The Effects of the Chicxulub Impact Found in the Subsurface of Northern Louisiana*

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Abstract

Approximately 65 Mya the impact of a large bolide (~6 km in diameter) into the water of the Gulf of Mexico's northern shelf on the Yucatan Peninsula, the Chicxulub Impact, had well-known far-ranging/worldwide effects: 1. an earthquake, 2. tsunami's, 3. direct ejecta, 4. atmospheric debris fall-back, and 5. climatic effects from atmospheric modification. Most of northern Louisiana, within about 1200 km of the impact site, was a marine shelf of the Gulf of Mexico with some lowlands near the northern border at the time of the impact. Tsunami "mega ripples" about 17 m high with about 1 km wavelength have been recognized and analyzed in 3D and 2D seismic data from northern central Louisiana. Several authors have demonstrated that the shelf around the Gulf of Mexico collapsed as a result of the earthquake and have mapped the resulting mass-transport deposits. A conventional core from about 1500 m depth (Justiss Oil Company, LA Central IPNH No. 2) from LaSalle Parish in Louisiana has been obtained and analyzed. This core contains about 10 m of Paleogene Midway Shale, about 13 m of the mass-transport deposit and about 17 m of pre-impact Cretaceous marl. Evidence from surrounding wells indicates this core was retrieved from deep within the trough of the tsunami rippled surface⋯thus it contains only about 13 m of mass-transport material while the thickness of the deposit under a ripple peak is about 30 m. Analyses include: 1) "inch by inch" visual inspection, 2) thin-section description, 3) intact core XRF data, 4) electron microscopic imaging and elemental analysis, 5) insoluble (in 10% HCl) weight percent, and 6) XRF and XRD analysis of the insoluble component. The present interpretation of the sequence of events recorded in the core is: 1) relatively undisturbed Upper Cretaceous coccolith rich chalk (marl), 2) a well-developed marine hardground, 3) mass transport deposit mobilized by the Chicxulub Impact earthquake, at least at this locality, material from up-dip was transported over an intact hardground, 4) less-well-developed hardground capping the mass-transport deposit, with

some material included which was ballistically/atmospherically transported from the Chicxulub Impact site, and 5) Paleogene terrestrially sourced clays of the Midway Shale.

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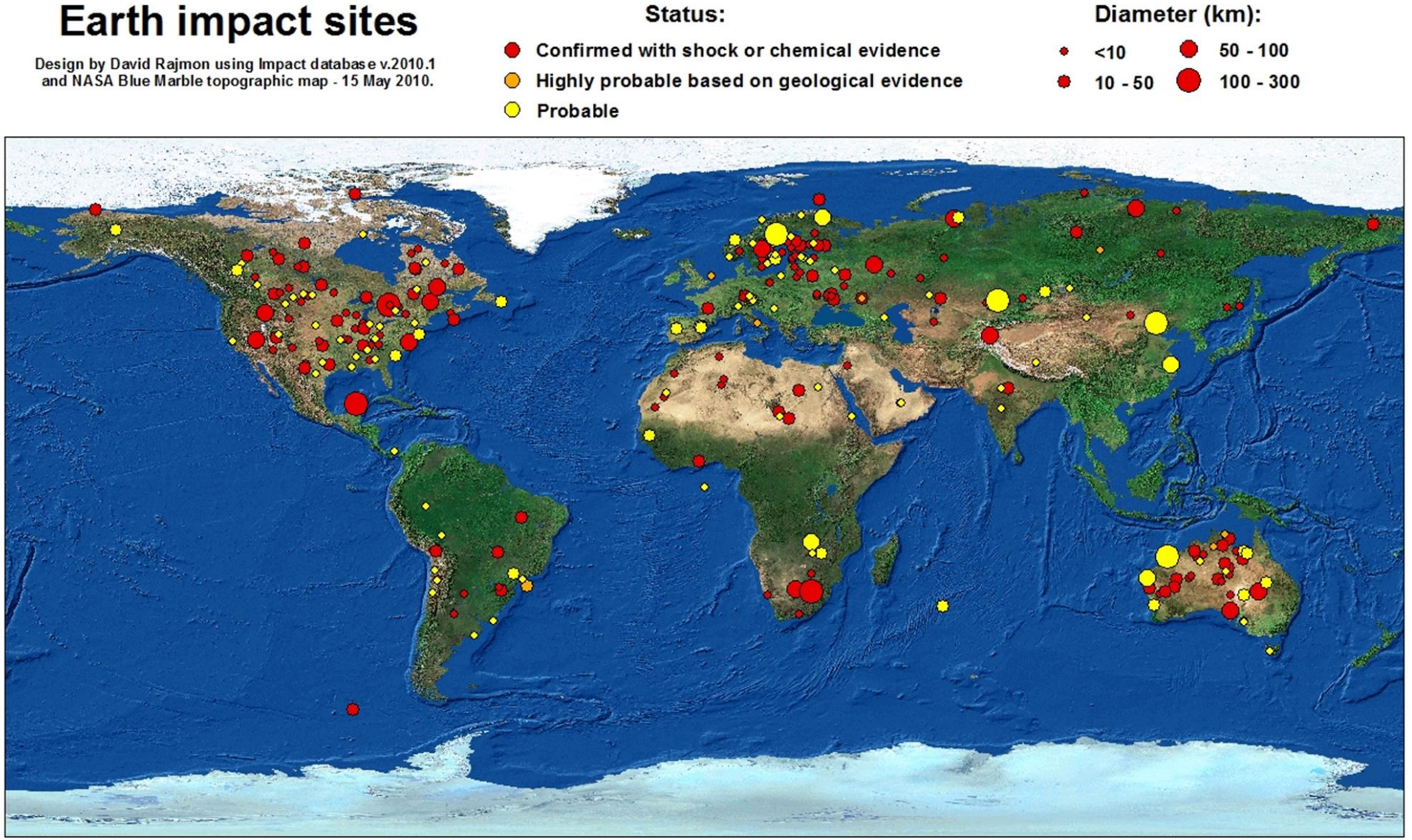
- University of Louisiana at Lafayette

  School of Geosciences

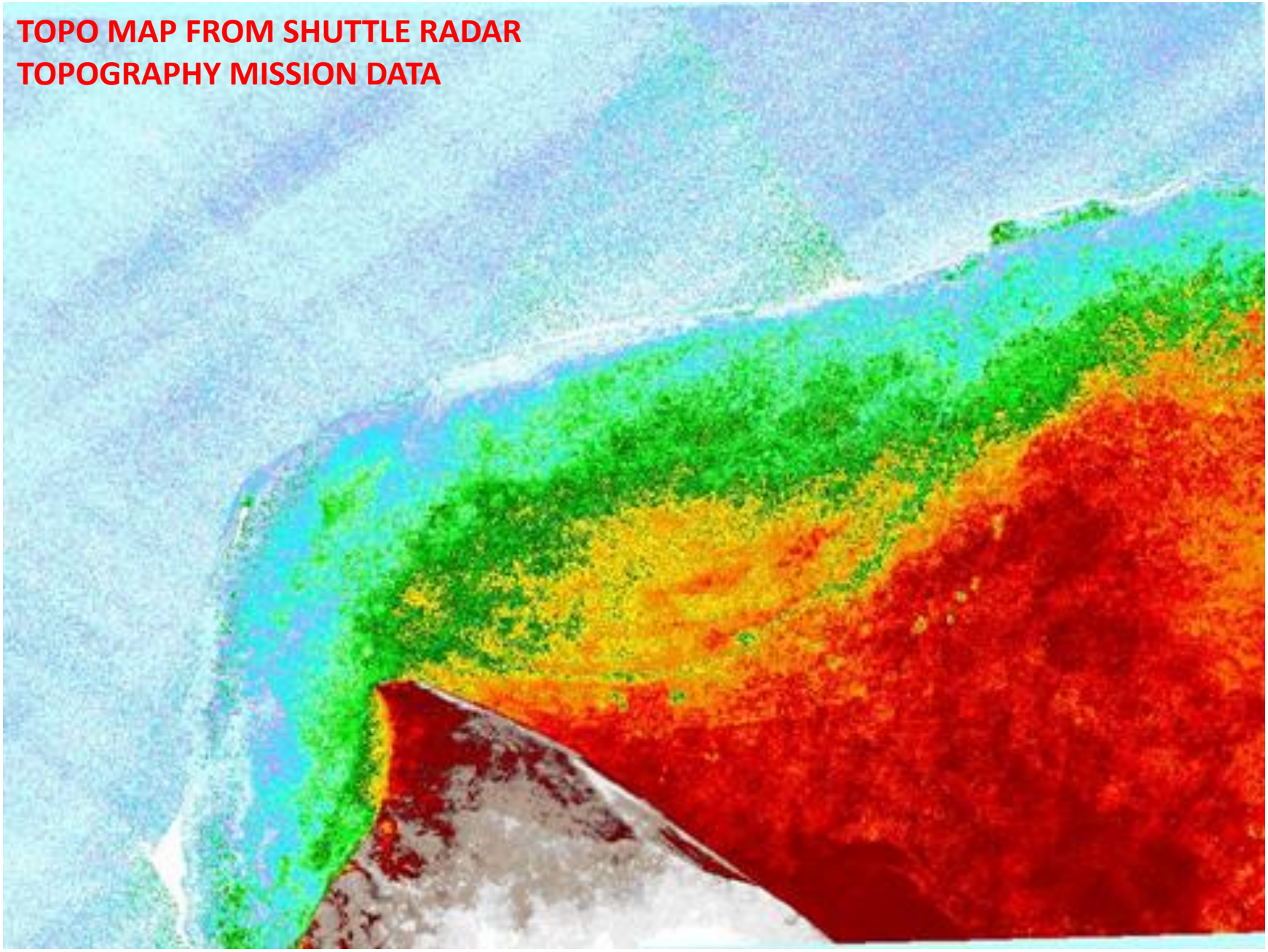
Outline:

- Chicxulub Impact and effects
- Seismic data in northern Louisiana…description
- Well in northern Louisiana…description
- Influence on petroleum migration and trapping
- Suggestions for exploration

http://www.passc.net/EarthImpactDatabase/New%20website_05-2018/World.html



TOPO MAP FROM SHUTTLE RADAR TOPOGRAPHY MISSION DATA



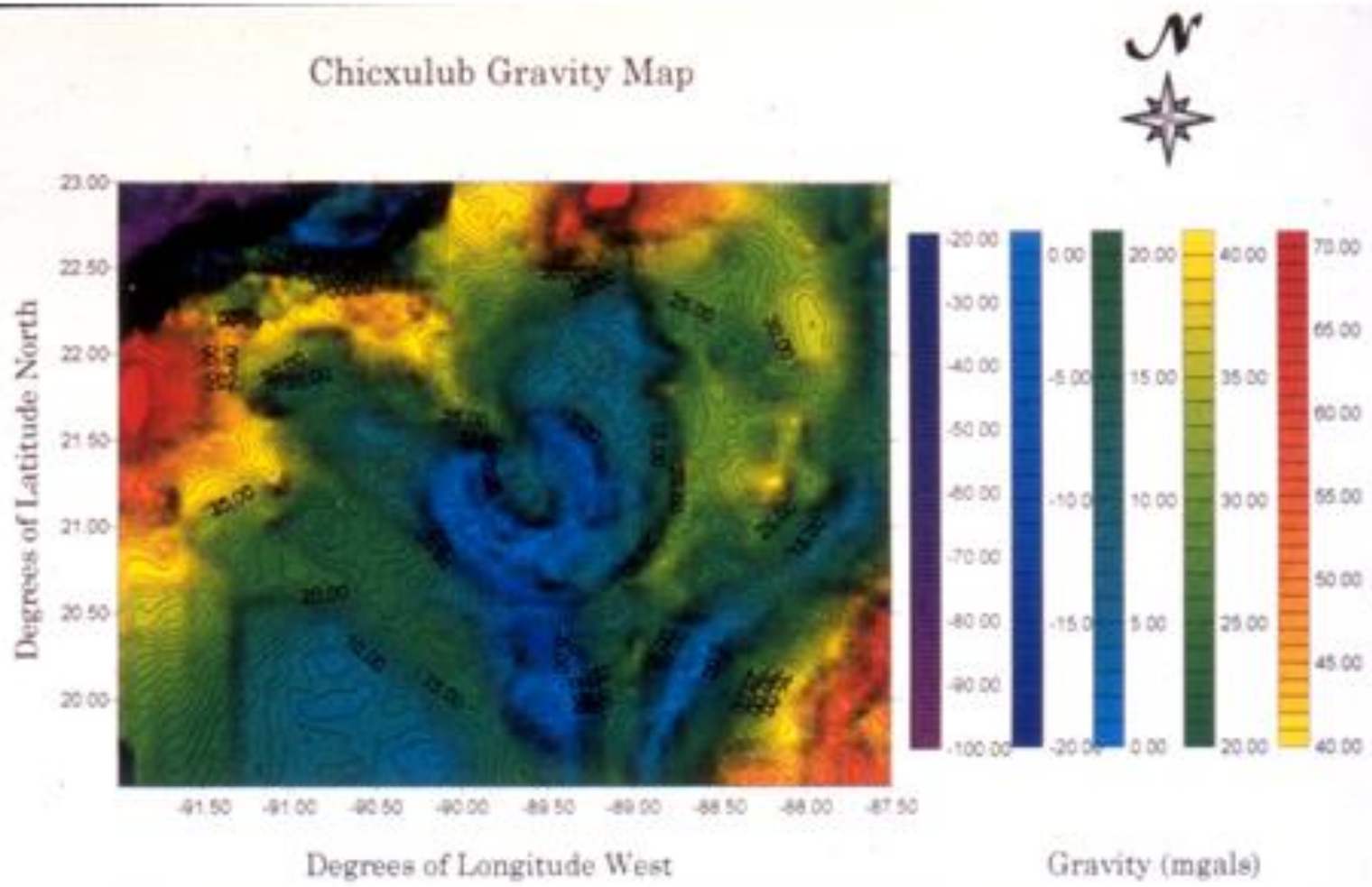


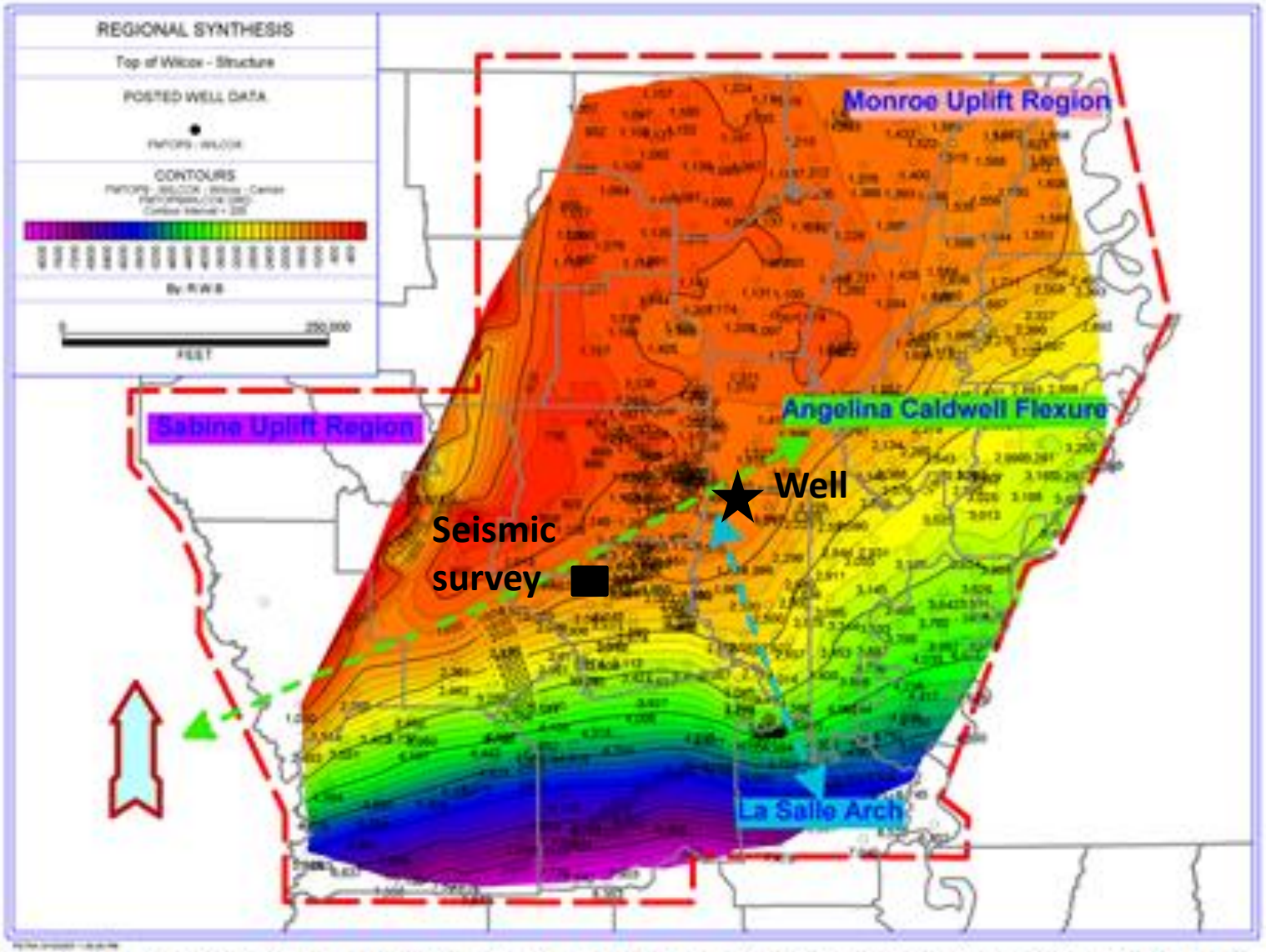
Figure 1.3 Chicxulub Gravity Map. Bouguer correction applied on onshore data, free air correction applied to offshore data.

Data distribution very similar to topography/bathymetry (Figure 1.2)

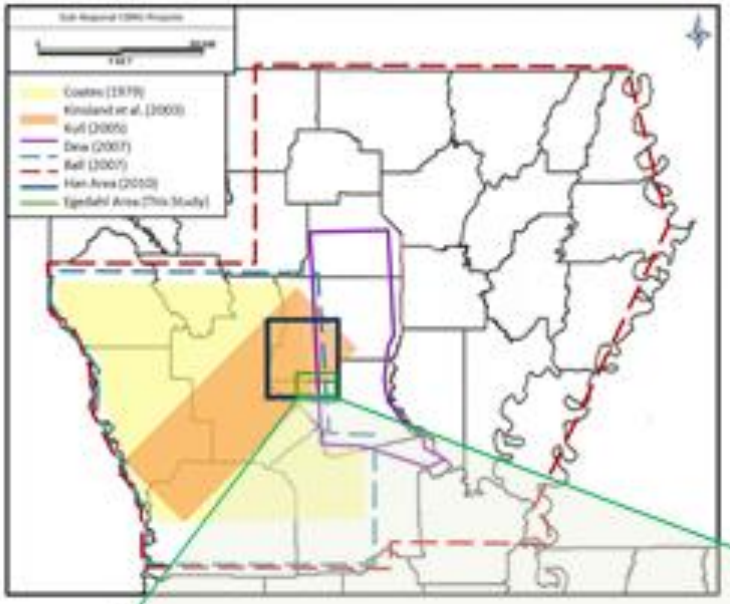
Geologic effects at this distance:

- Earthquake
- Tsunami
- Fallback/settling of ejecta

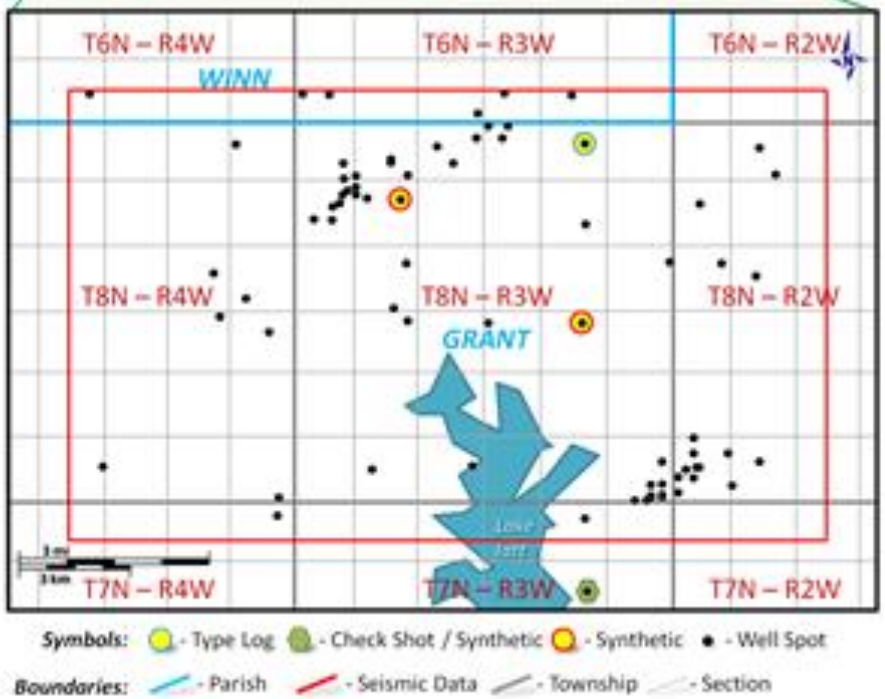
Structure Top of Wilcox Group

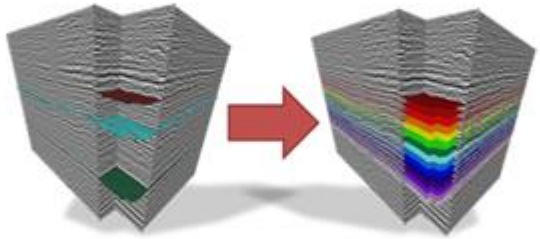


Ball and Kinsland (2009) we digitized the wells, took deepest, now have about 1500



IATT LAKE 3D...
7 miles x 12 miles

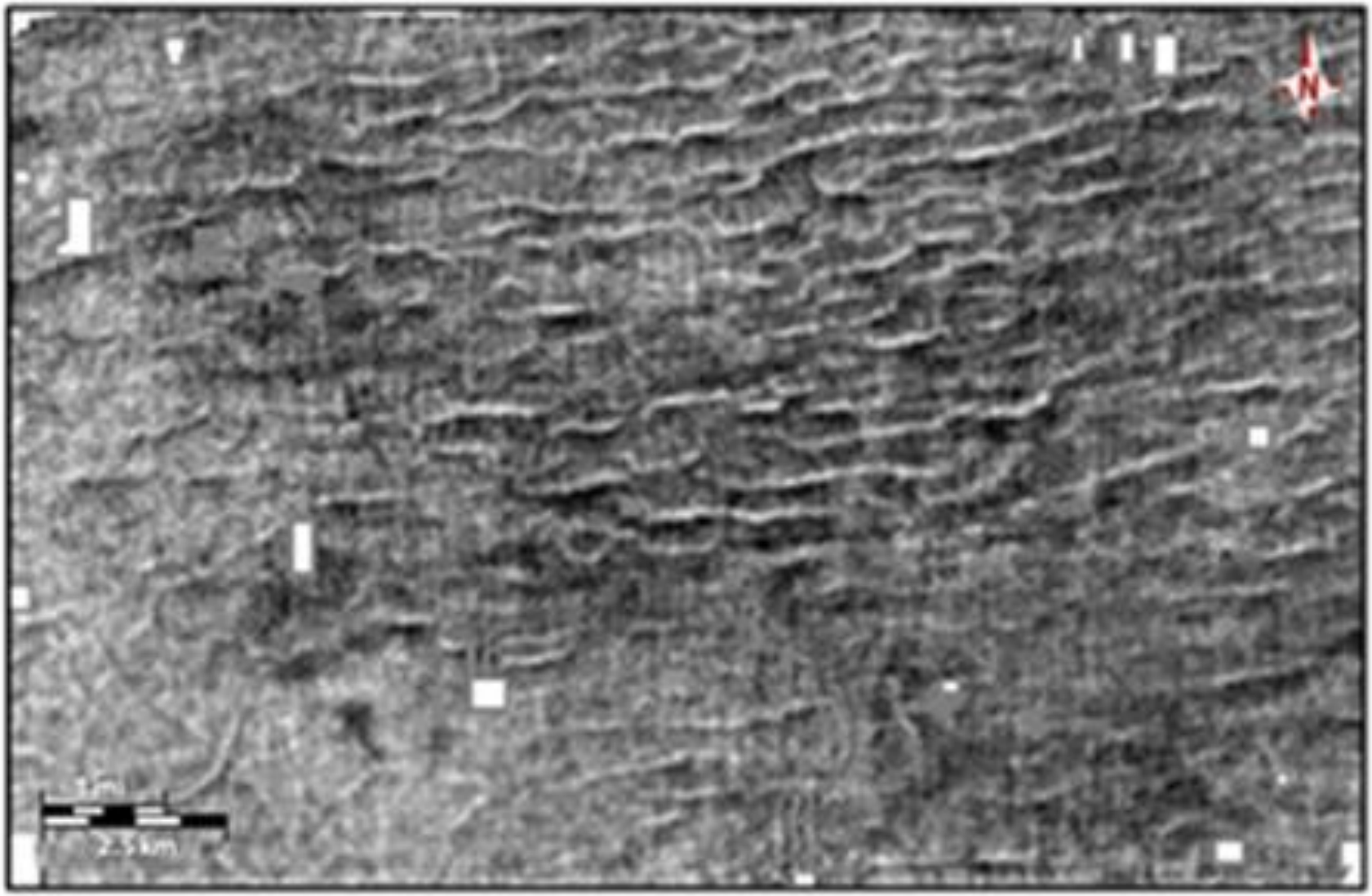




Egedahl, Kinsland and Han (2012) detailsthe study of the 3D.

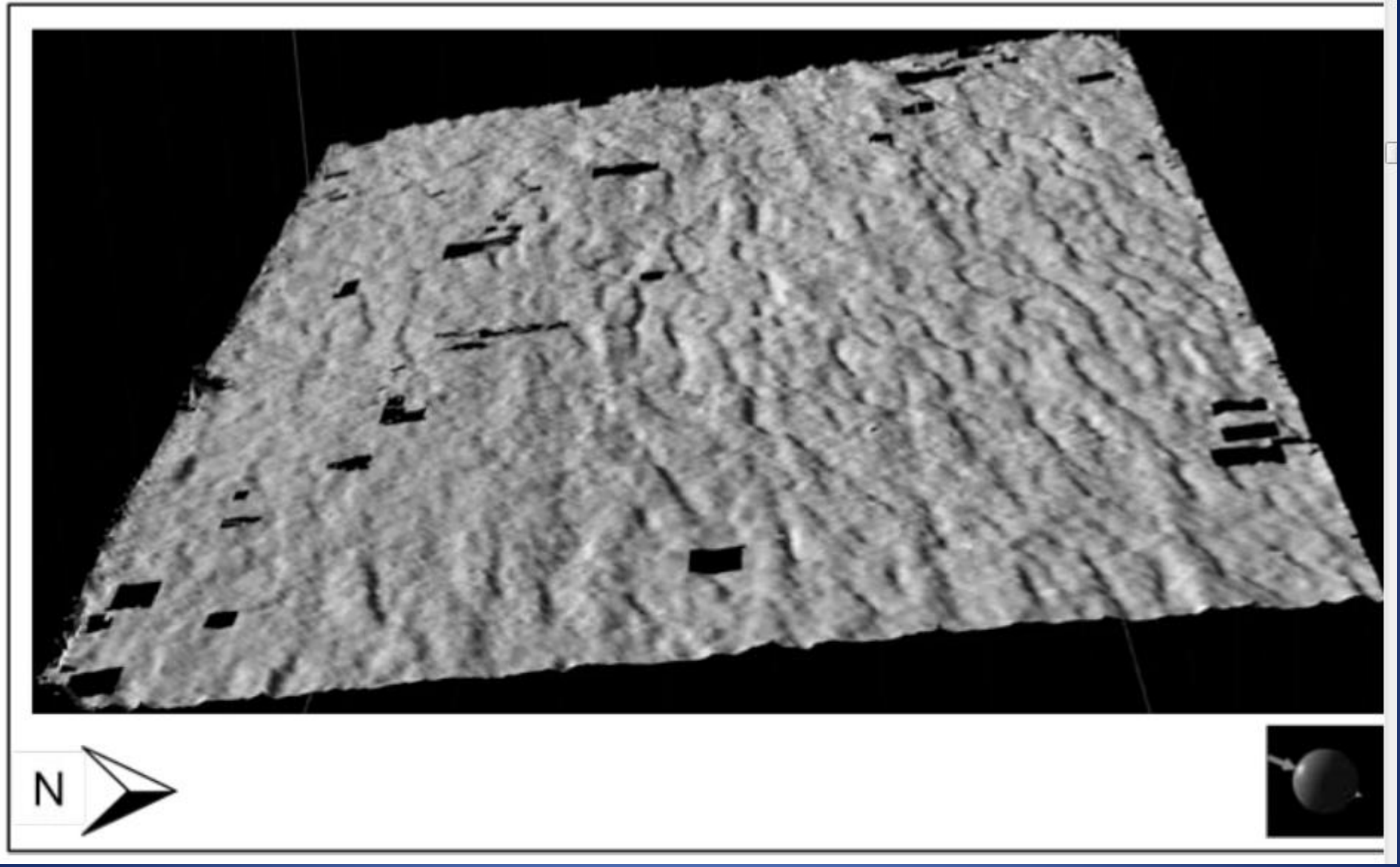
Devon Energy donated top two seconds for CBM study.

STRATAL SLICE…RIPPLES AT THE K/PG BOUNDARY…¼ TO ½ MILE WAVELENGTH.

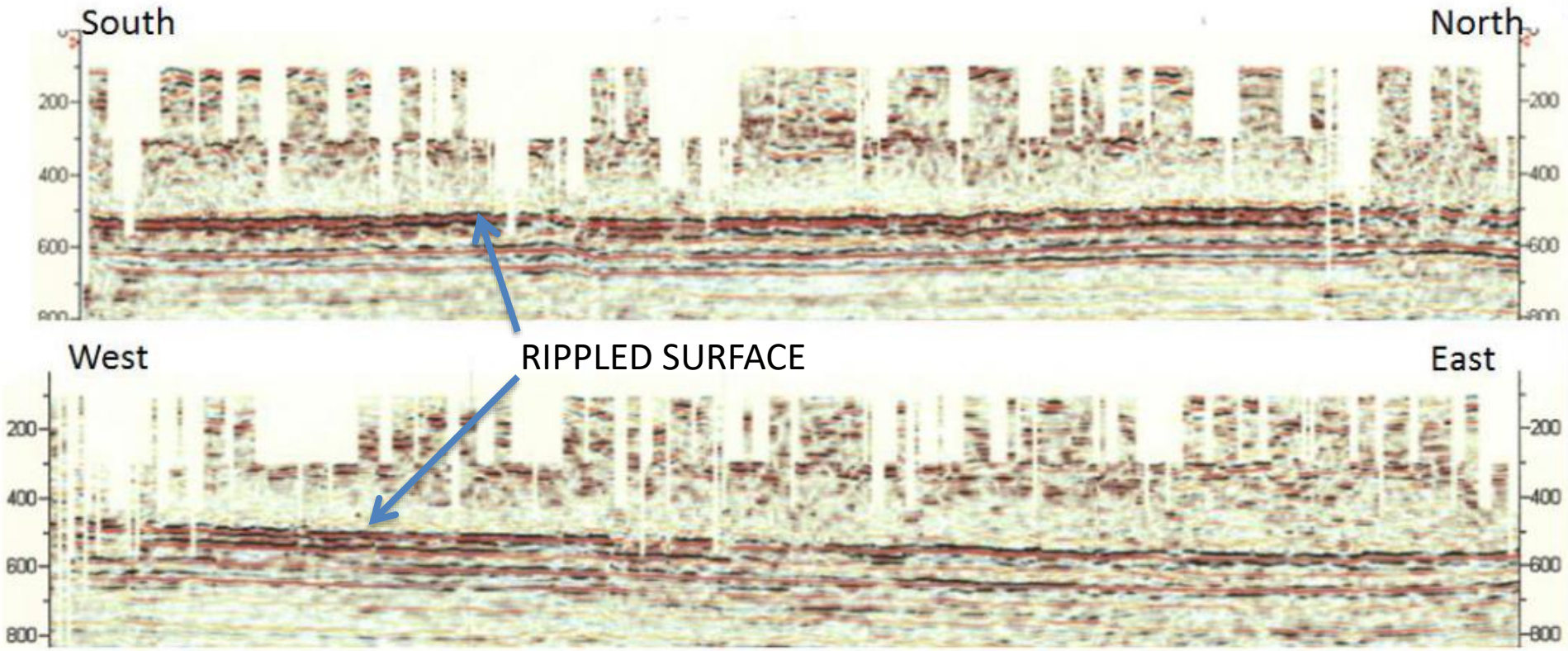


What is this?

RIPPLES FROM THE CHICXULUB IMPACT TSUNAMI



Perspective view of a mapped seismic horizon that is determined to be roughly coincident with the contact between Upper Cretaceous strata and the Paleogene Midway Shale. The seismic survey is roughly 11.5 km (7 miles) north to south and 17.7 km (11 miles) east to west. Strong (2013)(thesis). **ASYMMETRIC RIPPLES ARE ABOUT 50 FT (15 m) HIGH**



NOTE THAT RIPPLES ARE NOT OBVIOUS IN THE E-W SECTION

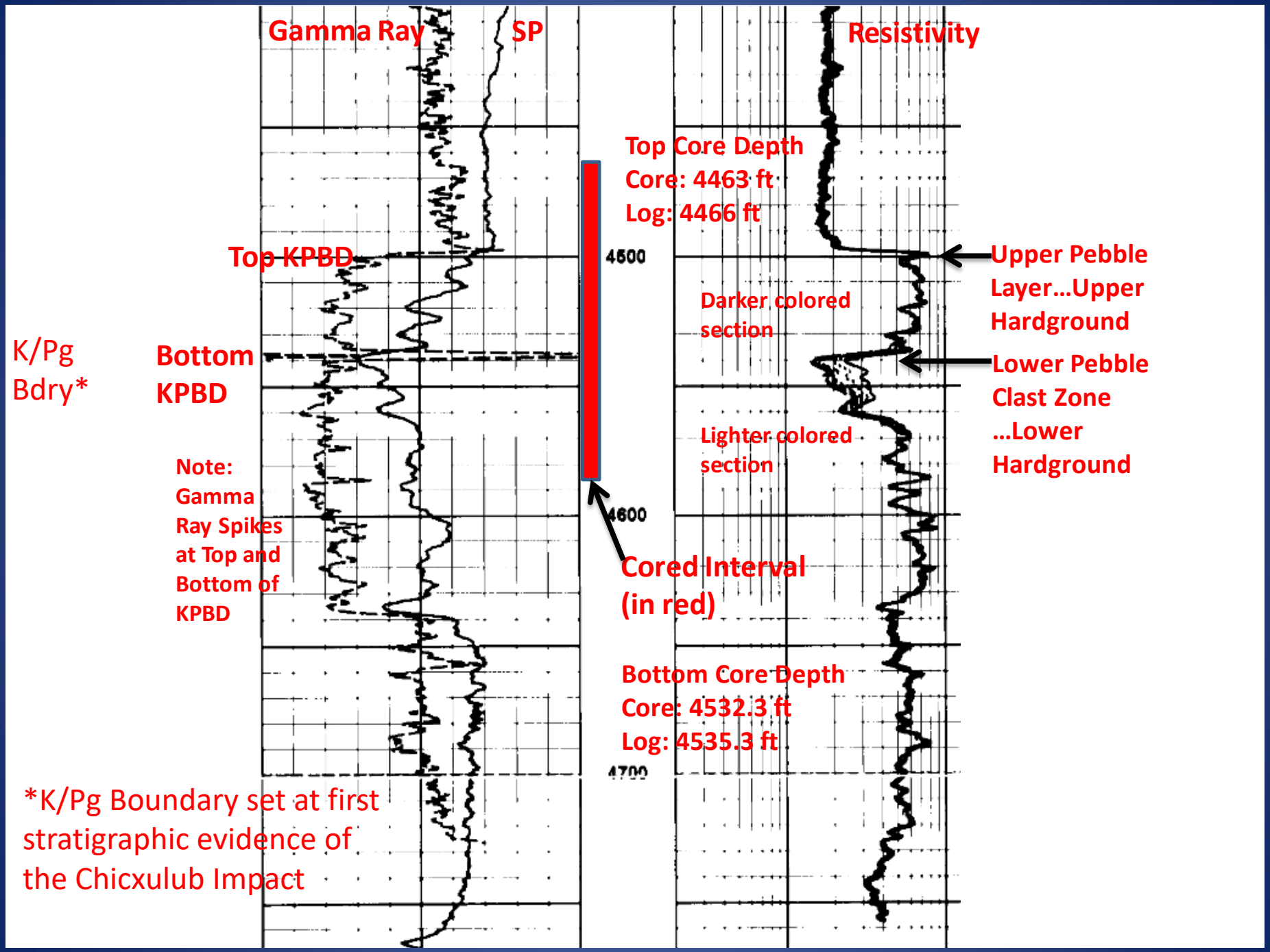
DATA FROM BODCAW 3D SURVEY…563 sq mi centered about 50 mi north-northwest of the Iatt Lake 3D

COURTESY OF SEISMIC EXCHANGE INC. (SEI)

Justiss Oil donated access to IPNH No. 2 core

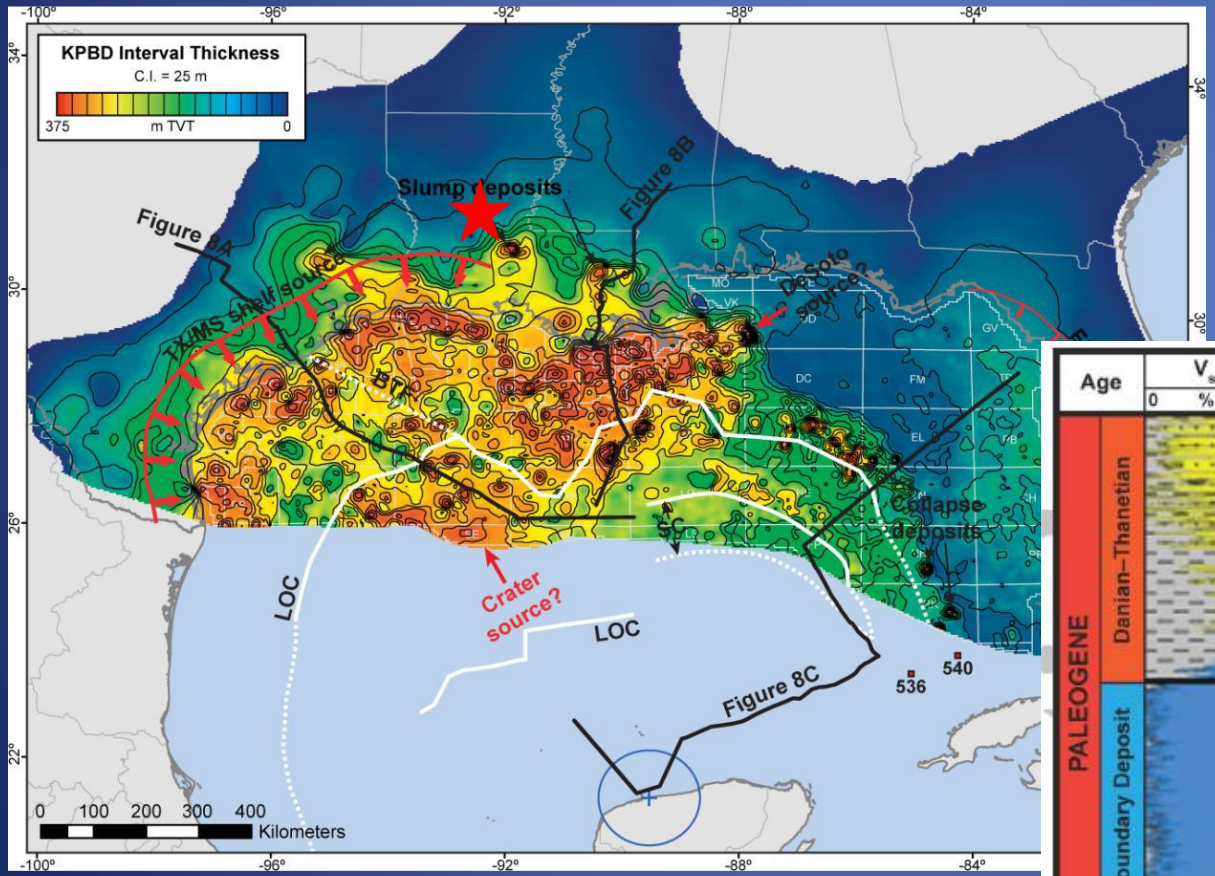
700 FT OF MIDWAY SHALE ABOVE

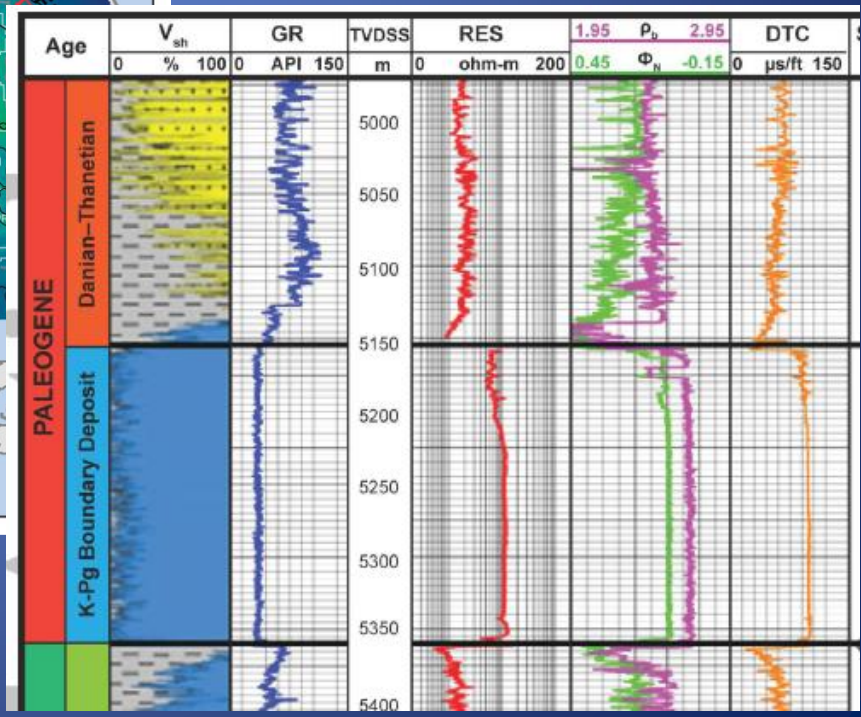
150 FT OF CARBONATE BELOW

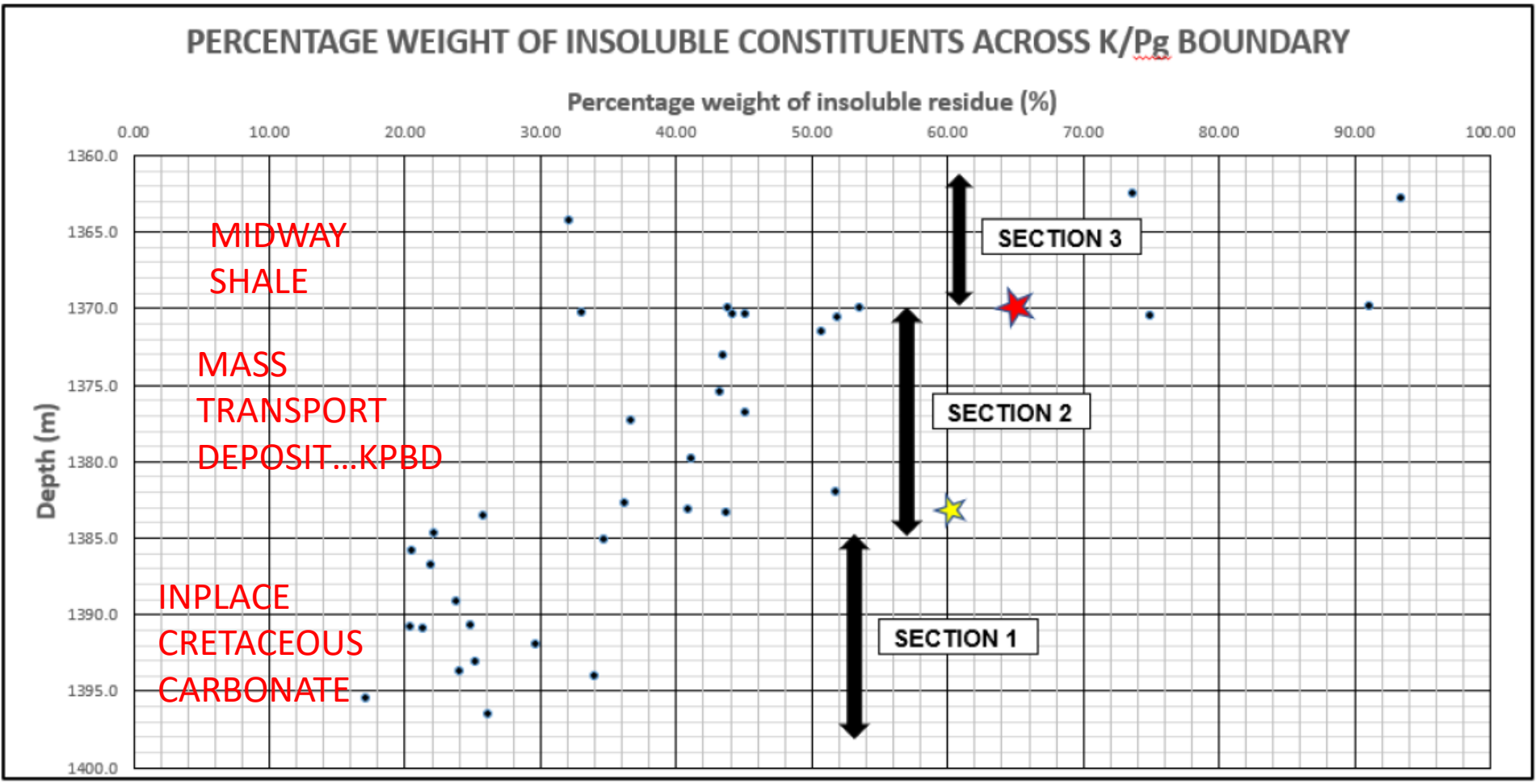

Gamma Ray
SP
Resistivity
Top Core Depth
Core: 4463 ft
Log: 4466 ft
Top KPBD
4500
Upper Pebble Layer…Upper Hardground
Darker colored section
K/Pg Bdry*
Bottom KPBD
Lower Pebble Clast Zone …Lower Hardground
Lighter colored section
Note: Gamma Ray Spikes at Top and Bottom of KPBD
4600
Cored Interval (in red)
Bottom Core Depth
Core: 4532.3 ft
Log: 4535.3 ft
4700
*K/Pg Boundary set at first stratigraphic evidence of the Chicxulub Impact

JANUARY 2016 SANFORD, SNEDDEN AND GULICK (2016) The Cretaceous-Paleogene boundary deposit in the Gulf of Mexico: Large-scale oceanic basin response to the Chicxulub impact

Defines Cretaceous/Paleogene Boundary Deposit…KPBD

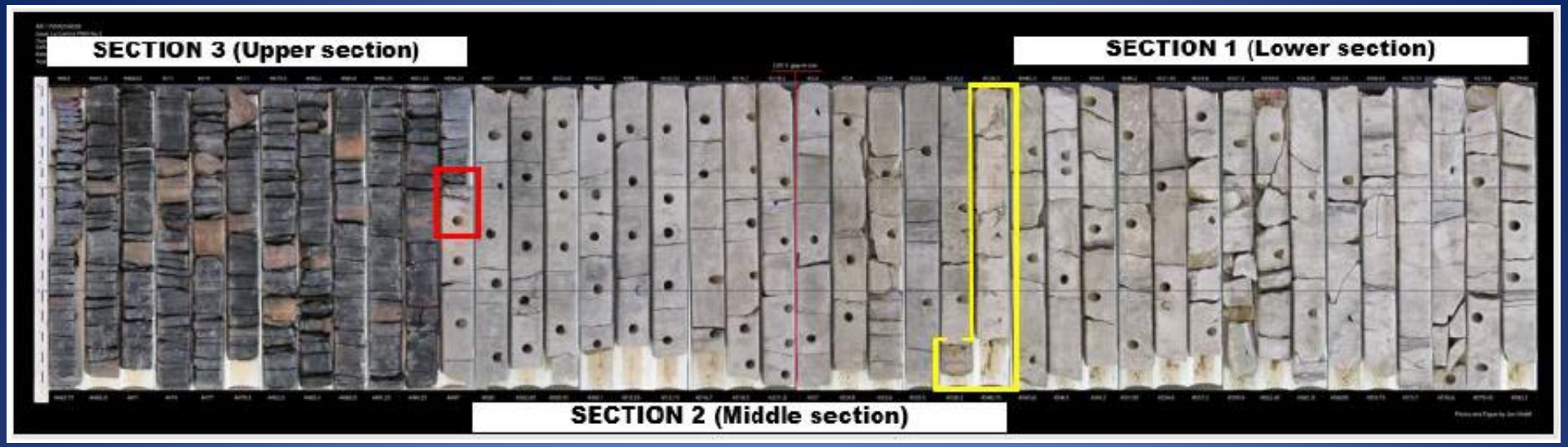






A cross-plot showing percentage weight of insoluble components of the Justiss LA Central IPNH No. 2 well-core with depth; ★ | Marks the upper hardground and rippled surface. ★ represents the lower hardground and K/Pg boundary.

(Muchiri, 2018 (thesis); Kinsland et al., 2017b)

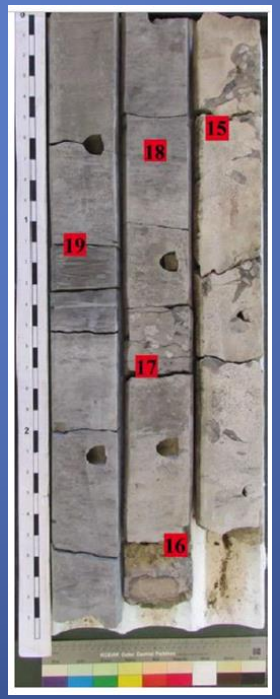


Midway Shale

Mass Transport Deposit: KPBD

Pre-impact Chalk/Marl

Upper Hard Ground



Lower Hard Ground

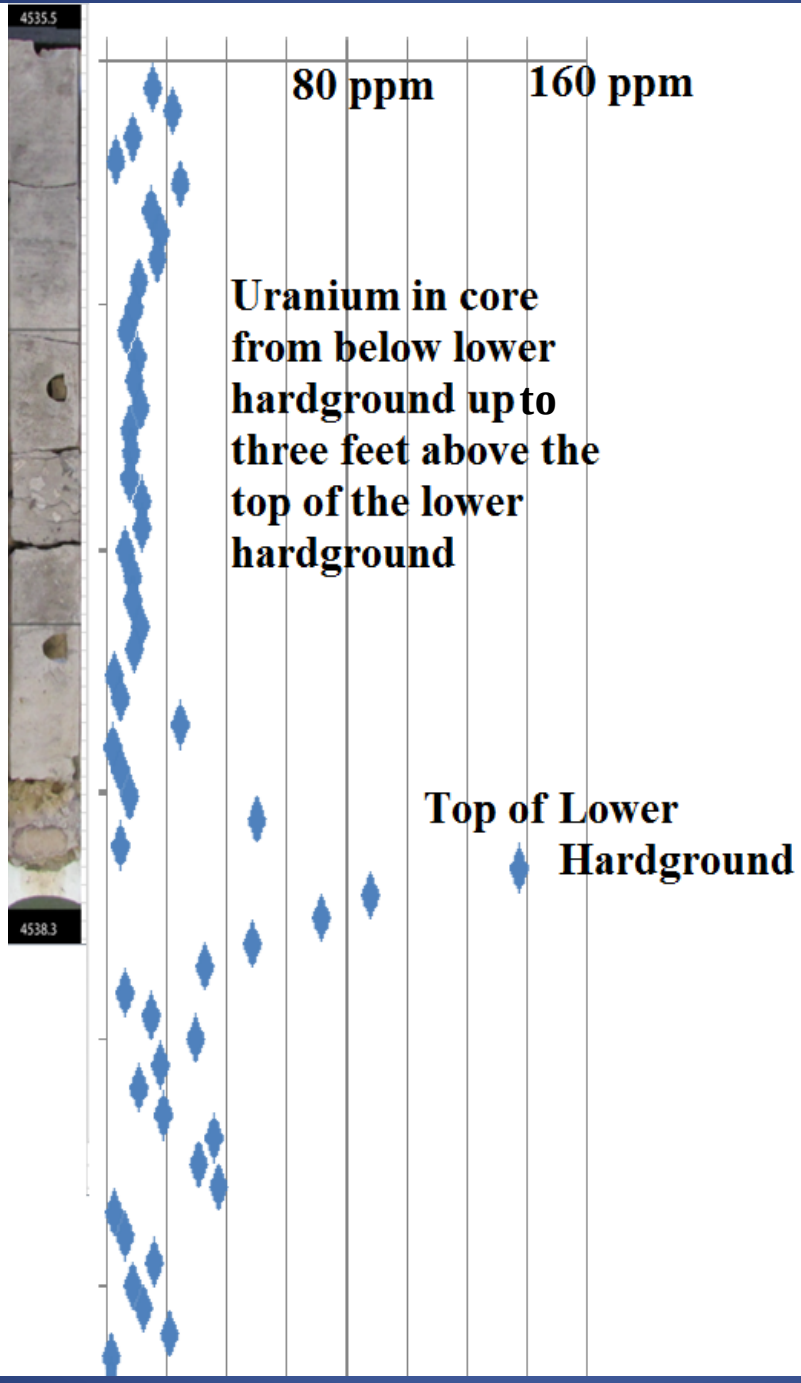
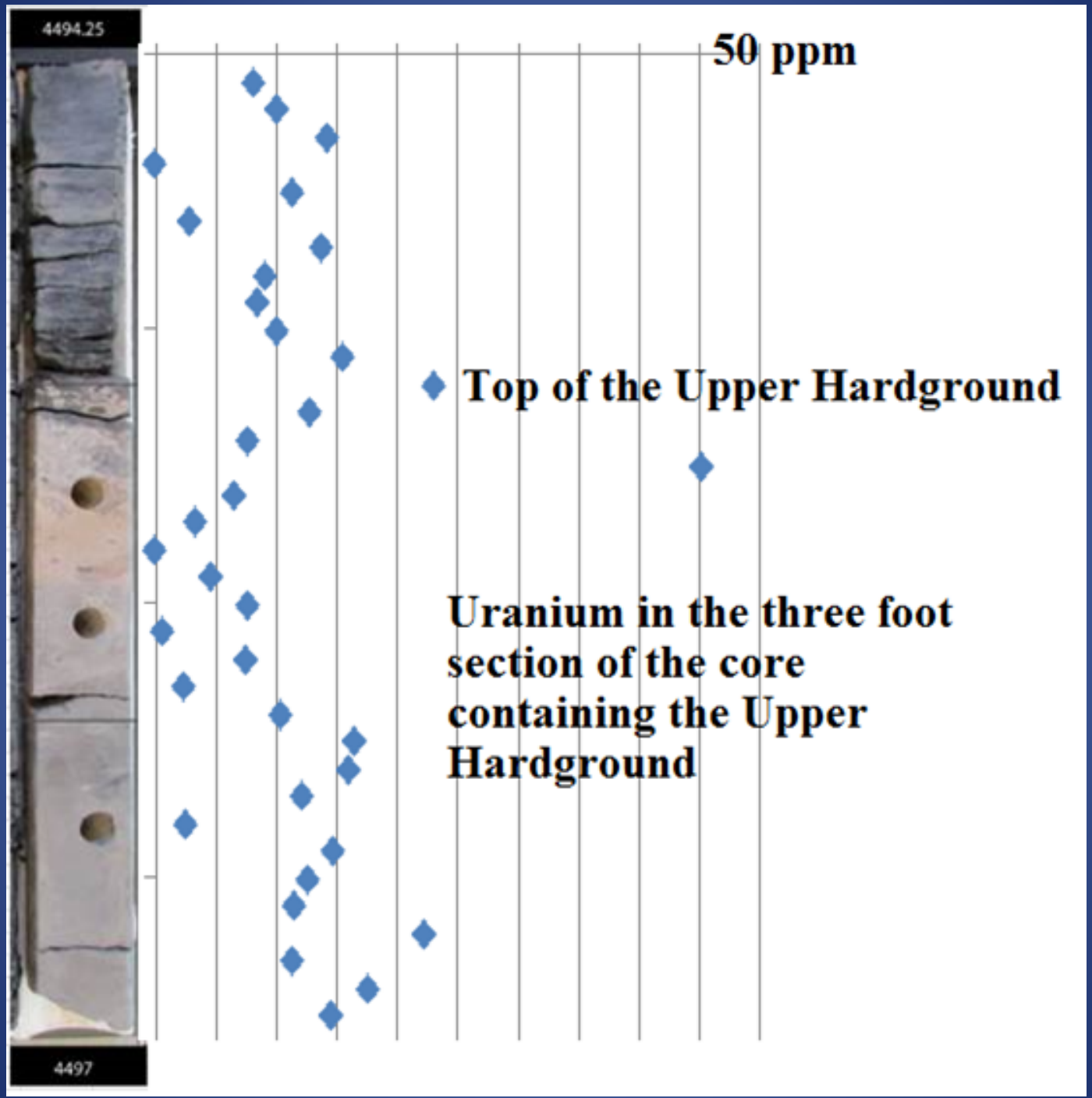
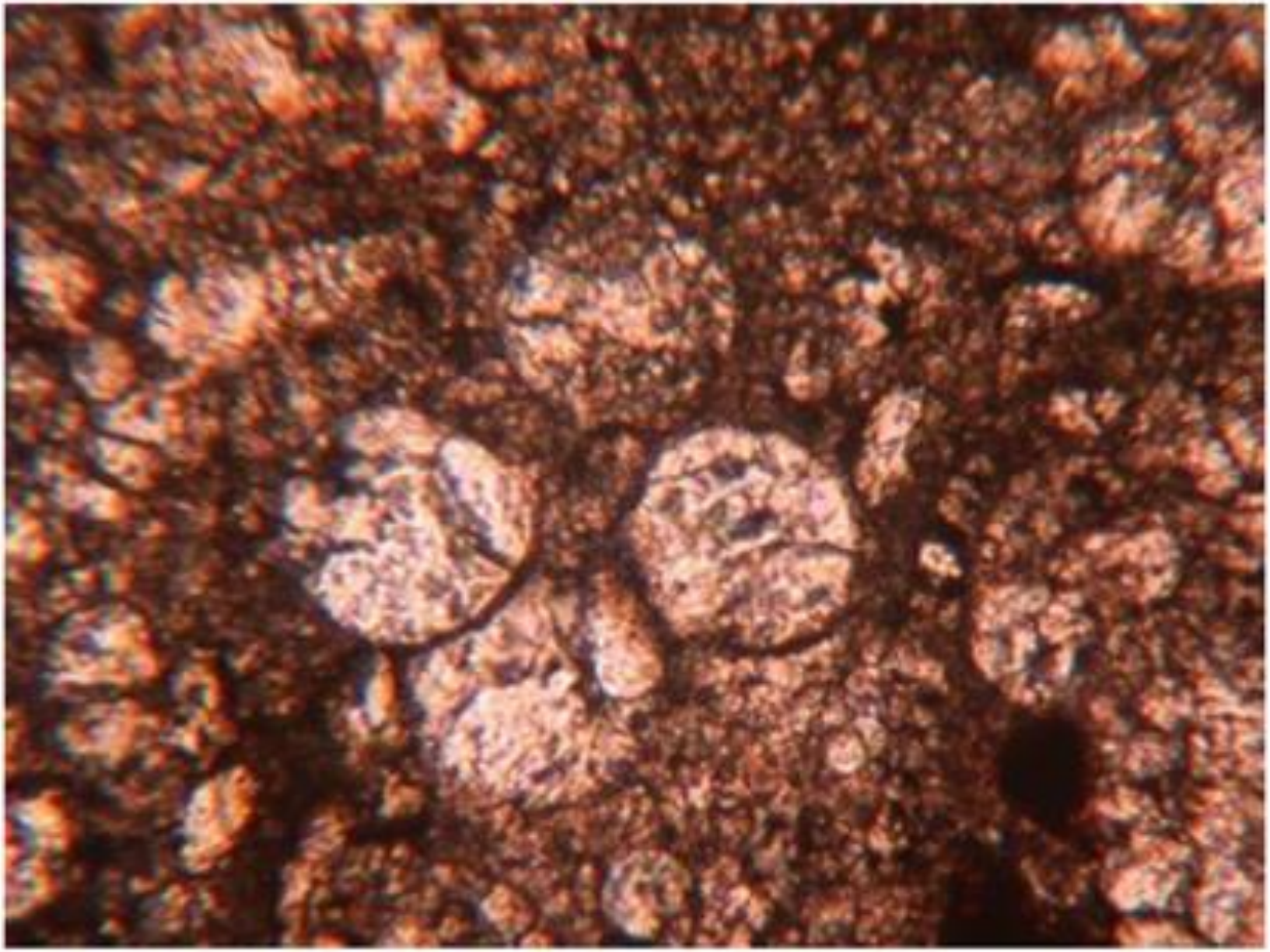


Figure: Frederick (2019) (thesis)

These and other XRF Data from core: John Virdell, UT Austin

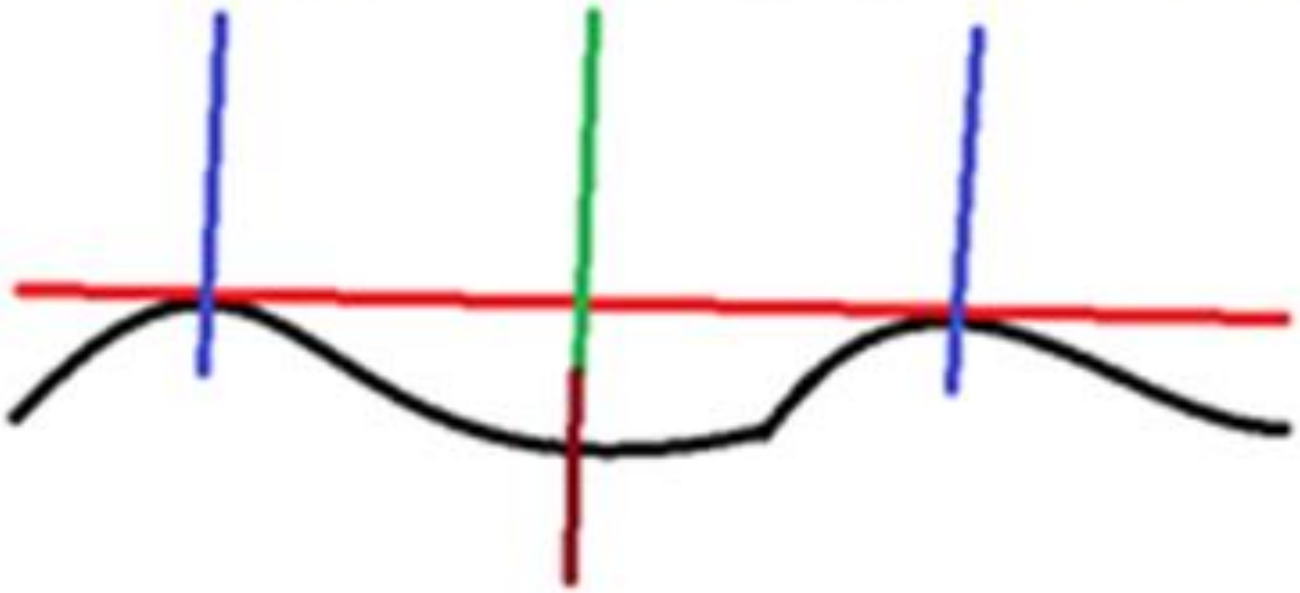

4494.25
4497
50 ppm
Top of the Upper Hardground
Uranium in the three foot section of the core containing the Upper Hardground


Muchiri (2018) thesis
ULL
SEI
15.0kV
X5,000
1μm
WD 33.0mm



Sample 30 4494'6" – 4494'4" Calcite filled spherules. Spherule diameter about 0.2 mm. Spherules are "Chicxulub Impact indicators" perhaps second only to Ir which we have yet to seek.

How we came to have the special IPNH #2 core across the boundary?

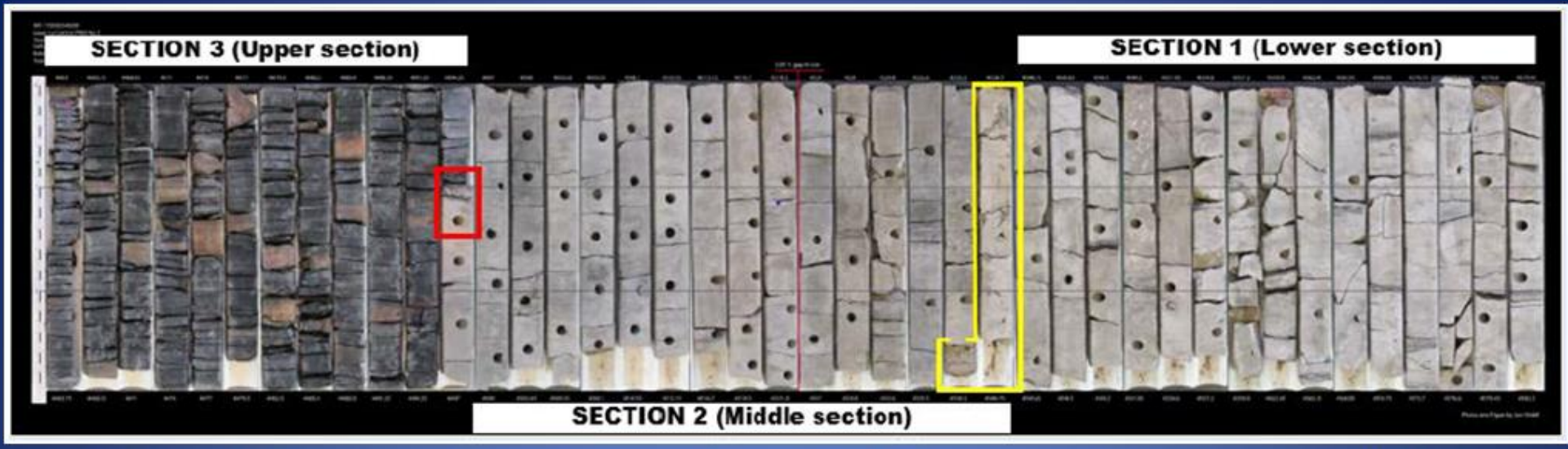


Black line	Rippled Surface of KPBD
Blue lines	Two Earlier Wells
Red line	Erroneously Mapped KP Surface
Green line	Well Expecting KP at Red Elevation
Maroon line	Core Barrel Set Early

Interpretation of the Core (numbered in time order…bottom up)

6) Paleogene terrestrially sourced clays of the Midway Shale
5) less-well-developed hardground, “upper pebble layer” of Kinsland et al. (2017), with some material ballistically/atmospherically transported from the Chicxulub Impact site.
4) Modification by tsunamis from the impact
3) mass transport deposit mobilized by the Chicxulub Impact earthquake (Sanford et al., 2016), at least at this locality, material from up-dip was transported over intact hardground. The mass transport/hardground contact is then the K/Pg boundary (Molina et al., 2006),
2) a well-developed marine hardground, that this “lower pebble clast zone” of Kinsland et al. (2017) is a hardground was originally suggested by Galloway (2017)
1) relatively undisturbed Upper Cretaceous coccolith rich chalk (marl) Kinsland et al. (2017), Muchiri (2018), Shellhouse (2017)

NOW…HYPOTHESES RELATING THE CHICXULUB IMPACT'S INFLUENCE ON PETROLEUM MIGRATION AND TRAPPING



Midway Shale

Mass Transport Deposit: KPBD

Pre-impact Chalk/Marl

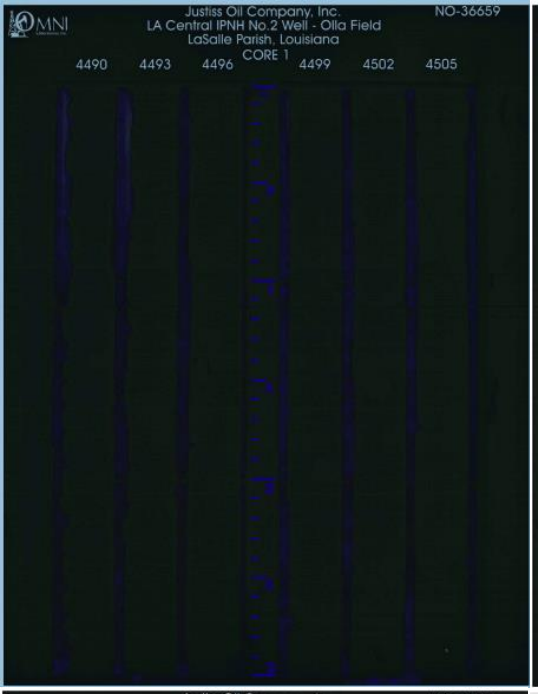
Many regular coring/ expansion fractures.

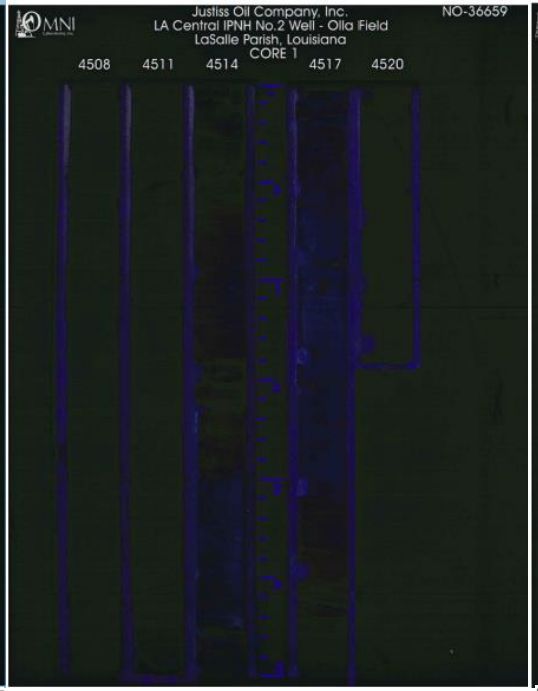
Dominantly coring/expansion fractures

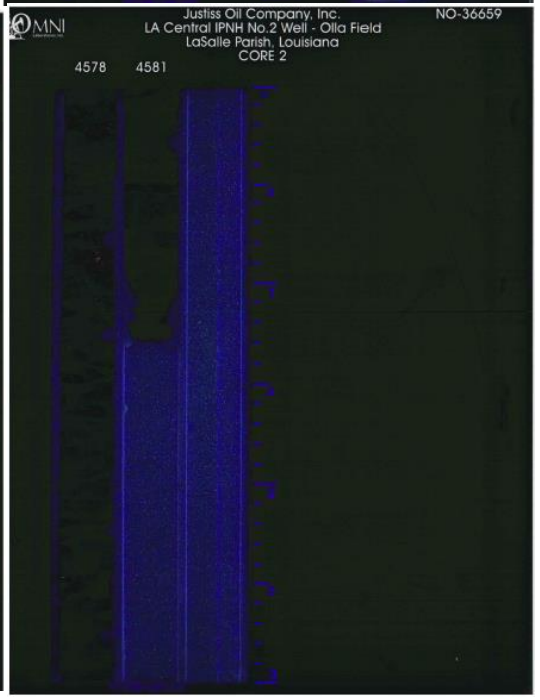
Many irregular fractures

I interpret the irregular fractures in the pre-impact Cretaceous carbonates to be the result of the mega-quake (estimates from magnitude 12 to 14) from the Chicxulub Impact. Ground displacements of a meter have been observed in magnitude 9 earthquakes. Magnitude 10 would yield 10 meters, magnitude 11 – 100 meters, magnitude 12 – 1000 meters... Two things are clear 1) such displacements as for a 12 - 14 did not happen, 2) large displacements surely did occur.

I suggest that the earthquake from the impact fractured the Cretaceous strata enhancing vertical permeability.







UV fluorescence of the six boxes of display core.

Oil trapped below KPBD. Justiss has produced from this straight hole from this horizon. They produce from other wells in the area with horizontal wells in this horizon.

12-4-06

OMNI Laboratories, Inc.

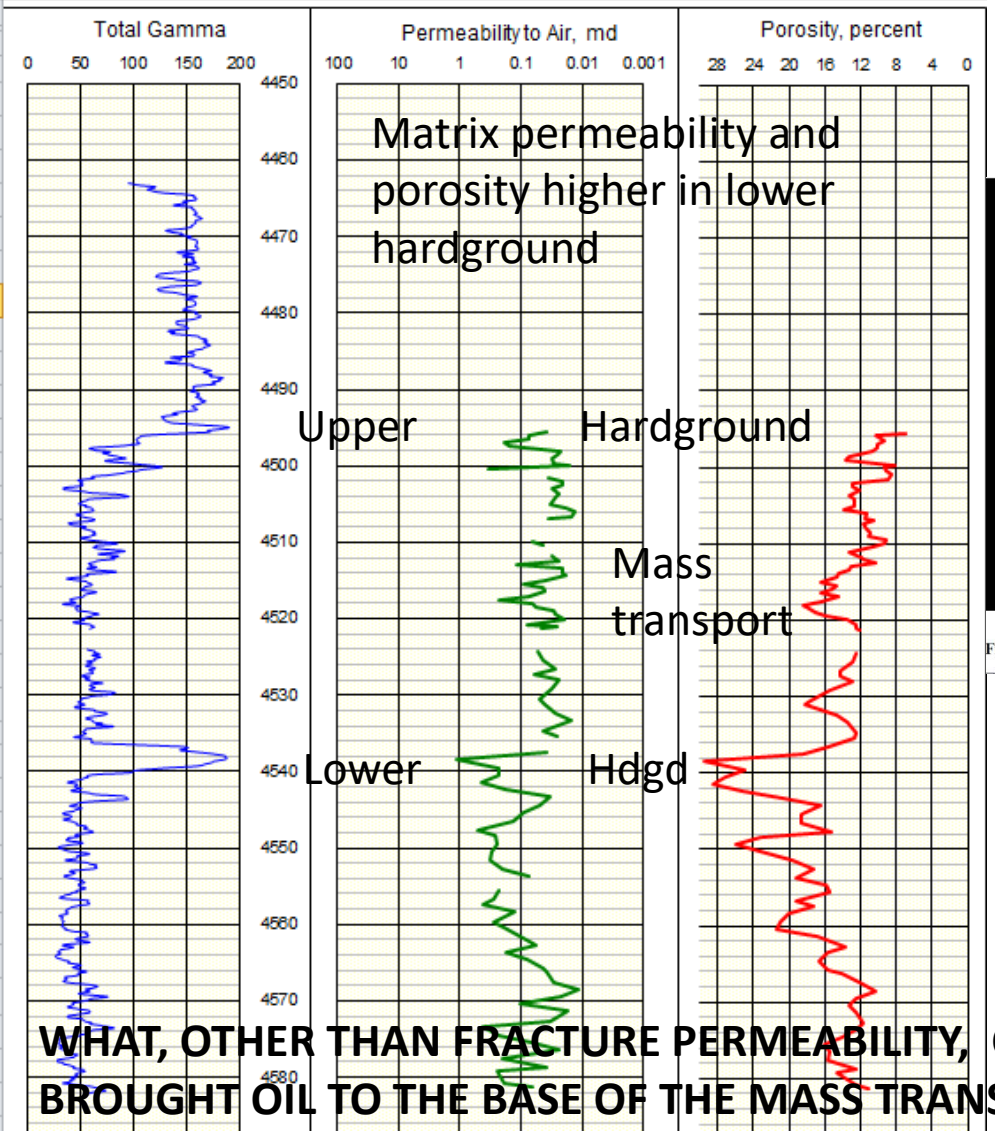
CORE GAMMA, PERMEABILITY, AND POROSITY PROFILE PLOT

VERTICAL SCALE 5 inch:100 feet

Justiss Oil Company
LA Central IPNH No. 2
LaSalle Parish, Louisiana

Olla Field
File: NO-36659

Core 1 & 2



WHAT, OTHER THAN FRACTURE PERMEABILITY, COULD HAVE BROUGHT OIL TO THE BASE OF THE MASS TRANSPORT?

Thin section images from Shellhouse (2014)(Thesis)

Typical of mass transport

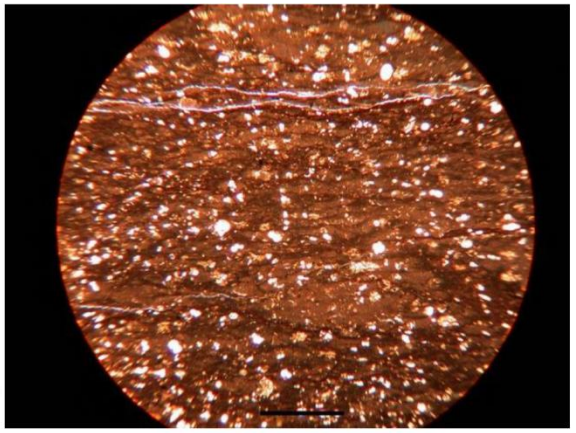


Figure 14. Sample 24 thin section, 4504'5"-4504'3". 2.5x lens, plane polarized light, 1 mm scale bar at bottom.

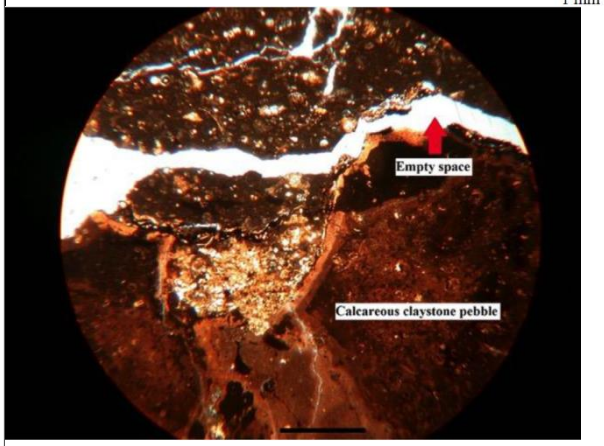


Figure 13. Sample 16 thin section, 4538'2"-4538'0". 2.5x lens, plane polarized light, 1 mm scale bar at bottom.

Each of these two is from the upper portion of the lower hardground.

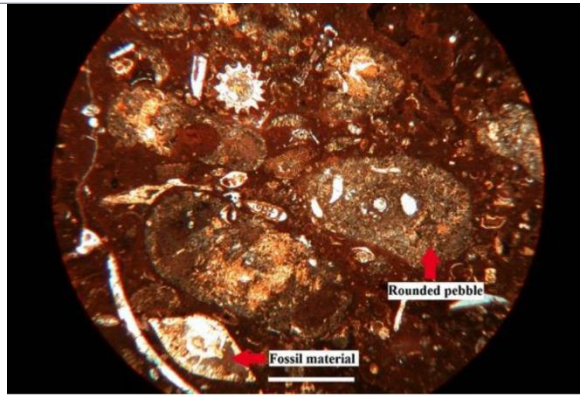


Figure 12. Sample 15 thin section, 4538'10"-4538'8". 2.5x lens, plane polarized light, 1 mm scale bar at bottom. Porous rounded calcareous pebbles in clay matrix.

ARE THERE OTHER AREAS AROUND THE GULF OF MEXICO BASIN WHERE FRACTURES BROUGHT THE OIL TO THE BASE OF THE MASS TRANSPORT*…HAVE THEY ALL BEEN FOUND…HAVE WE LOOKED FOR THEM?

HOW MANY OF THE LARGER IMPACTS (SHOWN IN THE WORLDWIDE MAP) HAVE PRODUCED SIMILAR (OR OTHER) IMPACT EFFECTS WHICH HAVE AFFECTED MIGRATION/TRAPPING…HAVE ANY BEEN FOUND…HAVE WE LOOKED FOR THEM

*The Cantarell Complex in the Bay of Campeche, Mexico is hosted in shelf collapse carbonates and sealed by ejecta and tsunami deposits.

Egedahl, K. D. V., 2012, Seismic facies study of 3D seismic data, northern Louisiana, Wilcox Formation: Master's Thesis, University of Louisiana at Lafayette, Lafayette, Louisiana, 86 p.

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