Some Observations on Simpson Group Production in the Eola-Robberson Field, Garvin County, Oklahoma*

Jerry McCaskill[1]

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Abstract

The Simpson Group in the Eola-Robberson field, Garvin County, Oklahoma has produced nearly 100 MMBO and 125 MMCFG since its discovery in the Sohio #1 Howard well in 1947. At least 10 different structural blocks within the field produce from the Simpson. Using Eola-Robberson field nomenclature, the Bromide Dense, Upper Bromide or 2nd Bromide (Basal Bromide of Tomlinson's measured Simpson section on Oil Creek), Basal Bromide or 3rd Bromide (Basal Tulip Creek of Tomlinson's measured Simpson section on Oil Creek), Upper McLish, Basal McLish and Basal Oil Creek produce in the Eola portion of the field. The Bird's Eye Limestone in the Upper Oil Creek Formation produces in a few wells in the Robberson buried hill portion of the field.

Original hydrocarbon columns vary from 500ft to 3500ft with different oil-water contacts in each zone in each block. The West Eola Block had initial gas caps in each zone, as did the Basal McLish in the South Block; the other reservoirs had no initial gas cap. Because of the small water legs in most of the blocks, there are very few reservoirs with even weak water drives, necessitating secondary recovery in much of the field. Several wells have drilled previously bypassed blocks in the past decade with good results. Modern wireline log suites, imaging logs, and repeat formation testers have also helped document significant bypassed and stranded reserves.

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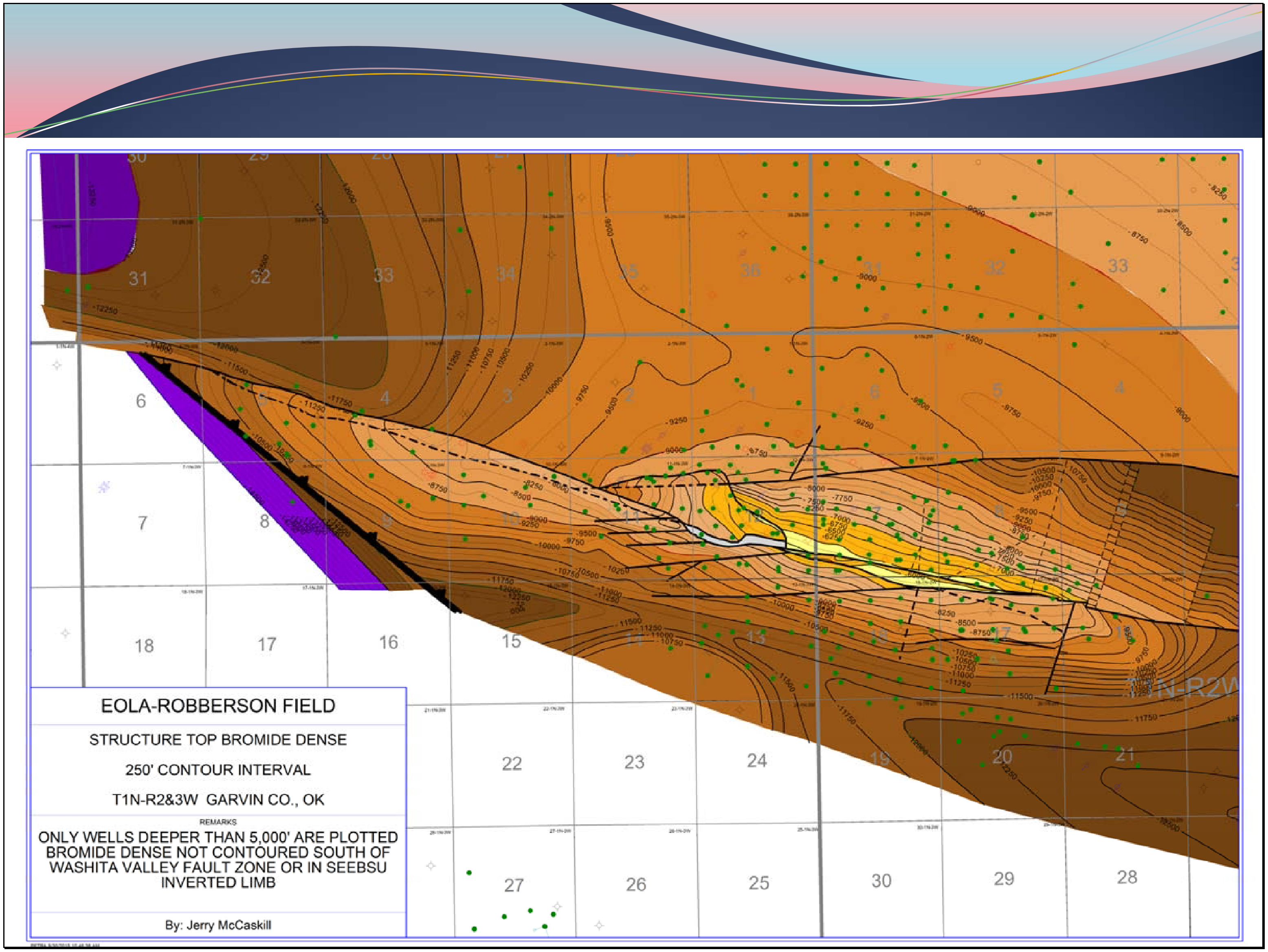


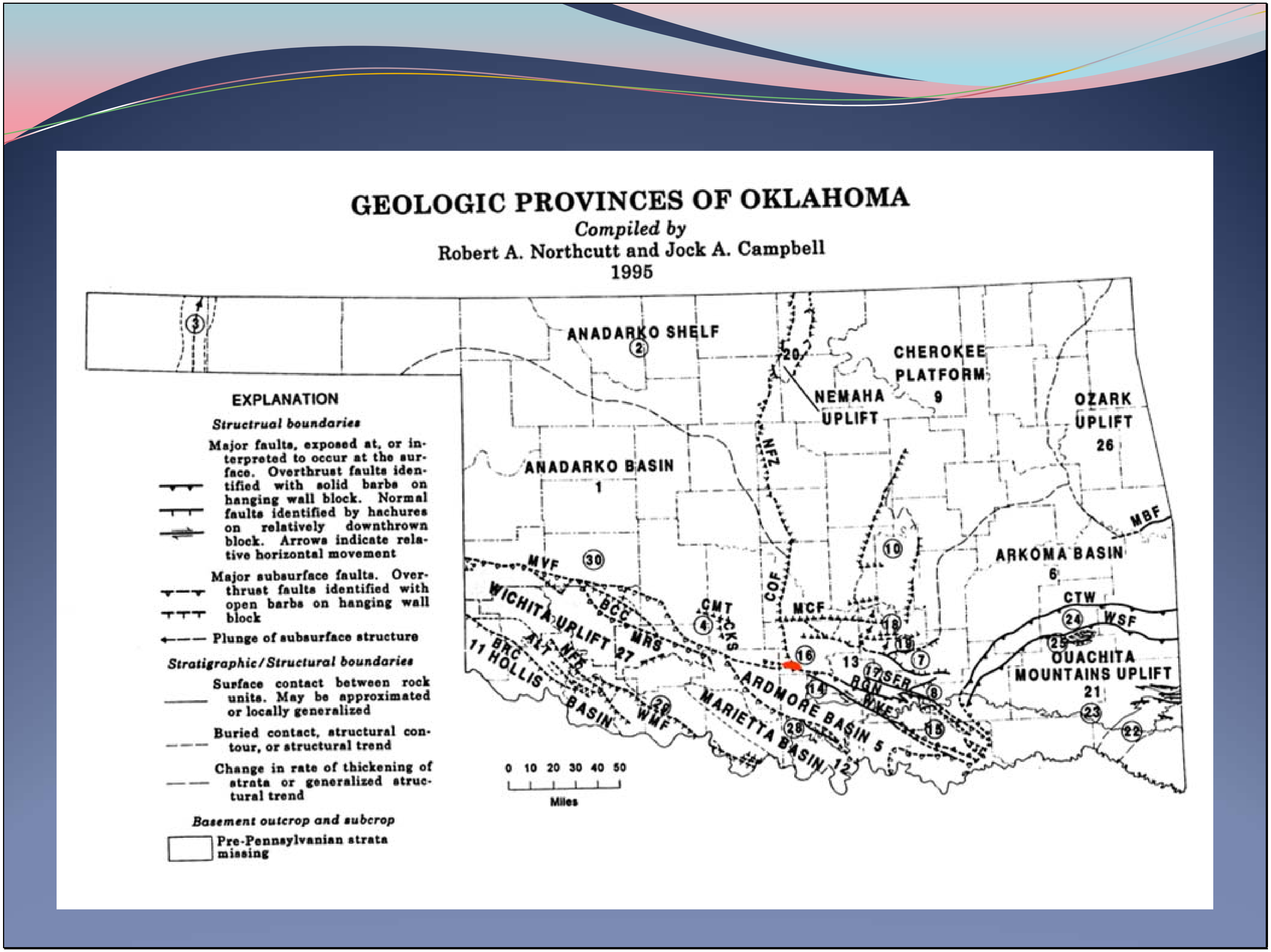
Presenter's notes: This talk is about Simpson Group production in the Eola-Robberson field. We shall be looking at this structure map throughout the talk; it uses a 250-foot contour interval and changes in color shades every 1000ft. I was "raised" around this field, and in 1981 I worked as sample catcher on a Simpson development well near the crest of the structure; in 1986 I mud-logged my first well in the field on a fractured reservoir well with overturned Hunton, and in 1989 I started consulting on the Eola North Fault Block Unit Simpson waterflood. I was able to stretch that 3-month contract out for more than 20 years, and during that time and the time since, I have been able to participate in getting 70 new wells drilled and a larger number of old wells re-completed with 10 different companies.

LOOK AROUND
For more fields like Eola

LOOK IN
For what remains in fields like Eola

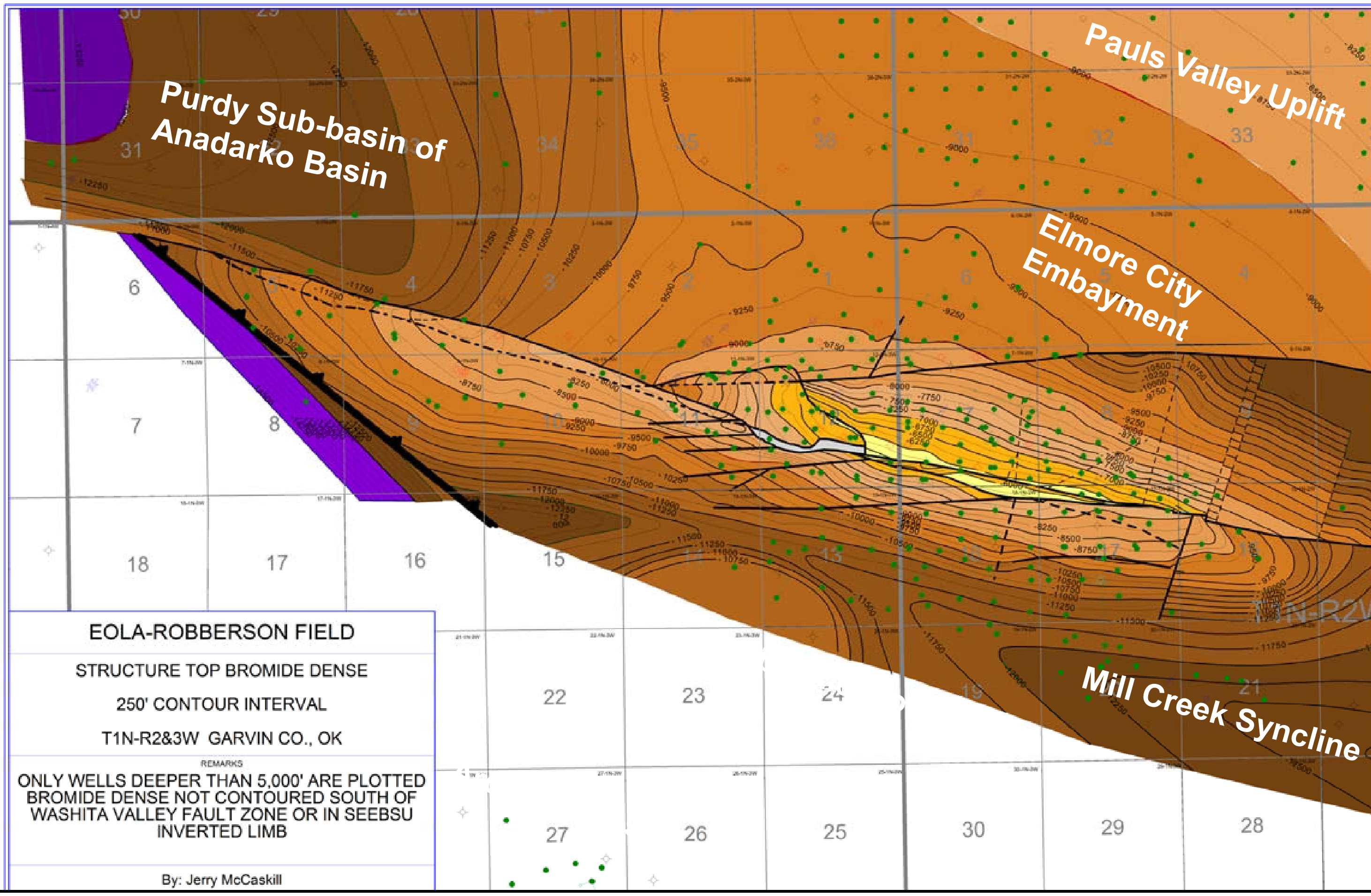
LOOK OUT
For some of the things seen in the Simpson at Eola

Presenter's notes: I hope to leave you with: (1) how to look for other fields like Eola, (2) where and how we found remaining reserves in a mature field with the hope that some of those methods can be applied to other fields, and (3) show some of the interesting things we have seen so may be they won't surprise you as much as they did me if you see them.

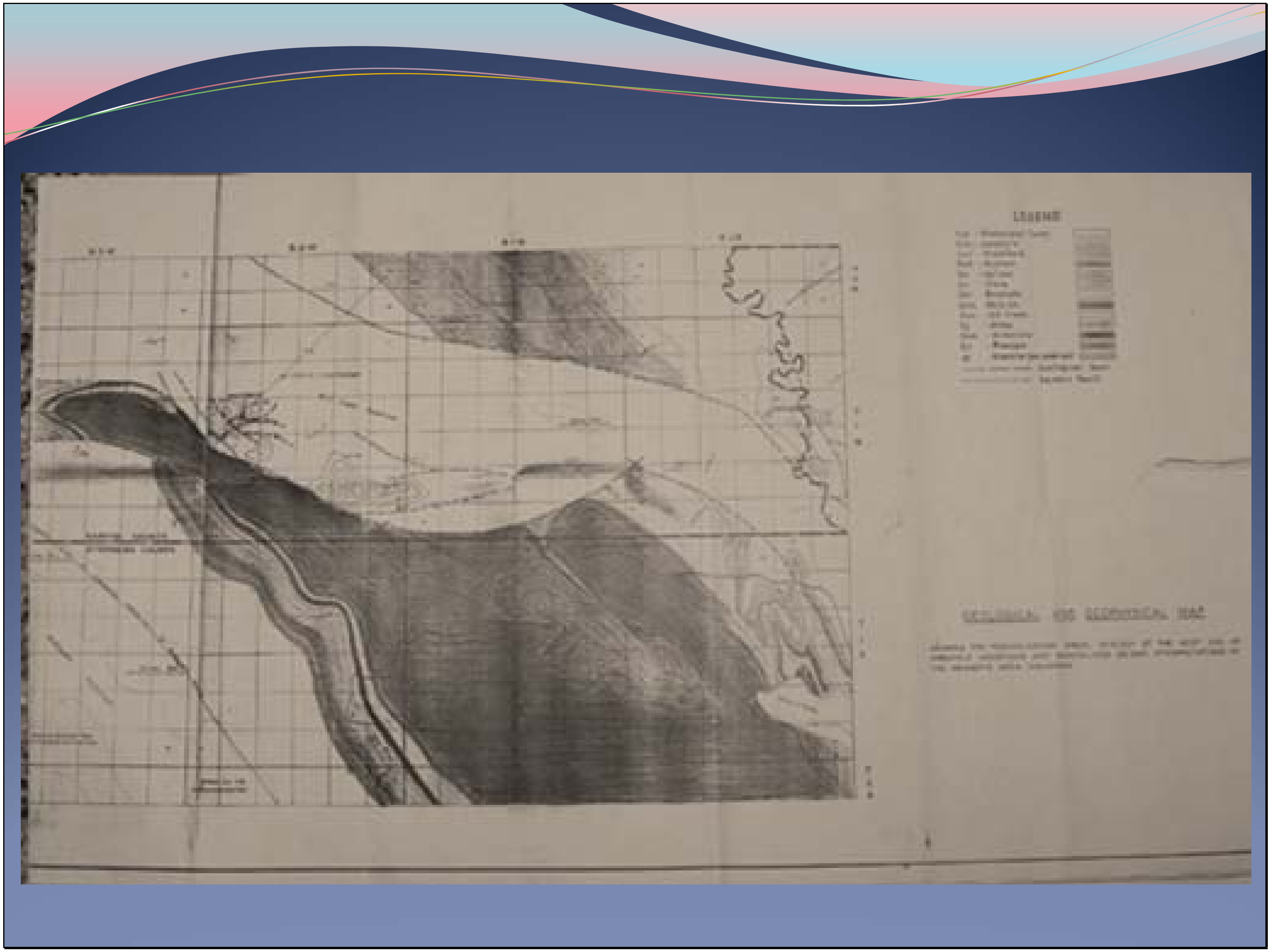


Presenter's notes: The Eola field is located in south-central Oklahoma at the very southeast corner of the Anadarko basin and at the western end of the Arbuckle Mountains in the area where the Washita Valley, Reagan and Sulfur fault zones appear to coalesce. The Pauls Valley uplift is to the north and the Ardmore basin is to the south.

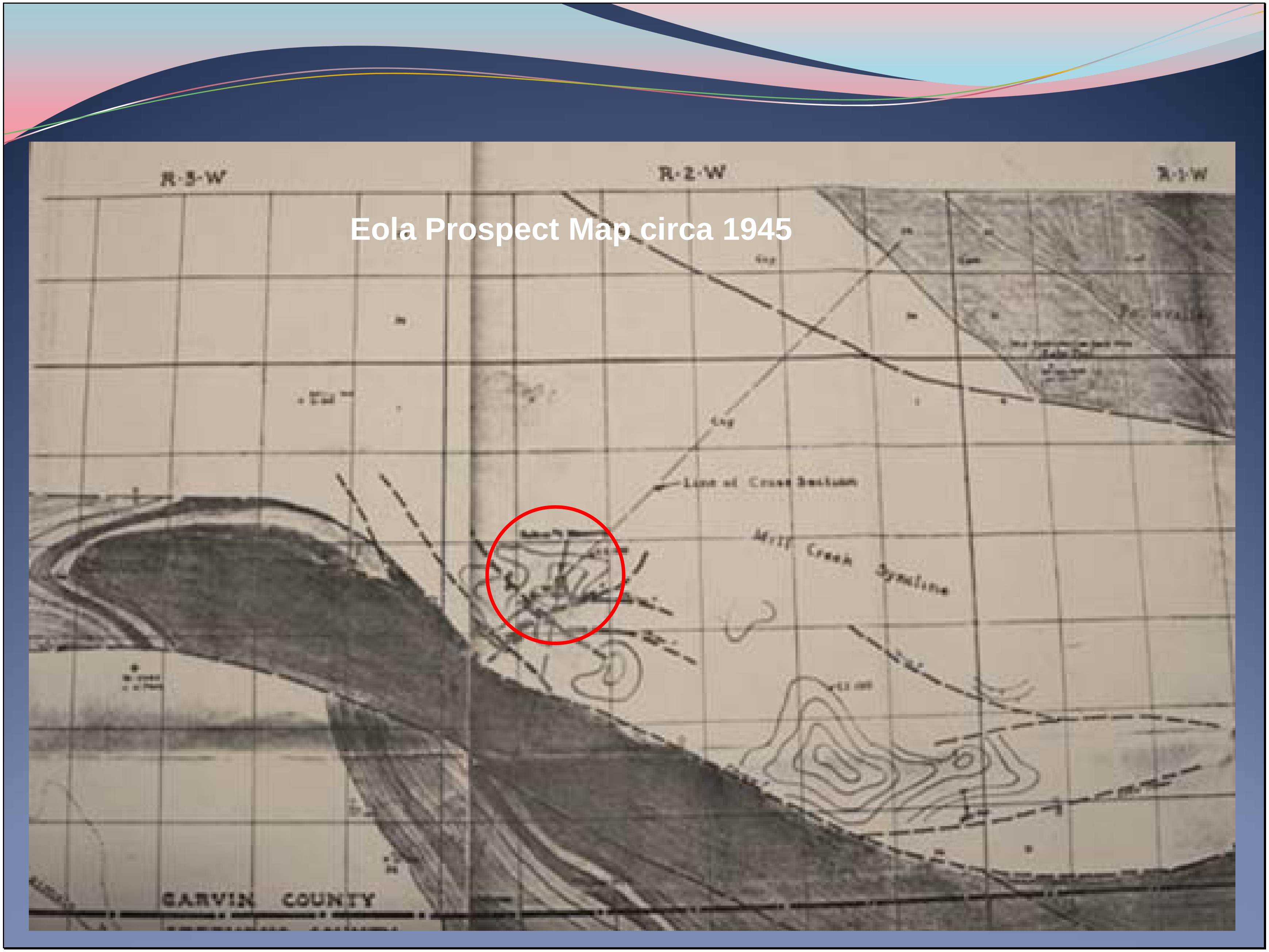
Eola-Robberson Field
Structure on Top Bromide Dense
250’ C.I., 1000’ Shade Change



Presenter’s notes: The Eola structure has around 11,000ft of positive relief above the deepest part of Purdy Sub-basin and around 8000ft of relief above the deepest part of the Mill Creek Syncline. This area has been surrounded with development of the SCOOP (South Central Oklahoma Oil Play, acronym courtesy of Continental). Woodford development areas have included Continental in the Mill Creek Syncline, Rim Rock on the Pauls Valley uplift, Newfield and Continental in the Purdy Sub-basin and Continental, Newfield and XTO in the Ardmore Basin. This is a simplified map that does not show the inverted beds and ignores many faults less than 200ft. The Eola Fault that bisects this structure is what Tomlinson referred to as a “scissor fault” – apparent reverse fault in the west portion of the map and an apparent normal fault in the east. These faults divide the field into a number of isolated reservoir blocks.



Presenter's notes: After Apache and Cumberland fields were discovered along the mountain fronts in the early 1940s, Sohio (The Standard Oil Company - Ohio) implemented a field mapping program along the Mill Creek Syncline which showed potential for oil fields. A magnetometer survey was then conducted; it identified leads to be further defined with 2-D seismic. Although continuous reflectors were rare in the Eola area, converging dip panels delineated a number of prospects as shown on this 1945 map. Leases were then taken on the defined prospects. This map shows the subcrop under the Pennsylvanian on the Arbuckle Mountains to the south and the Pauls Valley uplift to the north.



Presenter’s notes: Oral tradition says, because of flooding on Wild Horse Creek, Sohio drilled the lead near Eola instead of the larger feature to the southeast that was in the Wild Horse Creek floodplain. The Sohio #1 Howard well was started in 1945.

Day 194

Further correlation down the hole must, at this time, be done with samples since the electric log failed to go below 6662. Unfortunately, definite sample correlations are difficult since the zones of correlation in the Springer appear to be of very similar lithology, namely, impermeable black shaley and sandy lime. It is thought a zone topped at 6960 could be correlated with a zone in the House No. 1 topped at 7972. This is not definite since it is possible to be one of several zones whose lithologic characteristics are similar. However, if the rate of thinning indicated rather clearly by the proposed correlation continues, we should very soon encounter identifiable lithology.

On the basis of the above information, you will probably feel that we should continue drilling. If we do not benefit from the unconformity at the base of the Chatanooga shale, and Mississippi lime is encountered, it may be well to seek other information before drilling ahead.

Mr. Smith feels that in the previous geophysical work the Pontotoc was of such great influence that recorded reflections were not from lower beds. By the use of a geophone placed opposite the Mississippi lime, we may then by some method be able to penetrate upper beds and record such reaction on the lime at its contact in the subsurface. Such work would appear to be of sufficient economical importance for:

1. Structural or regional possibilities could be investigated to explain the thinning in the Springer shale.

The first known major orogeny in Southern Oklahoma was early Pennsylvanian or at the close of Springer time. Before this, Southern Oklahoma was a broad area of sedimentation with thinning of beds to the northwest. When this is remembered, thinning of such magnitude in respect to Amerada's House No. 1 at first suggests structure; however, it may be equally true the movement at end of Springer time had greater influence on the Howard area than on the House area, causing greater thinning in beds by compression. The two wells would then appear to be located in a positive area neither giving nor receiving sedimentation until possible later faulting and Pontotoc deposition.

2. If structure is indicated, the favorable position of the Howard in respect to such structure may be ascertained before

3. The costly expense is initiated of drilling the Pre-Pennsylvanian section.

Presenter's notes: After more than 6 months of drilling, it was apparent that the reflectors seen on the seismic, thought to be Hunton, were actually in the Permian conglomerates, although a recognizable Springer/Goddard-type shale was encountered more than 1000ft high to a previously drilled dry hole in the field. This is a copy of a letter to Sohio Headquarters in Cleveland suggesting that by drilling deeper through the Goddard and running a geophone in the well next to the Mississippi lime (Sycamore) some usable seismic information on the structure might be found.

PRESS RELEASE January 27,1947 **Day 428**

THE STANDARD OIL COMPANY (OHIO) ANNOUNCES THE DISCOVERY OF A NEW OKLAHOMA OIL FIELD

The Standard Oil Company of Ohio, through its general office at Cleveland, today announced the completion and preliminary testing by its subsidiary, Sohio Petroleum Company, of its Howard #1 well in Sec. 17, 1N-3W, Garvin County, Oklahoma, about 60 miles south of Oklahoma City.

Commenced in November, 1945, and finished 15 months later in January, 1947, at a depth of 10,234 feet, the well, due to hardness of formations penetrated, required 275 rock bits to drill. Casing of 5-1/2 inch diameter was set at 10,084 feet and testing through 2-1/2 inch tubing began January 23, 1947. Following the cleaning up of the mud and water left from the drilling operations, the well flowed clean oil at the rate of approximately 100 barrels an hour. The well is now being operated under various sized chokes to determine its productivity under various rates of flow. The gas-oil ratio is about 800 cubic feet of gas to 1 barrel of oil and the quality of the oil is 39° A.P.I. and similar in appearance to the Oklahoma City Wilcox oil. Approximately 140 feet of Bromide sand section carrying oil saturation was penetrated and the well was bottomed in the Upper McKish dolomite. The well was not drilled on to the lower McKish sand which has been found productive in other areas.

Sohio's 8,000 acres around this well are estimated to cover over 90% of the prospective area, as indicated by the seismograph data. Additional drilling rigs are expected to be moved into the field at once and the construction of operating and housing facilities is contemplated in connection with the development program.

Presenter's notes: Sohio management did agree to continue drilling, and after 15 months and 275 bits the well was completed flowing 2400 BOPD in 1947 from the Basal Bromide Sand.

FROM: Hill and Knowlton of Cleveland, Republic Bldg., Cleveland, Ohio *Well File*

FOR: The Standard Oil Company (Ohio)

For immediate release
7/18/47

Cleveland, July 18 -- The Standard Oil Company (Ohio) has struck oil for the second time in the same well -- Sohio's Number 1 Howard, the discovery well of the Eola Field in Garvin County, Oklahoma, 60 miles south of Oklahoma City.

Its subsidiary, Sohio Petroleum Company, has completed test drilling of this well in the Basal McLish Sand to a total depth of 10,818 feet.

Results of this test indicate that the reserves discovered in this lower horizon, the McLish Sand, are greater than those developed in the upper horizon, the Bromide Sand.

A 140 foot section of Bromide Sand, whose discovery last January attracted so much attention, flowed 39 degree API oil through a 1-1/2 inch top hole choke at a rate of approximately 2,400 barrels per day. A 21-hour drill stem test made last week on the lower zone, the McLish section, using a 1/2 inch choke at the bottom of the hole, resulted in a production rate of 672 barrels per day of 43 degree API oil, with 2,300 lbs. pressure on the bottom choke.

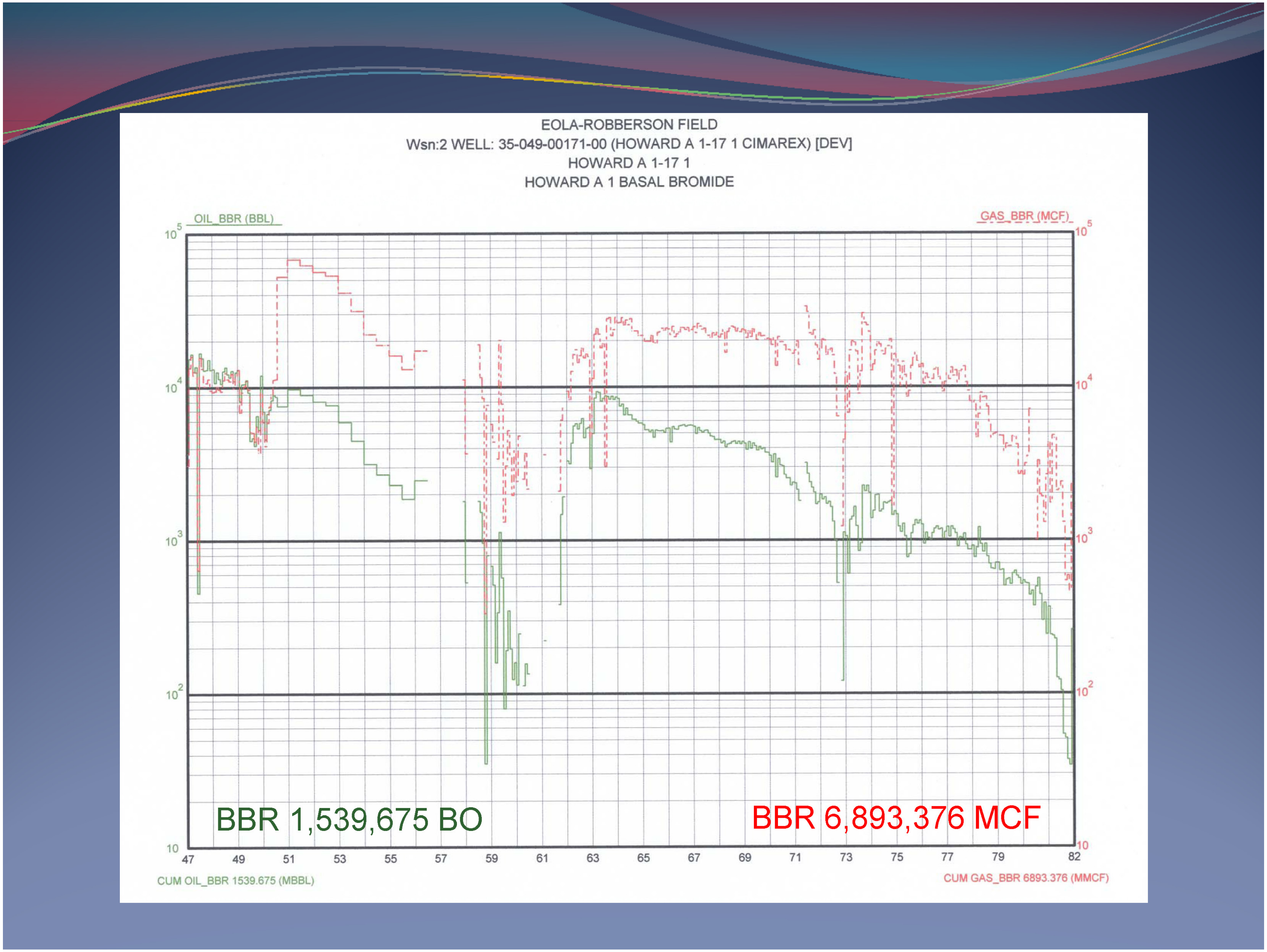
Top of the Basal McLish Sand was encountered at 10,713 feet, and 88 feet of the 105 feet drilled below this depth was considered effective pay sand, according to complete laboratory analysis of porosity and permeability.

Further drilling was stopped at that point because of the delicate mechanical problems involved in deepening further the small hole, although it is estimated that only one-half of the lower saturated McLish zone had been penetrated.

The lower horizon was then plugged off and the well put back on production in the original Bromide Sand. Production from that sand immediately snapped back to its original flow, and the well is now producing currently its 400 barrels per day allowable as established by the Oklahoma Corporation Commission.

Day 600

Presenter's notes: The well was then deepened further and encountered Upper McLish which tested 672 BOPD, and cored 88ft of the Basal McLish, which also looked productive. Both of these zones were plugged back to produce the Basal Bromide sand at its 400 BOPD allowable.



Presenter's notes: The well produced more than 1,500,000 BO and nearly 7 BCF from the Basal Bromide from 1947 until 1982, at which time it was temporarily abandoned due to surface problems.

Day 600

- 2 -

Sohio Petroleum Company, with extensive holdings in Eola Field, is presently drilling 3 off-set wells to the discovery well, and 2 out-post wells.

Geoligists are of the opinion that there are other pay zones immediately below the lower McLish Sand.

Eola Discovery Well
Howard A 1

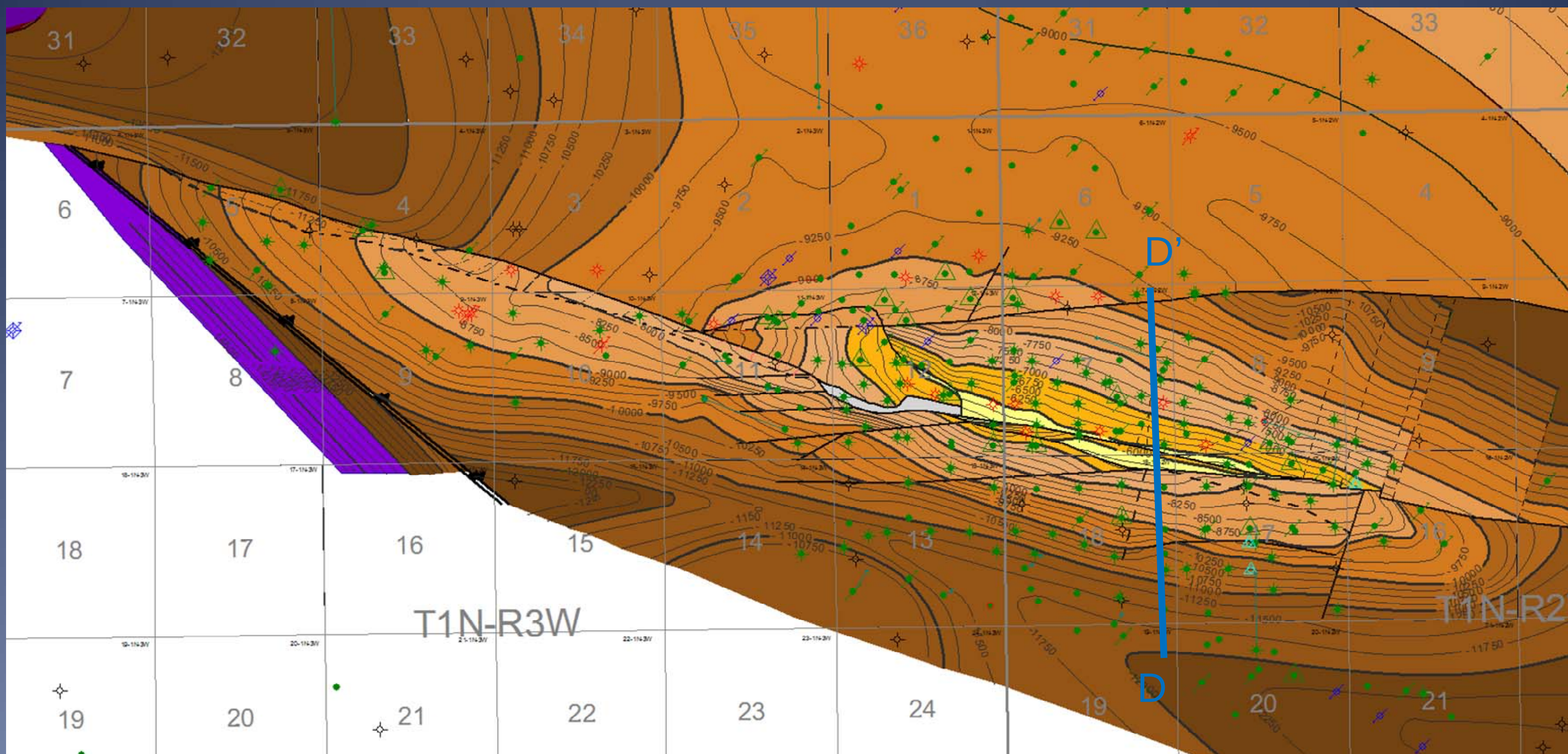
WELL TOTAL
1/1947-4/1994
1,890,000 BO
9,265,536 MCF

Upper Bromide
1/1982-4/1994
41,533 BO
325,677 MCF

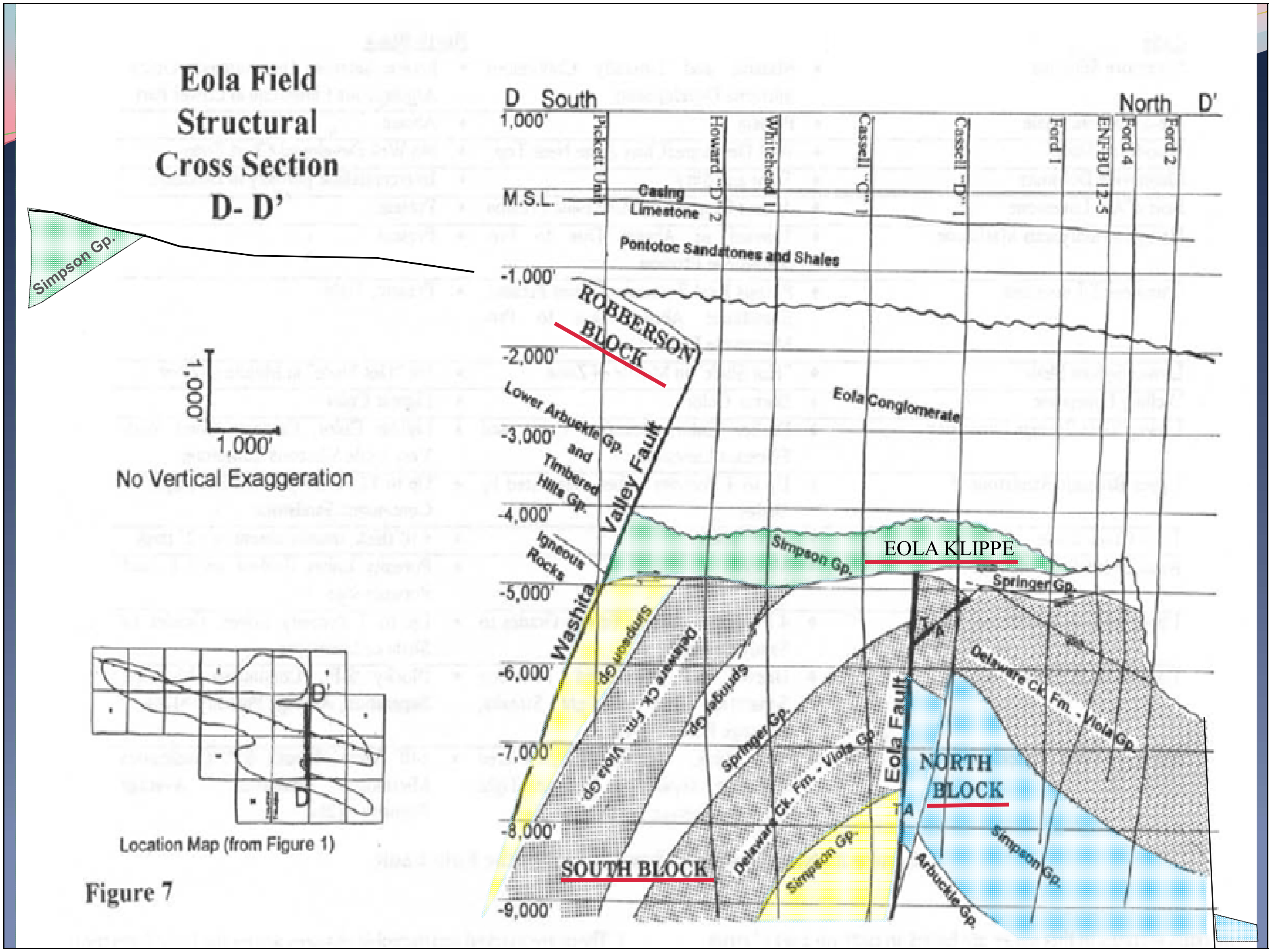
Basal Bromide
1/1947-4/1994
1,539,675 BO
6,896.376 MCF

Basal McLish
11/1950-2/1962
308,792 BO
2,043,483 MCF

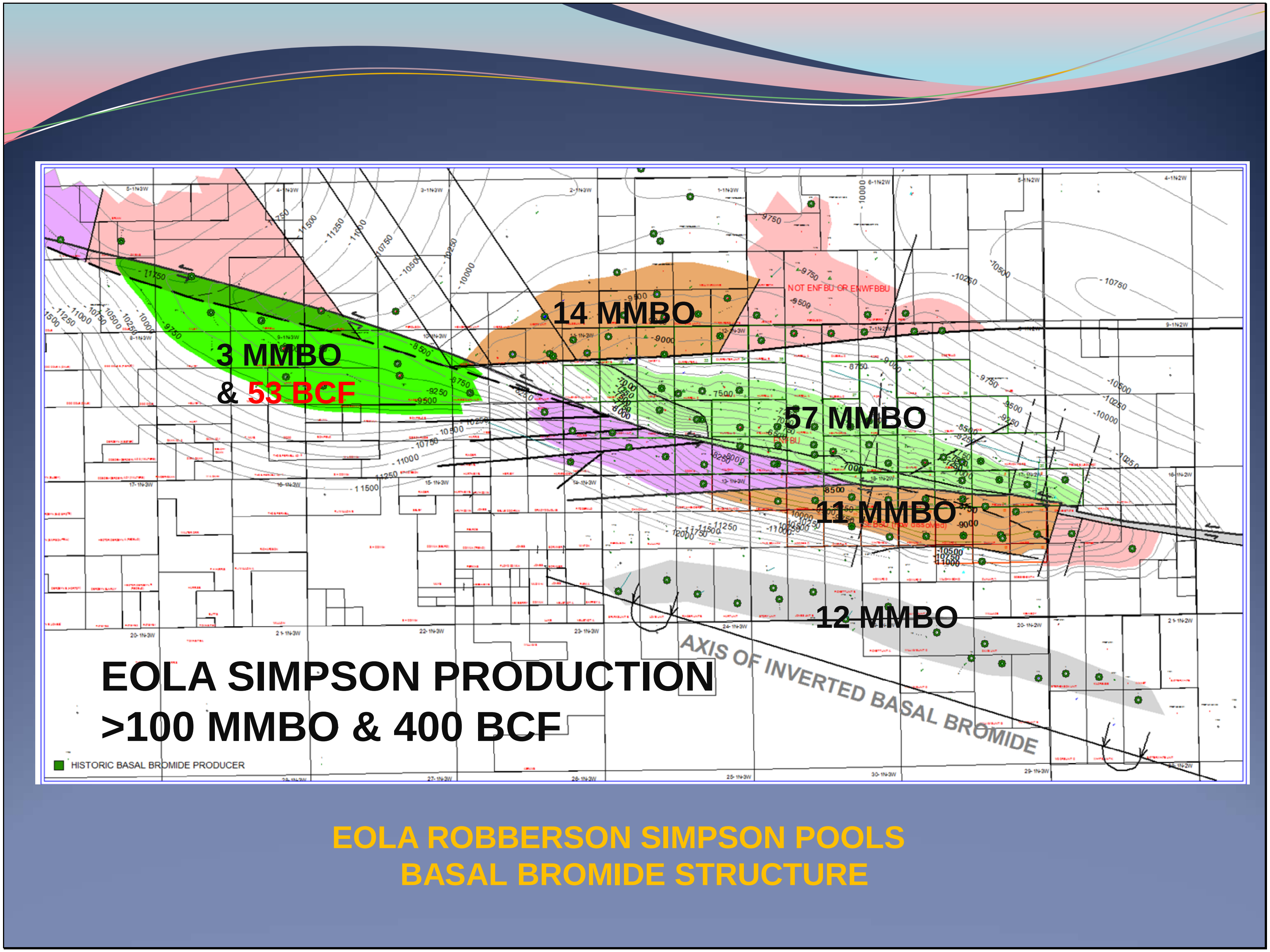
Presenter's notes: All Simpson zones combined in the discovery well produced nearly 1.9 million BO and more than 9 BCF. Sohio had found a honey-pot, which was to remain the company's star field until Prudhoe Bay was discovered.



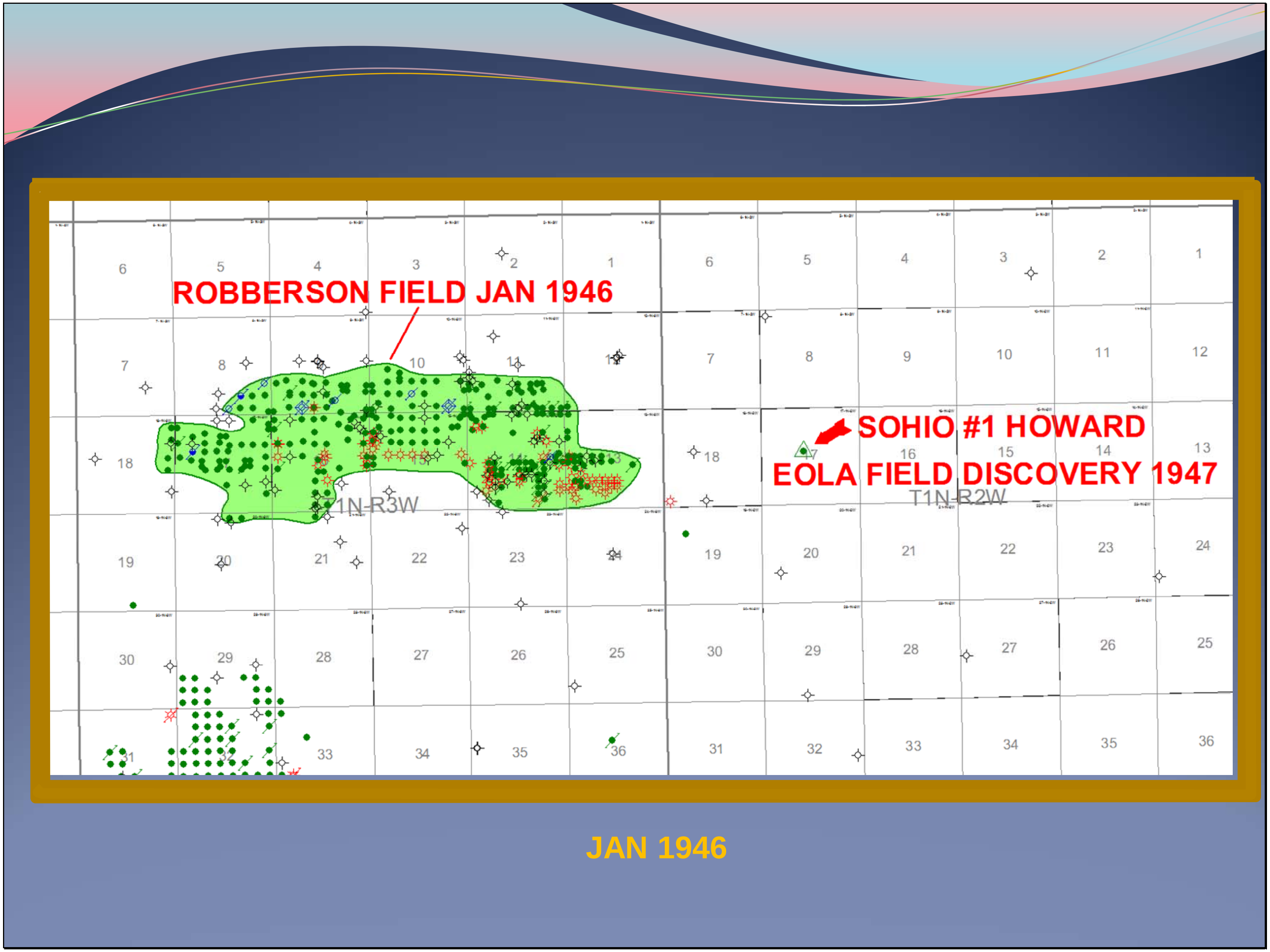
Presenter's notes: This map shows the location of a cross section (D-D') across the main fault blocks.



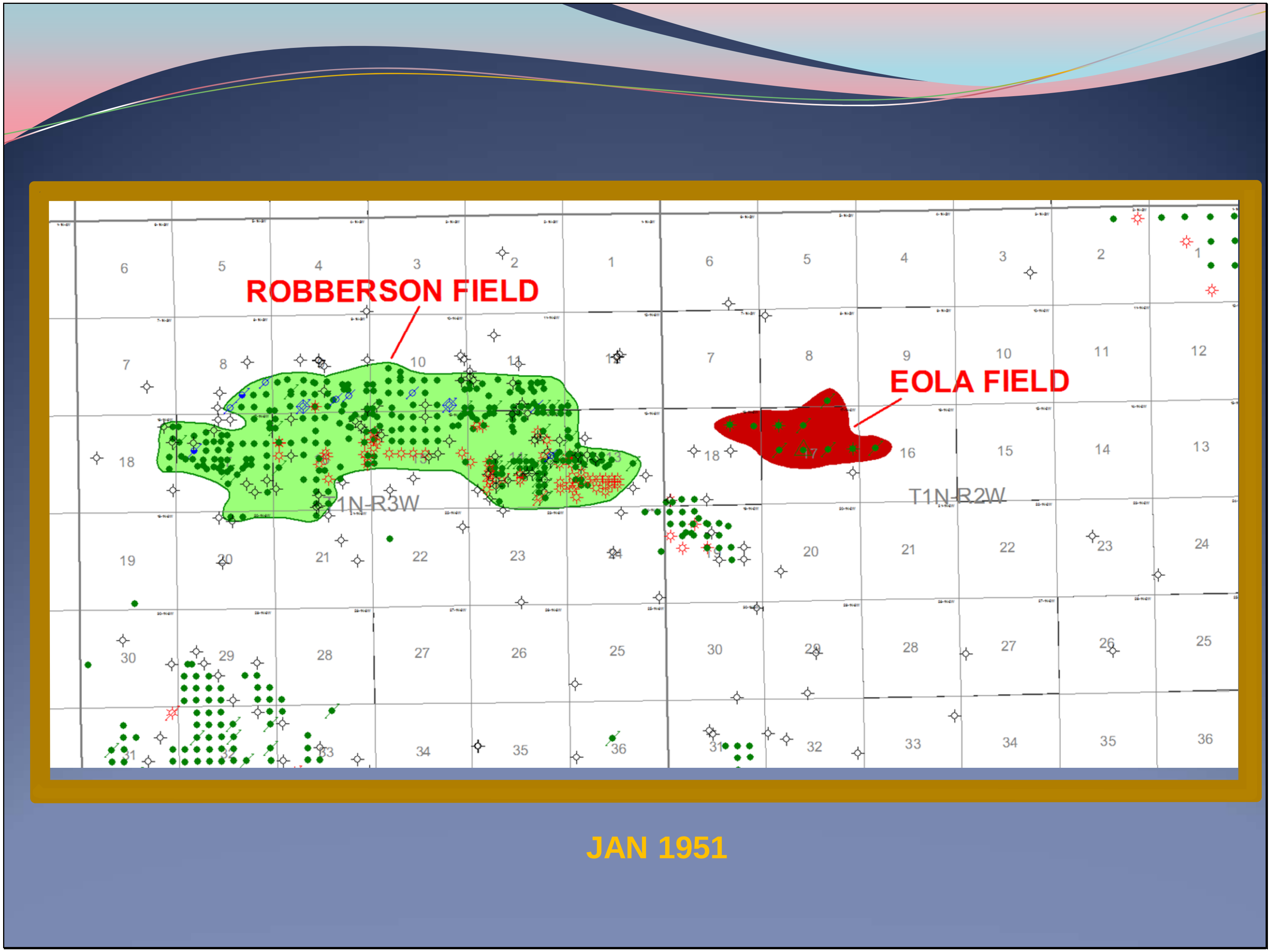
Presenter's notes: The block south of the Washita Valley Fault that brings igneous and Arbuckle Group up in buried hills as shallow as 1400ft from the surface is called the Robberson Block. The Simpson is eroded off most of this block but is present on the south side of the block at least in one place in the western part of the field. The area between the Washita Valley Fault and the Eola Fault is called the South Block and includes the inverted Simpson beds. North of the Eola Fault is the North block and production on the downthrown side of an 800-ft fault is called the Northwest Block although the lithology is the same as in the North Block. A thrust sheet of Simpson across the Eola Structure is called the Eola Klippe.



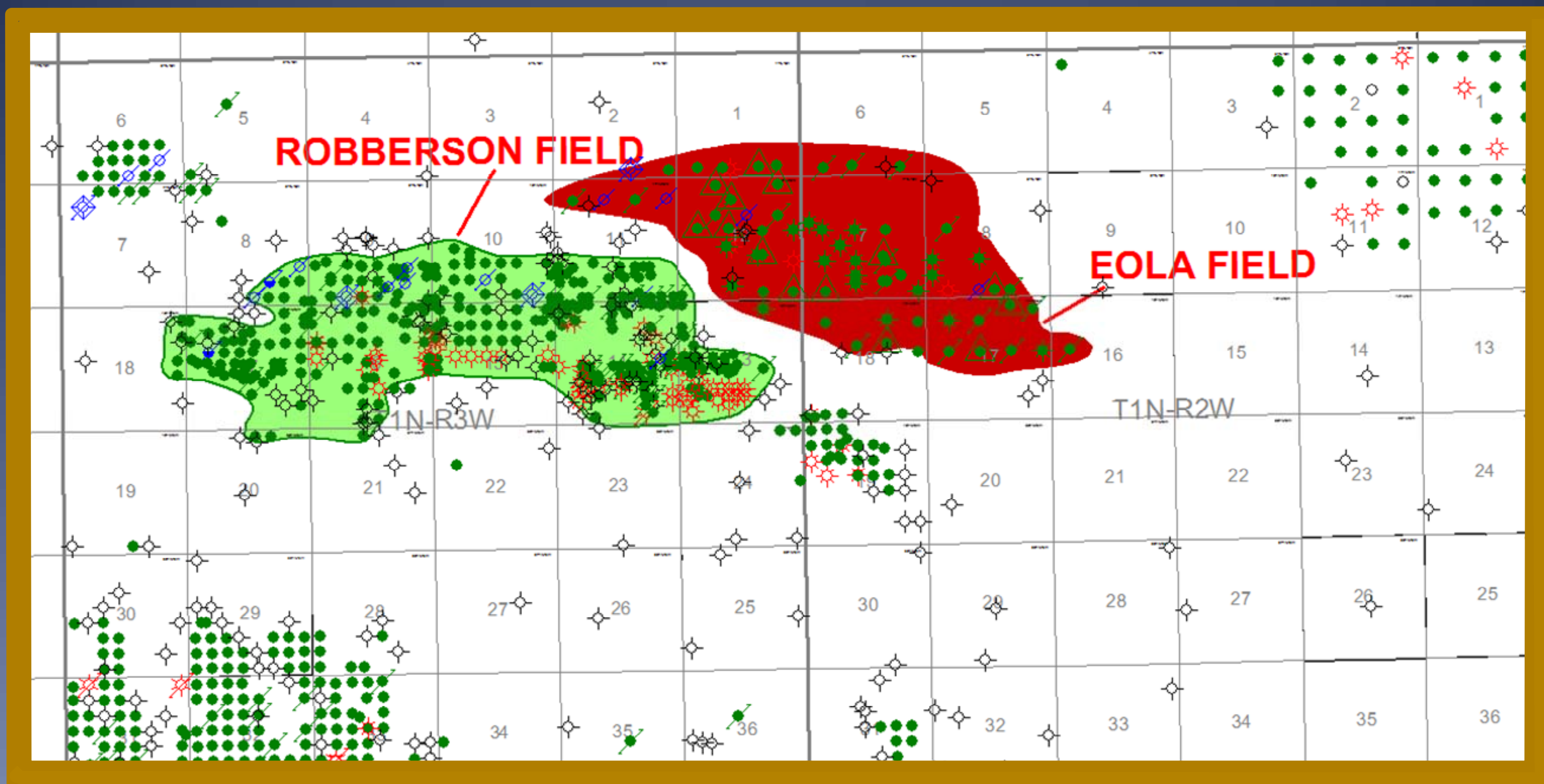
Presenter's notes: The discovery well was in the South Block which has made 11 MMBO; the North Block has made 57 MMBO; the Northwest Block has made 14 MMBO; the Inverted Trend has made 12 MMBO; and the West Block with large primary gas caps has made 3 MMBO and 53 BCF to give cumulative production from the Simpson at Eola-Robberson in excess of 100 MMBO and 400 BCF.



Presenter's notes: The next series of Slides shows the historic development of the field in 5-year increments. The discovery well was 2 miles east of the Robberson field, which produces from shallow Permian sands and the underlying Arbuckle buried hills. Production from 400ft to 3000ft began in 1920.

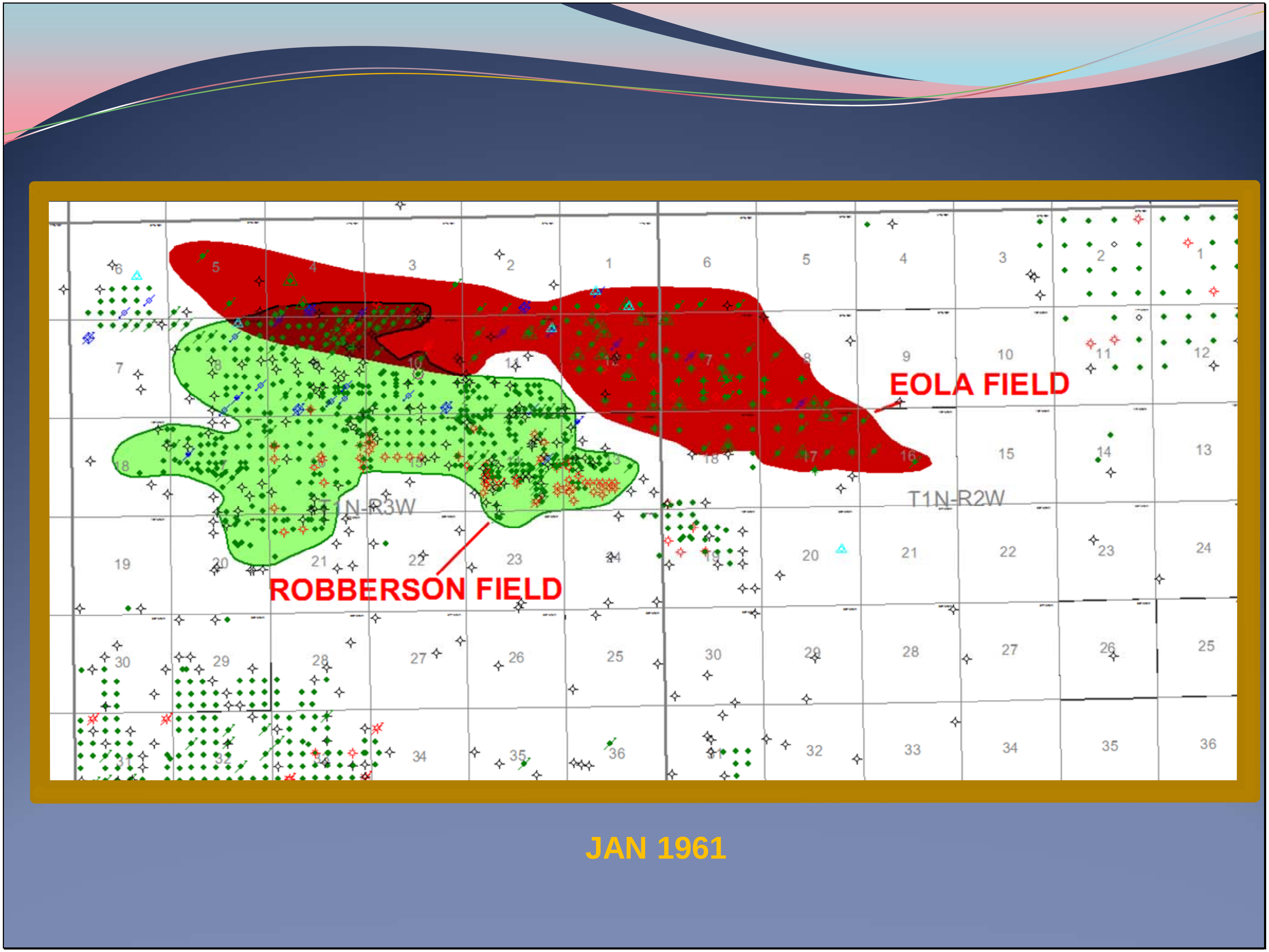


Presenter's notes: The field was developed with 40-acre offsets which resulted in 2 dry holes and 8 producers in the South Block. The well in section 8 was nearly 2000ft high to the discovery well and wet in the Basal Bromide, showing the presence of a big fault separating the North Block from the initial development. This well was productive in other Simpson sands and the Basal Bromide was later found to be productive in structurally higher wells in the North Block.

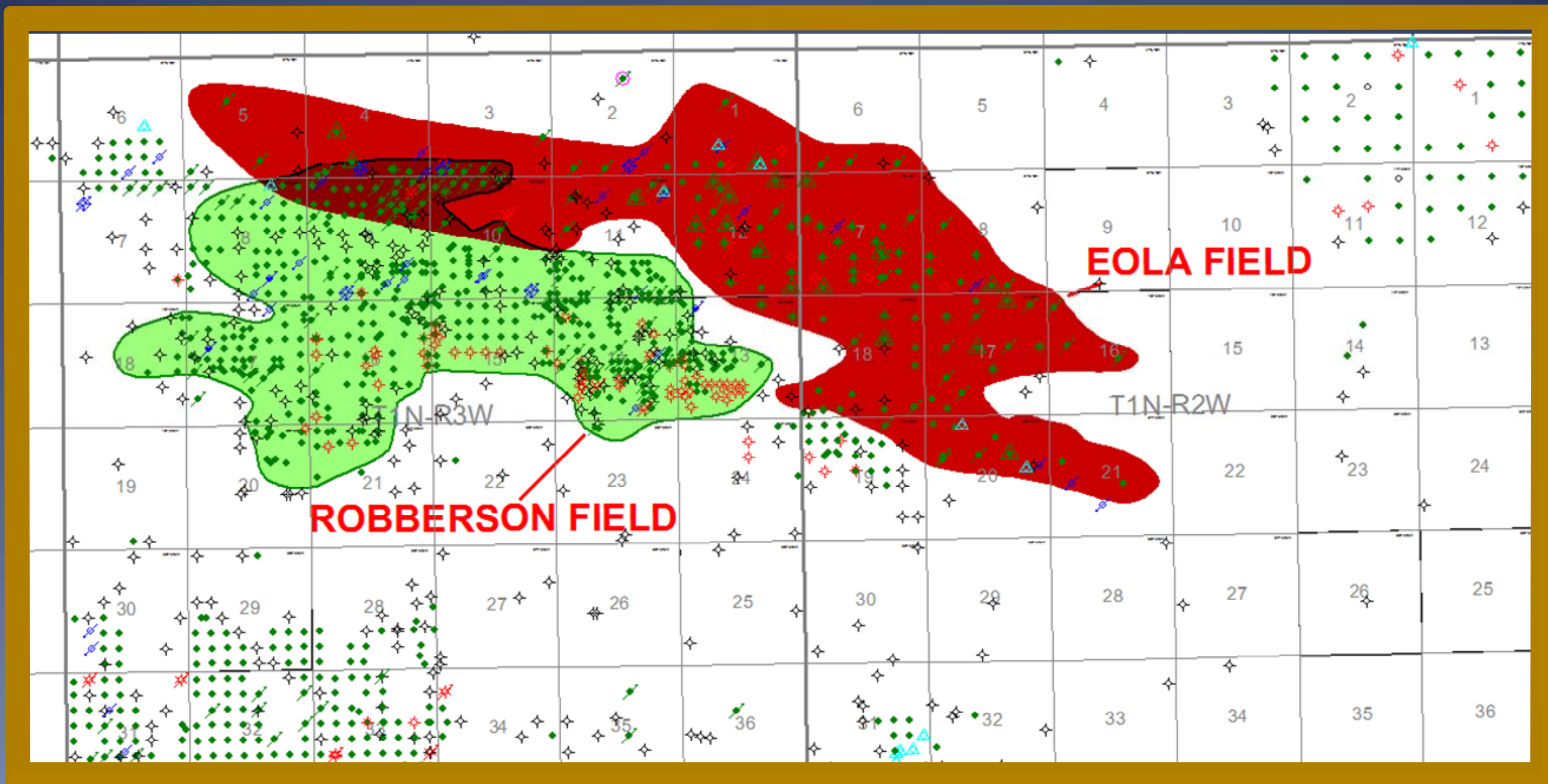


JAN 1956

Presenter's notes: The early 1950s saw aggressive development of the North Block by Sohio, as well as discovery by Stanolind of a downthrown productive block, referred to as the Northwest Block.

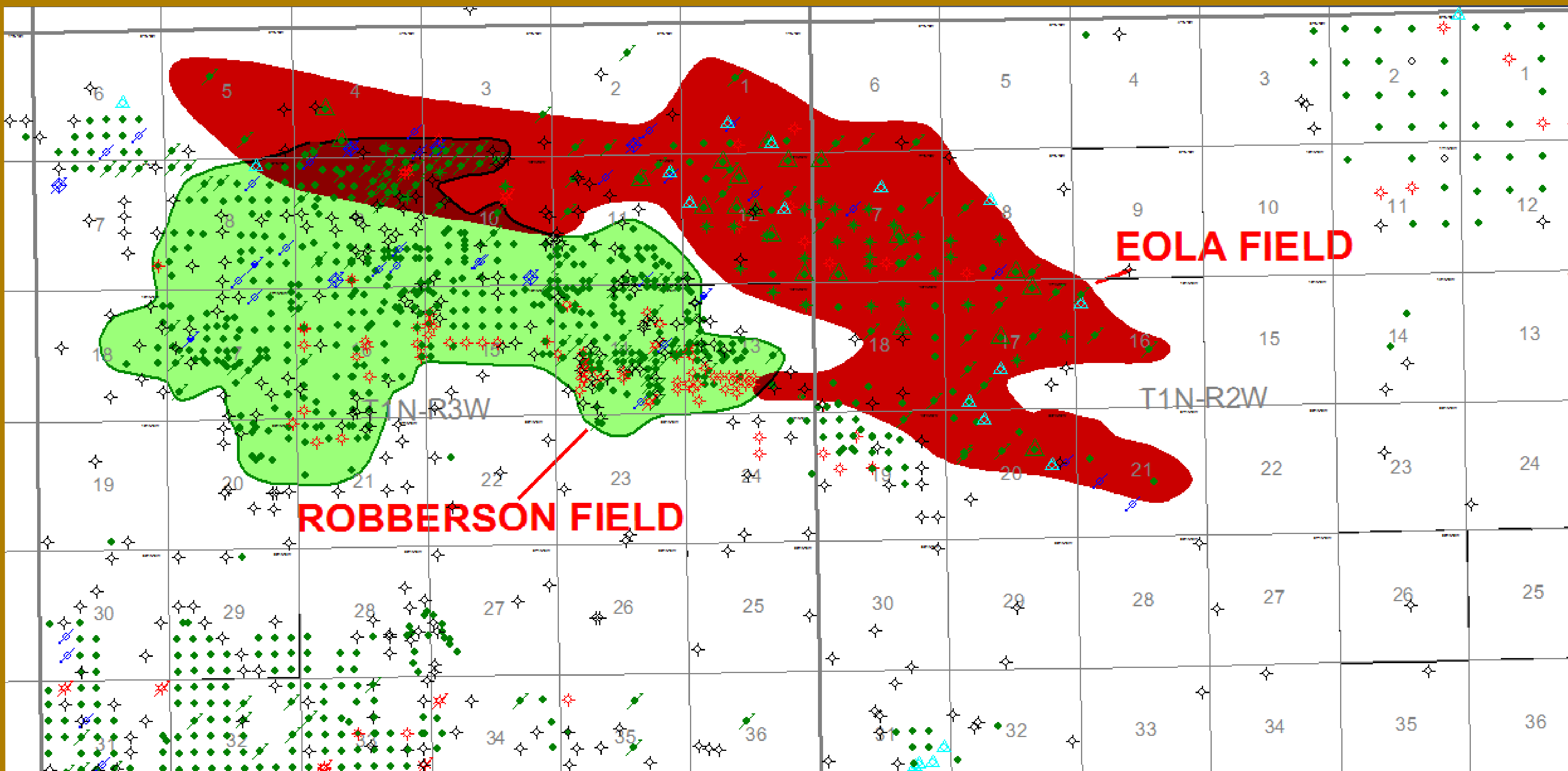


Presenter's notes: The late 1950s saw the westward extension of the field and the development of the West Block by a number of operators.

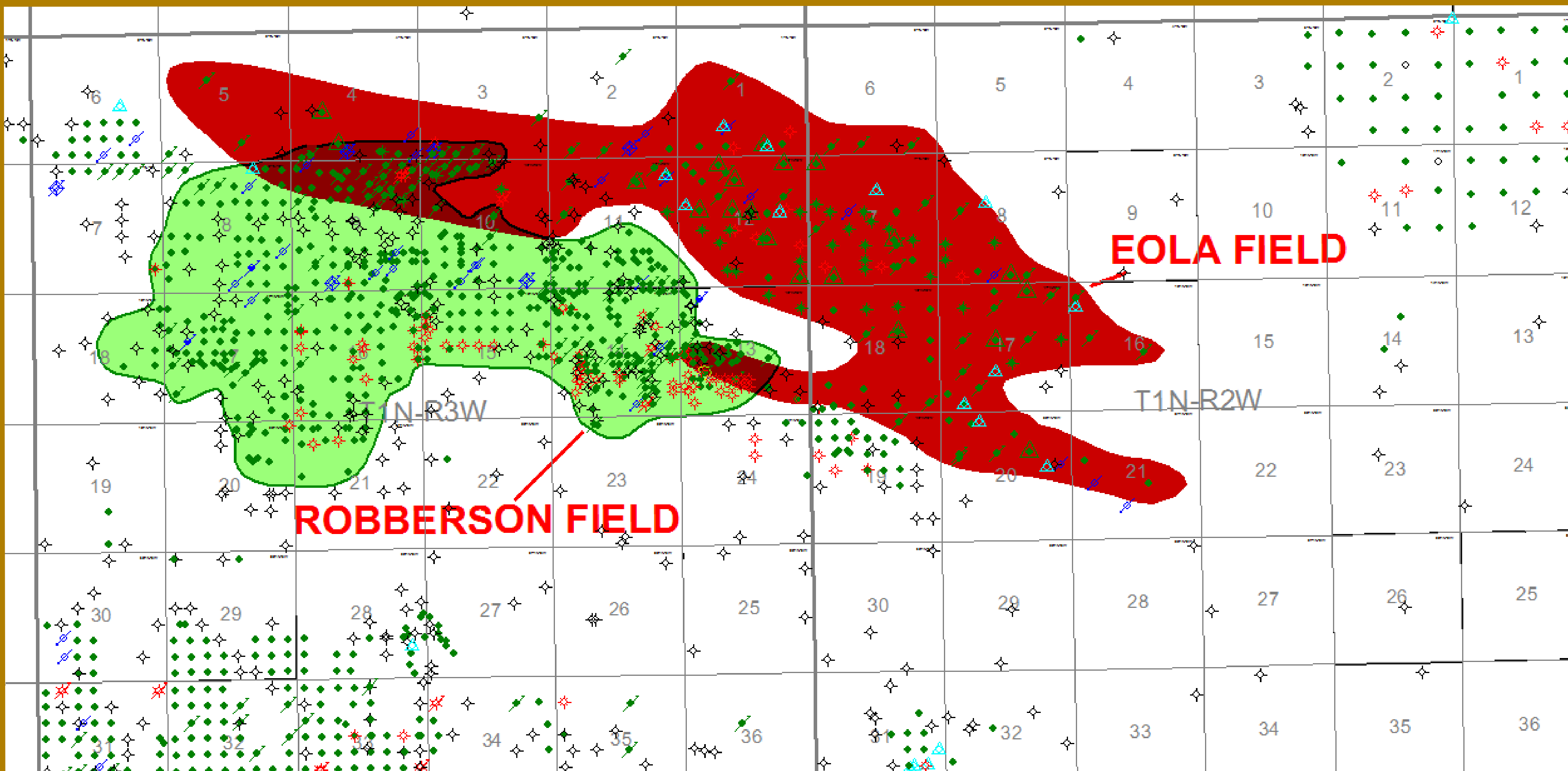


JAN 1966

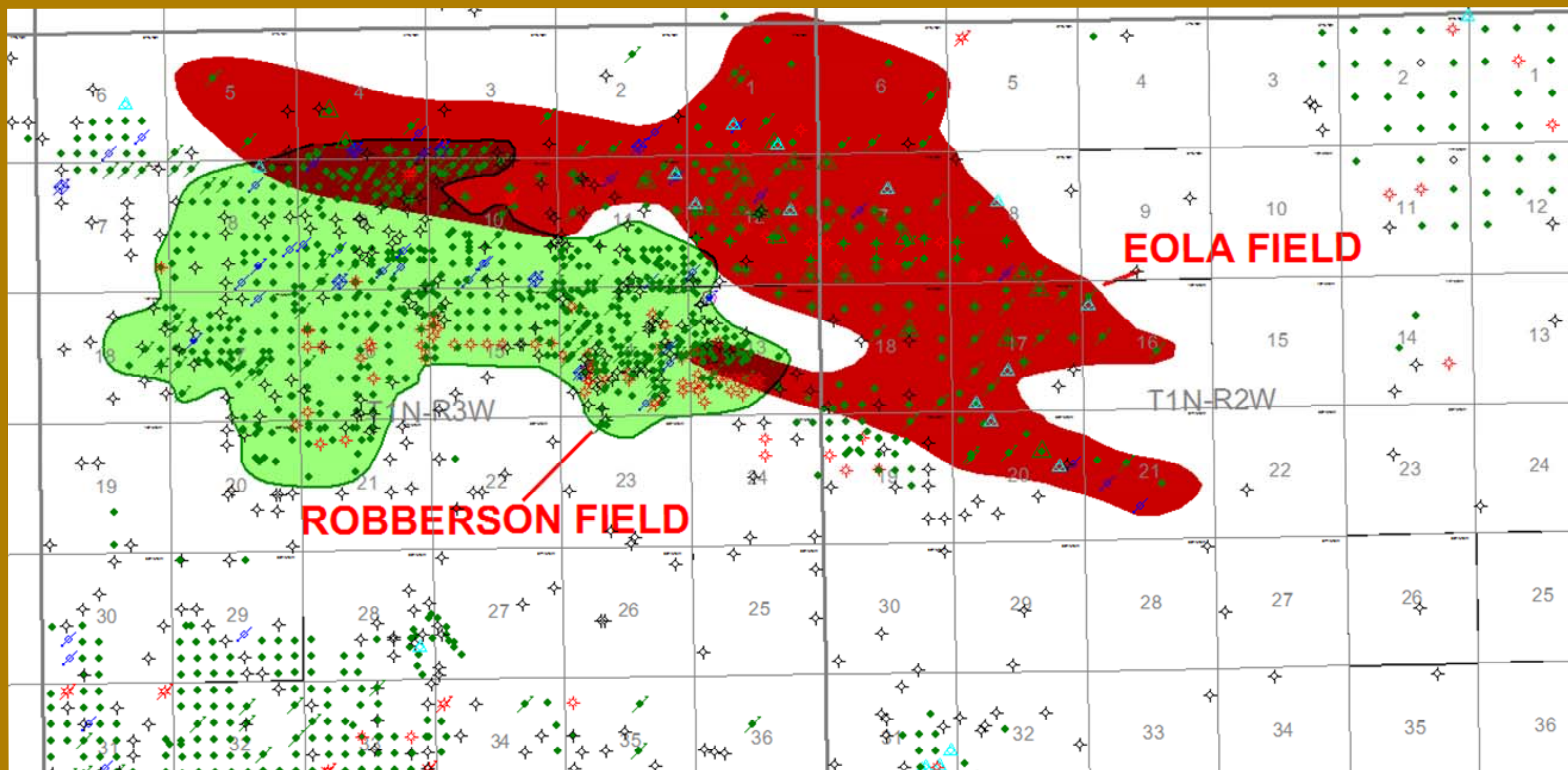
Presenter’s notes: In the early 1960s Stanolind (to become Pan-American then to become Amoco) delineated the inverted trend in the Bromide and McLish on leases that Sohio had let expire to the south of the initial development.



JAN 1971

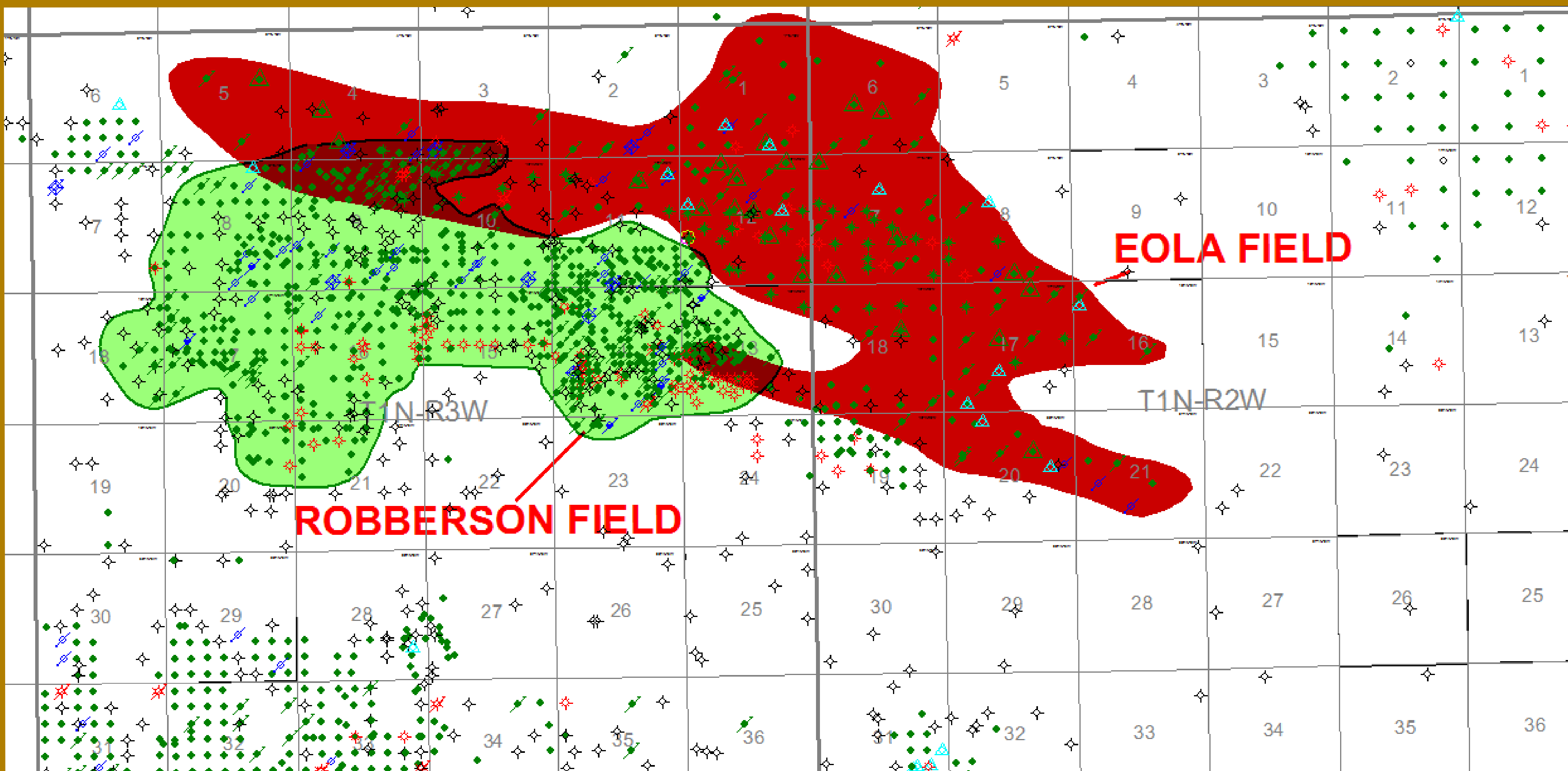


JAN 1976

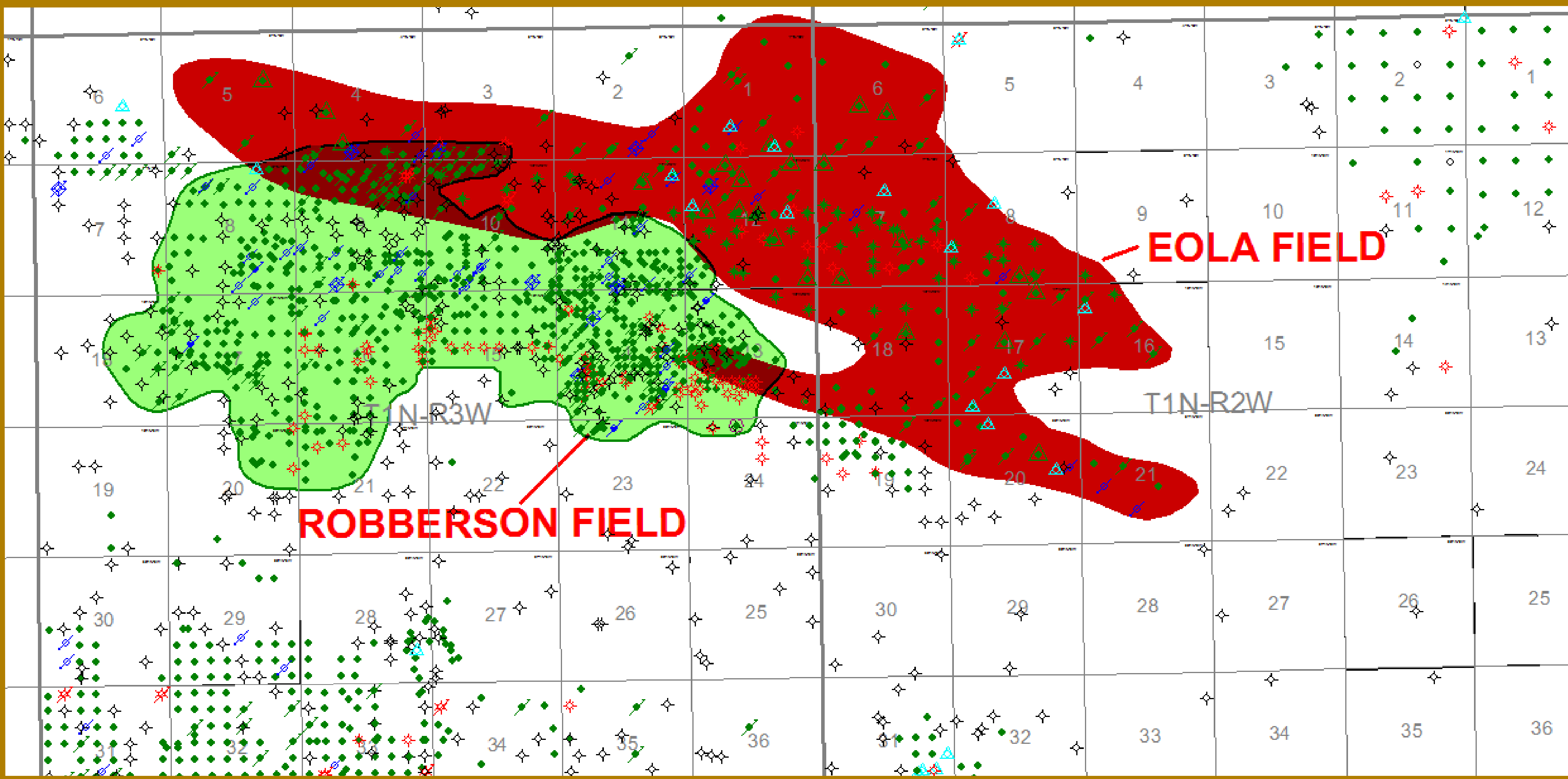


JAN 1981

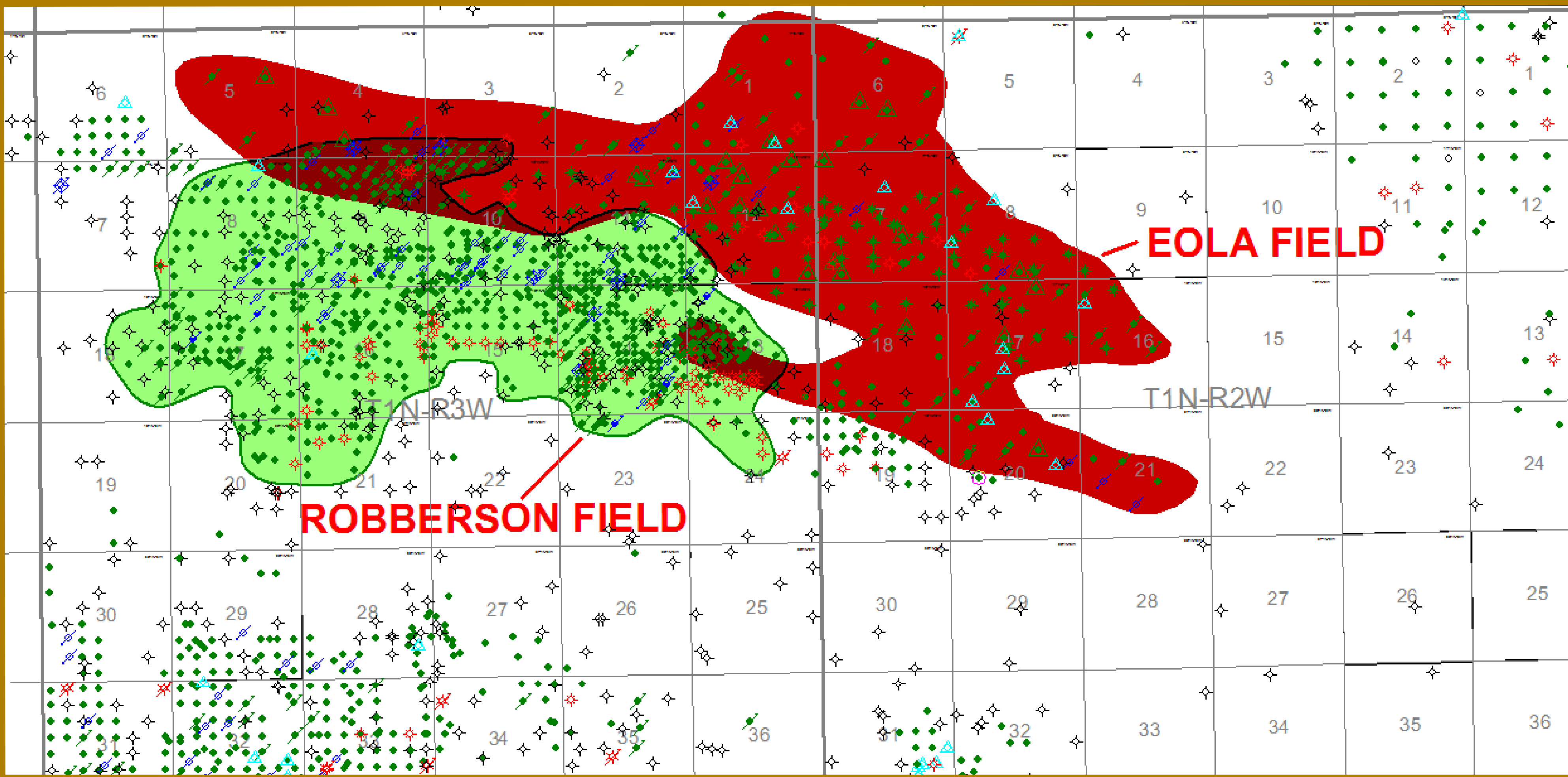
Presenter's notes: The 1980s saw some Bromide and Upper McLish development north of the Northwest Block.



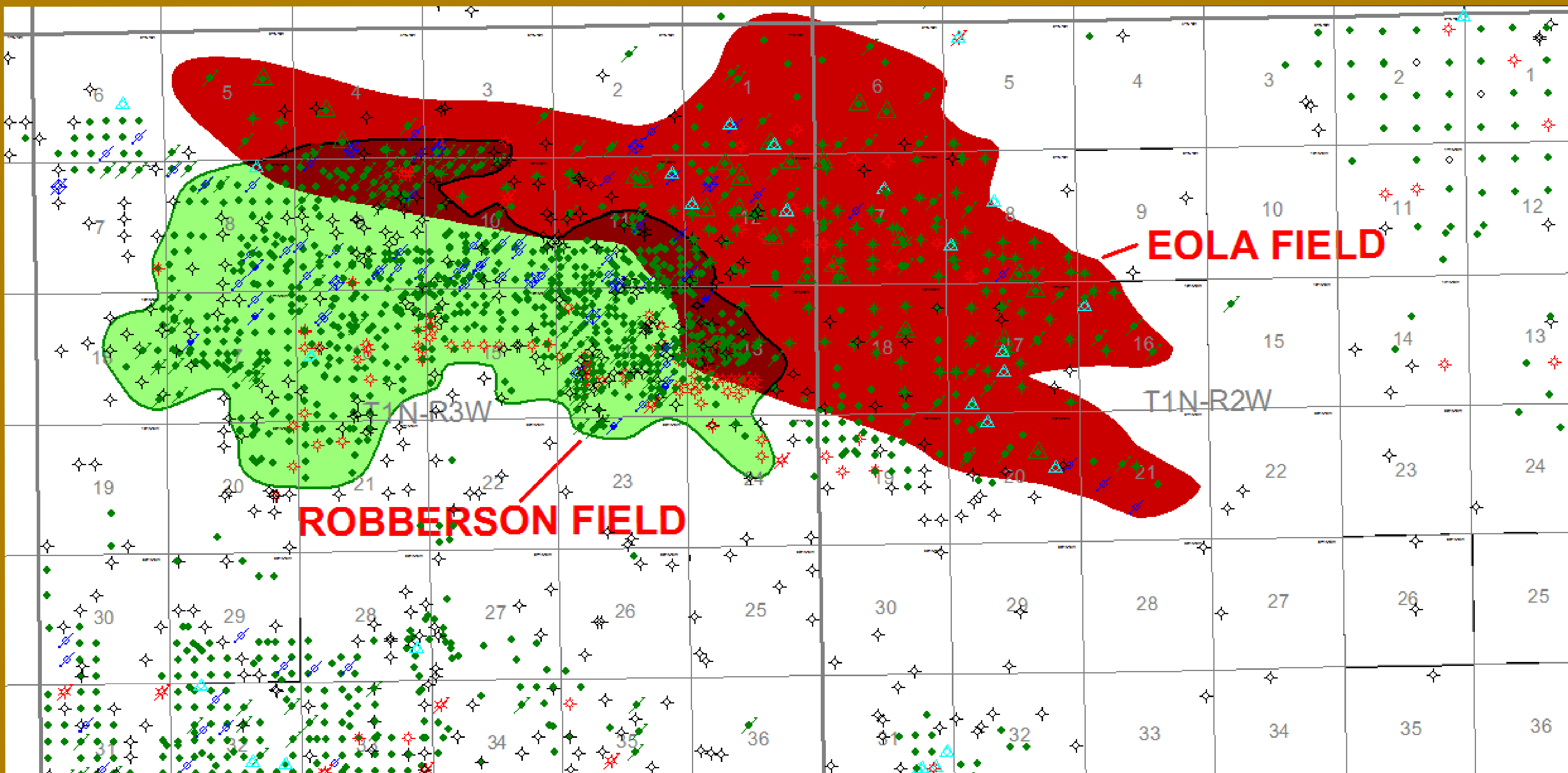
JAN 1986



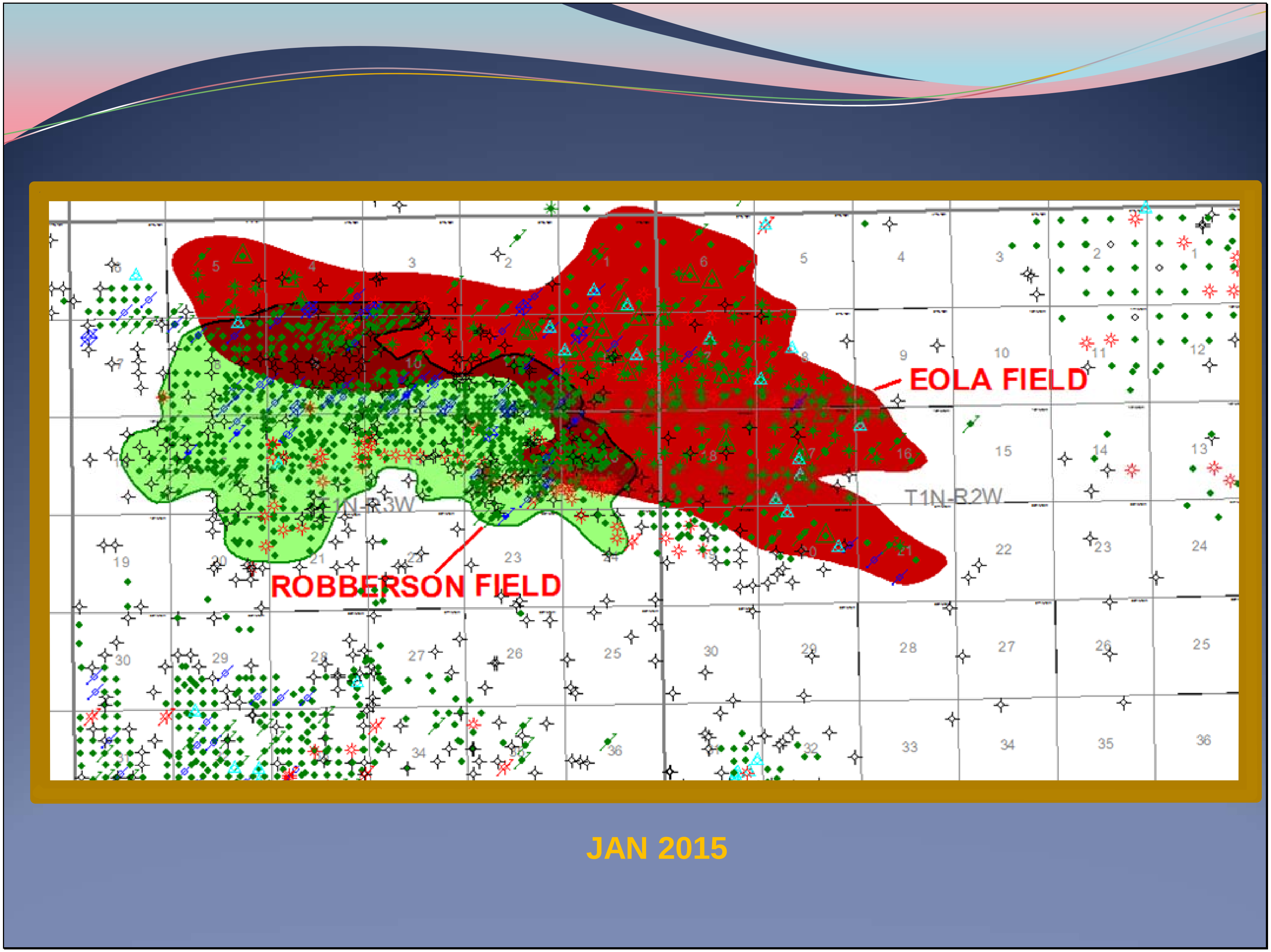
JAN 1991



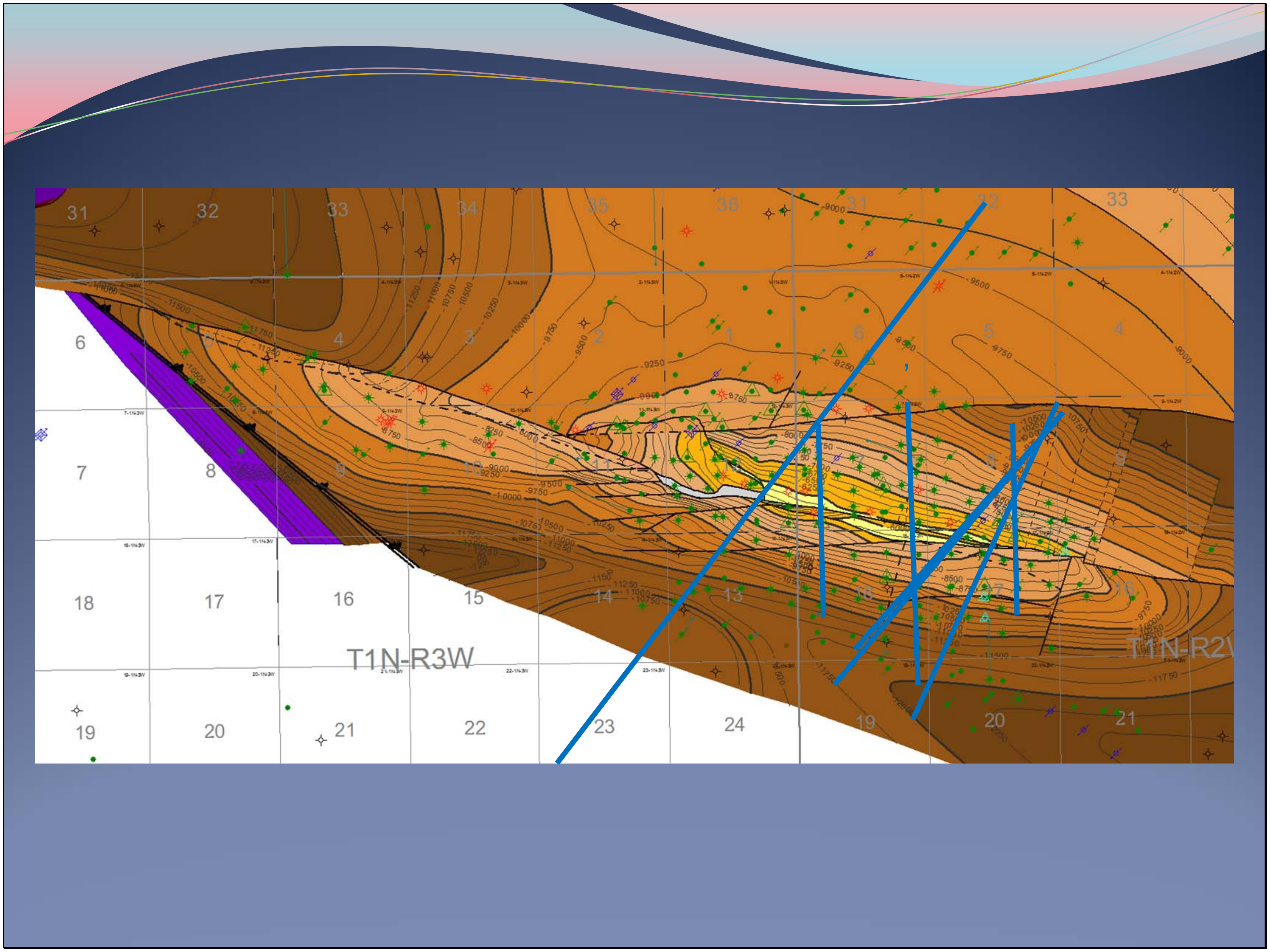
JAN 2006



JAN 2011



Presenter's notes: Through 2015 the overlying fractured reservoirs were developed extending the area of the field, but any new Simpson producing blocks were mainly within the 1980s outline of the field. The combined field area is called Eola-Robberson and also includes the buried-hill Arbuckle and Pontotoc production from the contiguous South Eola field to the south and the Royal field to the west.



Presenter's notes: Since 1947 a number of wells have been drilled and a considerable data has been gathered, including a large number of fault cuts; so many of the structural questions have been answered. Now I shall show a number of one-to-one vertical exaggeration cross sections across the field. I have highlighted the top of the Viola in purple, and most of these are in the same general area of the field. The cross sections show that, although many of the structural questions have been answered, there is significant disagreement on what that answer is.

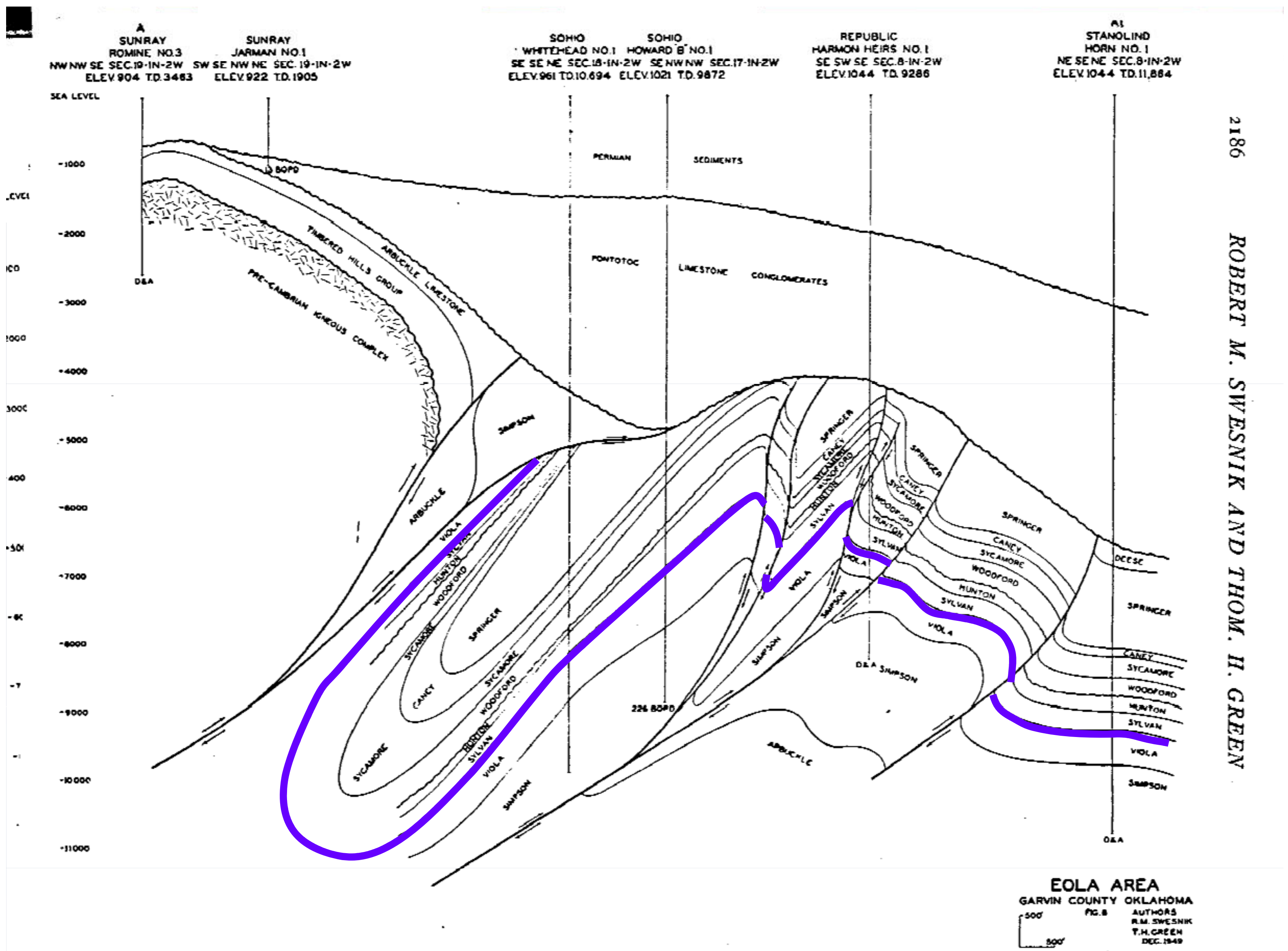
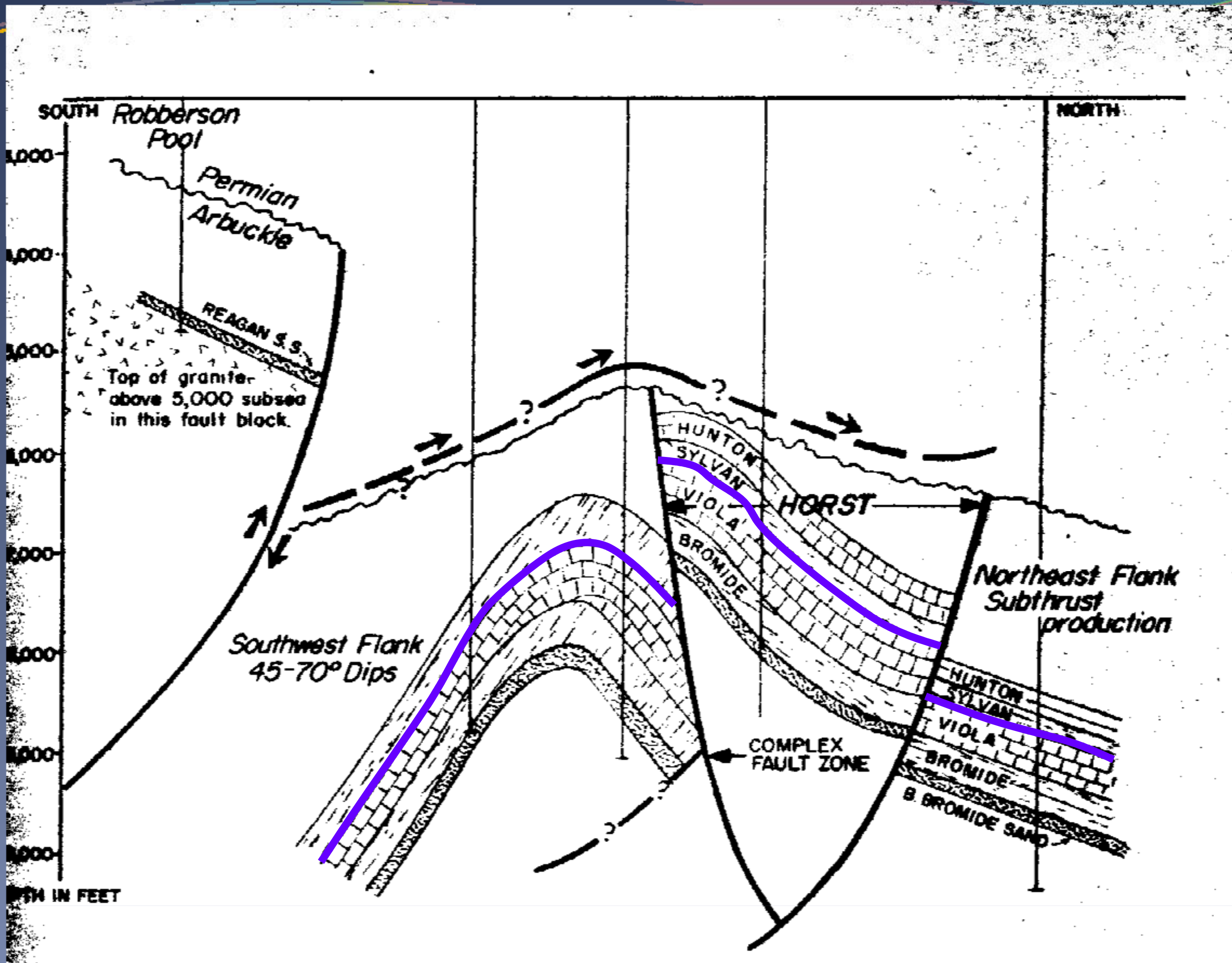


FIG. 6.—Section AA', southwest to northeast (see Fig. 5).

Swesnik & Green, AAPG Bull., Vol. 34, No. 11, p.2176-2199, Nov. 1950



3—Eola has over 3,000 ft. of relief; on the northeast flank oil is trapped against a reverse that has between 800 and 1,400 ft. of throw.

Morrisey & Walper, O&GJ, Jul. 11 1955

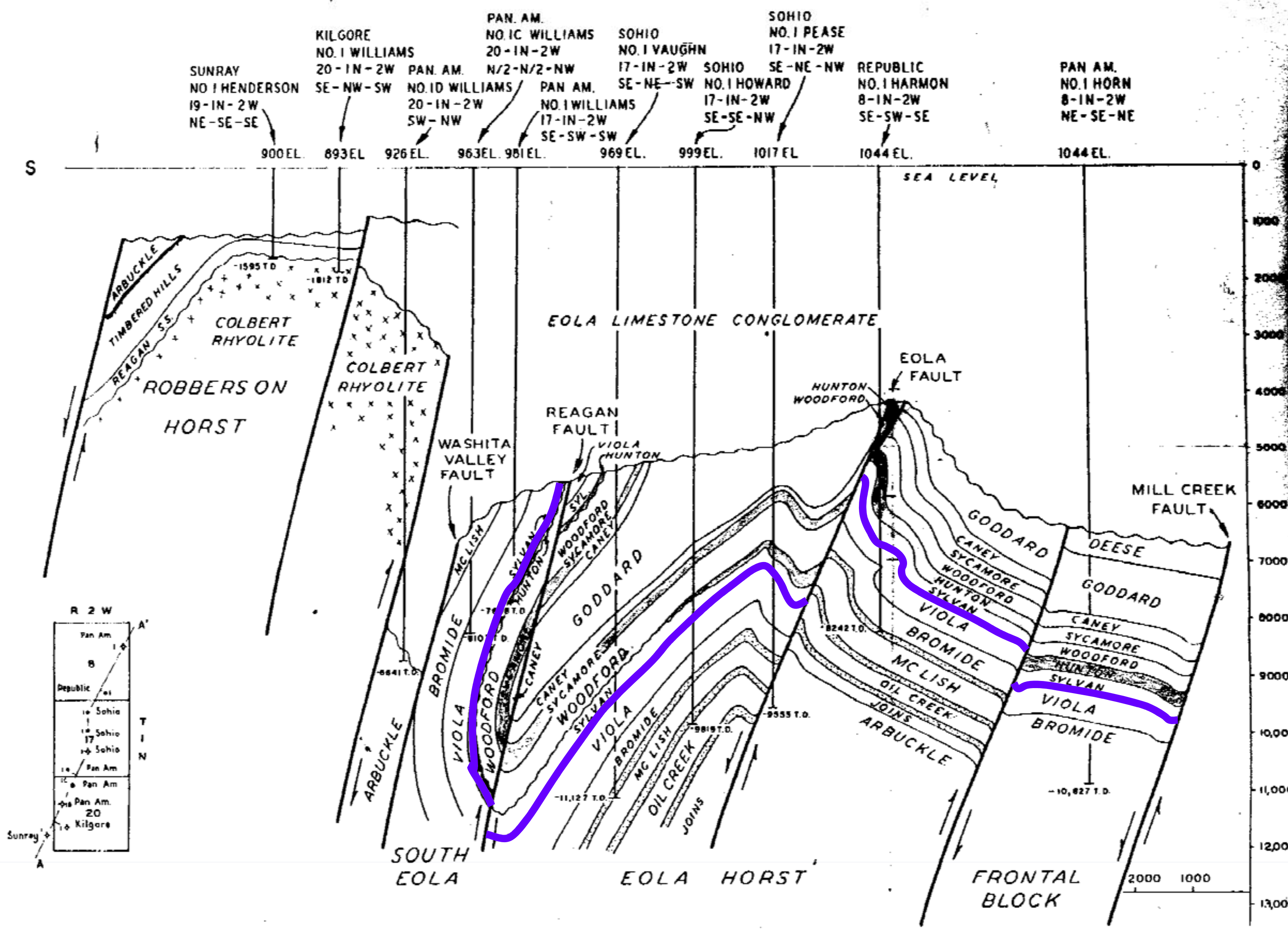


FIG. 6.--Structure sections, Eola field, Line A-A' from southwest to northeast, through secs. 19, 20, 17, and 8, T. 1 N., R. 2 W. (Fig. 5).

Harlton, AAPG Bull. Vol. 48, No. 9, p. 1555-1567, Sep. 1964

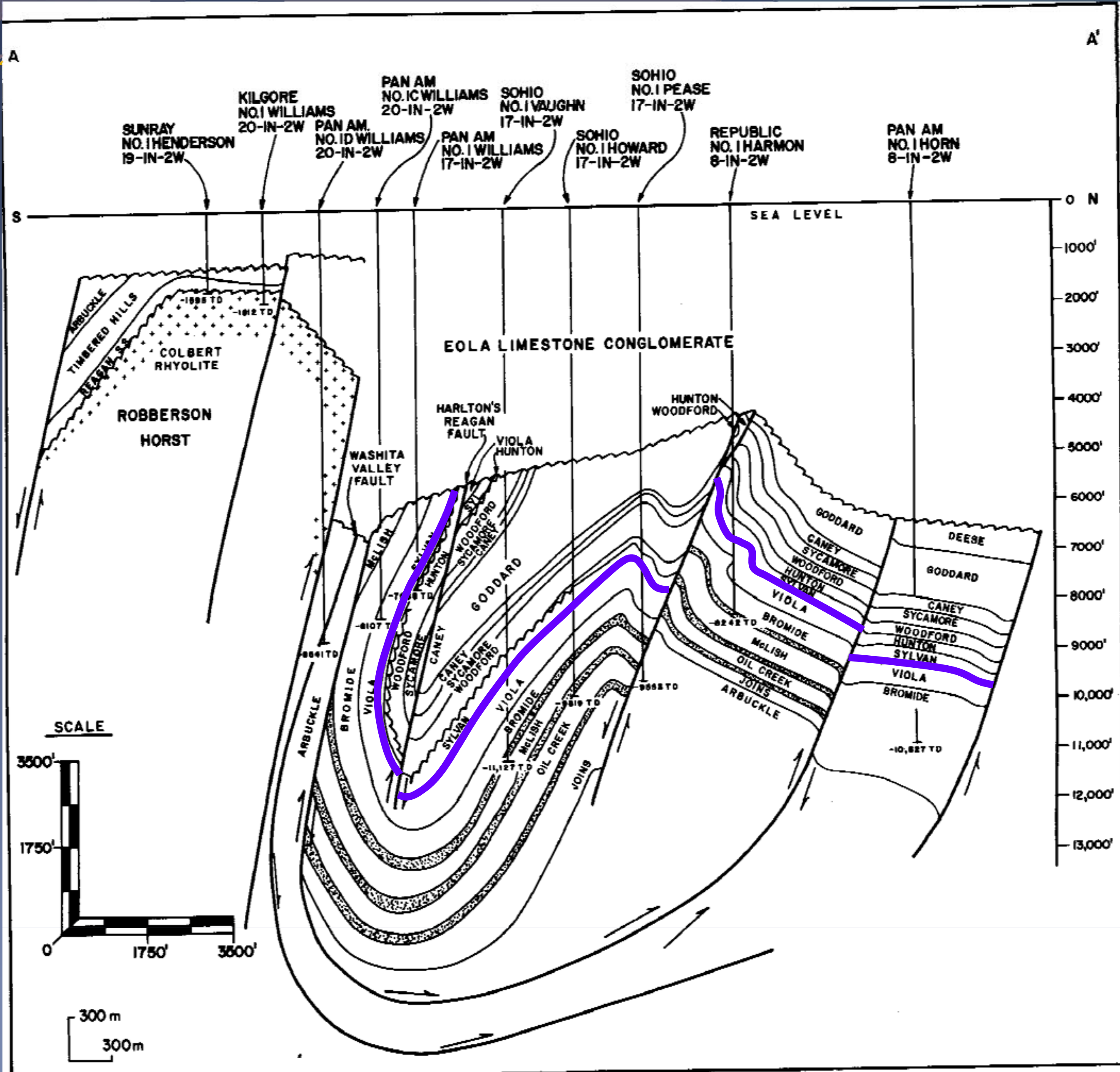
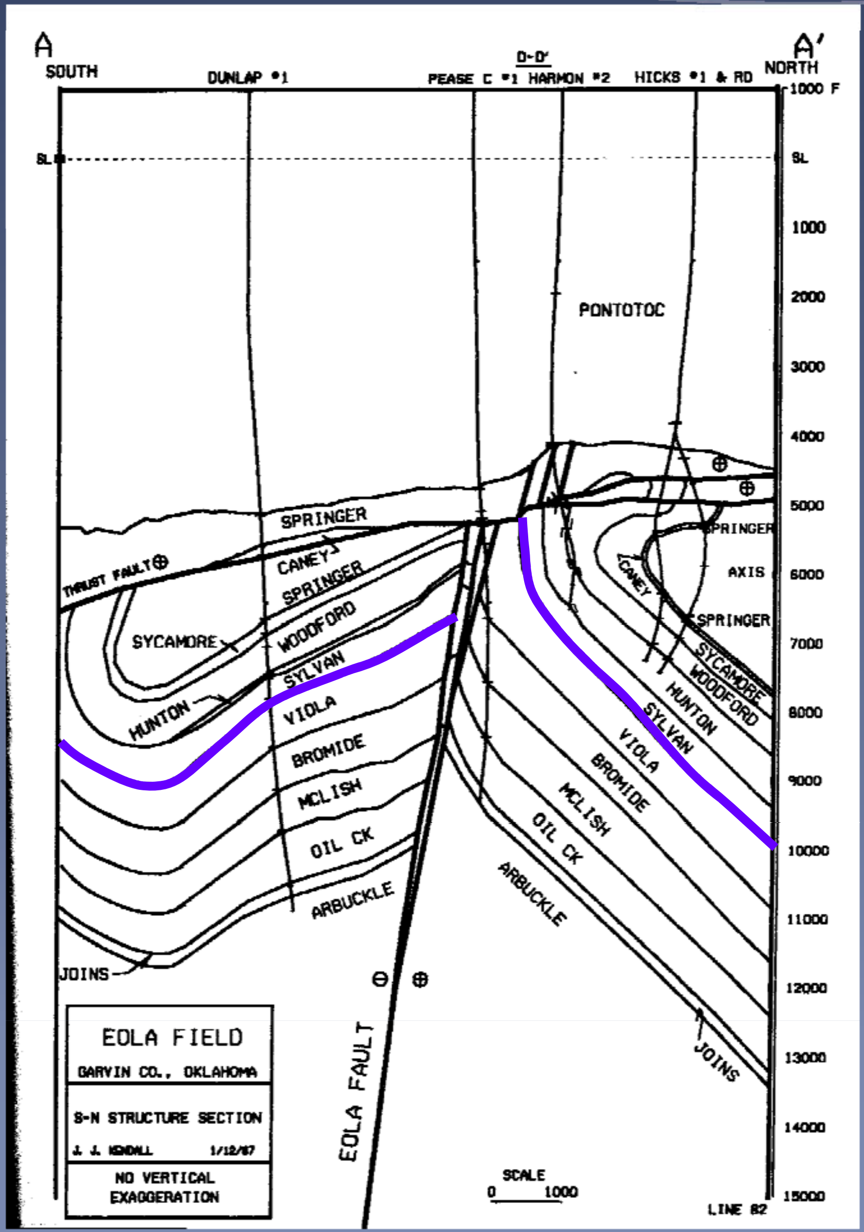
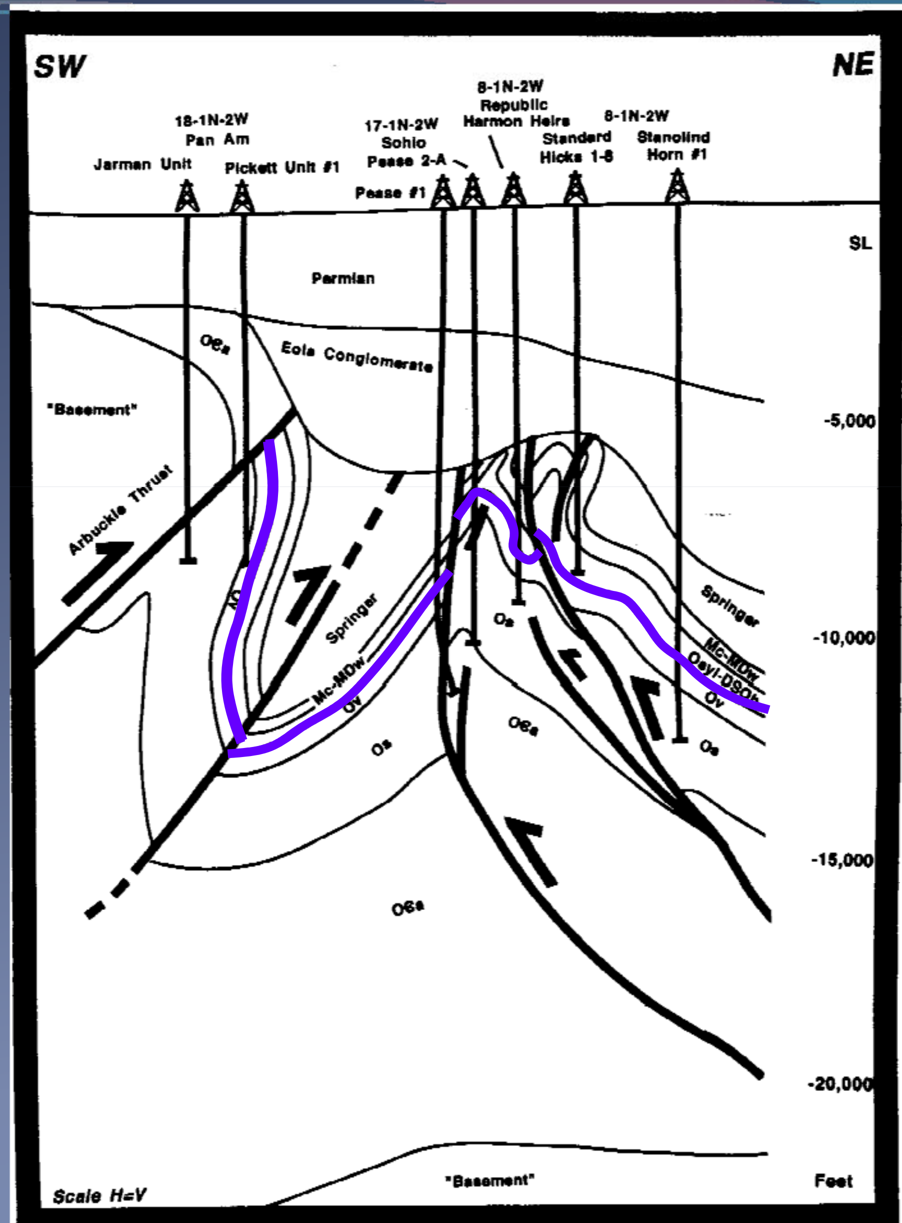


FIG. 6—Cross section AA', Eola field, from Harlton (1964); revised. Multiple fault types occur in Washita Valley fault zone.

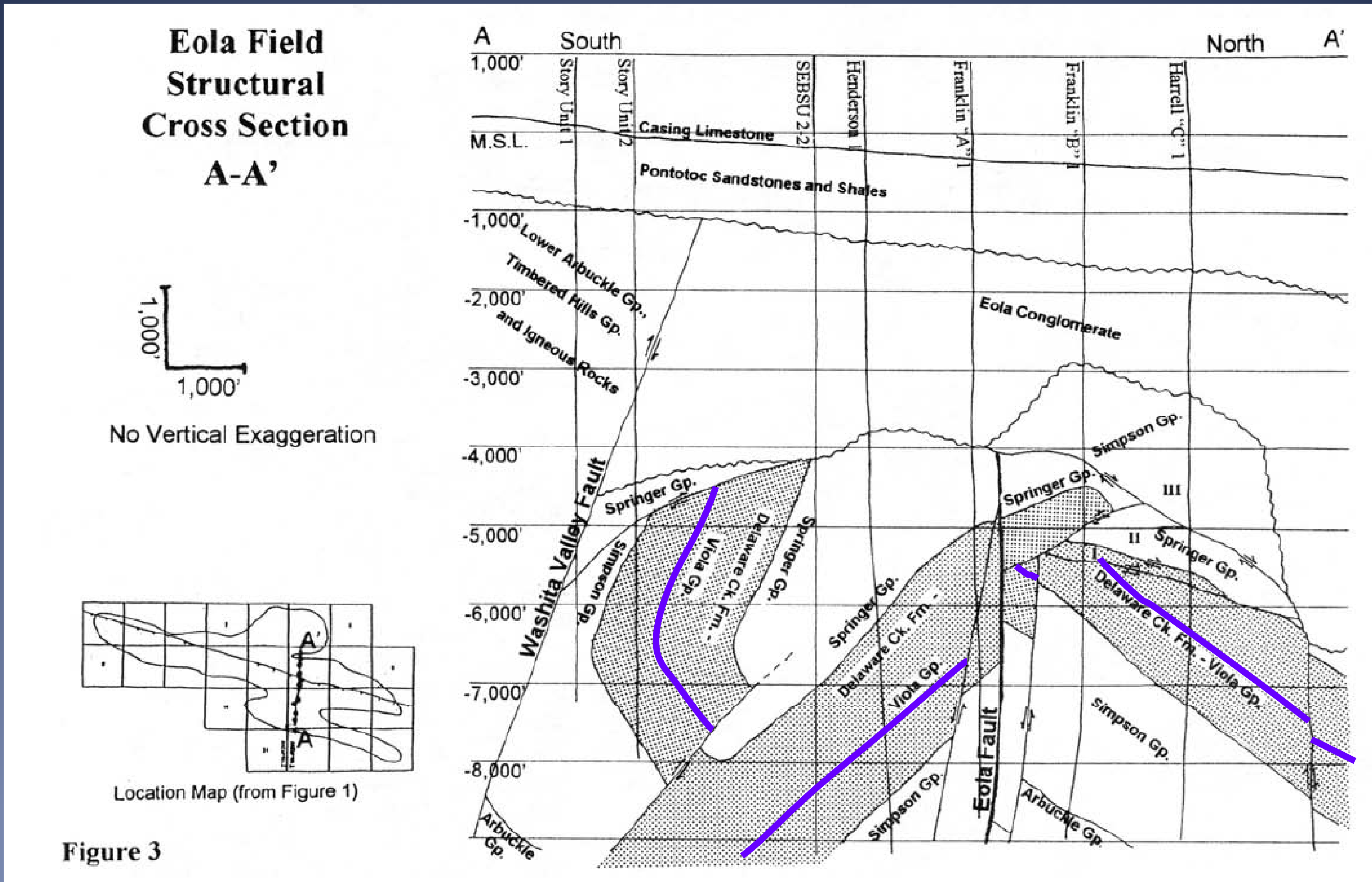
Phillips, AAPG Bull., Vol. 67, No. 9, p. 1363-1390, Sep. 1983



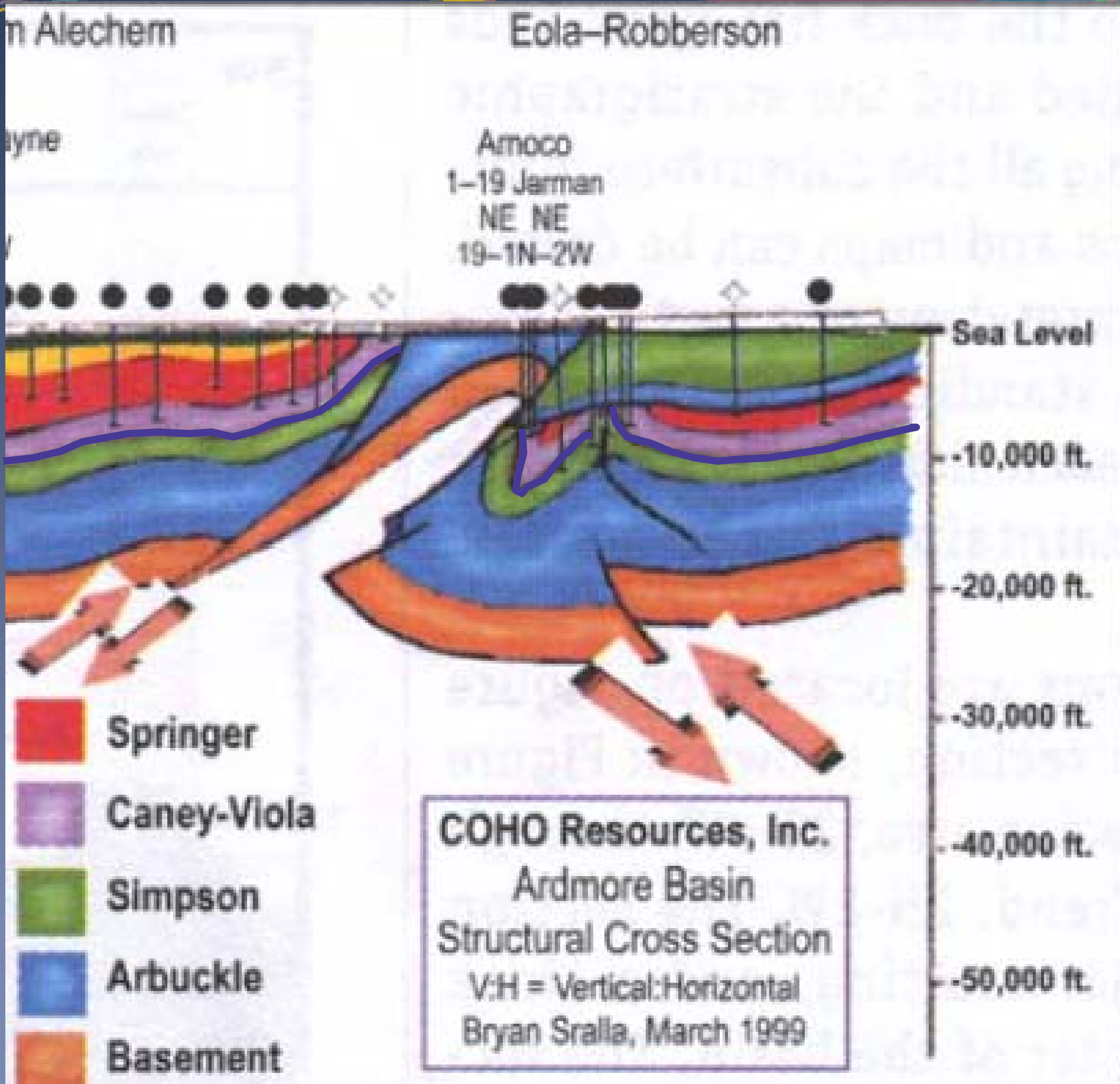
Kendall, OGS Circular 95, p. 236-239, 1993



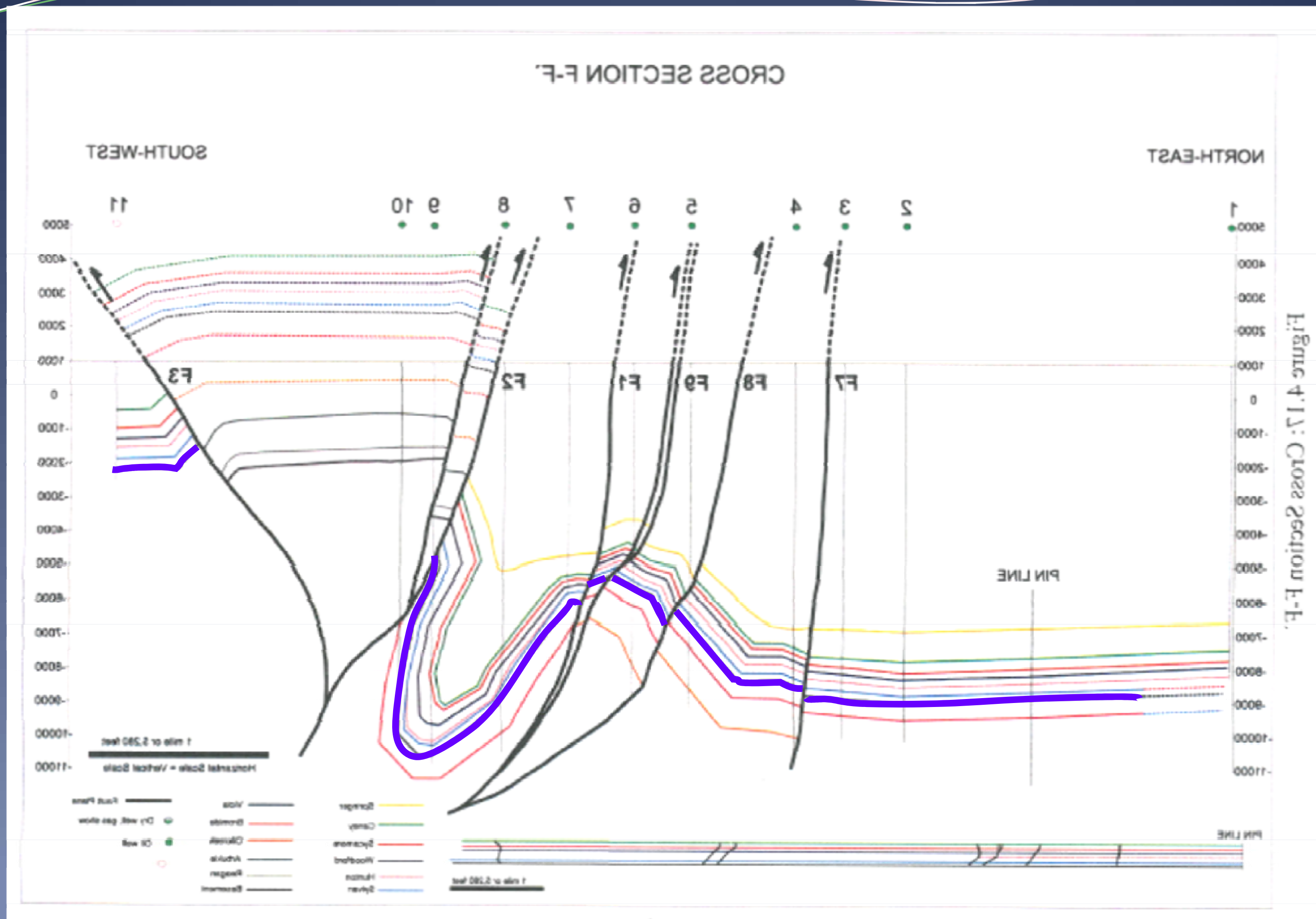
Saxon, OGS Circular 97, p. 280-282, 1995



McCaskill, University of Oklahoma M.S. Thesis, 68 pp., 1997

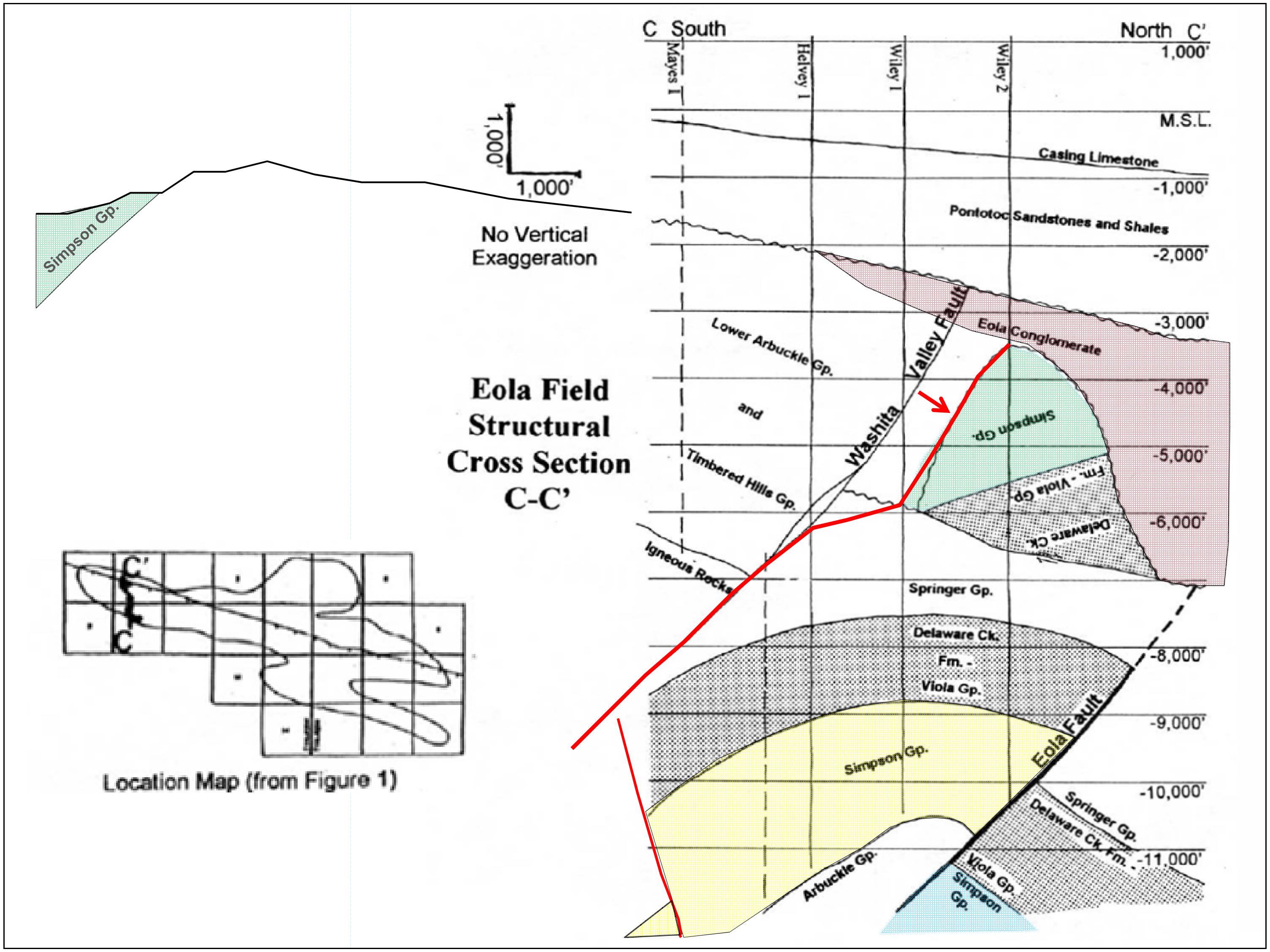


Allen, OCGS Shale Shaker, p. 11-21, Jul-Dec 2000



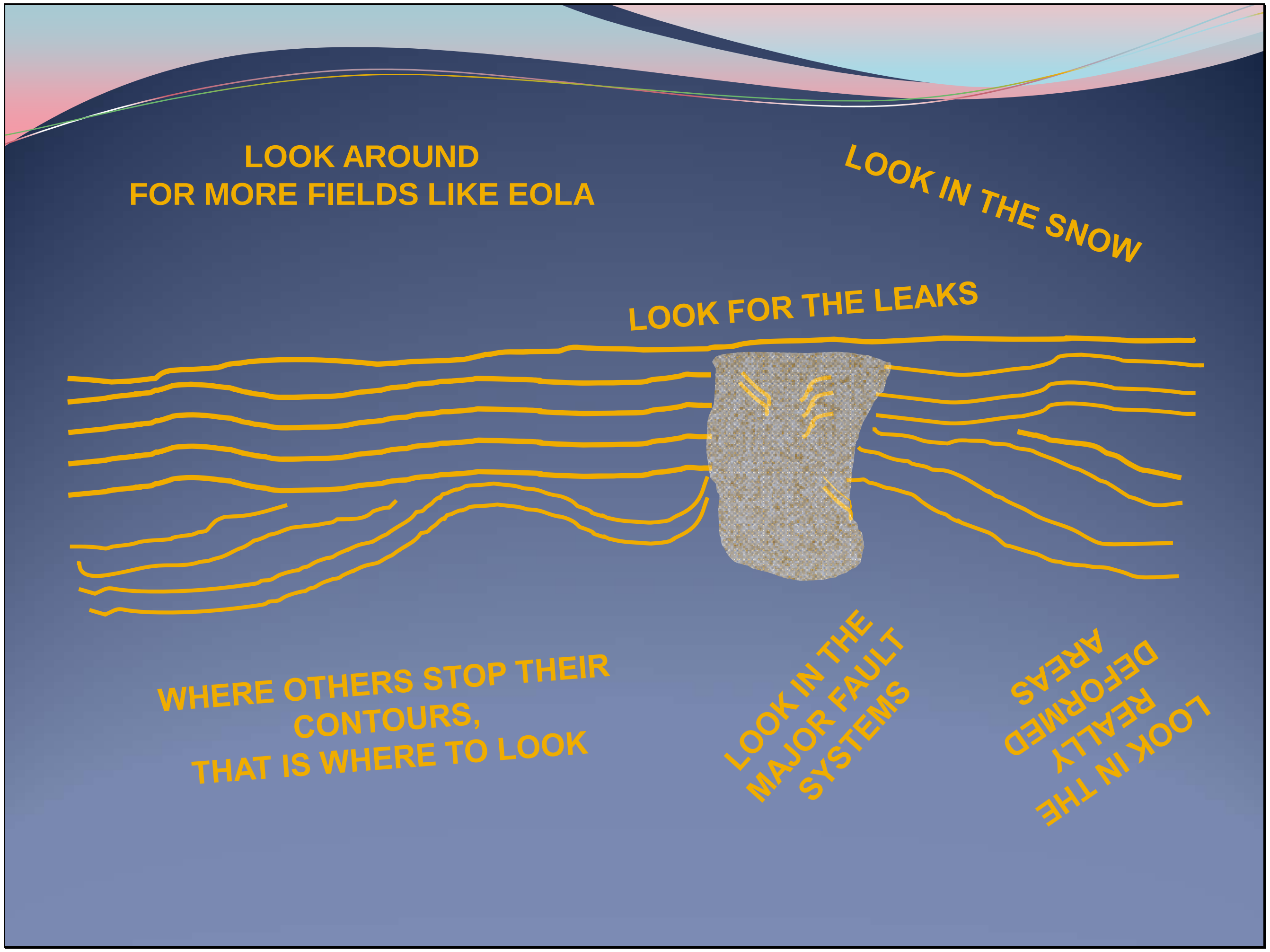
Kilic, University of Tulsa M.S. Thesis, 143 pp., 2013 – Rotated to north on right

Presenter's notes: This illustration is reversed to keep North on the right side of the cross section.



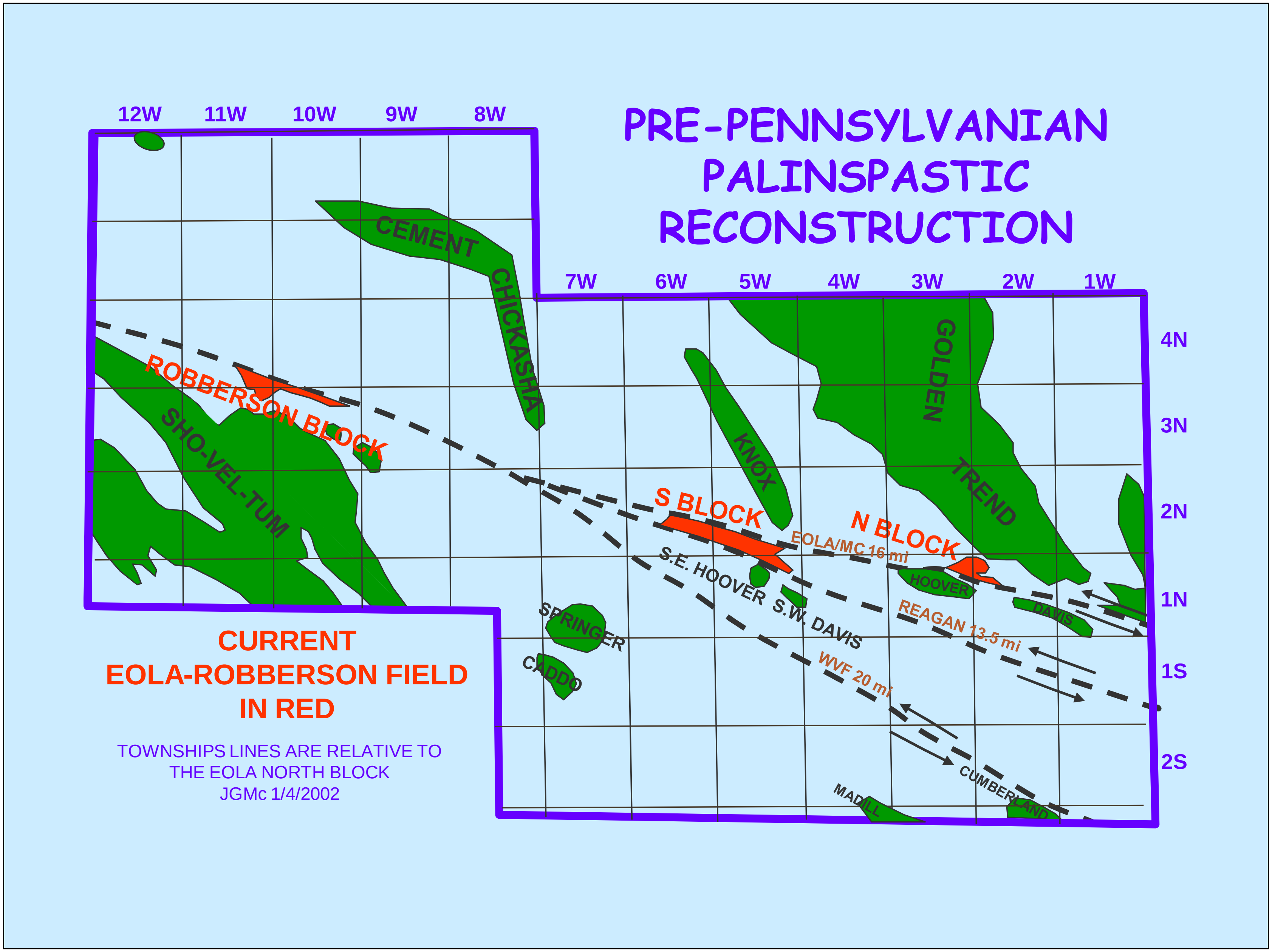
Presenter's notes: Some of the cross sections are from my 1997 OU M.S. Thesis. Since then, here are some of the changes in my thinking:

- The south edge of the Eola Klippe seems to be a fault contact in most cases, instead of an erosional contact, based on image logs.
- The Washita Valley Fault is not as planar as would be expected, but where control is dense, it shows some folding or fault displacement.
- The Eola Fault is not quite as low of an angle as shown on this cross section, close to 65° in most areas.
- Several new faults and fault blocks have been found with additional drilling; the fault in the lower left of the cross section has around 2000ft of apparent reverse displacement that was encountered in a new well (in 2014).

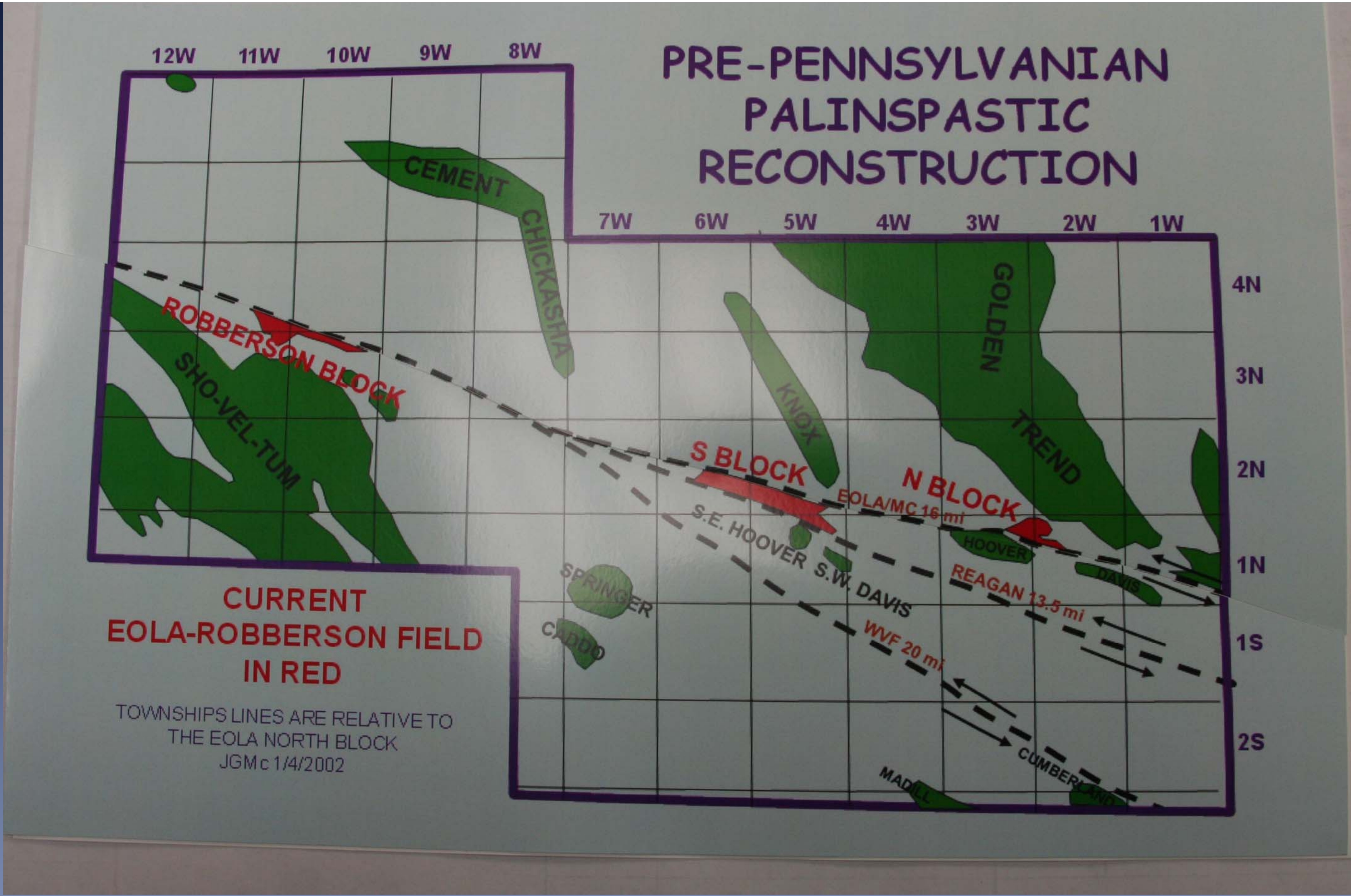


Presenter's notes: Although I have not discovered as yet another field like Eola, that doesn't prevent me from giving advice on how to do it, based on what I have seen:

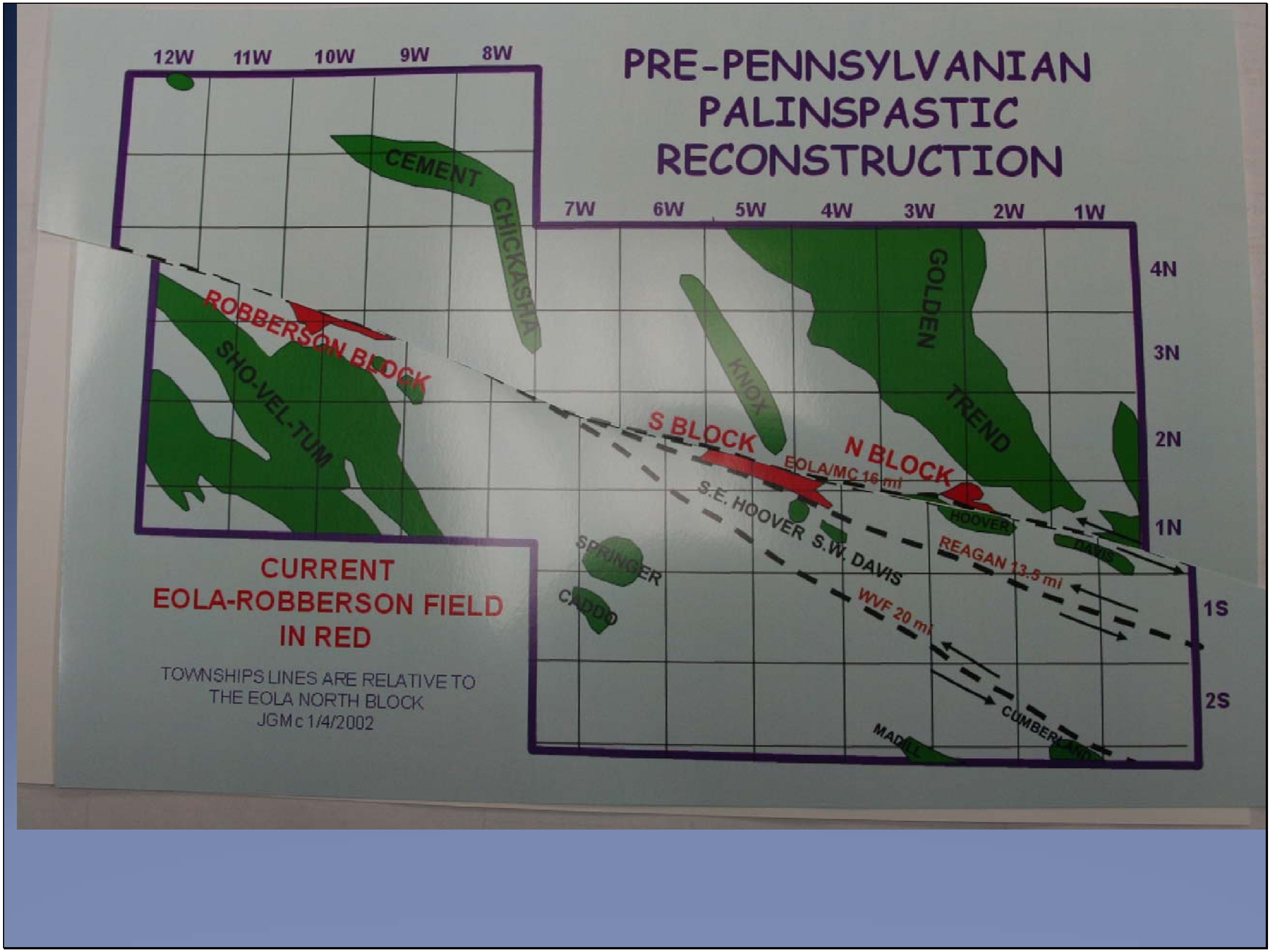
- Look in the intensely deformed areas, places with overturned beds and lots of repeated section, places that are hard to figure out.
- Look for areas with major fault system interactions; it takes big faults to make big structures.
- Look in the snow; this is a cartoon of what I have seen on the seismic lines at Eola, beautiful reflectors in the basin to the south, beautiful reflectors in the basin to the north, and near lack of discernible reflectors over the productive portion of the field. At least 2 notable wells have been based drilled in the complex areas on the flanks of Eola using 3-D seismic; the first was nearly 2000ft low to prognosis and the second is more than 10,000ft low to the drilling prognosis.
- Look for the leaks; the Permian rocks that produce at Robberson don't produce in any of the abundant stratigraphic pinchouts in the Anadarko Basin, but nearly all of them have accumulations updip of the major faults in the Eola field.



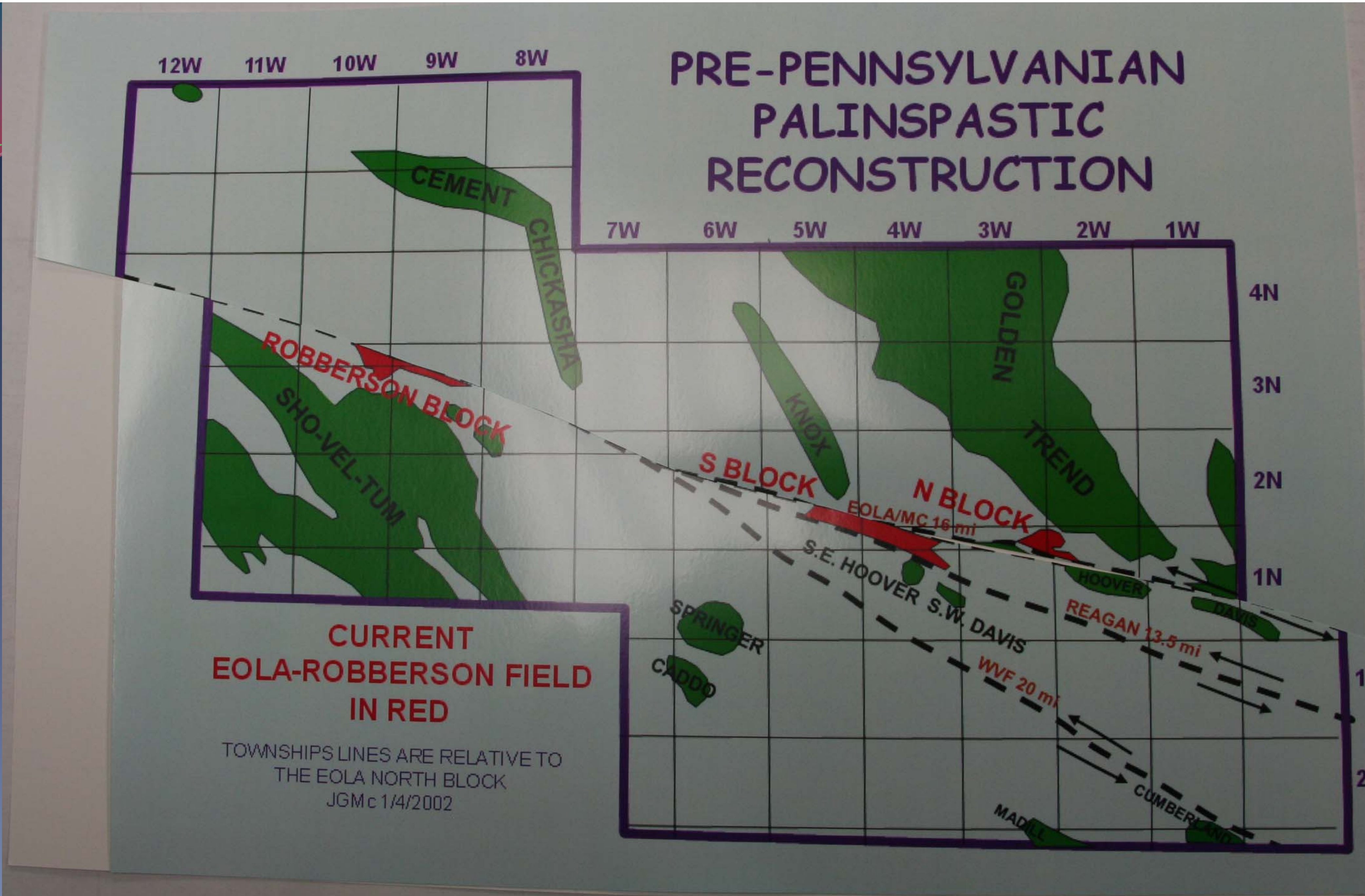
Presenter's notes: In looking at the Simpson stratigraphy, it is important to realize how far apart the rocks in the main blocks were deposited. This shows the Robberson Block, South Block and North Block rocks in their relative depositional locations with the land grid pinned to the North Block. I shall show an animation of how the blocks moved to their current position.



LOCATION AT TIME OF DEPOSITION



Presenter's notes: Although the Eola Fault shows large amounts of displacement, it does not appear to displace some of the major structures associated with the Washita Valley Fault; so I have placed early movement along the Eola Fault and later movement along the Washita Valley and Reagan faults.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SHO-VEL-TUM
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S.E. HOOVER S.W. DAVIS
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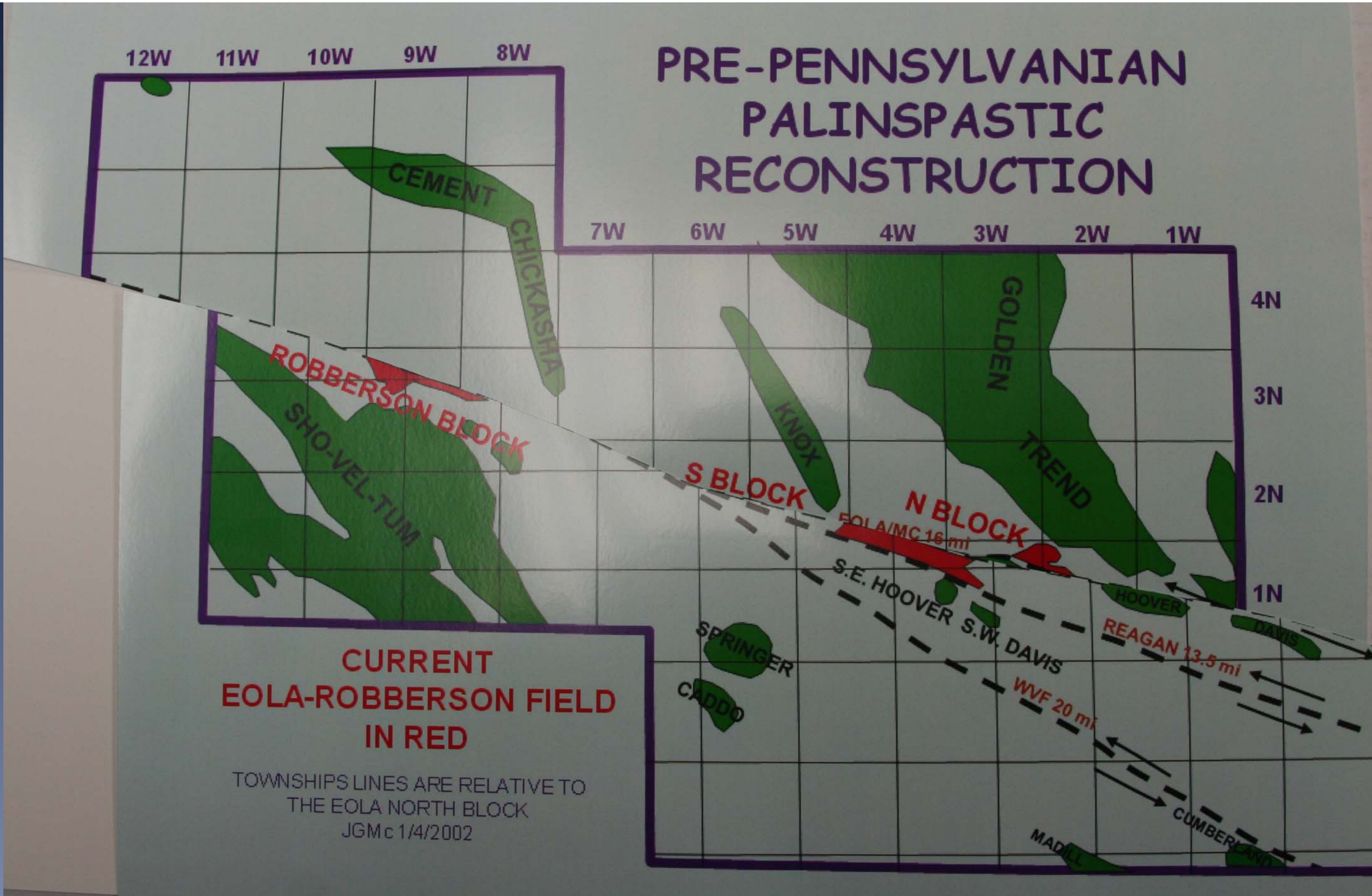
REAGAN 13.5 mi
WVF 20 mi
SPRINGER
CADDO
CUMBERLAND
MADILL
CURRENT
EOLA-ROBBERSON FIELD
IN RED
TOWNSHIPS LINES ARE RELATIVE TO
THE EOLA NORTH BLOCK
JGMc 1/4/2002



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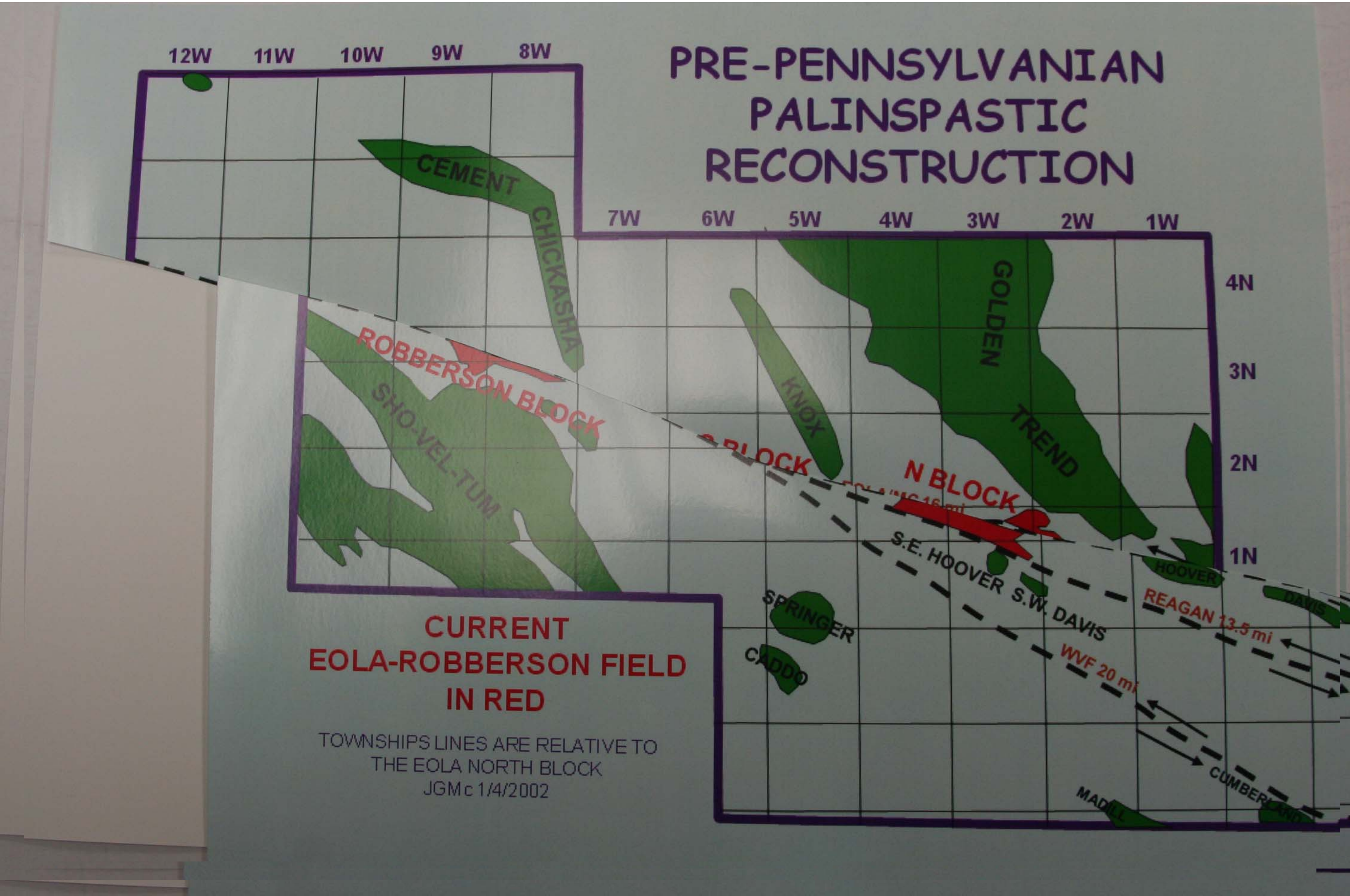
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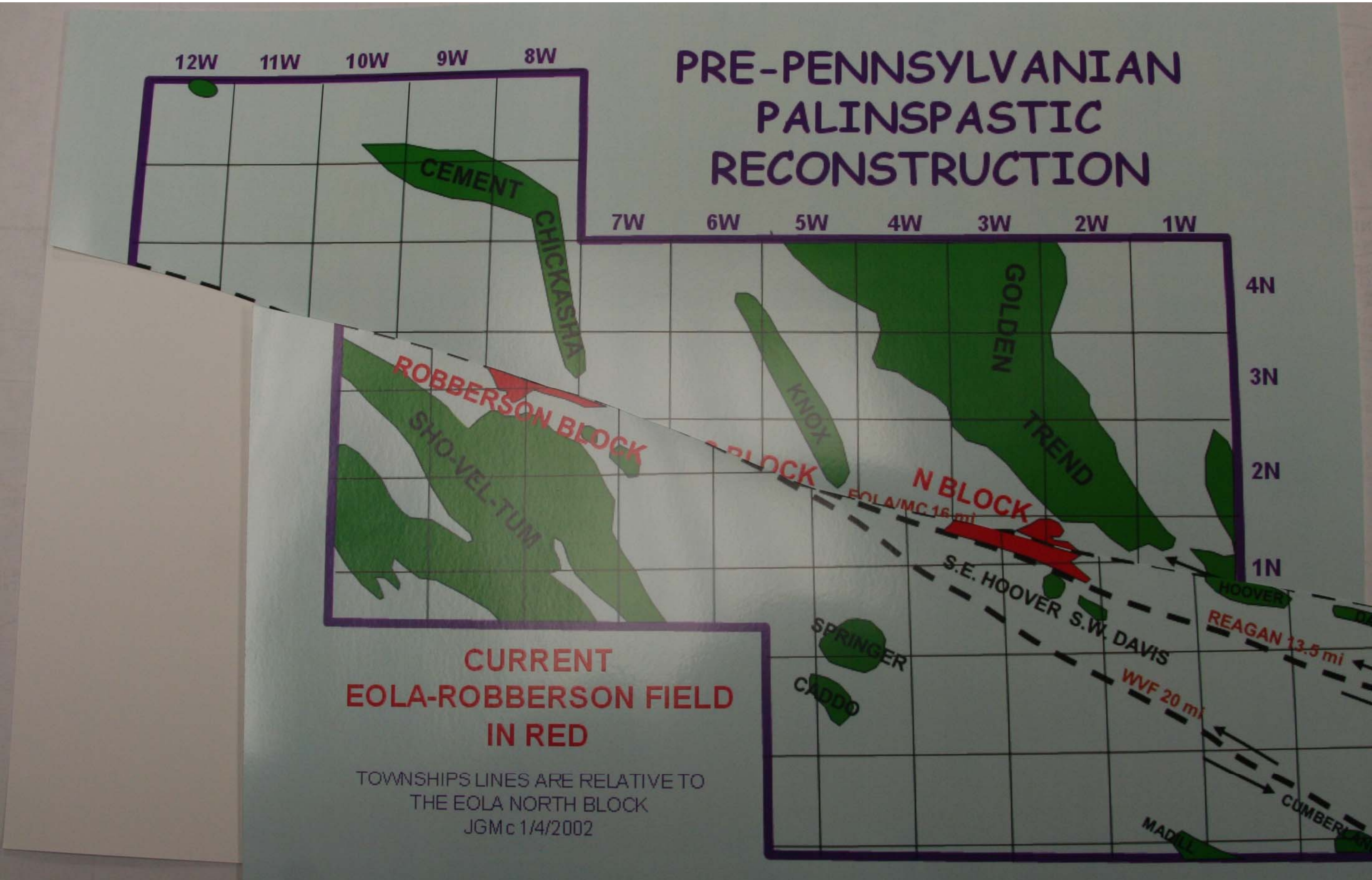

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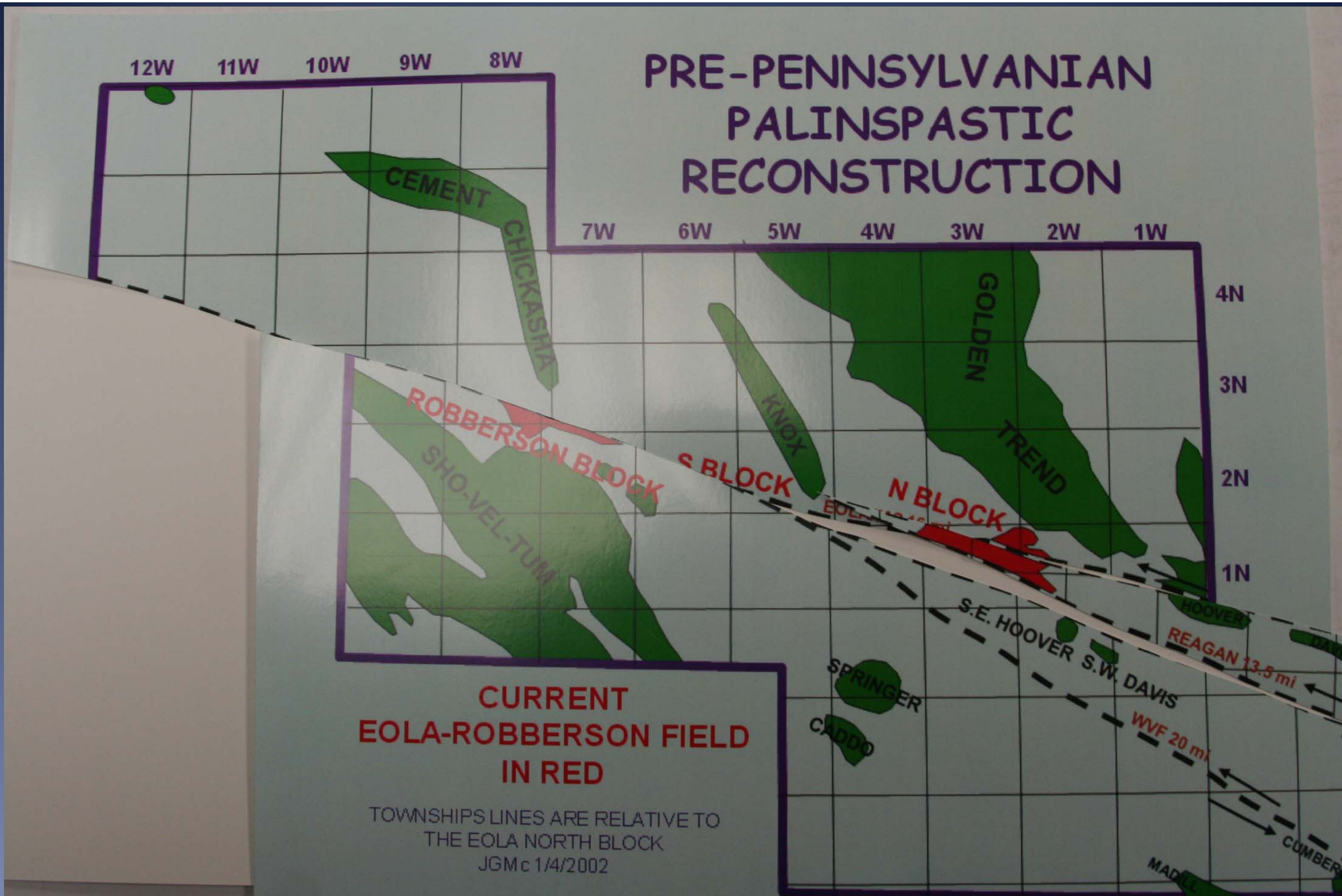

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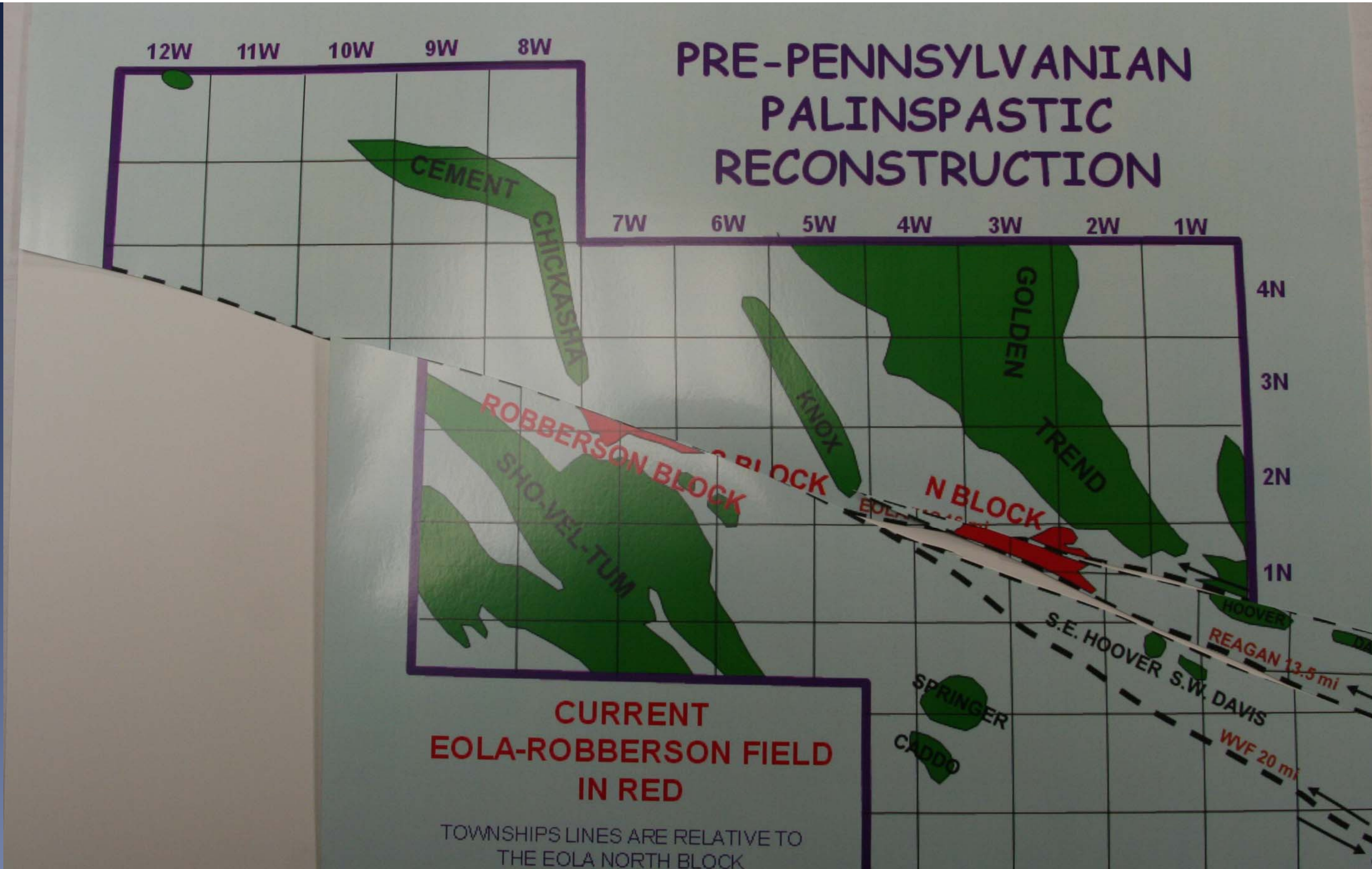
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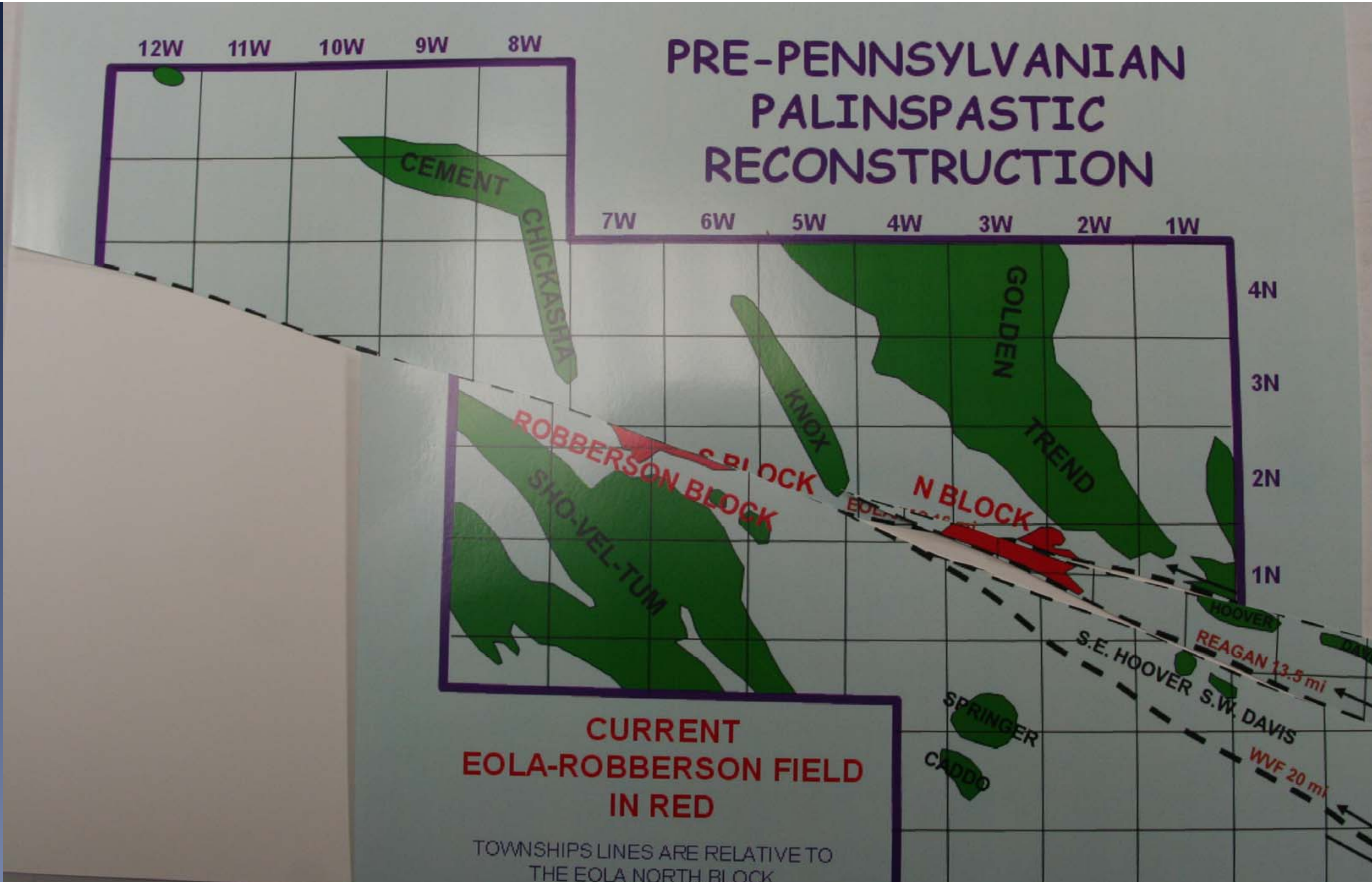

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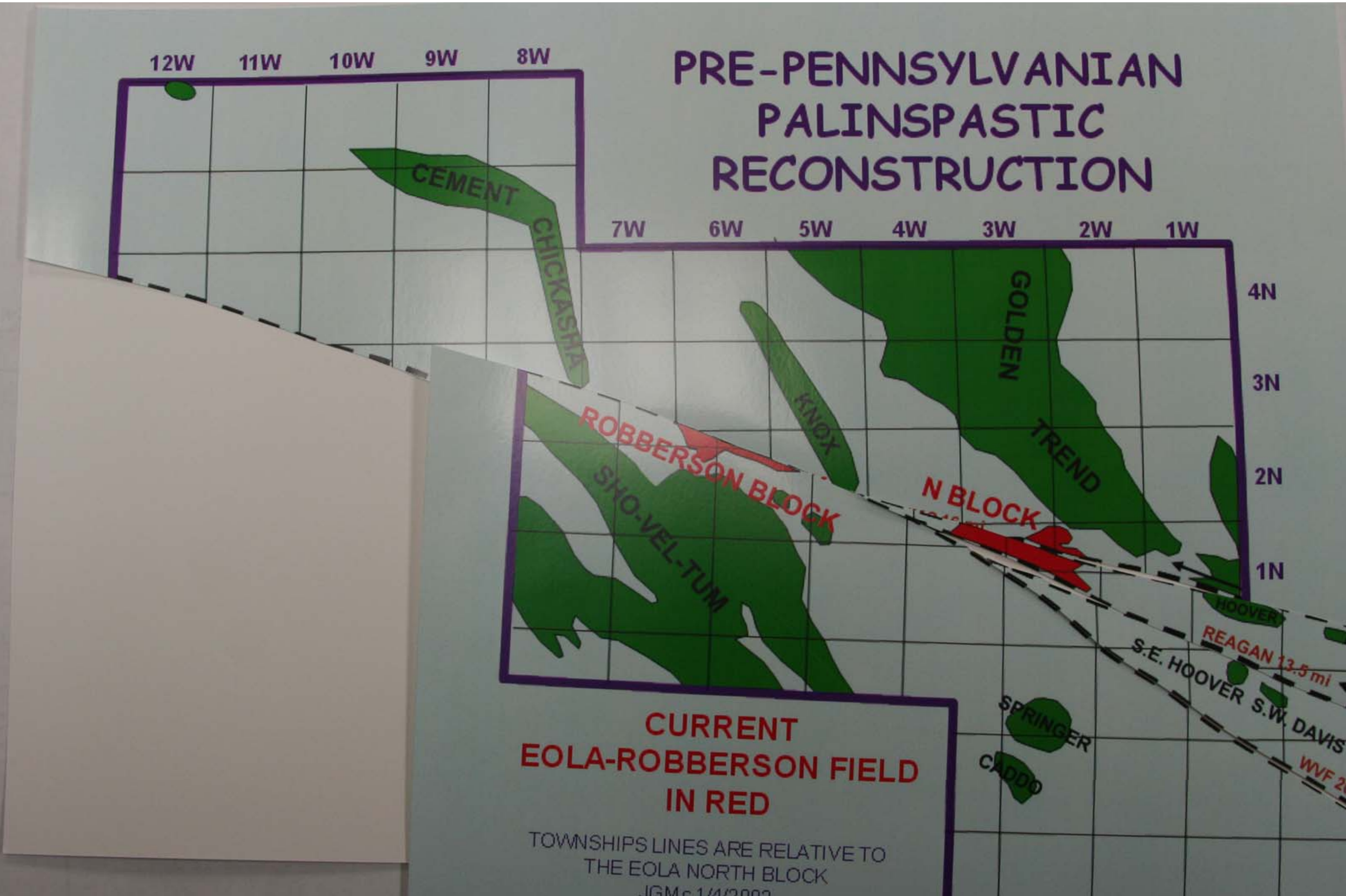

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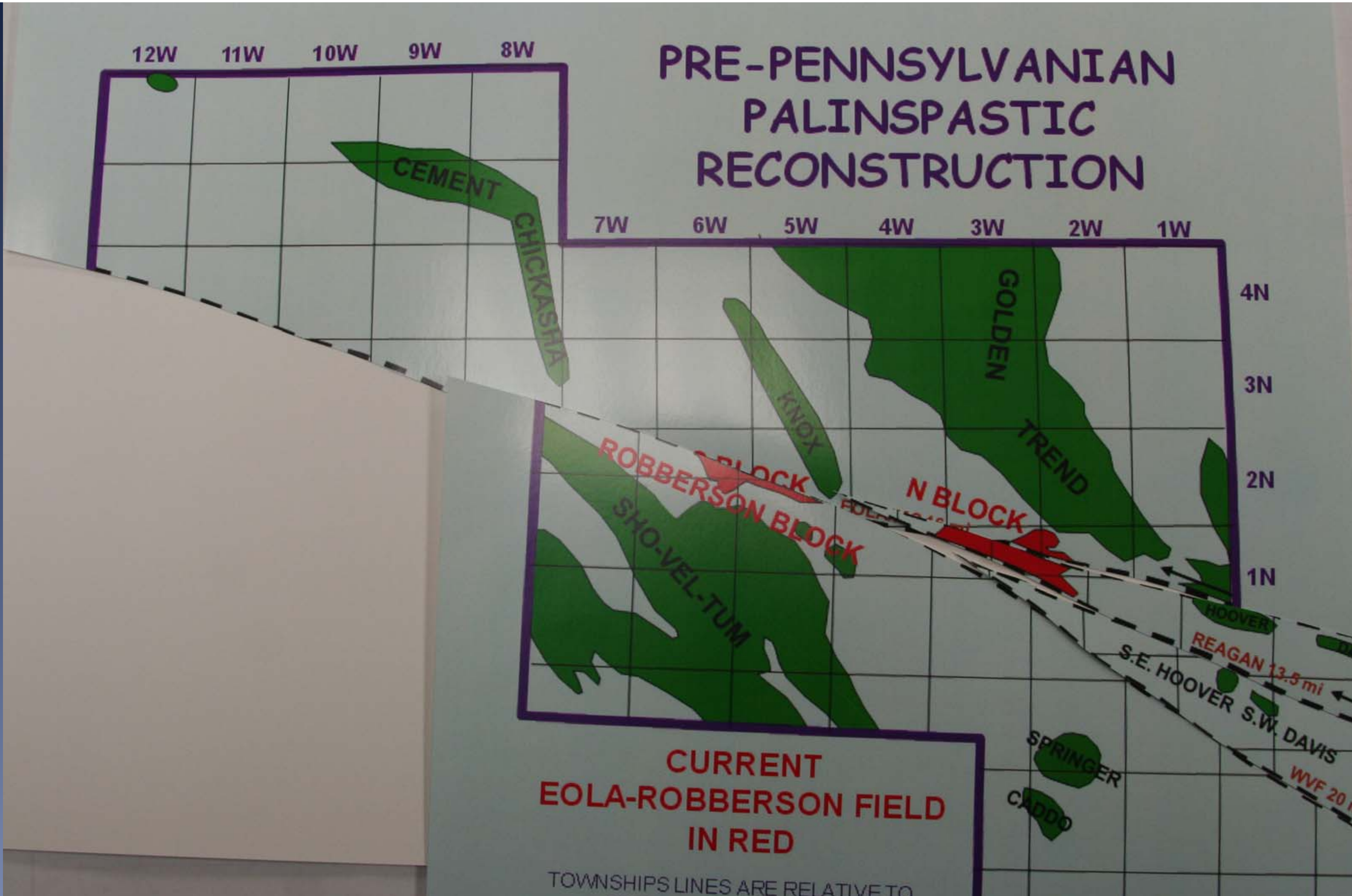
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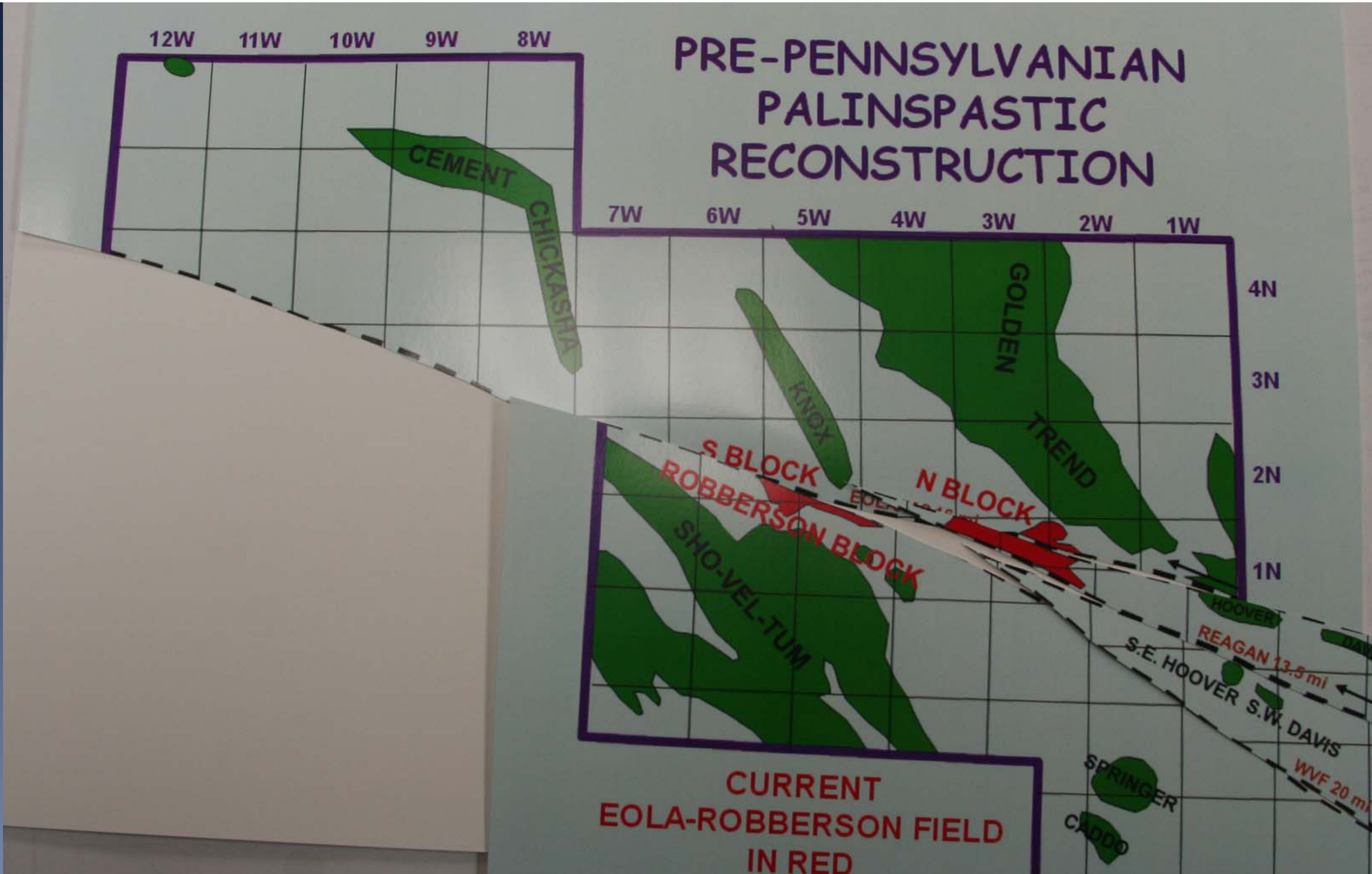
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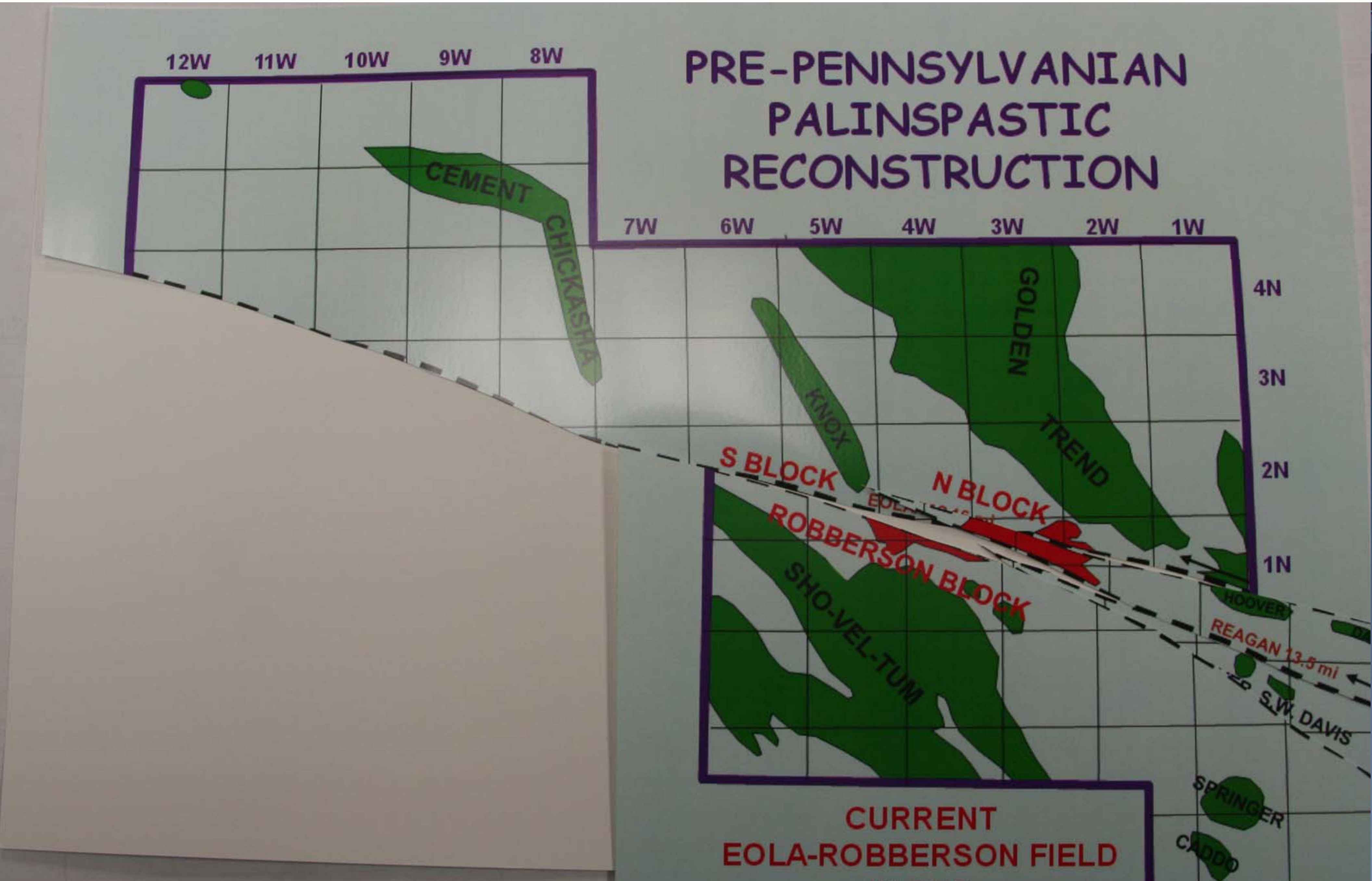
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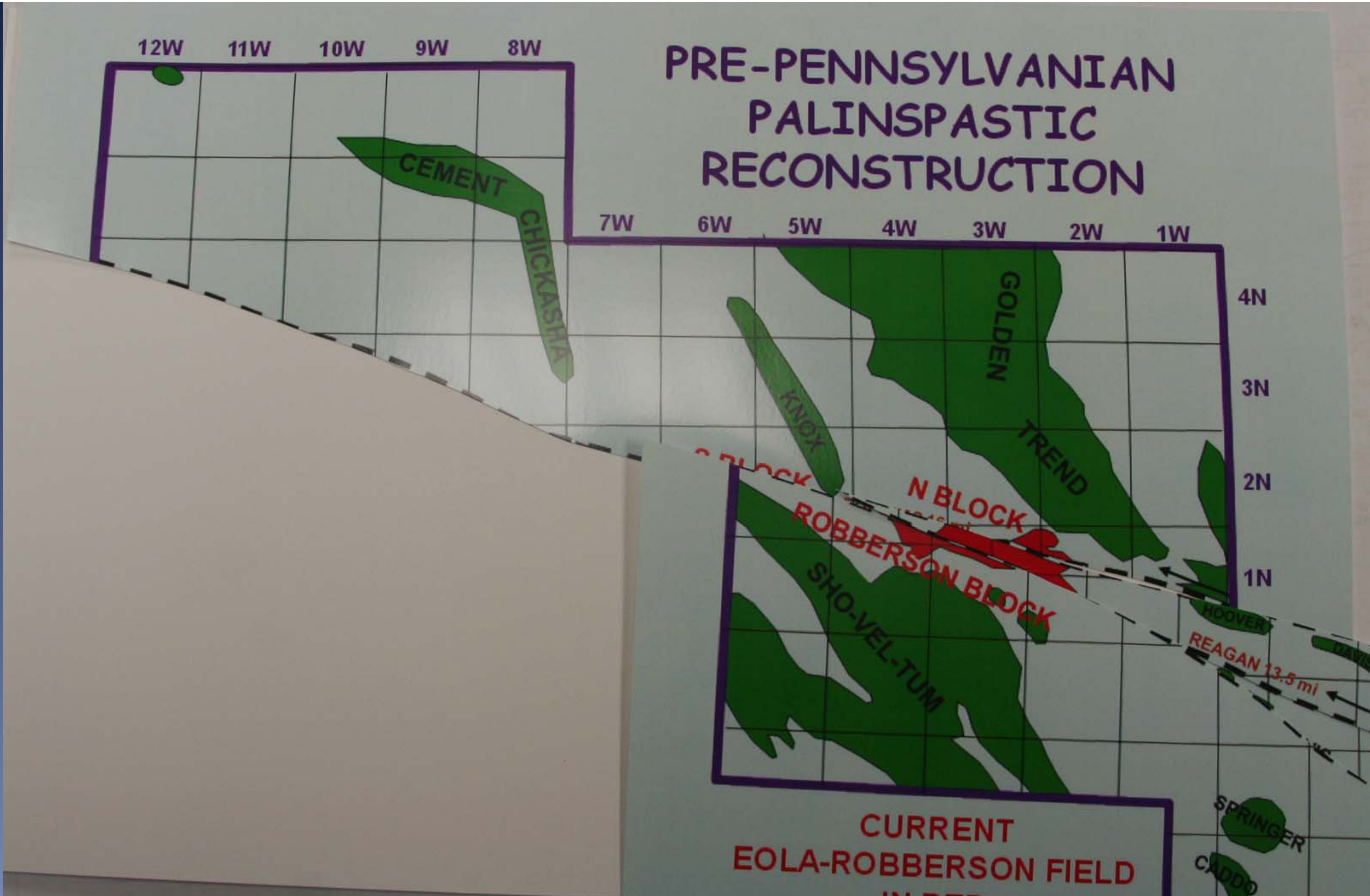
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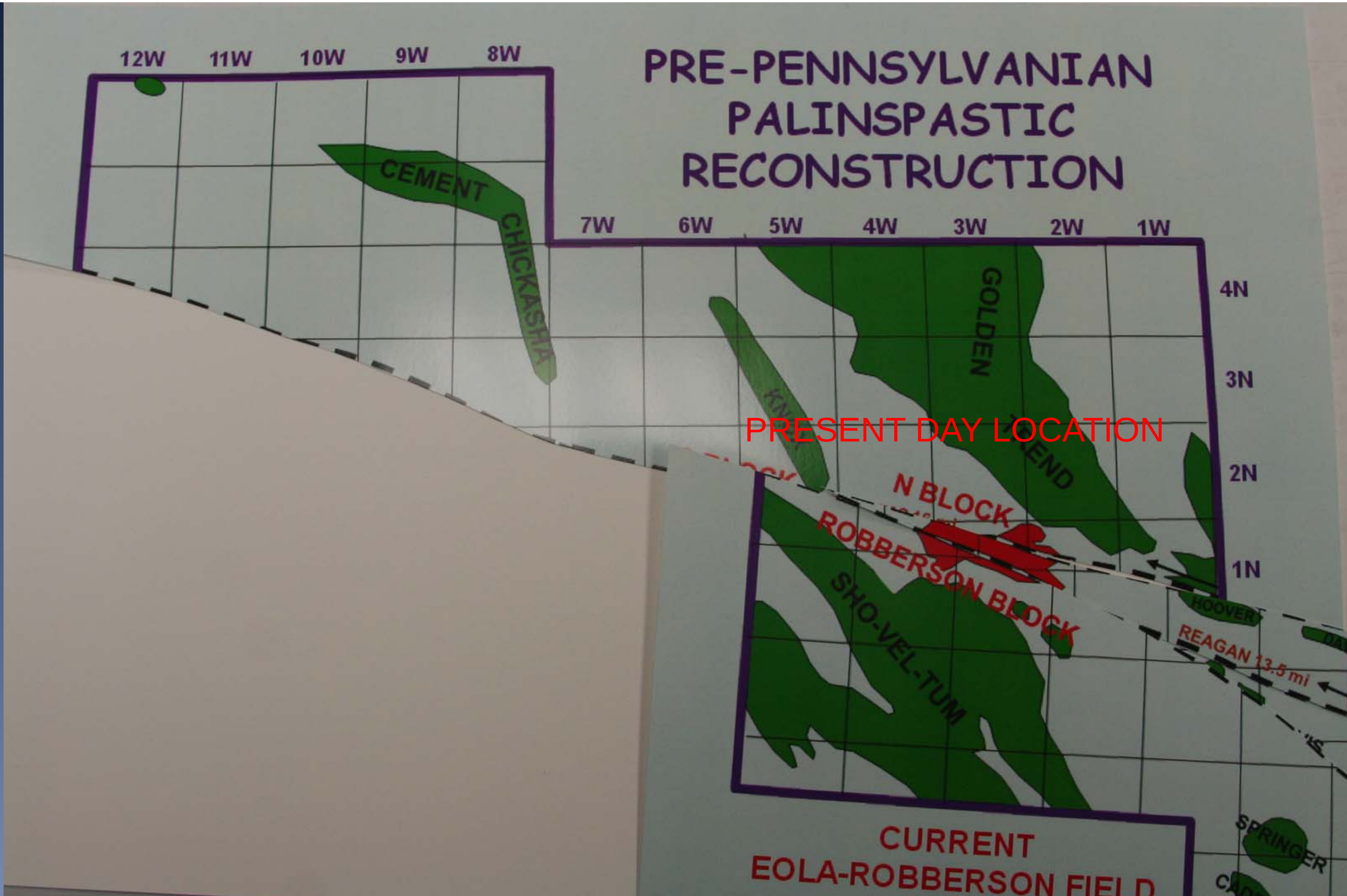

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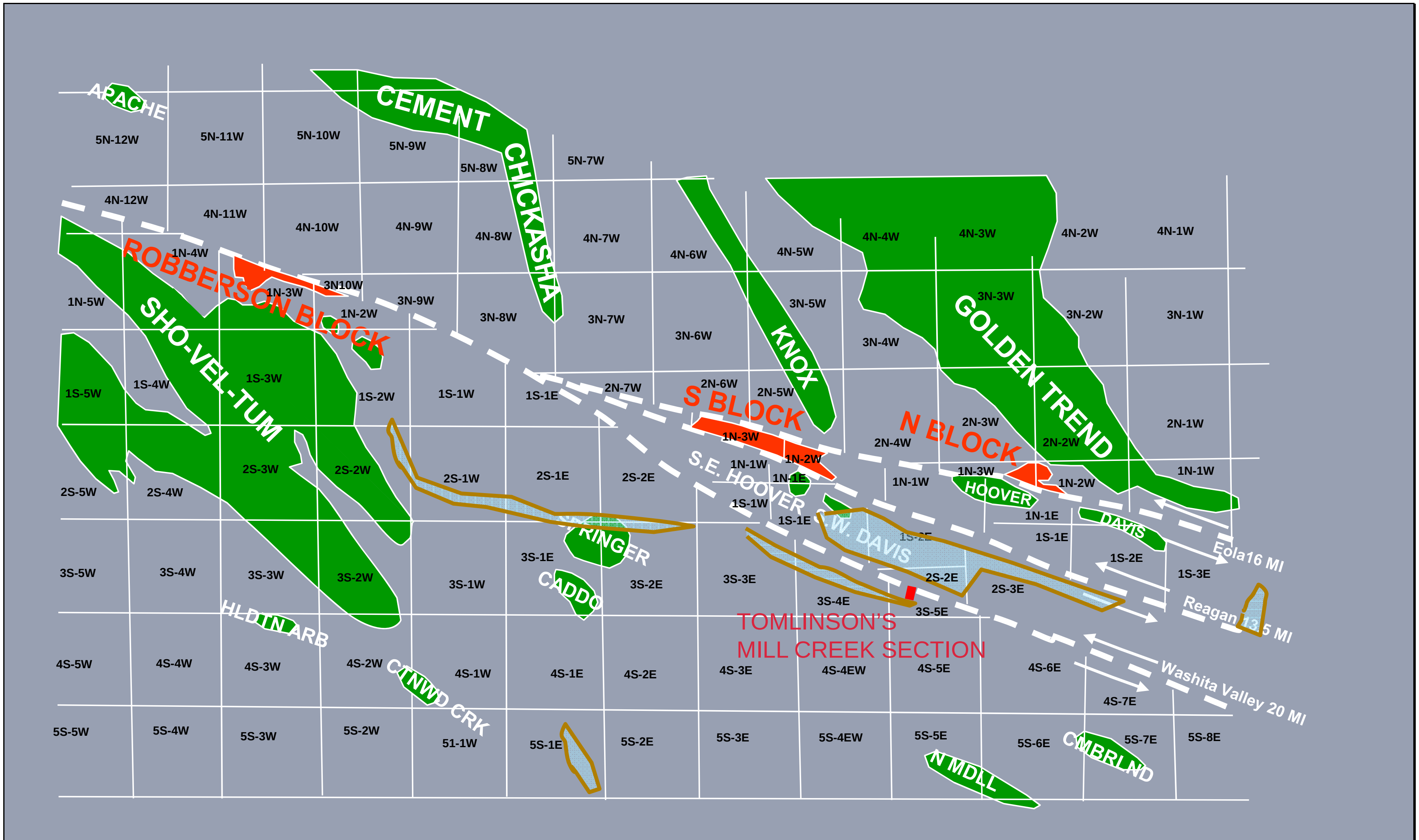
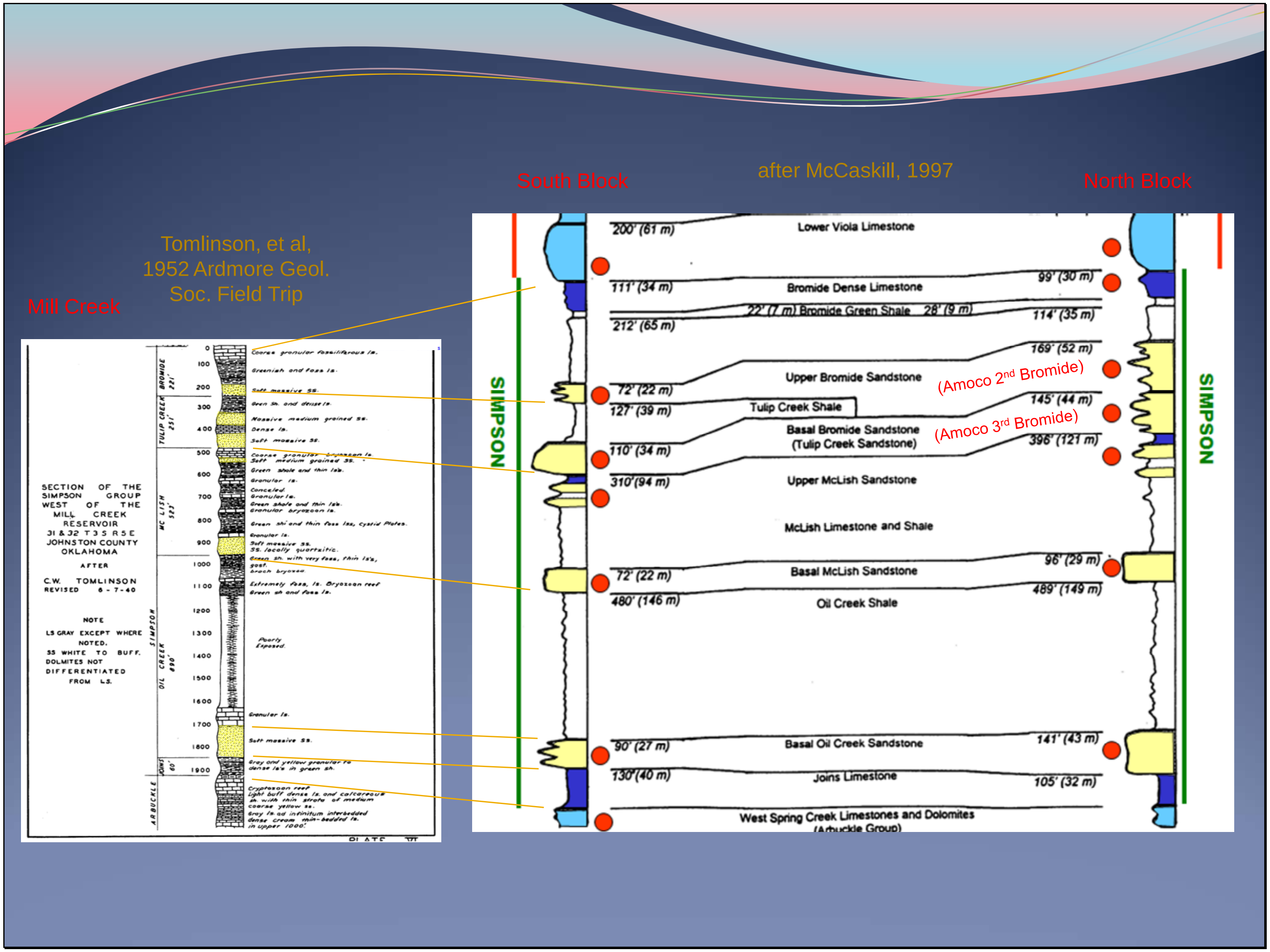
CURRENT
EOLA-ROBBERSON FIELD



Palinspastic Restoration of Southern Oklahoma, Woodford Outcrop in Light Blue,

Presenter's notes: This is a rough palinspastic restoration that has current Township and Range land grid information for each block, along with the present-day Woodford outcrops. In the next slide refer to Tomlinson's Simpson measured section on Mill Creek.

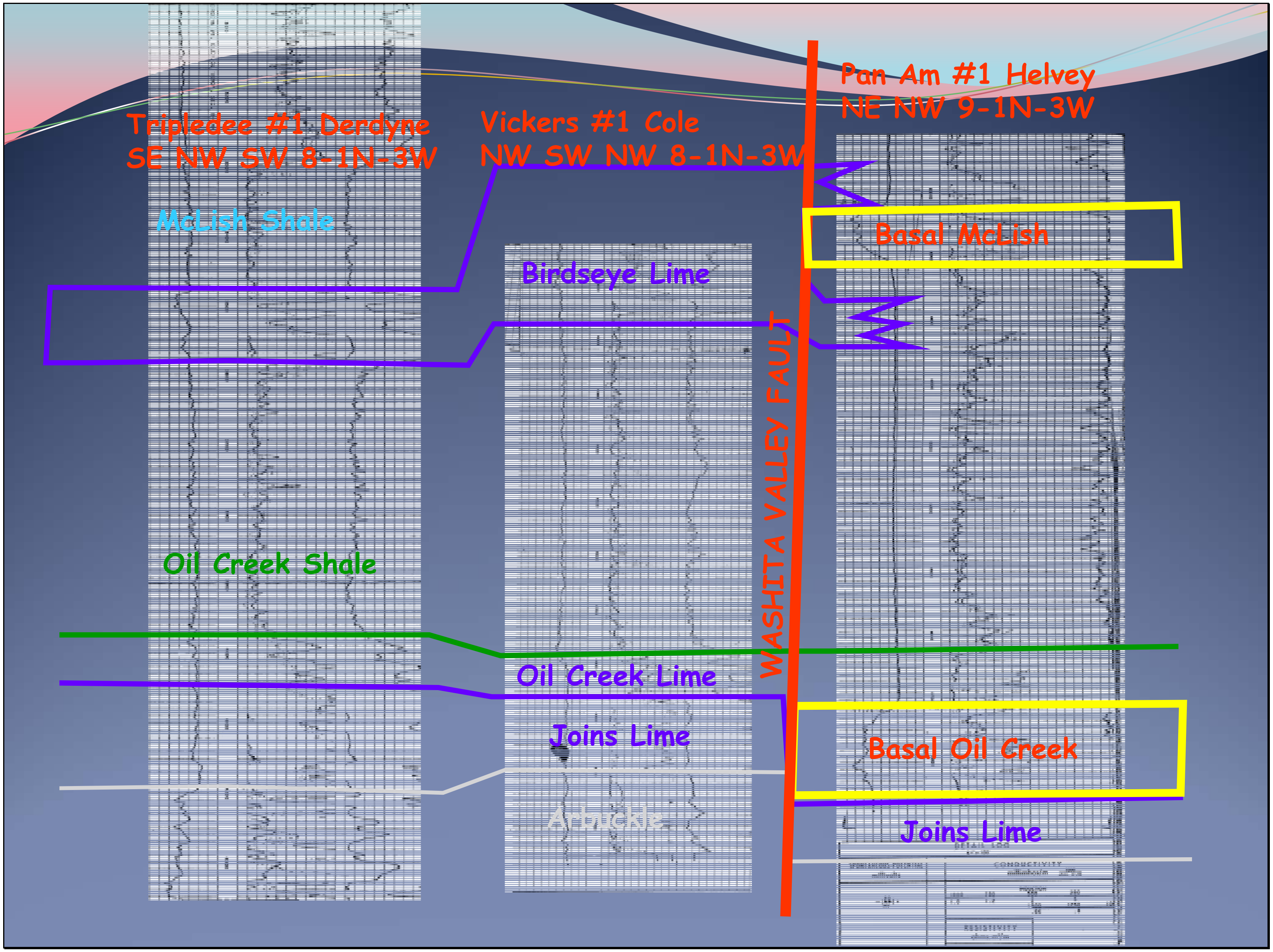


Presenter's notes: Each Formation in the Simpson group, except the Joins, has a basal sandstone in the area of the North and the South Block. The basal sandstone of Tomlinson's Bromide is called at Eola by the Sohio term, "Upper Bromide" or by the Amoco term, "2nd Bromide". The basal sandstone in Tomlinson's Tulip Creek formation is called by the Sohio "Basal Bromide" or by the Amoco "3rd Bromide". I have been using and will be using the Sohio terminology for this talk. At Eola, north of the Washita Valley Fault, all Simpson production is from sandstones, except the Upper McLish in the South Block which grades to a sandy dolomite, and the Bromide Dense in the North Block that has porosity developed in the limestone.

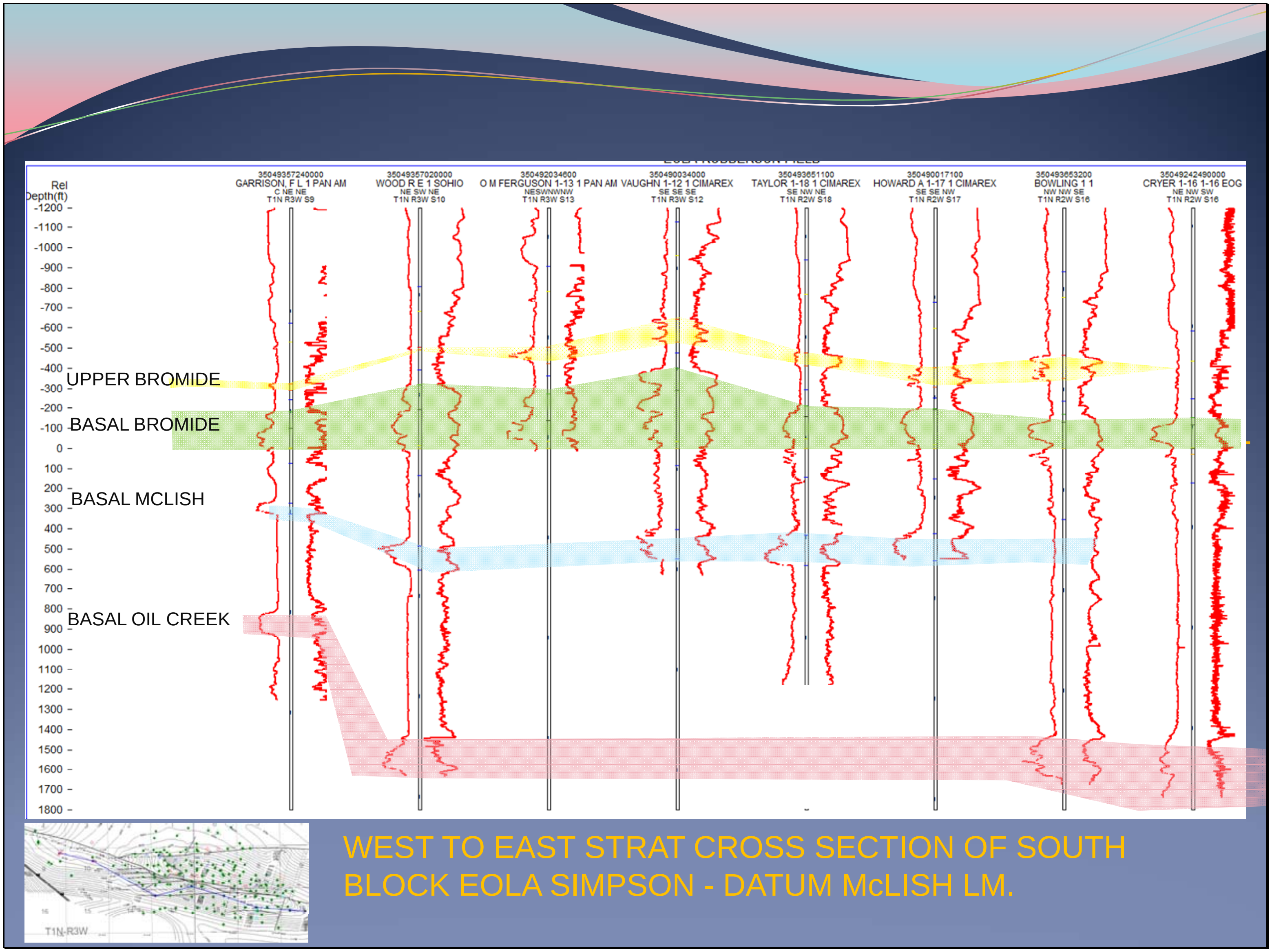
Pan-American # 1 Lynn Wiley, 4-1N-3W , Garvin Co., OK 9,870-80'

Presenter's notes: There are distinct lithology changes at the top of the Simpson group from the dark siliceous limestones and cherts of the lower Viola to the light, low-insoluble-residue limestone of the Bromide Dense.

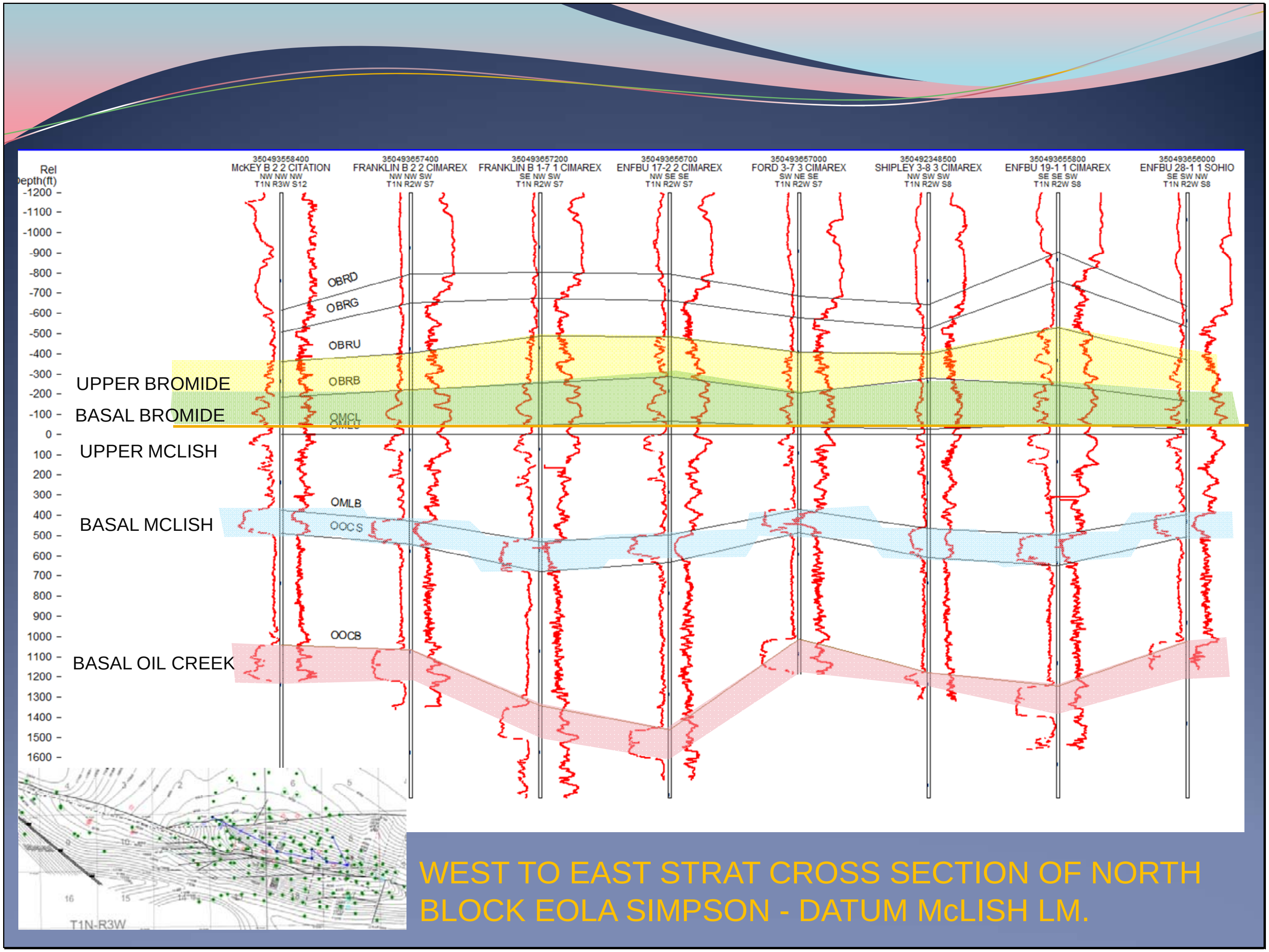
Presenter's notes: Likewise, at the base of the Simpson, the Joins has a mottled fossiliferous appearance typical for most Simpson limestones contrasted with the uniform texture and color of the Arbuckle Group.



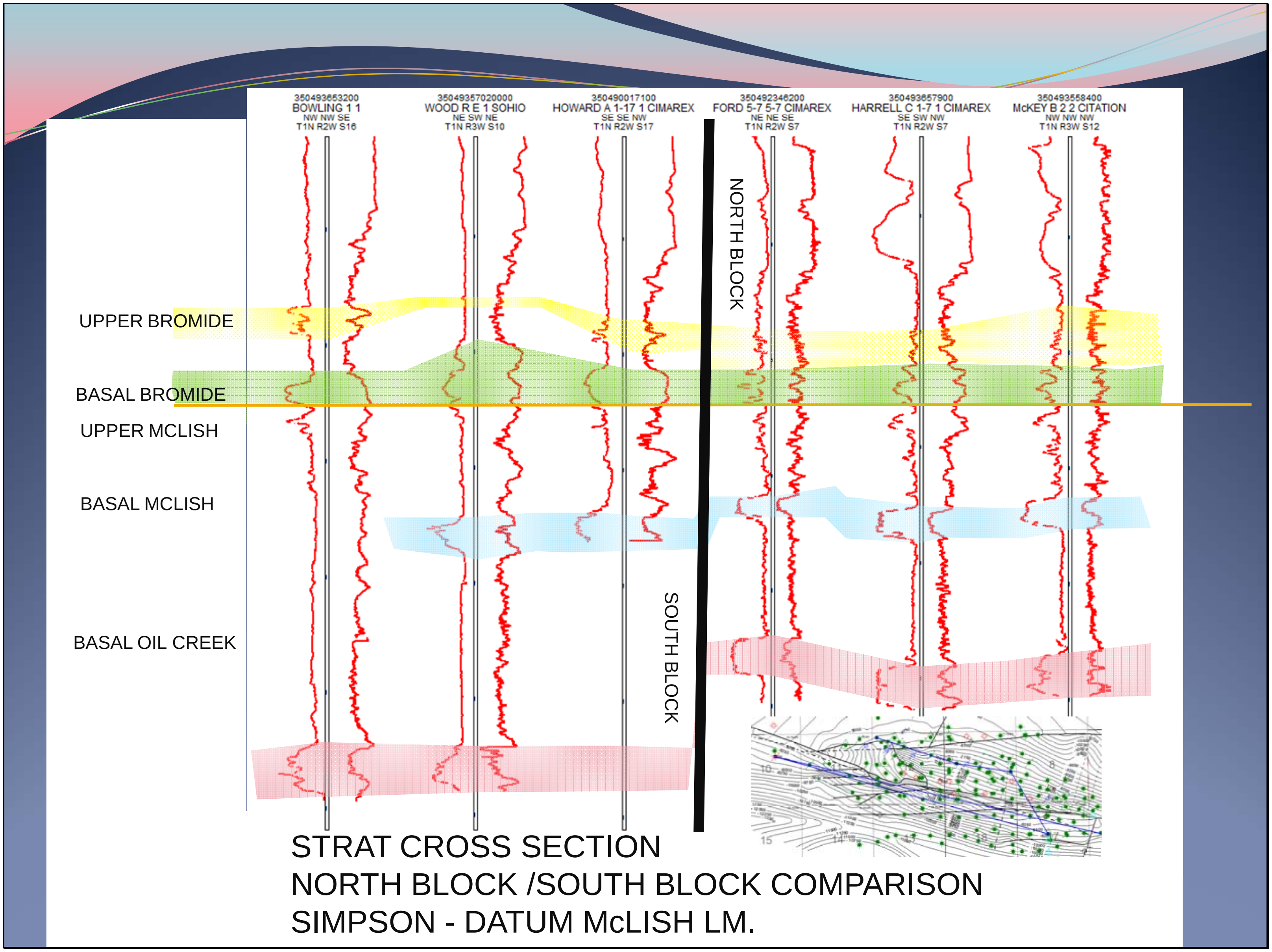
Presenter's notes: In the Robberson Block, only the Bromide Sandstone is developed with the Basal McLish and Basal Oil Creek sandstones being absent. The Bromide sand is present and appears to have decent porosity (not shown on these logs), but has not been productive to date. There is a limestone developed above and below the interval that correlates with the absent Basal McLish that is called the Bird's-eye Limestone. The Bird's eye has been productive in a few wells in the Robberson Block, as well as in the Ardmore Basin.



Presenter’s notes: I shall show a series of cross sections illustrating the character of the Simpson sands in the North Block and the South Block. This section extends from the west to the east across the length of the productive South Block at Eola. Changes in thickness and missing sands are due to folding and faulting, not stratigraphic changes. In the South Block the Basal Oil Creek and Basal McLish are both well developed but commonly show a serrated SP indicative of permeability variations which are also very apparent on the microlog. The Upper McLish Sandstone is often poorly developed and is a sandy dolomite in some productive wells. The Basal Bromide is massive with an extra bench of porous sandstone developing toward the west. The Upper Bromide is separated from the Basal Bromide by a thick, green Tulip Creek Shale.



Presenter's notes: This cross section extends across the North Block in the area of the North Fault Block Unit and NW Fault Block Unit. In the North Block, the Basal Oil Creek and Basal McLish are both very blocky, indicating nearly continuous permeability. The Upper McLish sandstones are well developed in most of the wells and the Basal Bromide has several porosity/permeability lobes. The Upper Bromide sandstone rests directly on the Basal Bromide sandstone without any intervening Tulip Creek Shale.



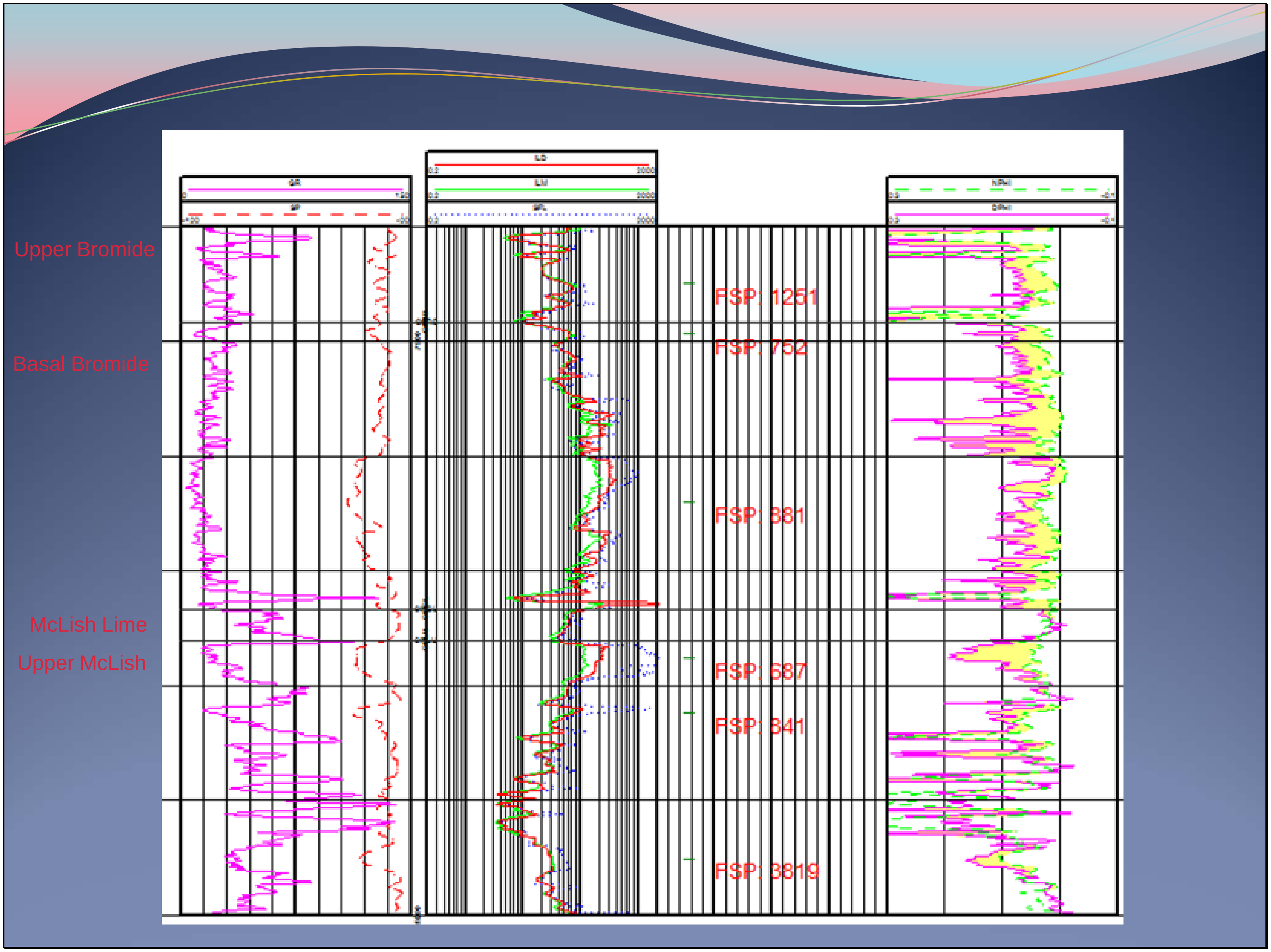
Presenter's notes: This cross section splices wells from the previous two cross sections to contrast the North Block and South Block rocks:

- Basal Oil Creek and Basal McLish are more blocky in the North Block, more serrate in the South Block.
- Basal Bromide is more massive in the South Block and more lobed in the North Block.
- A thick Tulip Creek shale separates the Upper and Basal Bromide in the South Block, but it is absent in the North Block.

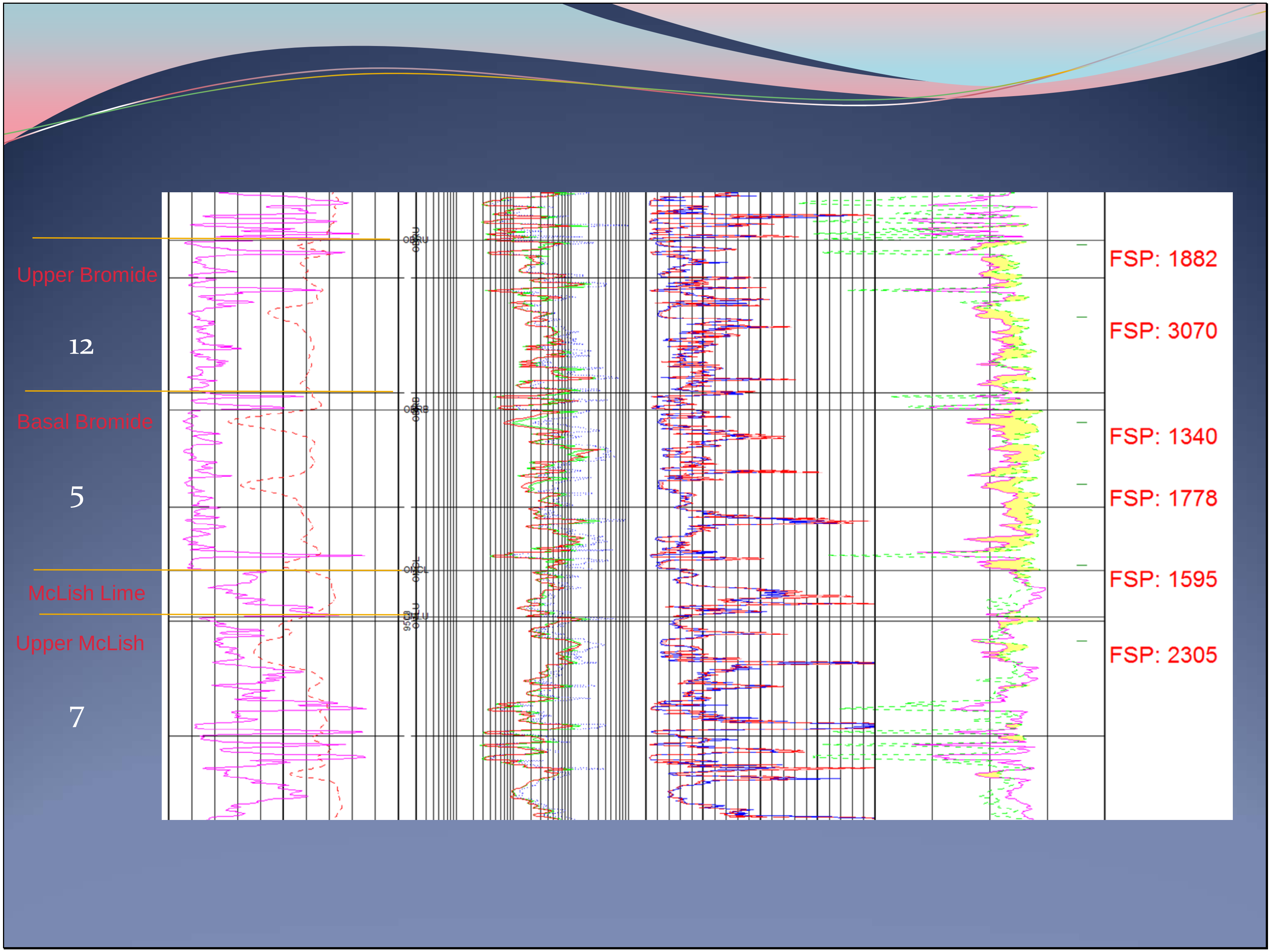
MULTI-SET PRESSURE TEST DATA SUMMARY

Set	Depth	TVD	Hydrostatic Pressure		Formation Pressure		Buildup Time(Min)	Remarks	
			Before	After	Initial Draw Down	Final Buildup			
1	8122		4130		483	1453	1	12CC	Upper McLish
2	8082		4092		241	1498	8.5	10CC	Upper McLish
3	7995		4040		914	3240	3.5	17CC	Upper McLish
4A	7953		4022		760	1533	2.5	10CC	Upper McLish
4B	7953		4022		1165	1556	5.5	PLUS 8CC MORE	Upper McLish
5	7934		4013		285	1532	5	14CC	Upper McLish
6	7912		4002		386	1533	3	10CC	Upper McLish
7	7876		3985		374	1537	8.5	10CC	Upper McLish
8	7809		3951		954	1336	2	14CC	Basal Bromide
9	7797		3947		245		2.5	10CC MOVED DOWN 2FT	
10	7799		3946		987	1278	3	12CC	Basal Bromide
11	7766		3929		471	1027	3	8CC	Basal Bromide
12	7719		3904		236		2.5	9CC MOVED DOWN 2FT	
13	7721		3902		264		8.5	9CC MOVED UP 10FT	
14	7711		3894		672	1007	5	10CC	Upper Bromide
15	7635		3857		308	476	8.5	9CC	Upper Bromide
16	7601		3840		300	484	5.5	10CC	Upper Bromide
17A	7430		3758		293			8CC POSS PAD LEAK	Upper Bromide
17B	7430		3758		285	476	5	PLUS 4CC MORE	Upper Bromide
18	7019		3568		288	298	4	8CC	Upper Bromide

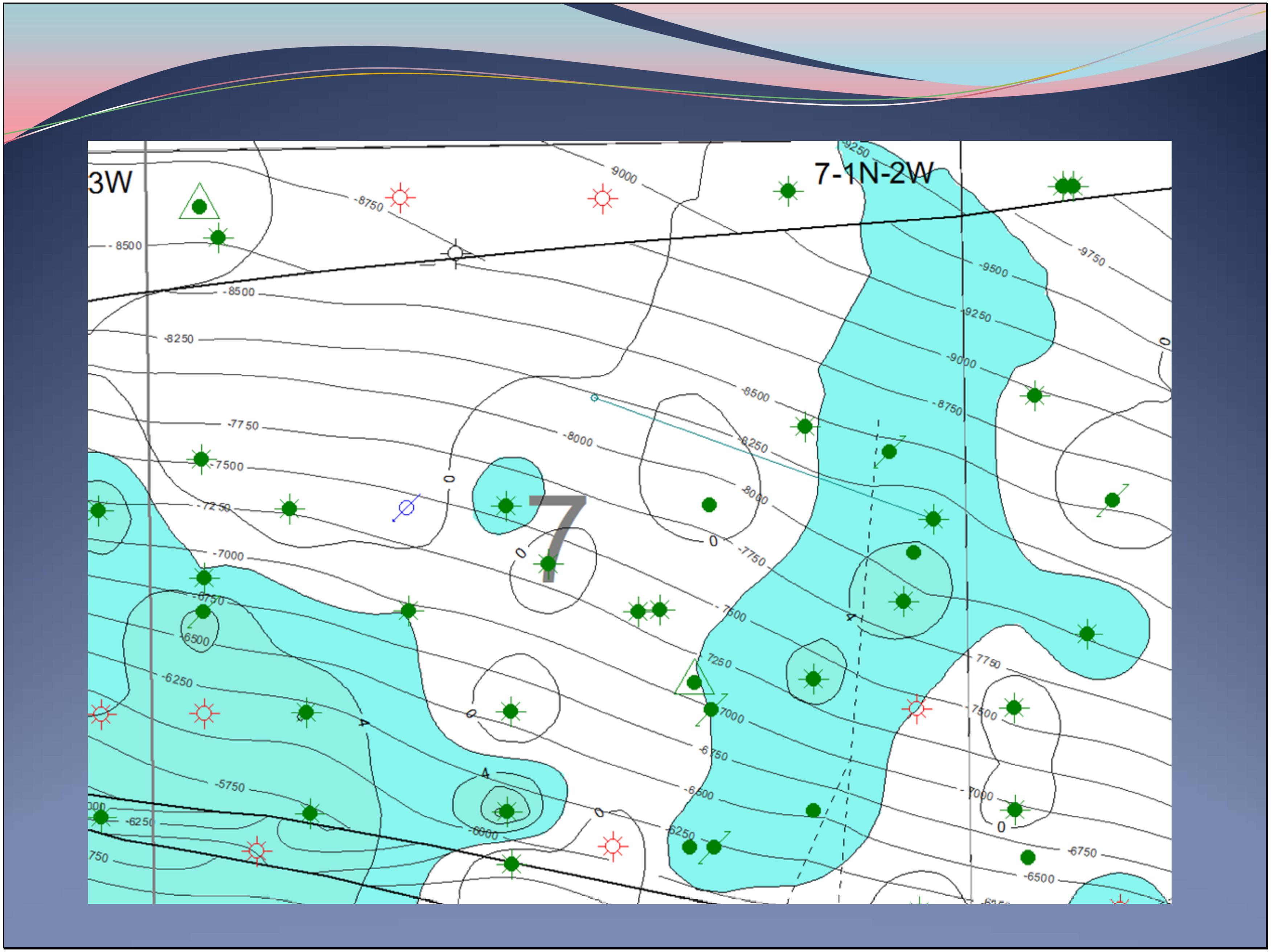
Presenter's notes: The Basal Bromide was waterflooded in the South Eola Fault Block starting in 1956 (SEBSU), and Bromide, McLish and Oil Creek were flooded in the Eola Northwest Fault Block in 1960 (NWFBU) and in the Eola North Fault Block in 1966 (ENFBU). In the next few Slides I show how we have found more reserves in this very mature field. This is a table showing Sidewall Formation Tester pressures from a well drilled into the waterflood. The sands highlighted in green show some support from the waterflood, while those highlighted in blue show no support from injection, and the one highlighted in red had virgin pressure and does not appear to show any effects of depletion.



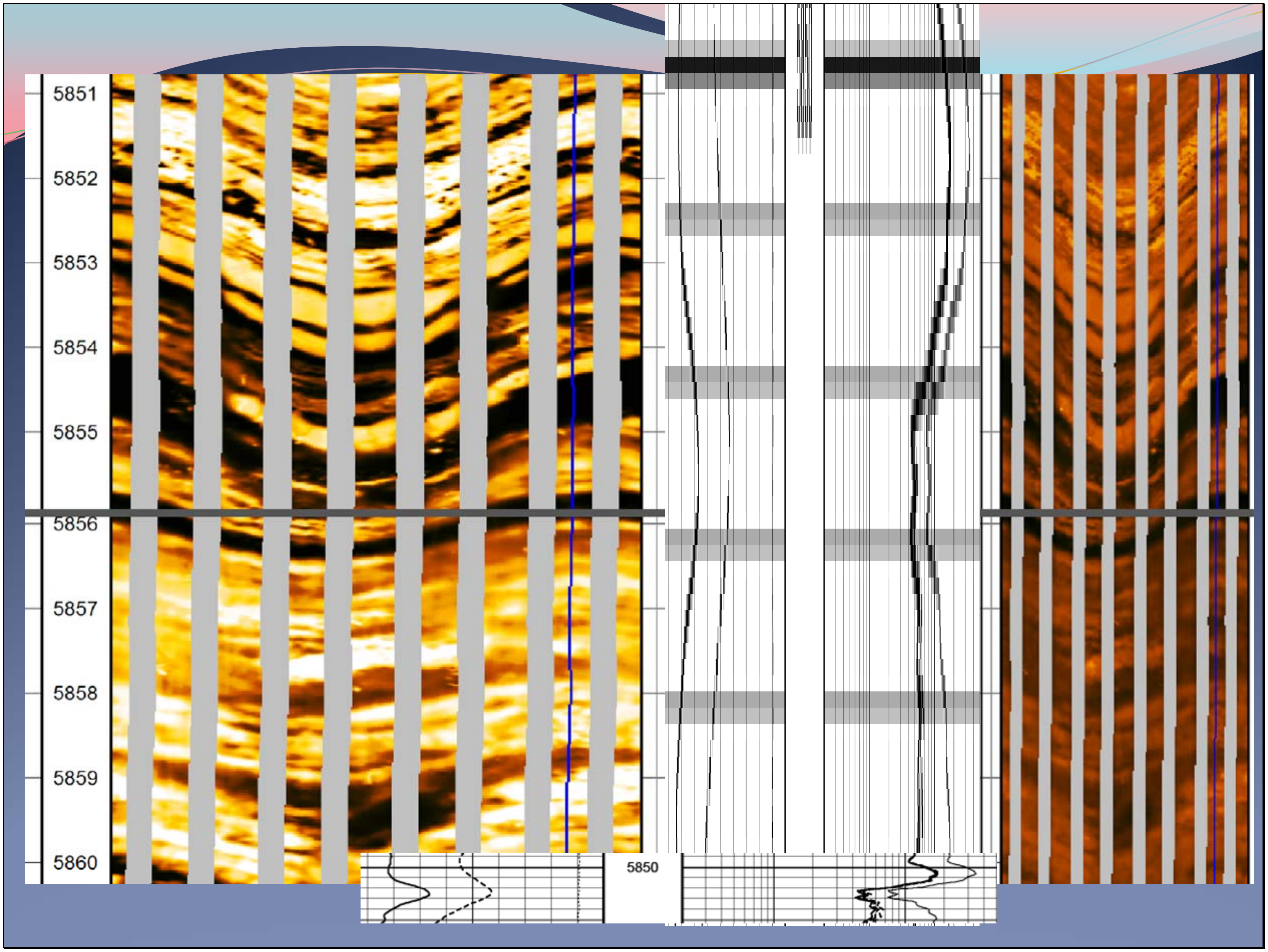
Presenter's notes: This is a similar case with the pressures shown on the openhole logs; again note the sand at the bottom with virgin reservoir pressure that shows to be undrained by nearly 40 years of production in surrounding wells. Note the Gamma Ray is nearly continuous low readings in the Upper and Basal Bromide; yet the reservoir is clearly compartmentalized with porosity and permeability lobes not in communication with each other. Note also that zones with low cross-plot porosity commonly have good formation-tester permeability (and in some cases the opposite is true); these permeable zones may well show-up better on the micolog and SP logs than they do on the porosity tools.



Presenter's notes: This is another example of the wireline formation tester showing pressure separation in some originally wet sands and some with strong waterflood support. Note the permeability lobes. In the North Block the Upper Bromide has 12 mappable permeability lobes; the Basal Bromide has 12, and the Upper McLish has 7.

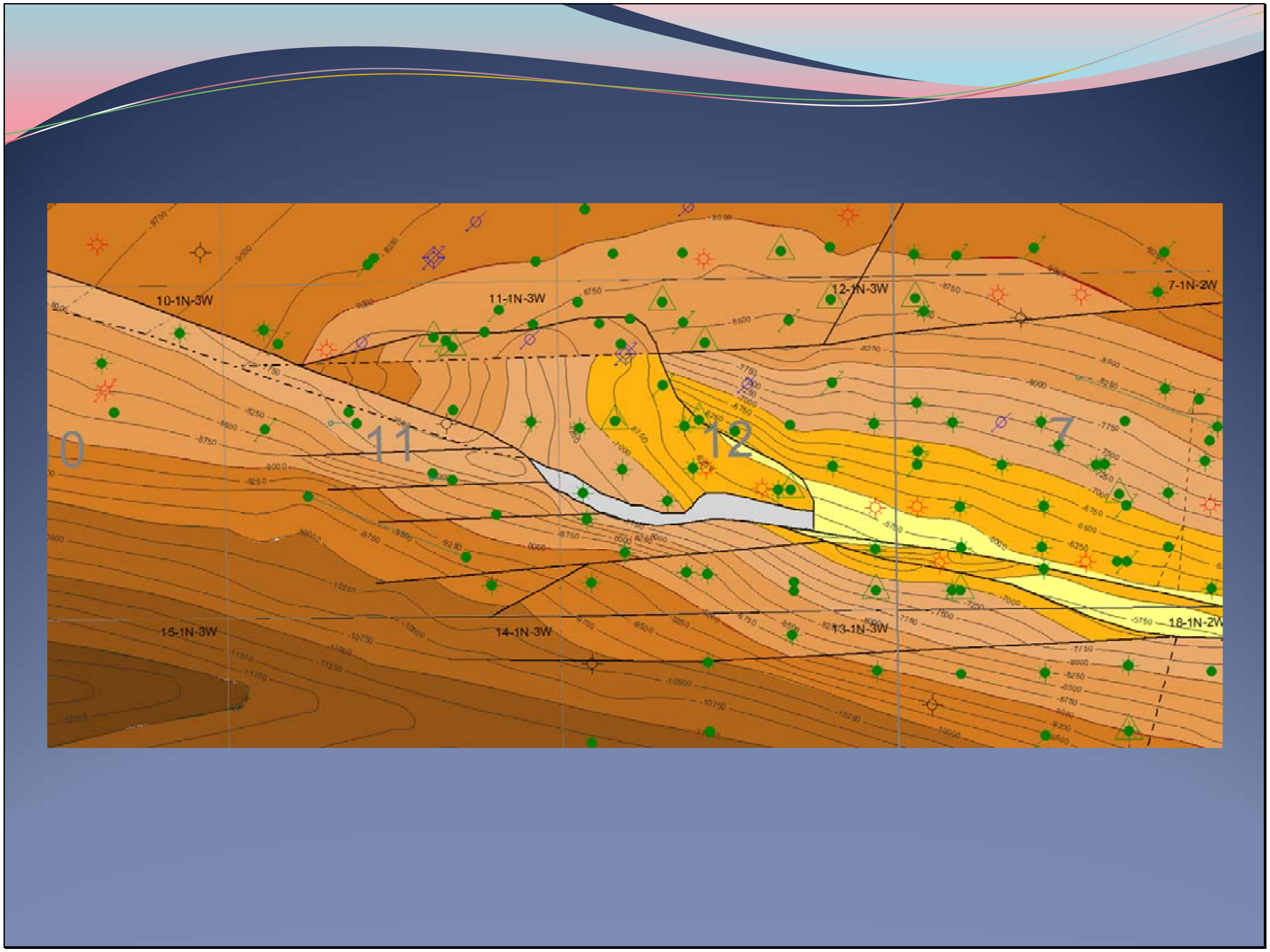


Presenter's notes: This is a map of one of the thin lobes showing the importance of mapping to insure that injection wells have sand continuity with producers in the same zone and vice versa.

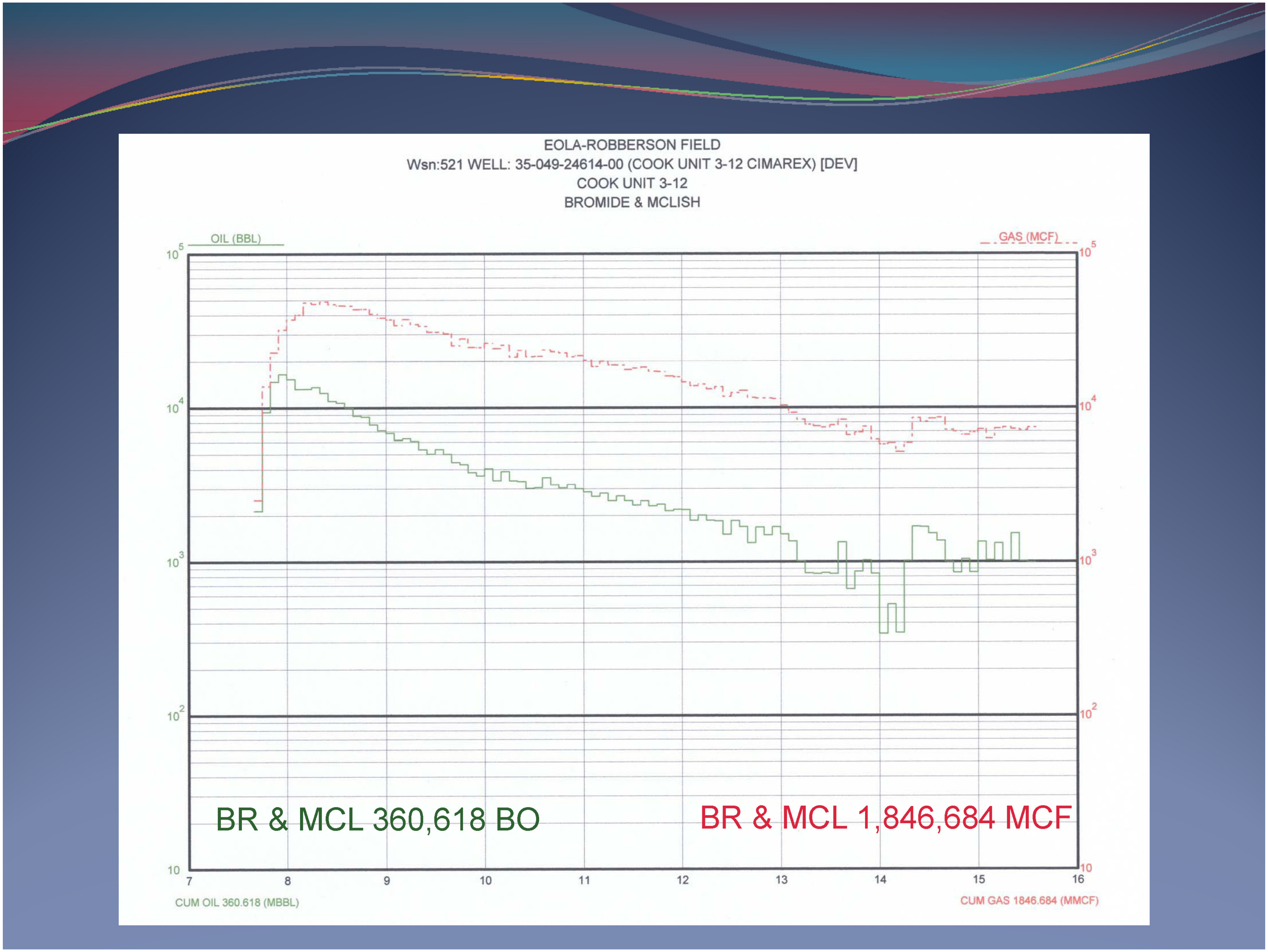


Presenter’s notes: Here is a slide of a microelectric imaging log. Ten feet of the good-definition modern-resistivity array log over the zone is shown at the bottom; this same interval is stretched to match the scale on the imaging log to show the detail of the imaging tool. The Bromide sand shale layers are all being averaged in the array resistivity tool, but their thin-bedded nature can be seen on the image. In the static image on the right, the actual resistivity from each sand layer can be quantified based on color. This shows that the sand layers are indeed wet, and it is not just the shale layers that are pulling the resistivity down.

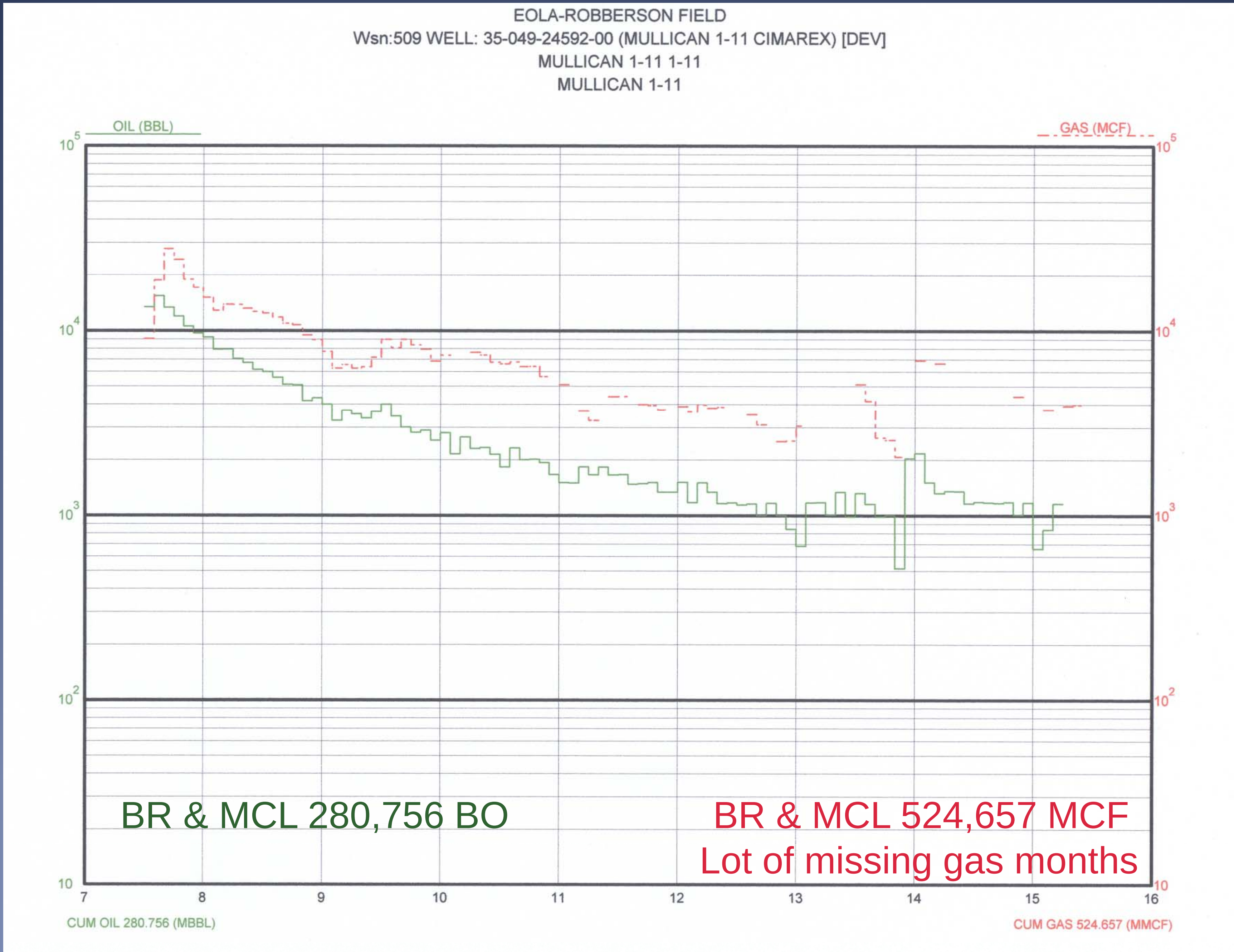
Presenter’s notes: The Eola Fault is a scissor fault, apparent reverse fault on one end and apparent normal fault on the other end – up to the south in the west (left side) and down to the south in the east (right side). How the structure transitions is shown on the next slide.

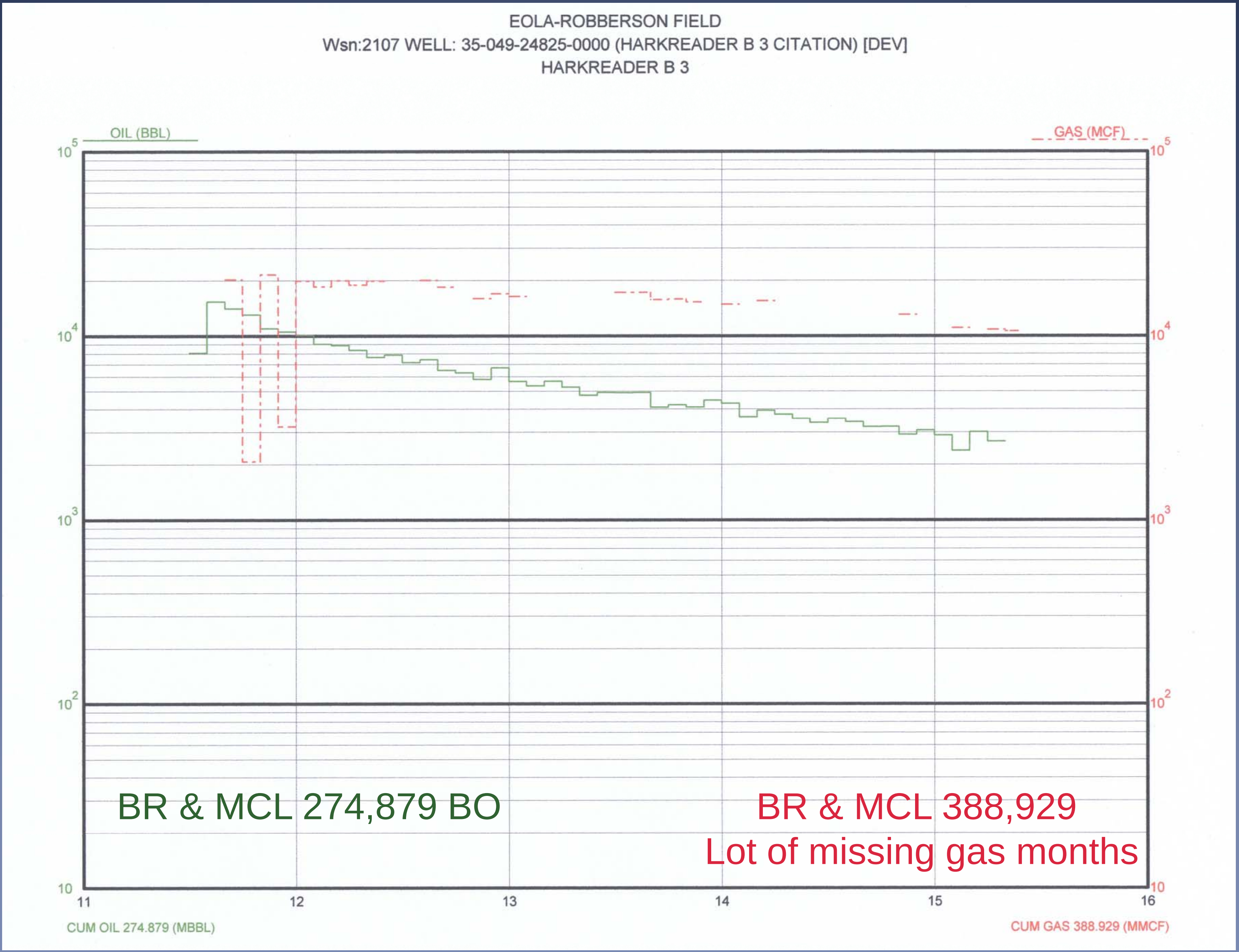


Presenter's notes: The well in the SE SW Section 12 had produced more than 400,000 BO & nearly 1 BCF from the Bromide before it was plugged back to test the fractured reservoirs. It was still making 5 BOPD when plugged back. There was no fractured reservoir producer in the SW SW Section 12; so our team decided to drill a fractured reservoir well in that 40 acres and ask for management approval to take the well to the McLish since the old well had decent-looking Basal McLish logs but had tested water and was plugged back. Management approved going to the Simpson, and we found full columns with virgin pressure indicating a fault must be separating the two wells. Offsetting the well to the west found separate reservoir, and when Citation drilled a west offset they found still another reservoir. We drilled a well to the SW and cut an oil-water contact; we sidetracked the well 600ft updip and found a different oil-water contact, and drilling a well to the south we found pressures that indicated it was in the same block as the original 1950s well. These reservoir blocks appear to be very small and the faults appear to be sealing.

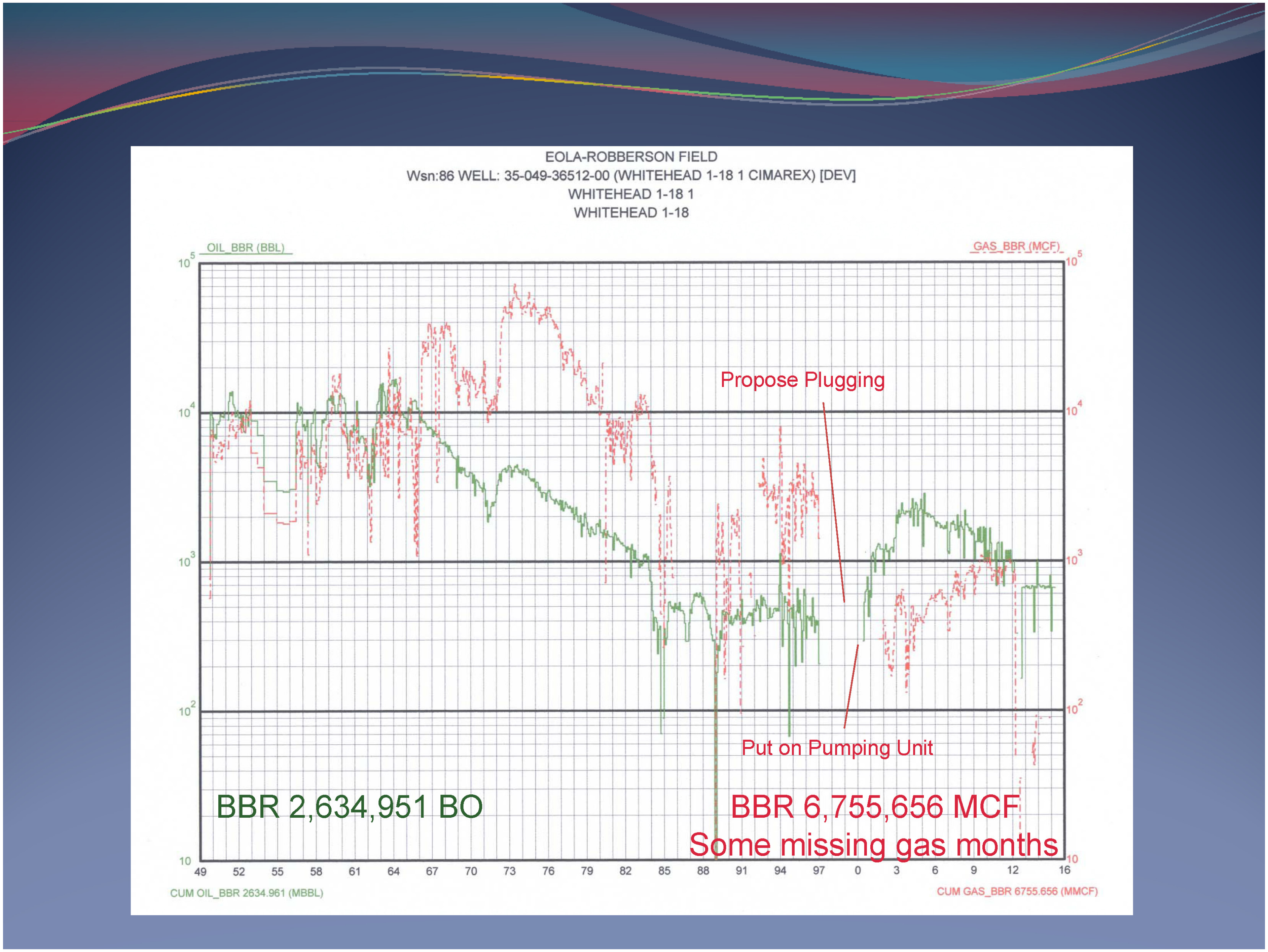


Presenter's notes: The fault blocks are very small, but with the good porosity and thickness of the Simpson sands they were also very economic as shown by this and the two following slides.

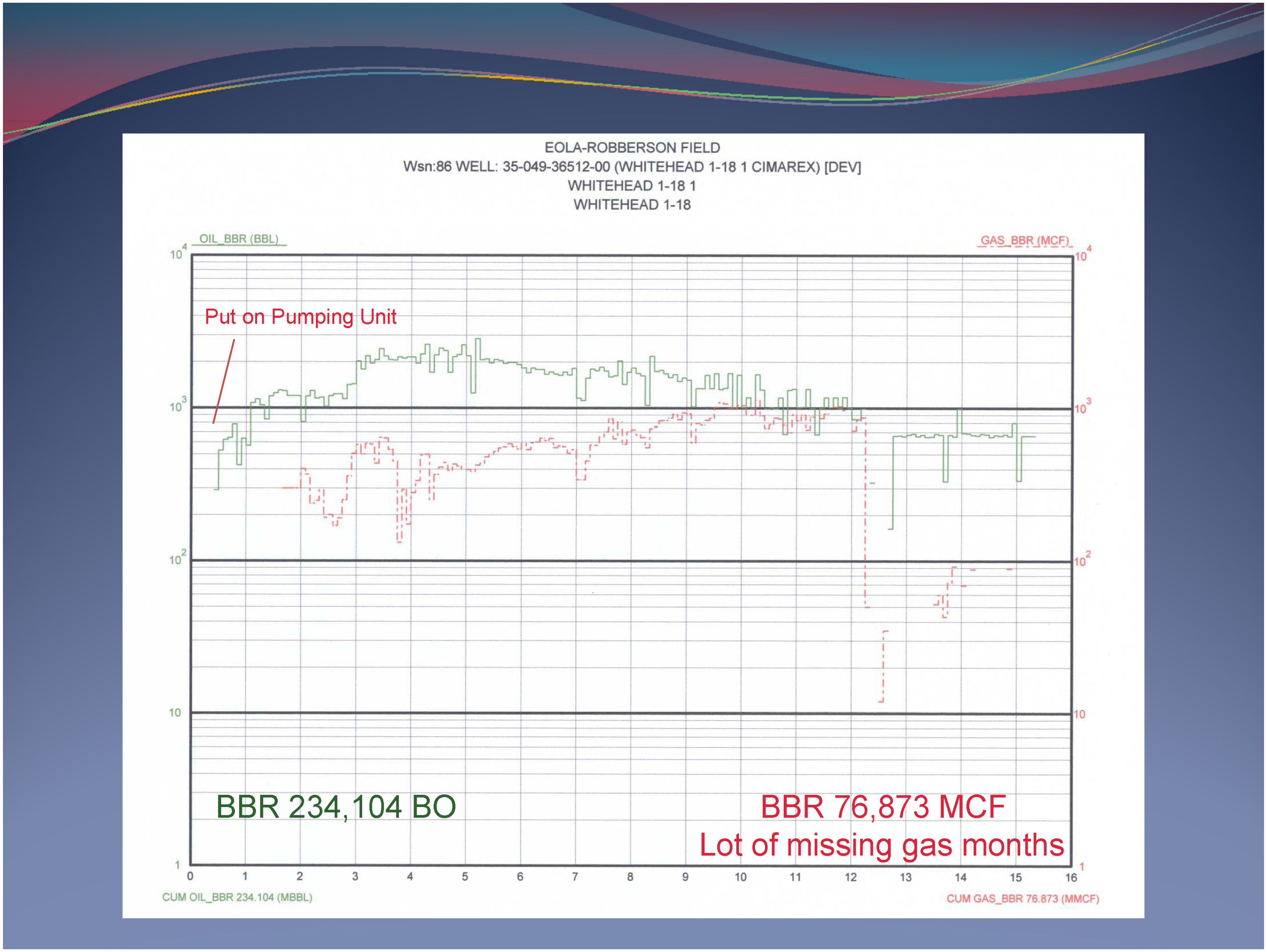

EOLA-ROBBERSON FIELD
Wsn:509 WELL: 35-049-24592-00 (MULLICAN 1-11 CIMAREX) [DEV]
MULLICAN 1-11 1-11
MULLICAN 1-11
OIL (BBL)
GAS (MCF)
BR & MCL 280,756 BO
BR & MCL 524,657 MCF
Lot of missing gas months
CUM OIL 280.756 (MBBL)
CUM GAS 524.657 (MMCF)



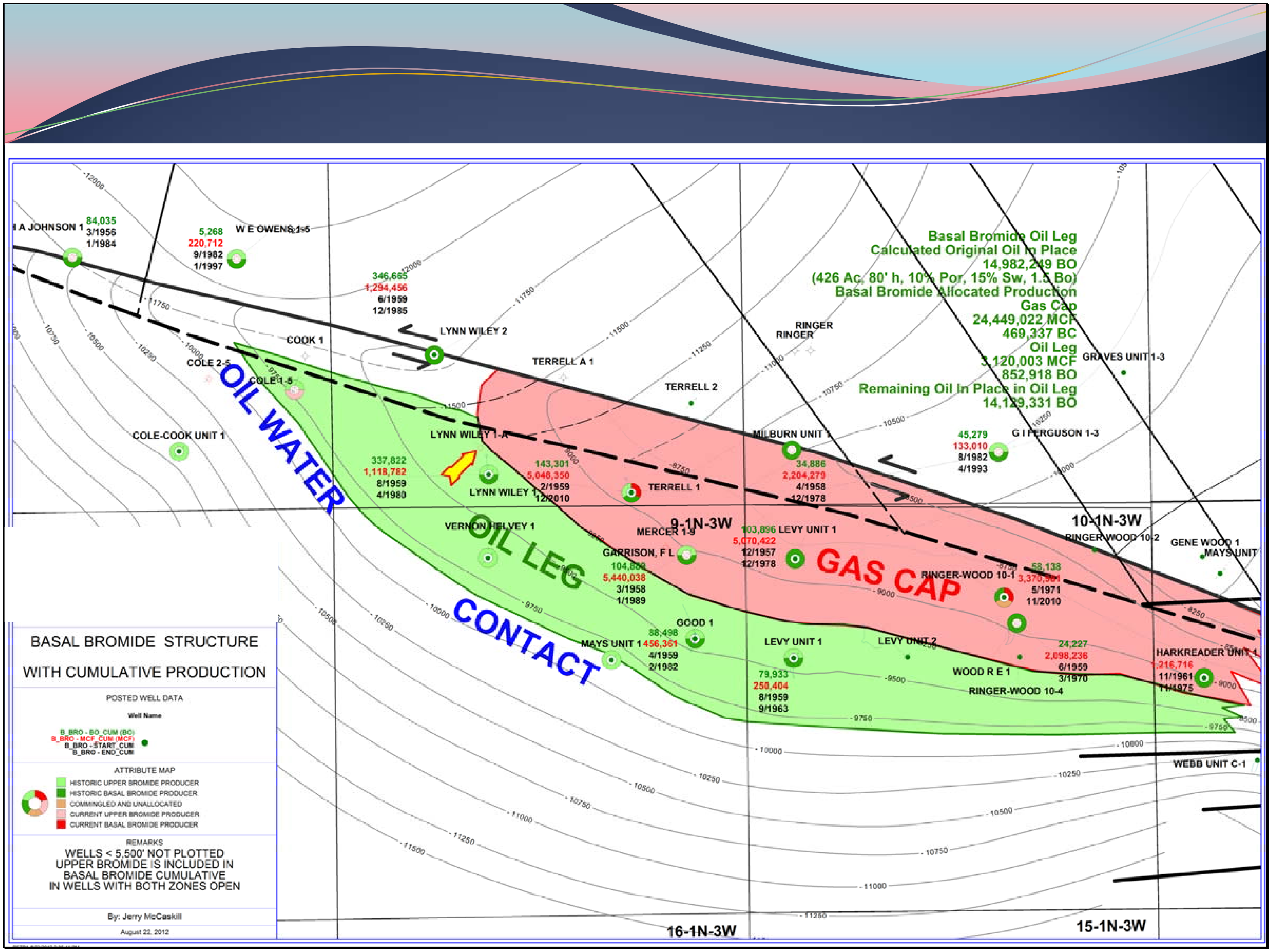
EOLA-ROBBERSON FIELD
Wsn:2107 WELL: 35-049-24825-0000 (HARKREADER B 3 CITATION) [DEV]
HARKREADER B 3
OIL (BBL)
GAS (MCF)
CUM OIL 274.879 (MBBL)
CUM GAS 388.929 (MMCF)
BR & MCL 274,879 BO
BR & MCL 388,929
Lot of missing gas months



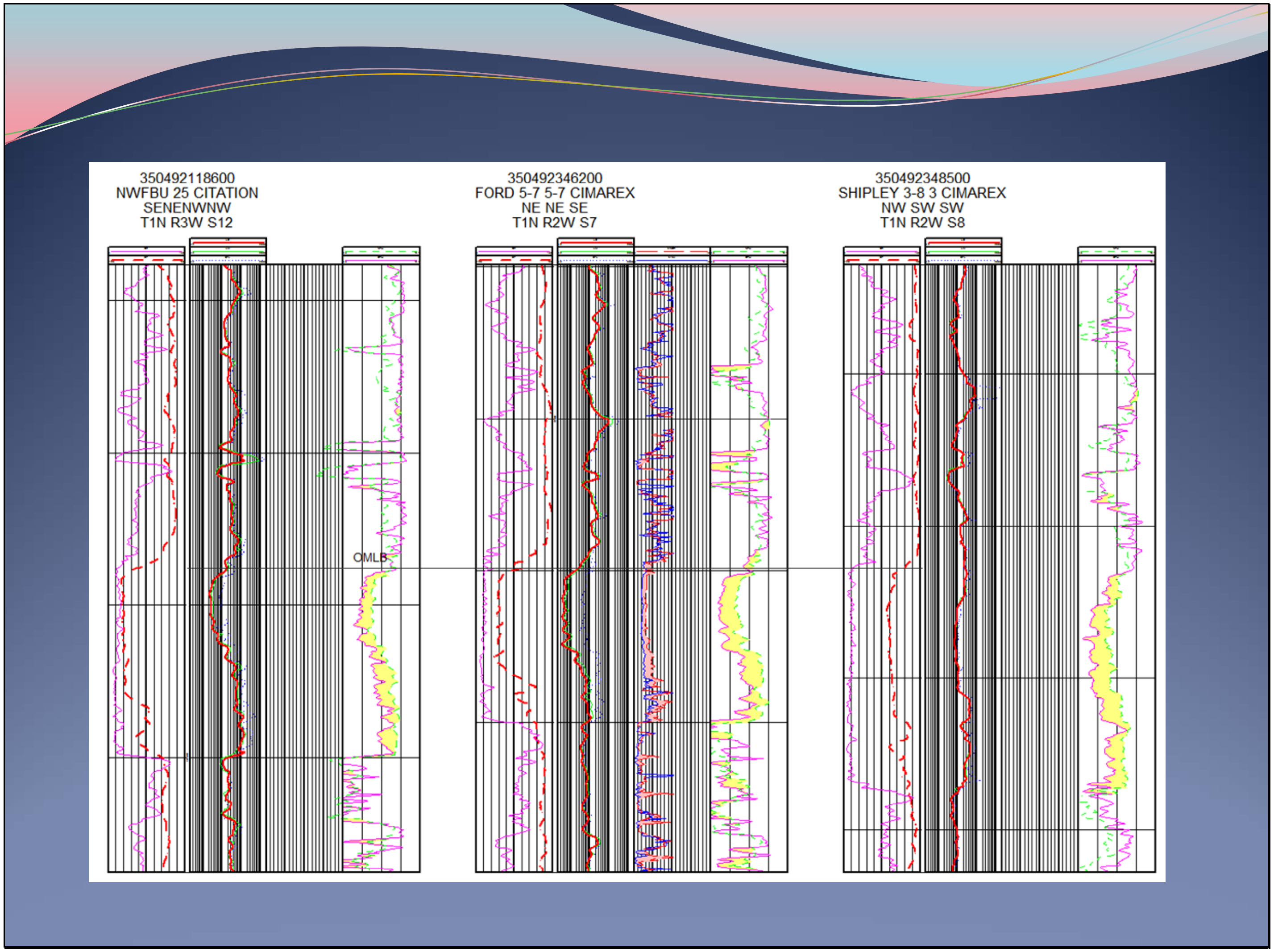
Presenter's notes: Here is a Bromide well in the South Block that had been on gas lift and had produced more than 2,400,00 BO since 1949. When the well had been unable to produce for several years, it was proposed to plug the well back to test the fractured reservoirs. Wireline SIBHP showed that the well had less than 400 psi pressure before it stopped producing. The engineer recommended that the well be put on a pumping unit before coming uphole.



Presenter's notes:The well started pumping 18 BOPD increasing over the next 4 years to 75 BOPD and has made in excess of 200,000 BO from a very pressure-depleted zone. The high-quality Simpson reservoirs can still make a lot of oil from low pressures if they can be lifted effectively.



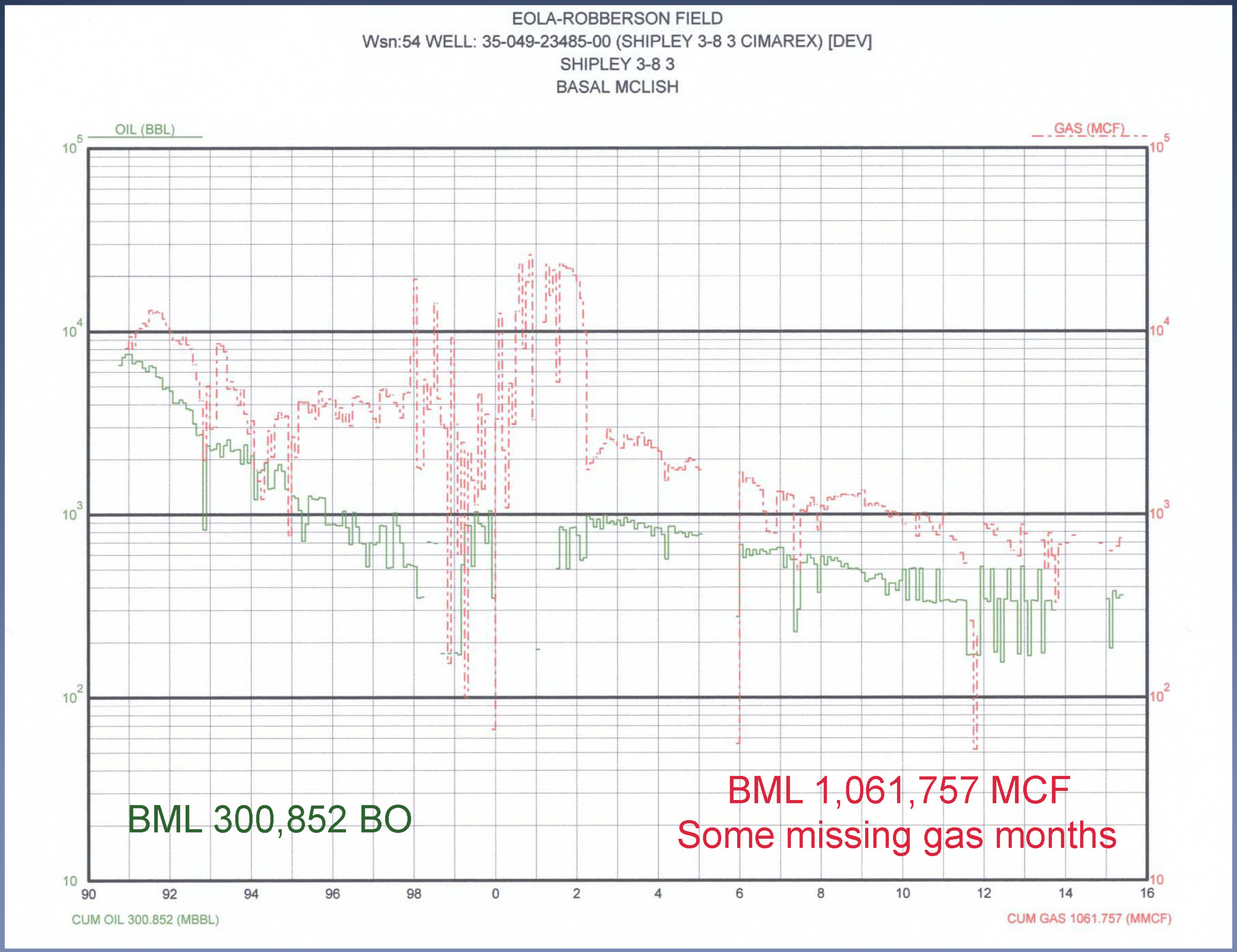
Presenter's notes: This is an example of remaining reserves in the West Block. The Basal Bromide, Basal McLish and Basal Oil Creek each had large primary gas caps above the oil legs. Because there were a number of operators and the liquids in the gas cap were valuable, this block was not unitized, and the gas caps were blown down competing with the flowing oil wells. When the oil wells ceased flowing, pumping them from these depths (11,000'+) was difficult in the 1960s. The rough calculations show that of the original 15 MMBO in place in the oil leg, less than 1 MMBO has been recovered; the rest is still in the reservoir. CO2, Nitrogen, Lean Gas, HPAI or some other secondary recovery mechanism will be necessary to recover the stranded oil in the Simpson oil legs on this end of the field.



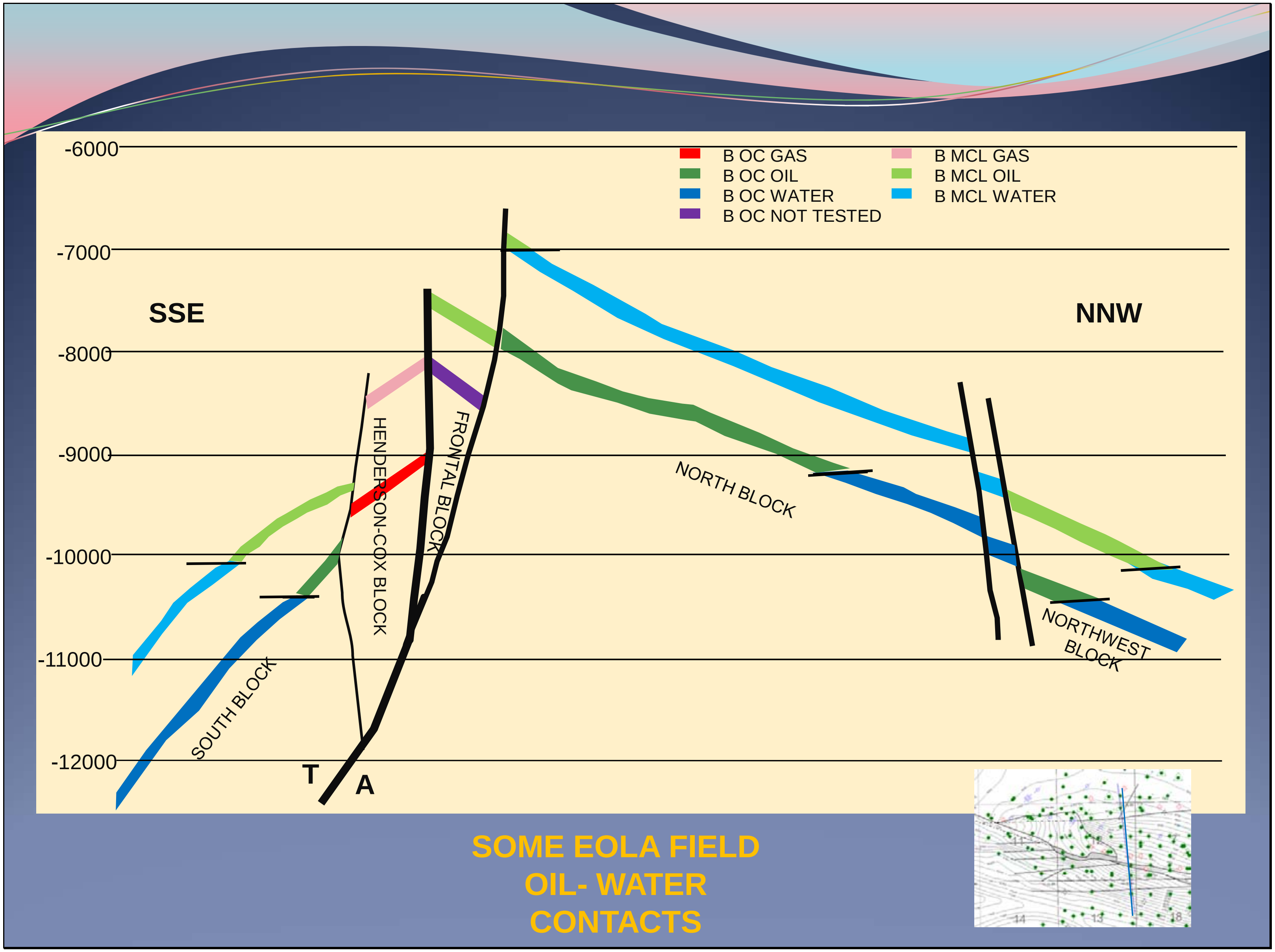
Presenter's notes: Here is one of the LOOK OUT slides. The Basal McLish in the Northwest Fault Block has very low resistivities and calculate to be wet using standard equations (Well on left). Wells have produced at rates as high as 1400 BOPD from 0.7 ohms. The low-resistivity zone is near the top, and if the lower part of the zone calculates to be productive, it is a good indication that the top is also productive.

On the upthrown side of the Northwest Block fault the middle well looks obviously wet, but the samples had a great live-oil show including gas – some of the "prettiest-looking" oil sand I have seen in the samples. We tested the well in spite of the logs, and it was indeed wet. My thoughts are that sometime in the recent geologic past this reservoir leaked along one of the faults. Possibly this is where part of the Robberson Permian production came from.

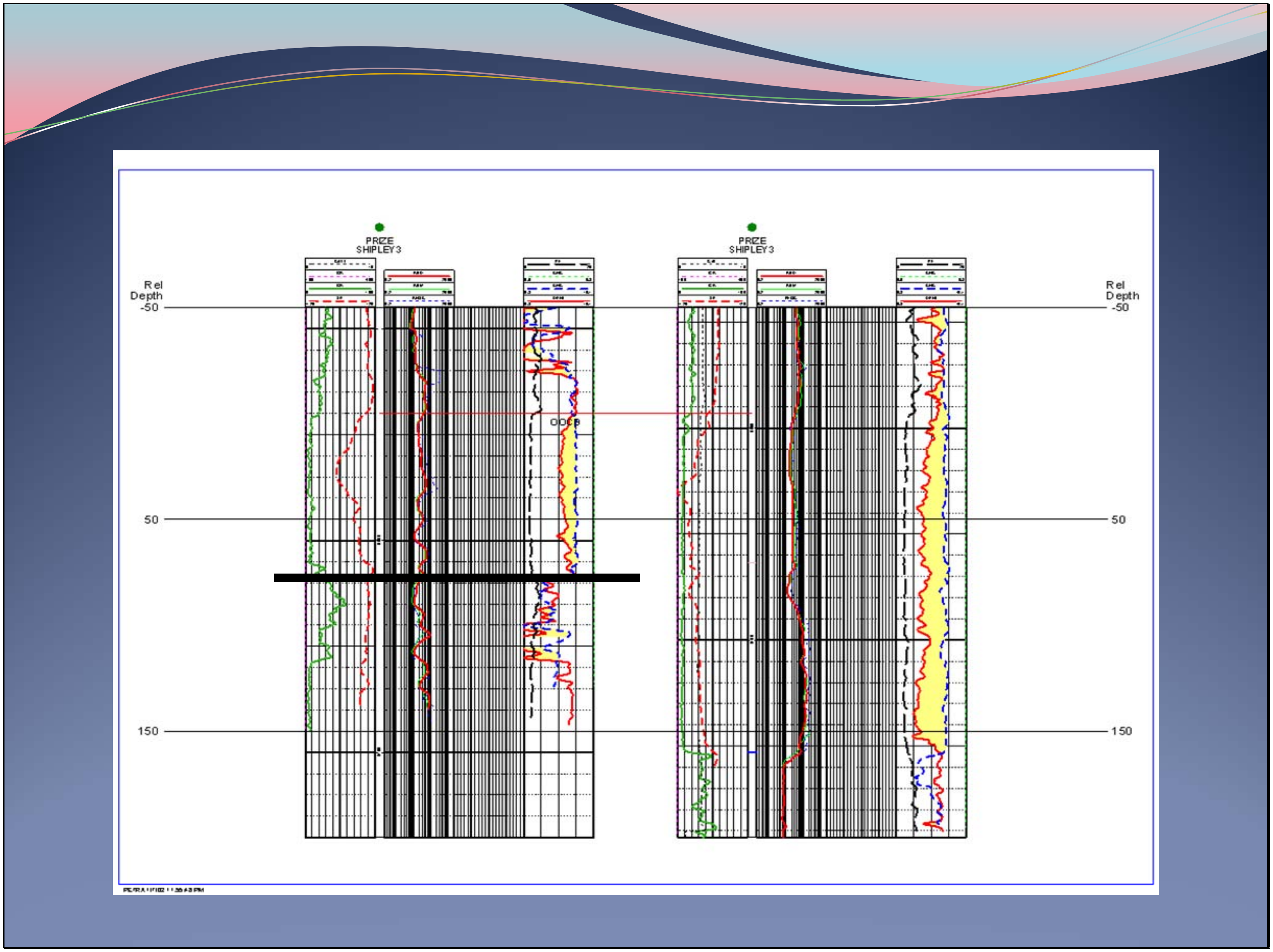
The well on the right shows a full section of sand "loaded" with oil. This well was drilled slightly updip to a well that had watered-out near the crest of the structure.



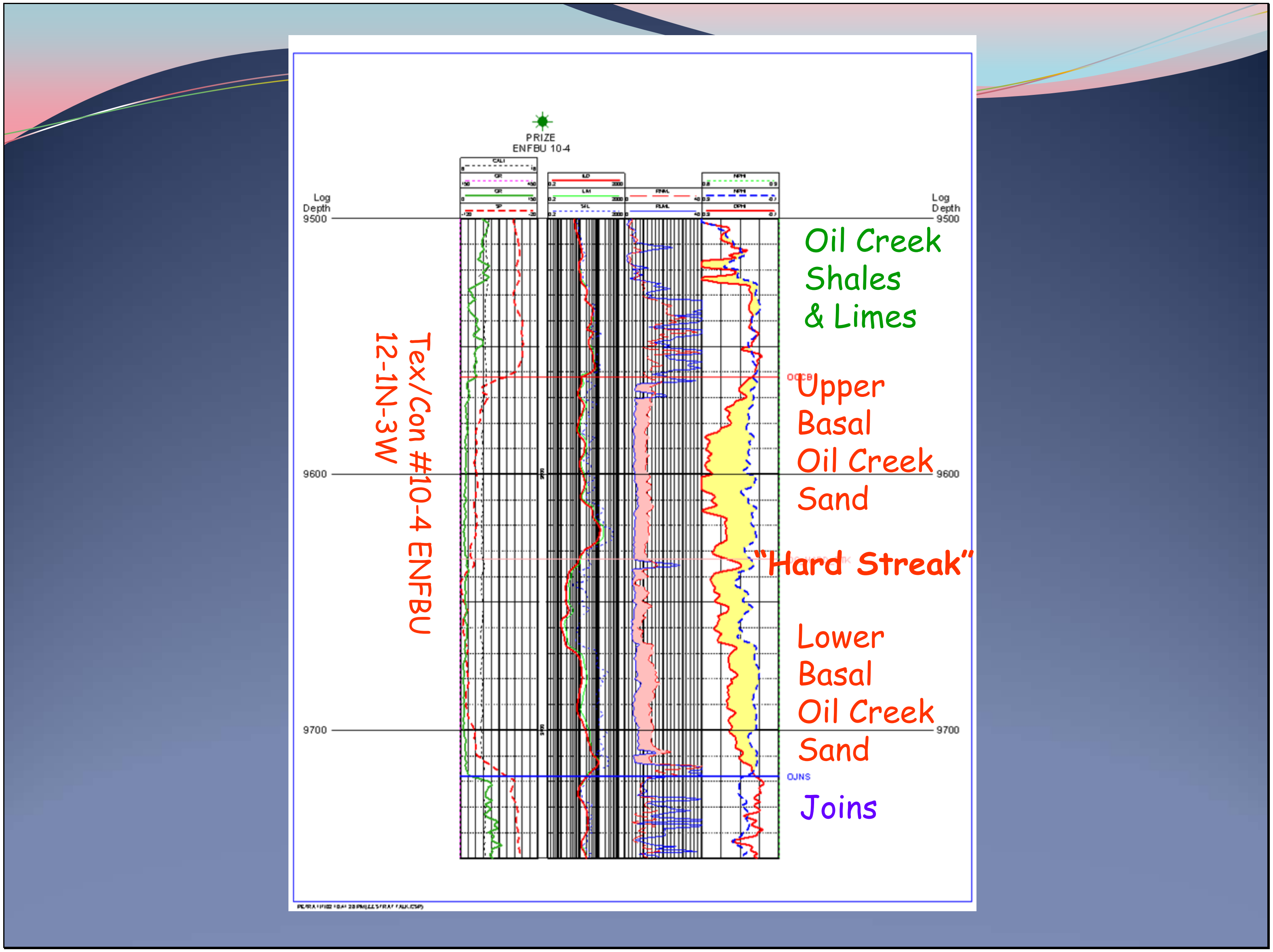
Presenter's notes: The attic oil well has made more than 300,000 BO and is still making more than 10 BOPD 26 years later.



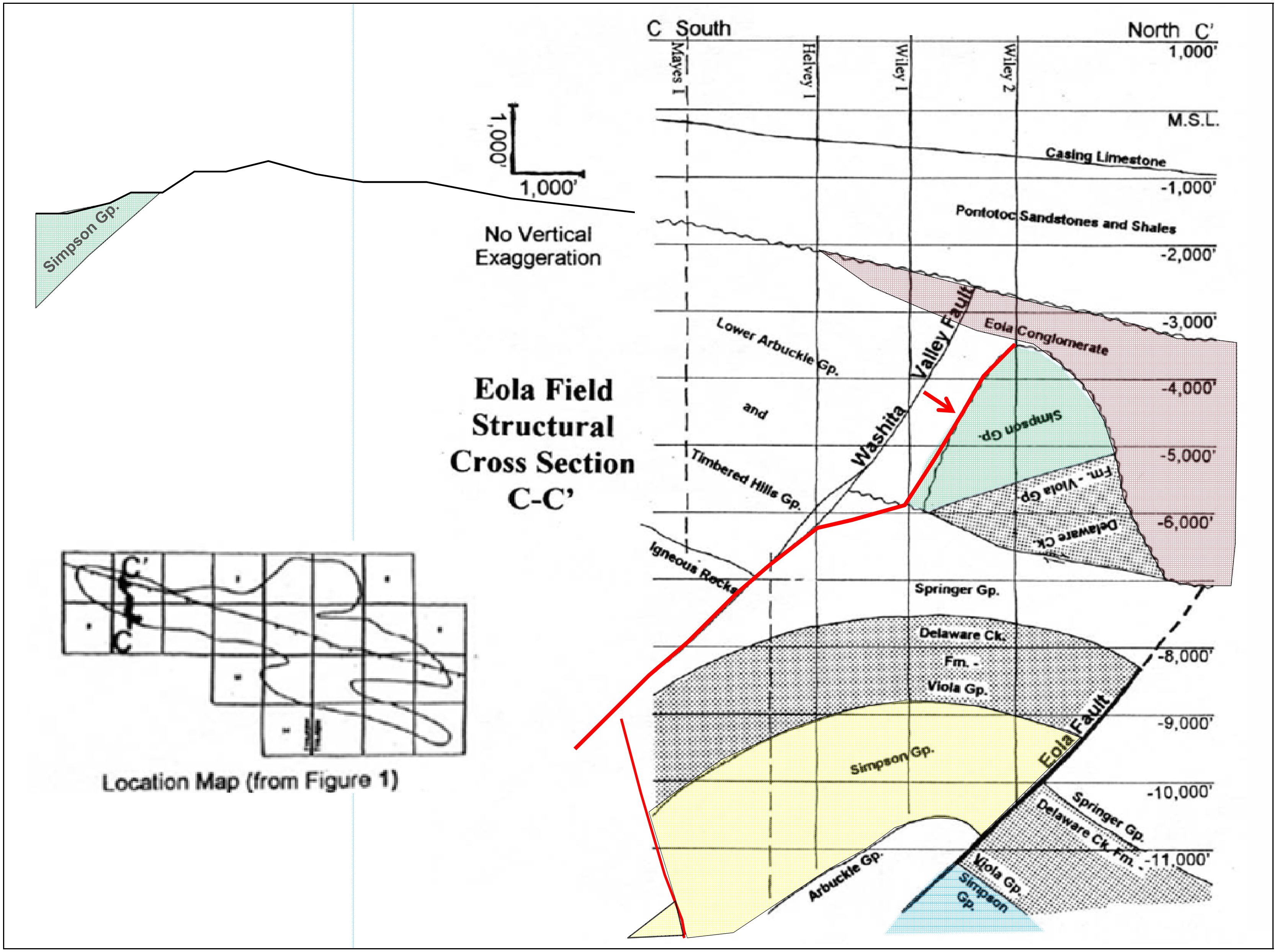
Presenter's notes: This cross section shows the location of the previous well in the very small Basal McLish reservoir near the crest of the structure. It also shows how many of the reservoirs produce from well below the oil-water contacts in other blocks, and how many of the reservoirs are on the downthrown side of the faults. It shows the importance of testing each prospective block as opposed to just using structural elevation to condemn drilling a block.



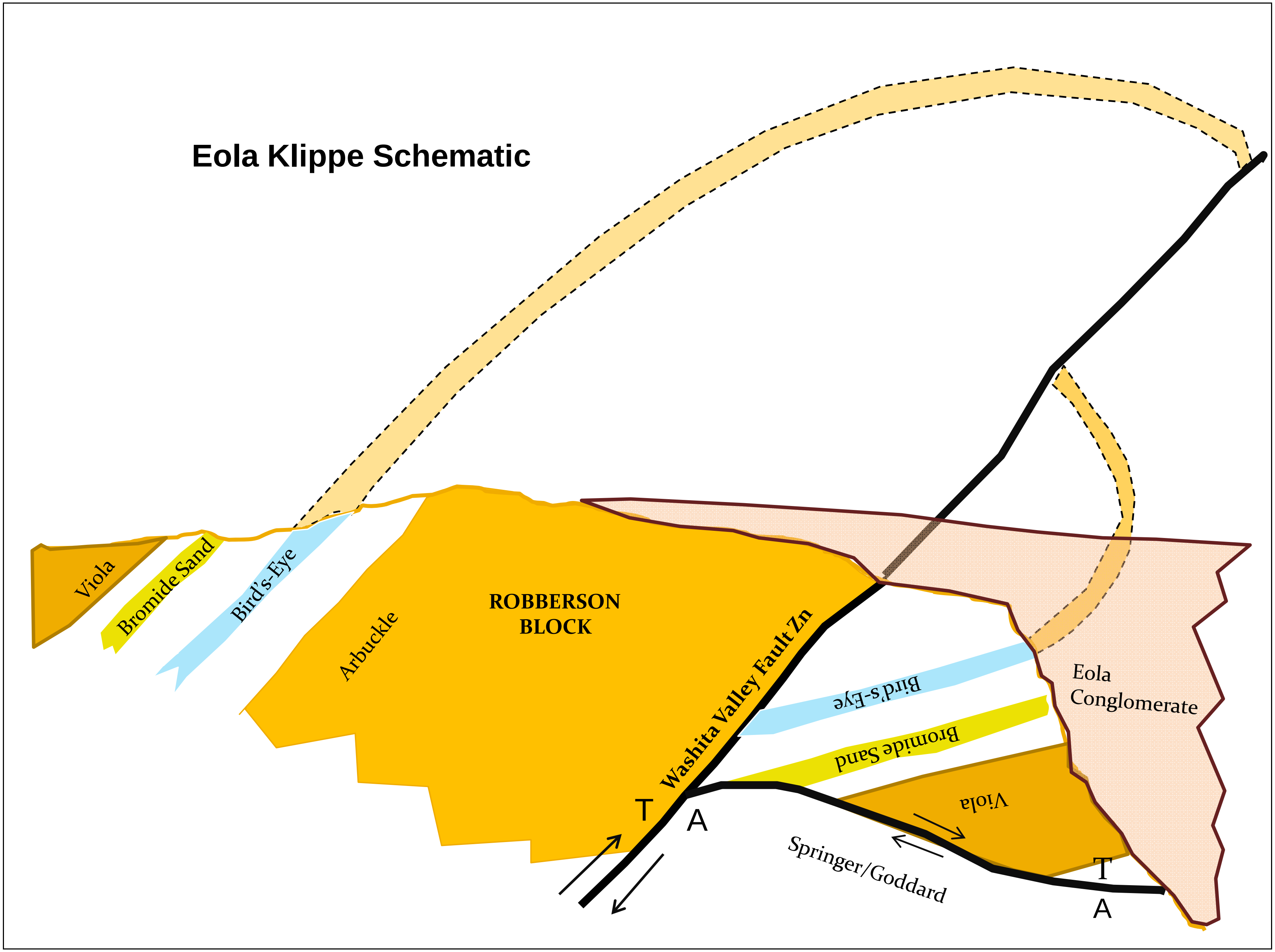
Presenter's notes: Here is one last LOOK OUT. The same well (shown in a previous slide) productive in the Basal McLish cut a fault in the Basal Oil Creek along the frontal zone at the crest of the structure (on left). In addition to removing much of the Basal Oil Creek section, deformation bands associated with the faulting destroyed much of the porosity (cross-plotting, somewhere near 5%). When the well was sidetracked to a location around 60ft away (on right of slide), the fault and the deformation bands were not present, resulting in more than 150ft of 10%+ cross-plot porosity. The well made more than 75,000 BO in less than 2 years from the Basal Oil Creek and was still capable of making 30 BOPD when plugged back to produce from the Basal McLish.



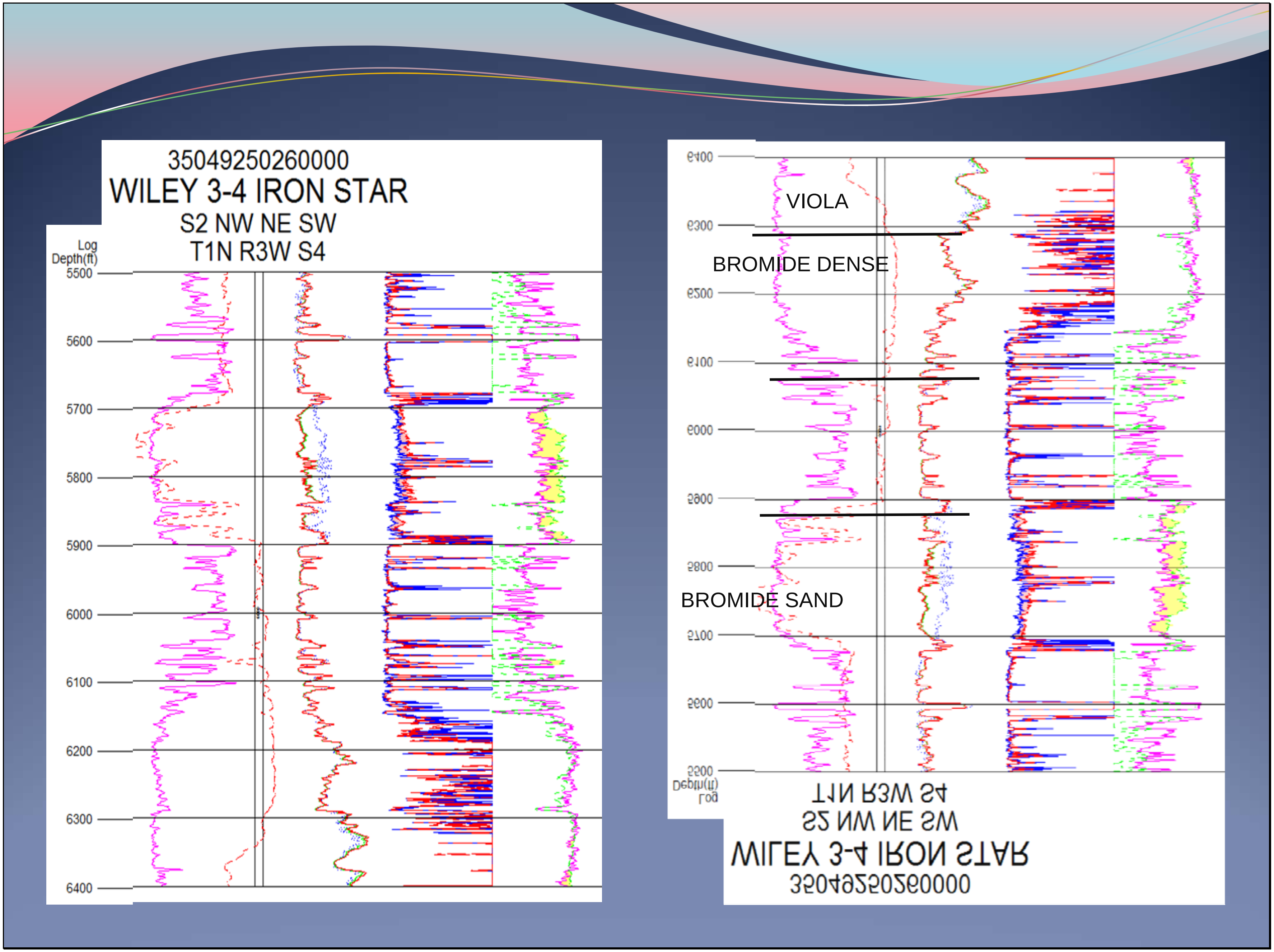
Presenter's notes: The Basal Oil Creek in much of Southern Oklahoma has a "hard streak" that separates the sand into 2 separate reservoirs. At Cumberland they are called Upper Basal Oil Creek and Lower Basal Oil Creek and have pressure and fluid separation. In this well the upper section has mainly been affected by gas injection from the crest of the structure, and the lower section has been watered-out by water injection along the flanks of the structure. There appears to be 20ft of Basal Oil Creek sand at the bottom of the upper section that has not gassed out or watered-out that may be remaining recoverable oil.



Presenter's notes: The Eola Klippe is a thrust sheet that came across much of the Eola structure north of the Eola Fault. It can be more than 3000ft thick and has well developed Bromide sands and Bird's-eye lime as well as Viola, although they are most commonly inverted. Whether present and trapping, these sands can produce in excess of 100,000 BO per well.



Presenter's notes: In my opinion, the Eola Klippe was an overturned limb of the Washita valley Fault, that was faulted through and later eroded.



Presenter's notes: Here is an example of the Eola Klippe, the middle of the porosity track is 10% on a -10% to 30% scale. This particular zone is wet, but "nice things could happen" in this zone on future wells drilled in this area.

THANKS TO:
SOHIO / SOPC / BP EXPLORATION / STANDARD OIL / TEX/CON
PG&E REOURCES
PARKER & PARSLEY
PIONEER NATURAL RESOURCES
MAGNUM HUNTER / GRUY PETROLEUM
NEWKUMET EXPLORATION
EOG
PRIZE ENERGY
CIMAREX
IRON STAR ENERGY
McENCO
OCGS, ARDMORE GEOLOGICAL SOCIETY, TGS, AAPG MID CONTINENT, AAPG