Development of Structures Related to the Offshore Extent of the Minab Fault, Makran Accretionary Complex, Offshore Iran*

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Abstract

The Makran Accretionary Complex (MAC), Iran and Pakistan, is a fold-thrust system bound by the Murray Ridge and Ornach Nal Fault to the east and the Minab Fault System (MFS) to the west. It is c. 1000 km wide and the frontal c. 125 km of the system is submerged beneath the Gulf of Oman. We use 2D seismic reflection data to investigate the structural style and evolution of the offshore, Iranian segment of the MAC. Overall, the MAC is characterized by laterally continuous, north-dipping thrust faults, which are overlain by south-verging, non-cylindrical, fault-propagation folds.

Two principal structural domains are identified; (i) an inner domain, located immediately offshore, which is characterized by normal faults in the lower sequence and E-W-striking, thrusts and fault-propagation folds in the upper sequence and (ii) an outer domain, close to the deformation front, which is dominated by E-W-striking thrusts and fault-propagation folds that affect the entire sequence.

Immediately offshore from the onshore trace of the MFS, the MFS itself is not imaged, suggesting that the structure does not continue offshore or that its offshore expression is too subtle to be imaged by seismic data. Instead, the structures in domain (i) are intensely thrusted, with reactivation on the normal faults. The thrusts and associated folds in domain (ii) trend NW-SE and, in contrast to the laterally-continuous structures that characterize the rest of domain (ii), folds in this location are only c. 20 km long and have a wavelength of c. 5 km.

Similar shallow-level fold structures are observed above the offshore extent of the Kazerun Fault, western Iran. Neither these folds, nor the structures offshore from the MFS can be adequately described by a flower structure model, implying that this model has limited applicability in strongly mechanically layered sequences. In the examples above, the cover sequences are decoupled from the major basement fault and flower structures do not form.

Reference

Grando, G., and K. McClay, 2007, Morphotectonics domains and structural styles in the Makran accretionary prism, offshore Iran, *in* G. Storti, and P. Vannucchi, (eds.), Deformation of soft sediments in nature and laboratory: Sedimentary Geology, v. 196/1-4, p. 157-179.

DEVELOPMENT OF STRUCTURES RELATED TO THE OFFSHORE EXTENT OF THE MINAB FAULT, MAKRAN ACCRETIONARY COMPLEX, OFFSHORE IRAN

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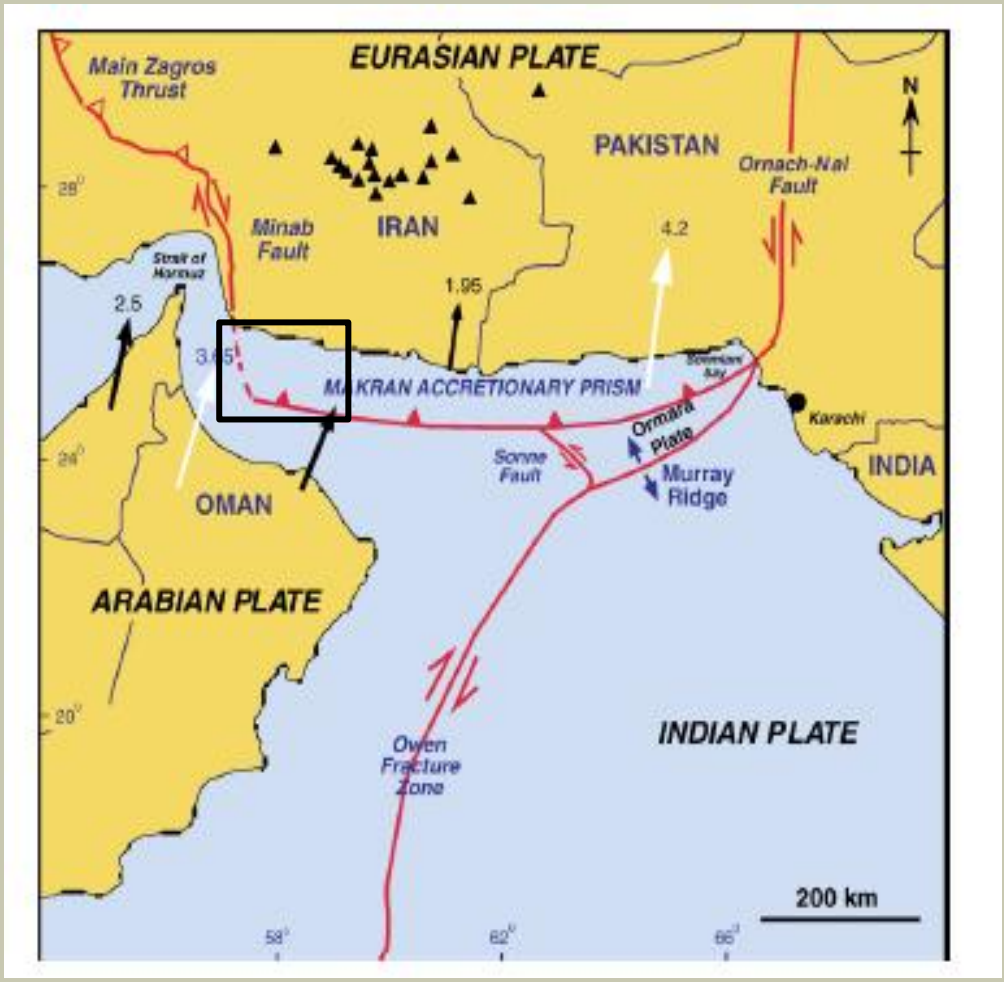
Presenter's notes: We thank IHS for access to software and GGS for the data for this project.

Outline

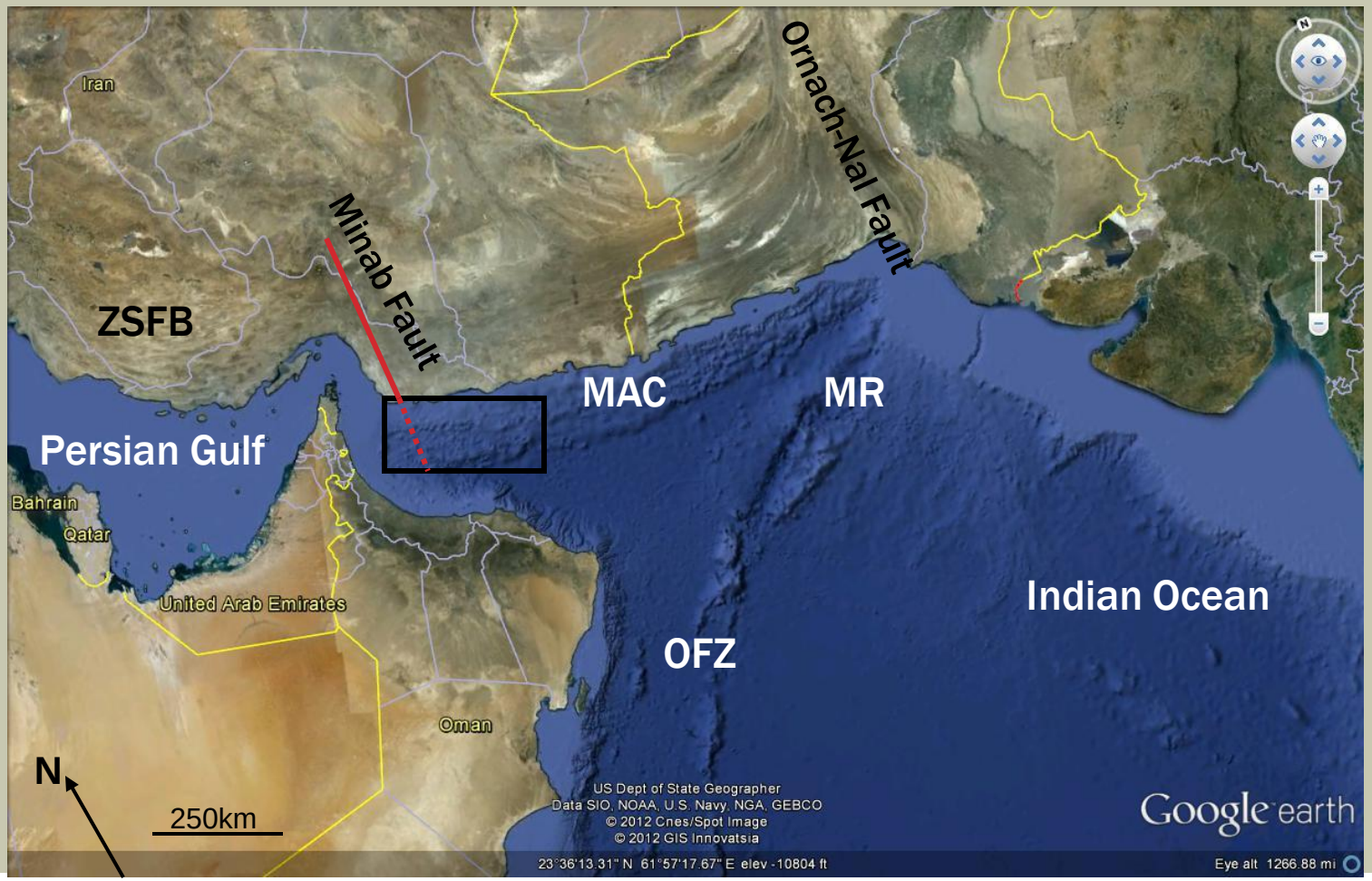
- Geologic setting of the Makran Accretionary Complex
- Previous work & sea floor morphology of the MAC
- Along-strike style transition from thrust-dominated zone to strike-slip dominated zone



Grando & McClay, 2007

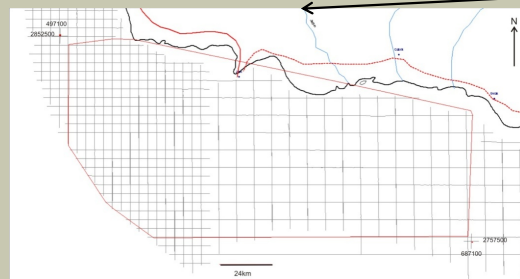
INTRODUCTION

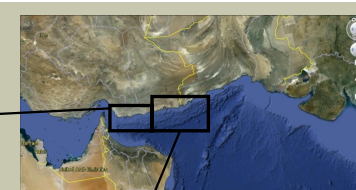
- Location & Geology of the Makran Accretionary Complex

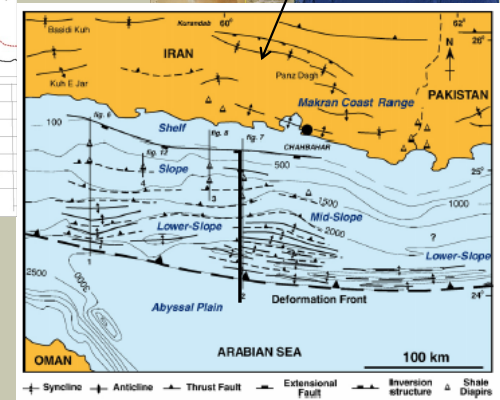


PREVIOUS WORK

- Correlation in the main part of the MAC







- Elongate zones of folds & thrusts

Grando & McClay, 2007

Presenter's notes: The highlighted line is the line shown on the following slide - this is the line that best shows features of the prism, including the deformation front.

PREVIOUS WORK

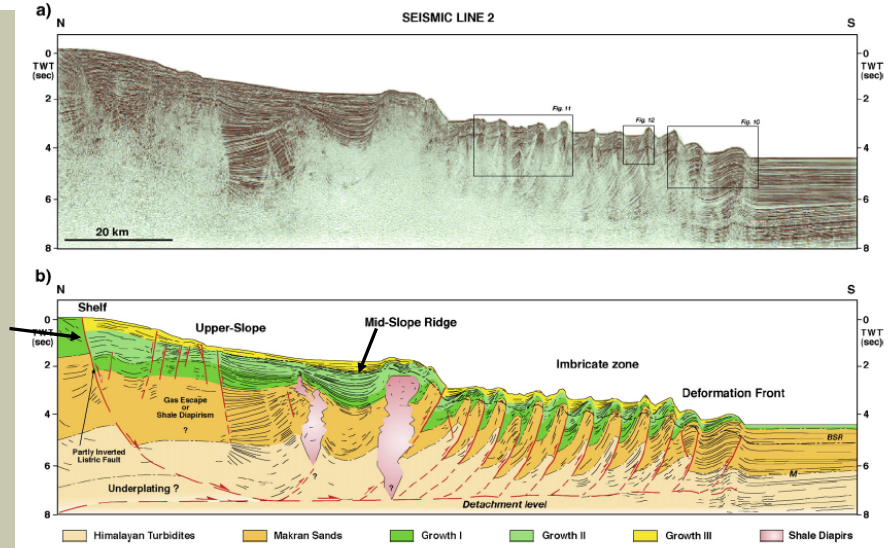


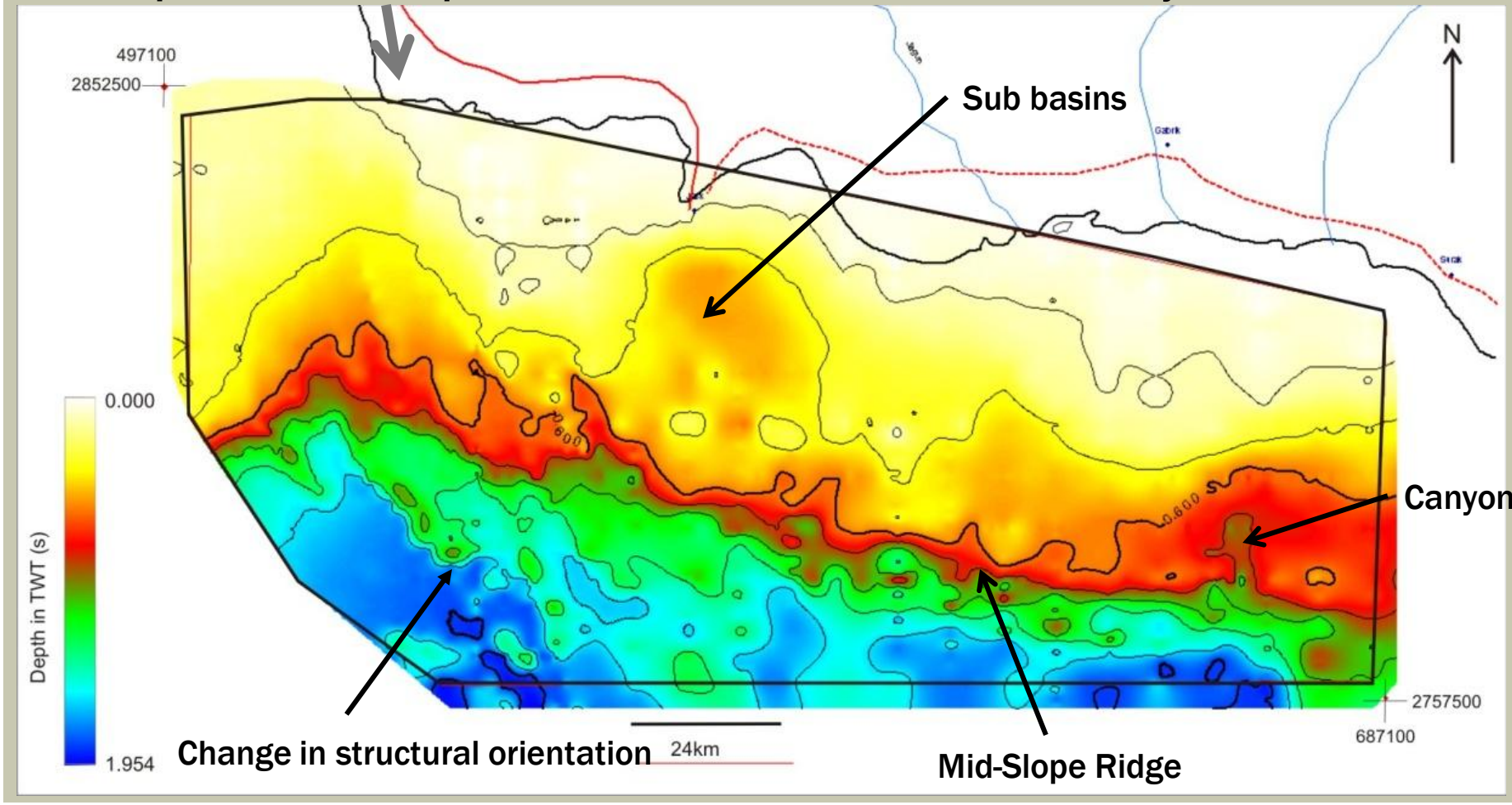
Fig. 7. (a) Regional N–S seismic profile across the western sector of the offshore Makran accretionary prism. The profile crosses the shelf area, the slope basins and the outermost part of the accretionary prism. In front of the prism the M unconformity separates the fan deposits of the Himalayan Turbidites from the shelf-slope sediments of the Makran Sands. (b) Interpretation of seismic line in (a). Vertical exaggeration at the sea floor is approximately 6:1. Fig. 2 shows the location of regional seismic line 2.

Grando & McClay, 2007

Presenter's notes: the Arrowed level is the top of Growth Package 2 (per Grando & McClay, 2007). This is the approximate level of the blue marker horizon in our interpretations.

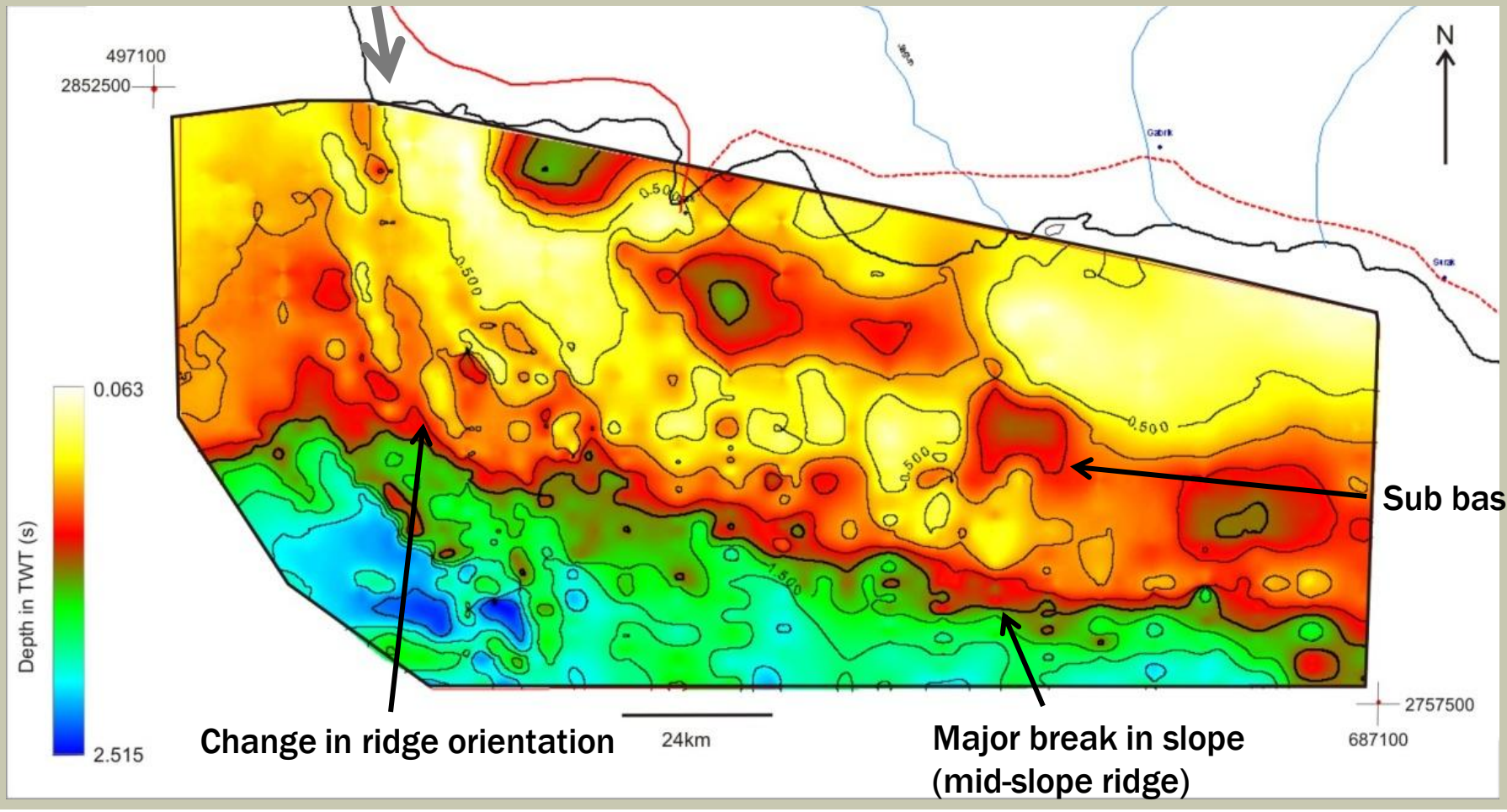
MAC – SEA FLOOR MORPHOLOGY

- Top surface map of the sea floor within the study area



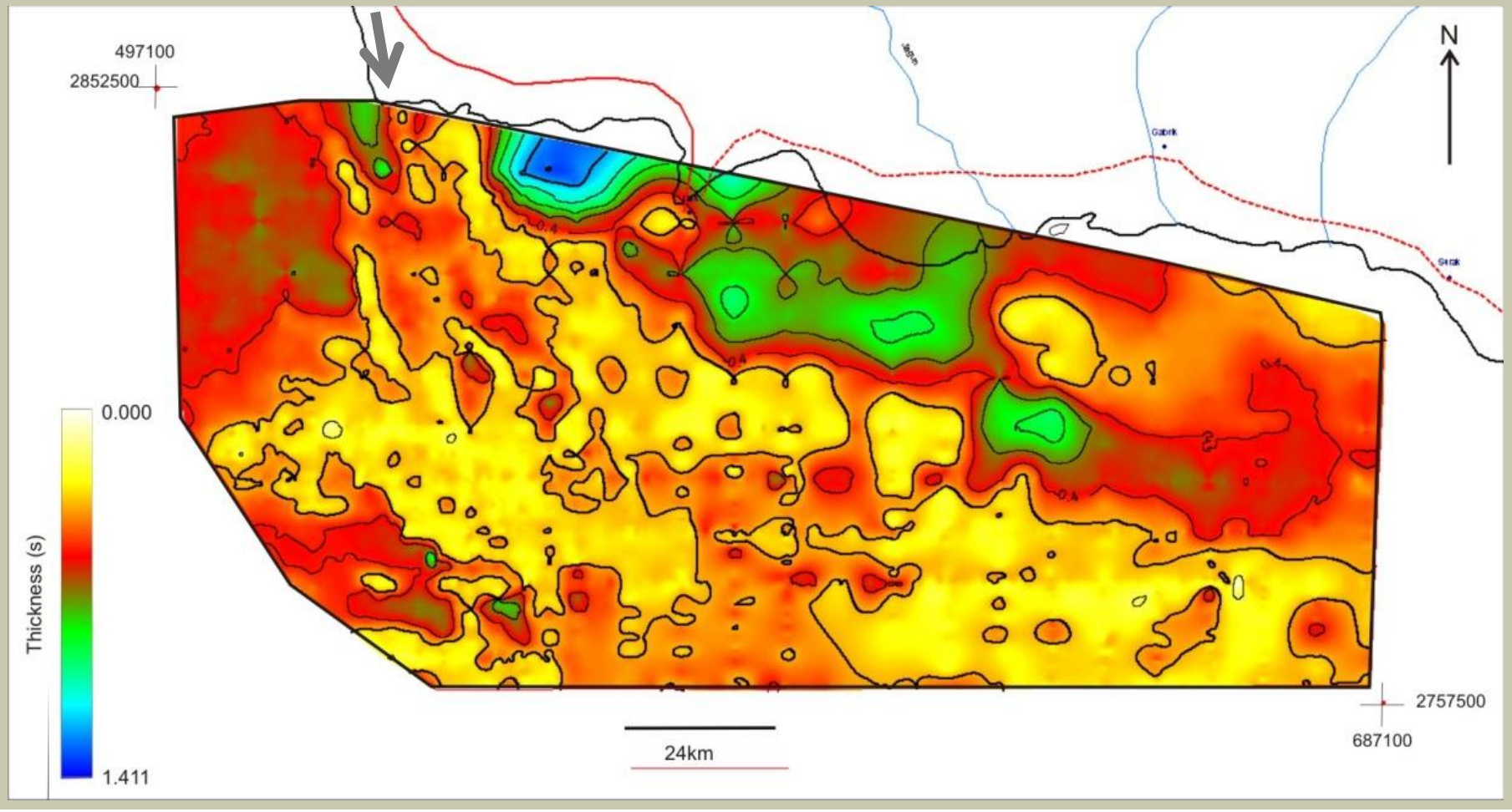
MAC – INTERNAL STRUCTURE

- Top surface map of a marker horizon within the growth sequences



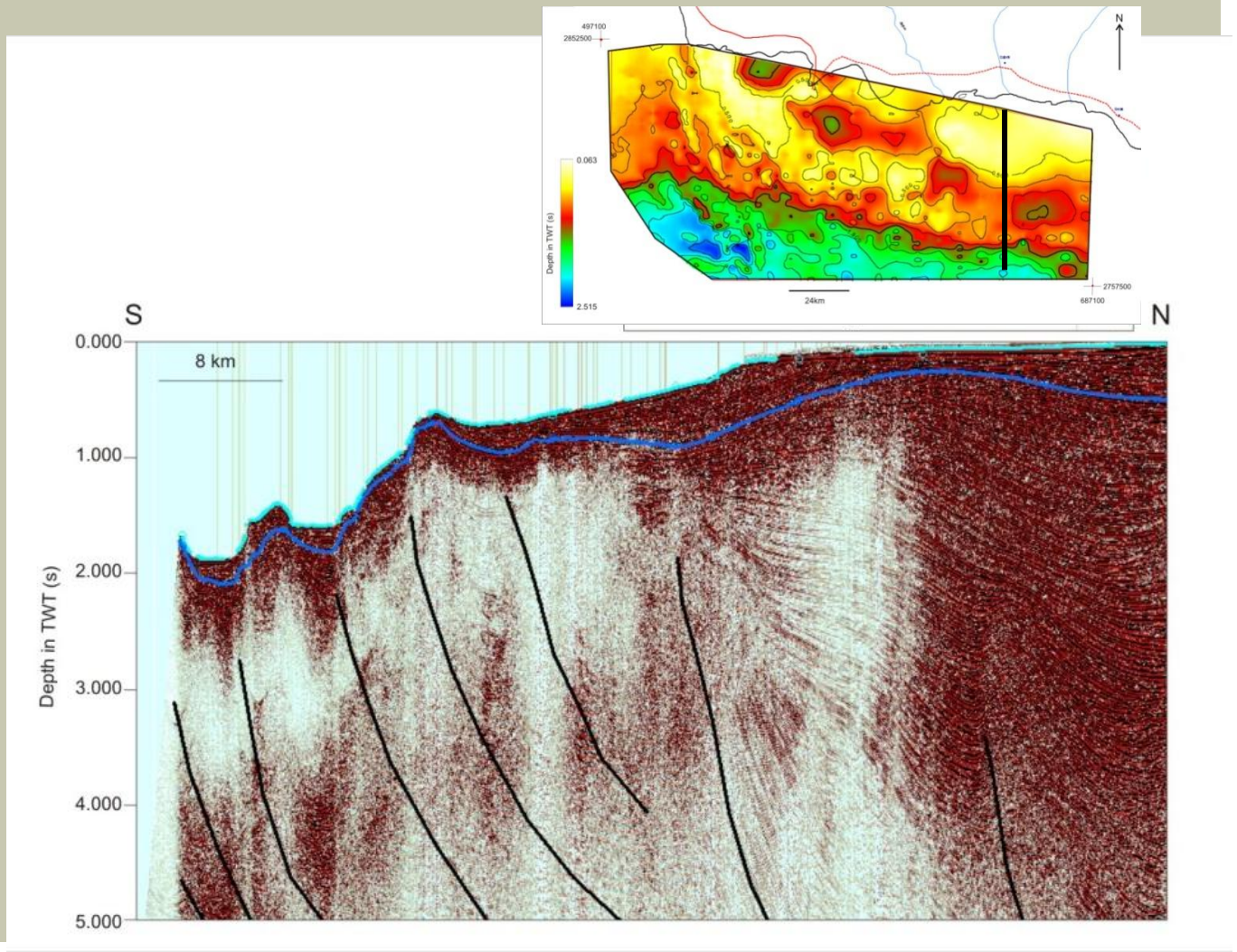
MAC – INTERNAL STRUCTURE

- Isochron map, upper growth sequence



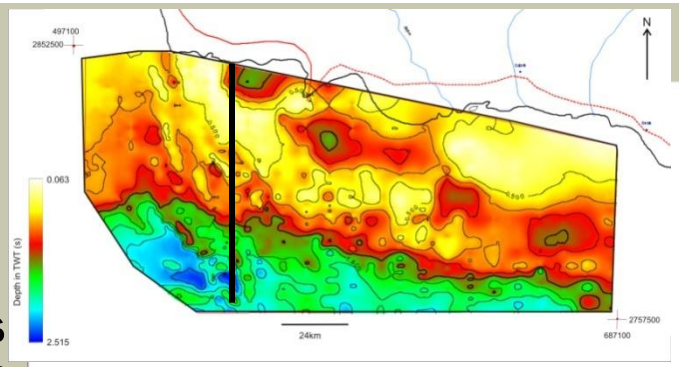
MAC INTERNAL STRUCTURE – N-S LINE

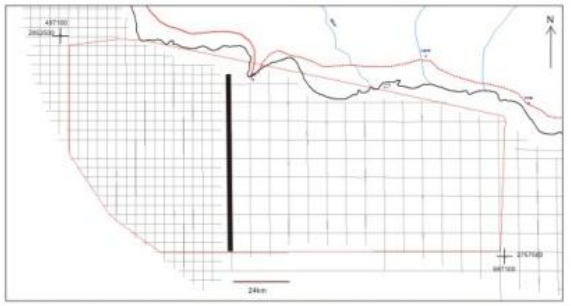
- N-dipping thrusts, spacing approx 8km
- Asymmetric, S-verging fault propagation folds, amplitude 0.2s (TWT)
- Normal faults to N of line
- Multiple unconformities

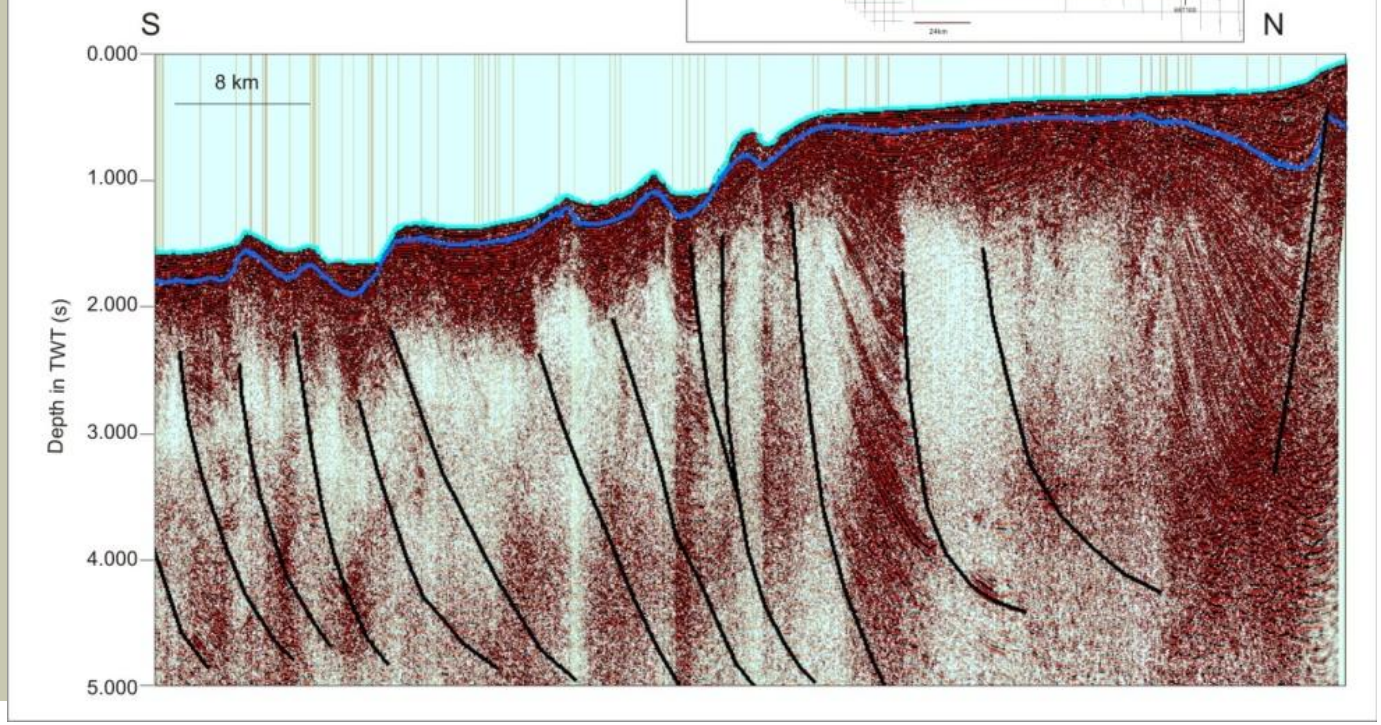


MAC INTERNAL STRUCTURE – N-S LINE

- Steeper N-dipping thrusts, spacing approx 5km
- Fold amplitudes still approx 0.2s (TWT)
- Basin-bounding normal fault to N of line
- Unconformities mark growth packages

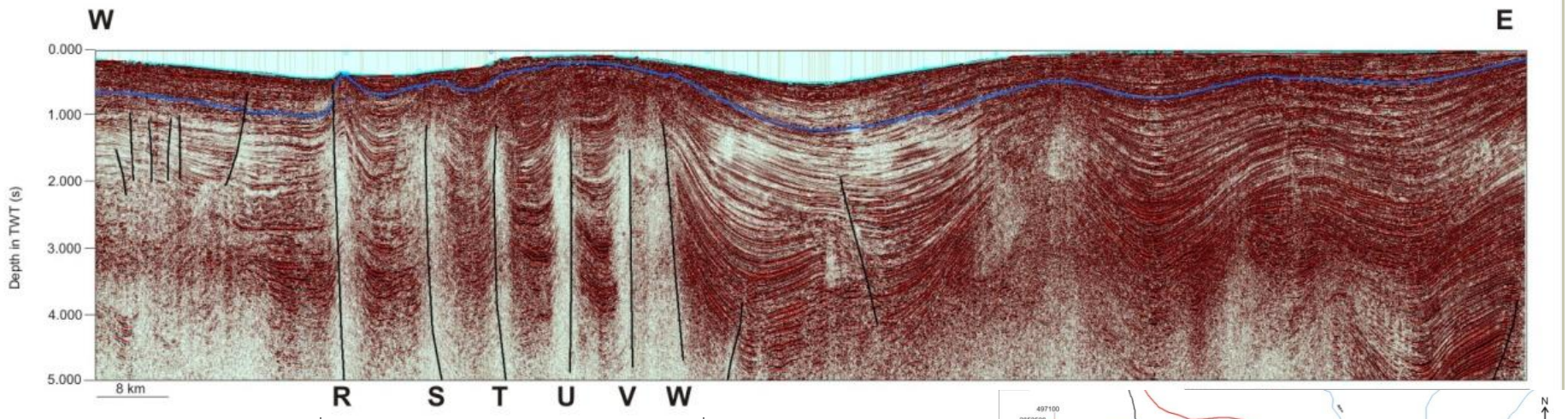


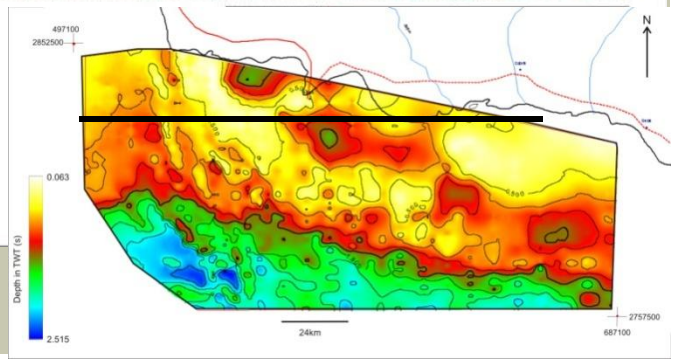




MAC STRUCTURE – E-W LINE

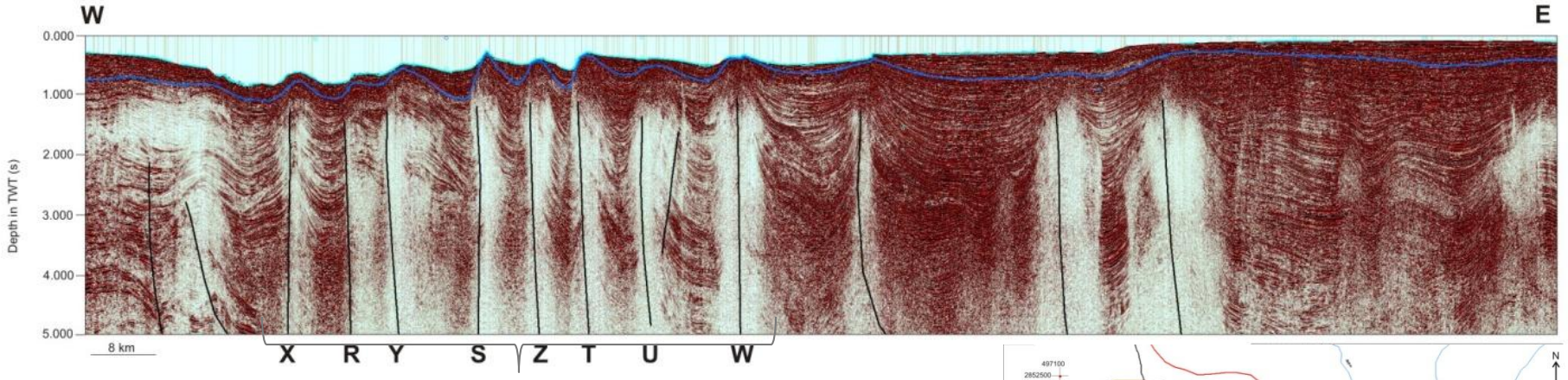
- Dominantly symmetrical faults across Minab Fault Zone
- Faults near vertical, spacing approx 10km



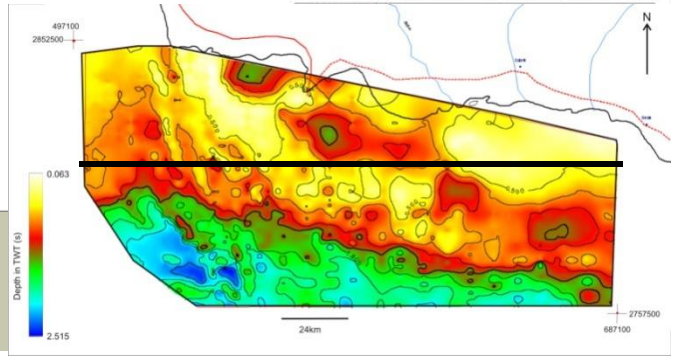


MAC STRUCTURE – E-W LINE

- Strike-slip fault spacing between 5 and 10km
- Near-vertical faults
- Dominantly symmetric folds

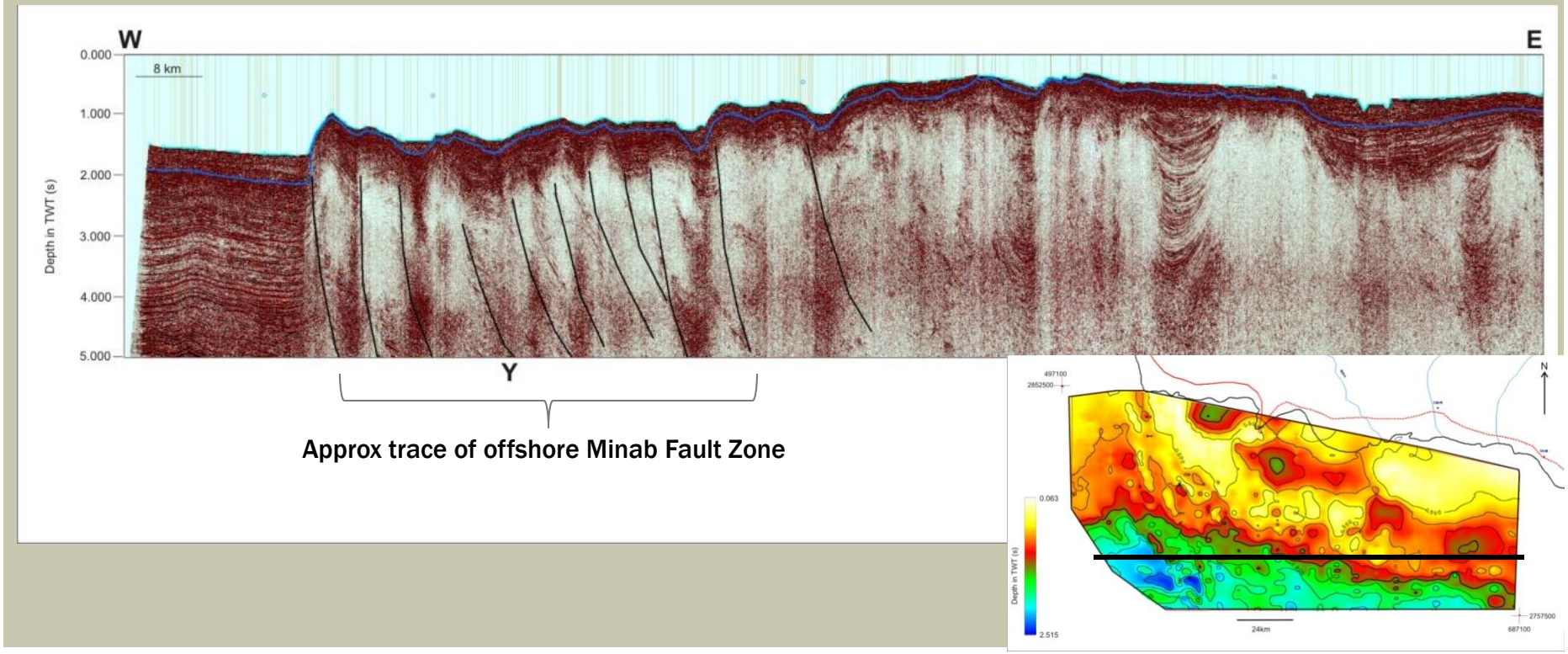


Approx trace of offshore Minab Fault Zone



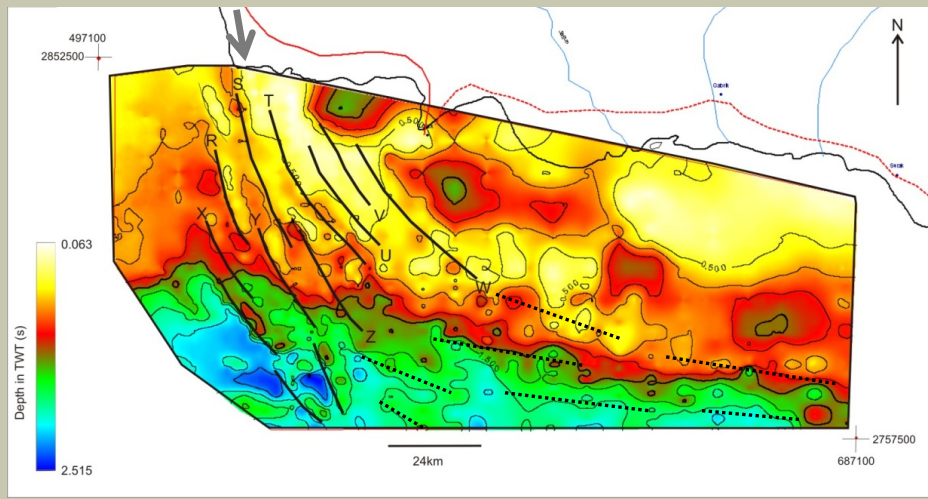
MAC STRUCTURE – E-W LINE

- Faults less steep, spacing 5-10km
- Folds asymmetric
- Undeformed zone to the W of the MFZ trace



MINAB FAULT ZONE

- **Minab Fault Zone marked by a distributed zone of dominantly west-stepping en-echelon strike-slip faults and folds**



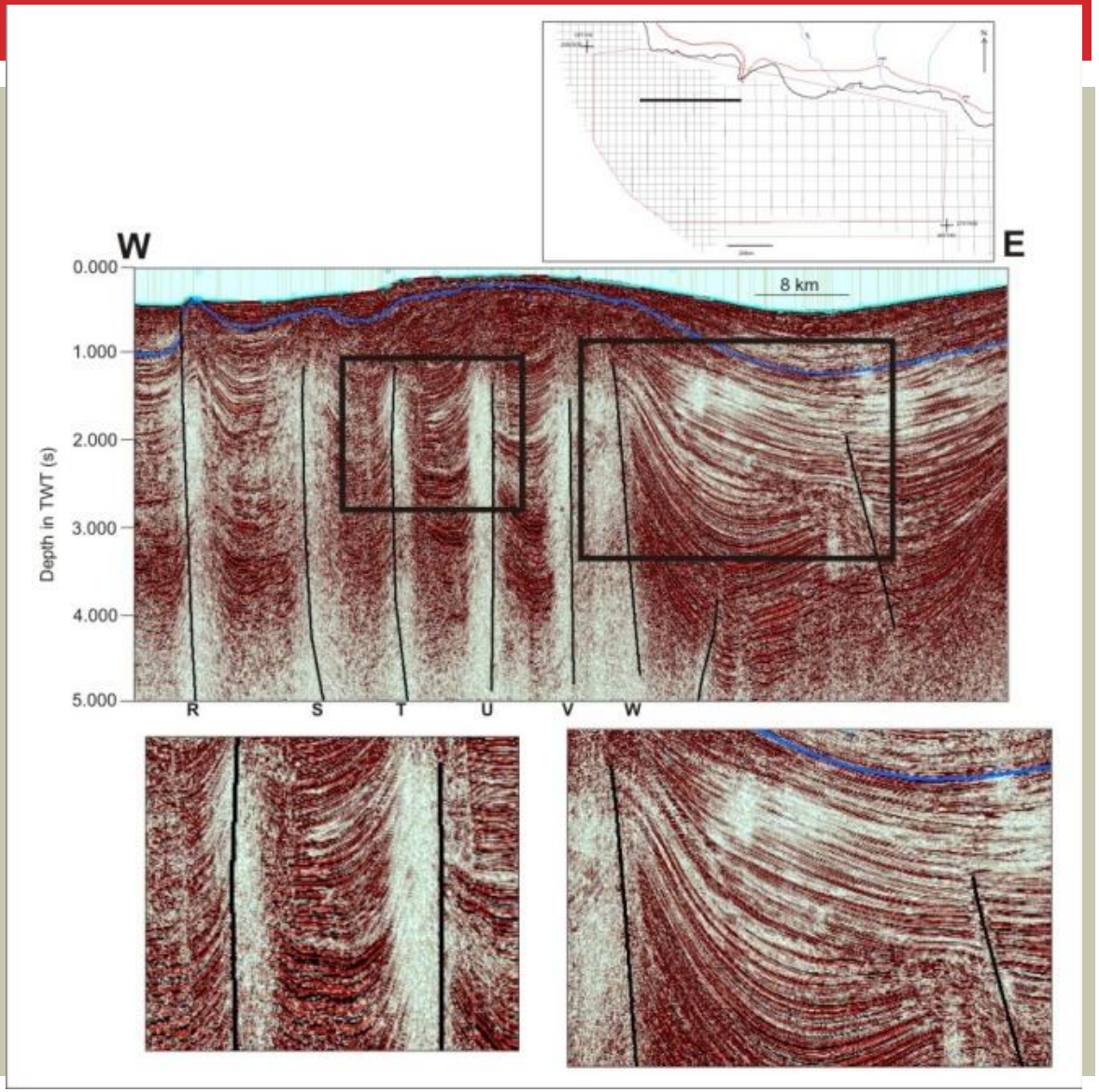
Intra-growth sequence surface

Presenter's notes: Dashed lines are structures outside of the MFZ region; note the change in strike. These are approximate locations of faults because few faults breach this particular horizon.

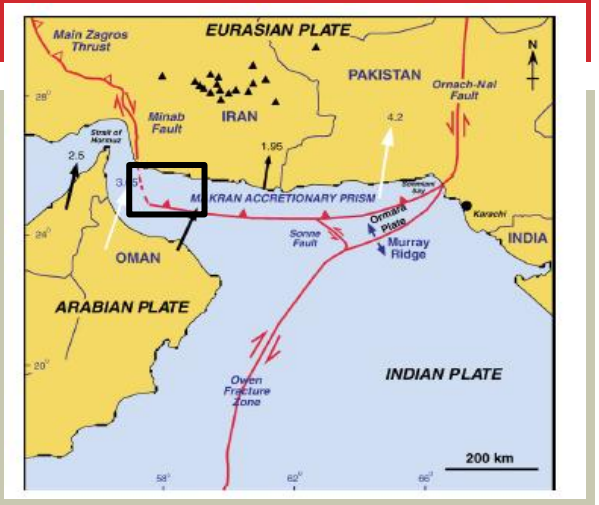
MINAB FAULT ZONE

- Strike-slip basin fill is distinctly different from thrust-related basin fill

- Unconformities
- Symmetry
- Offset



CONCLUSIONS



- Presented reflection seismic evidence of a change in structural style along a major accretionary prism, potentially related to deeper structures
- Documented change in fault spacing and fold amplitude and thus potential trap size
- Distributed zone of deformation, soft-linked en-echelon structures visible rather than hard-linked flower structures, decoupled from basement by overpressured shale