Chicxulub Impact Tsunami Deposits at the K–Pg Boundary in Northern Louisiana?*

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Abstract

Features resembling large-scale dunes with average trough-to-trough length of 600 m (1,970 ft) and average trough-to-peak height 16 m (52 ft) exist on a seismic horizon at or near the Cretaceous-Paleogene (K–Pg) boundary over the 200 km^2 (77 mi^2) of a 3D seismic survey from northern Louisiana. We examined the seismic data volume to determine whether the features observed in the data represent acquisition or processing artifacts. We conclude that the features are neither due to acquisition footprints nor to other data artifacts and are images of paleotopography as expressed in the distinctive seismic horizon characteristic of the uppermost Cretaceous strata.

Seismic velocities determined from correlation of several well logs with the seismic data and volume of shale calculations performed on the well log data are utilized to investigate the possible lithology of the unit within which the dunes are developed. The results are consistent with the expectation that the uppermost Cretaceous is the Arkadelphia Marl as is common over northern Louisiana. Further investigations are underway to determine the true lithology and paleontology within these dune-like features.

We investigated several possible depositional processes which might explain these dune-like features, including soft-sediment slumping, eolian dune deposition, mega-flood deposits and tsunami-caused subaqueous dunes (in particular those of the 2011 Tohokuoki tsunami at Kesennuma Bay, Japan). Our hypothesis is that these features represent large-scale, flow-transverse bedforms emplaced by tsunami waves generated by the end-Cretaceous Chicxulub impact event on the Yucatán Peninsula.

References Cited

Blakey, R., Colorado Plateau Geosystems Inc., Paleogeography library. Web Accessed June 13, 2013, http://cpgeosystems.com/globaltext2.html.

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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Færseth, R.B., and B.H. Sætersmoen, 2008, Geometry of a major slump structure in the Storegga slide region offshore western Norway: Norwegian Journal of Geology, v. 88, p. 1-11.

Johnston, J.E. III, P.V. Heinrich, J.K. Lovelace, R.P. McCulloh, and R.K. Zimmerman, 2000, Folio series no. 8: Stratigraphic Charts of Louisiana 2000, 5 p.

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Moore, J.G., R.A. Schweickert, J.E. Robinson, M.M. Lahren, and C.A. Kitts, 2006, Tsunami-generated boulder ridges in Lake Tahoe, California-Nevada: Geology, v. 34/11, p. 965-968.

Scheffers, A., 2006, Ripple marks in coarse tsunami deposits: Annals of Geomorphology, Supplementary, v. 146, p. 221-233.

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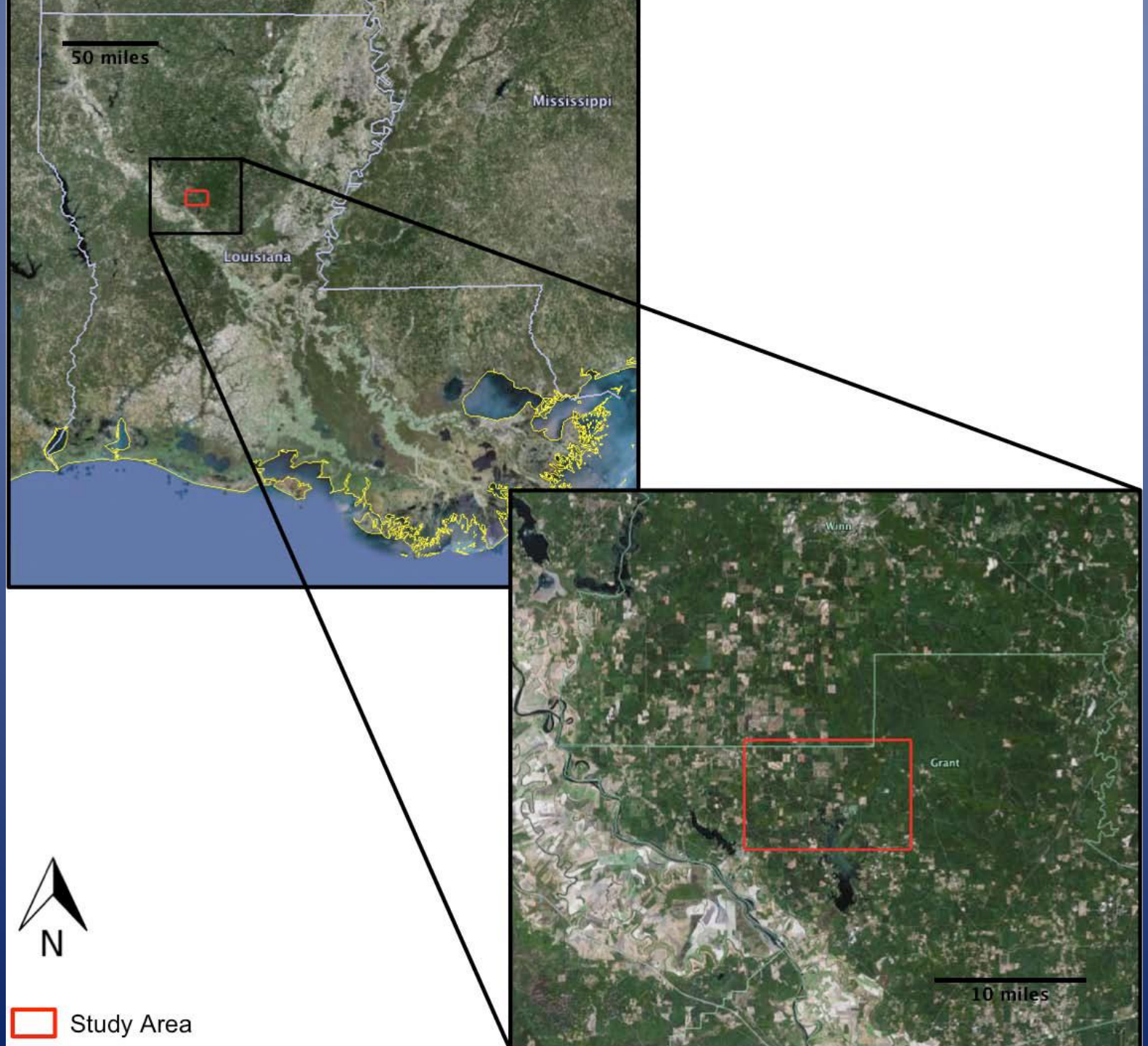
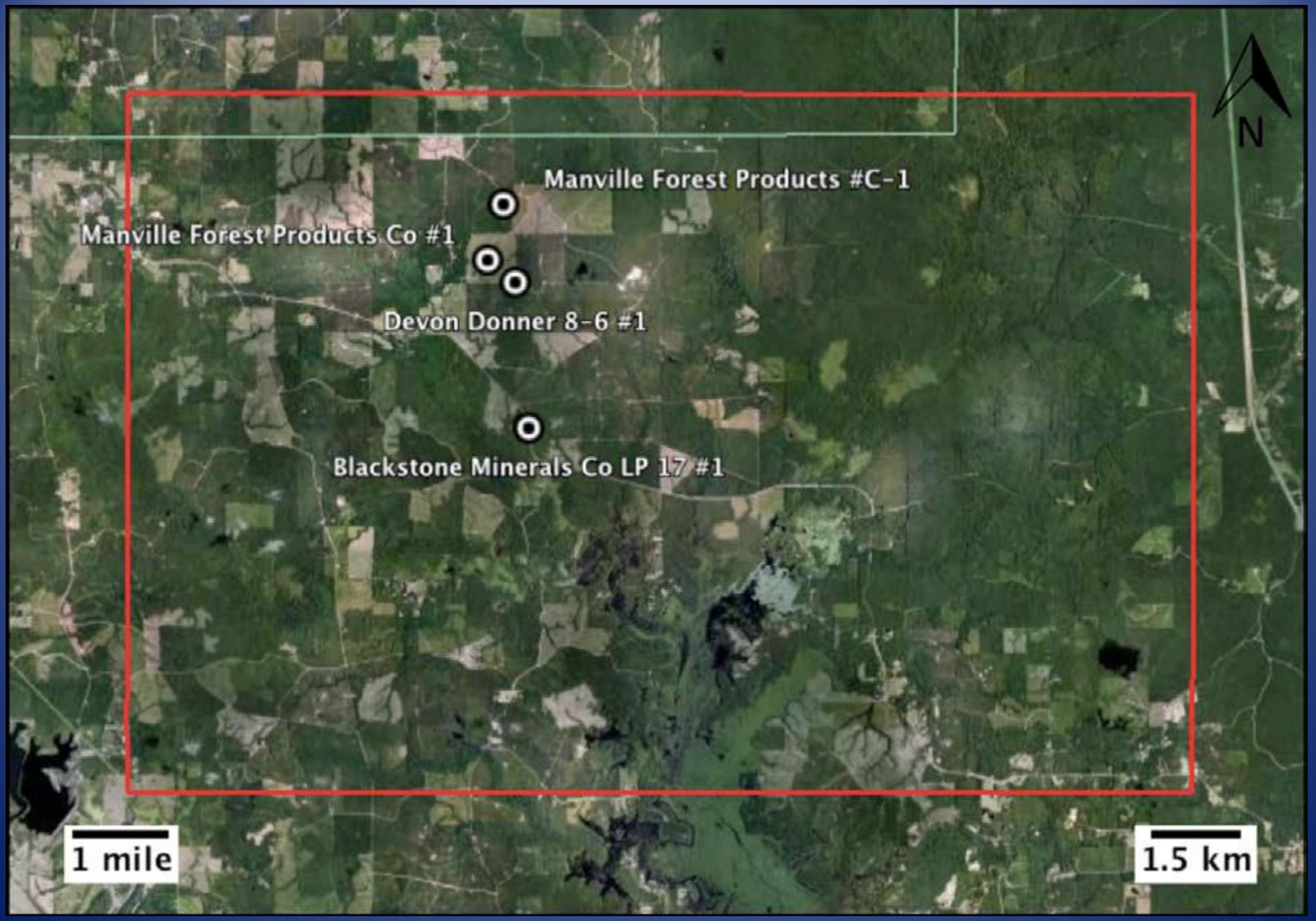

50 miles
Mississippi
Louisiana
Winn
Grant
10 miles
N
Study Area


Manville Forest Products #C-1
Manville Forest Products Co #1
Devon Donner 8-6 #1
Blackstone Minerals Co LP 17 #1
N
1 mile
1.5 km

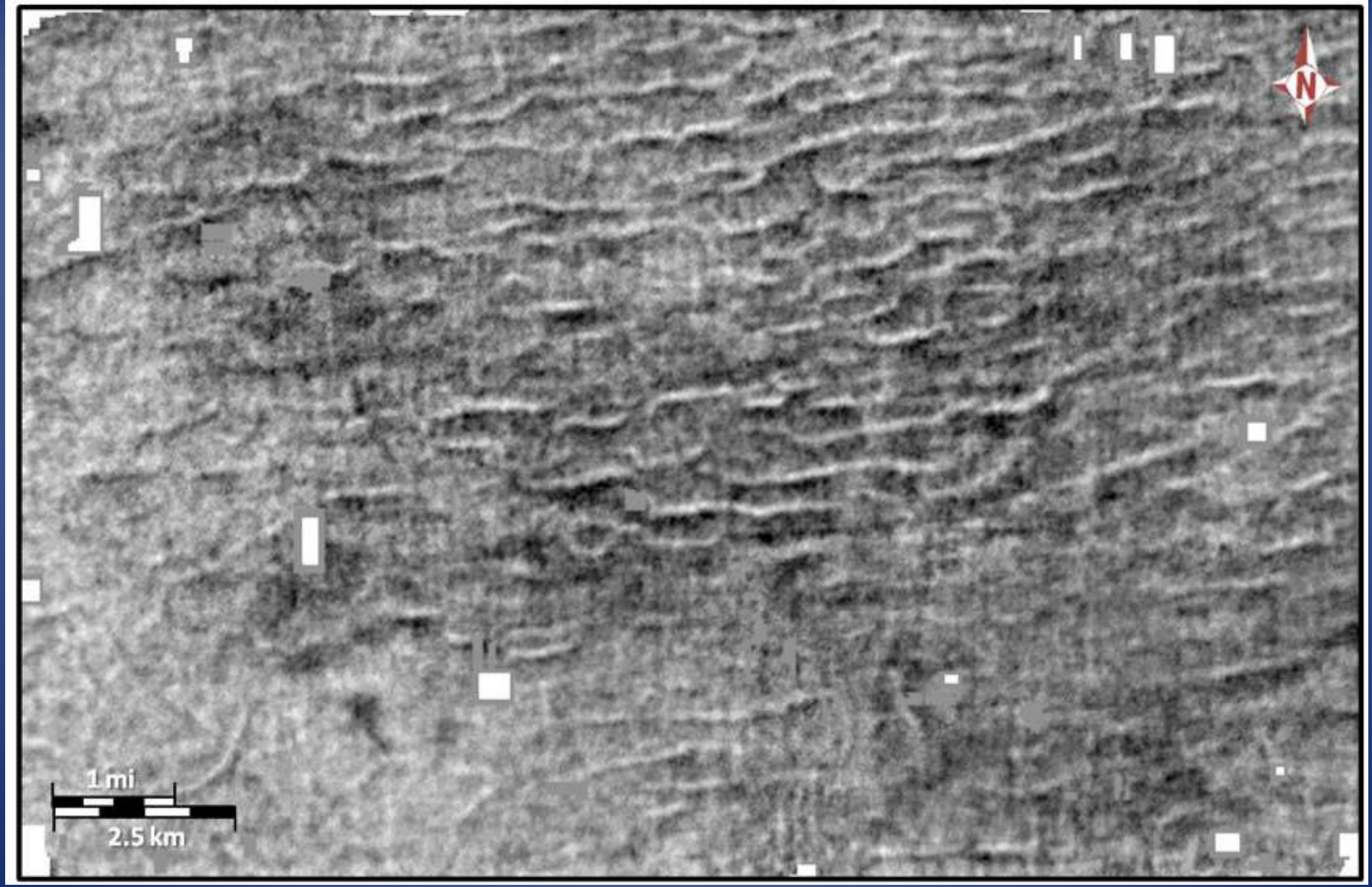
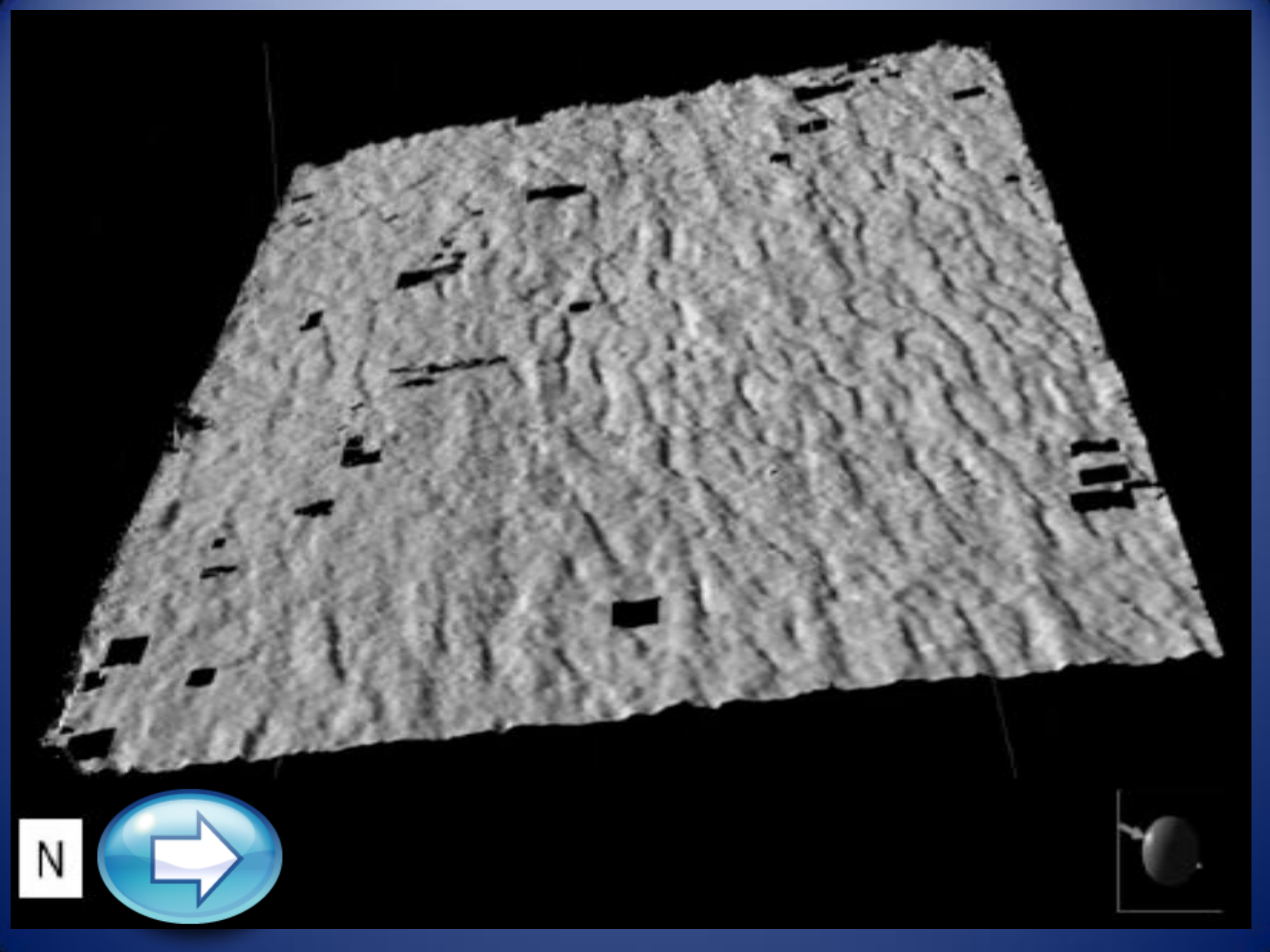
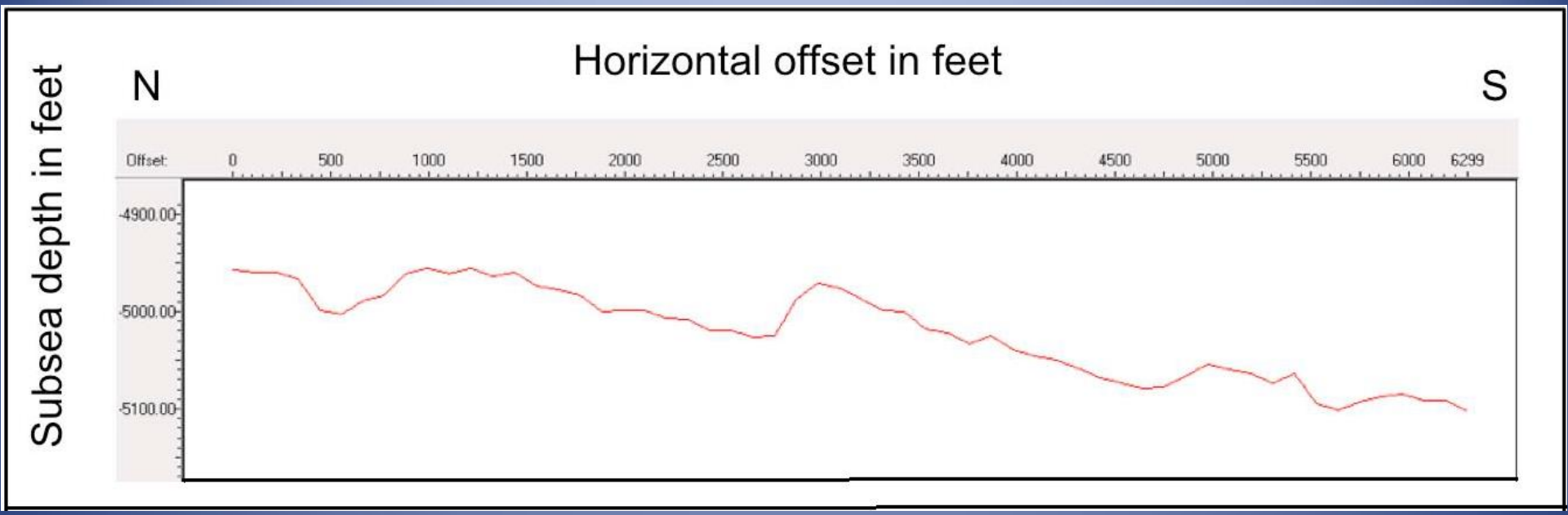


IMAGE FROM THESIS OF KAARE EGEDAHL (2012) AND EGEDAHL ET AL. (2012).
DATA FROM TOP TWO SECONDS OF 3D DATA VOLUME DONATED BY DEVON ENERGY


N

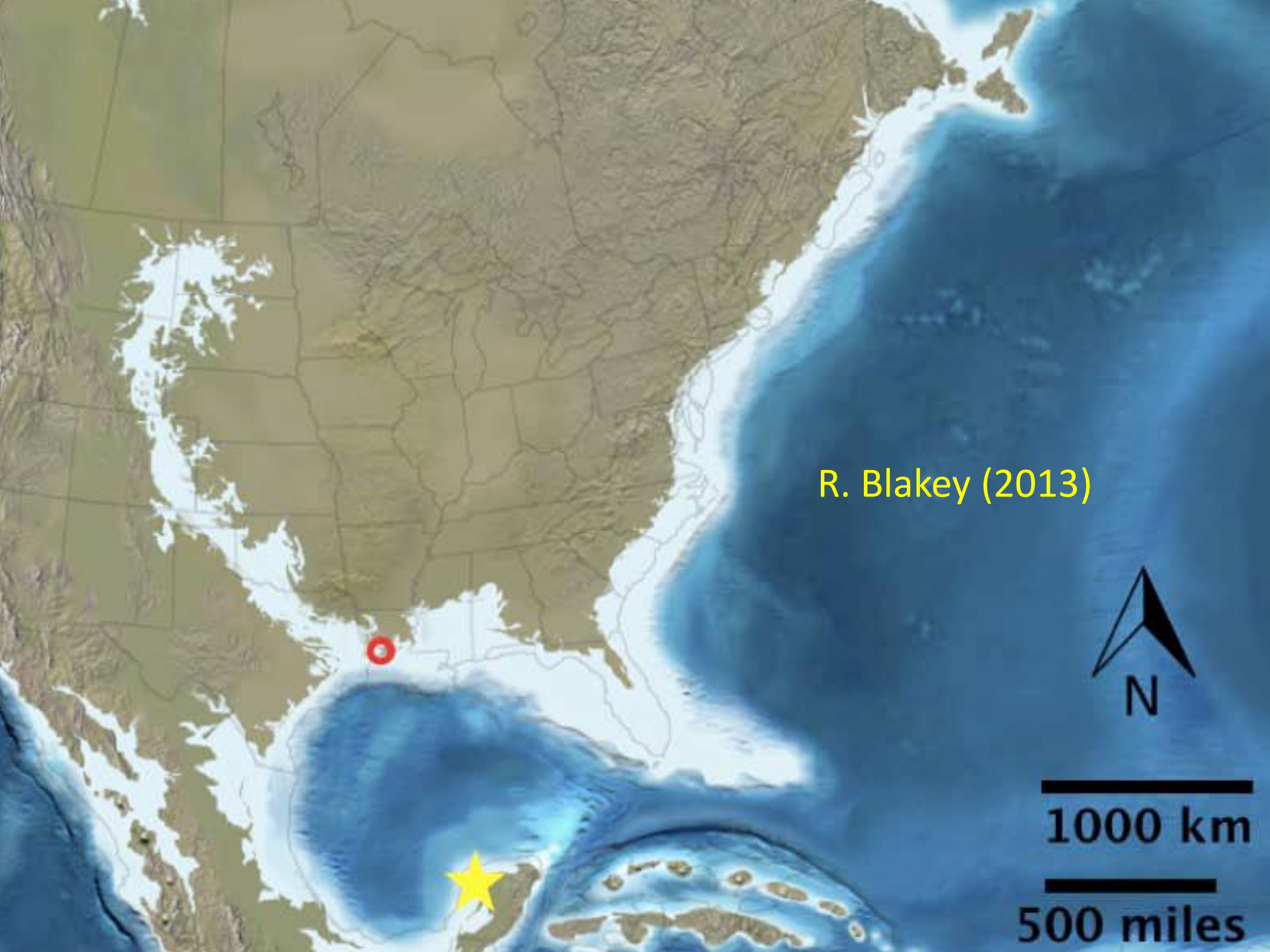


SECTION FROM TIME-DEPTH CORRECTED SEISMIC DATA. NOTE SOUTHERLY DIP. WAVELENGTH ABOUT 2000 FEET. COMPACTED AMPLITUDE ABOUT 60 FEET. STOSS SLOPE ROUGHLY SOUTHERLY FACING.

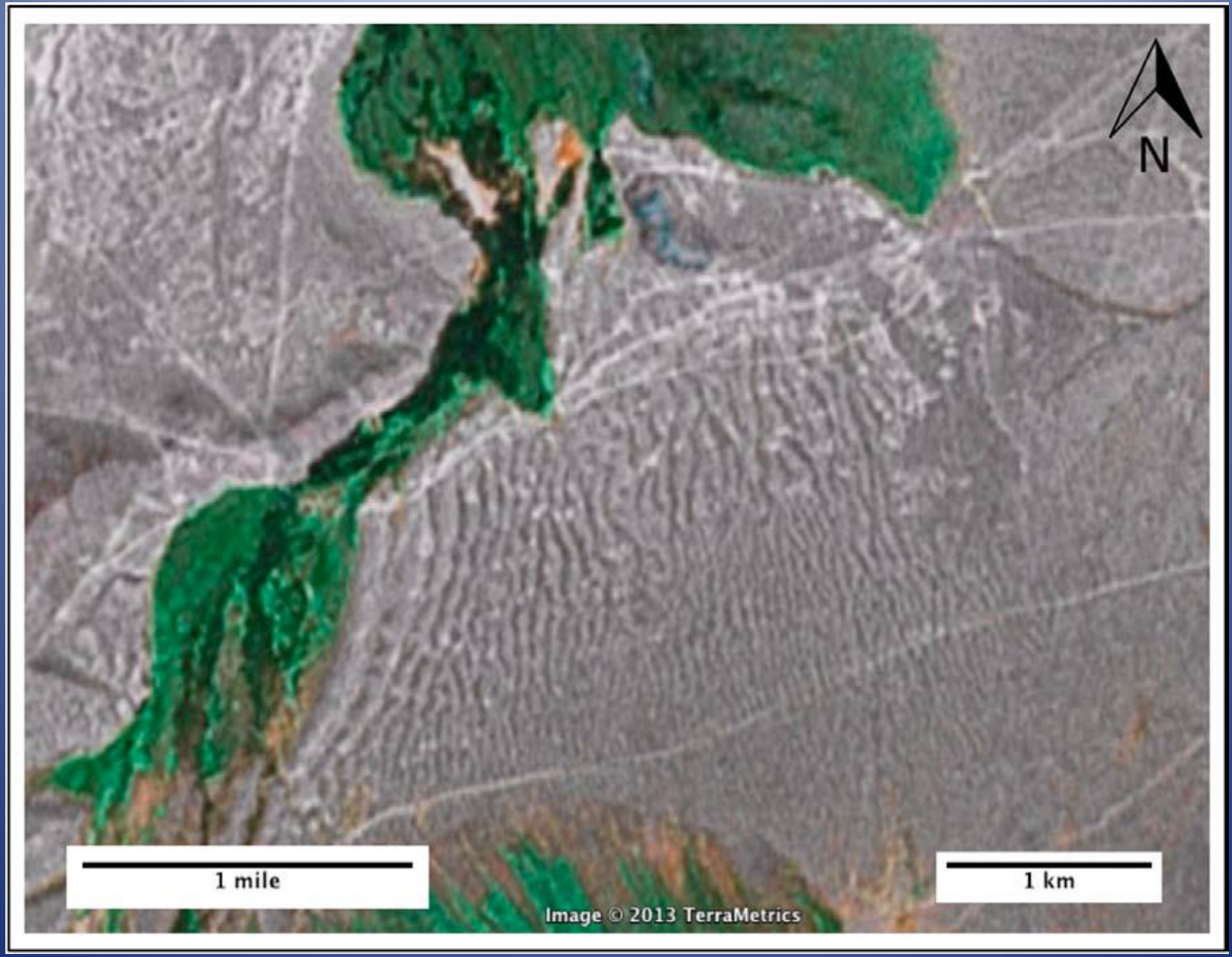
ERATHEM	SYSTEM	SERIES	GROUP	FORMATION/ MEMBER	REMARKS
CENOZOIC	PALEOGENE	PALEOCENE	Wilcox	Sabinetown	These are surface units ; generally undifferentiated in the subsurface.
				Pendleton	
				Marthaville	
				Hall Summit	4) Informal usage lumps Carrizo Formation with Wilcox Group.
				Lime Hill [5]	
				Converse	5) Formerly designated as members of the Logansport Formation.
				Cow Bayou [5]	
				Dolet Hills [5]	
				Naborton	
			Midway	Porters Creek Clay	These units are present only very locally at the surface.
				Kincaid	
MESOZOIC	CRETACEOUS	GULF	Navarro *	Arkadelphia	The only Mesozoic rocks (all upper Cretaceous) that have been identified at the surface are those on a few piercement salt domes in the northern part of the state.
				Nacatoch	
				Saratoga	
			Taylor *	Marlbrook	
				Annona	
				Ozan	
			Austin *	Brownstown	
				Tokio	
			Eagle Ford *	Upper #	
				Lower #	
			Tuscaloosa	Upper	
				Middle	6) Equivalent to the Woodbine of Texas.
				Lower	

Johnston et al. (2000)

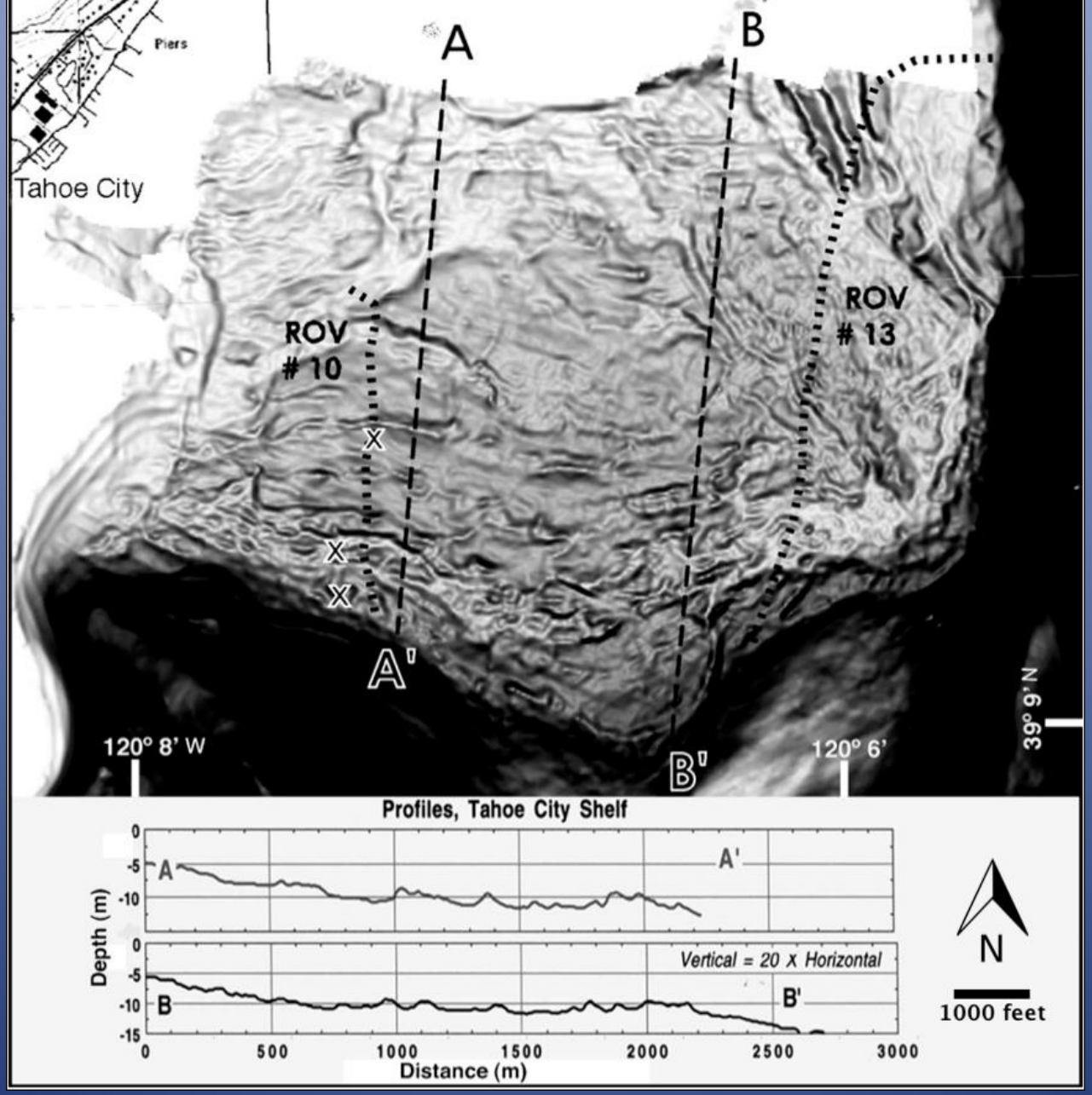

R. Blakey (2013)
N
1000 km
500 miles
Study Area
Chicxulub


R. Blakey (2013)
N
1000 km
500 miles

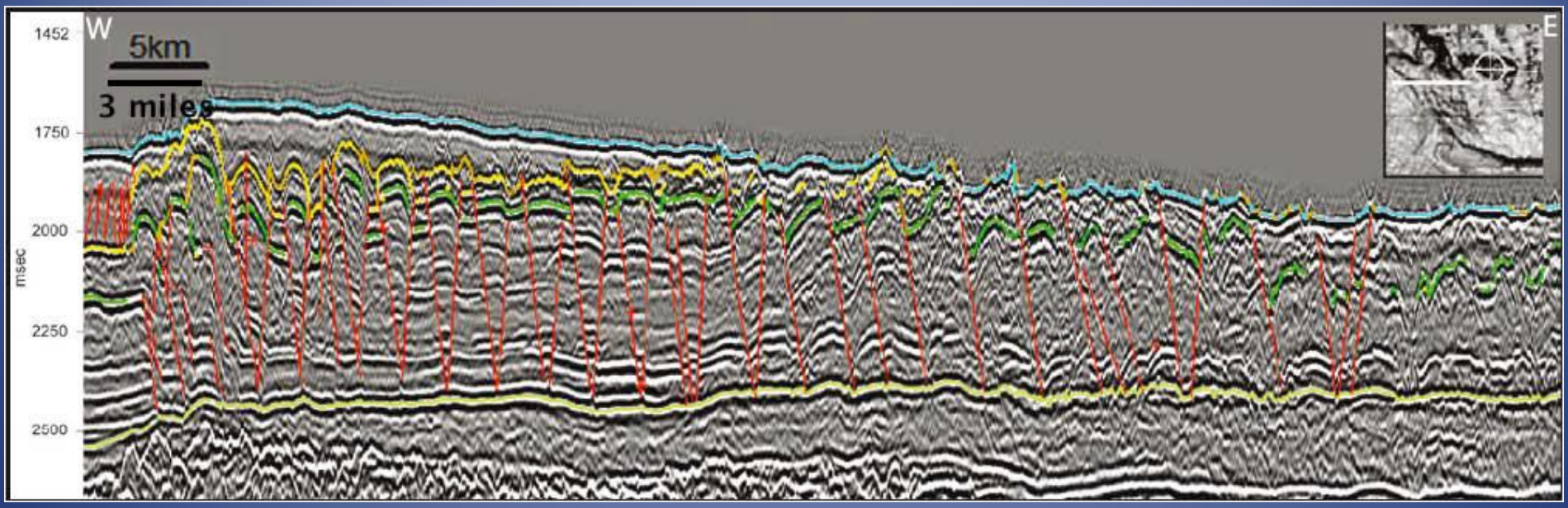
Satellite imagery from Google Earth displays an example of dunes on a gravel bar near Quincy, Washington, USA, resulting from the catastrophic discharge of Pleistocene Lake Missoula.



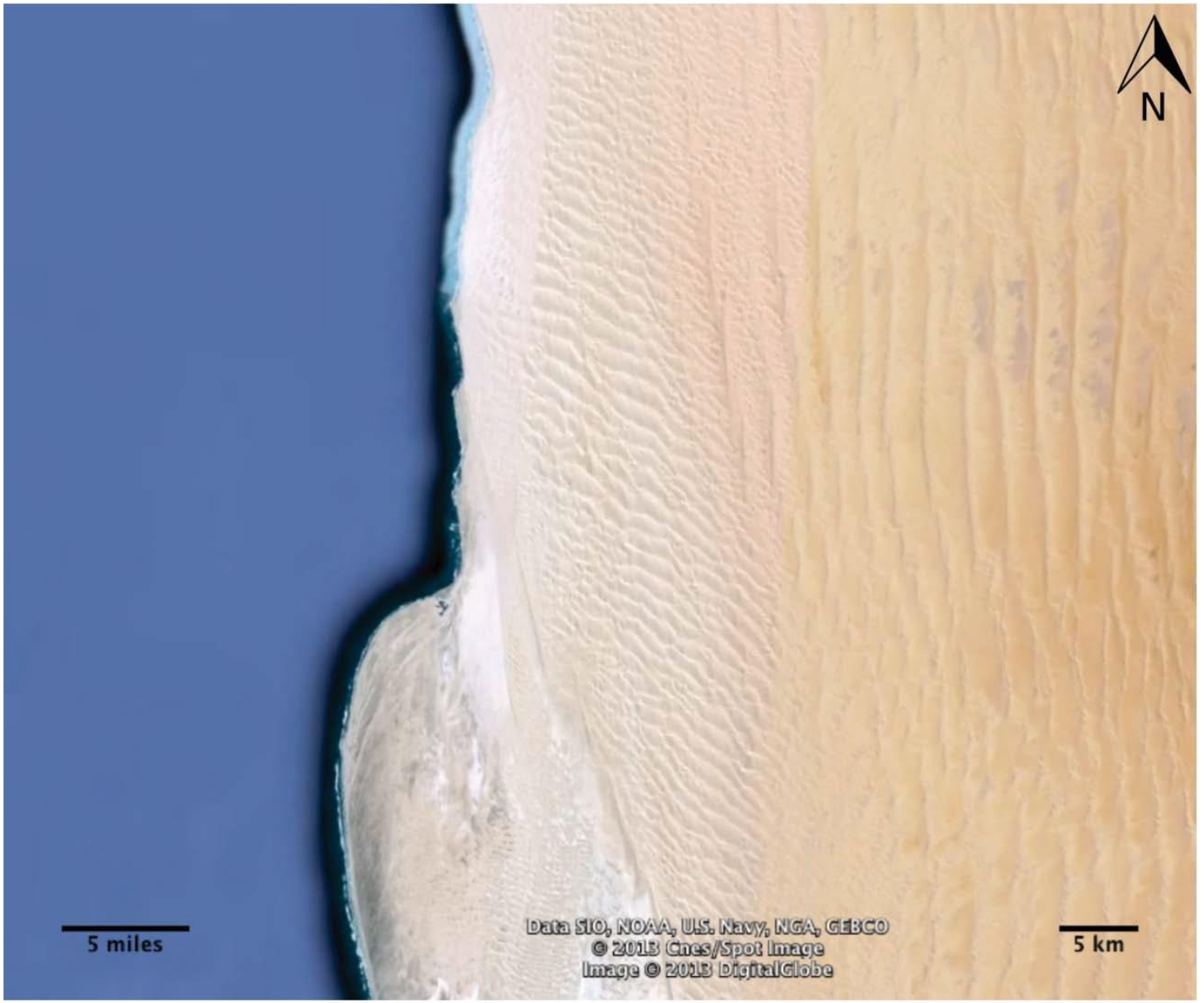
Satellite imagery from Google Earth showing gravel dunes that formed in the Altai Republic in Eastern Europe during the catastrophic discharge of a glacier-dammed lake during the Pleistocene Epoch



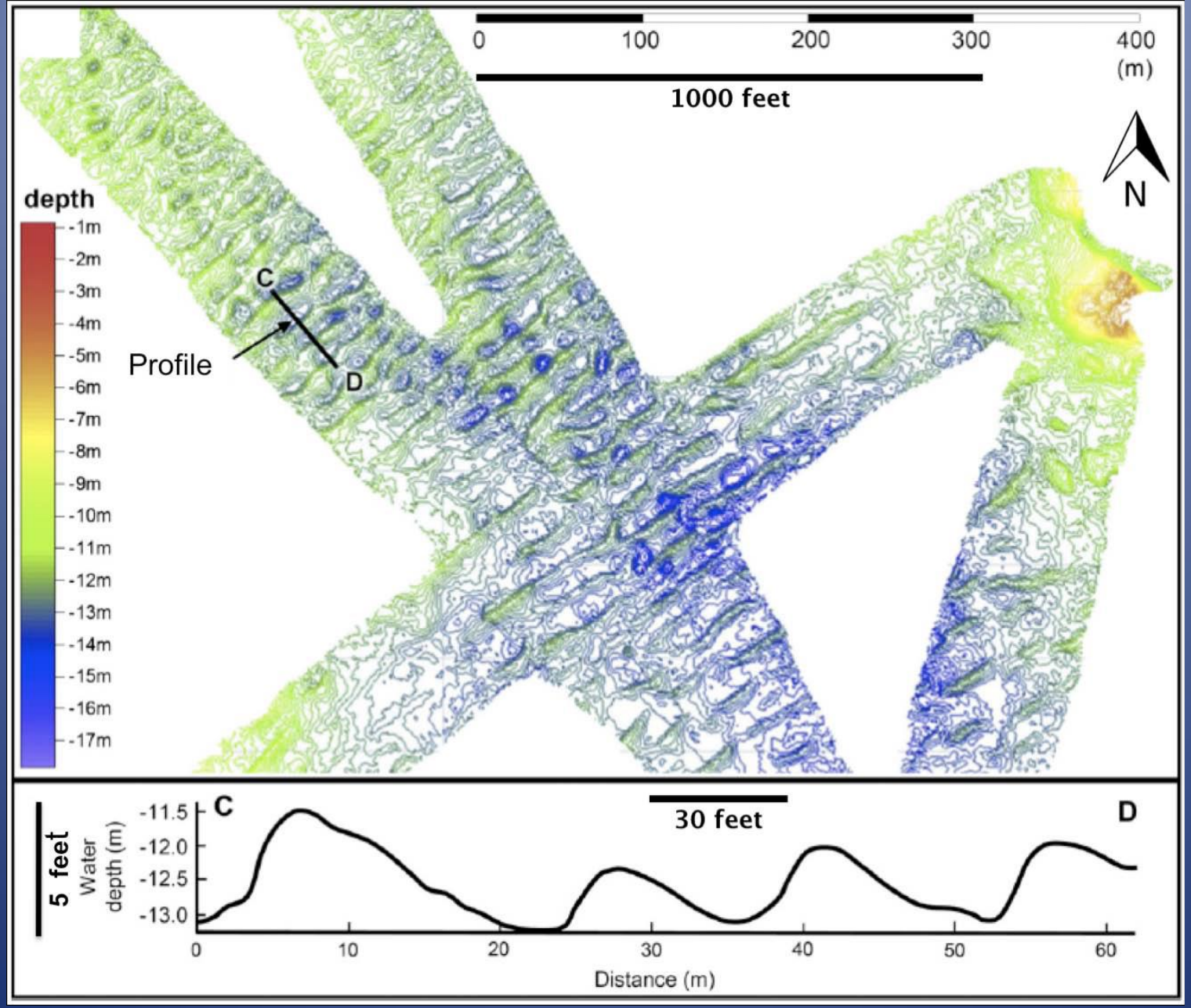
Bathymetry of Lake Tahoe near Tahoe City, California. Boulder ridges trending east to west are ascribed to deposition from a landslide-induced tsunami (modified after Moore et al., 2006).



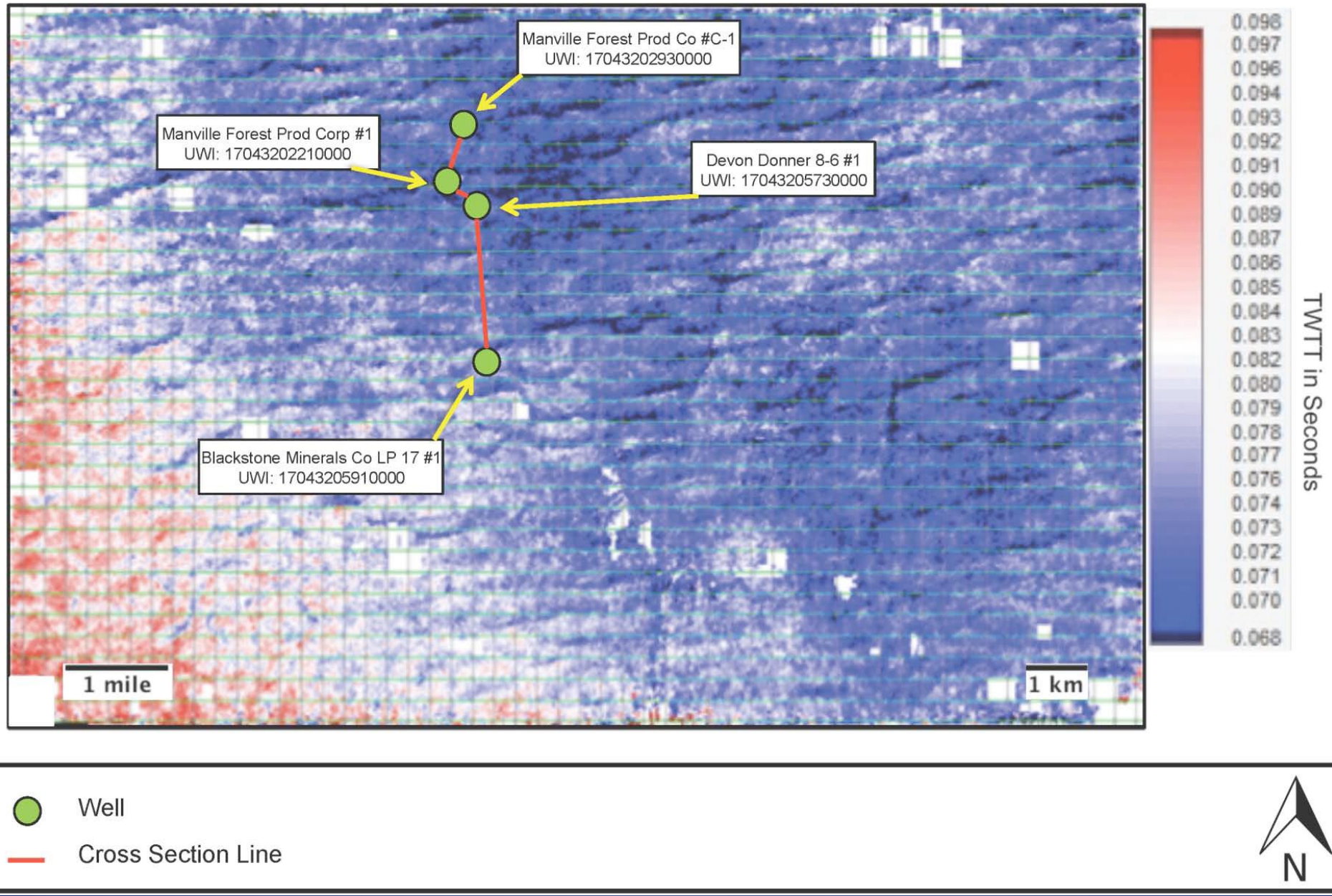
modified after Færseth and Sætersmoen, (2008)



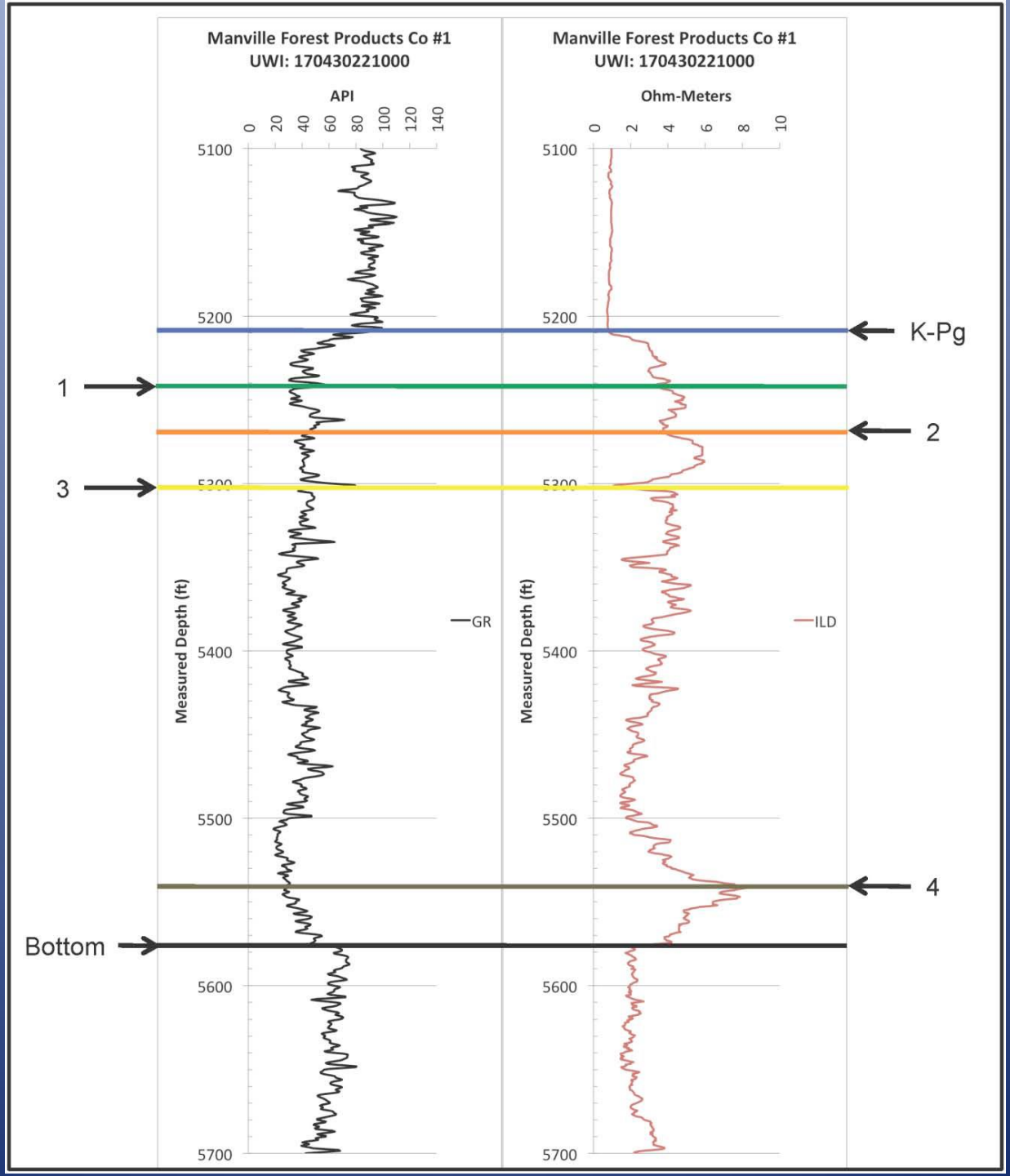
Modern aeolian dunes from the Namib sand sea on the coast of Namibia, Africa. Image from Google Earth.

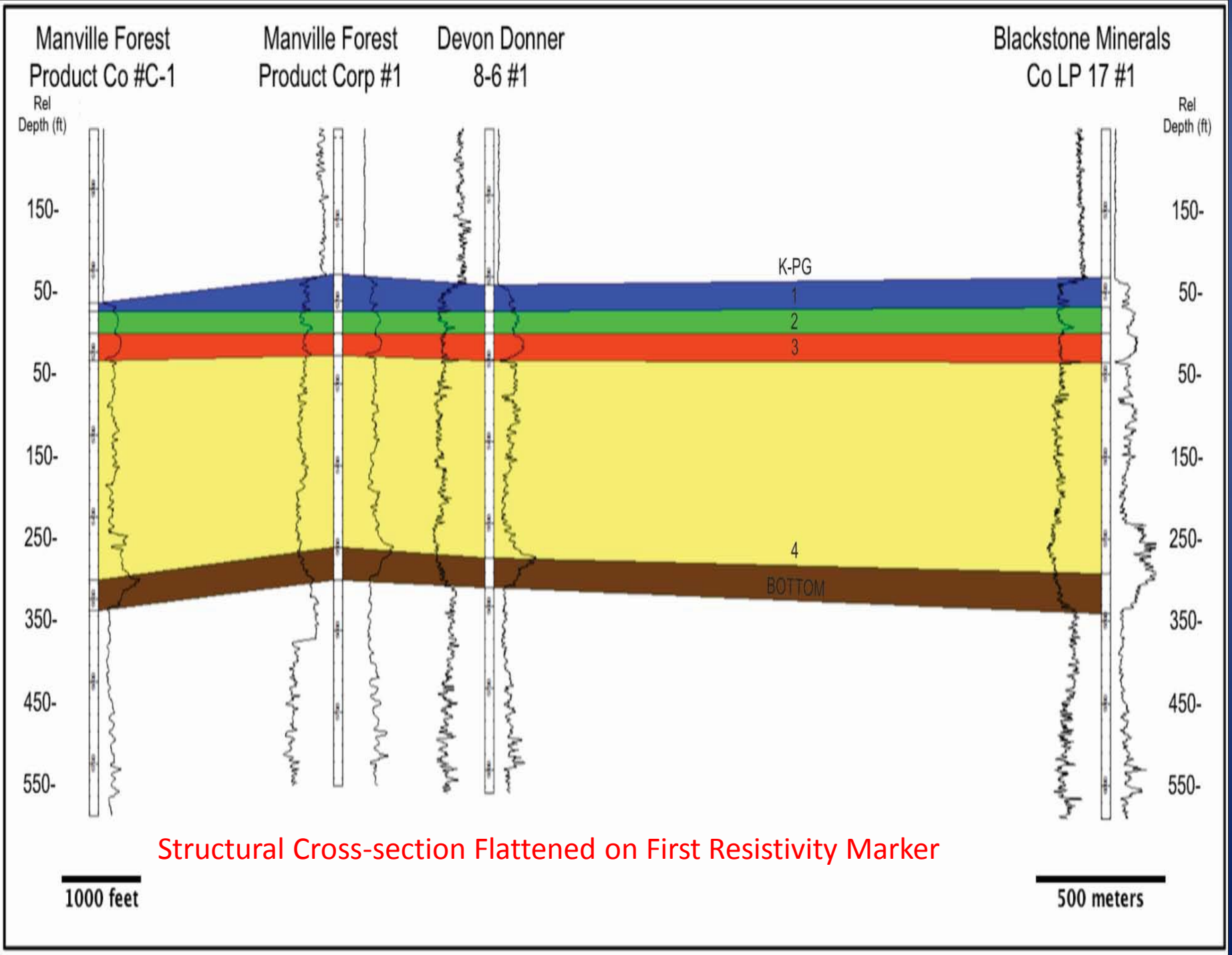


Subaqueous dunes resulting from the 2011 Tohoku earthquake and tsunami in Kesennuma Bay, Japan (modified after Haraguchi et al., 2013).

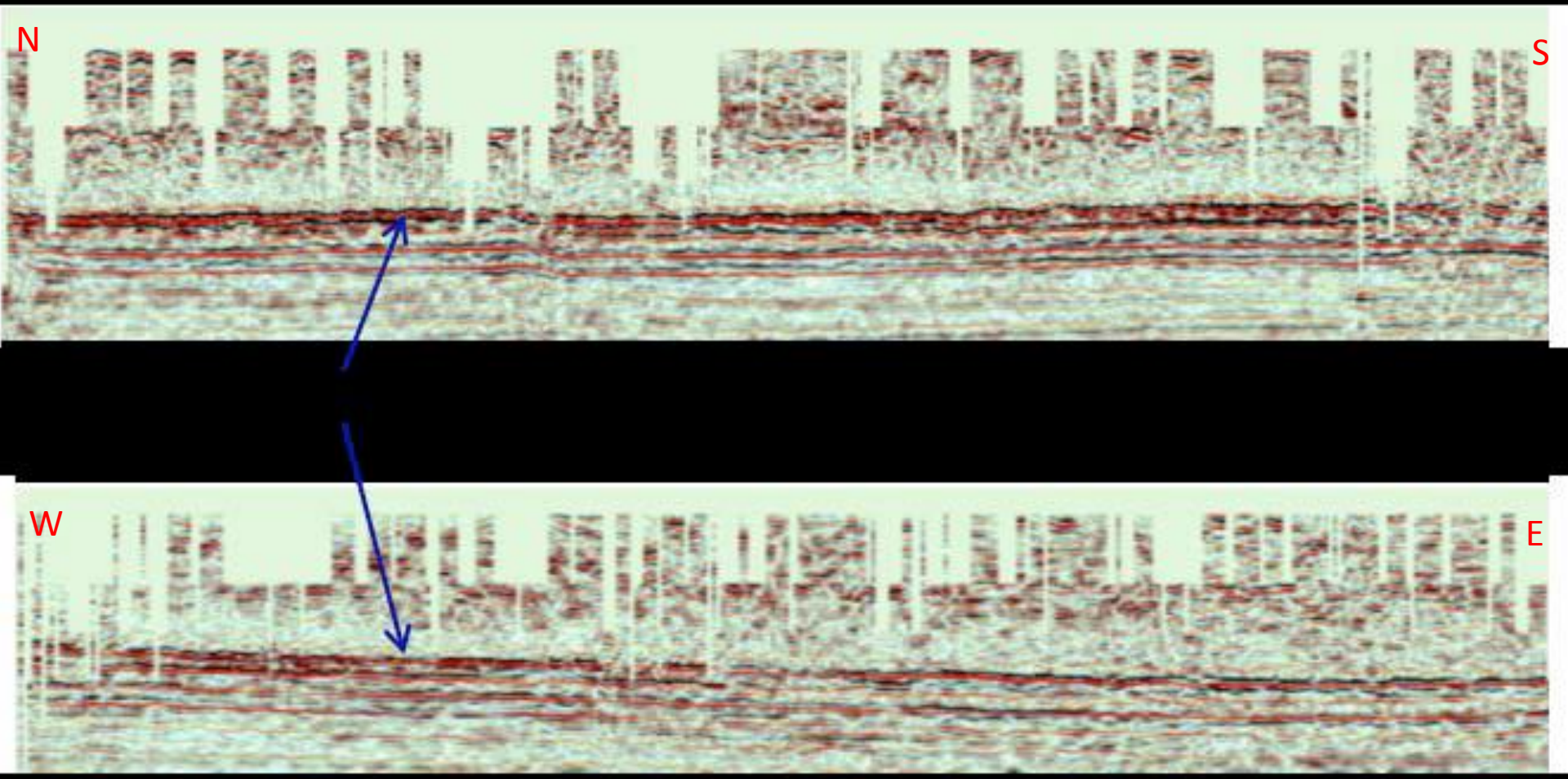


Isochron from K-Pg horizon to Sub K-Pg 2 horizon and location of cross-section through wells.

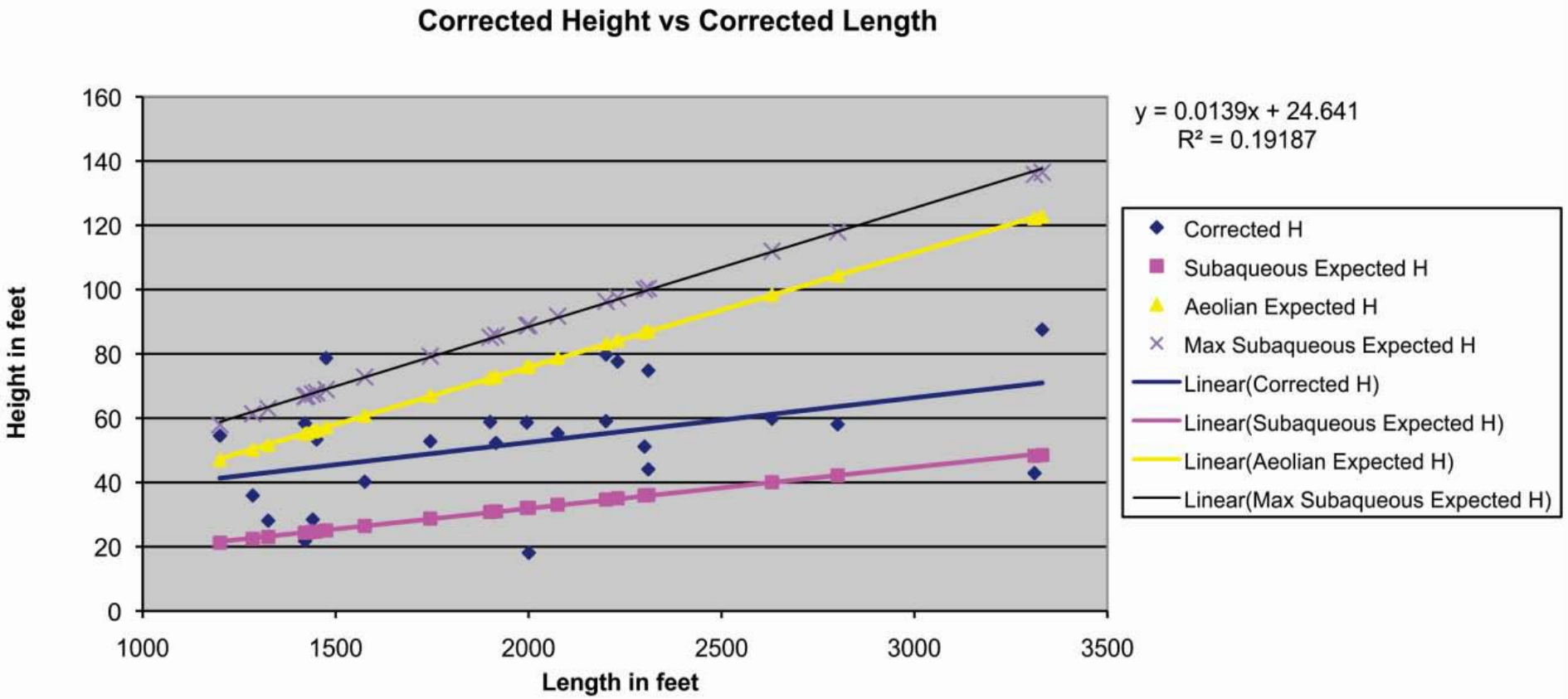

Manville Forest Products Co #1
UWI: 170430221000
API
0
20
40
60
80
100
120
140
5100
5200
5300
5400
5500
5600
5700
Measured Depth (ft)
GR
Manville Forest Products Co #1
UWI: 170430221000
Ohm-Meters
0
2
4
6
8
10
ILD
K-Pg
1
2
3
4
Bottom

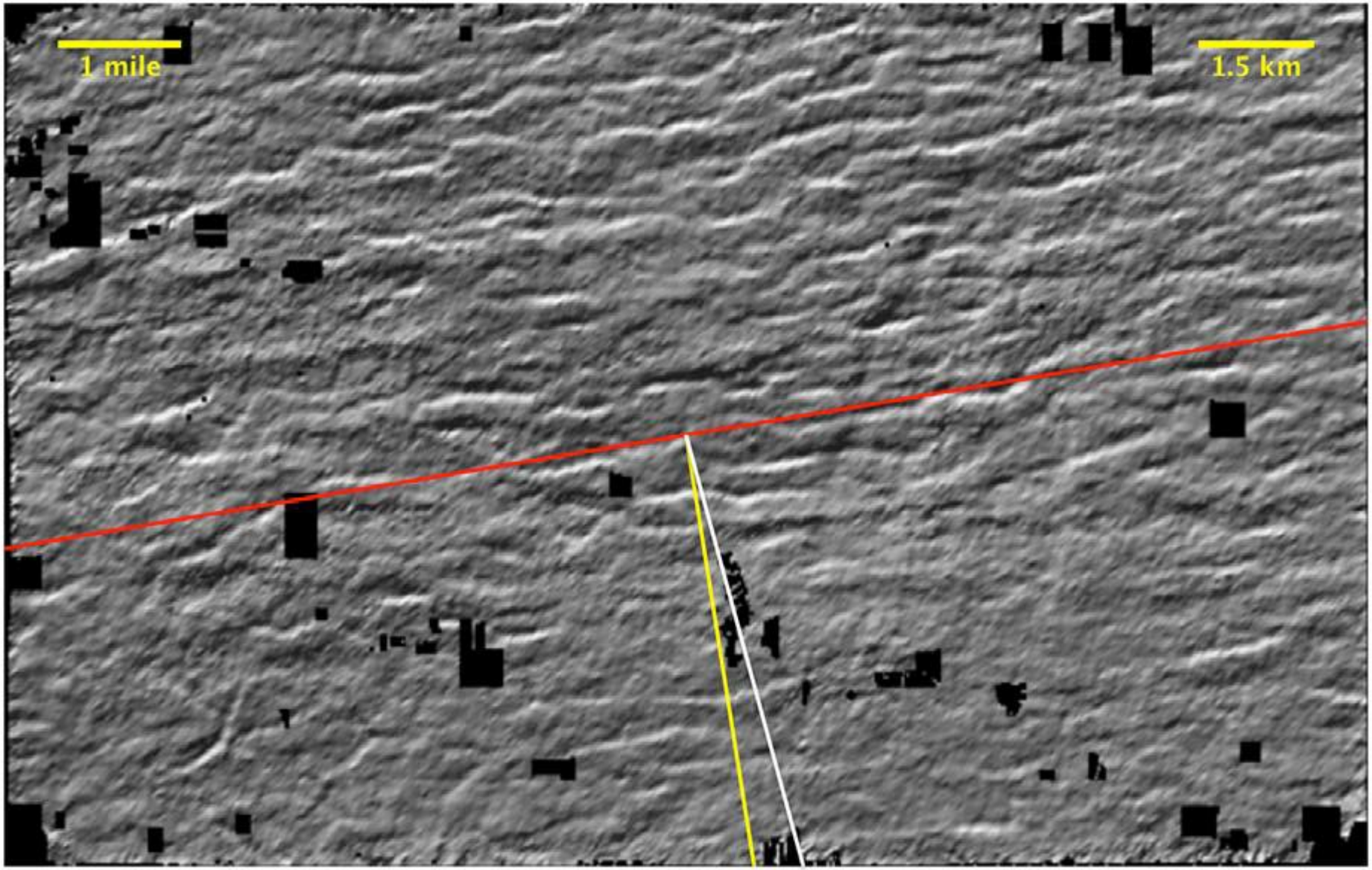


Structural Cross-section Flattened on First Resistivity Marker



DATA FROM PROPRIETARY 3D ABOUT 50 MILES NORTH OF THE DEVON 3D SHOWN COURTESY OF SEISMIC EXCHANGE, INC.


Corrected Height vs Corrected Length
Height in feet
Length in feet
0
20
40
60
80
100
120
140
160
1000
1500
2000
2500
3000
3500
y = 0.0139x + 24.641
R² = 0.19187
Corrected H
Subaqueous Expected H
Aeolian Expected H
Max Subaqueous Expected H
Linear(Corrected H)
Linear(Subaqueous Expected H)
Linear(Aeolian Expected H)
Linear(Max Subaqueous Expected H)


1 mile
1.5 km
Legend
Trend of Trough Lines
Normal to Trough Lines
To Chicxulub
N

CONCLUSIONS:

1. FEATURES ARE NOT A) AN ACQUISITION FOOTPRINT B) AEOLIAN DUNES C) SLUMP FEATURES
2. THICKNESS IN WELL – LOGS IS CONSISTENT WITH TOPOGRAPHY IN SEISMIC DATA
3. DEGREE OF PRESERVATION INDICATES THESE ARE NOT SUBAERIAL FEATURES AND THAT THEY MUST HAVE FORMED BELOW STORM WAVEBASE (50M…165FT)
4. GEOMETRICAL INDICES FROM PLAN VIEW CONSISTENT WITH KENSENNUMA BAY, TOHOKU EARTHQUAKE, TSUNAMI
5. ORIENTATION CONSISTENT WITH EXPECTED TSUNAMI FROM THE CHICXULUB IMPACT

YET TO DO IN NORTHERN LOUISIANA:

1. MAP THE CRETACEOUS SURFACE

2. MAP THE LOG FACIES OF THE UPPER CRETACEOUS

3. ANALYZE AVAILABLE CORE AND CUTTINGS
   A) Determine lithologies
   b) Determine paleontology
   c) Seek ejecta particles
   d) Analyze geochemistry

Blakey, R., Colorado Plateau Geosystems Inc., Paleogeography library, <http://cpgeosystems.com/globaltext2.html> Accessed June 13, 2013.

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