV) showing porous oil-stained strata. For detailed view see Plate 1 pdf. Each box of core contains 10 ft. Top of core is in upper left next to well log. Base of core is in lower right. Full-diameter core analysis cleaned some core of oil saturation to measure porosity and permeability.

Plate B-2. EMSU R.R. Bell #4 basal Queen, Grayburg, and upper San Andres well log, core description, and core photographs (Plain light and UV) showing oil-stained strata. For detailed view see Plate 2 pdf. Top of core is in upper left. Base of core is in lower right. Core utilized for oil (So) and water (Sw) saturation analysis was crushed and not available for photography.

B. GEOLOGIC AND ENGINEERING INTERPRETATIONS WILL IDENTIFY VERTICAL FRACTURES AND PLUMES WHICH WOULD NOT PREVENT VERTICAL MIGRATION OF FLUIDS

7. While working on Eunice Monument South Unit (EMSU) and Eunice Monument South Unit Expansion Area B (EMSUB), Grayburg cores were found to be vertically fractured, with the area surrounding the well in communication with San Andres water that raised up section through fractures and form vertical plumes within the Grayburg reservoir:
   - Plumes of water tend to be in individual wells and contain high-water cuts when mapped throughout EMSU.
   - Water chemistry studies verified that plumes of water were sourced from the underlying San Andres. **San Andres residual oil zone (ROZ) contains low salinity water (<10,000 ppm) that is sulfate rich.**
   - A fracture study conducted on EMSU-679 identified individual fractures. In general, two sets of fractures were identified, one set trending northwest to southeast and another set trending northeast to southwest.

8. Additional work confirmed three water chemistries to be present within EMSU. From top to bottom they are:
   - Connate water in the Grayburg reservoir that contains a salinity of 120,000 ppm. Barium (Ba) is present in the connate water and was derived from dissolution of K-feldspar grains in interbedded dolomitic sandstones. Barium and potassium ions are approximately the same size, with barium replacing potassium ions in the K-feldspar crystal lattice.
   - Edge water entered the west side of the Grayburg reservoir in EMSU. Edge water is composed of low salinity (<10,000 ppm) sulfate-free water. Edge water entry is due to a drop in reservoir pressure. Edge water is sourced from the Goat Seep Aquifer 1.5 to 2 miles west and down-dip of EMSU. Goat Seep Aquifer edge water is in communication with the Grayburg reservoir. Water was sourced into the Goat Seep Aquifer from the present-day Guadalupe and Glass mountains.
   - **Bottom water is in the San Andres residual oil zone (ROZ).** Bottom water contains low salinity (<10,000 ppm) water that is sulfate rich. Bottom water was sourced from the Southern Rocky

Mountain Epeirogen west of the Sacramento Mountains by meteoric recharge of fresh water down-dip into the Permian Basin. Recharging meteoric water dissolved San Andres evaporite strata ($CaSO_4$), which accounts for the source of sulfate (SO_4) in San Andres bottom water at EMSU, EMSUB, and AGU. **If produced water is injected into the San Andres ROZ and that water contains ions such as Ca, Na, K, Ba these ions will mix with SO_4 to precipitate cement (scale) within the ROZ, which will reduce reservoir quality and damage future ROZ productivity.**

It should be noted that water analysis of Goodnight's Wrigley SWD had the following comparison with Empire's produced water samples. The high levels of sodium and calcium cause major concern for scale precipitation in the San Andres ROZ interval.

	Average Chloride (mg/L)	Average Sodium (mg/L)	Average Calcium (mg/L)	Average Potassium (mg/L)
Goodnight	86,147	45,602	4,016	924
Empire	10,542	6,426	652	202

The following figures and previous illustrations confirm the points made above.

Exhibit B-10. Structural cross section of Grayburg reservoir in EMSU. The double humped asymmetric anticline gently dips to the east (right) into the lateral stratigraphic trap and dips 5° to the west (left) into the Delaware basin and is in pressure and fluid communication with the Goat Seep Aquifer. Folding of brittle dolostone reservoir strata created fractures. The Eunice-Monument complex of unitized oil fields is positioned atop the Eunice High structural block. The Eunice High is broken into smaller structural blocks.

Exhibit B-11. The Eunice High is broken into a series of smaller basement-cored structural blocks. This interpretation overlays Exhibit B6 as a comparison. These smaller structural blocks re-adjusted during the Laramide orogeny to uplift and fold Grayburg reservoir strata in EMSU into a double-humped asymmetric anticline and created a series of fractures. Top of San Andres was used as the datum to illustrate vertical offset of individual deep-seated basement structural blocks within the Eunice High.

Exhibit B-12. A Chevron in-house fracture study was performed on EMSU-679 oriented core (120 ft). Fractures were measured in Lower Grayburg reservoir and upper San Andres residual oil zone (ROZ).

Exhibit B-13. **EMSU-679 total fractures and their orientation in lower Grayburg reservoir and San Andres residual oil zone (ROZ).** Two fracture trends stand out. One is northwest to southeast and another is northeast to southwest. A total of 313 vertical fractures were measured.

Exhibit B-14. EMSU-679 large vertical fractures 1-3 ft in height. A major trend is northwest to southeast, with a minor trend northeast to southwest. A total of 24 fractures measured.

Exhibit B-15. EMSU-679 pyritized vertical fractures. A major trend is northwest to southeast, with minor trends to the northeast to southwest and east to west. 12 pyritized fractures were identified and measured.

Exhibit B-16. EMSU-679 fractures bounding collapse breccias and solution pipes. Two subtle trends are northeast to southwest and east to west. A total of 3 were measured.

Exhibit B-17. EMSU-679 San Andres core containing less porous, solution-widened, oil-stained, en echelon fractures from 4233-34 ft (-637 to -638 ft). Core is 89 ft below top of the San Andres. San Andres strata is less porous, brittle, and was easily fractured and solution-widened during structural movement that formed the Eunice Monument asymmetric anticline. Core width is 3 inches (7.62 cm). Left: Core photograph is dry. Right: Core photograph wet. Porosity = 4.8%. Permeability = 102 mD to 1292 mD. Oil saturation = 33.8%. Water saturation = 46.4%.

Exhibit B-18. EMSU-679 San Andres porous, oil-stained core containing solution-widened stylolitic tension gashes from 4175 ft (-579 ft). These small fractures are the most common fractures identified in Eunice Monument unitized oil fields (Lindsay, 2014). There are several in this field of view. Note the large tension gash that has undergone coring induced fracturing (**red arrow**). Several small fractures are throughout the field of view, most are solution-widened. Note pinpoint moldic porosity is throughout the field of view. Width of core is 3 inches (7.62 cm). Core photograph is dry. Porosity = 12.5%. Permeability = 5.2 mD. Permeability is low due to non-touching pinpoint moldic pores that lack connectivity. Oil saturation = 24.2%. Water saturation = 36.3%. Core is 31 ft beneath top of the San Andres.

Exhibit B-19. EMSU-679 San Andres residual oil zone (ROZ) vertical, solution-widened, en echelon fractures (**red arrows**) in porous, oil-stained strata from 4261-62 ft (-665 to -666 ft). Core is 117 ft beneath top of the San Andres. Core width is 3 inches (7.62 cm). Core photograph is dry. Porosity = 12.3%. Permeability = 1.4 mD. Oil saturation = 19.4%. Water saturation = 41.2%.

Exhibit B-20. EMSU-679 San Andres cores containing vertical stylolites (**red arrows**). Vertical stylolites were created by compression associated with the Laramide orogeny. Compression reactivated deep-seated fault blocks to fold Permian strata and form the Eunice Monument double-humped asymmetric anticline. Left: EMSU-679 4184 ft (-588 ft) (dry), 40 ft beneath top of San Andres. Right: EMSU-679 4188 ft (-592 ft) (wet), 44 ft beneath top of San Andres. Left: Core porosity = 6.3%, permeability = 5.7 mD, oil saturation = 26.5%, and water saturation = 60.7%. Right: Core porosity = 3.2%, permeability = 0.9 mD, oil saturation = 2.7%, and water saturation = 81.3%. Core widths are 3 inches (7.62 cm).

Exhibit B-21. A water chemistry study in EMSU revealed three water chemistries. First, connate water (120,000 ppm) in the Grayburg reservoir contains barium (Ba). Second, low salinity (<10,000 ppm) edge water entered the west side of the Grayburg reservoir. Edge water contains no sulfate. Edge water is sourced from the Goat Seep Aquifer, which is 1.5 to 2 miles down-dip of the west unit boundary of EMSU. Edge water entry into the Grayburg reservoir was by a drop in reservoir pressure due to production through time. Edge water is sourced from the present-day Guadalupe and Glass mountains. **Third, low salinity (<10,000 ppm) bottom water, in the San Andres reservoir residual oil zone (ROZ) is sulfate rich.** San Andres water was sourced from the Southern Rocky Mountain Epeirogen west of the Sacramento Mountains by meteoric recharge, which dissolved evaporite beds ($CaSO_4$) as it recharged into the subsurface and added sulfate (SO_4) to the low salinity water.

C. OIL IS PRESENT IN THE SAN ANDRES AS SHOWN BY CORE DATA, LOG DATA AND PETROPHYSICS

9. **Cores within the San Andres were found upon examination and description to be porous and oil stained. Core analysis data also revealed that the San Andres was porous and contained oil saturation:**
   - The oil/water contact in the San Andres residual oil zone (ROZ) was found to be -719 ft to -750 ft (subsea) and potentially deeper.

The following figures and tables, along with previous illustrations, confirm the points made above.

Exhibit B-22. **Combined cores from EMSU-649 (upper and middle Grayburg core) and EMSU-679 (lower Grayburg and upper San Andres core) show the complete Grayburg reservoir and upper San Andres residual oil zone (ROZ) on the west side of EMSU.**

Exhibit B-23. Left: Combined EMSU-649 and EMSU-679 well logs and core descriptions that contain the complete Grayburg reservoir and upper San Andres residual oil zone (ROZ) to beneath the Lovington Sandstone. Right: Close-up of EMSU-679 well log and core from Premier Sandstone at the base of Grayburg reservoir down section, crossing basal lag conglomerate (top red) and unconformity (red line) that separates Grayburg reservoir from upper San Andres residual oil zone (ROZ). Top of San Andres is at 4144 ft (-548 ft). Base of cored interval is 4358 ft (-762 ft). **Black arrows point to top and bottom of porous, oil-stained residual oil zone (ROZ) in San Andres ROZ.** Porosity and oil stain is above Lovington Sandstone in the upper San Andres. Red = Collapse breccia. Blue = Dolostone. Black bars = Porous–oil-stained dolostone strata.

Table B-1. EMSU-679 San Andres core analysis 4141-4170 ft (-545 to -574 ft). **Green** = oil saturation percentage (So).

Table B-2. EMSU-679 San Andres core analysis 4170-4196 ft (-574 to -600ft). **Green =** oil saturation percentage (So).

Table B-3. EMSU-679 San Andres core analysis 4196-4225 ft (-600 to -629 ft). **Green =** oil saturation percentage (So).

Table B-4. EMSU-679 San Andres core analysis 4225-4251 ft (-629 to -655 ft). **Green** = oil saturation percentage (So).

Table B-5. EMSU-679 San Andres core analysis 4251-4280 ft (-655 to -684 ft). **Green** = oil saturation percentage (So).

Table B-6. EMSU-679 San Andres core analysis 4280-4321 ft (-684 to -725 ft). **Green** = oil saturation percentage (So).

Table B-7. EMSU-679 San Andres core analysis 4321-4350 ft (-725 to -754 ft). **Green** = oil saturation percentage (So).

Table B-8. EMSU-679 San Andres core analysis 4350-4358 ft (-754 to -762 ft). **Green** = oil saturation percentage (So).

Exhibit B-24. EMSU R.R. Bell #4 cored the complete Grayburg reservoir and upper San Andres residual oil zone (ROZ) in southeast part of EMSU. Well location is next to the east unit boundary and up-dip lateral stratigraphic trap where reservoir porosity pinches out.

Exhibit B-25. Left: EMSU R.R. Bell #4 well log and core description of the complete Grayburg reservoir and San Andres residual oil zone (ROZ). Top of Grayburg is at 3645 ft (-94 ft). Top of San Andres is at 3883 ft (-332 ft). Base of cored interval is at 4006 ft (-455 ft). Right: Close-up view from Premier Sandstone (yellow) in the base of the Grayburg reservoir and unconformity (red line) that separates overlying Grayburg reservoir from the underlying upper San Andres residual oil zone (ROZ). San Andres core penetrated 20 ft beneath the base of the Lovington Sandstone.

Exhibit B-26. **EMSU R.R. Bell #4 well log and core description of San Andres residual oil zone (ROZ).** Arrows point to porous, oil-stained strata on the well log and in the core. Porous, oil-stained strata are present from top of the San Andres to beneath the Lovington Sandstone. Black bars = Porous–oil-stained dolostone strata.

Table B-9. EMSU R.R. Bell #4 San Andres core analysis from 3883 ft to 3969 ft (-332 ft to -418 ft) in the residual oil zone (ROZ). **Green** = Oil saturation percentage (So). Core analysis depths were off by 100 ft and were hand adjusted to their proper depth.

Table B-10. EMSU R.R. Bell #4 San Andres core analysis from 3969 ft to 4006 ft (-418 ft to -455 ft) in the residual oil zone (ROZ) to the base of the cored interval. **Green** = Oil saturation percentage (So). Core analysis depths are off by 100 ft and were hand adjusted to their proper depth. Lovington Sandstone between 3973–3986 ft helped locate proper core depths.

D. THE PROPOSED SALTWATER DISPOSAL OPERATIONS WILL IMPAIR CURRENT WATERFLOOD OPERATIONS AND RESULT IN THE WASTE OF VALUABLE OIL AND GAS RESERVES

10. From my perspective, injection of high salinity produced saltwater into the San Andres reservoir residual oil zone (ROZ) will do three things:

- ***First, injection of high salinity produced water will communicate up section into the Grayburg reservoir through fractures and impair existing waterflood operations.***

- ***Second, being a high salinity heavier fluid, through time injection of produced water will work its way down-dip into the Goat Seep Aquifer and contaminate a source of low salinity water (<10,000 ppm) in the Chihuahuan Desert.***

- ***Third, San Andres residual oil zone (ROZ) water is sulfate rich (SO_4). Injection of produced saltwater, most likely containing Ca, Na, K, or Ba ions, will come in contact with SO_4 and precipitate cement (scale) in porous oil saturated San Andres ROZ and reduce reservoir potential.***

The following figure and preceding illustrations confirm the points made above.

Exhibit B-27. Structural cross section through EMSU showing low salinity (<10,000 ppm) edge water entry into west side of EMSU. Source of edge water is Goat Seep Aquifer down-dip 1.5 to 2 miles of the west unit boundary of EMSU. Edge water entry is due to a drop in reservoir pressure from production through time. Injection of produced high salinity saltwater into San Andres strata will be sucked up by the drop in reservoir pressure to form vertically-oriented plumes of water entry into the Grayburg reservoir. **Produced water, being heavier than low salinity (<10,000 ppm) edge water, will eventually through time work its way down-dip to contaminate the Goat Seep Aquifer. Goat Seep Aquifer is one of only two sources of deep subsurface low salinity (<10,000 ppm) water in the Chihuahuan Desert.** The second source of deep subsurface low salinity (<10,000 ppm) water is the Capitan Aquifer farther to the west of EMSU. San Andres residual oil zone (ROZ) will become cemented by the introduction of produced water, most likely containing Ca, Na, K, and Ba, that will precipitate cement (scale) within the ROZ's pore system and reduce reservoir potential.

E. IT IS MORE LIKELY THAN NOT THAT GOODNIGHT'S INJECTION OF HIGH SALINITY WATER INTO THE SAN ANDRES WOULD CONTAMINATE THE GOAT SEEP LOW SALINITY AQUIFER ATTACHED TO THE EUNICE MONUMENT AND ARROWHEAD FIELDS DUE TO ITS GREATER DENSITY AND INCREASED PRESSURE AS MORE WATER IS INJECTED.

11. High resolution 3-D seismic data show that reservoirs along the Eunice Monument trend of unitized oil fields are immediately up-dip approximately 1.5 to 2 miles from the Goat Seep Aquifer a source of low salinity (<10,000 ppm) water:
    - Down-dip immediately west of the unitized oil fields the Grayburg underwent erosion at the end of Grayburg deposition, with the down-dip part of the Grayburg eroded.
    - The Goat Seep Aquifer is attached to the eroded edge of the Grayburg and is in pressure and fluid communication with Eunice Monument South Unit (EMSU) and Arrowhead Grayburg Unit (AGU).
    - Through time as EMSU and AGU produced oil and reservoir pressure decreased, edge water from the Goat Seep Aquifer entered the west side of the two reservoirs.

- Edge water entry into EMSU has been mapped and extends in the lower part of the Grayburg reservoir (-350 ft and down section).
- Edge water from the Goat Seep Aquifer is low salinity (<10,000 ppm) and free of sulfur.
- Goat Seep aquifer is recharged from the present-day Guadalupe Mountains to the northwest and Glass Mountains to the south. These two mountain ranges capture rain and occasional snow and recharge low salinity water (<10,000 ppm) into the subsurface. This low salinity water (<10,000 ppm) recharges the Goat Seep Aquifer.

The following figures and preceding figures, plates, and tables illustrate and confirm the points made above.

Exhibit B-28. Upper cross section from EMSU unitization hearings. Lower cross section is 3-d seismic through the same area. These show down-dip Goat Seep Aquifer (left) connected with Grayburg reservoir in EMSU (middle). Up-dip is lateral stratigraphic trap (right) and overlying vertical seal in base of Queen Formation. 3-d seismic show down-dip Goat Seep Aquifer (left) attached to eroded edge of Grayburg. Red arrows outline Grayburg. San Andres underlies the Grayburg. Datum is Yates Sandstone.

Exhibit B-29. Upper and lower illustrations show down-dip eroded edge of Grayburg Formation, with Goat Seep Dolostone attached to Grayburg, Western Escarpment, Guadalupe Mountains.

Exhibit B-30. Detailed outcrop study of San Andres, Cherry Canyon, Grayburg, and Queen formations from Western Escarpment, Guadalupe Mountains up-dip into Brokeoff Mountains west of the Guadalupe Mountains. Down-dip of eroded Grayburg edge is Goat Seep Dolostone (pink-red) attached directly to Grayburg Formation. Guadalupe Mountains receive rain and occasional snow and recharge meteoric water into the subsurface through the Goat Seep to become a low salinity (<10,000 ppm) aquifer free of sulfate in the subsurface. From Rush and Rankey (2023).

F. DOCUMENTATION SHOWS THERE IS NOT AN EFFECTIVE SEAL BETWEEN THE OVERLYING GRAYBURG PRODUCING ZONE AND THE UNDERLYING SAN ANDRES (CAN BE FOUND IN SPE PAPERS)

12. At first when studying Eunice Monument South Unit (EMSU) it was thought that the unconformity and non-porous strata that separated overlying Grayburg reservoir from underlying San Andres reservoir were isolated from each other and the two formations were not in communication. This has been proven to not be correct. **The Grayburg reservoir and San Andres reservoir residual oil zone (ROZ) are in communication via fractures:**

- Upon the crest of the Eunice High structural block, which created the greater Eunice Monument structural closure for EMSU-B, EMSU, and AGU reservoirs, there are fractures.
- The asymmetric anticline at EMSU is not a simple asymmetric anticline, but an anticline that contains a series of basement-cored smaller fault blocks that created a double-humped asymmetric anticline. These structural complexities along the crest of the structure created a series of fractures.
- It has been documented that San Andres low salinity (<10,000 ppm) water enriched in sulfate, is in communication with Grayburg reservoir strata through fractures in the crest of the structure.

- Fractures breached non-porous strata associated with the unconformity that separates San Andres reservoir strata from Grayburg reservoir strata.
- Fractures allowed San Andres water to communicate vertically up section to form what is termed a plume of water.
- Plumes of water were easily identified by water chemistry, which identified low salinity water (<10,000 ppm) that contain sulfate.
- San Andres water in the residual oil zone (ROZ) at the Eunice Monument complex of unitized oil fields was sourced from the Southern Rocky Mountain Epeirogen west of the Sacramento Mountains.
- Field work along U.S. Highway 82 west of Artesia, New Mexico and east of the foothills of the Sacramento Mountains identified San Andres collapse breccia horizons where evaporite strata ($CaSO_4$) were dissolved by recharging meteoric water to form cave horizons that filled with collapse breccia of overlying carbonate strata.
- Dissolution of evaporite strata ($CaSO_4$) added sulfate (SO_4) to low salinity San Andres water as it recharged into the subsurface.
- Through time recharging meteoric water delivered low salinity water (<10,000 ppm) containing sulfate (SO_4) into the San Andres residual oil zone (ROZ) at EMSUB, EMSU, and AGU.

The following figures and preceding illustrations confirm the points made above.

Exhibit B-31. San Andres collapse breccia along U.S. Highway 82 near the foothills of the Sacramento Mountains, New Mexico. Meteoric recharge of low salinity (<10,000 ppm) water dissolved San Andres evaporite strata ($CaSO_4$) and formed a cavernous porosity, which caused carbonate strata forming the cave roof to collapse. Dissolved evaporite strata ($CaSO_4$) added sulfate (SO_4) to low salinity (<10,000 ppm) meteoric water as it recharged farther into the subsurface.

Exhibit B-32. EMSU R.R. Bell #4 3958 ft (-407 ft) nonporous to porous, partially oil-stained strata containing solution-widened fractures. Core is 75 ft beneath top of the San Andres. Porosity = 8.2%. Permeability = 50.4 mD. Oil saturation = 15.4%. Water saturation = 41.0%. Core width is 3 inches (7.62 cm). Left: Core is dry. Right: Core is wet. Well location is near southeast unit boundary of EMSU. Within EMSU near the up-dip pinch out of the reservoir porosity, permeability, and oil saturation decrease and eventually terminate.

Exhibit B-33. EMSU-679 San Andres swarm of vertical fractures. Some fractures are solution-widened and oil-stained, and some are simple hairline fractures. Fractures are in nonporous (tight) to porous strata along the edge of a solution pipe or sink hole. Core is 11 ft beneath top of the San Andres. Porosity = 11.4%. Permeability = 560 mD to 1,044 mD. Oil saturation = 14.5%. Water saturation = 35.4%. Note intense fracturing in less porous strata adjacent to porous, oil-stained, grain-rich strata that filled the solution pipe or sink hole. Left: core is dry. Right: core is wet. Laramide (Late Cretaceous-Early Cenozoic) reactivation of basement-cored fault blocks folded Permian strata and preferentially fractured less porous San Andres dolostone strata. Core width is 3 inches (7.62 cm).

Exhibit B-34. EMSU-679 San Andres 4335 ft (-739 ft) with less porous (gray) to more porous (beige) strata, adjacent to solution-widened fractures that are partially calcite cemented. Core is 191 ft beneath top of San Andres. Left: Core is dry. Right: Core is wet. Core width is 3 inches (7.62 cm). Porosity = 3.7%. Permeability = 11 mD to 46 mD. Oil saturation (So) = 0.0%. Water saturation (Sw) = 88.3%. Note porosity zonation adjacent to fractures (beige color), while strata farther away from the fracture is less porous (gray). Initial solution-widening of fractures was via undersaturated fluid that extended away from fractures into surrounding matrix and was followed later by a calcite cementation event as fluid reached saturation.

G. PROOF OF CHANNELING AND CROSSFLOW BETWEEN ZONES THROUGHOUT THE FIELD THEREFORE HAS BEEN DOCUMENTED BY PRODUCTION DATA AND INCREASE IN SULPHUR CONTENT. IT IS MORE LIKELY THAN NOT THAT THIS WILL OCCUR AS A RESULT OF GOODNIGHT'S SALTWATER DISPOSAL.

13. The above testimony confirms the following:

- **First, injection of high salinity produced water into the San Andres reservoir residual oil zone (ROZ) in EMSU will communicate up section through fractures into the Grayburg reservoir and will thereby result in the waste of hydrocarbons.**

- Additional water entry into the Grayburg reservoir at EMSU will more likely than not have negative effects on production within the reservoir.

- Injection of high salinity produced water will through time communicate down section to contaminate the low salinity (<10,000 ppm) Goat Seep Aquifer.

- Goat Seep aquifer is a source of low salinity (<10,000 ppm) water in the subsurface in this part of New Mexico where sources of fresh water are rare and should not be contaminated and will therefore harm public health and the environment.

- **Injection of high salinity produced water into EMSU, EMSUB, and AGU will impact the San Andres reservoir residual oil zone (ROZ) by the precipitation of cement (scale) in reservoir porosity, which will reduce porosity-permeability and future productivity. Goodnight's disposal water contains high levels of sodium (39,580-51,322 mg/L) and calcium (2206-5988 mg/L) when compared to Empire's produced waters which has an average of 6426 mg/L sodium and 652 mg/L calcium from 32 samples.**

I understand this Self-Affirmed Statement will be used as written testimony in this case. I affirm that my testimony above is true and correct and is made under penalty of perjury under the laws of the State of New Mexico. My testimony is made as of the date next to my electronic signature below.

/Robert F. Lindsay August 13, 2024

Robert F. Lindsay
5308 Green Tree Blvd
Midland, Texas 79707

Summary

Developed a strong background in the following: 1) reservoir characterization; 2) evaluation of reservoir potential in exploration wells; 3) assessing new play concepts; 4) unconventional carbonate source rock reservoir potential; and 5) teaching and mentoring. This includes integration of seismic, synthetic seismograms, well logs, cores, petrophysics, engineering and production data to fully evaluate and characterize reservoirs. Performed wellsite geology on exploration and development wells. Good computer skills. Excellent verbal and written communication skills. Conducted field work, measured numerous outcrop sections, and led numerous field trips. Taught graduate level geology courses (MS & PhD).

Professional Experience

Geologic Consultant, Lindsay Consulting LLC, 2016-Present, Midland, Texas

- Core description and reservoir evaluation: Conventional, tight, and unconventional reservoirs
- Field trip leader, Guadalupe Mountains and Apache Mountains, West Texas, building regional-scale sequence stratigraphic models
- Teaching graduate level courses, Affiliate Professor, Brigham Young University, describing cores, assessing reservoir potential, identifying up-dip stratigraphic traps, building reservoir-scale sequence stratigraphic models
- Adjunct Professor, University of Texas at the Permian Basin

Sr. Geological Consultant, Geological Consultant, & Geological Specialist, Carbonate Sedimentology & Sequence Stratigraphy, 2002-2015, Saudi Aramco, Dhahran, Saudi Arabia
Geological Technical Services Division (GLTSD)

- Described cores and evaluated reservoir potential in development and exploration wells from the following formations, which in stratigraphic order are:
  - Miocene;
    - Wadi WAQB
  - Palaeocene-Eocene;
    - Umm Er Radhuma
  - Cretaceous;
    - Masastrichtian
    - Aruma
    - Mishrif
    - Mauddud
    - Shu'aiba
    - Upper Ratawi
  - Jurassic;
    - Manifa
    - Hith Stringers
    - Rimthan
    - Arab-A
    - Arab-B
    - Arab-C
    - Arab-D
    - Jubaila
    - Hanifa
    - Hadriya source rock

        - Upper Fadhili
        - Lower Fadhili
        - Sharar
        - Faridah
        - Marrat
    - Triassic;
        - Jilh
        - Khuff-A
        - Upper Khuff-B
    - Permian;
        - Lower Khuff-B
        - Khuff-C
        - Khuff-D
- Described outcrops and led field trips through the following formations, which in stratigraphic order are:
    - Miocene;
        - Dam
        - Rus
        - Dammam
    - Cretaceous;
        - Aruma
        - Hausiyan
        - Shu'aiba eqivalent
        - Biyadh
        - Sulaiy
    - Jurassic;
        - Manifa equivalent
        - Hith
        - Arab-A-C Collapse Breccia
        - Arab-D
        - Jubaila J2
        - Jubaila J1
        - Hanifa Ullaya Member
        - Hanifa Hawatah Member
        - Tuwaiq Mtn T1
        - Tuwaiq Mtn T2
        - Tuwaiq Mtn T1
        - Dhruma D7 Hisyan Shale
        - Dhruma D7 Atash
        - Dhruma D6
        - Dhruma D5
        - Dhruma D4
        - Dhruma D2 Dhibi
        - Marrat
    - Triassic;
        - Minjur
        - Jilh
        - Upper Khuff-B
    - Permian;
        - Lower Khuff-B
        - Khuff-C
- Ghawar field Arab-D reservoir sequence stratigraphy and depositional model (6-8 year study)
- Regional Arab-D stratigraphic trap study

- Unconventional Jurassic carbonate source rock studies
- Khuff A regional sequence stratigraphy and depositional model
- Khuff B regional sequence stratigraphy and depositional model
- Evaluated Shaybah field-Early Cretaceous Shu'aiba porosity development and diagenesis (meso & microporosity)
- Evaluated Exploration Core Laboratory to improve its efficiency
- Evaluated carbonate reservoirs within the Partioned Neutral Zone for contract renewal with Chevron
- Frac sand regional study throughout Saudi Arabia
- Geology subject matter expert (SME) for the upstream professional development center (UPDC)
- Purchasing laboratory equipment: Minipermeameter
- Interview potential carbonate sedimentologists and geologists, via face to face and video conferencing from Dhahran, at AAPG conventions, and in Calgary, Colombia and Argentina
- Ph.D. titled "Grayburg Formation Reservoir-Scale Architecture and Sequence Stratigraphy, Permian Basin, USA" (Started 2004, Graduated July 7, 2014, University of Aberdeen, Scotland)
- Taught Ph.D. graduate course on carbonate sedimentology at King Faud University of Petroleum and Minerals (KFUPM) (2011 and 2013)
- Presented numerous talks and poster sessions at AAPG and Geo conferences and Dhahran Geoscience Society (DGS)
- Mentored several young geologists and helped locate graduate schools to attend
- Assisted in planning and presented in Predicting Stratigraphic Traps Workshop, 2014, Key note address speaker and presented poster session
- Assisted in planning and presented in Jurassic Workshop 2006
- Assisted in planning and presented in Second Jurassic Workshop 2011
- Assisted in planning and presented in Khuff Workshop
- Taught carbonate reservoir part of Advanced Petroleum Geology Workshop 2009
- Taught Jurassic Petroleum Systems field trip and core workshop 2014
- Taught How To Describe A Core to summer intern students
- Unconventional Jurassic carbonate source rocks, 2013-Present
- Regional Khuff Workshop in Bahrain (2007)
    - Presented talk on Khuff Formation of Saudi Arabia
- Gave Dhahran Geoscience Society (DGS) talks on:
    - Permian Basin: Frontier to Oil Province (2005)
    - Syria Field Trip (2006)
    - Distinguished Lecturer 2013-2014

Staff Geologist, Stratigrapher, 1990-2002, Chevron USA, Midland, Texas
Evaluation and characterization of numerous Permian Basin reservoirs for infill, horizontal, and development wells:

- Created sequence stratigraphic models with facies, rock types, engineering data, and production information superimposed on model to understand reservoir architecture in several large oil fields
- Pioneered use of high pressure Hg porosimetry to calculate effective vs. ineffective porosity and apply to reservoirs to determine volumetrics and economics
- Worked on the following productive intervals in the Permian Basin, which in stratigraphic order are:
    - Middle Permian (Guadalupian);
        - Queen
        - Grayburg
        - San Andres
    - Lower Permian (Leonardian);
        - San Angelo

    - Clear Fork
    - Tubb
    - Drinkard
    - Abo
  - Lower Permian (Wolfcampian);
    - Wolfcamp
    - Bursum
  - Pennsylvanian;
    - Cisco
    - Strawn
  - Mississippian;
    - Barnett
  - Devonian;
    - Woodford
    - 31 Formation
  - Silurian;
    - Fusselman
  - Ordovician;
    - Montoya
    - Simpson
    - Ellenberger
- Characterize pore systems, wettability and ability to drain reservoir by primary, secondary and tertiary recovery
- Side projects evaluating reservoirs in Gulf of Mexico, Kazakhstan, Syria, and offshore India
- Conducted outcrop studies of Permian (Guadalupian-Leonardian) Grayburg, Munn and San Andres formations (129 measured sections) as analogs to build subsurface reservoir models
- Led numerous field trips (30+) to study outcrop equivalents of subsurface reservoirs for geologists, geophysists, engineers, land representative, office services, summer interns and management
- Characterized Late Ordovician Montoya horizontal drilling play
- Taught MS level classes (UTPB) and taught short courses on carbonate sedimentology and reservoir characterization

Senior Geologist, Sr. Carbonate Petrographer, 1988-1990, Chevron USA, Hobbs, New Mexico
Reservoir evaluation and characterization of Permian Basin reservoirs, such as, new waterfloods, new discoveries, and mature waterfloods

- Charactrerized new discovery, correlating porosity, facies distribution, karst overprints, and built a stand up, see through, three dimensional model to utilize in solving day to day production problems
- Conformance work redirecting injection more effectively within a reservoir experiencing water cycling
- Well completion work utilizing core when open-hole logs could not be run in rough hole, completed well for 304 BO and no water
- Initiated outcrop studies to gain better insight into reservoir architecture of the Permian (Guadalupian) Grayburg Formation

Laboratory Supervisor, 1987-1988, Chevron USA, Denver, Colorado
Supervised in-house laboratory to support Rocky Mountain and Midcontinent Exploration and Development Divisions

- Core layout tables to describe cores, slabbing saws, and polishing wheels
- Rock petrophysics via thin sections, SEM, Xray and Hg porosimetry

- Geochemistry of produced oil and water, via gas chromatography and ICAP

Geologist, Carbonate Petrographer, 1985-1987, Chevron USA, Denver, Colorado
Evaluated and estimated reservoir potential and prediction of porosity occurrence in Midcontinent Exploration Division

- Conducted regional study of Middle Ordovician Simpson Group siliciclastic porosity distribution in Southern Oklahoma
- Conducted similar regional study of Early Ordovician-Late Cambrian Arbuckle Group carbonates
- Characterized carbonate and siliciclastic reservoirs in Central Oklahoma, Western Kansas, Northeast Oklahoma, and Michigan to assess reservoir potential
- Conducted field work and co-led field trips to Arbuckle and Wichita mountains to assess the Cambrian – Ordovician stratigraphy, structural geology, and reservoir potential of southern Oklahoma

Sr. Project Geologist, Lithostratigraphy, 1983-1985, Gulf Exploration Technology Center, Houston, Texas
Responsible for worldwide core descriptions, reservoir assessment and characterization

- Described offshore Zaire Early Cretaceous Pinda and Toca cores, identifying porosity types and permeability controls
- Identified Permian Basin injectivity problem, caused by precipitation of iron sulphide and carry over oil combing to create "black gunk" that occluded injection wells
- Work included Gulf of Mexico oil seeps, East coast Jurassic shelf margin core description, and Utah outcrops

Geologist, Senior Geologist & Supervisor Enhanced Oil Recovery Geology, 1977-1983, Gulf Oil, Oklahoma City, Oklahoma
Implemented enhanced oil recovery techniques, such as, CO2, nitrogen, polymer, miocellar polymer, alkaline, fire floods, etc. in various Rocky Mountain and Midcontinent reservoirs

- Responsible for site selection and all geologic work for a successful CO_2 pilot and unitization efforts, in Little Knife field, North Dakota
- Little Knife field unitization study
- Created geologic data base on all North Dakota unitized fields
- Characterized Permian Minnelusa reservoir in Powder River basin, built 3-d structural/stratigraphic fence diagram of complete field
- Characterized other oil fields in Oklahoma, Wyoming, Texas Panhandle, Utah, etc.

Geologist, 1976-1977, Gulf Energy & Minerals, Oklahoma City, Oklahoma
Responsible for development of western Kansas oil and gas fields and wellsite geology throughout the Midcontinent on Development and Exploration wells

- Drilled, cored and performed wellsite production geology on 27 wells, without mud loggers, in Oklahoma, North Texas, Texas Panhandle, Kansas, and Michigan
- Associated with two development discoveries

Education

B.S. Geology, 1974, Weber State College
M.S. Geology, 1976, Brigham Young University
Ph.D. Geology, 2014, University of Aberdeen (Scotland)

Military

U.S. Army Special Forces, 19th Special Forces Group (Airborne), Medical Specialist – Honorable Discharge

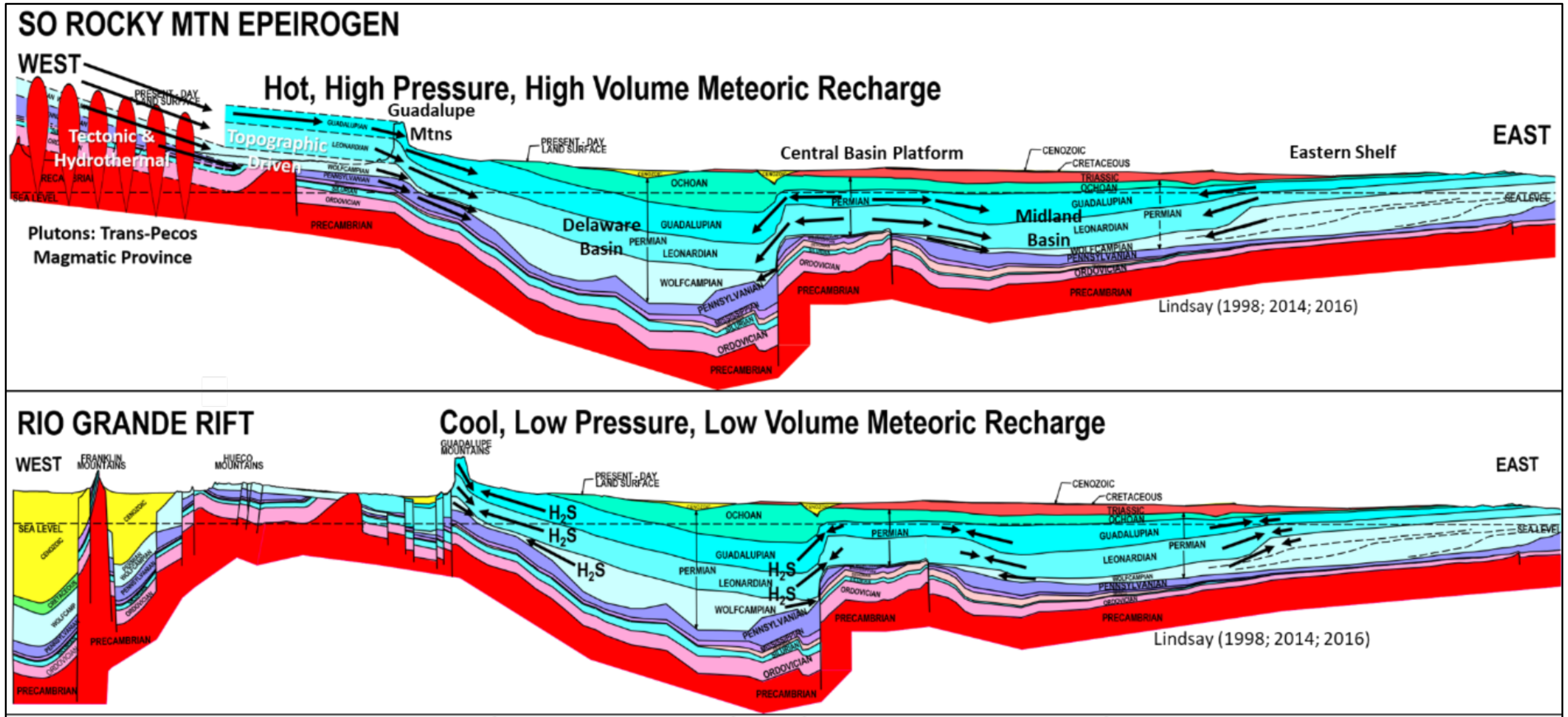
Professional Associations

American Association Petroleum Geologists
SEPM
West Texas Geological Society
Permian Basin Section SEPM
Dhahran Geoscience Society
National Spleological Society
SPE
SIPES

Honors

President West Texas Geological Society, 2000-2001
President Permian Basin Section–SEPM, 1995-1996
AAPG Distinguished Lecturer, 1994-1995
Honorary Life Membership Permian Basin Section–SEPM, 1999
Honorary Life Membership West Texas Geological Society, 2005
AAPG Delegate, West Texas Geological Society and Dhahran Geoscience Society
Member of Board of Professional Geoscientists in the State of Texas, #1386
Distinguished Lecturer Dhahran Geoscience Society (DGS) 2013-2014
Secretary, Society of Independent Earth Scientists, Midland Chapter SIPES

Exhibit B-1



Hot, High Pressure, High Volume Meteoric Recharge

Ramp/Shelf Reservoirs Swept

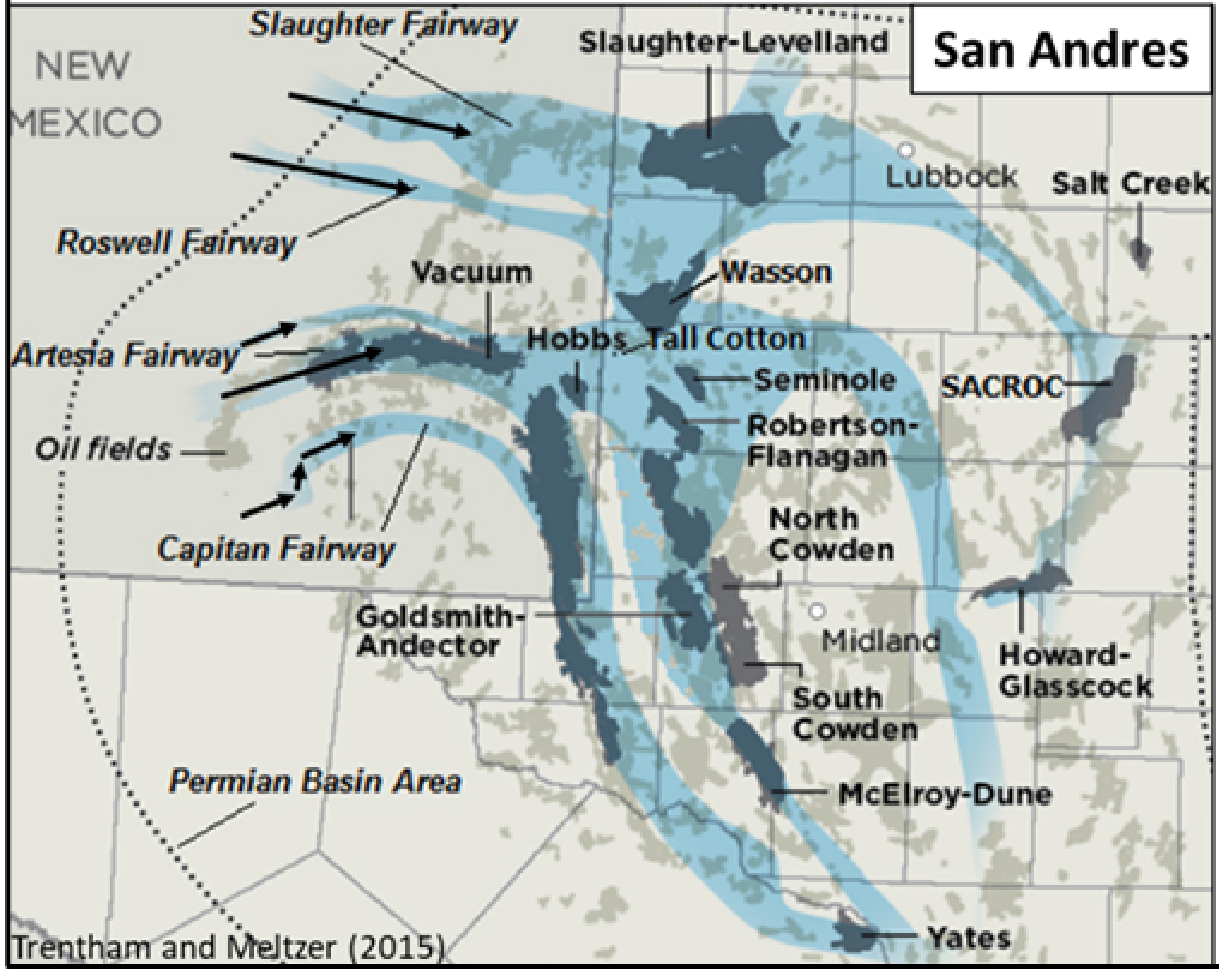
Cool, Low Pressure, Low Volume Meteoric Recharge

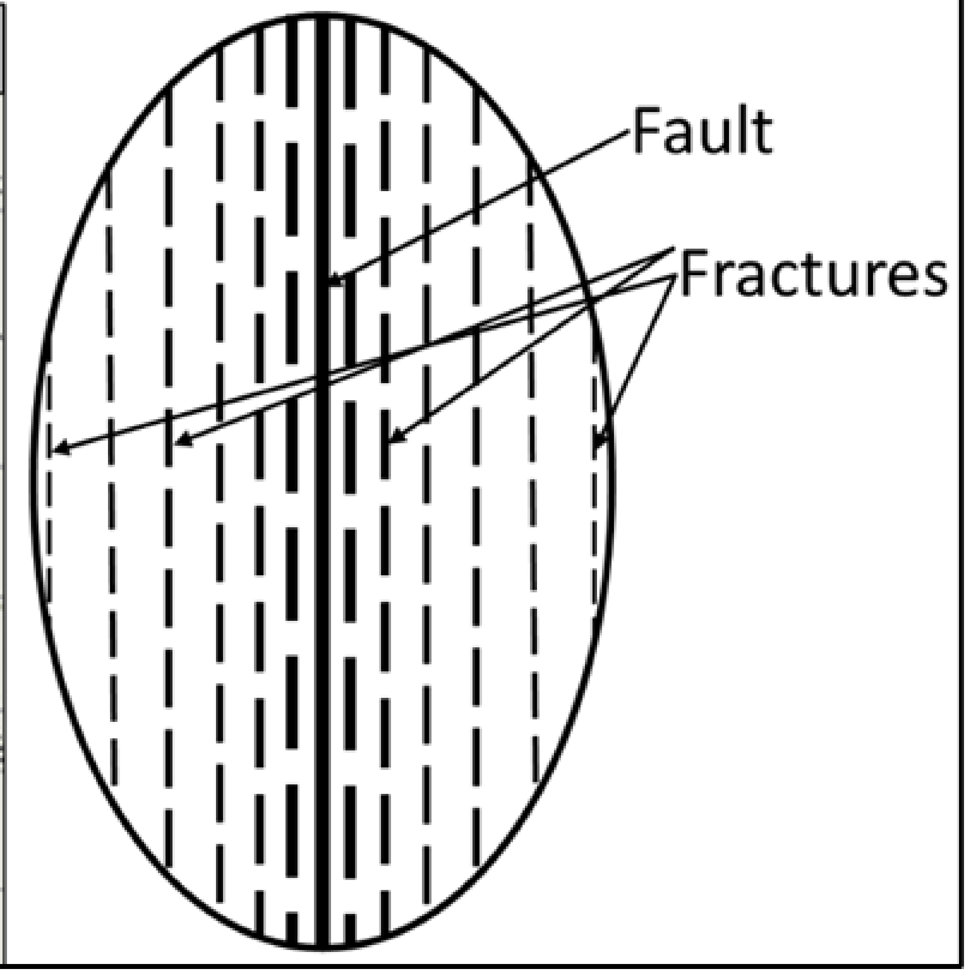
Ramp/Shelf Reservoirs Resaturate w/Mobile Oil

Late Eocene to early Miocene uplift of the southern Rocky Mountains resulted in relatively hot, high pressure, high volume, meteoric waters to recharge into the Permian Basin subsurface. This sweep of mobile oil out of stratigraphic and strato-structural traps, and structural closures created Residual Oil Zones. From Lindsay 1998, 2014, 2016.

Exhibit B-2

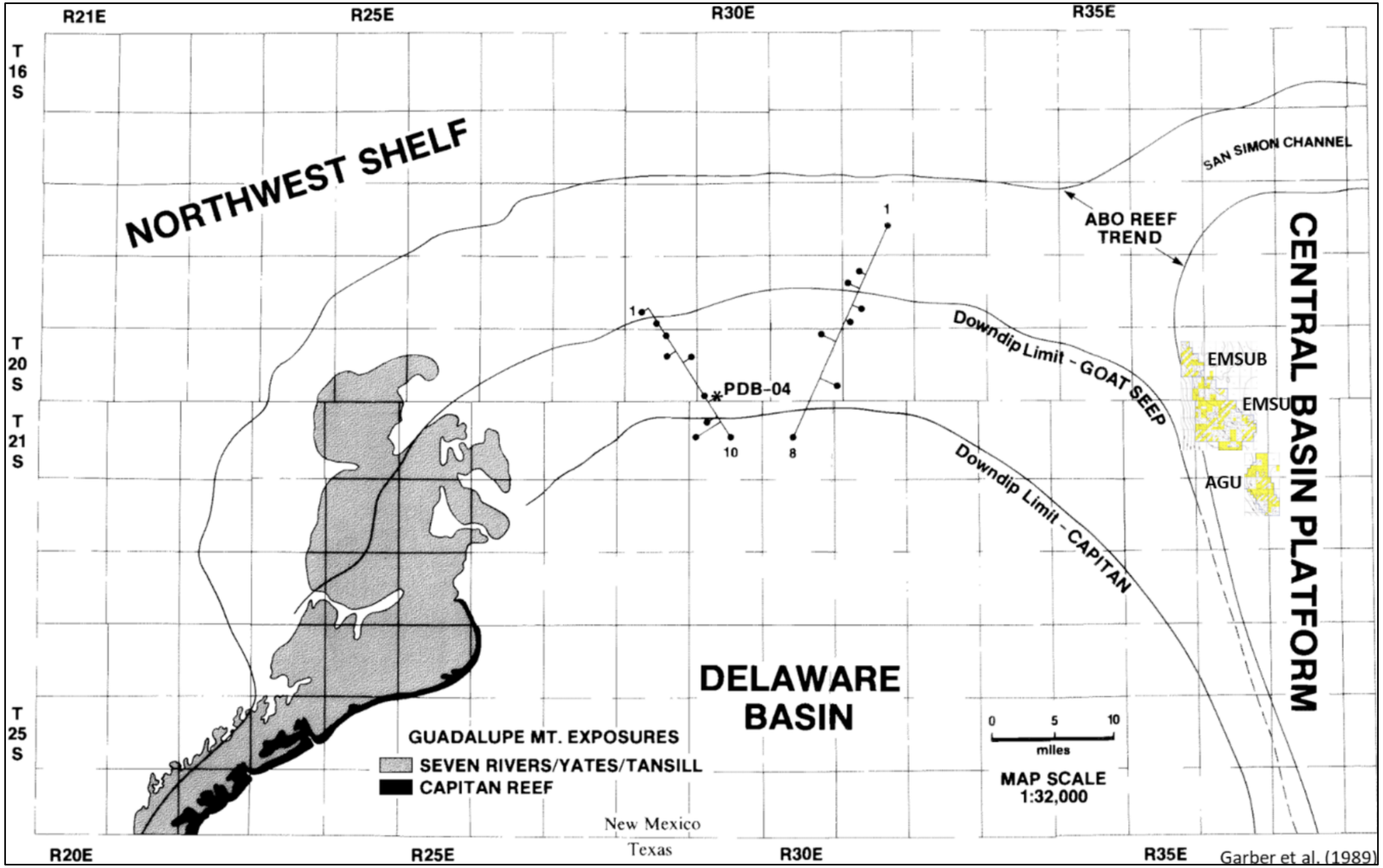
Porosity Fairways, Faults & Fractures





Left Figure: Map of regional San Andres porosity fairways.
Right Figure: A fracture halo, where a series of fractures surround a fault.

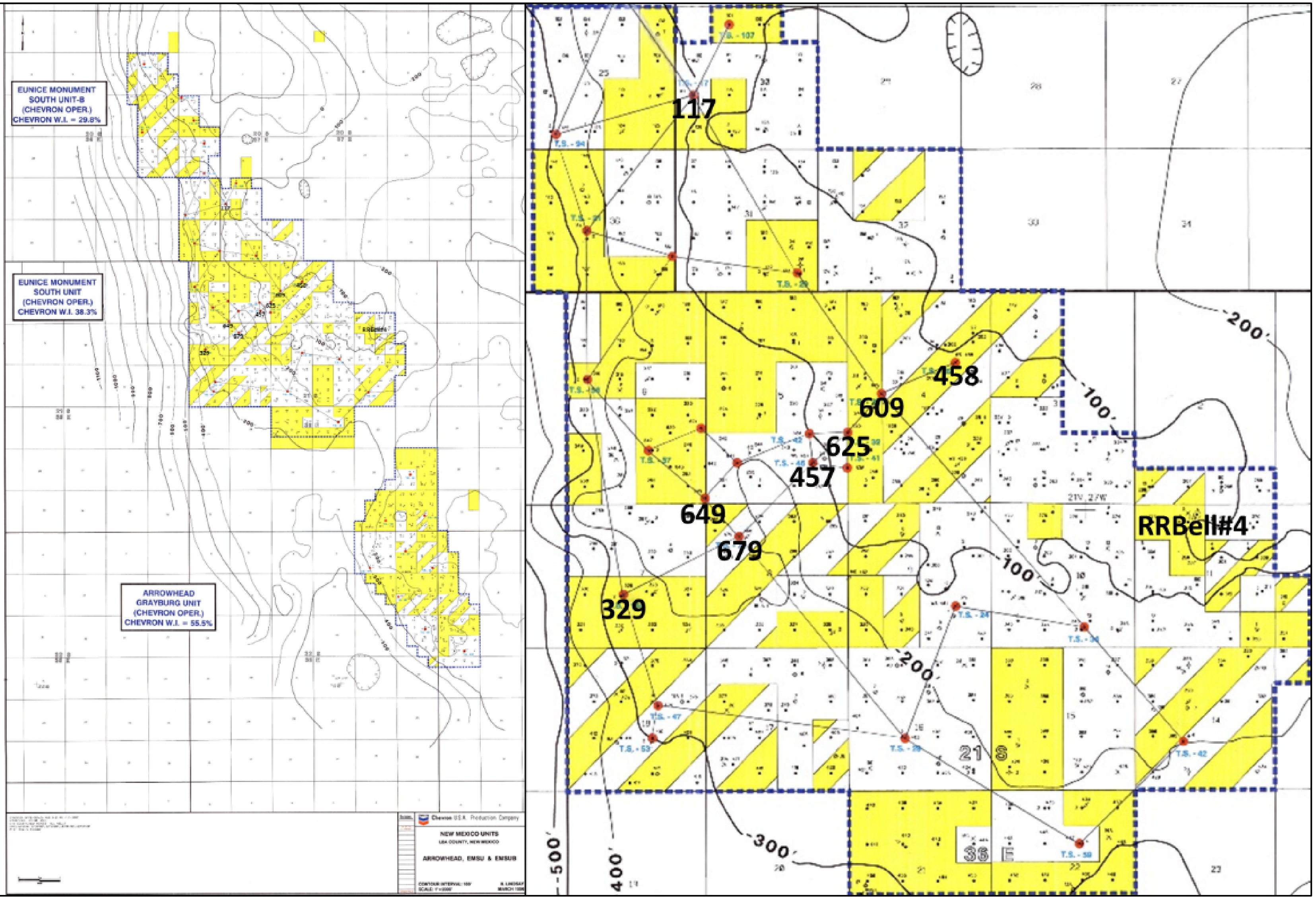
Exhibit B-3



Down-dip limits of Goat Seep and Capitan aquifers in relation to EMSU-B, EMSU, & AGU

Exhibit B-4

Eunice-Monument Complex of Unitized Oil Fields



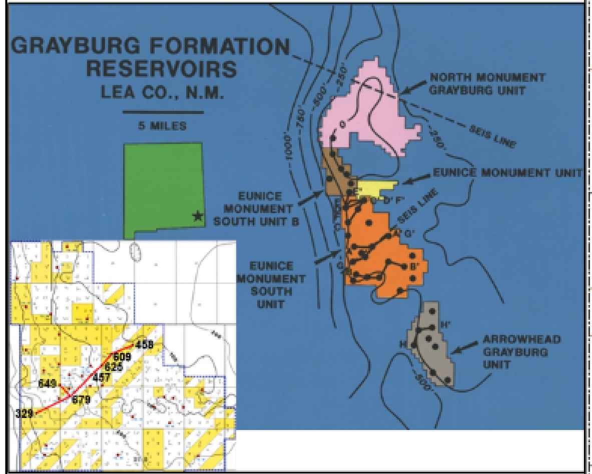
Left Figure: Index map of EMSU-B, EMSU, and AGU unitized oil fields.
Right Figure: EMSU-329 to EMSU-458 serve as the principle cross-section through the Grayburg (Cored wells EMSU-679 and RR Bell #4 also shown on the map)

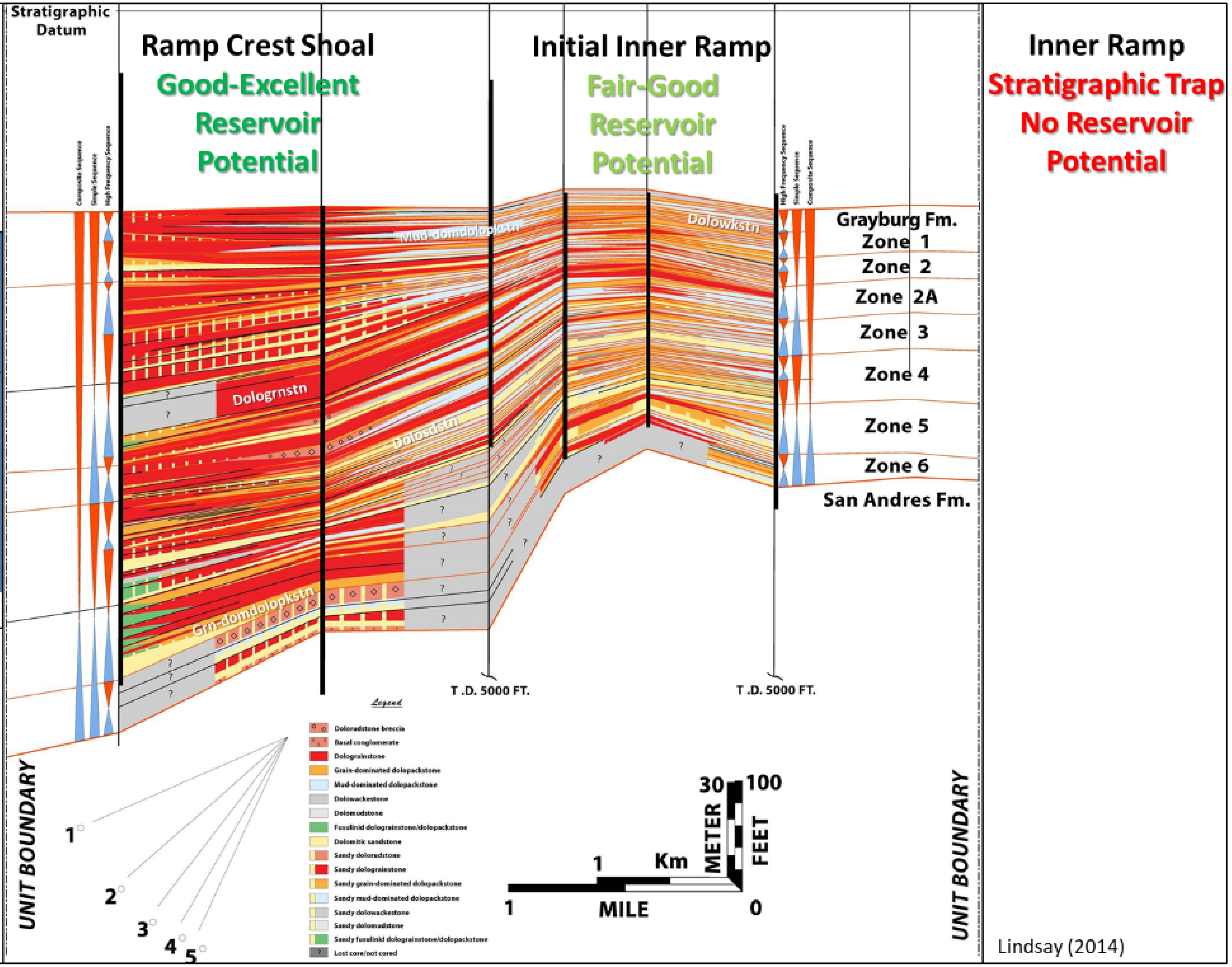
Exhibit B-5

Eunice Monument South Unit

Grayburg Reservoir

NW Central Basin Platform





Reservoir-scale sequence stratigraphic model of Grayburg reservoir architecture, composed of individual cycles of dolostone and interbedded siliciclastic strata.

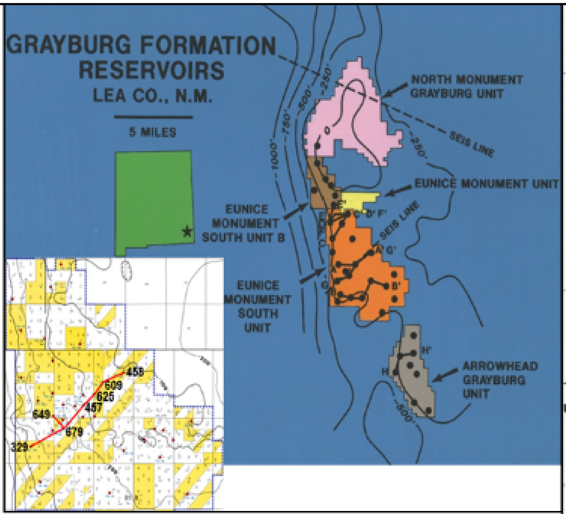
Exhibit B-6

Eunice Monument South Unit (EMSU)

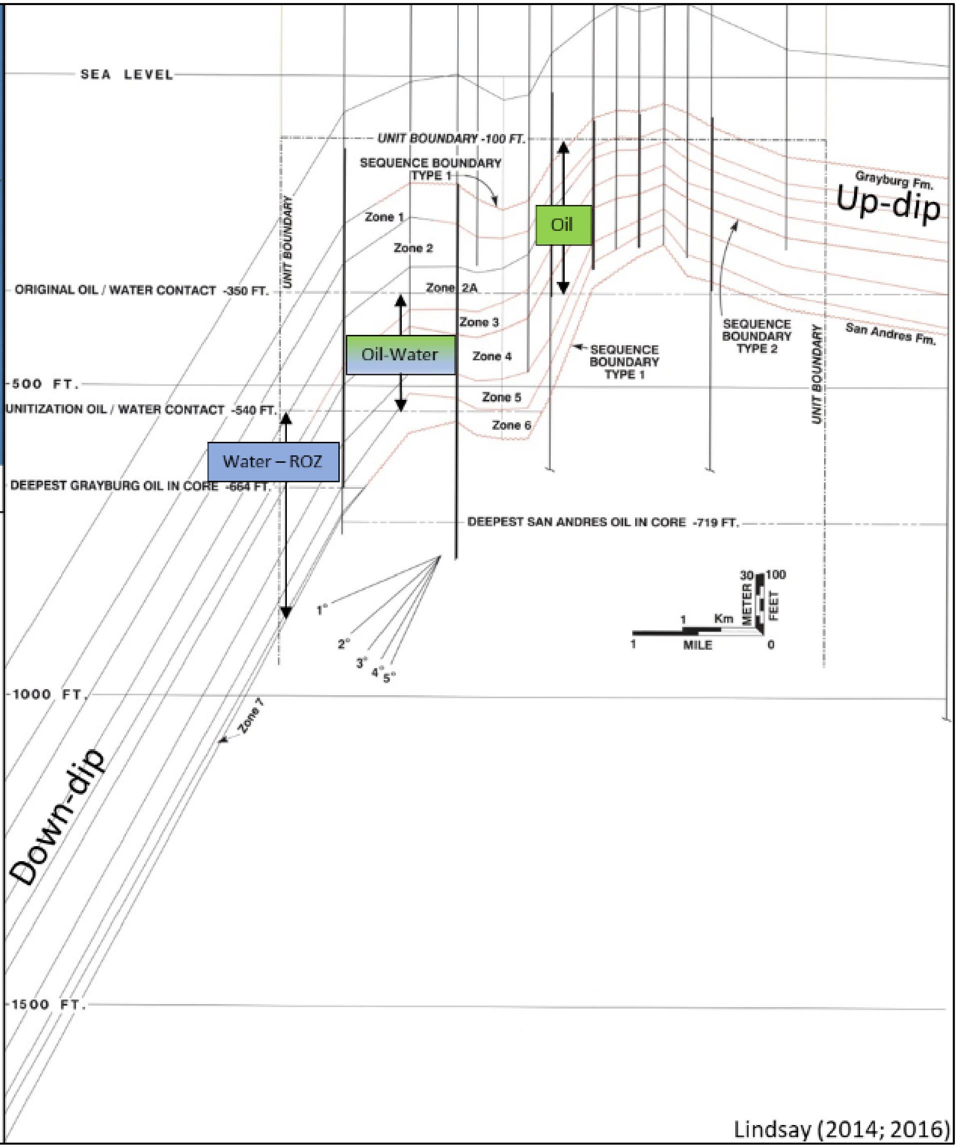
Grayburg Reservoir

&

San Andres Reservoir

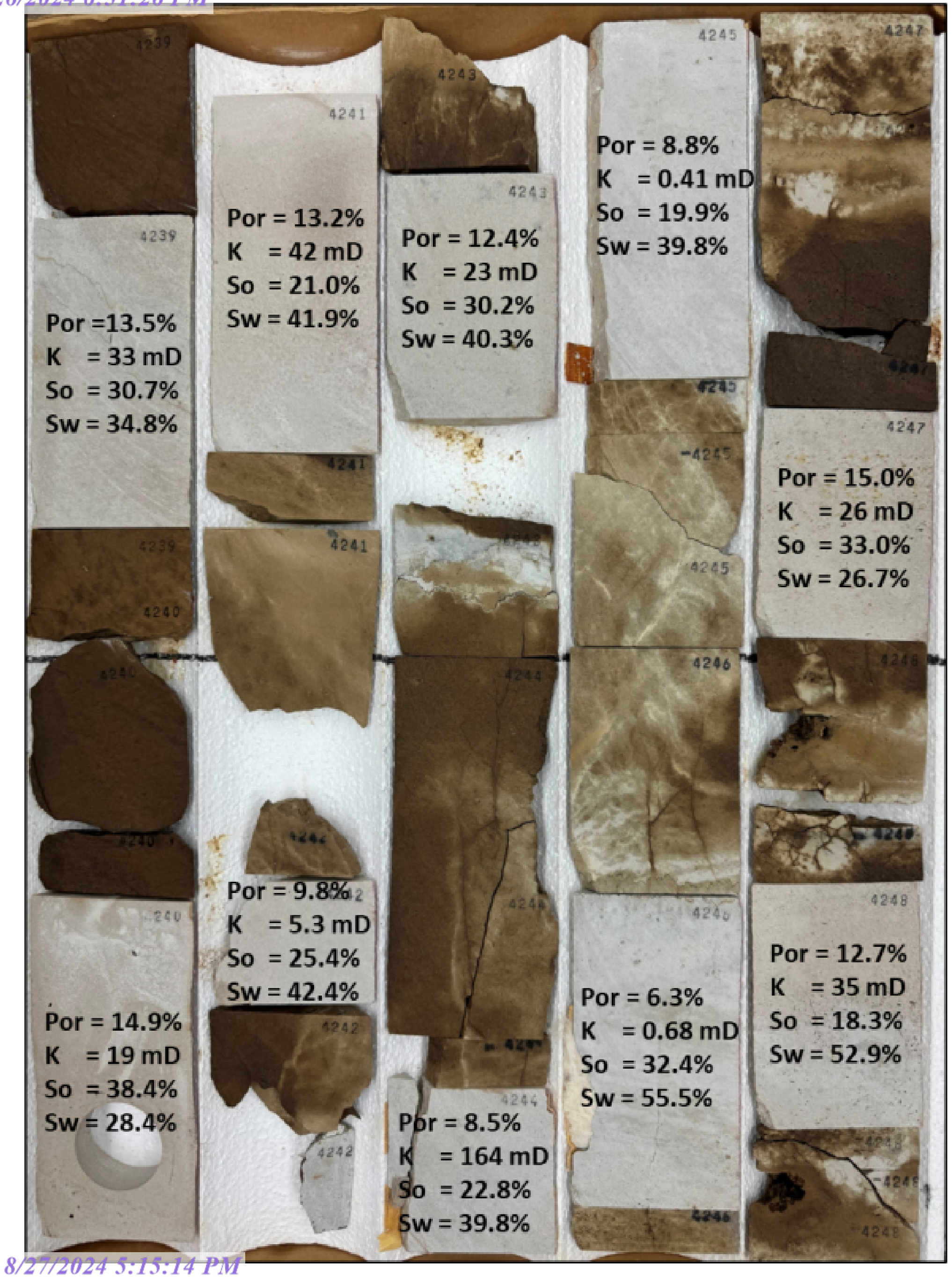


EMSU: Present-day Oil, Mixed Oil/Water & ROZ Column



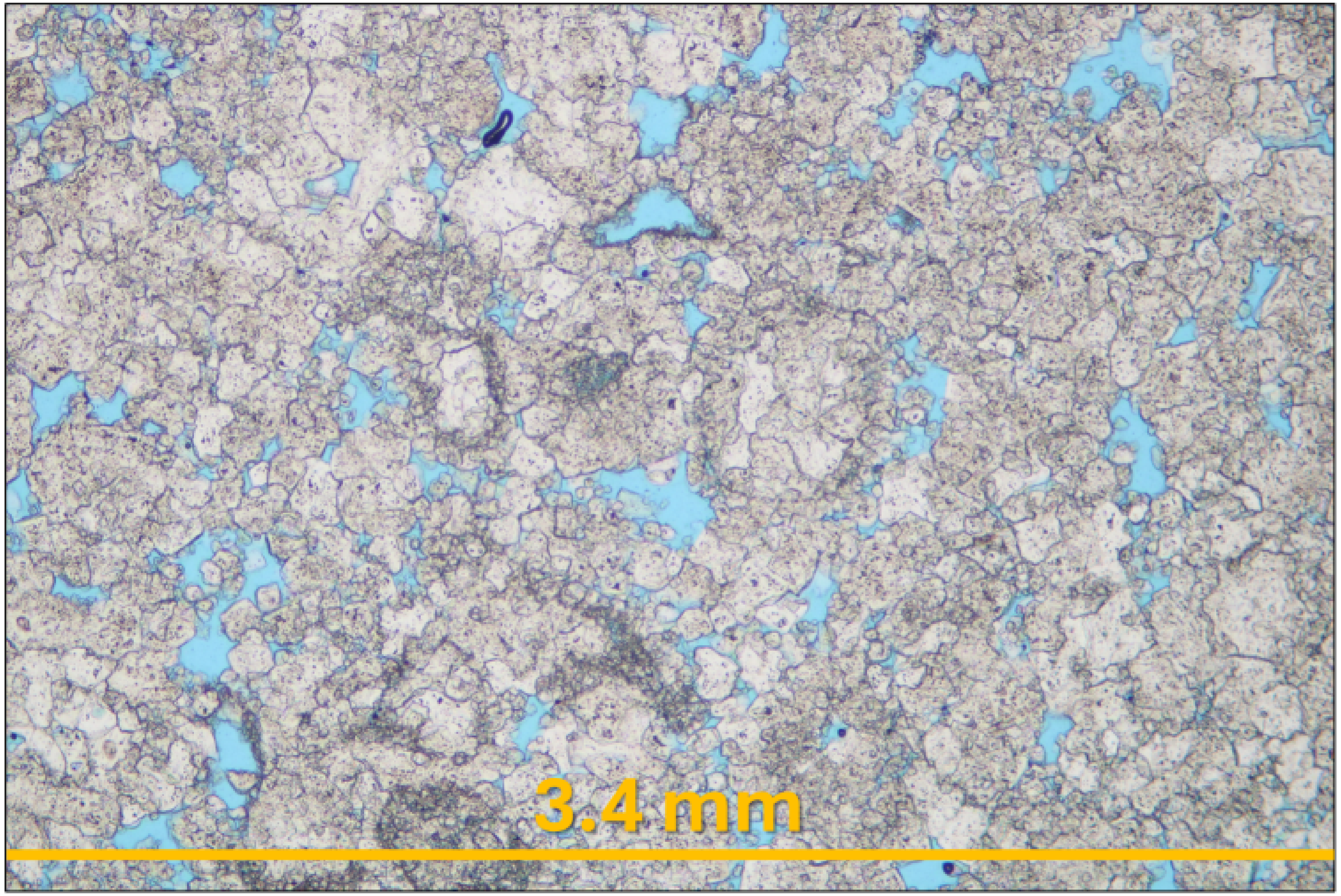
Dip-oriented structural cross section through EMSU. Note double humped shape of the asymmetric anticline. The structure flattens up-dip (right) into the non-porous lateral stratigraphic trap and steepens to 5° down-dip (left) into the Delaware basin.

Exhibit B-7



EMSU-679 San Andres core containing good porosity, permeability, and oil saturation from 4239 to 4249 ft (-643 to -653 ft). Foot by foot porosity (Por), permeability (K), oil saturation (So), and water saturation (Sw) data are from core analysis. Core is from 95 ft to 105 ft beneath top of the San Andres.

Exhibit B-8



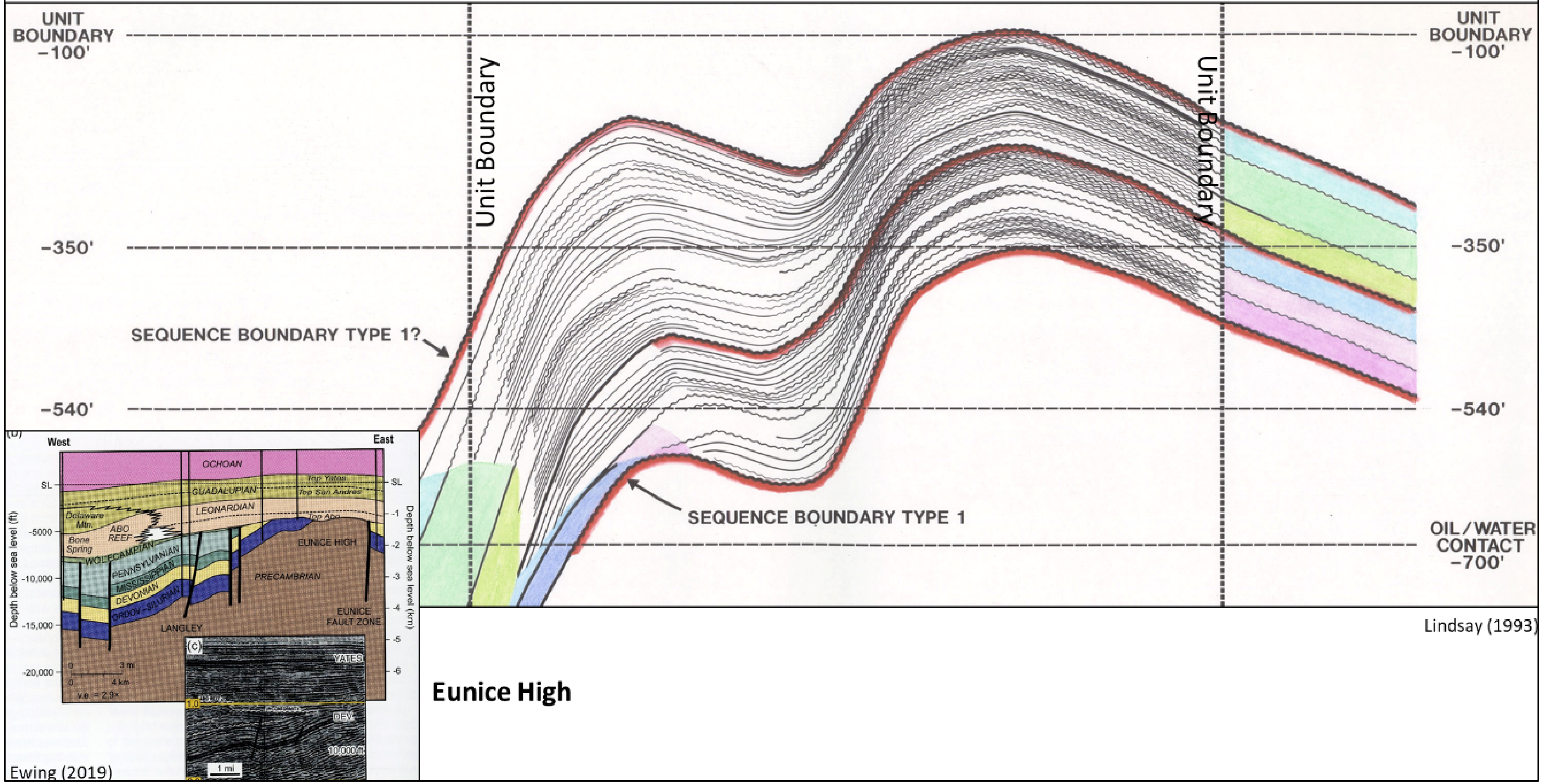
EMSU-679 San Andres residual oil zone (ROZ) photomicrograph of porous, oil-stained, grain-dominated dolopackstone from 4280.85 ft (-685 ft). Porosity = 14.9%. Permeability = 19 mD. Oil saturation = 38.4%. Water saturation = 28.4%. Blue = porosity. Thin section is from 97 ft beneath top of the San Andres.

Exhibit B-9

EMSU R.R. Bell #4 San Andres core containing fair to good porosity, low permeability, and fair to good oil saturation. Core photograph is from the base of the cored interval from 3996 to 4002 ft (-445 to -451 ft). Well location was adjacent to the up-dip stratigraphic trap where porosity, permeability, and oil saturation decreased.

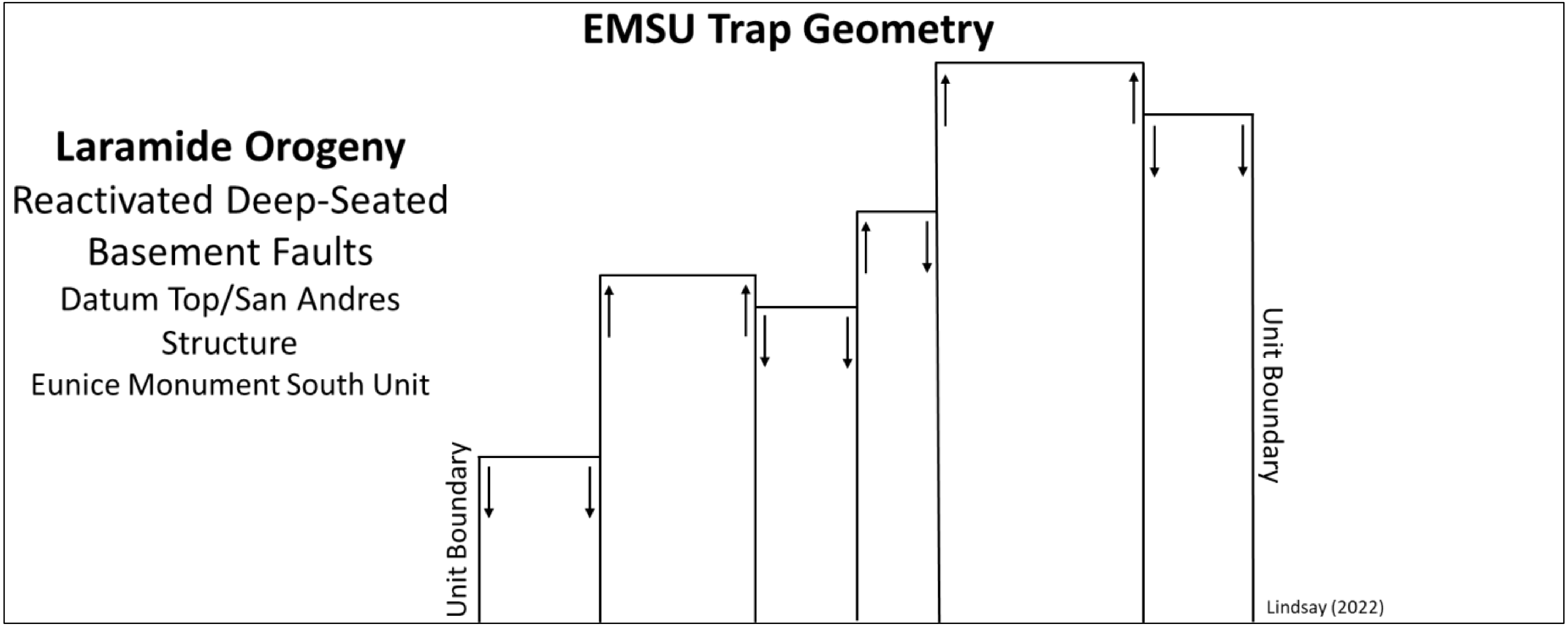
Exhibit B-10

EMSU Trap Geometry



Structural cross section of Grayburg reservoir in EMSU. The double humped asymmetric anticline gently dips to the east (right) into the lateral stratigraphic trap and dips 5° to the west (left) into the Delaware basin and is in pressure and fluid communication with the Goat Seep Aquifer.

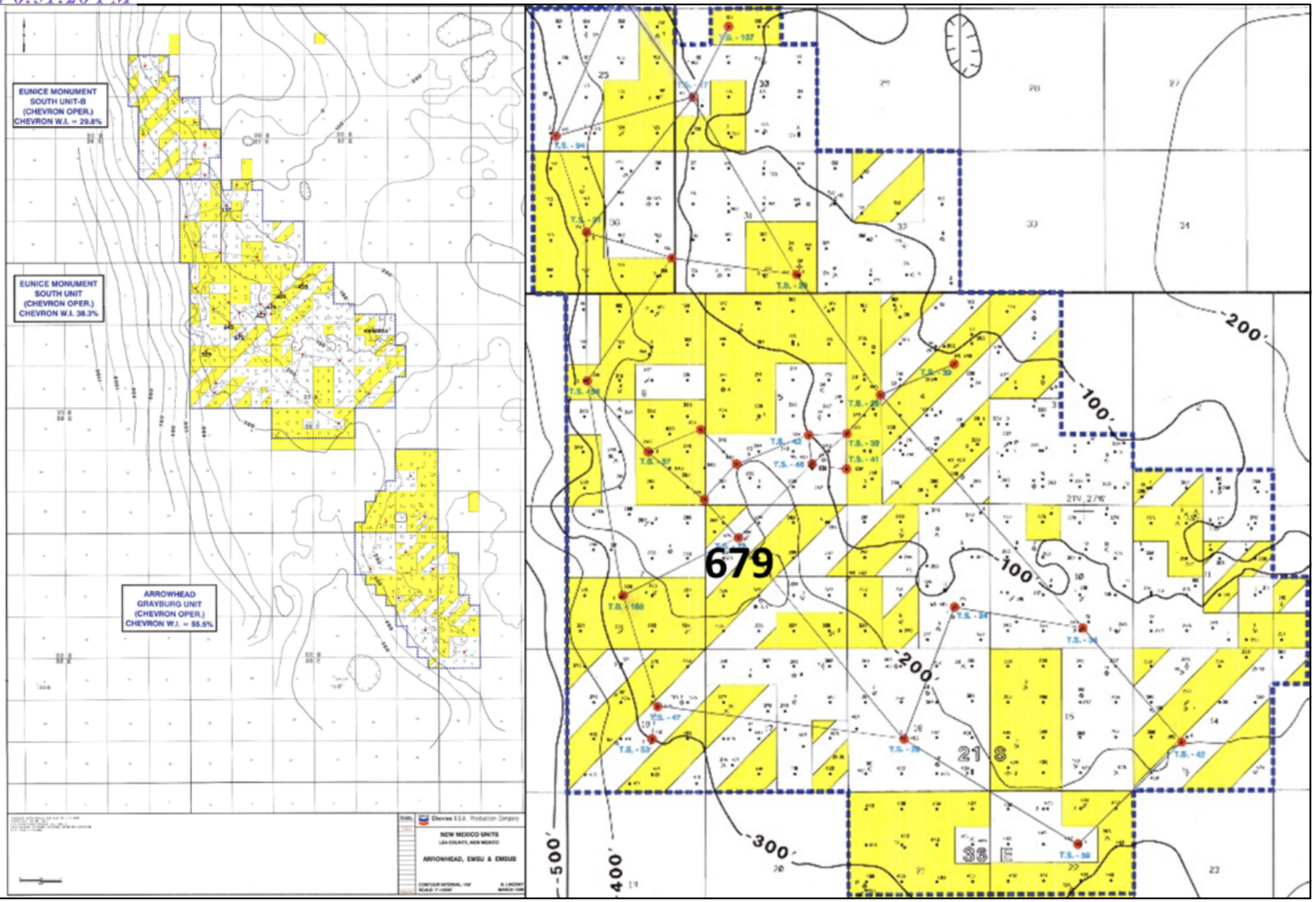
Exhibit B-11



The Eunice High is broken into a series of smaller basement-cored structural blocks. This interpretation overlays Exhibit B-6 as a comparison. These smaller structural blocks re-adjusted during the Laramide orogeny to uplift and fold Grayburg reservoir strata in EMSU into a double-humped asymmetric anticline and created a series of fractures. Top of San Andres was used as the datum to illustrate vertical offset of individual deep-seated basement structural blocks within the Eunice High.

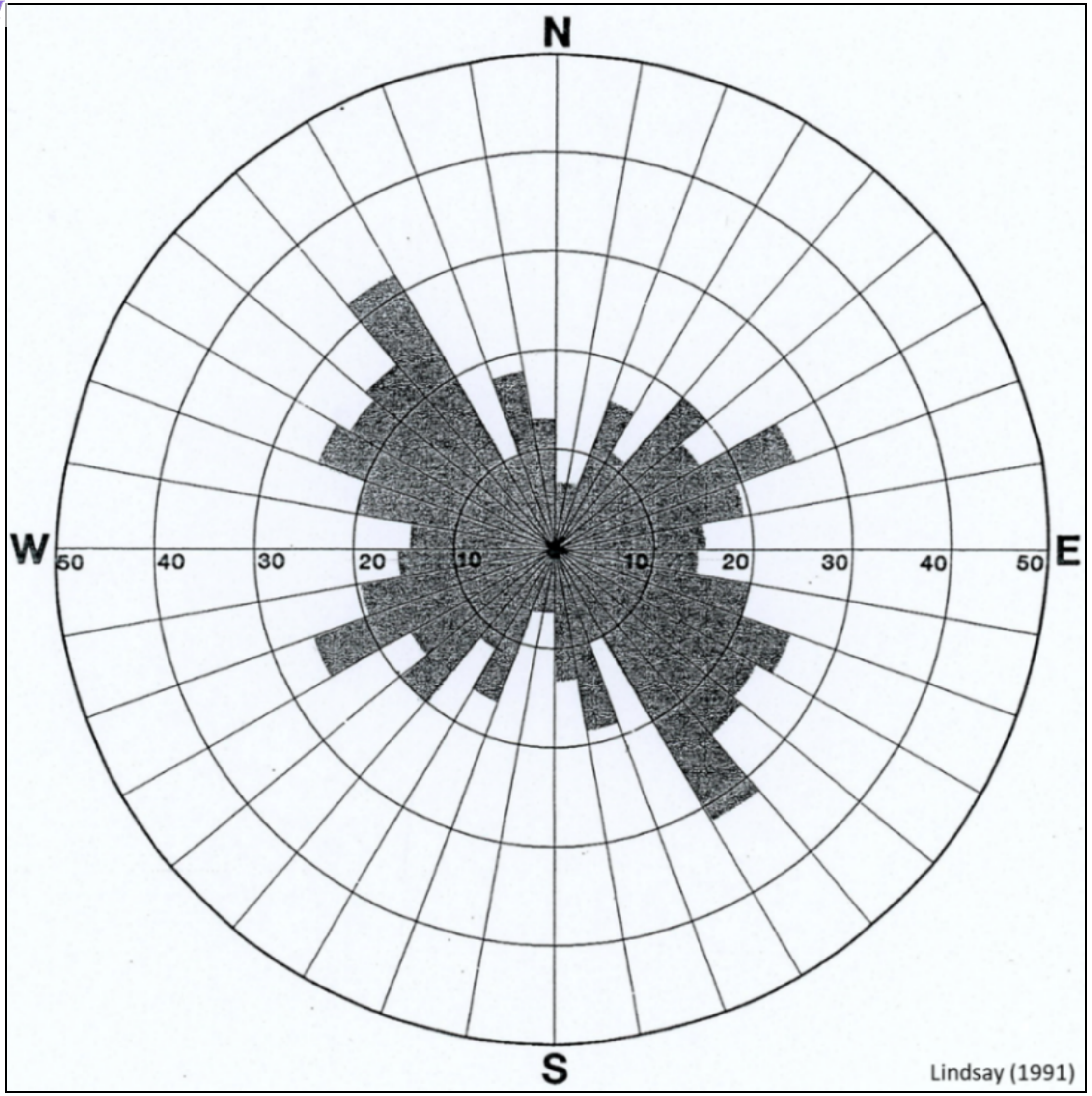
Exhibit B-12

EMSU-679 Lower Grayburg Fracture Study



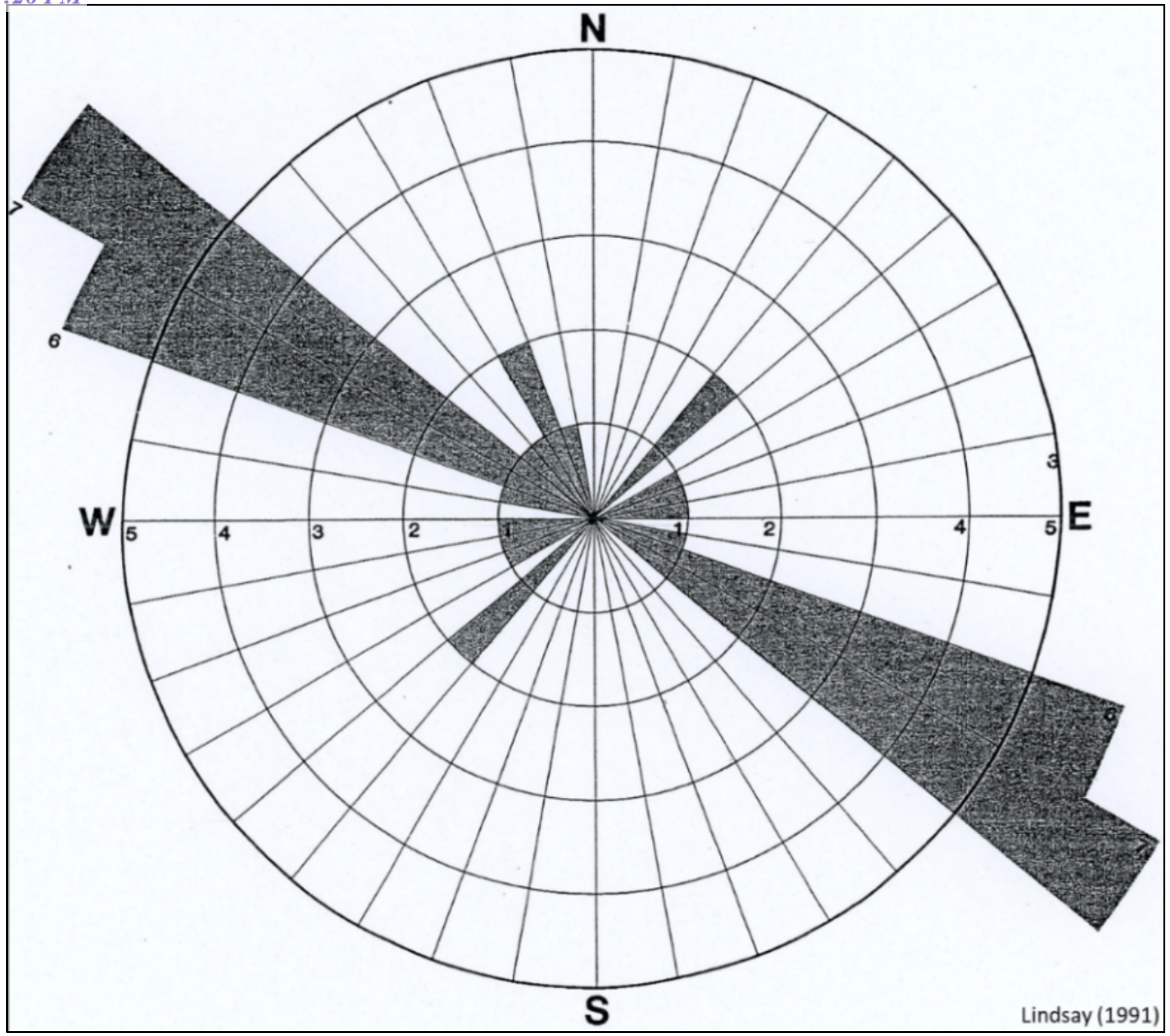
A Chevron in-house fracture study was performed on EMSU-679 oriented core (120 ft). Fractures were measured in Lower Grayburg reservoir and upper San Andres residual oil zone (ROZ).

Exhibit B-13



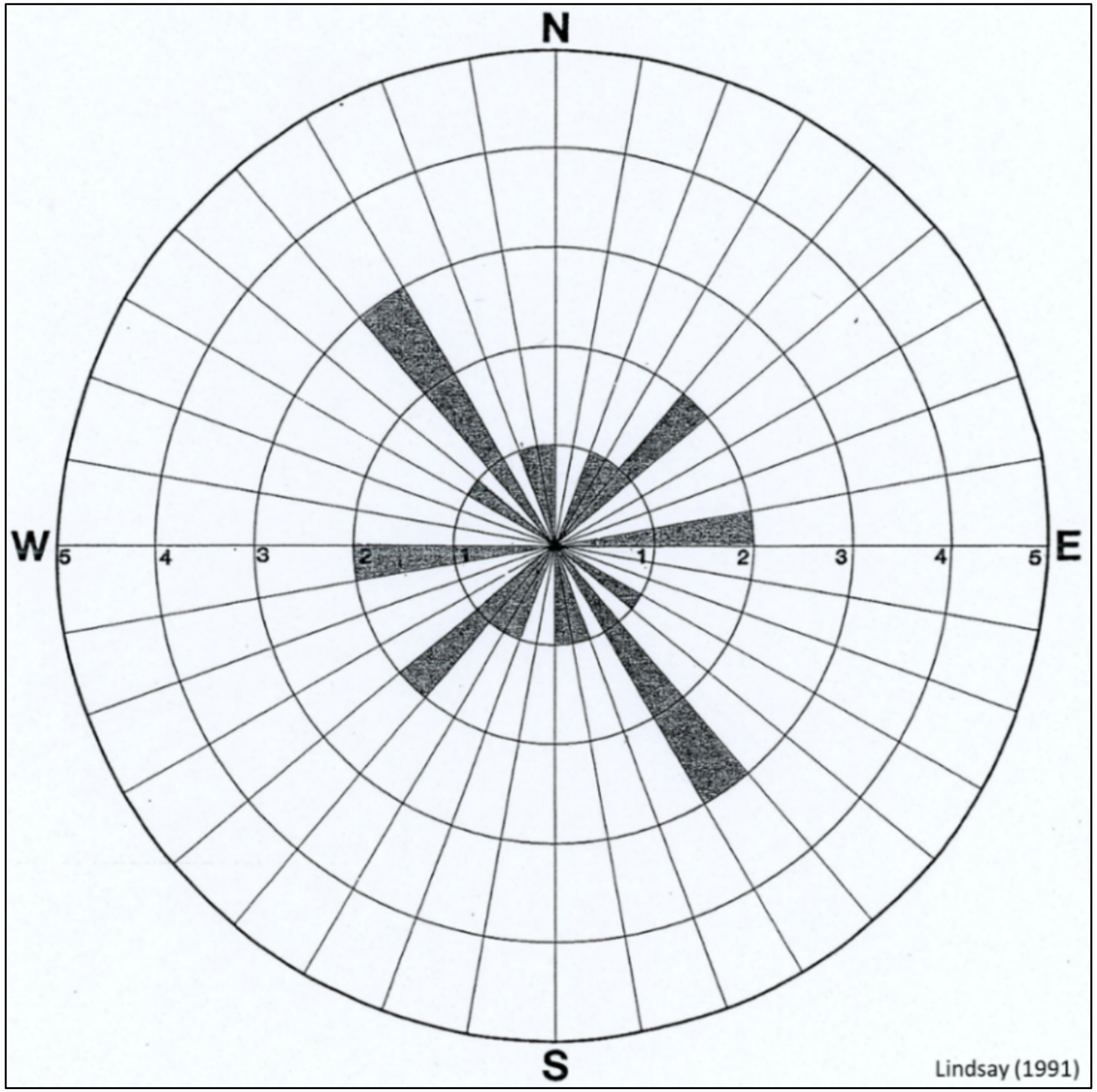
EMSU-679 total fractures and their orientation in lower Grayburg reservoir and San Andres residual oil zone (ROZ). Two fracture trends stand out. One is northwest to southeast and another is northeast to southwest. A total of 313 vertical fractures were measured.

Exhibit B-14



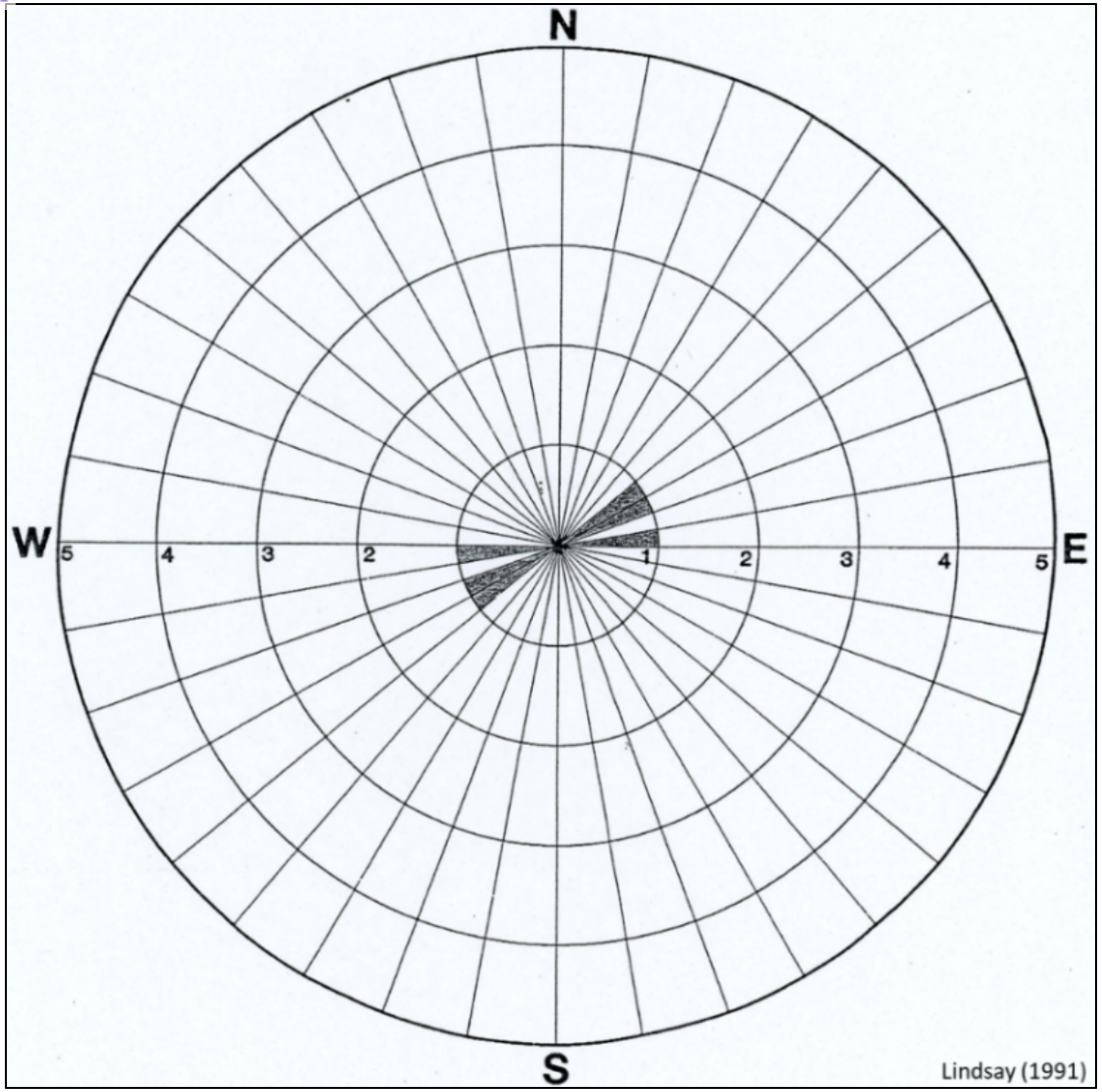
EMSU-679 large vertical fractures 1-3 ft in height. A major trend is northwest to southeast, with a minor trend northeast to southwest. A total of 24 fractures measured.

Exhibit B-15



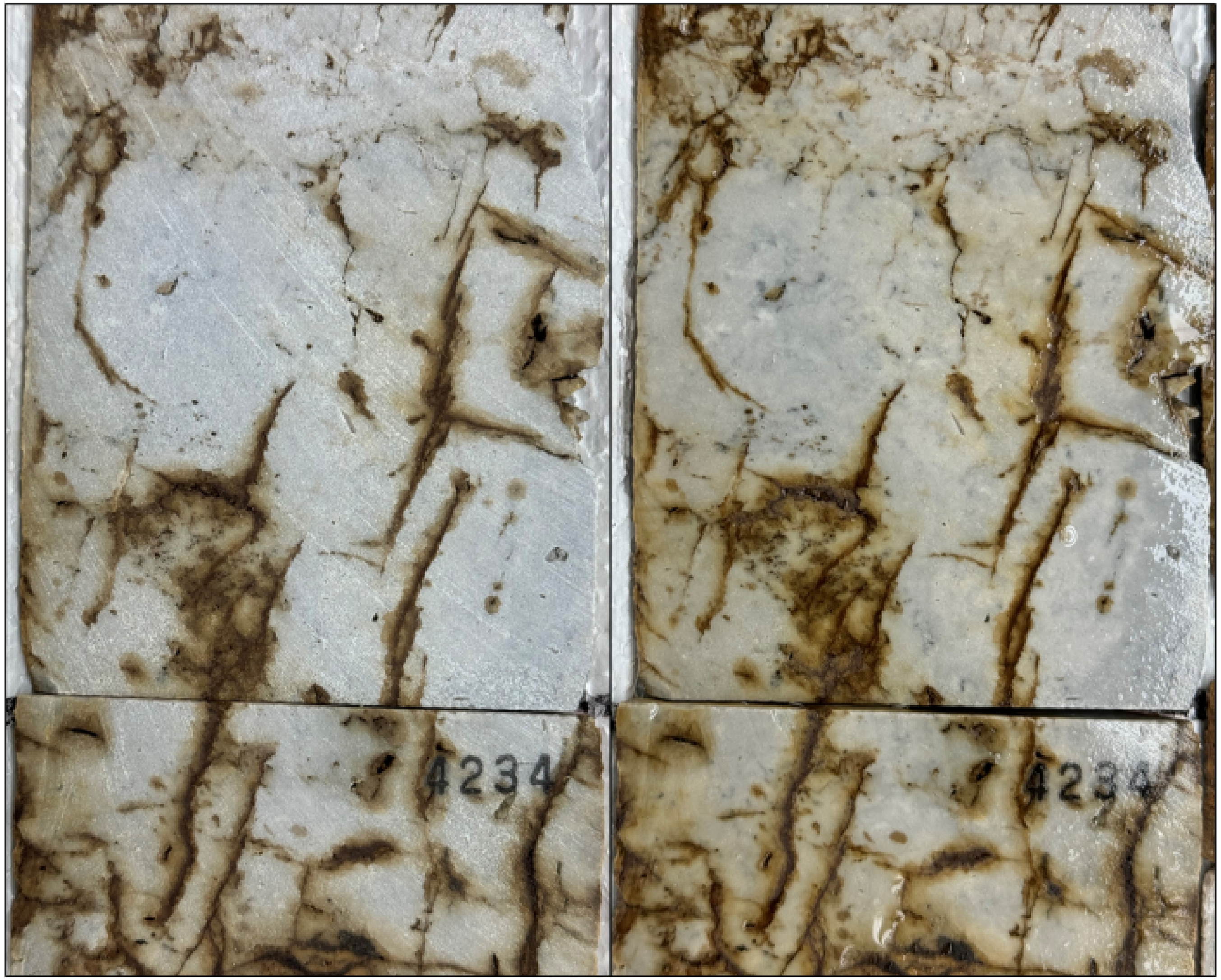
EMSU-679 pyritized vertical fractures. A major trend is northwest to southeast, with minor trends to the northeast to southwest and east to west. 12 pyritized fractures were identified and measured.

Exhibit B-16



EMSU-679 fractures bounding collapse breccias and solution pipes. Two subtle trends are northeast to southwest and east to west. A total of 3 were measured.

Exhibit B-17



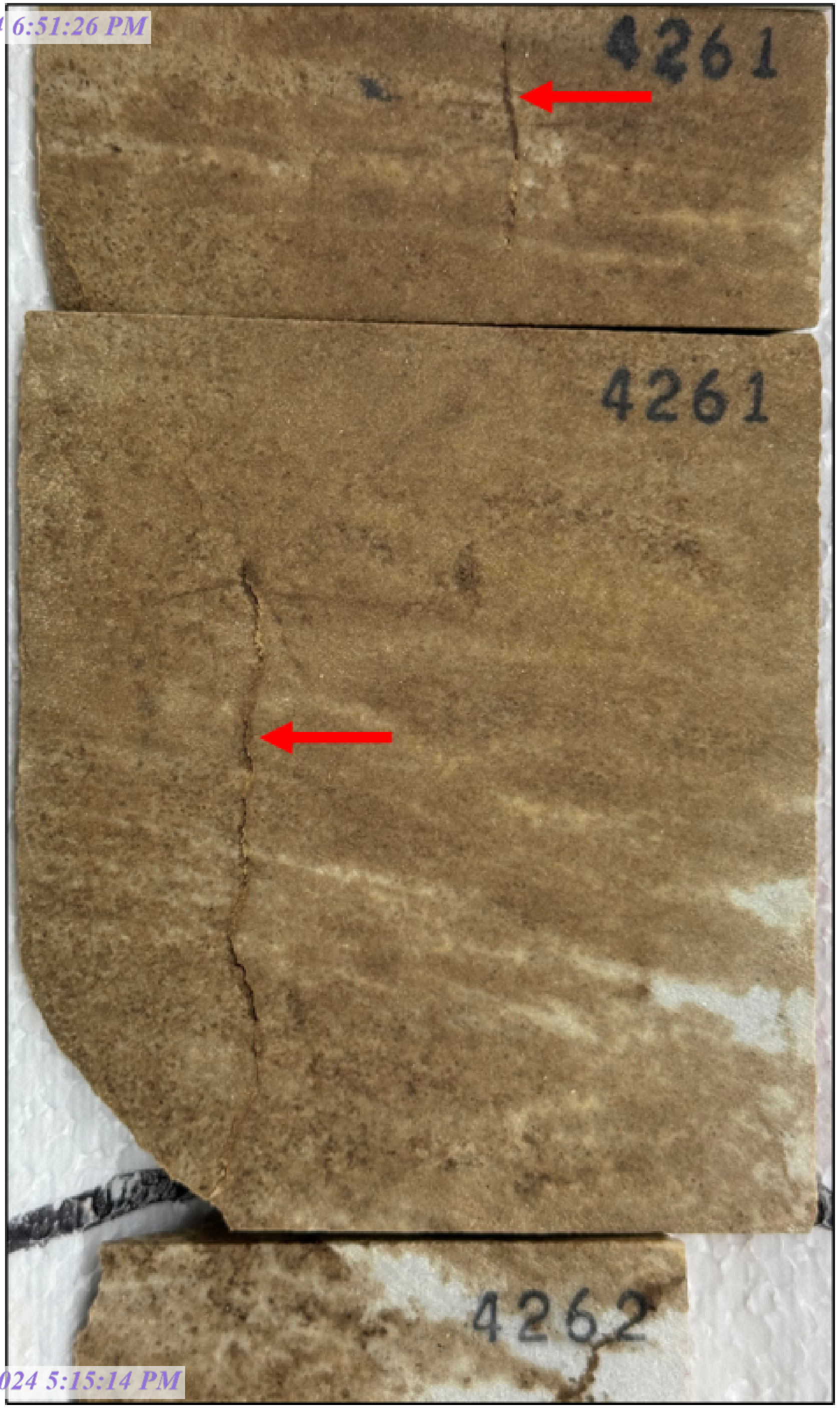
EMSU-679 San Andres core containing less porous, solution-widened, oil-stained, en echelon fractures from 4233-34 ft (-637 to -638 ft). Core is 89 ft below top of the San Andres. San Andres strata is less porous, brittle, and was easily fractured and solution-widened during structural movement that formed the Eunice Monument asymmetric anticline.

Exhibit B-18

EMSU-679 San Andres porous, oil-stained core containing solution-widened stylolitic tension gashes from 4175 ft (-579 ft). These small fractures are the most common fractures identified in Eunice Monument unitized oil fields (Lindsay, 2014). There are several in this field of view. Note the large tension gash that has undergone coring induced fracturing (red arrow).

Width of core is 3 inches (7.62 cm). Core photograph is dry. Porosity = 12.5%. Permeability = 5.2 mD. Permeability is low due to non-touching pinpoint moldic pores that lack connectivity. Oil saturation = 24.2%. Water saturation = 36.3%. Core is 31 ft beneath top of the San Andres.

Exhibit B-19



EMSU-679 San Andres residual oil zone (ROZ) vertical, solution-widened, en echelon fractures (red arrows) in porous, oil-stained strata from 4261-62 ft (-665 to -666 ft). Core is 117 ft beneath top of the San Andres.

Core is 117 ft beneath top of the San Andres. Core width is 3 inches (7.62 cm). Core photograph is dry. Porosity = 12.3%. Permeability = 1.4 mD. Oil saturation = 19.4%. Water saturation = 41.2%.

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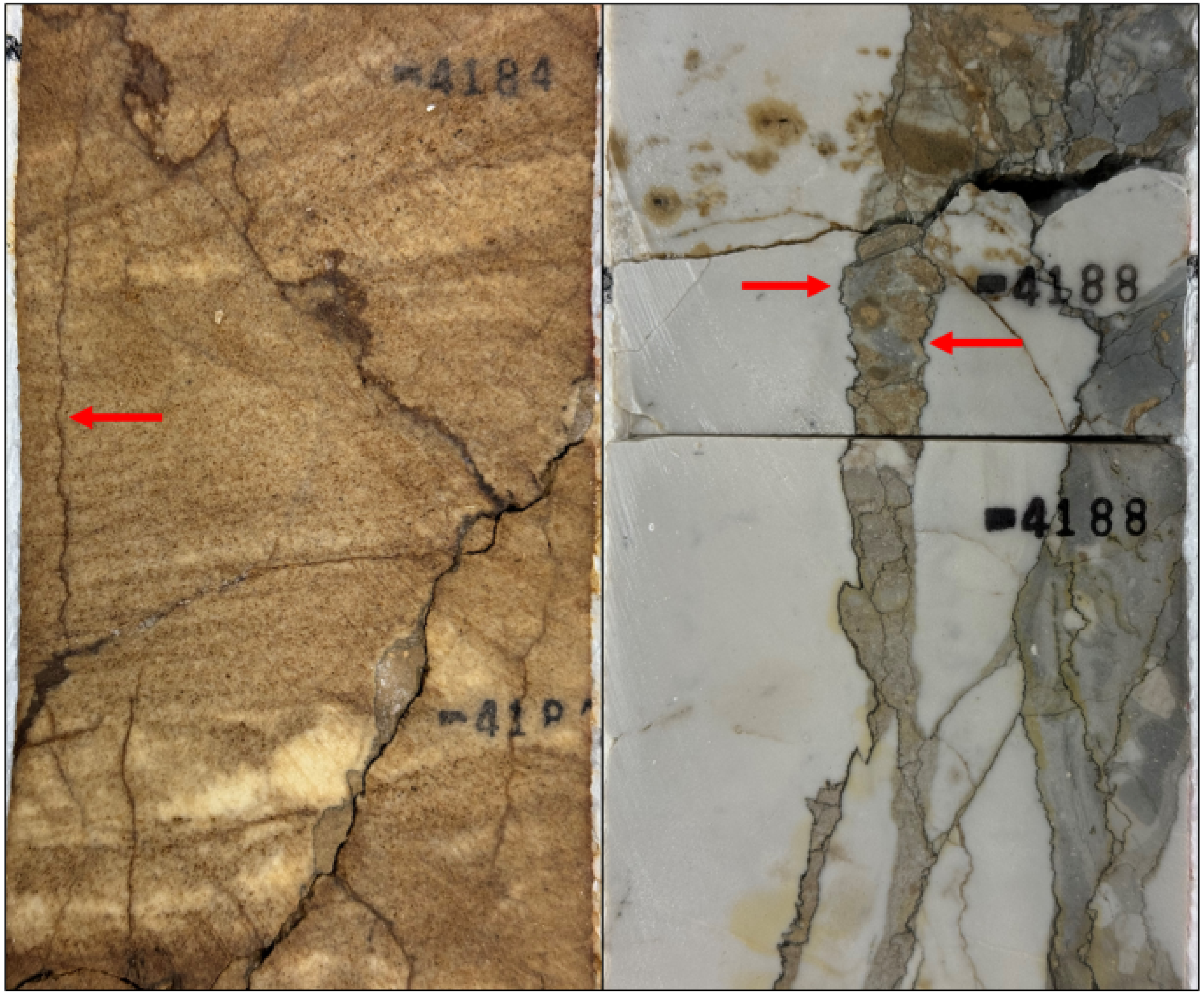
Exhibit B-20



EMSU-679 San Andres cores containing vertical stylolites (red arrows). Vertical stylolites were created by compression associated with the Laramide orogeny. Compression reactivated deep-seated fault blocks to fold Permian strata and form the Eunice Monument double-humped asymmetric anticline.

Left Figure: EMSU-679 4184 ft (-588 ft) (dry), 40 ft beneath top of San Andres. Right: EMSU-679 4188 ft (-592 ft) (wet), 44 ft beneath top of San Andres. Left: Core porosity = 6.3%, permeability = 5.7 mD, oil saturation = 26.5%, and water saturation = 60.7%.

Right Figure: Core porosity = 3.2%, permeability = 0.9 mD, oil saturation = 2.7%, and water saturation = 81.3%. Core widths are 3 inches (7.62 cm).

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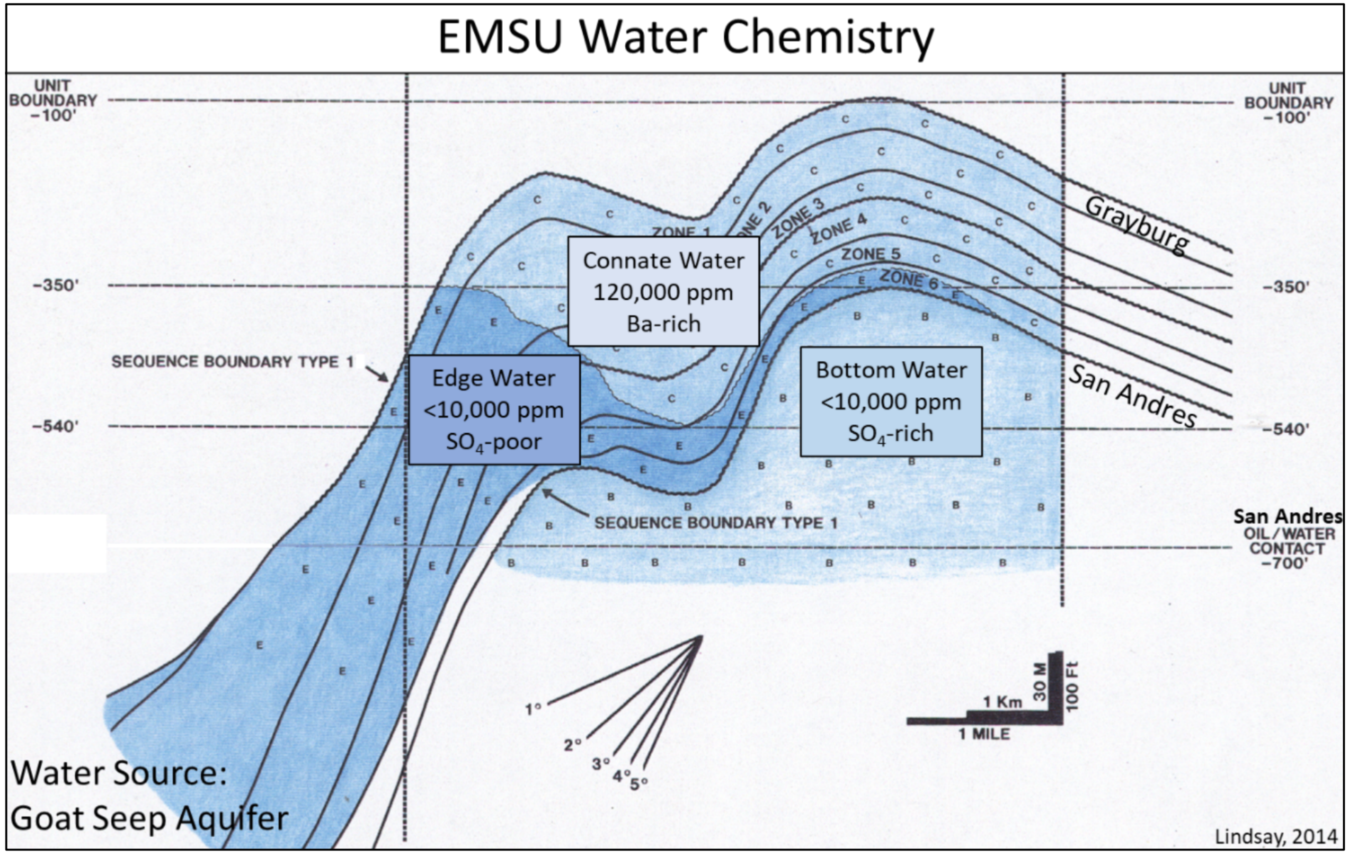
Exhibit B-21

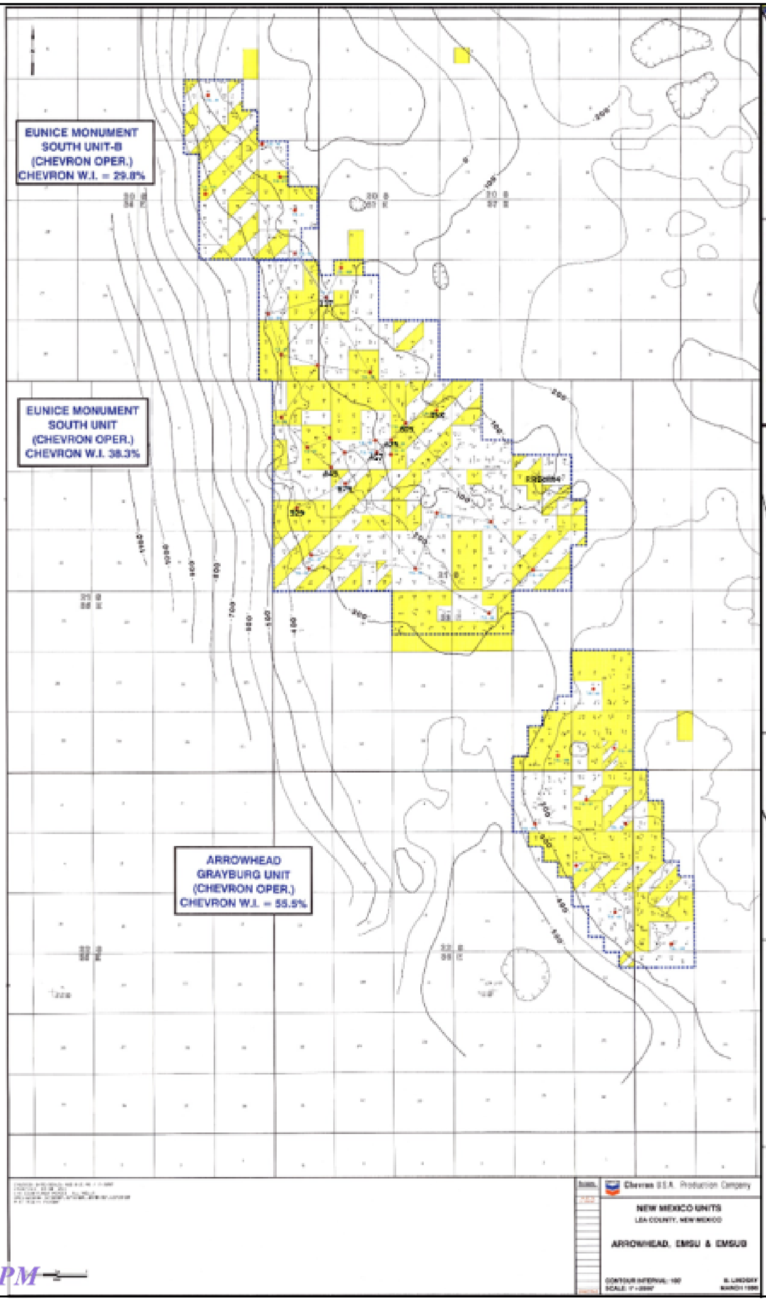


A Chevron water chemistry study in EMSU revealed three water chemistries. First, connate water (120,000 ppm) in the Grayburg reservoir contains barium (Ba). Second, low salinity (<10,000 ppm) edge water entered the west side of the Grayburg reservoir. Edge water contains no sulfate. Edge water is sourced from the Goat Seep Aquifer, which is 1.5 to 2 miles down-dip of the west unit boundary of EMSU. Edge water entry into the Grayburg reservoir was by a drop in reservoir pressure due to production through time. Edge water is sourced from the present-day Guadalupe and Glass mountains. Third, low salinity (<10,000 ppm) bottom water, in the San Andres reservoir residual oil zone (ROZ) is sulfate rich. San Andres water was sourced from the Southern Rocky Mountain Epeirogen west of the Sacramento Mountains by meteoric recharge, which dissolved evaporite beds (CaSO4) as it recharged into the subsurface and added sulfate (SO4) to the low salinity water.

Exhibit B-22

Eunice Monument Unitized Fields

EMSU-679 San Andres Core



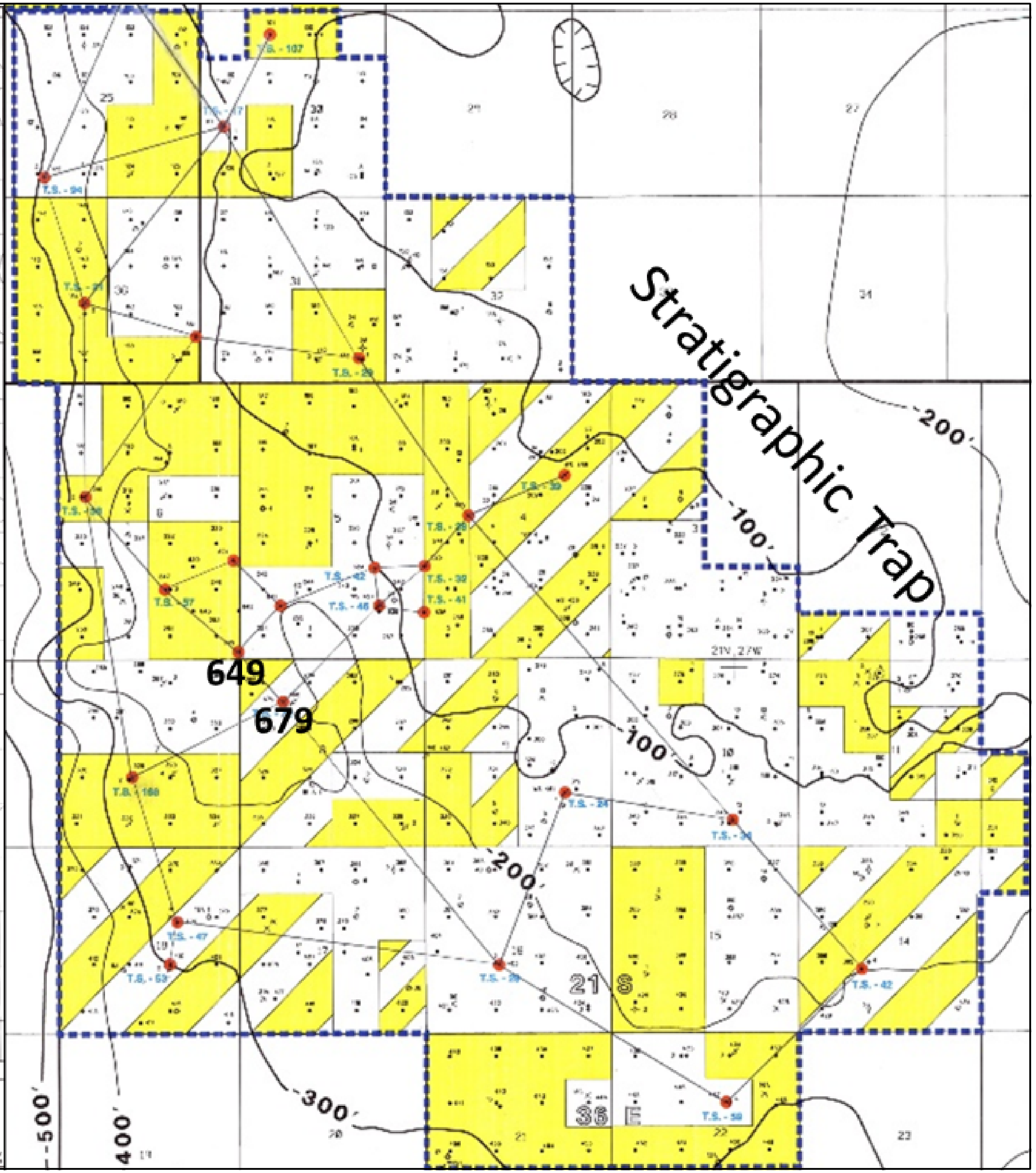
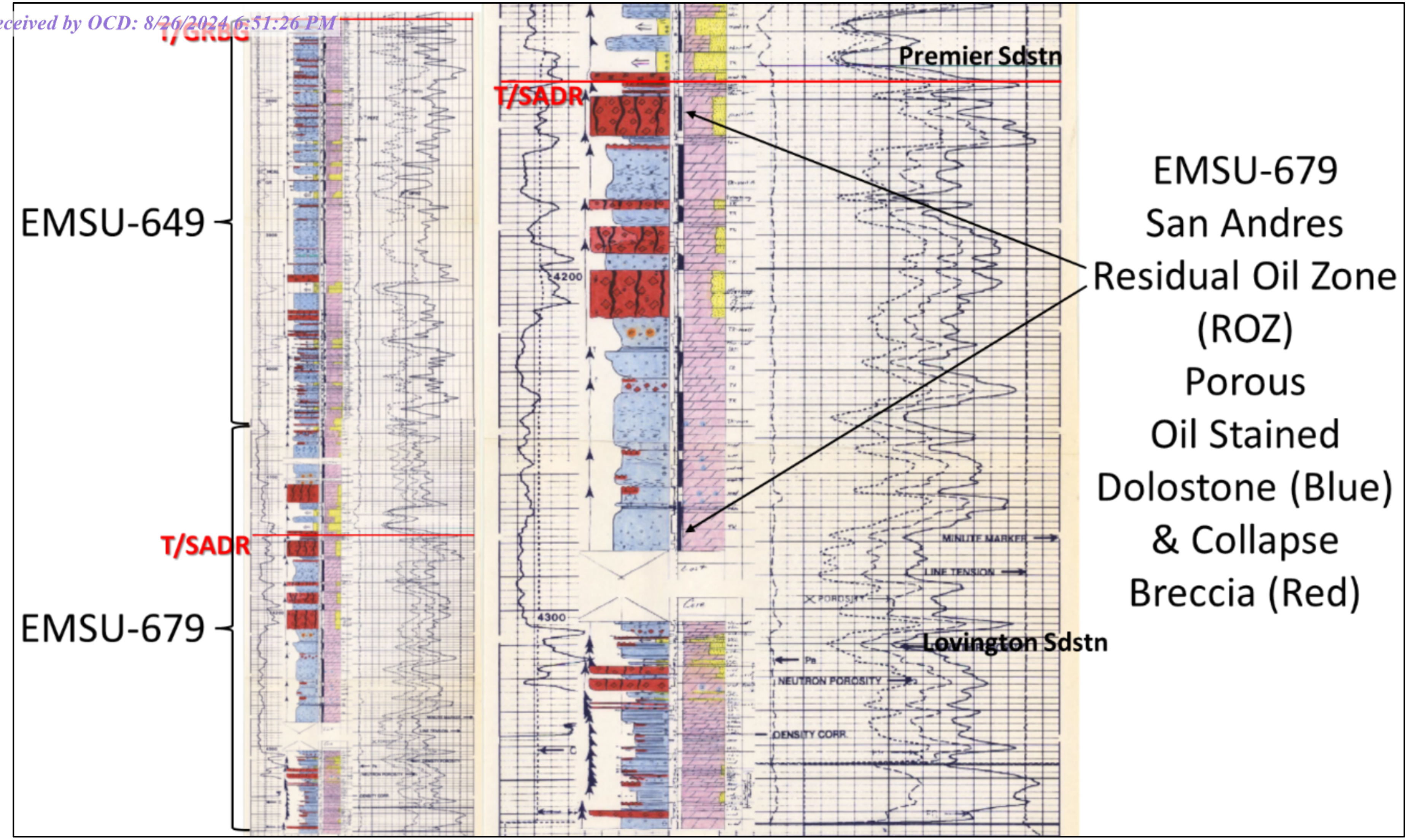


Exhibit B-23

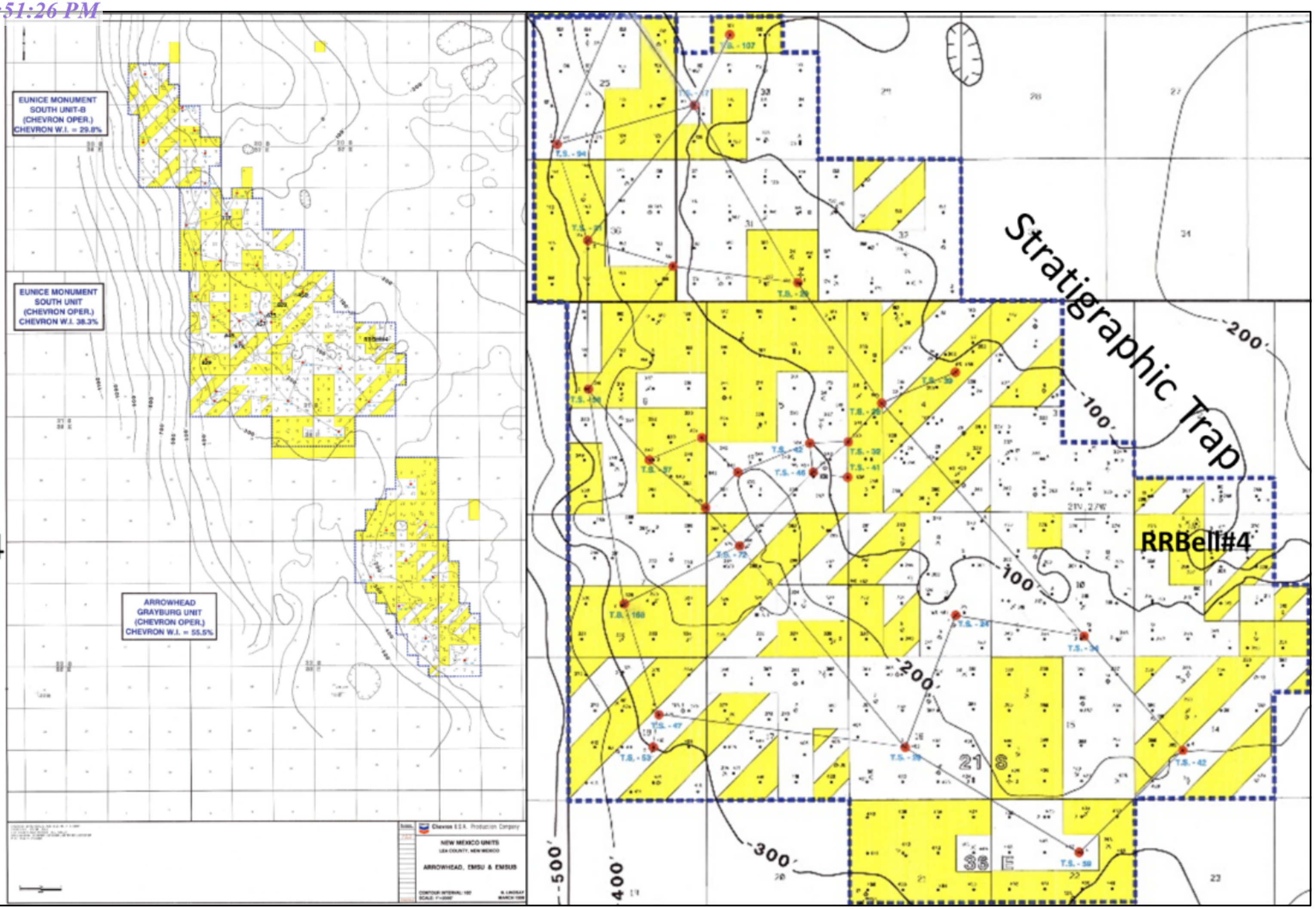


Left Figure: Combined EMSU-649 and EMSU-679 well logs and core descriptions that contain the complete Grayburg reservoir and upper San Andres residual oil zone (ROZ) to beneath the Lovington Sandstone. Right Figure: Close-up of EMSU-679 well log and core from Premier Sandstone at the base of Grayburg reservoir down section, crossing basal lag conglomerate (top red) and unconformity (red line) that separates Grayburg reservoir from upper San Andres residual oil zone (ROZ). Top of San Andres is at 4144 ft (-548 ft). Base of cored interval is 4358 ft (-762 ft). Black arrows point to top and bottom of porous, oil-stained residual oil zone (ROZ) in San Andres ROZ.

Exhibit B-24

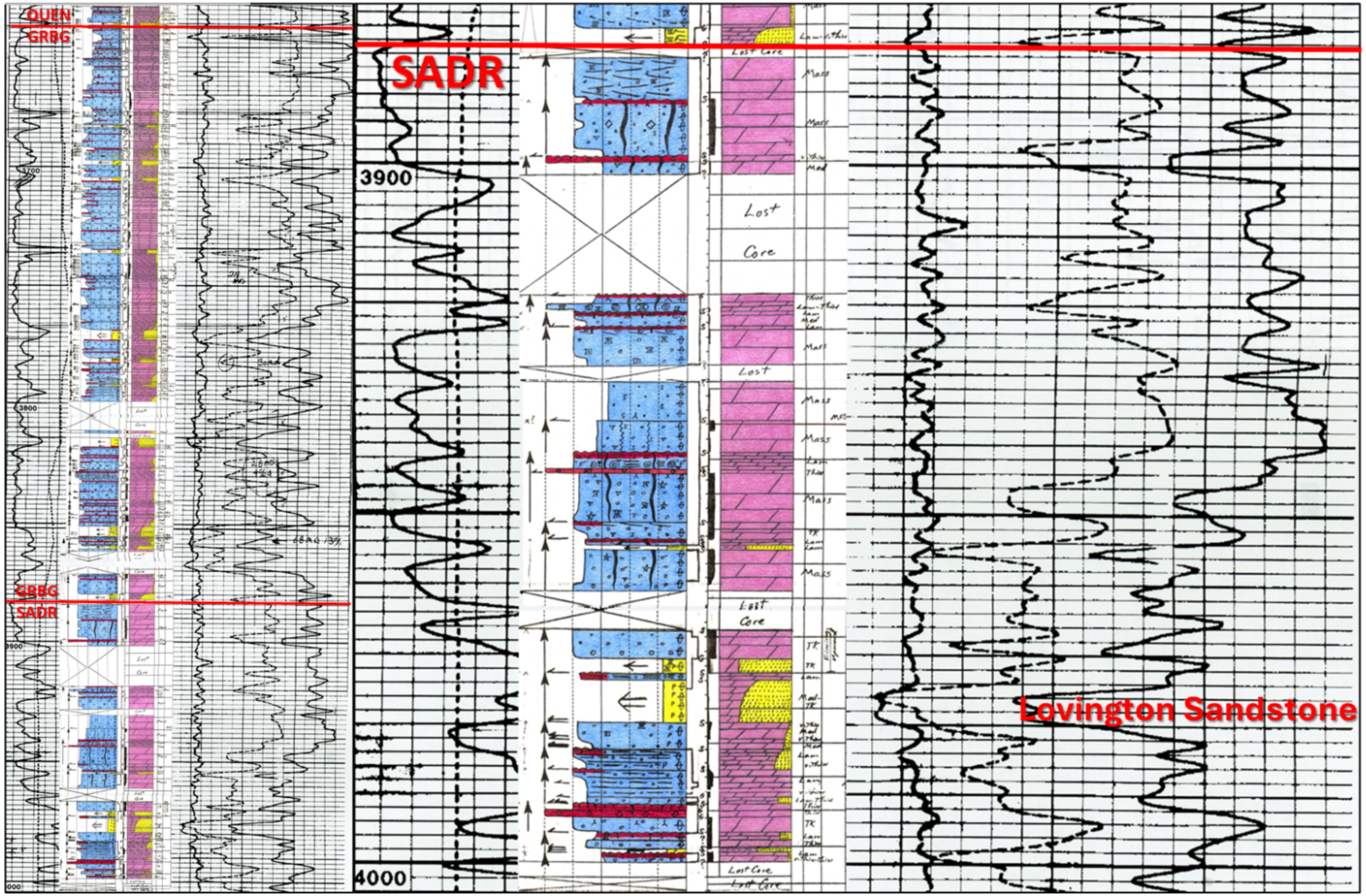
Eunice Monument Unitized Fields

EMSU R.R. Bell #4 San Andres Core



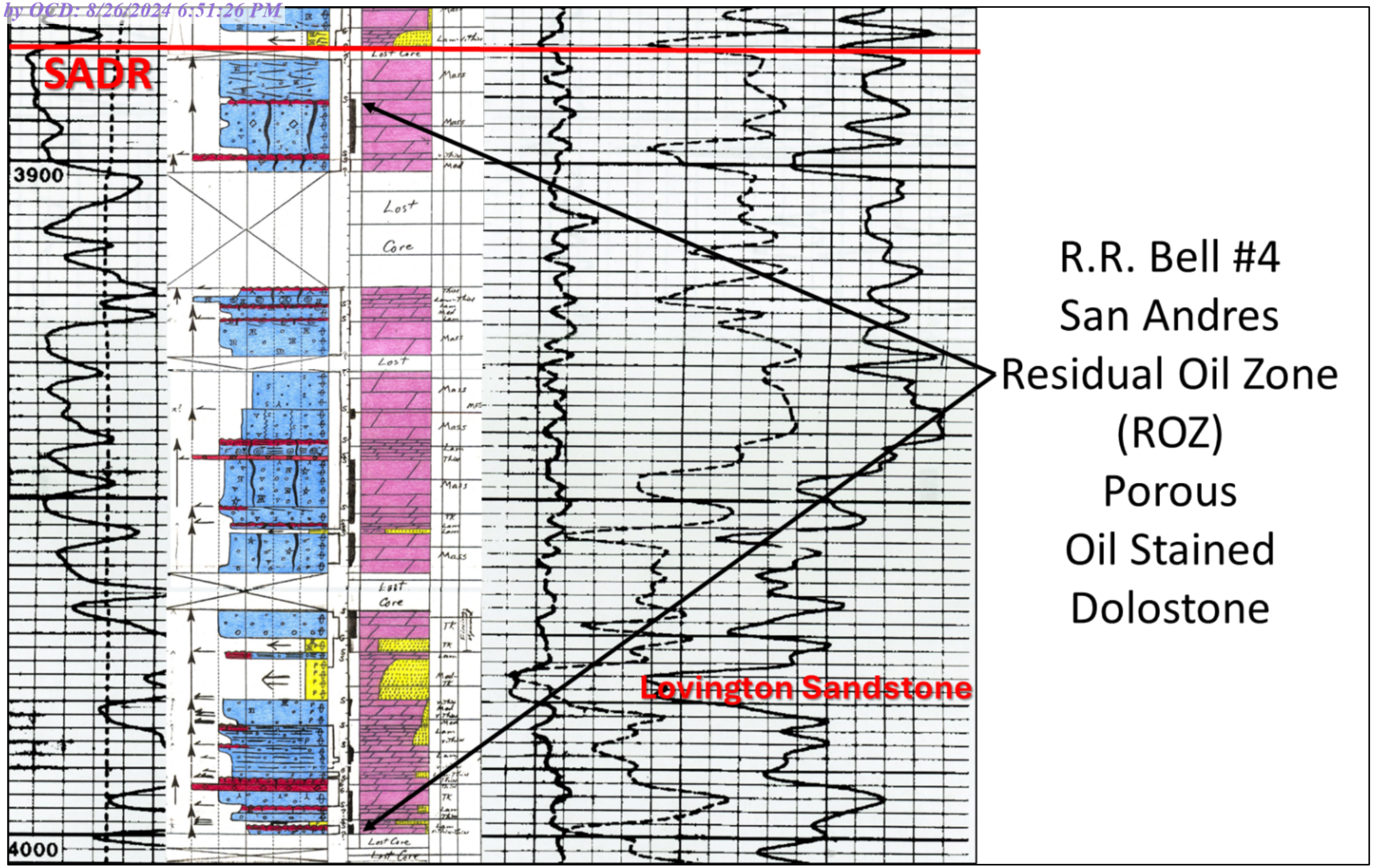
EMSU R.R. Bell #4 cored the complete Grayburg reservoir and upper San Andres residual oil zone (ROZ) in southeast part of EMSU. Well location is next to the east unit boundary and up-dip lateral stratigraphic trap where reservoir porosity pinches out.

Exhibit B-25



Left: EMSU R.R. Bell #4 well log and core description of the complete Grayburg reservoir and San Andres residual oil zone (ROZ). Top of Grayburg is at 3645 ft (-94 ft). Top of San Andres is at 3883 ft (-332 ft). Base of cored interval is at 4006 ft (-455 ft). Right: Close-up view from Premier Sandstone (yellow) in the base of the Grayburg reservoir and unconformity (red line) that separates overlying Grayburg reservoir from the underlying upper San Andres residual oil zone (ROZ). San Andres core penetrated 20 ft beneath the base of the Lovington Sandstone.

Exhibit B-26



EMSU R.R. Bell #4 well log and core description of San Andres residual oil zone (ROZ). Arrows point to porous, oil-stained strata on the well log and in the core. Porous, oil-stained strata are present from top of the San Andres to beneath the Lovington Sandstone. Black bars = Porous–oil-stained dolostone strata.