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Middle East to India Deepwater Pipeline (MEIDP) Crossing of the Indus Fan

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SAGE

Peritus

OFFSHORE TECHNOLOGY CONFERENCE

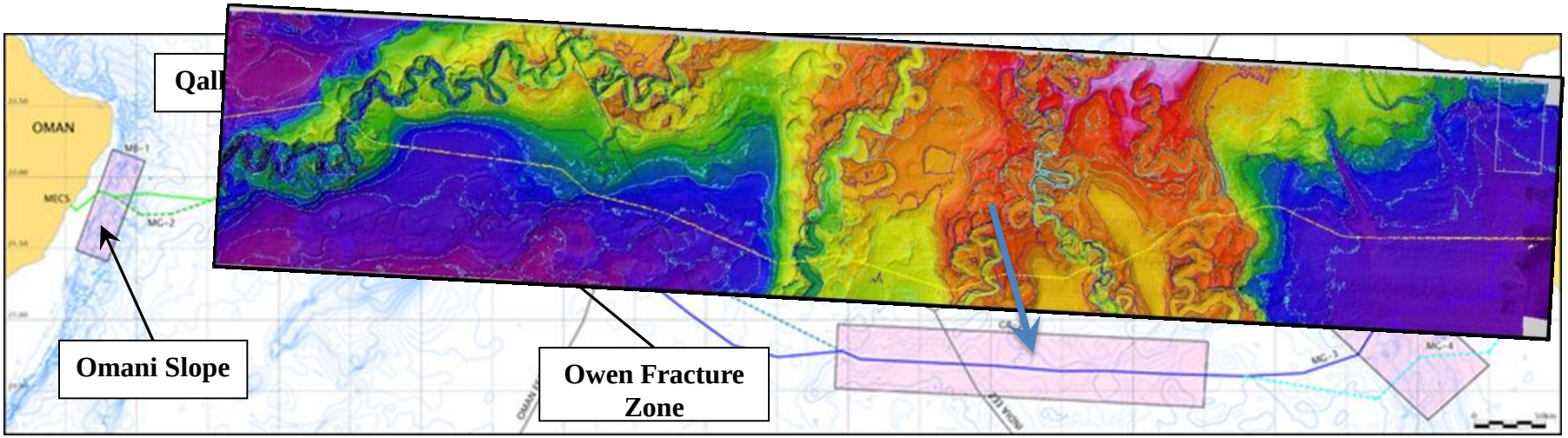
The Middle East to India Deepwater Pipeline (MEIDP) Project

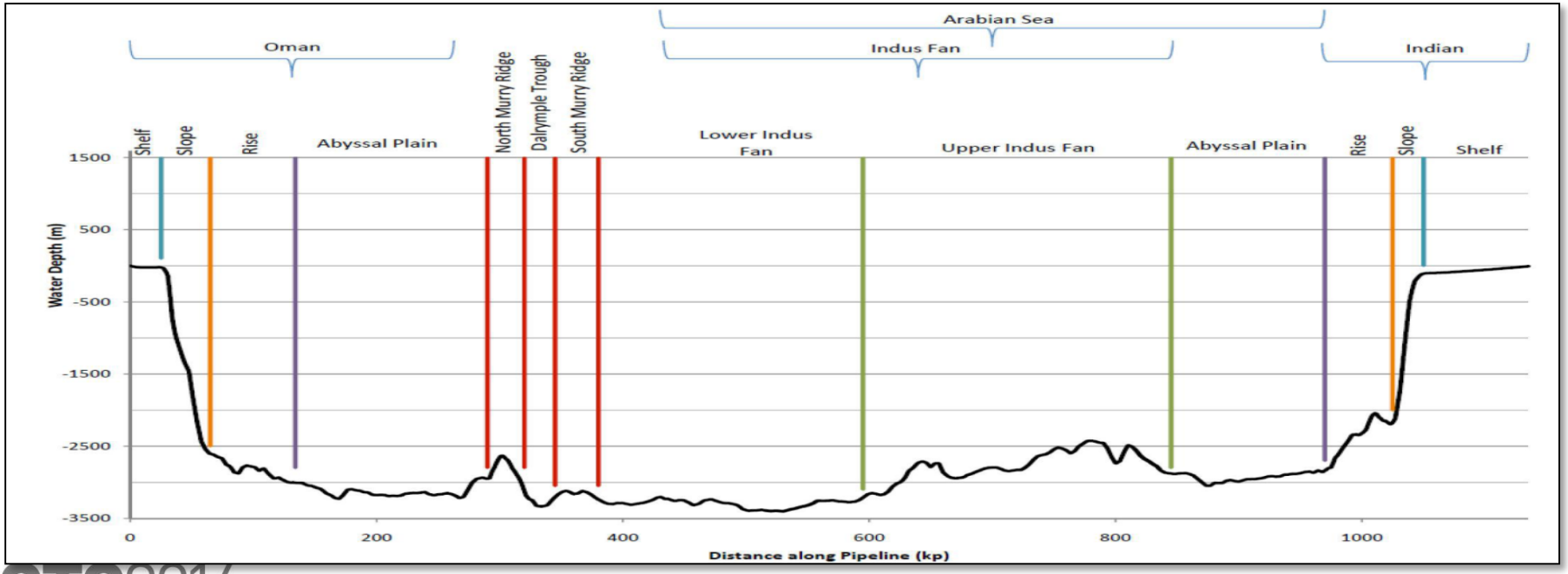
- MEIDP 1 will be the first in a series of pipelines supplying gas to the Gujarat coast of India, from the vast available resources in the Middle east, by the **safest, most economic** and **reliable** means
- The SAGE MEIDP Project is envisaged as an transmission pipeline **Infrastructure project** allowing transportation of multiple sources of Middle East Gas to the West Coast of India
- In May-June 2013 SAGE undertook a **multi-million $ Geophysical Survey** of the pipeline route across the Arabian Sea
- Assessments are now underway in all key areas along the route
- This presentation details the assessments of the **Indus Fan** crossing to confirm that the proposed pipeline is safe on the planned route.

MEIDP Details

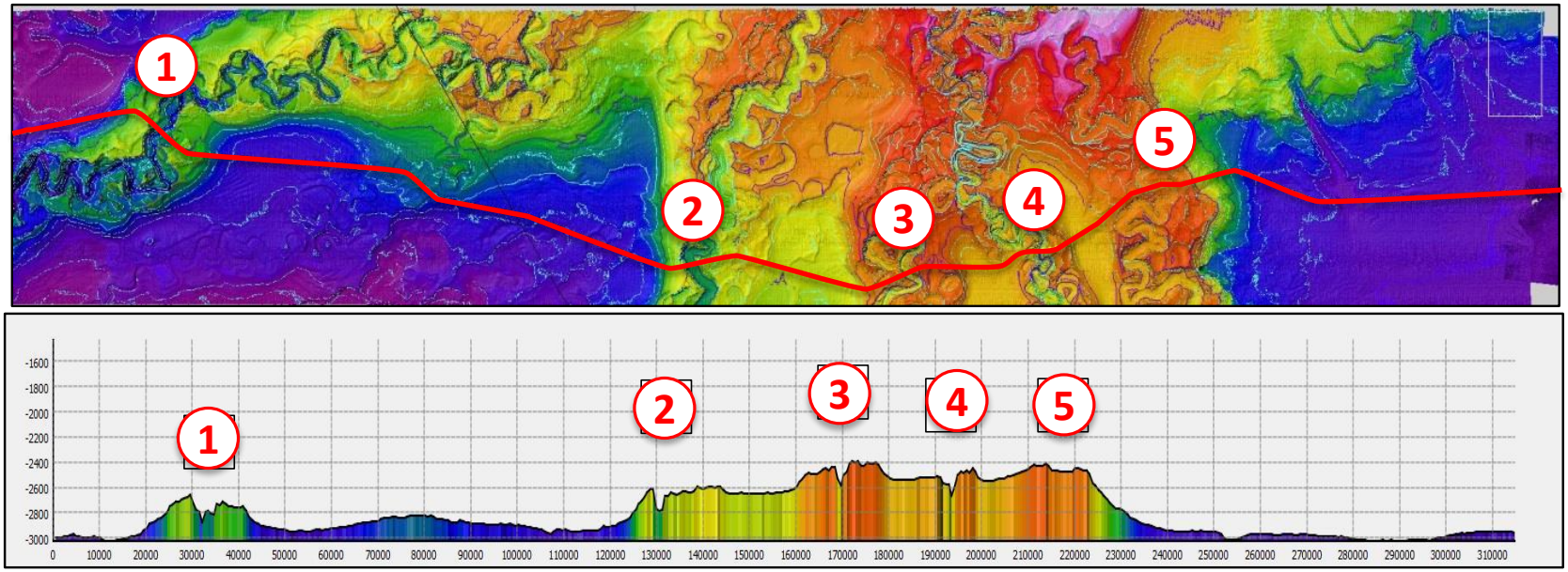
- Potential Start Points
  - Chabahar, Iran
  - Ras al Jafan, Oman
- End Point- South Gujarat
- Diameter 27.2”, 32.9-40.5mm WT (DNV OS-F101)
- Flowrate 1.1BSCFD (31.1mmscmd)
- Maximum Depth- 3,450 meters
- Length- 1,200- 1,300 kilometers
- Project to be executed over 7 year period
- Pipeline Construction over 2 years

MEIDP Survey Route





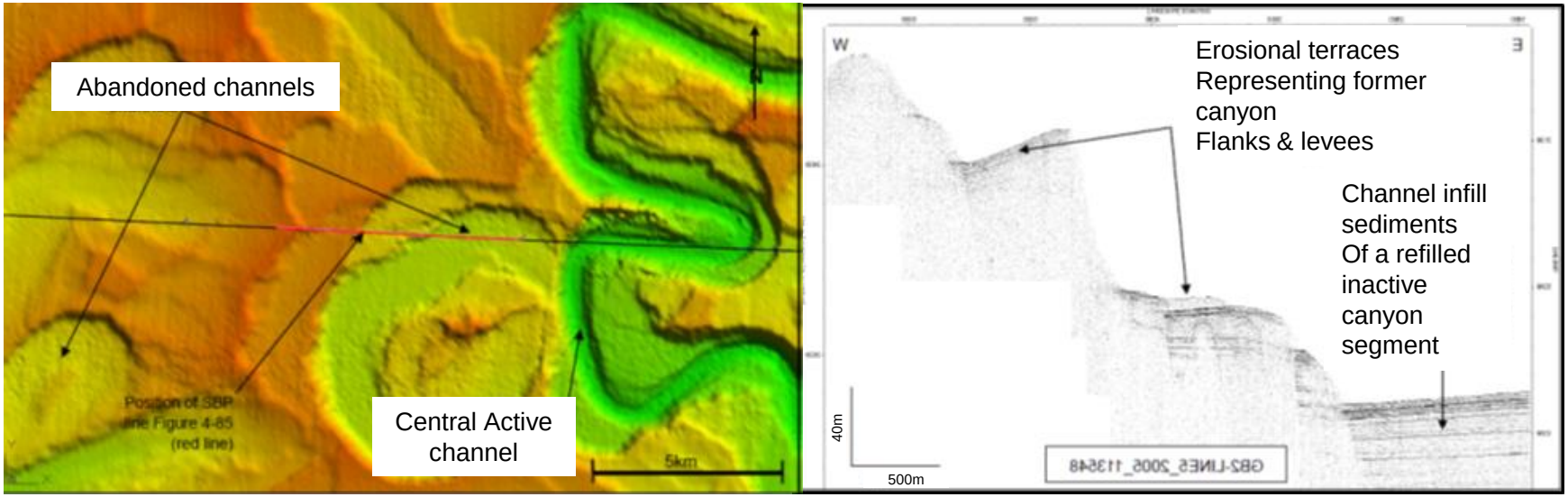
Indus Fan Characteristics



Indus River Abyssal Fan Route:-

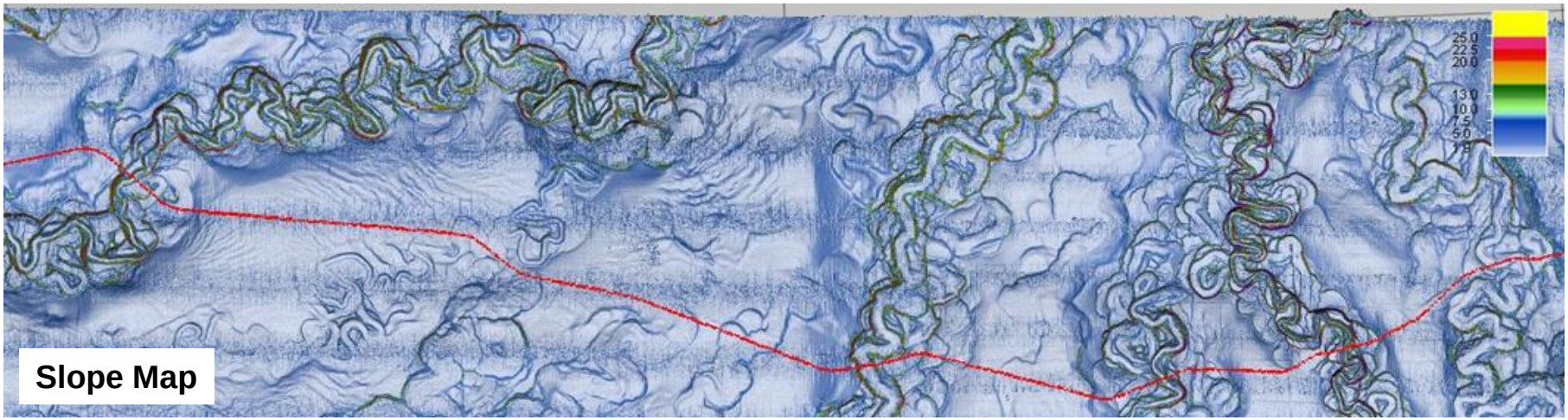
- water depths between 2100m - 3200m
- crosses five turbidity current Channels
- Channels up to 200m deep with side slopes up to 35°
- channels follow a meandering flow pattern in N-S direction

Indus Fan Characteristics



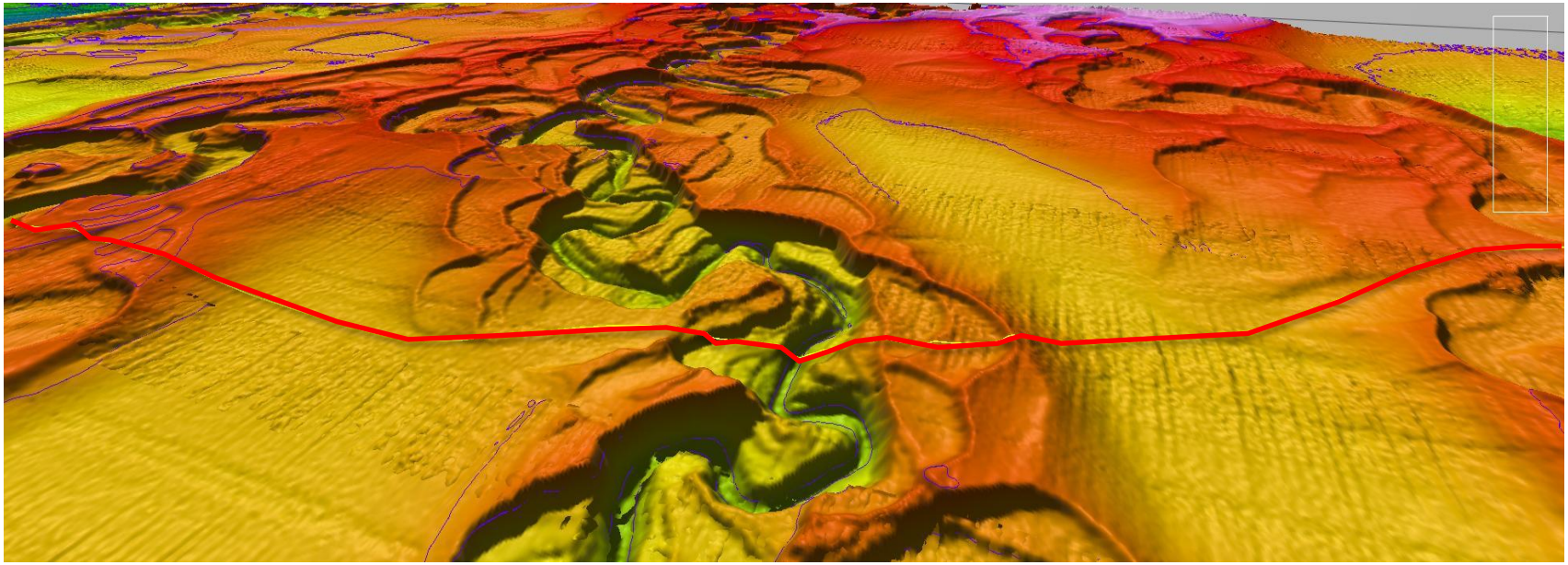
- generally the seabed is covered by a fine grained soft to very soft clay
- deposited by turbidity currents and mass wasting events.
- the sedimentary levees are a result of overspill sediments and deposits on both sides of the canyon/channels.

Channel Characteristics



Feature	General Heading of Channel (deg)	Elevation		Channel characteristic at MEIDP Crossing			Inter Channel Depth (m)
		Maximum Elevation (m)	Minimum Elevation (m)	Depth (m)	Main Channel Approximate Top(Base) width (m)	Channel crossing maximum slope (deg)	
Channel 1	255	-2780	-2865	85	1300(600)	17	-2960
Channel 2	205	-2590	-2780	190	2700 (1500)	24	-2640
Channel 3	190	-2430	-2580	150	2100 (500)	14	-2535
Channel 4	160	-2460	-2660	200	2300 (180)	18	-2545
Channel 5	170	-2380	-2470	90	5900(800)	12	

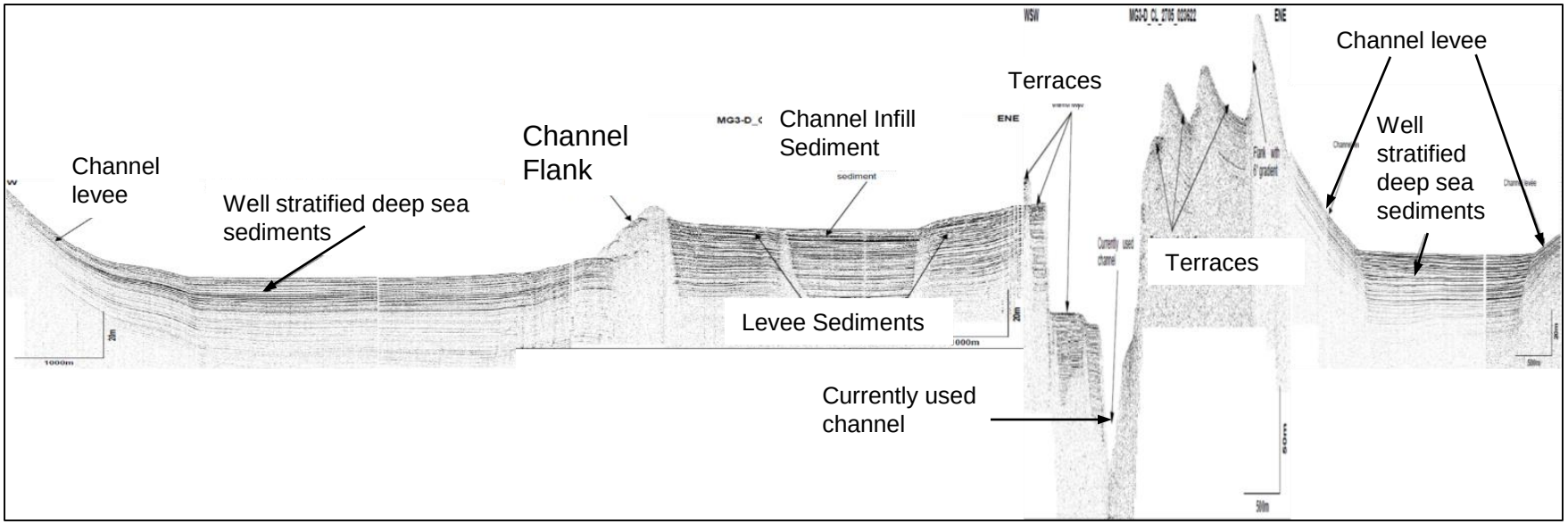
3D Seabed from survey across Indus Fan Channel 4



Of the four channels crossed:-

- only channel 4 that appears to be recently active in geological time,
- potential activity date around the last sea level low (20,000 years ago)
- Current activity is unknown

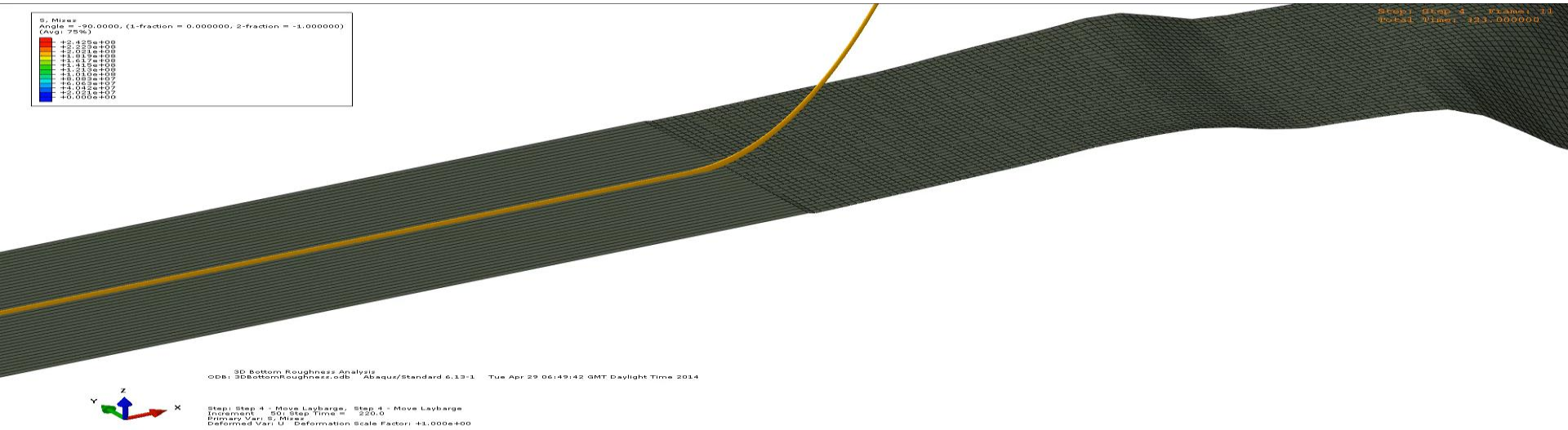
SBP Image through Indus Fan Channel 4



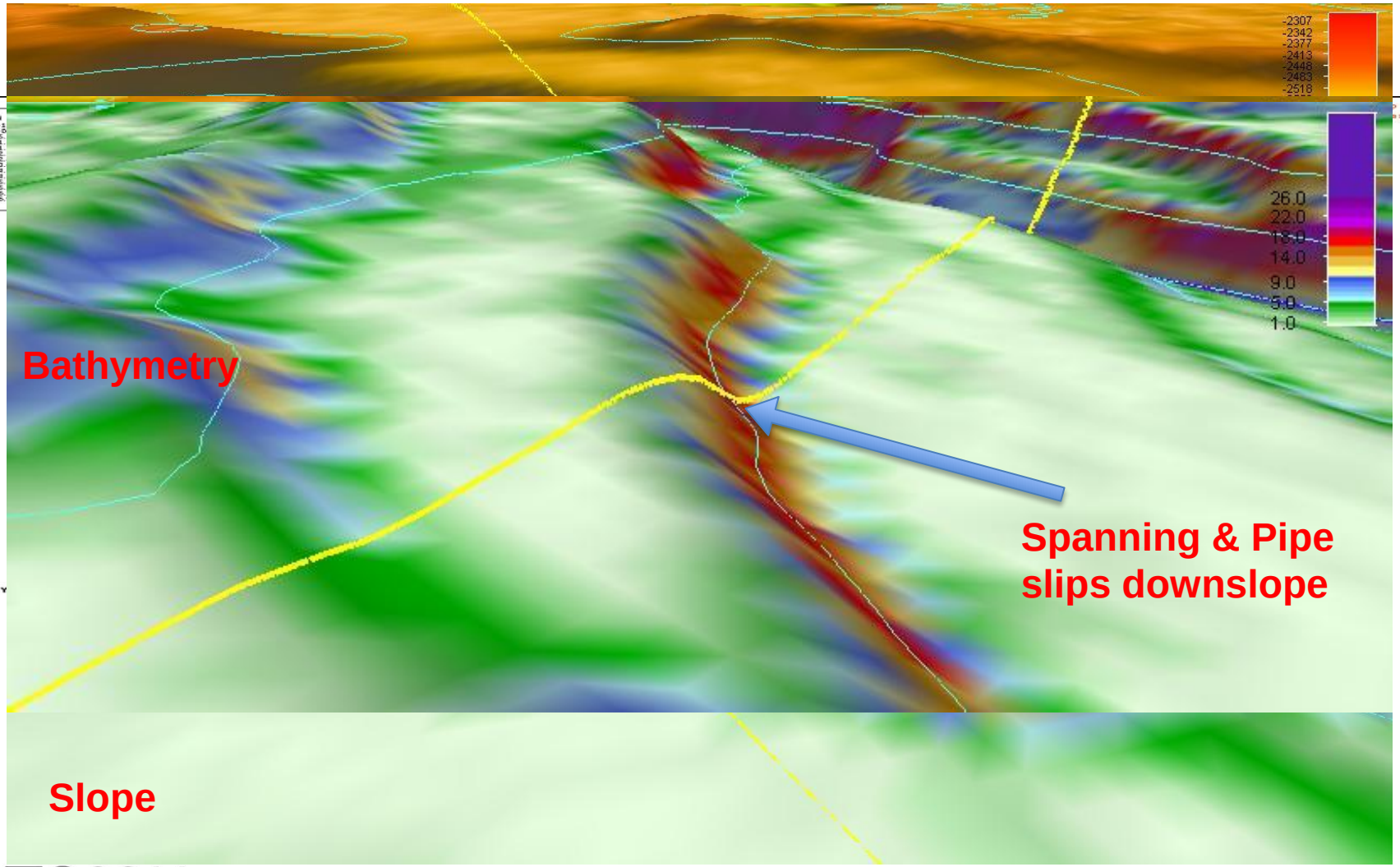
Key features of the route include:

- Well stratified deep sea sediments are observed between channels.
- Infill sediments are present on the levees and terraces between channel flanks and cut off channel loops
- Steep Channel Flanks.

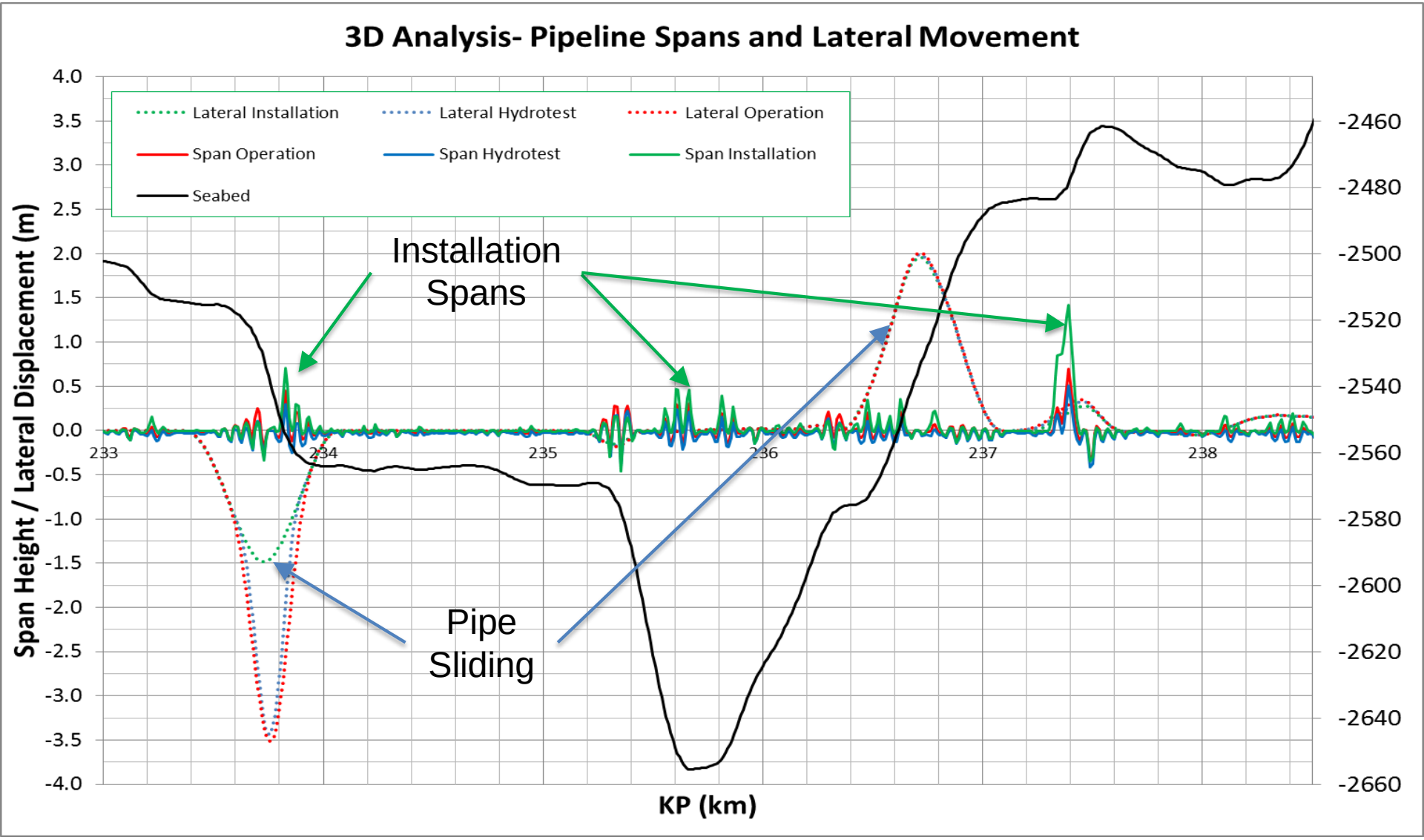

COPEN
Step: Step 4
Frame: 11
Total Time: 323.000000
3D Bottom Roughness Analysis
ODB: 3DBottomRoughness.odb Abaqus/Standard 6.13-1 Tue Apr 29 06:49:42 GMT Daylight Time 2014
Step: Step 4 - Move Laybarge, Step 4 - Move Laybarge
Increment 50: Step Time = 220.0
Primary Var: COPEN
Deformed Var: U Deformation Scale Factor: +1.000e+00


S, Mises
Angle = -90.0000, (1-fraction = 0.000000, 2-fraction = -1.000000)
(Avg: 75%)
Step: Step 4
Frame: 11
Total Time: 323.000000
3D Bottom Roughness Analysis
ODB: 3DBottomRoughness.odb Abaqus/Standard 6.13-1 Tue Apr 29 06:49:42 GMT Daylight Time 2014
Step: Step 4 - Move Laybarge, Step 4 - Move Laybarge
Increment 50: Step Time = 220.0
Primary Var: S, Mises
Deformed Var: U Deformation Scale Factor: +1.000e+00

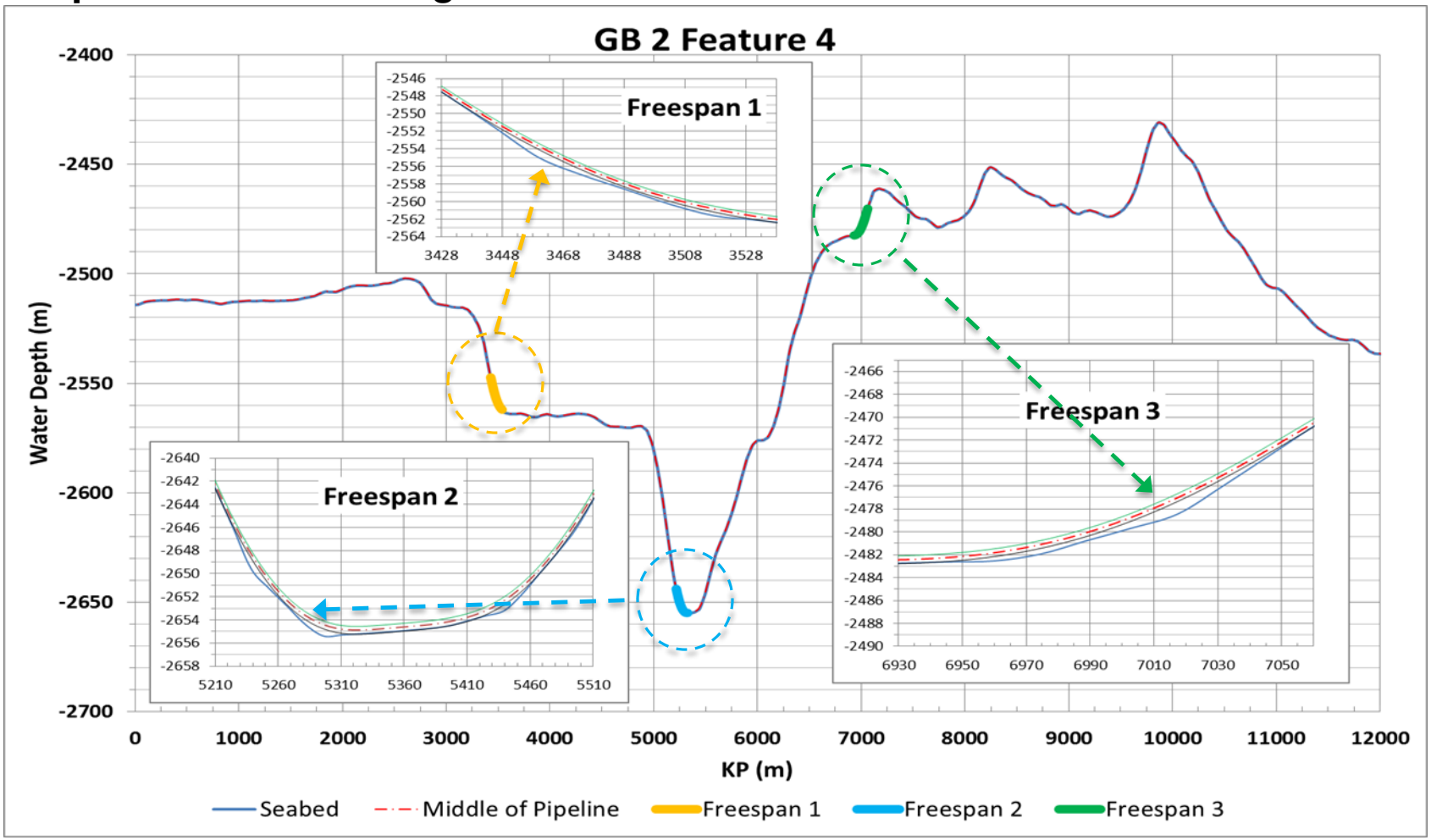
Pipeline Installed on 3D Seabed from survey across Indus Fan Channel 4



Channel #4 Assessment Overview



Spans of Note during Installation



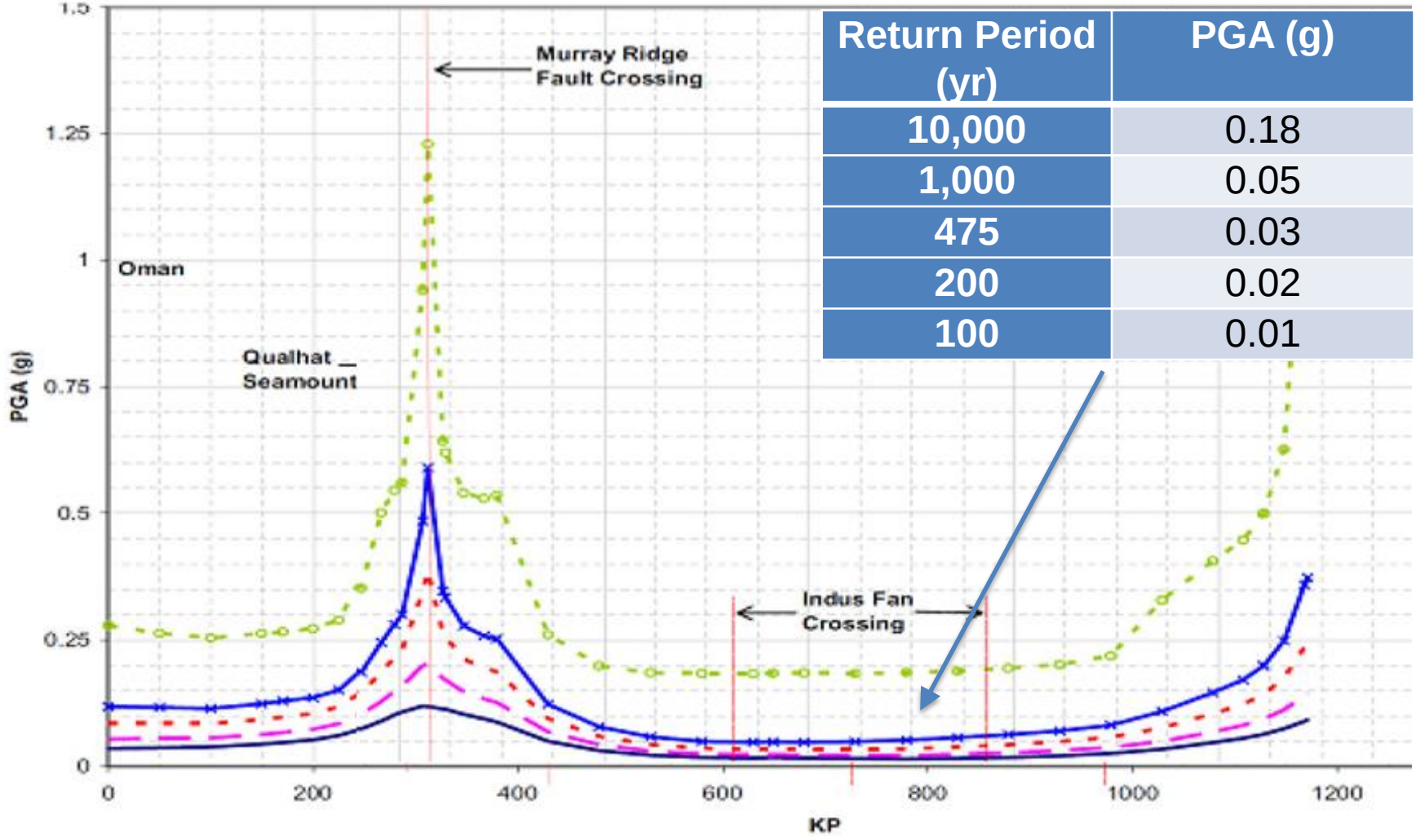
There were 3 spans of note observed in Channel #4.

- Maximum Span Lengths approx. 90m
- Maximum Span Heights approximately 1.75m

Seismicity for the Indus Fan

The Indus Fan is the least active seismic zone along the MEIDP route

Return Period (yr)	PGA (g)
10,000	0.18
1,000	0.05
475	0.03
200	0.02
100	0.01



Geohazards for the Indus Fan

Seismicity itself is not considered a hazard to this part of the route, however the pipeline will need to accommodate:

- Turbidity Currents
- Slope Stability of Channel walls
- Mud diapiers and Mud volcanos
- Irregular Seafloor

This work is ongoing

Image courtesy of the Open University

Possible Intervention Equipment for Indus Fan

Equipment Type	Indus Fan Water depth Range 2400m-3000m	Pre-lay Intervention				Post-lay Intervention			
		Trenching	Rock Dumping	Mattresses	VIV Suppression Strakes	Trenching	Rock Dumping	VIV Suppression Strakes	Pipeline Repair System
Trenching Machine	Current max working depth 2050m. Upgrade required to reach 3000m.					✓			
Mass Flow Excavation Spread	Current max working depth 3000m.	✓				✓			
Rock Dumping (Fall Pipe) Vessel	Current max working depth 2000m. Vessel/Fallpipe upgrade required to reach 2500m. Vessel modification and strengthening required to reach 3000m.		?				?		
ROV for Installing Mattresses, Mechanical Supports & Post-lay VIV Strakes	Current max working depth 4000m.			✓	✓			✓	
Pipeline Repair System	Current max working depth 3000m.								✓

Required for slope excavation on Levee Shoulders

Conclusion

The Indus Fan is a significant feature to be crossed by MEIDP and due account of the potential issues in crossing it must be taken into account in design.

The initial assessments made of installation across the Indus Fan indicate that with correct routing, the pipeline can cross the deep channels of the Indus Fan without major intervention, however assessment indicates that the pipeline may be prone to lateral movement at cross-slopes.

Initial assessments indicates Hydrotest may cause buckling issues at the levee shoulders, which need to be resolved.

Further assessments are required to ensure the five Fan Channels pose no significant problems during operation.

Acknowledgements / Thank You / Questions

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