IT4 – TOR Test

NZ 3D Processing

24 March 2021

INSTITUTE FOR GEOPHYSICS

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Passion for Geoscience

Outline

- **Objective:**

  To evaluate the benefit from tilted orthorhombic (TOR) VMB.

- **Procedure:**

  OBS data was divided into 6 azimuth sectors, which were used to run 6 TTI FWI. Tilted orthorhombic TOR models were then built base on 6 TTI models to handle azimuthal anisotropy. OBS only TOR FWI was run using converted TOR models as starting model to fully utilize the benefit from TOR setting.

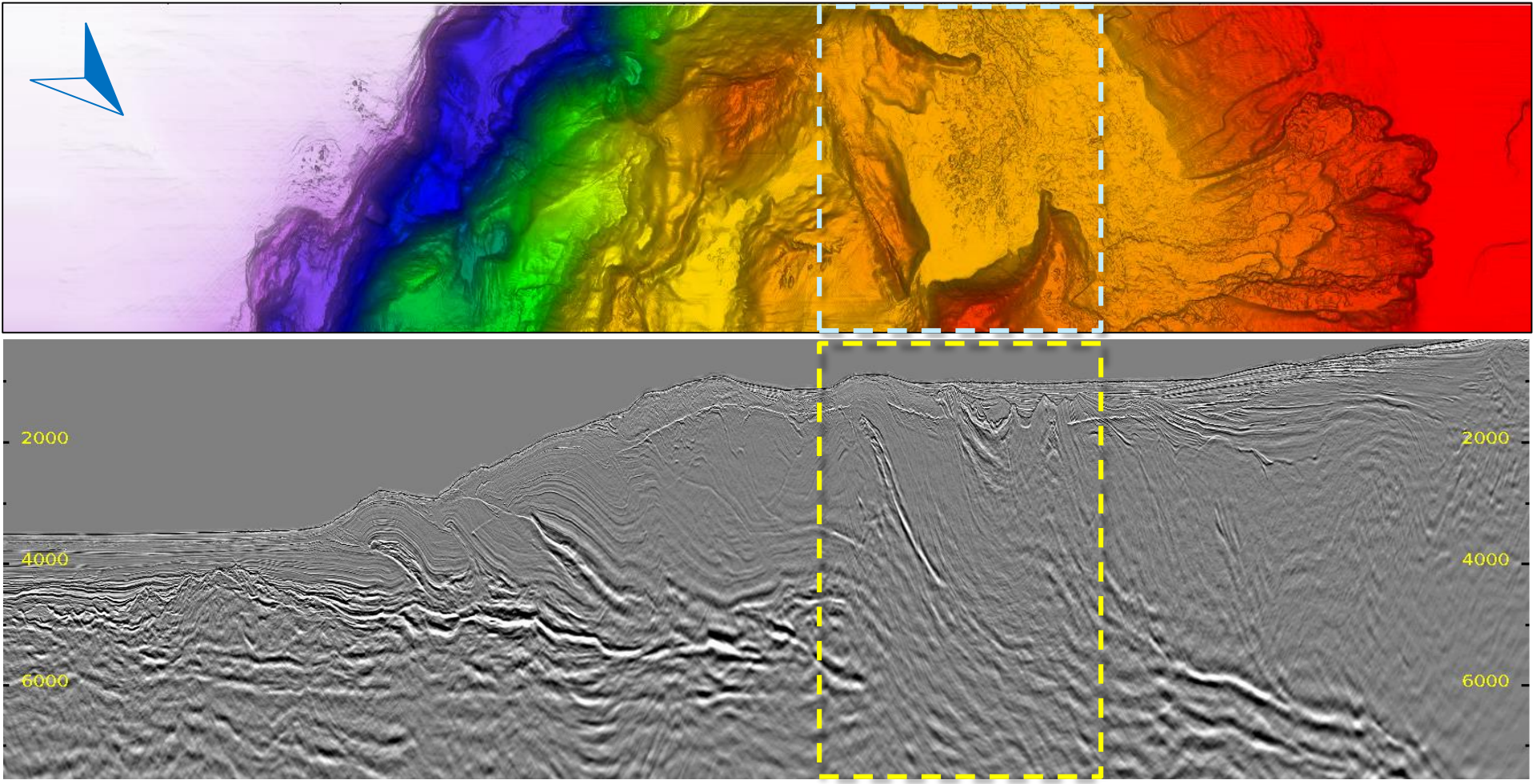
- **Display:**

  Velocity models, migrated depth full stack & gathers.

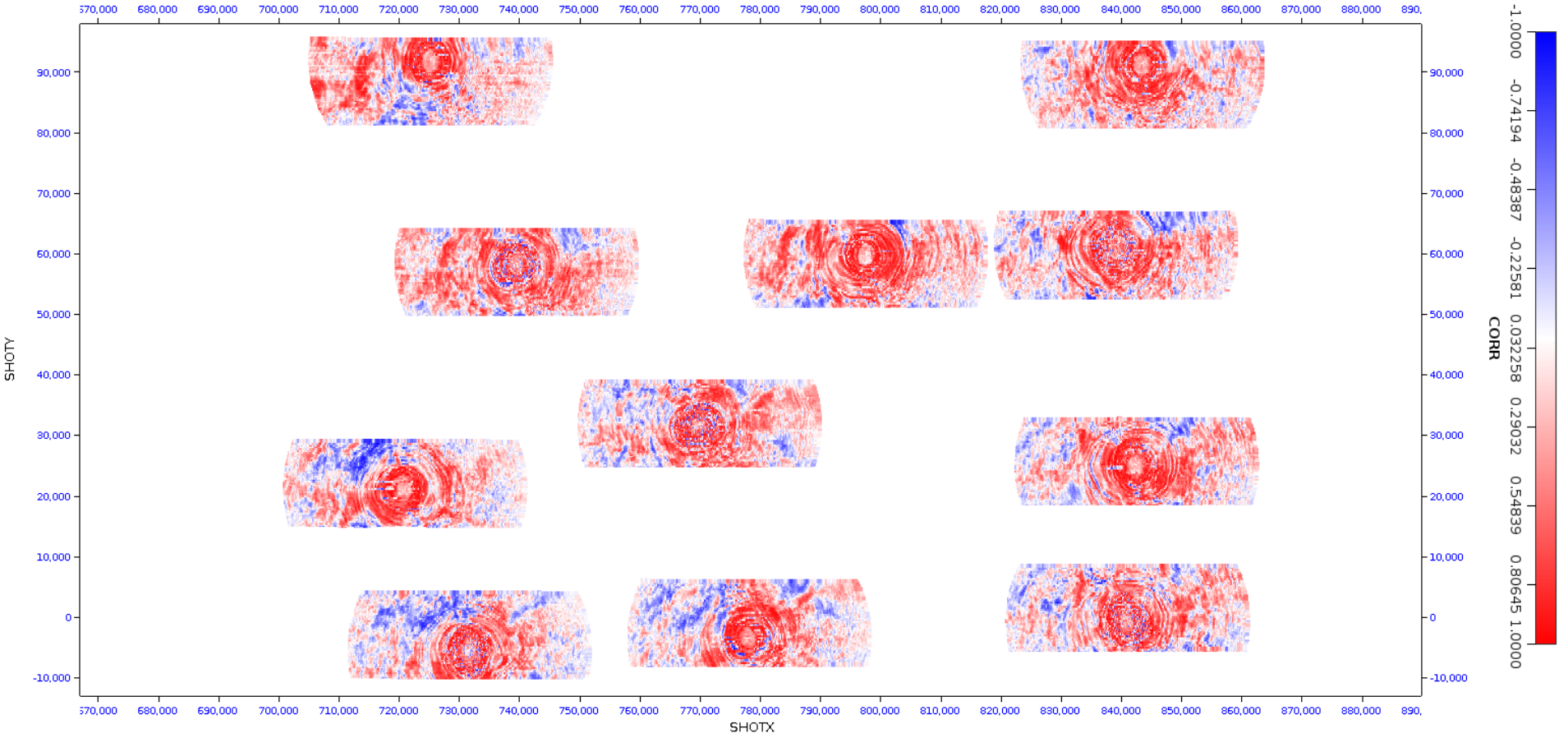
- **Observation and Recommendation:**

  20Hz TTI QRTM result has less migration swings and high frequency noises. Events in the deep sections are more continuous and better illuminated at places where velocity is complex.

Test Area



Synthetic and Real Data X-correlation: IT4 TTI Velocity



TOR Conversion

Tilted Orthorhombic Anisotropy

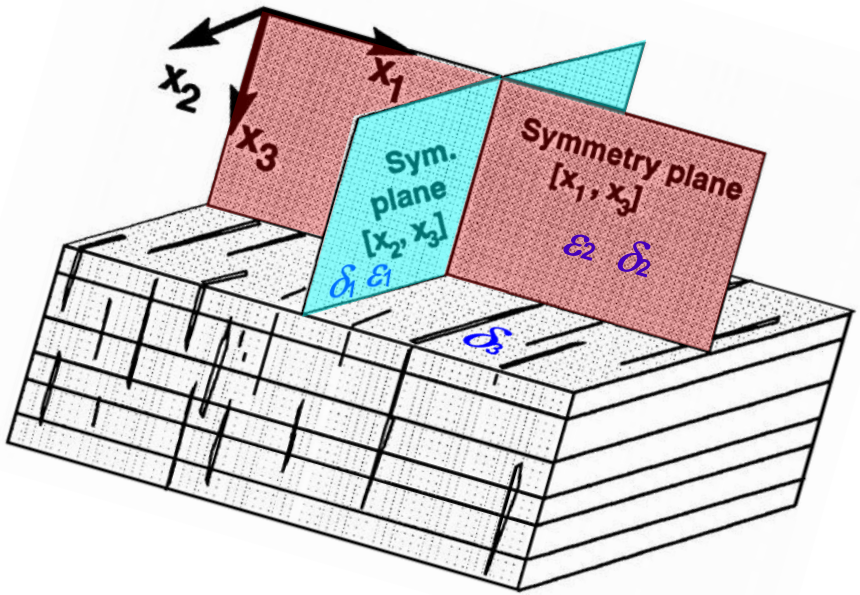


Figure courtesy of Professor Tsvankin

Tilted Transverse Isotropy (TTI)

$$V_{x1} = V_{x2} \neq V_{x3}$$

Parameters:

$$V_p, \delta, \varepsilon, \theta, \varphi$$

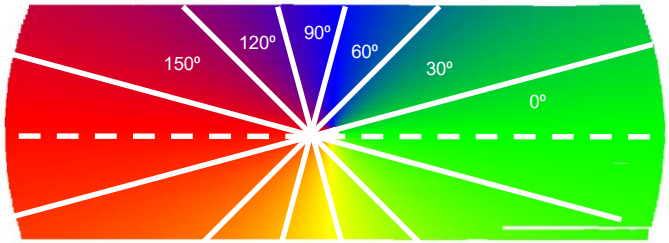
Tilted Orthorhombic

$$V_{x1} \neq V_{x2} \neq V_{x3}$$

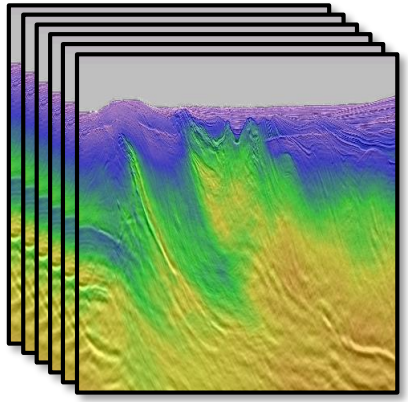
Parameters:

$$V_p, \delta_1, \delta_2, \delta_3, \varepsilon_1, \varepsilon_2, \theta, \varphi, \varphi_2$$

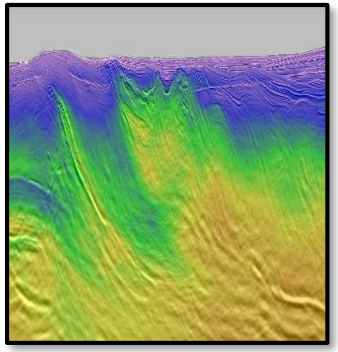
From TTI to TOR



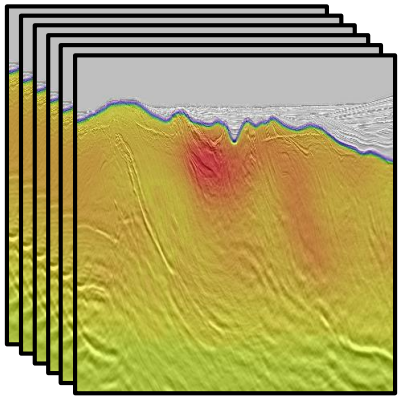
Azimuthal TTI FWI



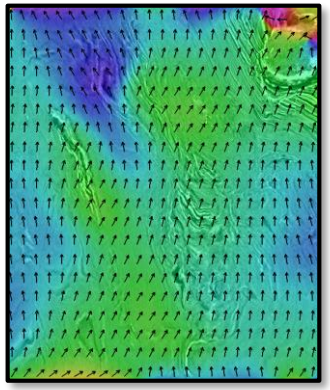
$V_{Azimuth}^{ISO\ FWI}$



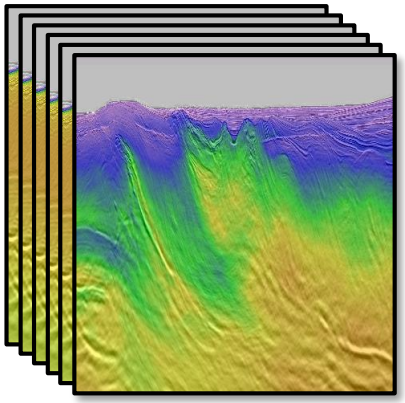
V_{Slow}



$Eps_{Azimuth}$

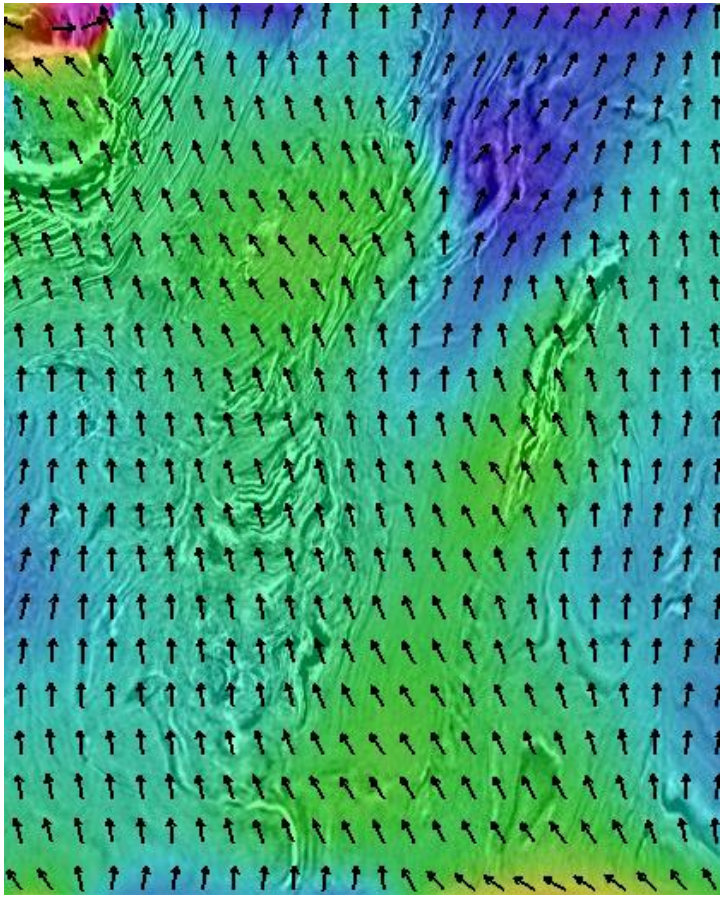


Slow velocity direction



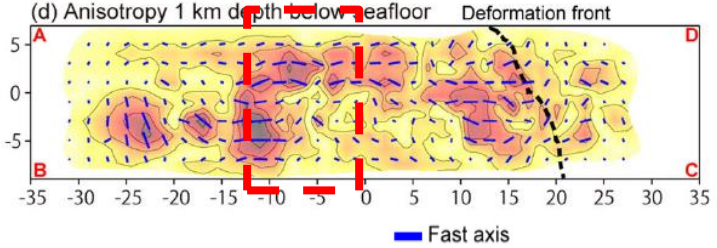
ORT Parameters

TOR Parameters: Slow Velocity Azimuth



- Slow velocity azimuth is aligned with dip direction of the structures, around 90 degree azimuth.

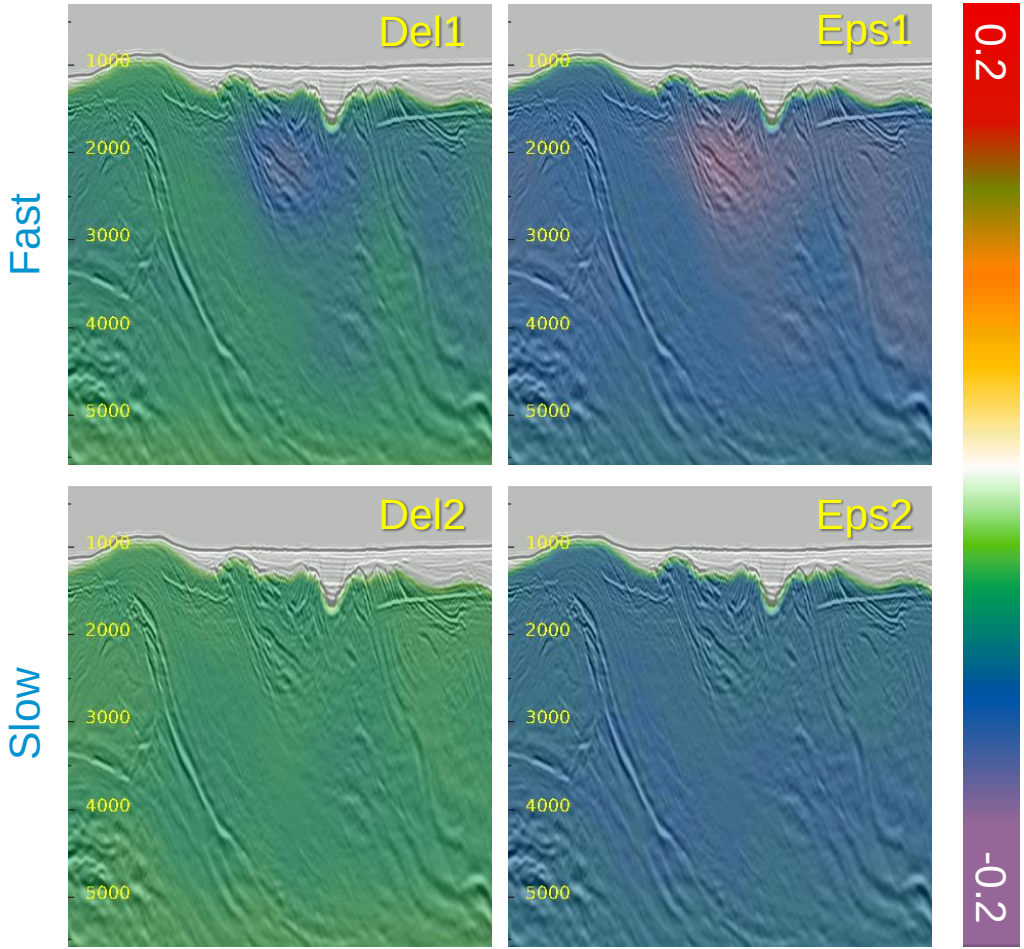
- This observation agrees with what's reported in the JAMSTEC paper.



Ryuta Arai, et al.,Three-Dimensional P Wave Velocity Structure of the Northern Hikurangi Margin From the NZ3D Experiment: Evidence for Fault-Bound Anisotropy, Journal of Geophysical Research: Solid Earth, 2020.

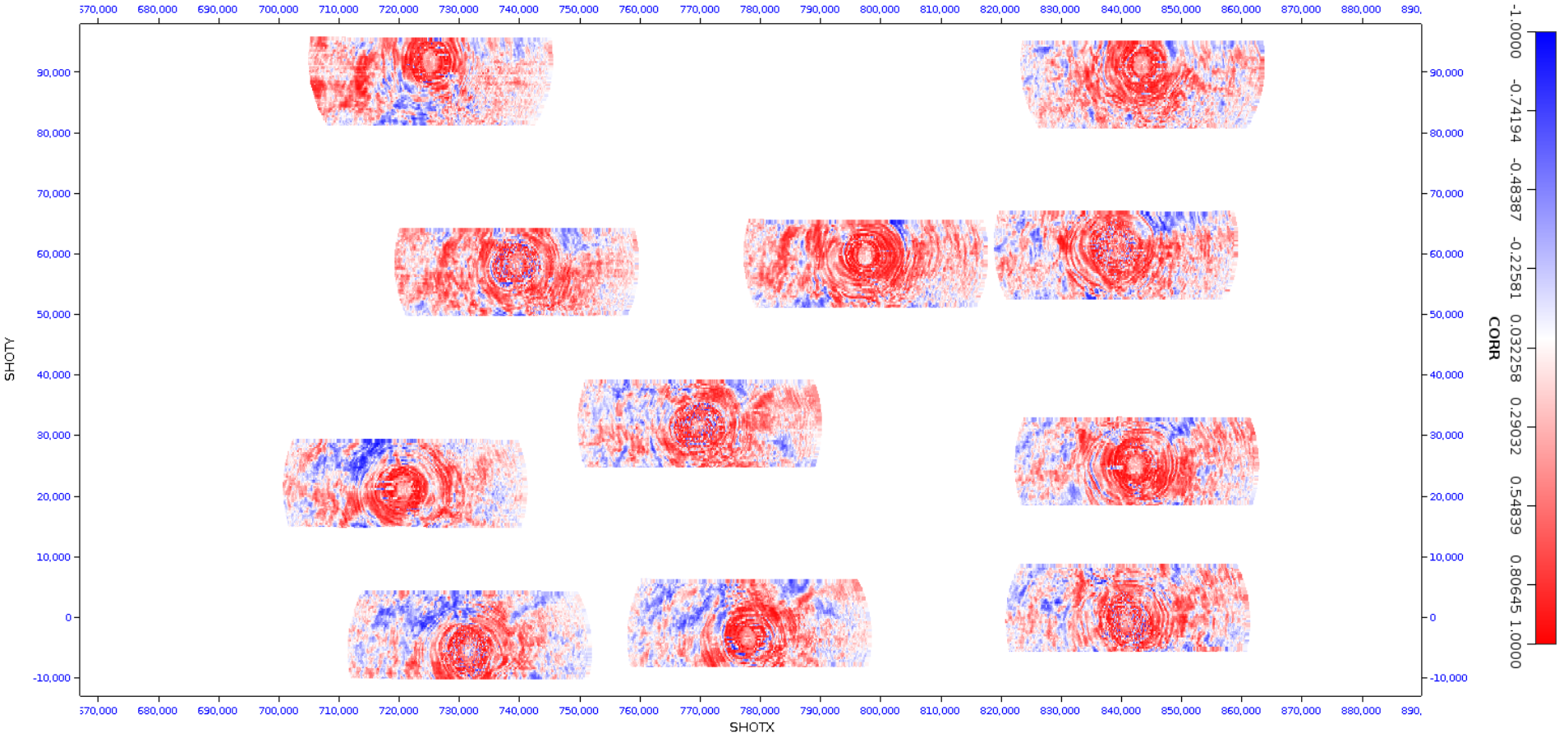
Acquisition direction

TOR Parameters: Deltas and Epsilons

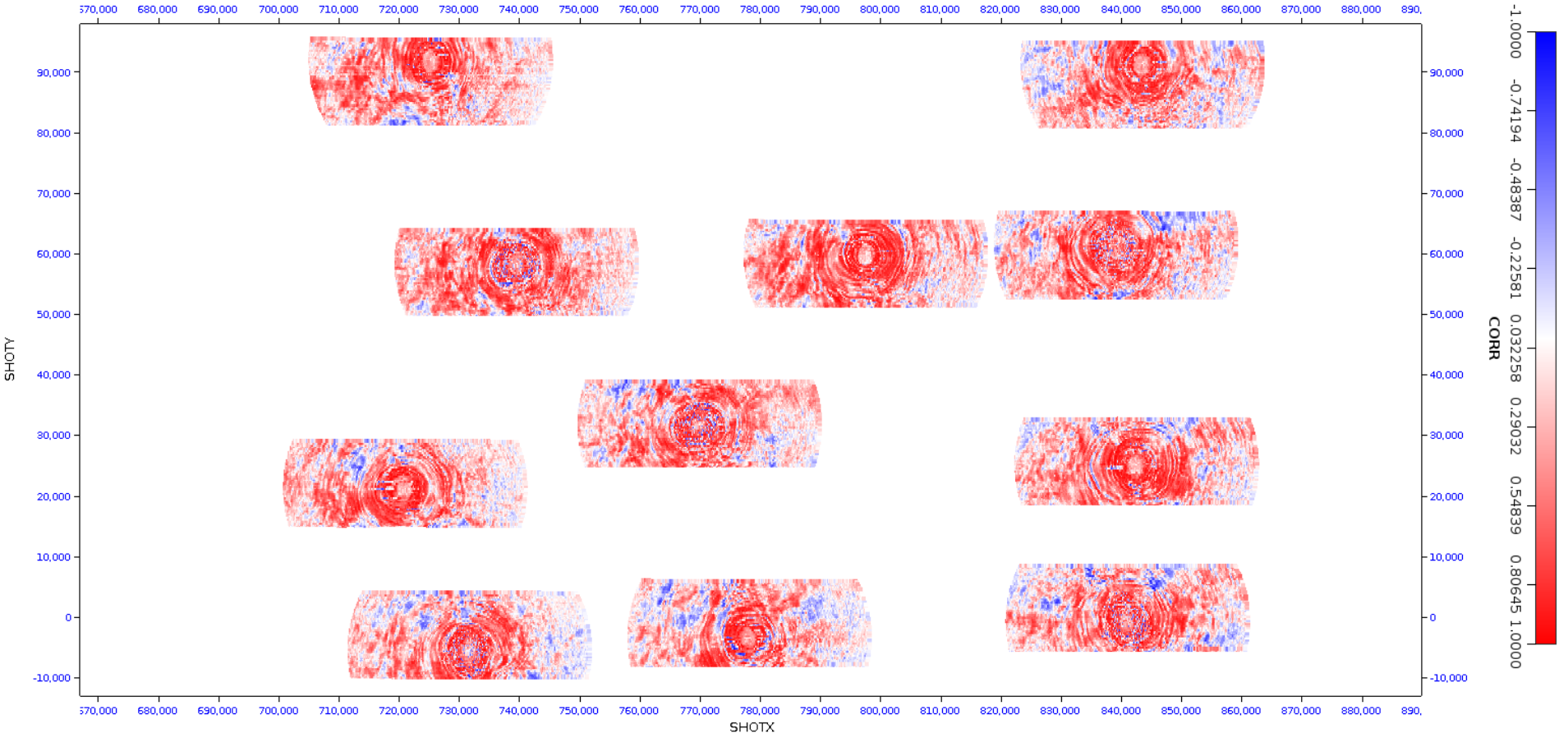


- Maximum ~6% del and eps difference between fast and slow velocity azimuth.
- This observation also aligns with what's reported in the JAMSTEC paper.

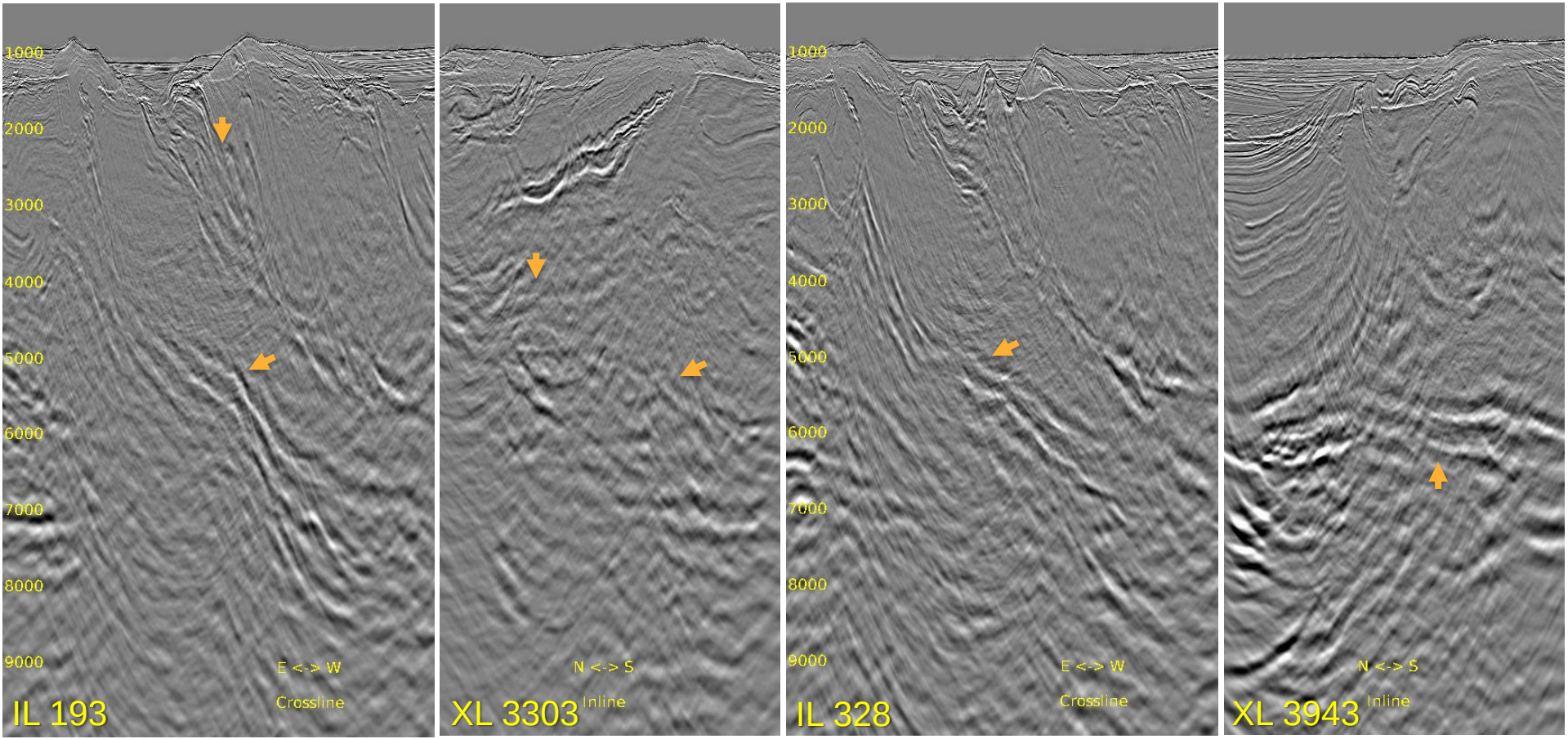
Synthetic and Real Data X-correlation: IT4 TTI Velocity



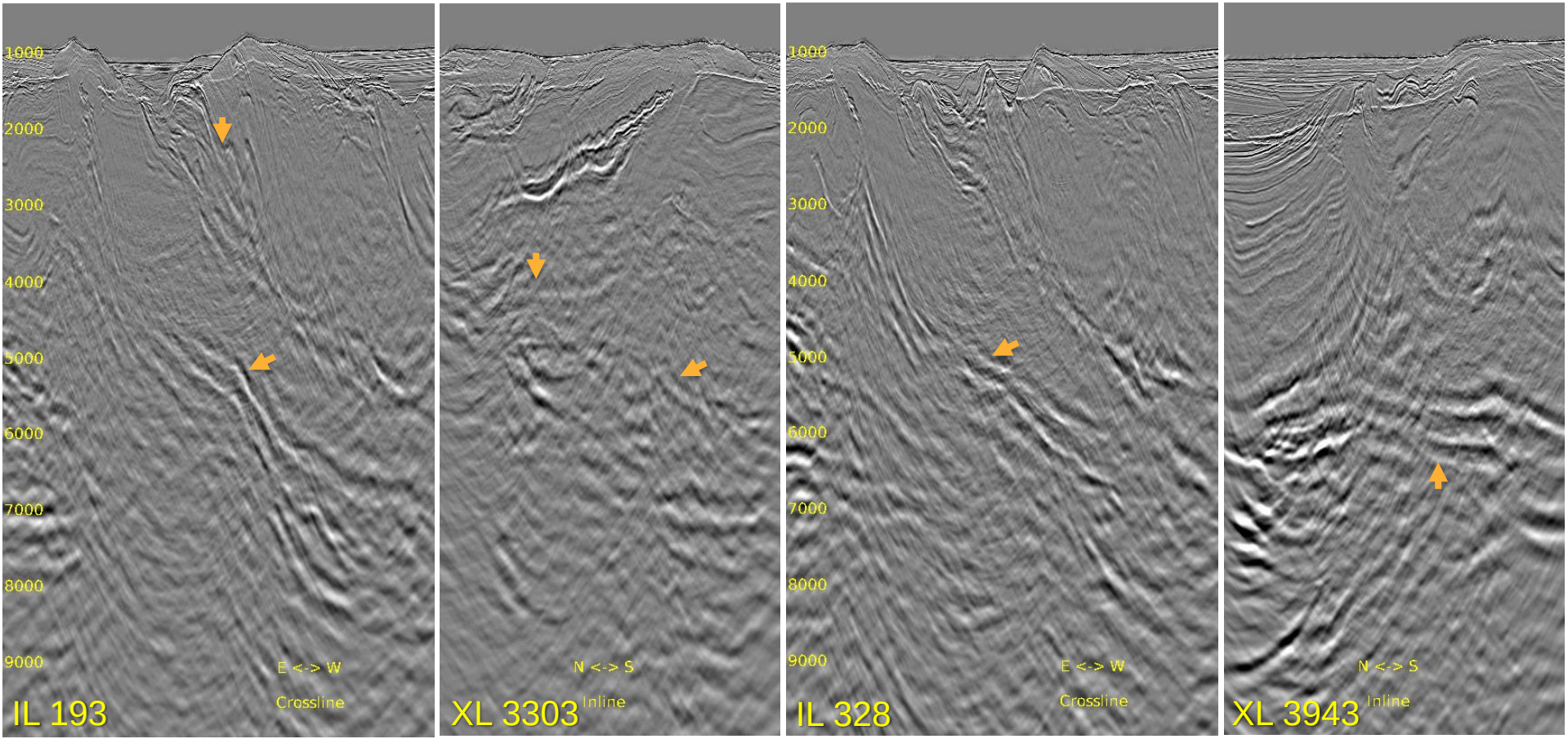
Synthetic and Real Data X-correlation: Converted TOR Velocity



Full Stack: IT4 TTI Result

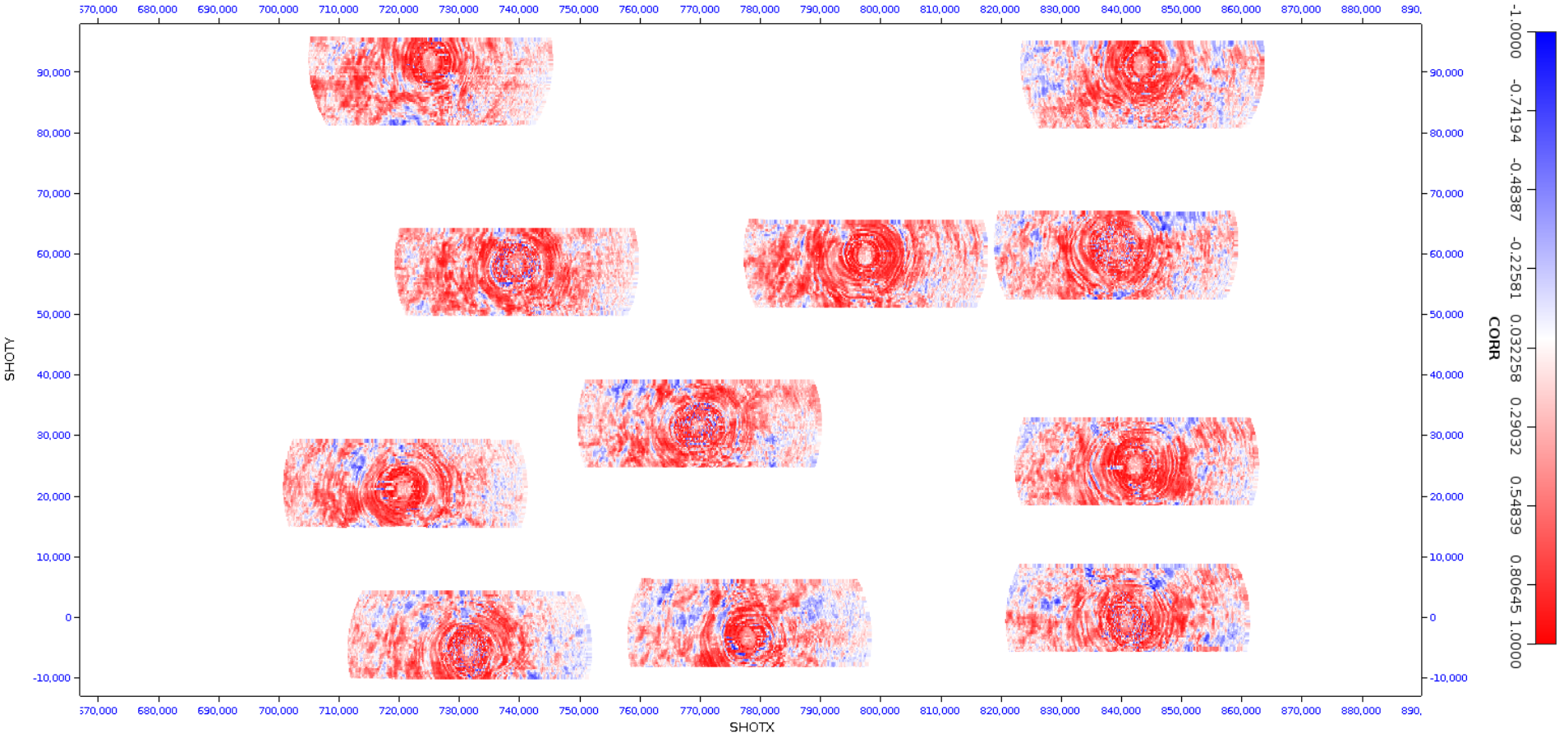


Full Stack: Converted TOR Result

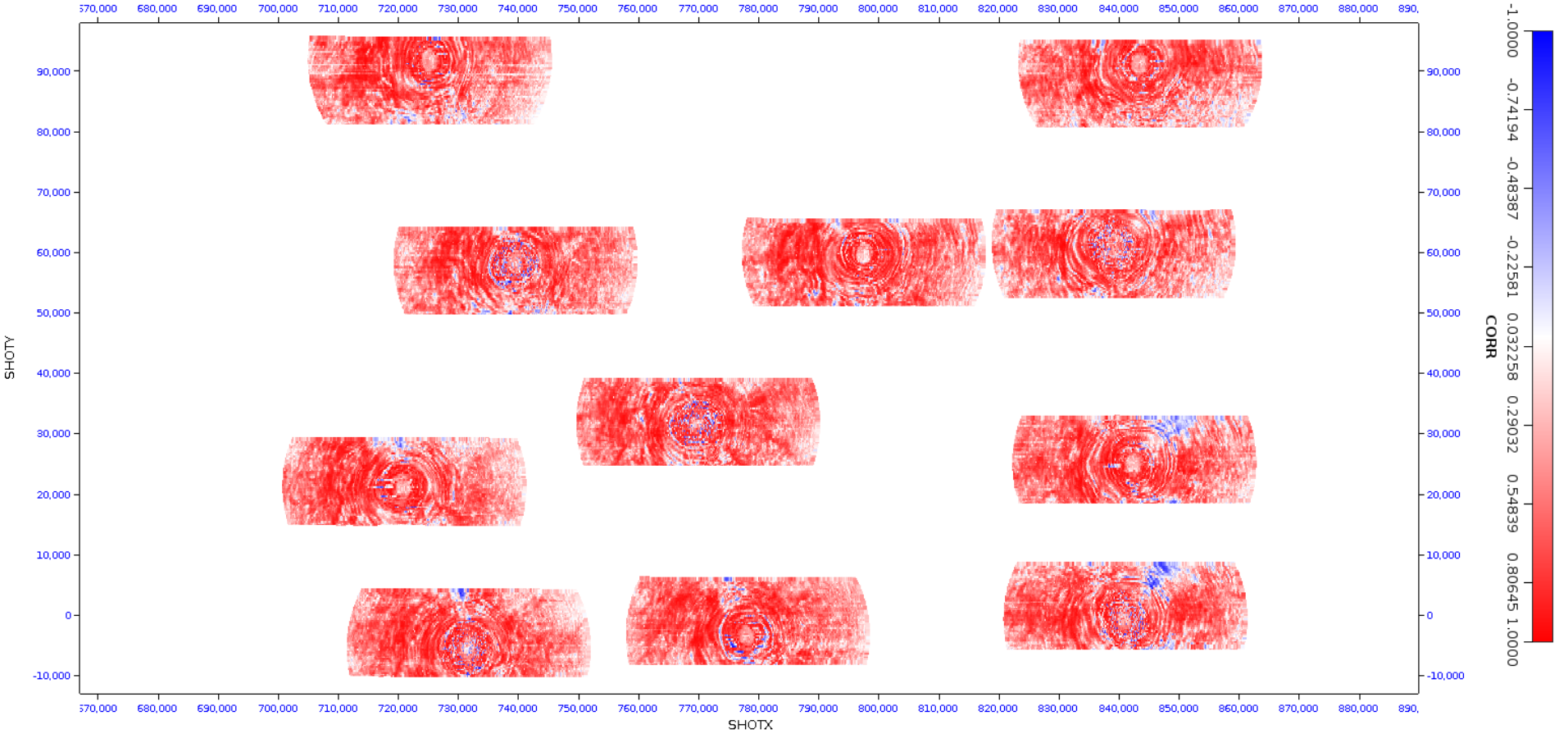


TTI vs TOR FWI

Synthetic and Real Data X-correlation: Converted TOR Velocity

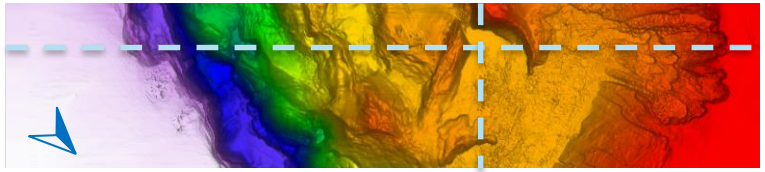


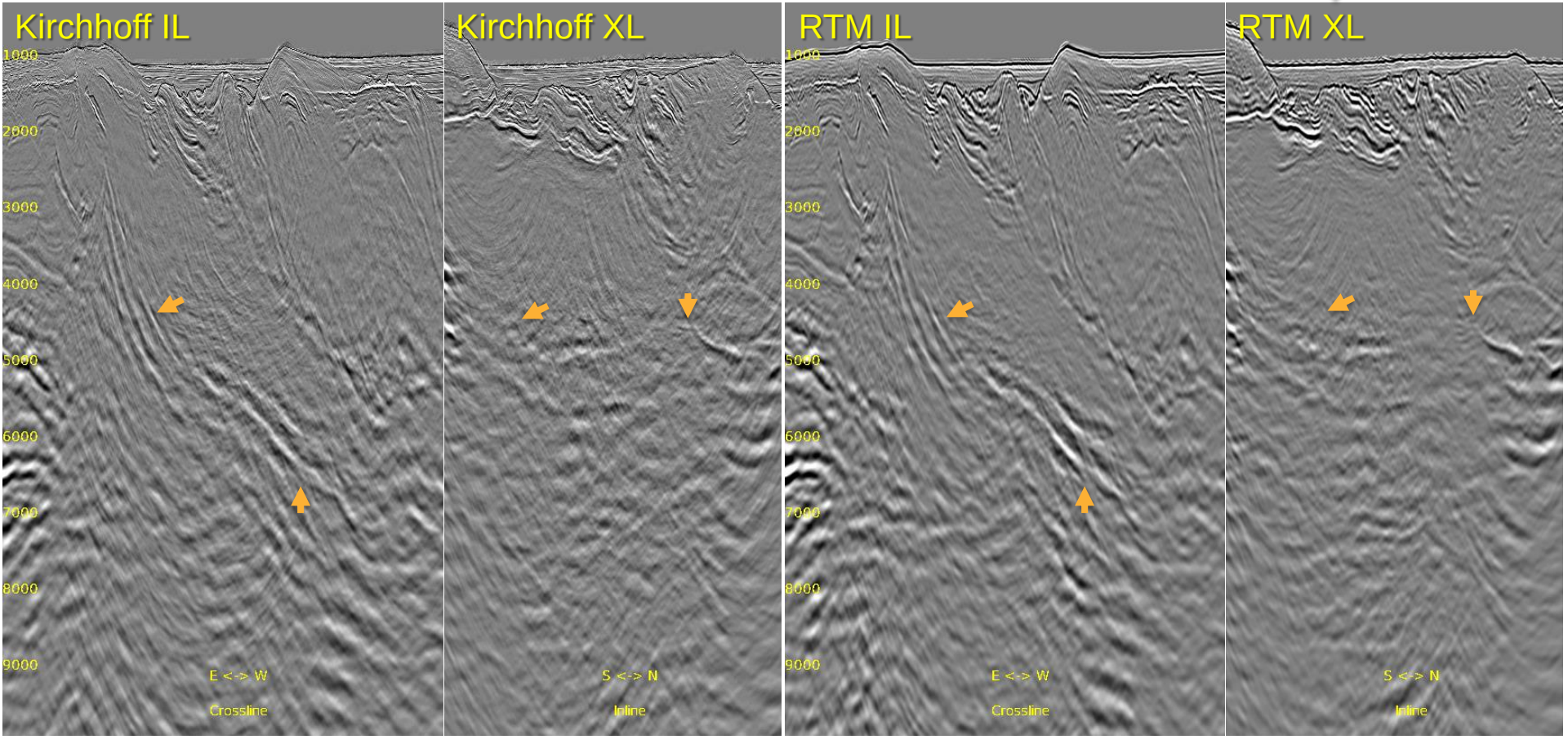
Synthetic and Real Data X-correlation: TOR FWI Velocity



Full Stack: IT4 TTI Result

Inline 307 & Crossline 3579





Full Stack: TOR FWI Result

Inline 307 & Crossline 3579