

Seismic Stratigraphy and Geomorphology of a Syn- to Post-Rift Depositional Succession, Qiongdongnan Basin, South China Sea*

Richard Wild¹ and Henry W. Posamentier²

Search and Discovery Article #10421 (2012)**

Posted July 16, 2012

*Adapted from oral presentation at AAPG Annual Convention and Exhibition, Long Beach, California, April 22-25, 2012

**AAPG © 2012 Serial rights given by author. For all other rights contact author directly.

¹Chevron Asia Pacific Exploration & Production Co., South China Sea Exploration, Houston, USA (Richard.Wild@chevron.com)

²Chevron ETC, Exploration and Reservoir Characterization Services, Houston, USA

Abstract

The Oligocene to Early Miocene stratigraphy of the Qiongdongnan Basin, South China Sea is commonly interpreted to represent the transition from predominantly non-marine alluvial and lacustrine syn-rift strata to post-rift, marine depositional environments. Whilst several deepwater wells have penetrated the post-rift marine succession, relatively little is known about the late syn-rift to early post-rift stratigraphy of this emerging exploration area.

Analysis suggests that the onset of the marine incursion occurred earlier than previously interpreted and is related to the initiation of an Early Oligocene episode of rifting. Rapid subsidence associated with the rift-climax resulted in a predominantly marine late syn-rift succession with marginal marine and/or subaerial depositional environments restricted to the basin margins or occupying isolated basin highs.

The application of seismic geomorphology has helped decipher and characterize complex syn- to post-rift sedimentary architectures and identify a range of geomorphic elements including slope fans and aprons, channel complexes, distributary lobes, sediment waves and mass transport deposits. Mapping these features using 3D visualization techniques such as seed picking and optical stacking in flattened seismic volumes facilitates a more detailed understanding of how depositional geometry responds to spatial and temporal variations in tectonic deformation and subsidence, the creation and/or destruction of accommodation and sediment supply. Ultimately,

this approach illustrates how in data limited environments the effective integration of seismic stratigraphy and geomorphology is key to the reduction of uncertainty with respect to reservoir prediction and connectivity in exploration and pre-drill analysis.

References

Gradstein, F.M., J.G. Ogg, and A.G. Smith, 2004, A Geologic Time Scale: Cambridge University Press, Cambridge, United Kingdom, p. 1-589.

Nichols, G., 1999, Sedimentology and stratigraphy: Blackwell Science Oxford, United Kingdom, 355 p.

Verdicchio, G., F. Trincardi, and A. Asioli, 2007, Mediterranean bottom-current deposits; an example from the southwestern Adriatic margin, in A.R. Viana, and M. Rebesco, (eds.), Economic and palaeoceanographic significance of contourite deposits: Geological Society Special Publications, v. 276, p. 199-224.

Zhu, W., B. Huang, L. Mi, R.W.T. Wilkins, N. Fu, and X. Xiao, 2009, Geochemistry, origin, and deep-water exploration potential of natural gases in the Pearl River Mouth and Qiongdongnan basins, South China Sea: AAPG Bulletin, v. 93/6, p. 741-761.

Seismic stratigraphy and geomorphology of a syn- to post-rift depositional succession, Qiongdongnan Basin, South China Sea



Richard Wild¹ & Henry Posamentier²

¹Chevron Asia Pacific Expl. & Prod. Co., South China Sea Exploration, Houston, USA

²Chevron ETC, Exploration and Reservoir Characterization Services, Houston, USA



Observations and key messages



- Seismic stratigraphy integrated with seismic geomorphology has helped decipher and characterize complex syn- to post-rift sedimentary architectures and identify a range of geomorphic elements
- New interpretation of syn-rift to post-rift strata:
 - Onset of marine incursion occurred earlier than previously interpreted, T70, Late Oligocene
 - Subsidence associated with rift-climax resulted in a predominantly marine late syn-rift succession with marginal marine and / or subaerial depositional environments restricted to the basin margins or occupying isolated basin highs



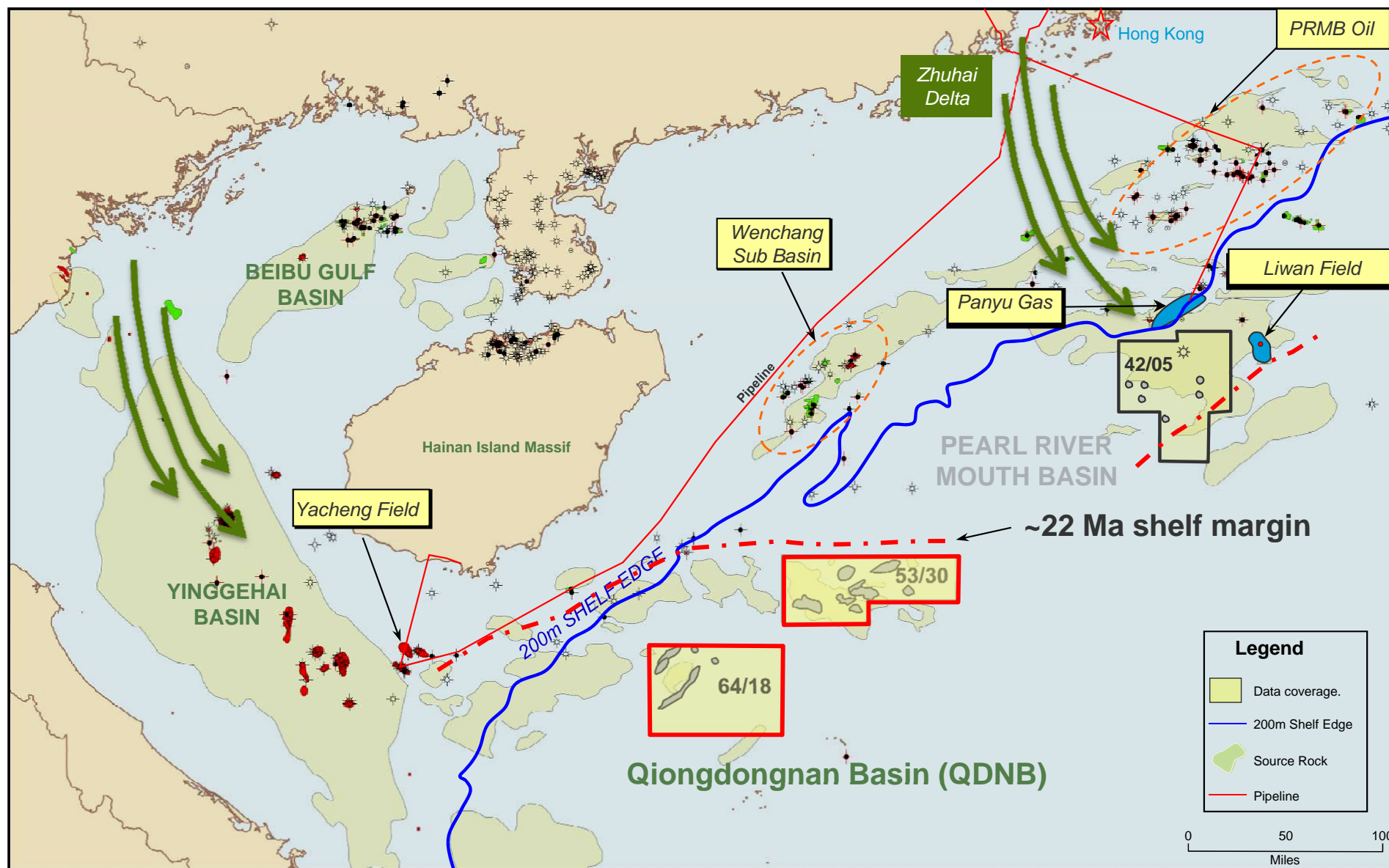
Observations and key messages



- Qiongdongnan Basin (QDNB) – syn-rift observations:
 - Lingshui Fm. (T60 – T70): marine depositional environments, deep marine depositional environments occupy basin and graben centers
 - Sediment input from basin margins as well as axial
- QDNB – post-rift observations:
 - Meishan Fm. (T40 – T50) and Sanya Fm. (T50 – T60): deep marine depositional environments (distributary lobes, channelized depositional env., MTDs and sediment waves / drifts)
 - Paleo shelf-edge oriented E-W with dominant input from the N (minor contribution from intra-basinal highs, horsts and tilted fault blocks)

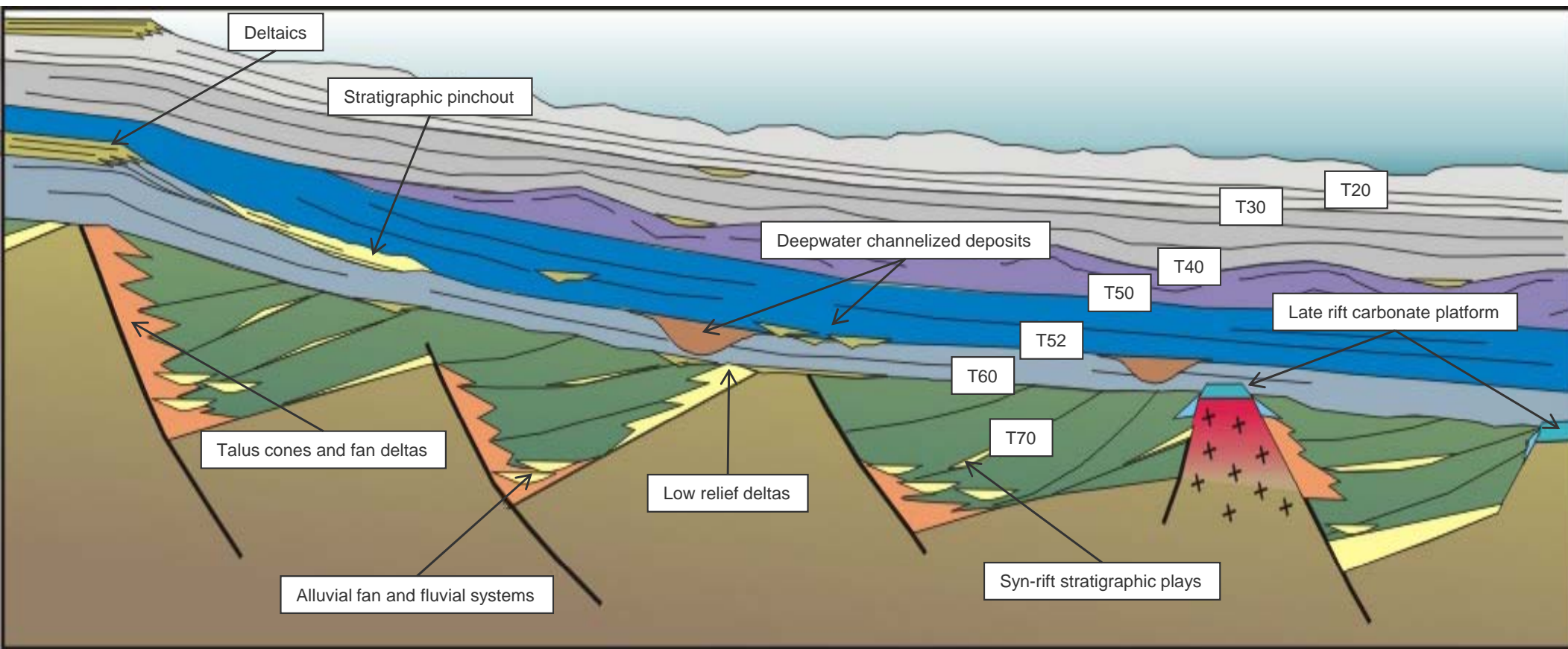


South China Sea location map - Miocene and modern day shelf edges paleo-sediment input





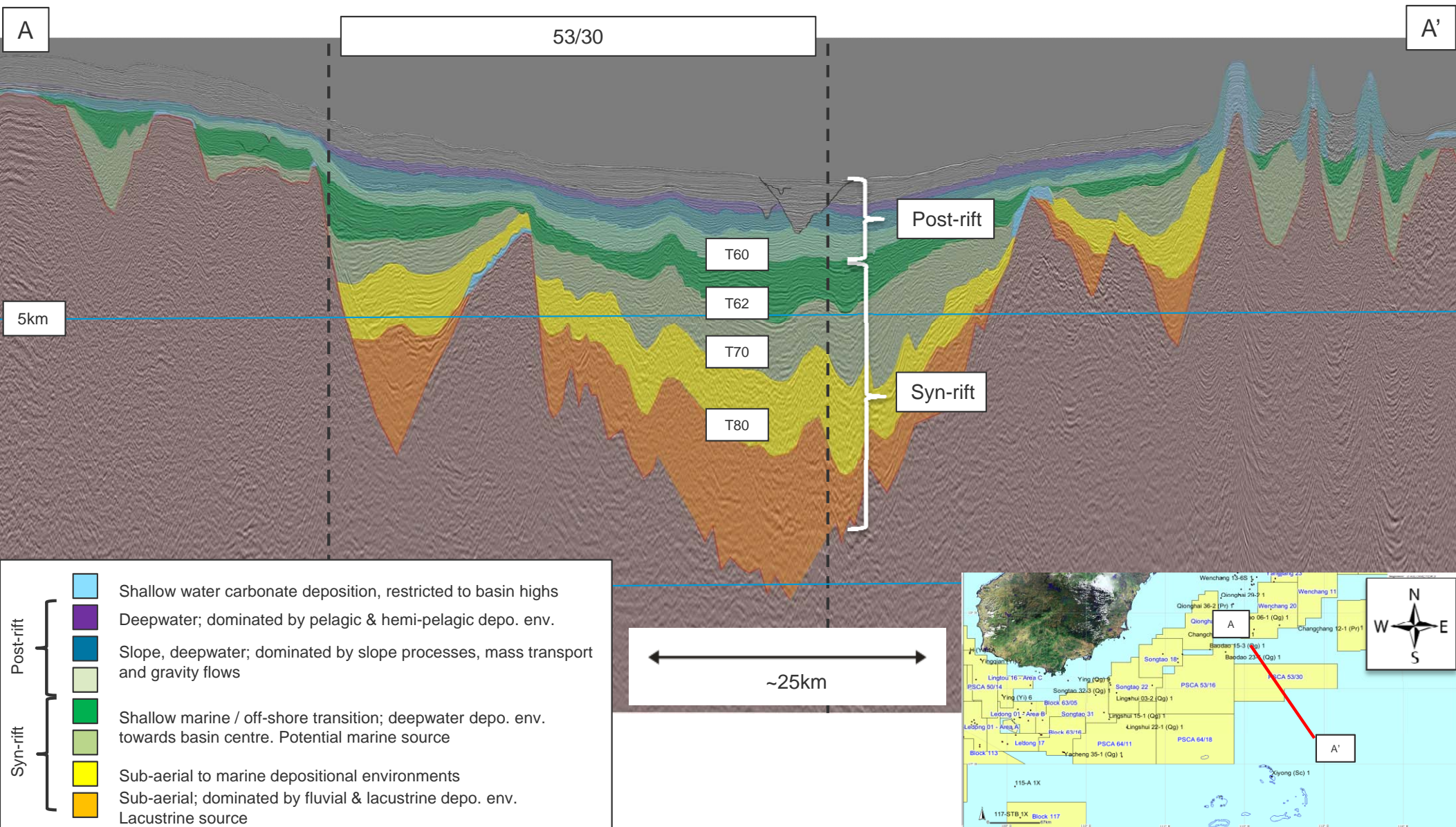
Basin schematics / South China Sea play type(s)





QDN Basin Regional Seismic Traverse

From Shenhui Massif across Xisha Trough (Block 53-30)





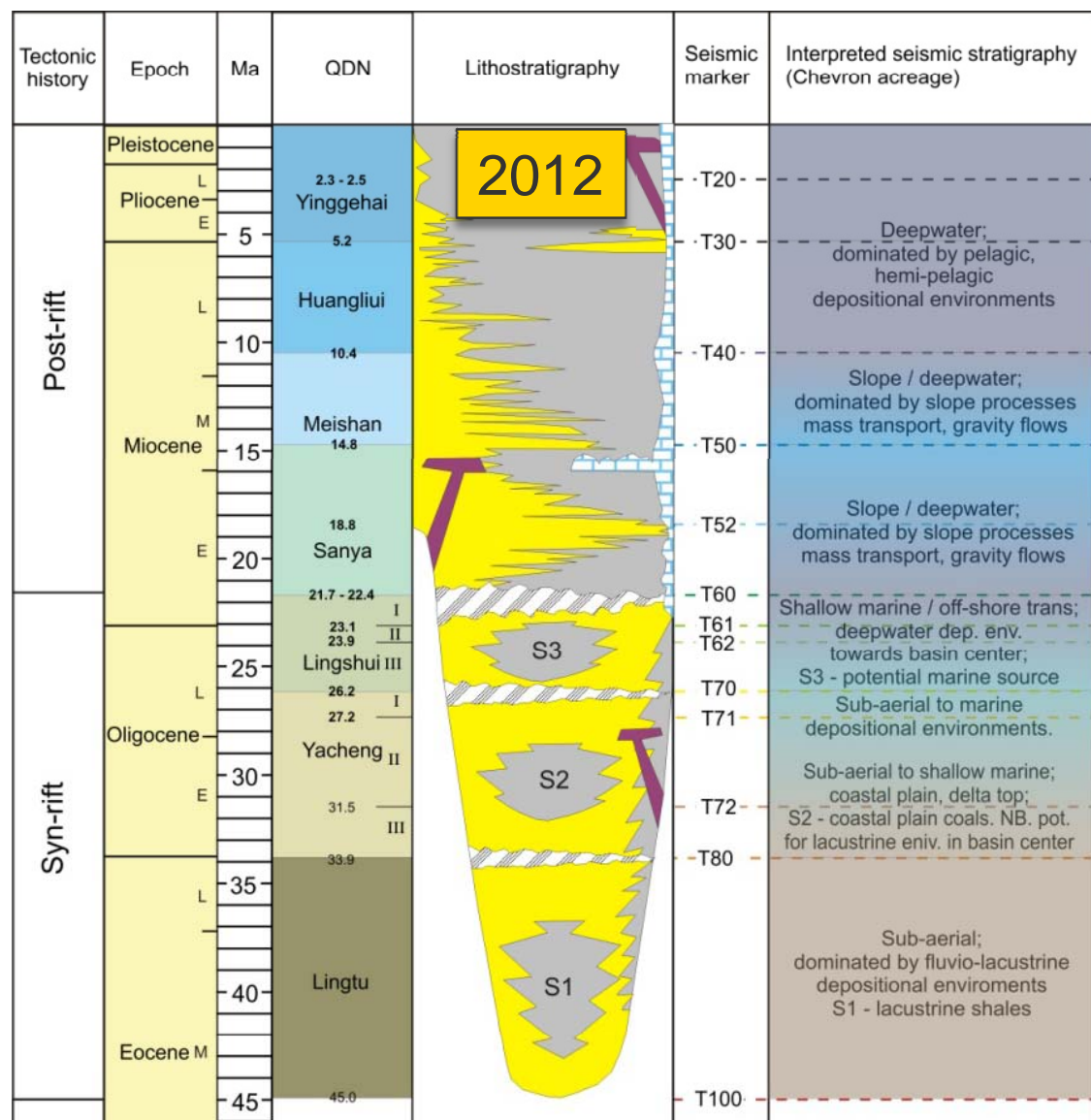
QDNB chronostratigraphic chart & dominant depositional environments



Geological Age	Strata	Age (Ma)	Source and Reservoir	Lithology	Depositional Facies
Quaternary		2009			Littoral
Pliocene	Yinggehai				Littoral to bathyal
Miocene	Huangliu	5.5			Littoral to bathyal
	Meishan	10.5	R		Littoral to neritic
	Sanya	16.5	R		Littoral to neritic
	Lingshui	21.0	R		Littoral to neritic
Oligocene	Yacheng	30.0	S		Coastal plain to neritic
	Undrilled	37.0	S		Lacustrine
Paleocene		57.5			
Pre-Tertiary Basement					

Post-rift

Syn-rift

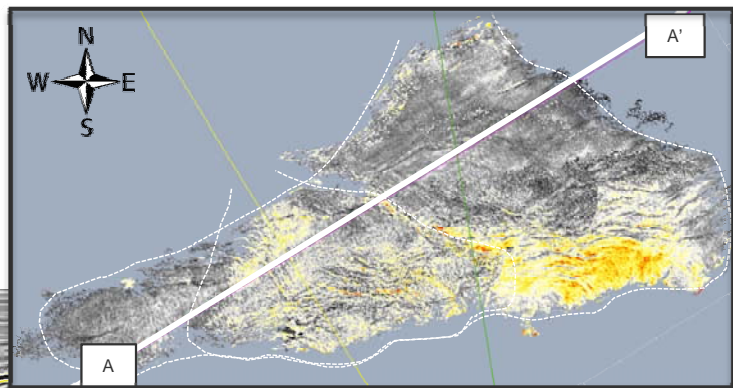


Geologic Timescale (Gradstein et al., 2004)

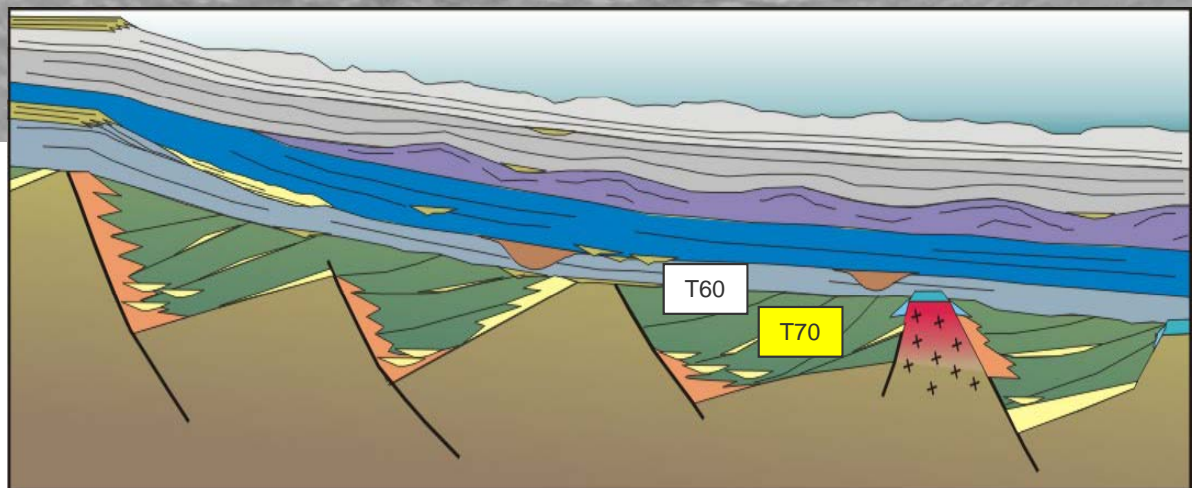
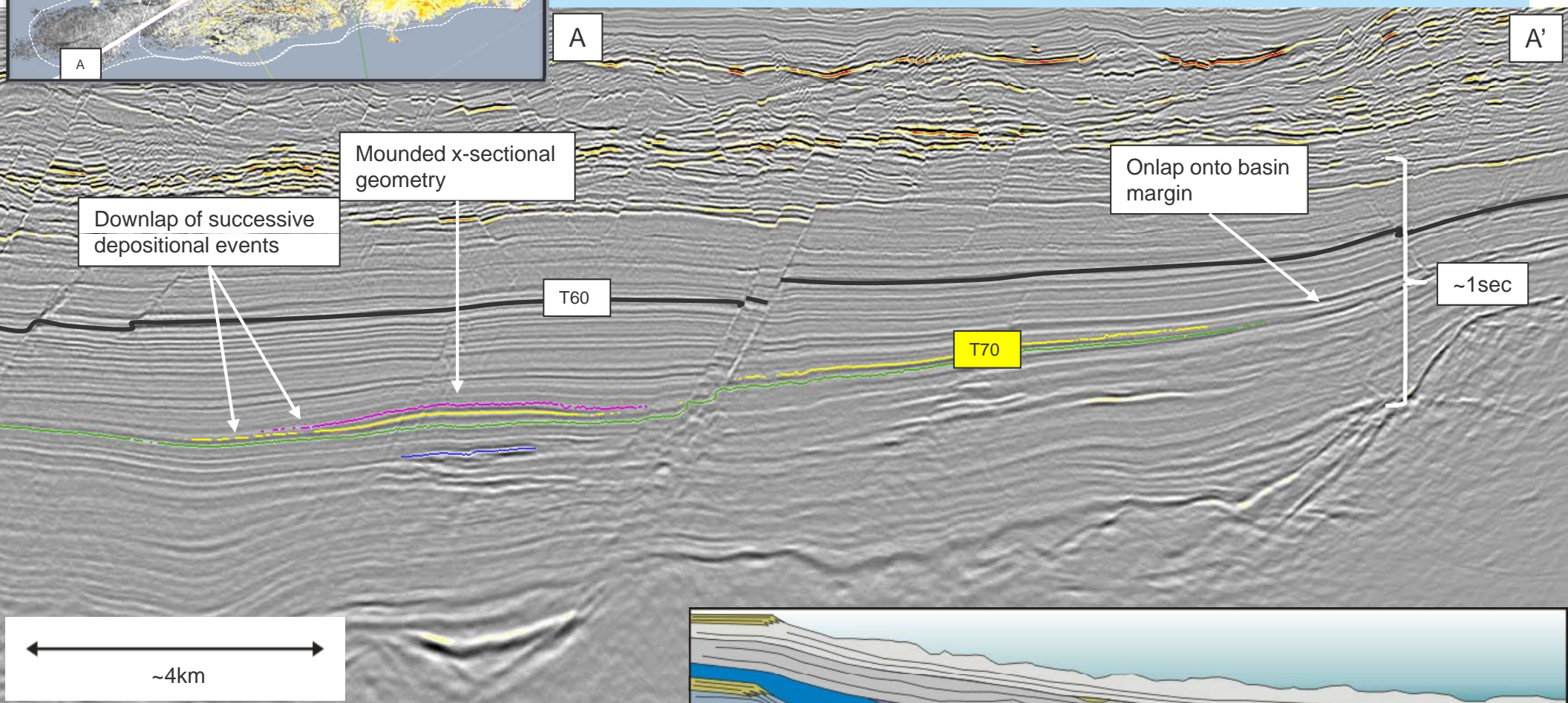
Tectonic analysis from Sun et al., 2009

Stratigraphic division / ages, CVX & CNOOC JSA, 2011 (ages in bold CVX)

Zhu et al., 2009. AAPG

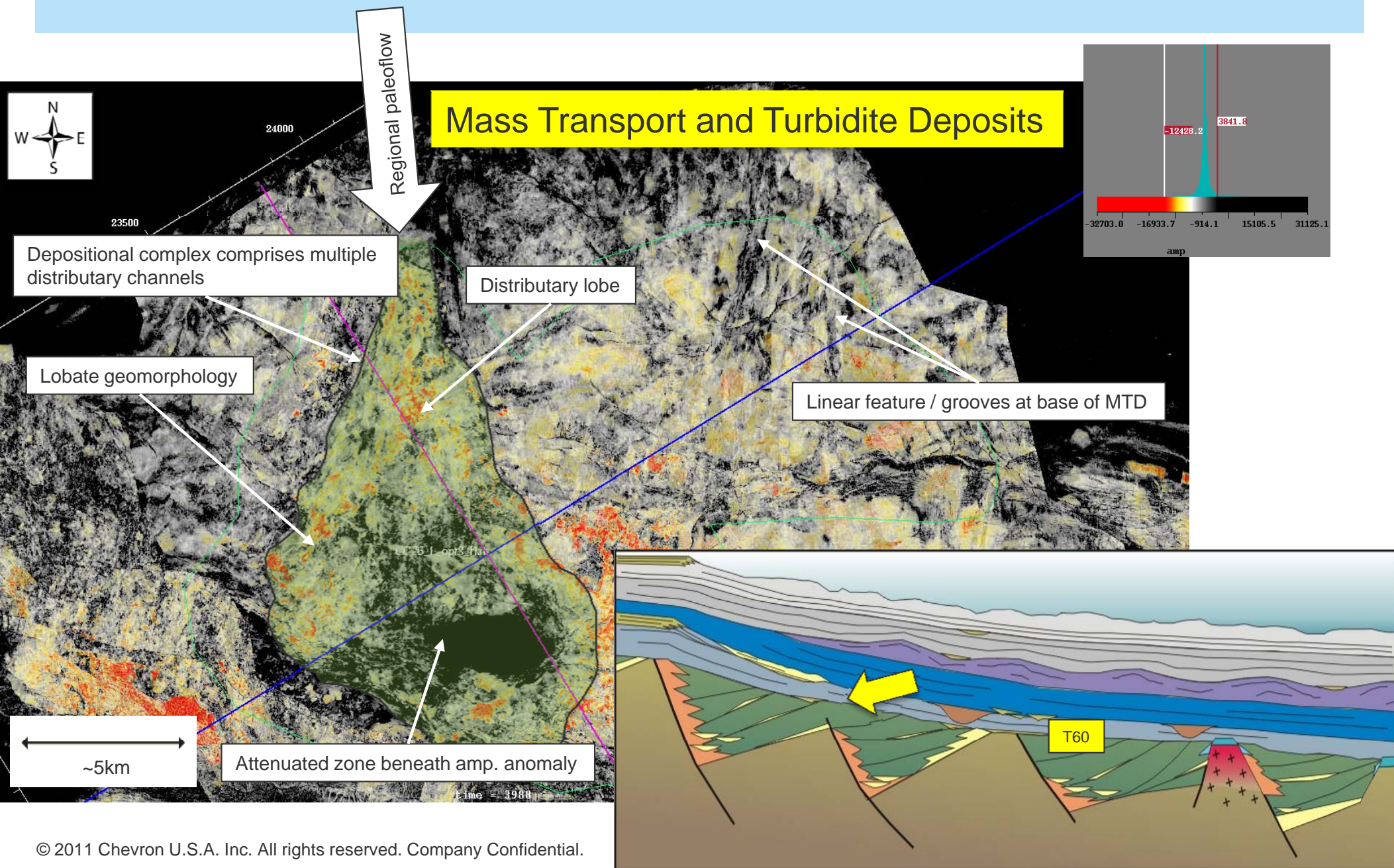


53/30, T62 - T70, Lingshui Fm. Distributary lobe complex, channelized sheet elements



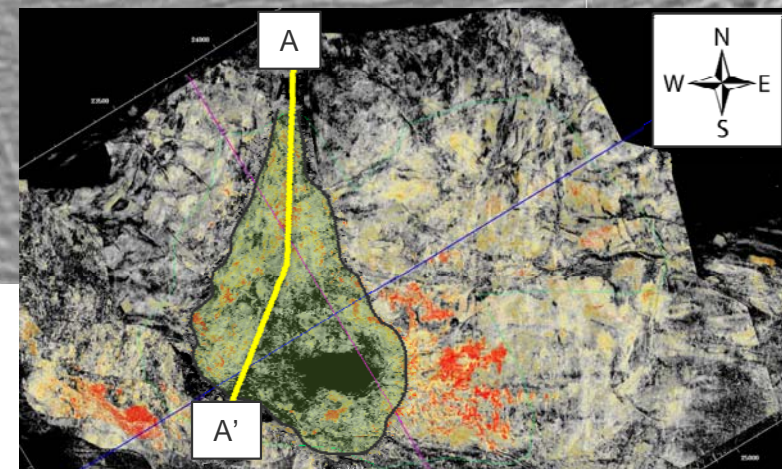
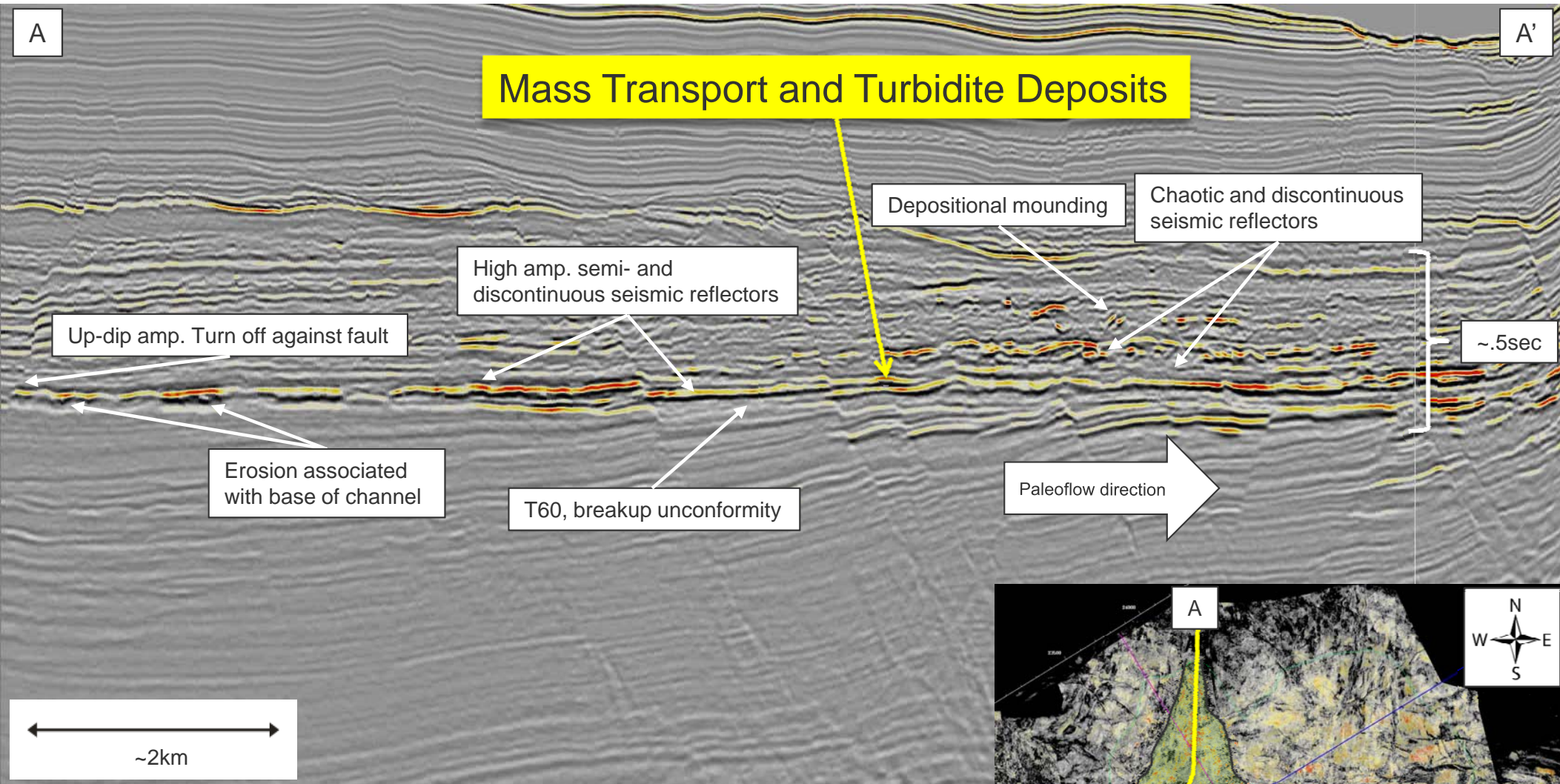


53/30, optical stack (60ms) illustrates distributive geomorphology within section above the T60, Sanya



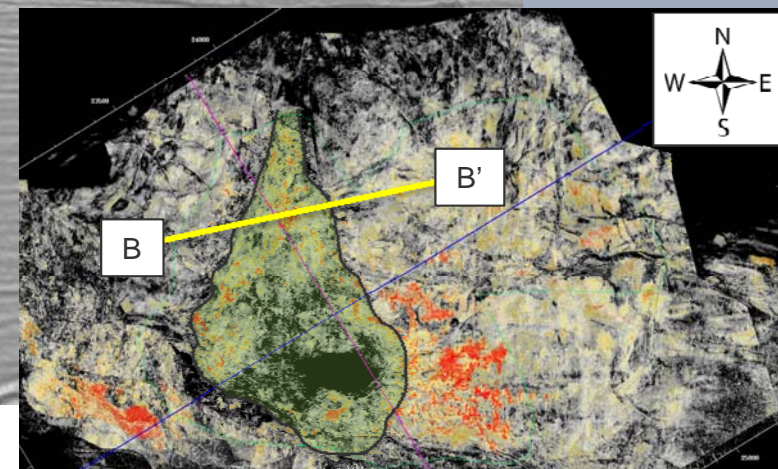
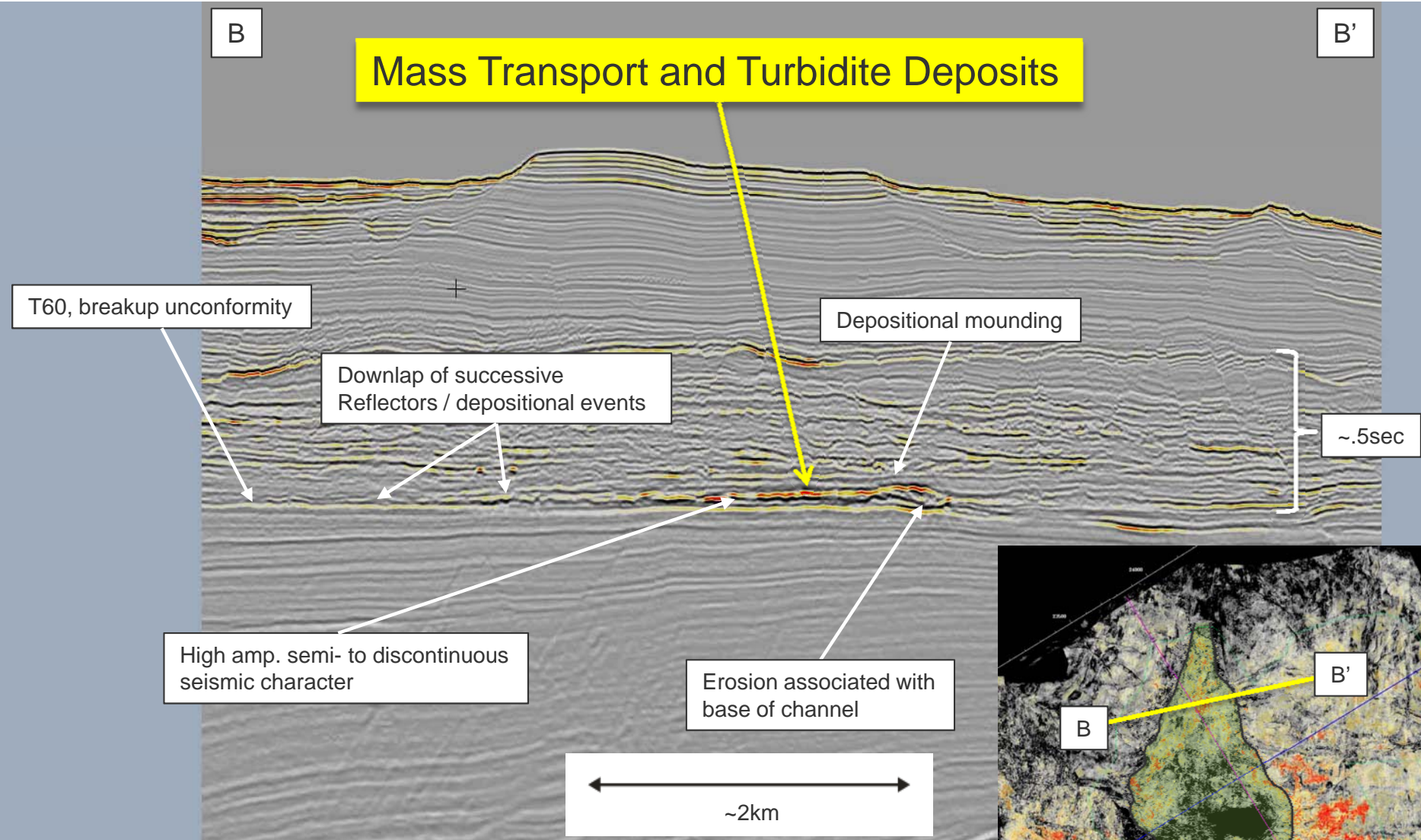


53/30, optical stack (60ms) illustrates distributive geomorphology within section above the T60, Sanya



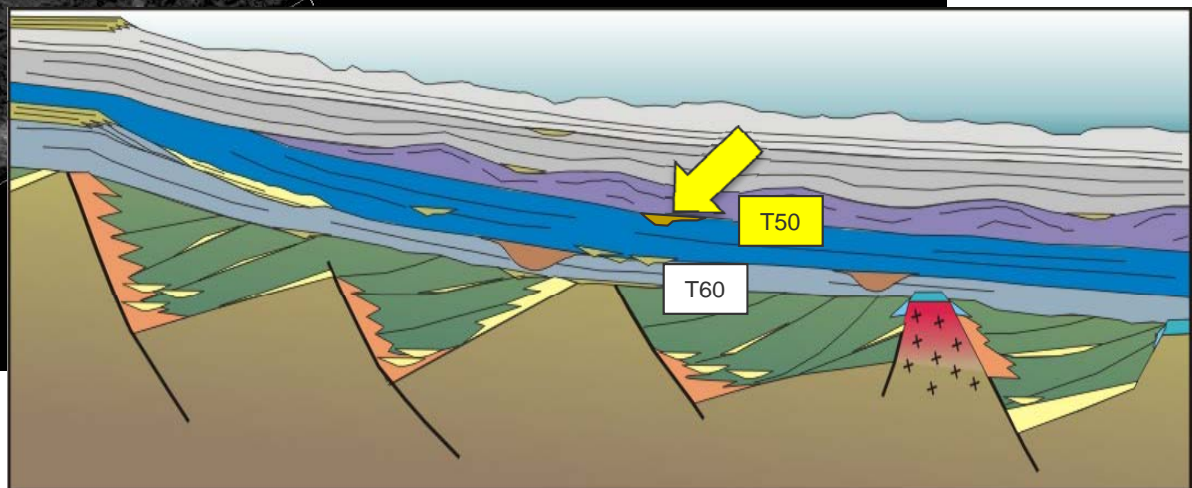
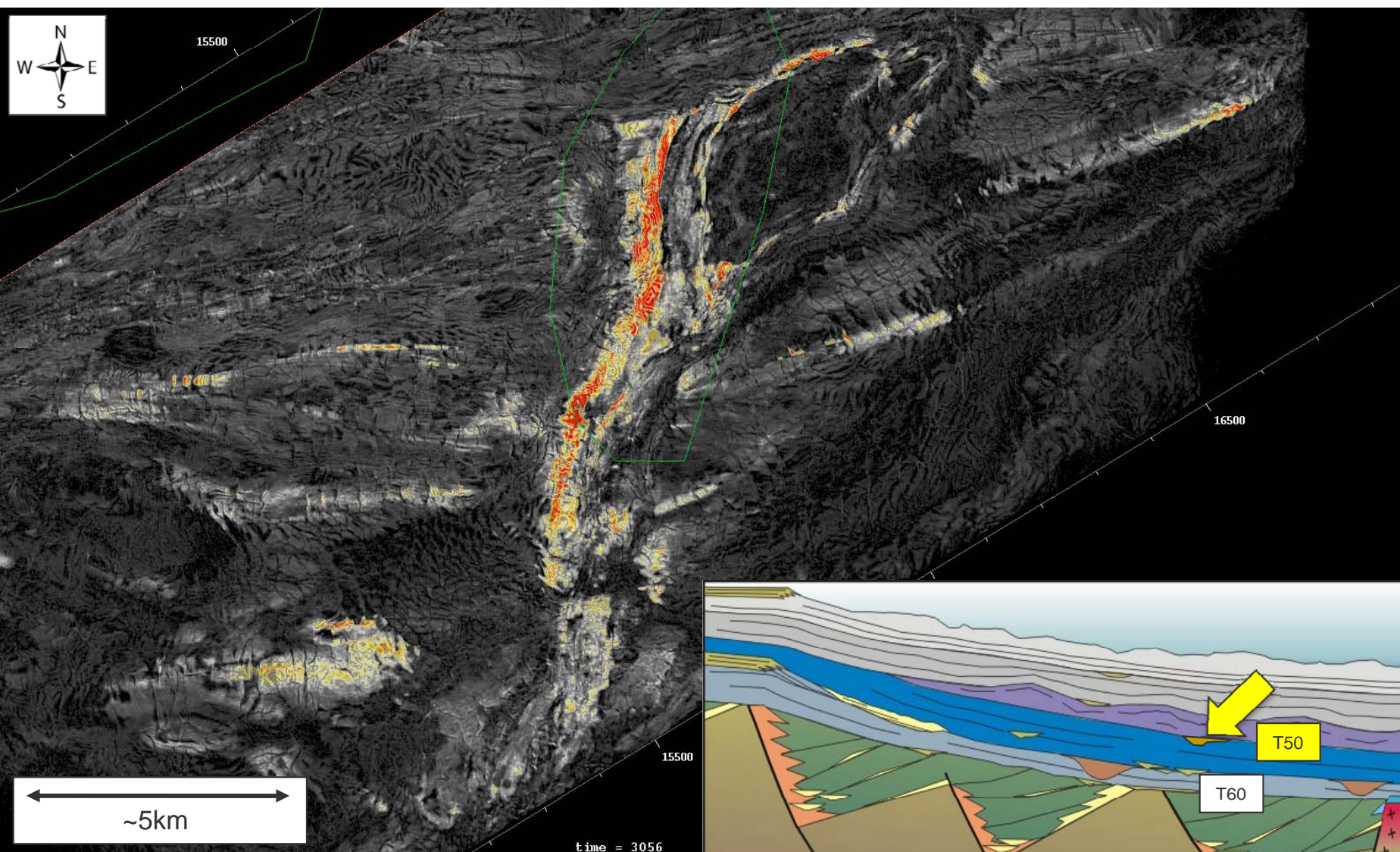


53/30, optical stack (60ms) illustrates distributive geomorphology within section above the T60, Sanya



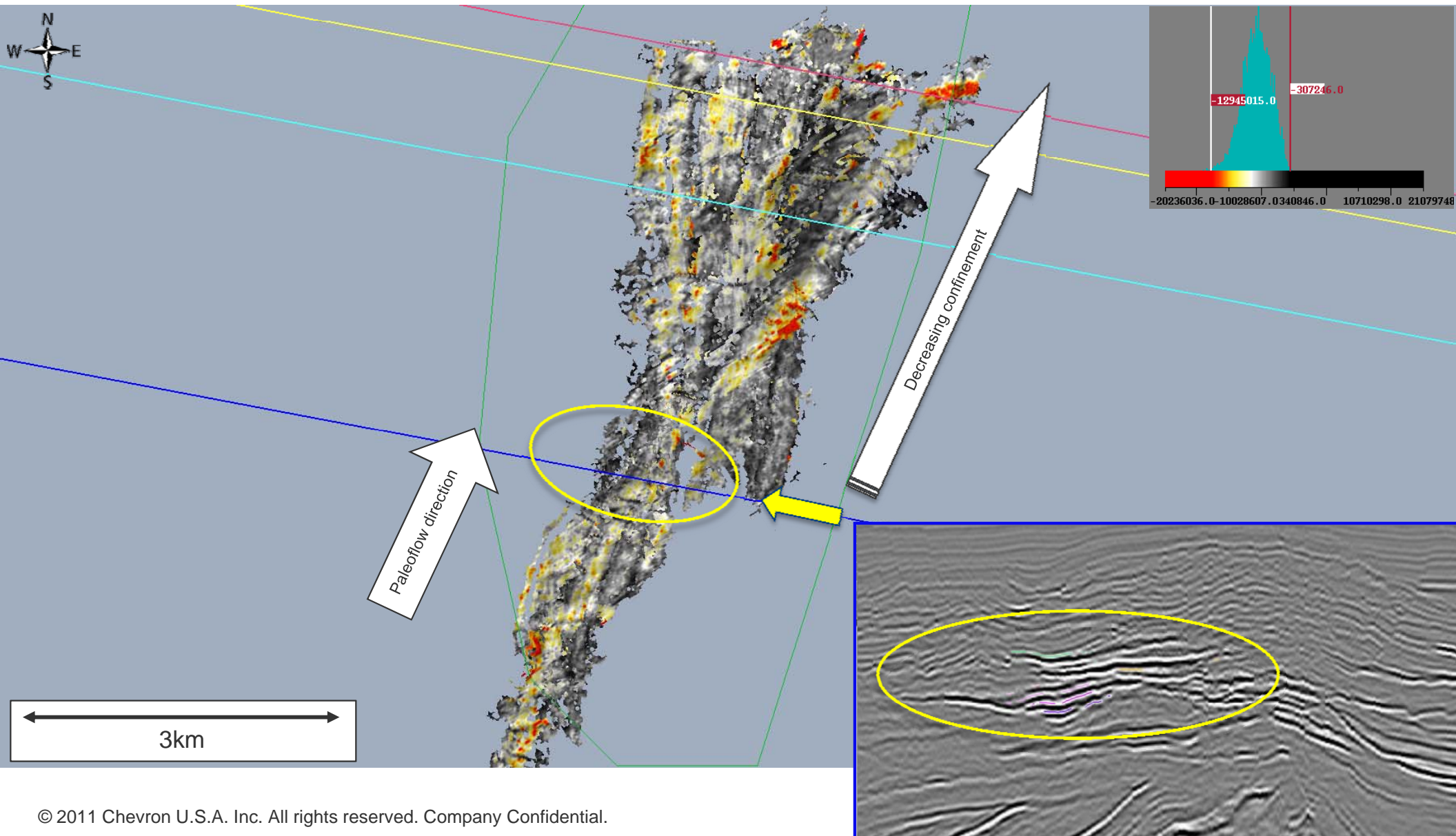


64/18, T50, Meishan: optical stack (60ms) illustrates linear geomorphology



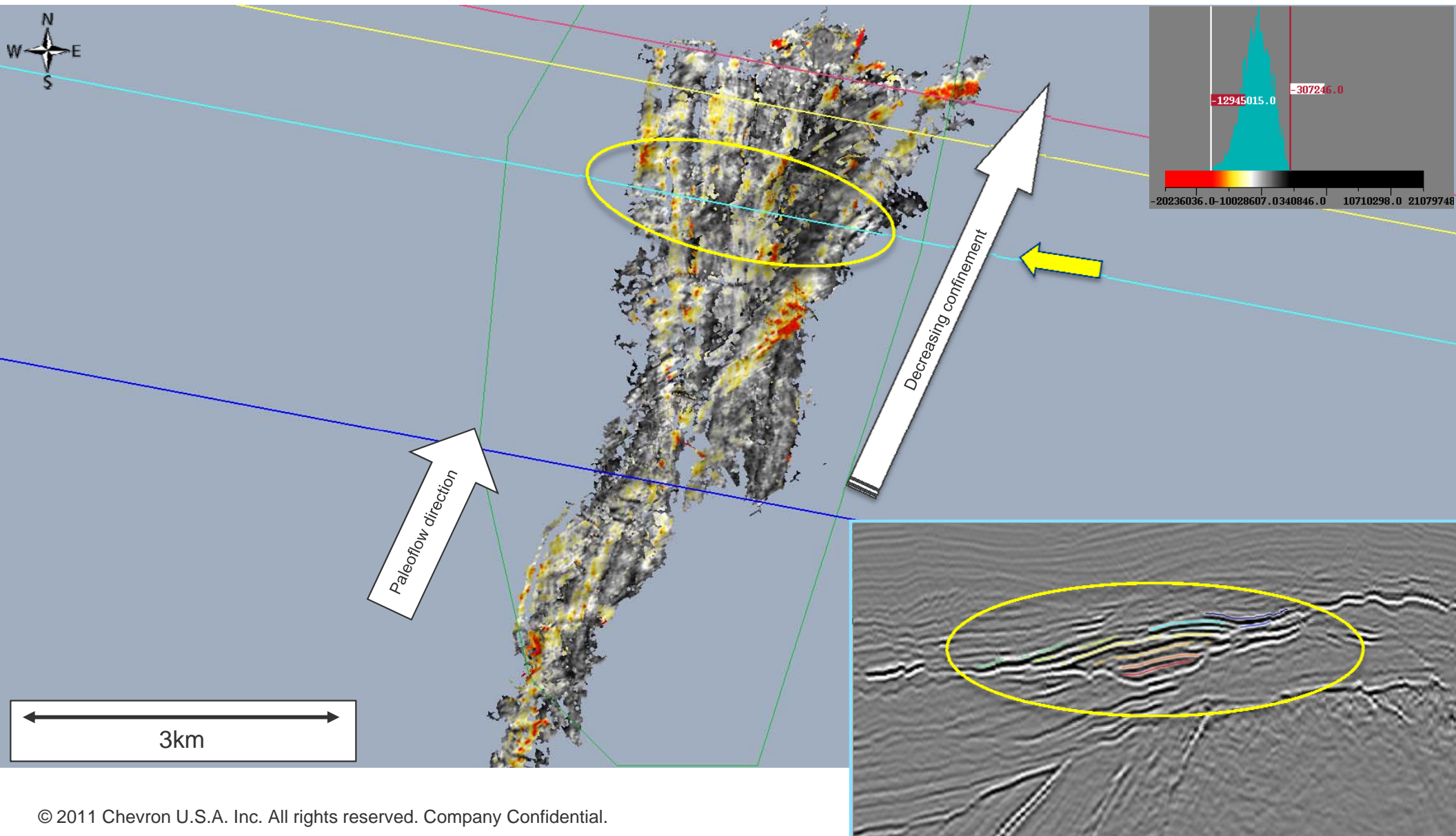


64/18, T50, Meishan: seed picking of individual elements reveals complex depositional architecture



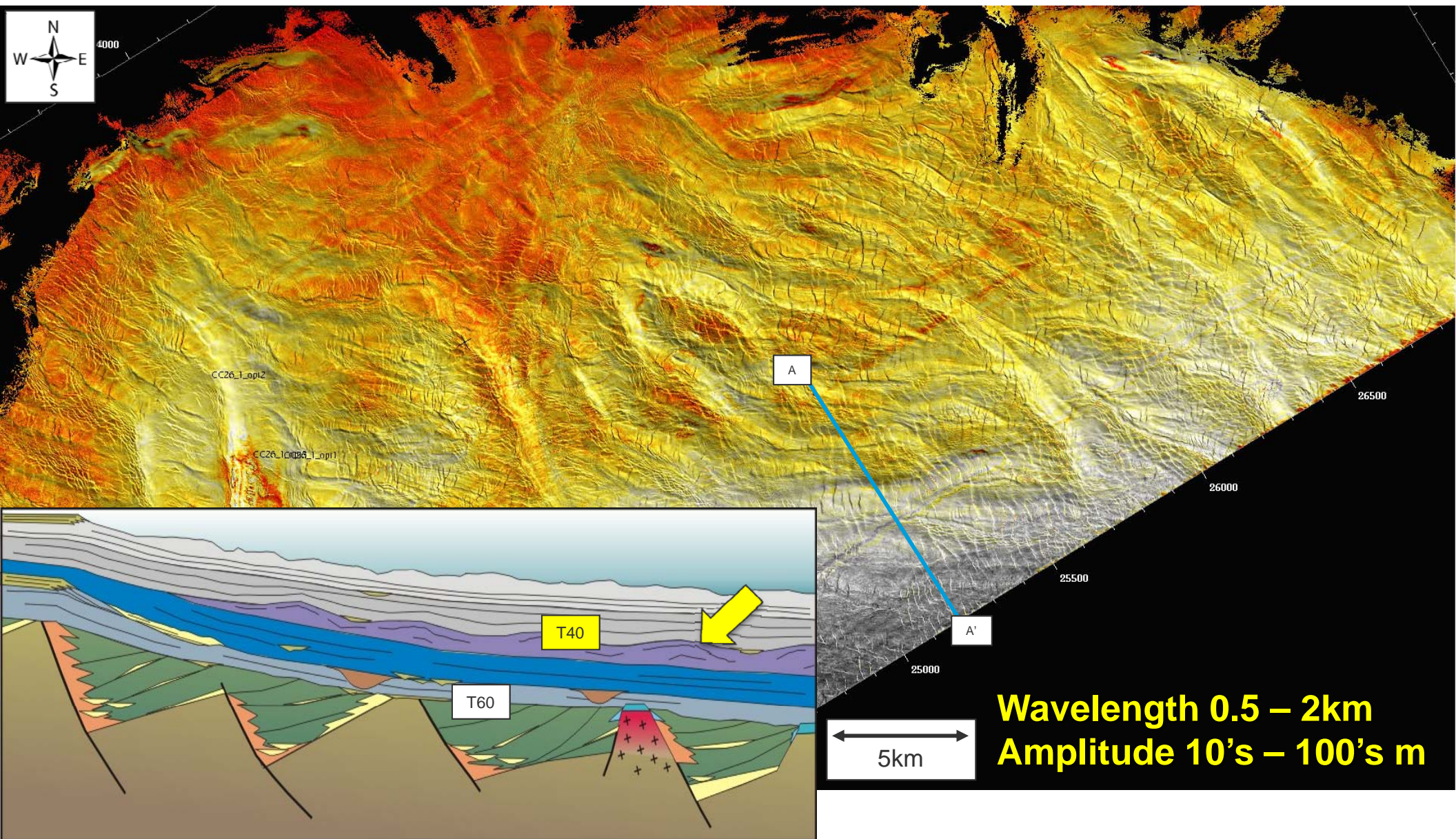


64/18, T50, Meishan: seed picking of individual elements reveals complex depositional architecture



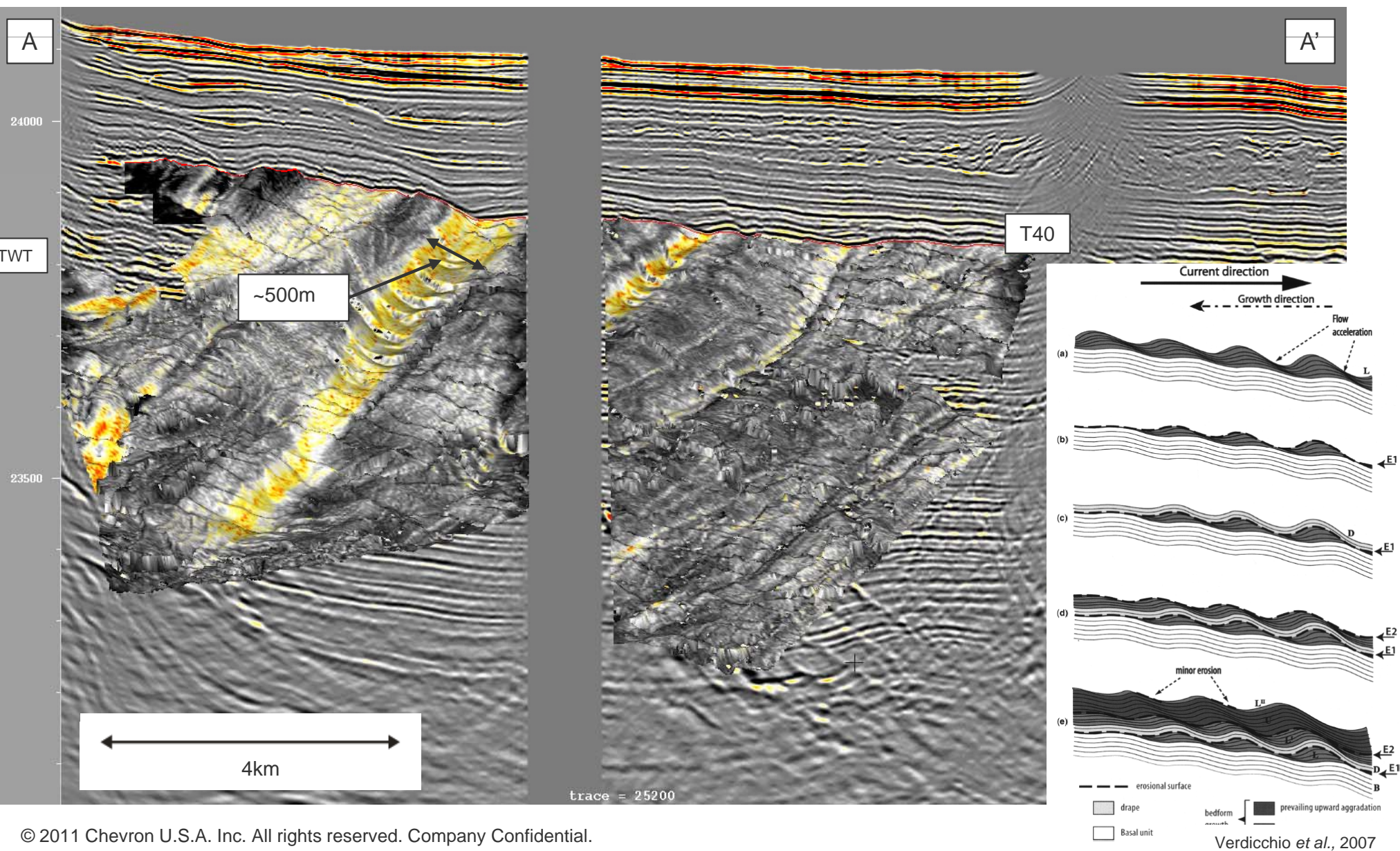


53/30 – T40, Meishan: sediment waves and drifts; bottom current (thermohaline and / or seasonally) driven



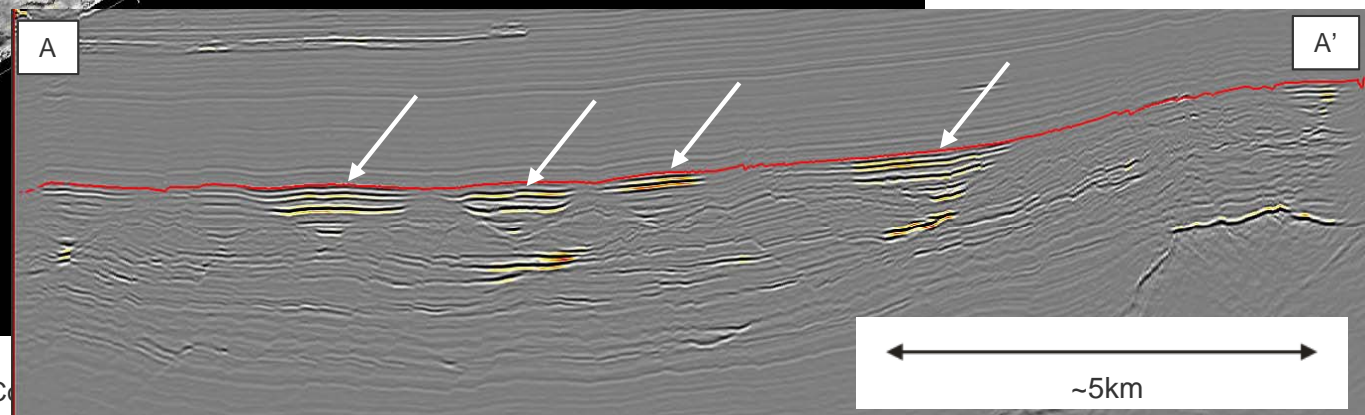
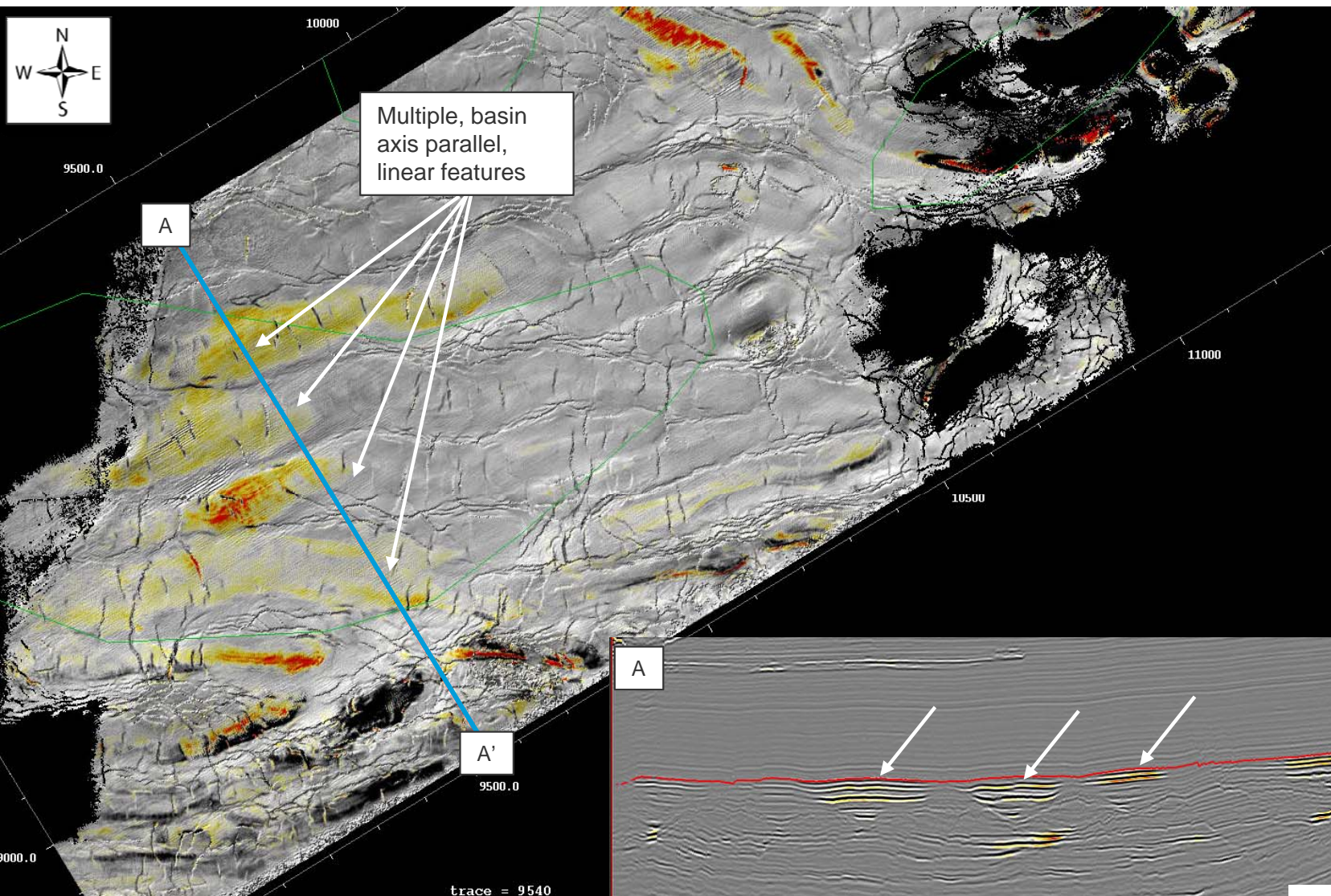


53/30 – T40, Meishan: sediment waves and drifts; bottom current (thermohaline and / or seasonally) driven



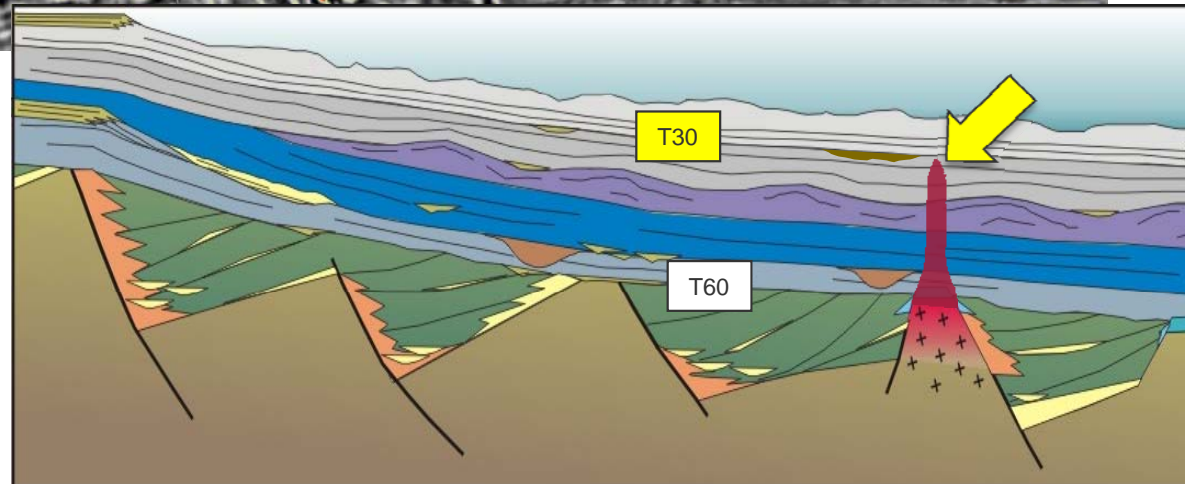
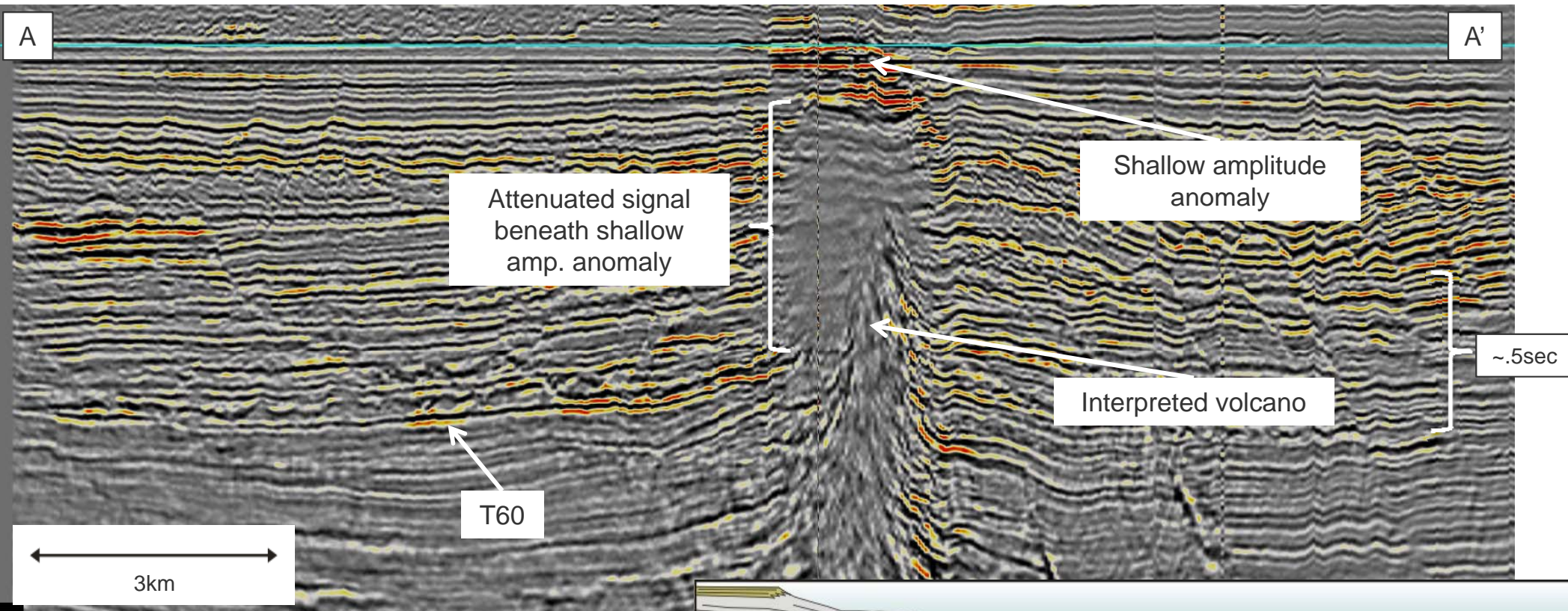


64/18 – T40, Meishan: bottom flow parallel sediment furrows



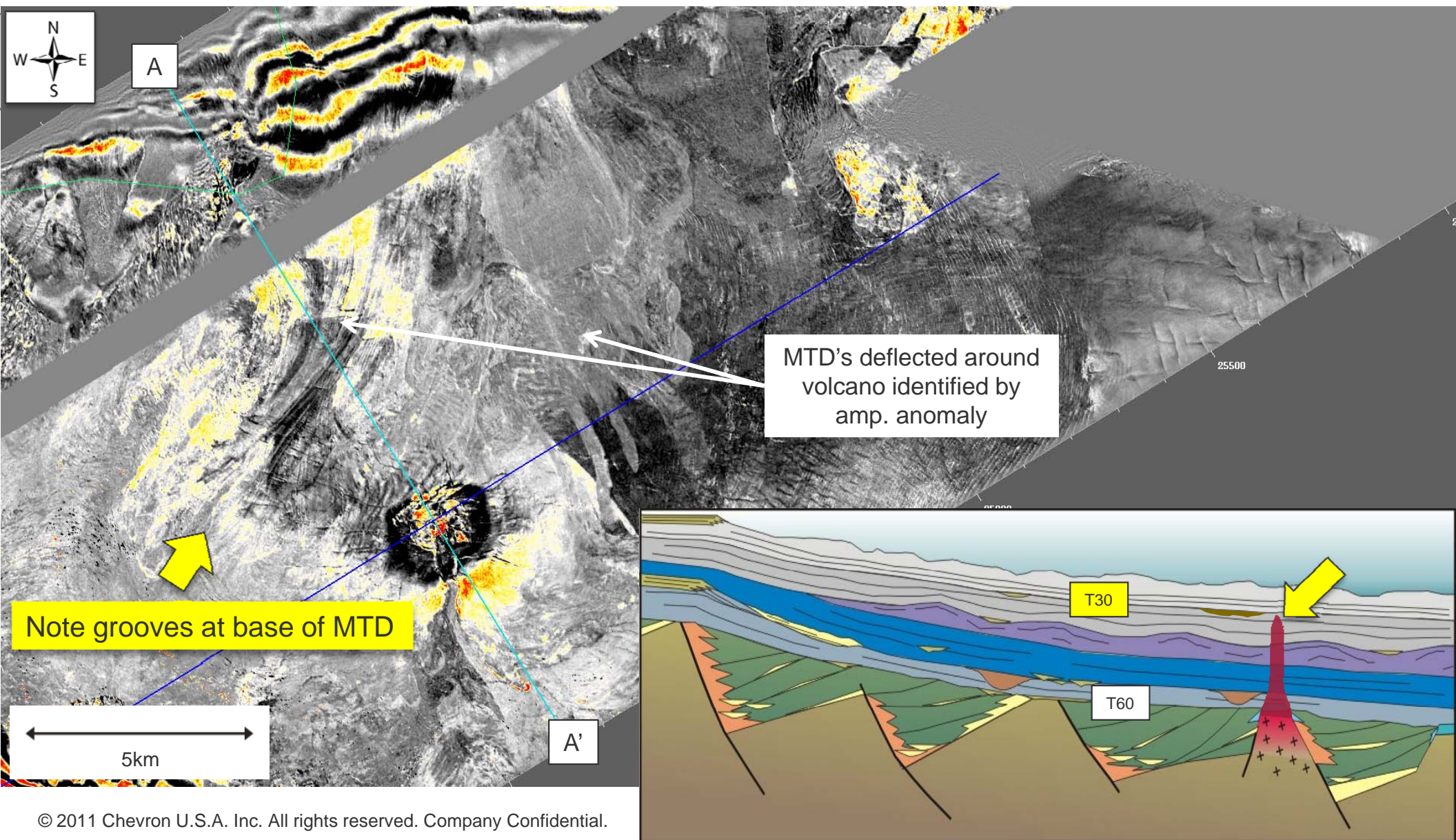


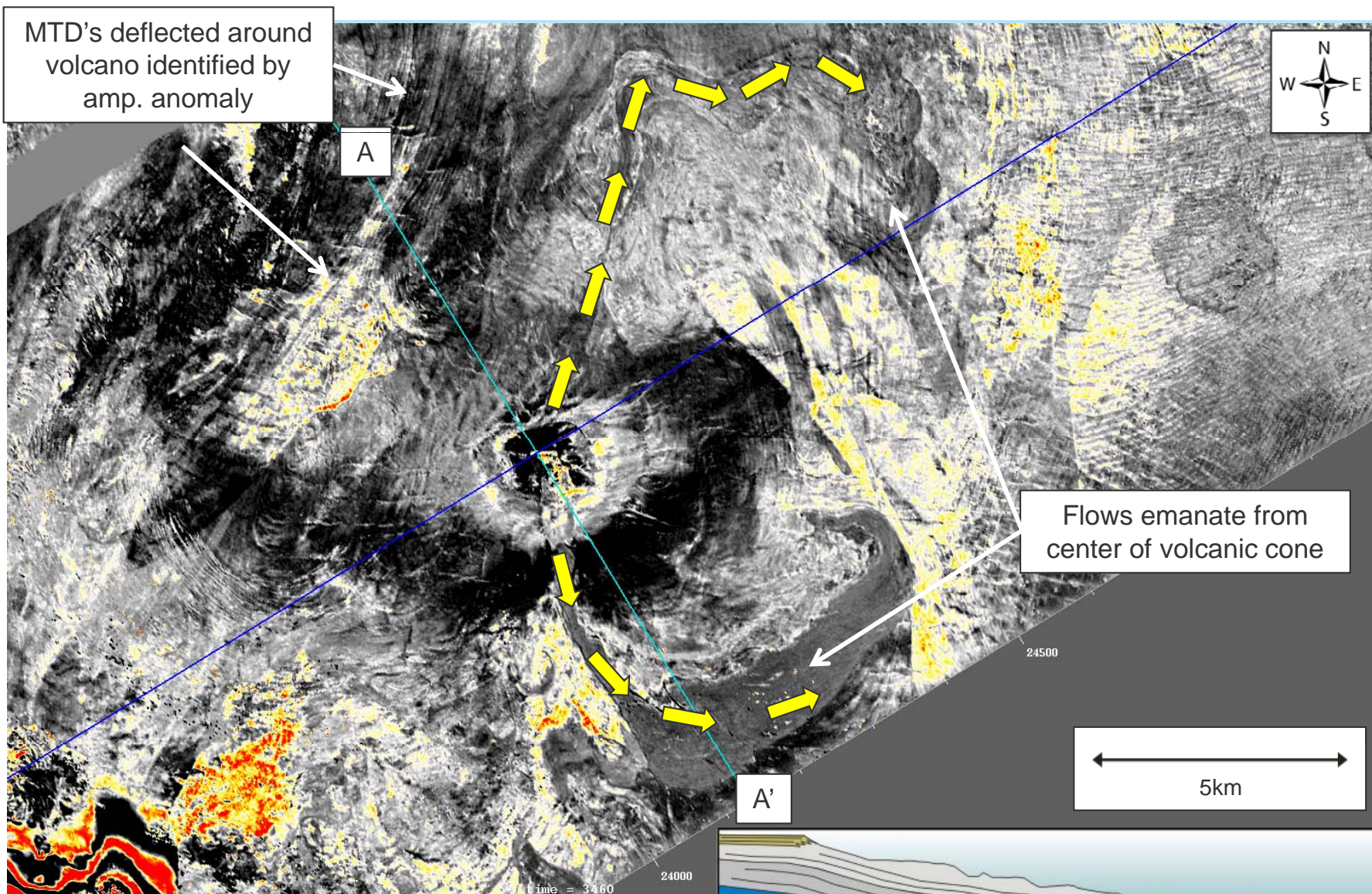
53/30, - T30, Huangliu: impact of volcanics on syn- and post-rift stratigraphy



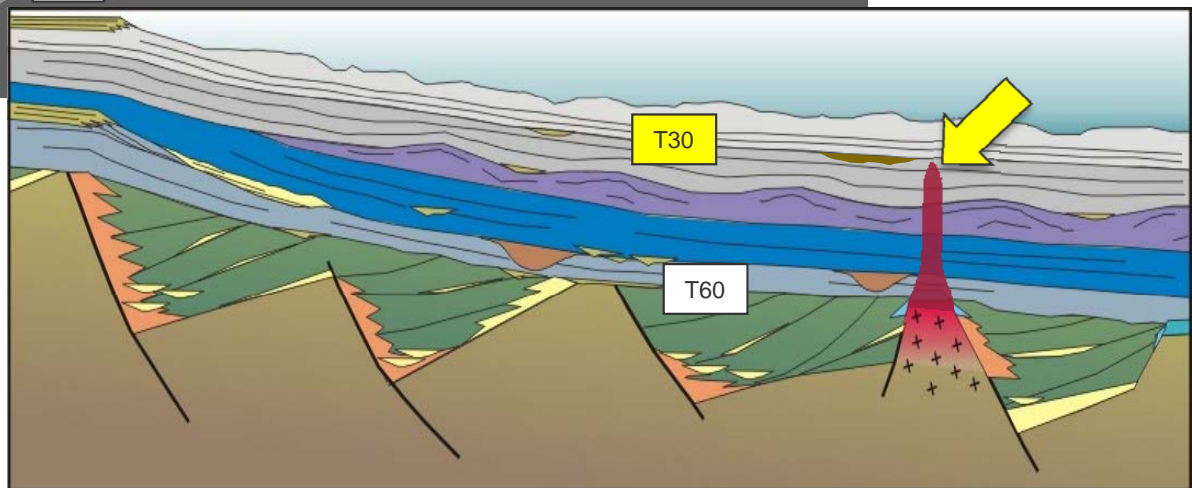


53/30, - T30, Huangliu: impact of volcanics on syn- and post-rift stratigraphy



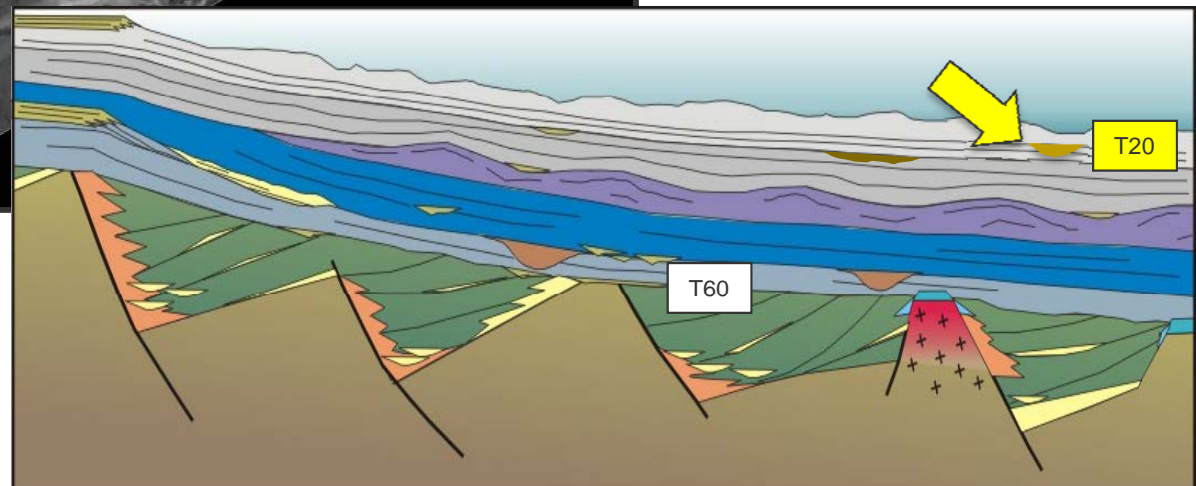
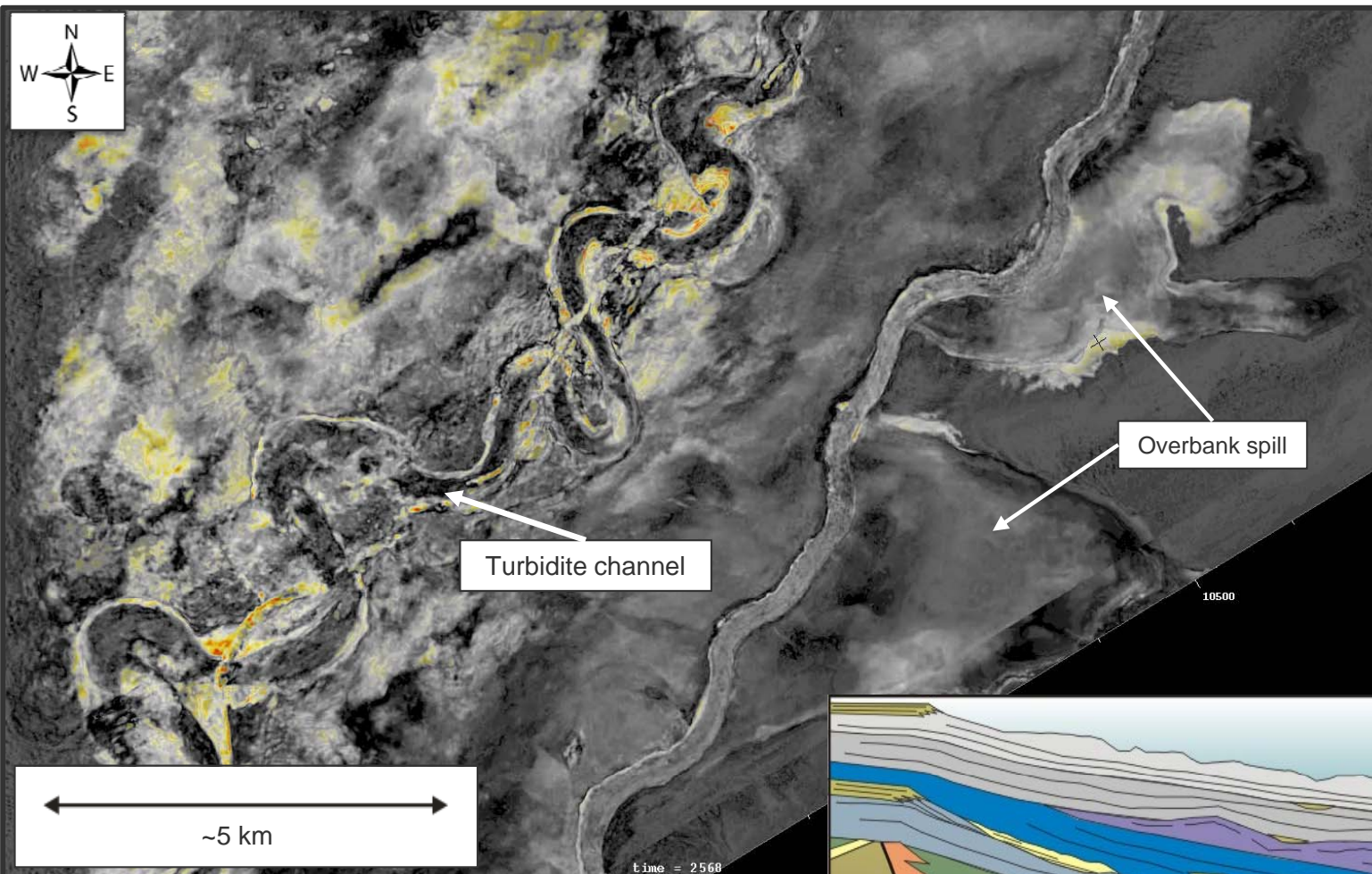


53/30, - T30, Huangliu: impact of volcanics on syn- and post-rift stratigraphy



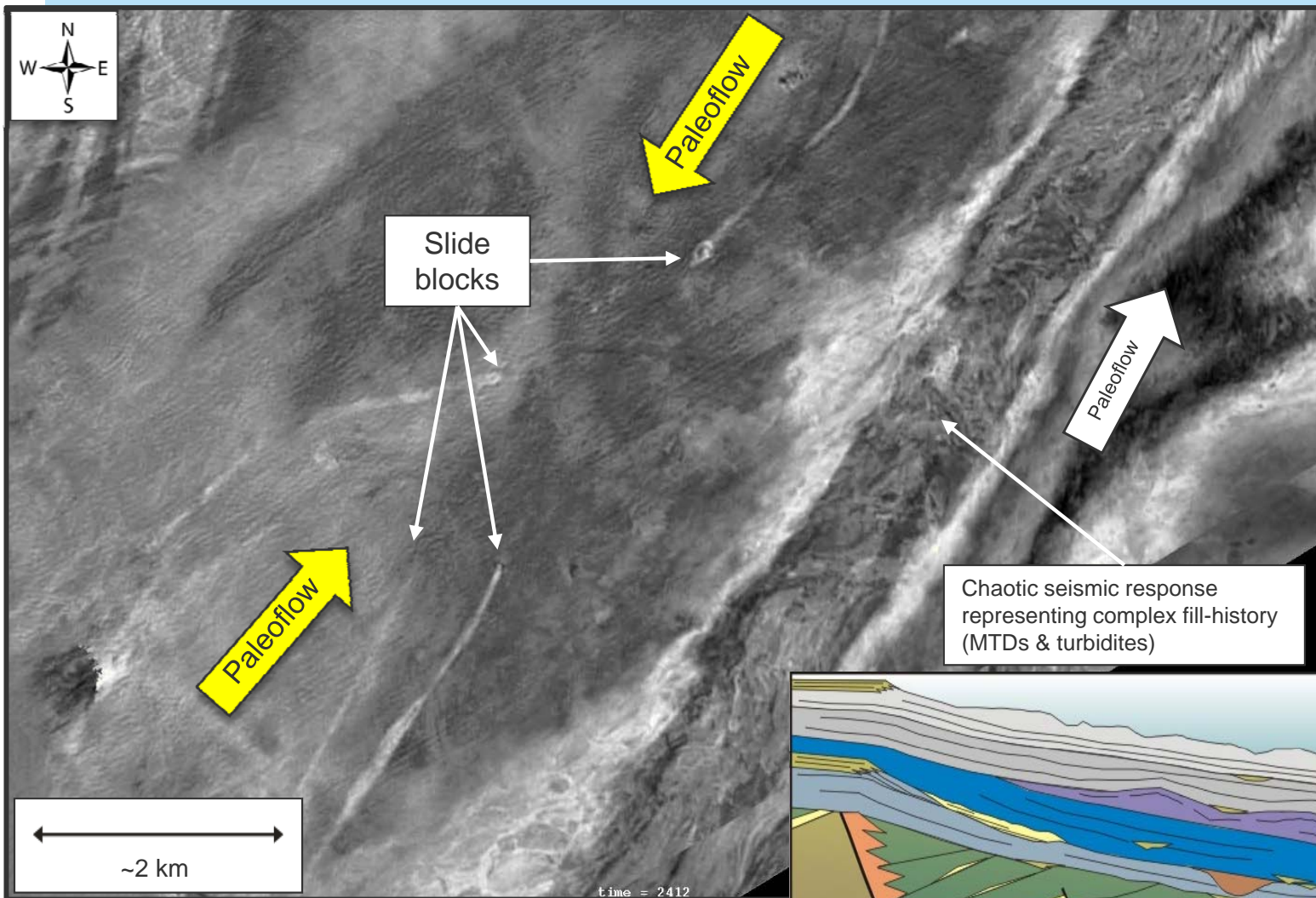


64/18 – T20, Yinggehai: sinuous channels and overbank flow

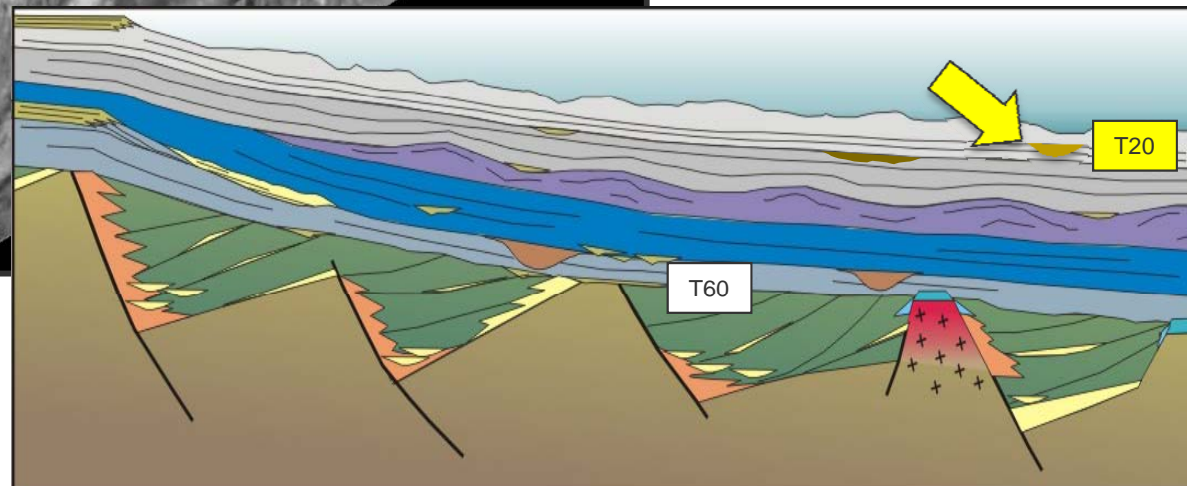




64/18 – T20, Yinggehai: MTDs and slide blocks, opposing transport directions

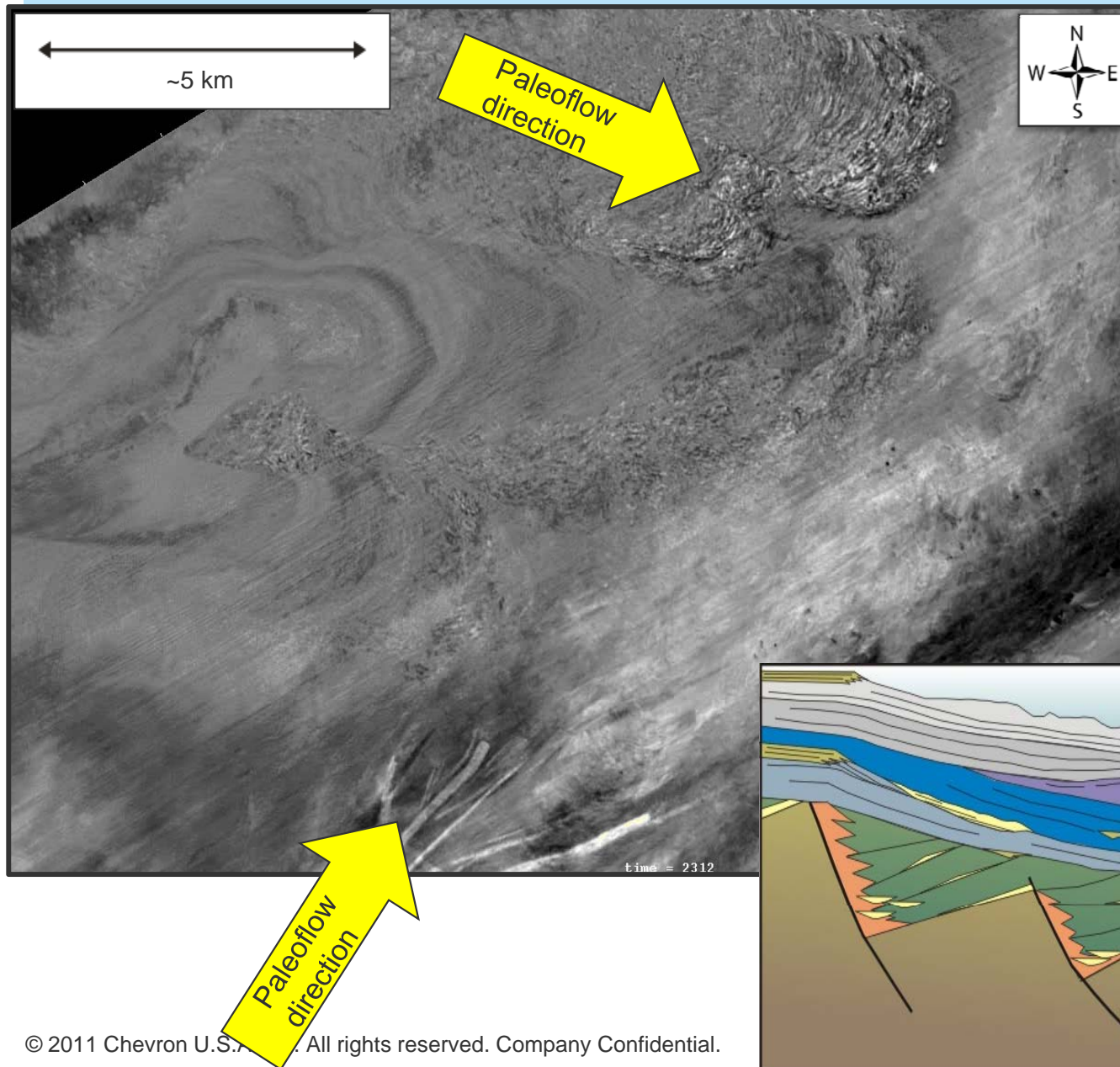


Note multiple input directions,
suggesting low-gradient basin floor

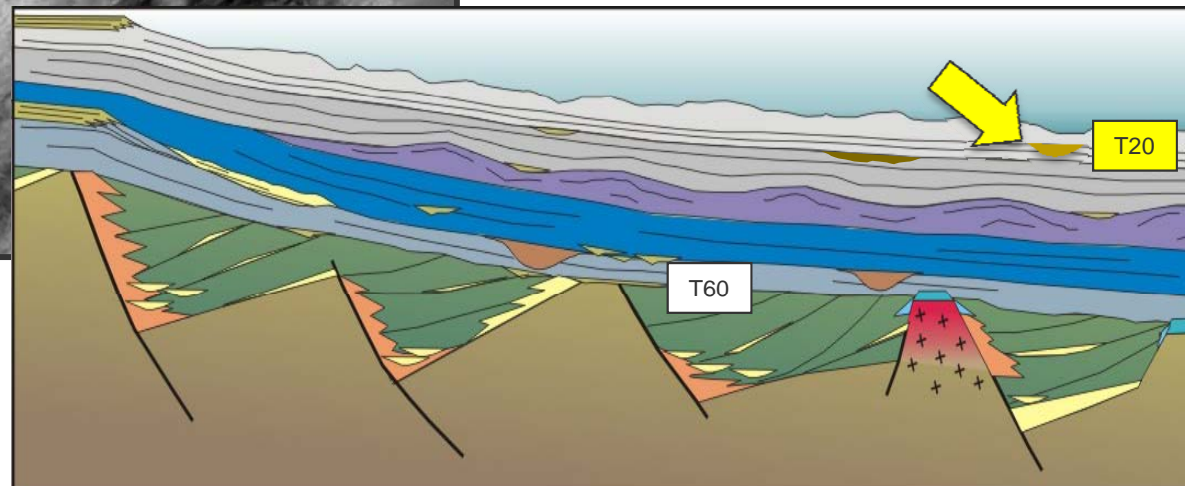




64/18 – T20, Yinggehai: MTDs and slide blocks, opposing transport directions



Note multiple input directions, suggesting low-gradient basin-floor





Observations and key messages



- Seismic stratigraphy integrated with seismic geomorphology has helped decipher and characterize complex syn- to post-rift sedimentary architectures and identify a range of geomorphic elements
- New interpretation of syn-rift to post-rift strata:
 - Onset of marine incursion occurred earlier than previously interpreted, T70, Late Oligocene
 - Subsidence associated with rift-climax resulted in a predominantly marine late syn-rift succession with marginal marine and / or subaerial depositional environments restricted to the basin margins or occupying isolated basin highs
 - Post-rift succession is dominated by deep marine depositional environments
- Leverage geomorphological observations to reduce uncertainty associated with reservoir prediction and connectivity in exploration and pre-drill analysis