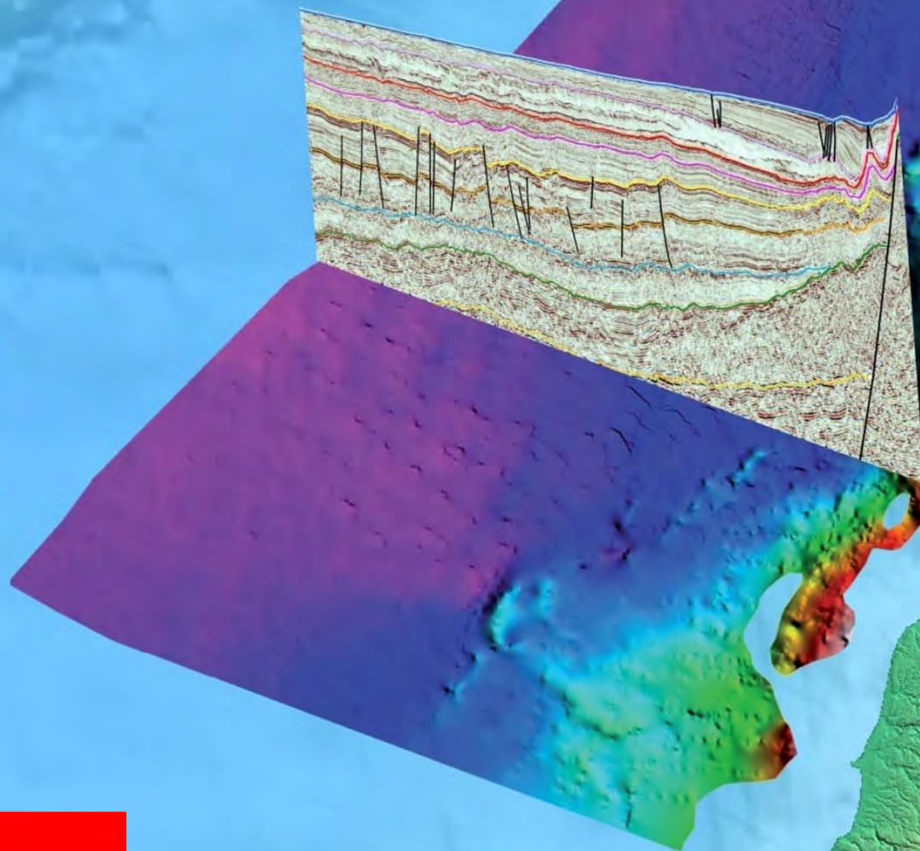


# Geophysical exploration and HC potential offshore Lebanon



Øystein Lie  
Petroleum Geo-Services





## **Presentation Outline**

- **Introduction**
- **Geophysical data**
  - Lebanon MC data library**
- **Petroleum systems**
- **Lebanon MegaSurvey and Petroleum potential**
- **Acquisition technology**
  - GeoStreamer**
  - GeoSource**
  - MAZ**
- **Summary**





## Petroleum Geo-Services



### Overview

PGS was founded in Norway in 1991, with 2 seismic ships and some highly innovative ideas on how to reshape the industry. Today we share the same drive to innovate as inspired our founders, though the team is bigger:

- 14 offshore seismic vessels
- 21 data processing centers
- 35 offices worldwide, employing around 3,500 people from 67 nationalities

PGS has a presence in over 25 countries with regional centers in London, Houston and Singapore. Our headquarters is in Oslo, Norway and the PGS share is listed on the Oslo stock exchange (OSE:PGS).

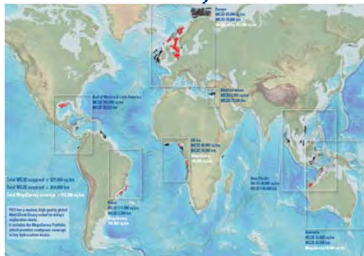


# Petroleum Geo-Services

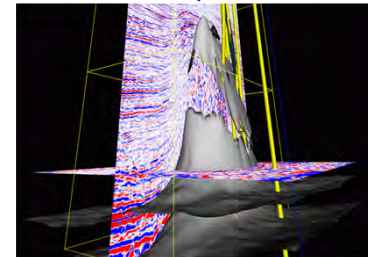
Marine Contract



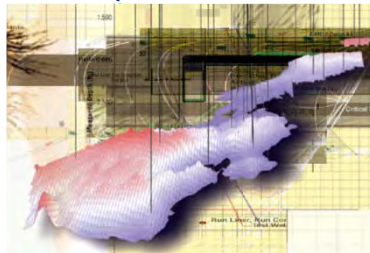
MultiClient



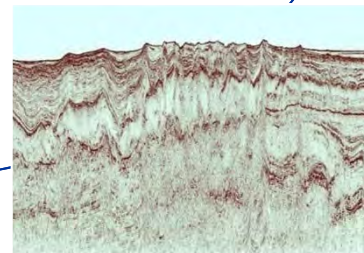
Research



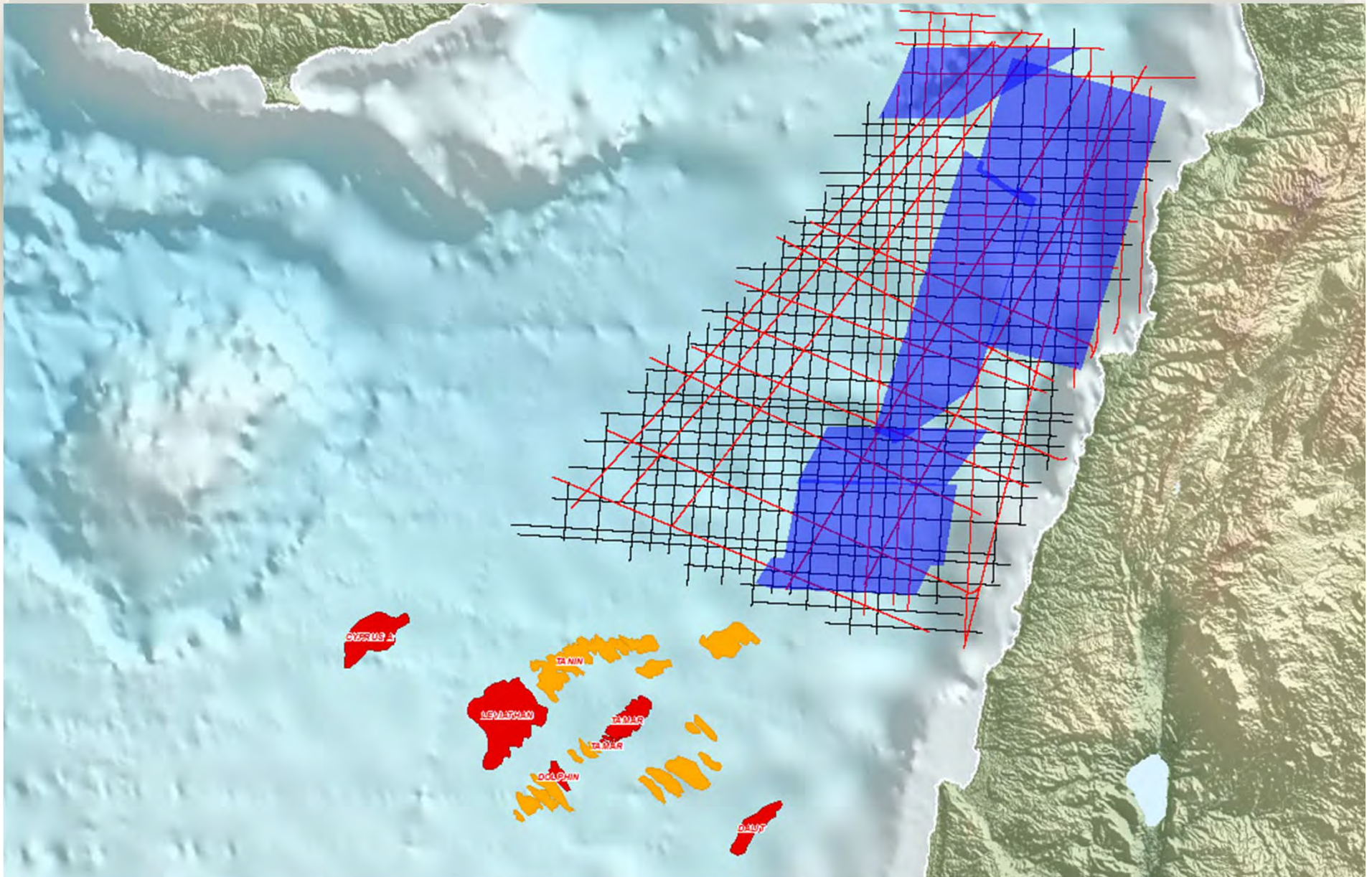
Reservoir



Data processing





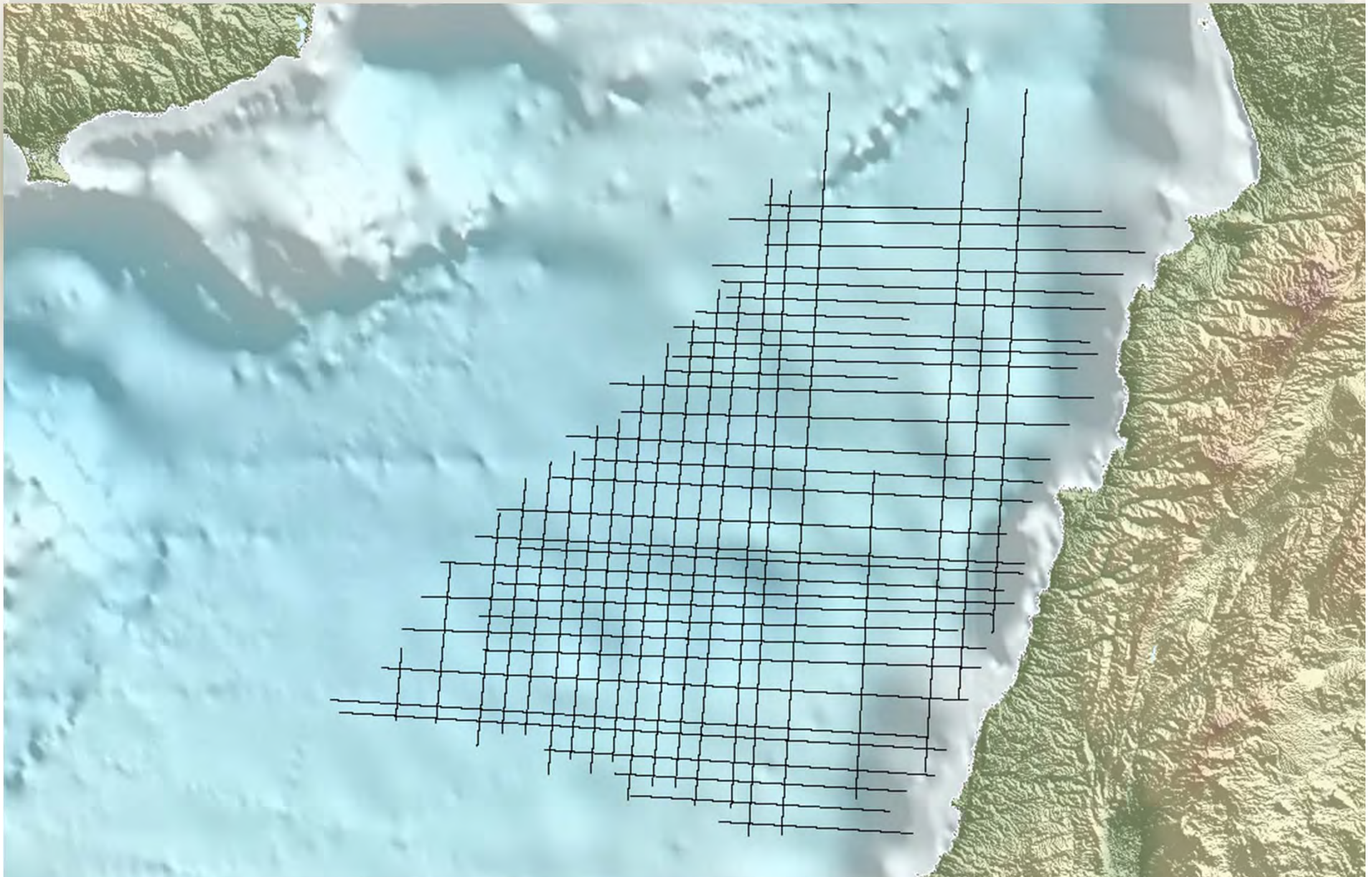






# Lebanon seismic MC2D data

MC2D-2008: 5000km

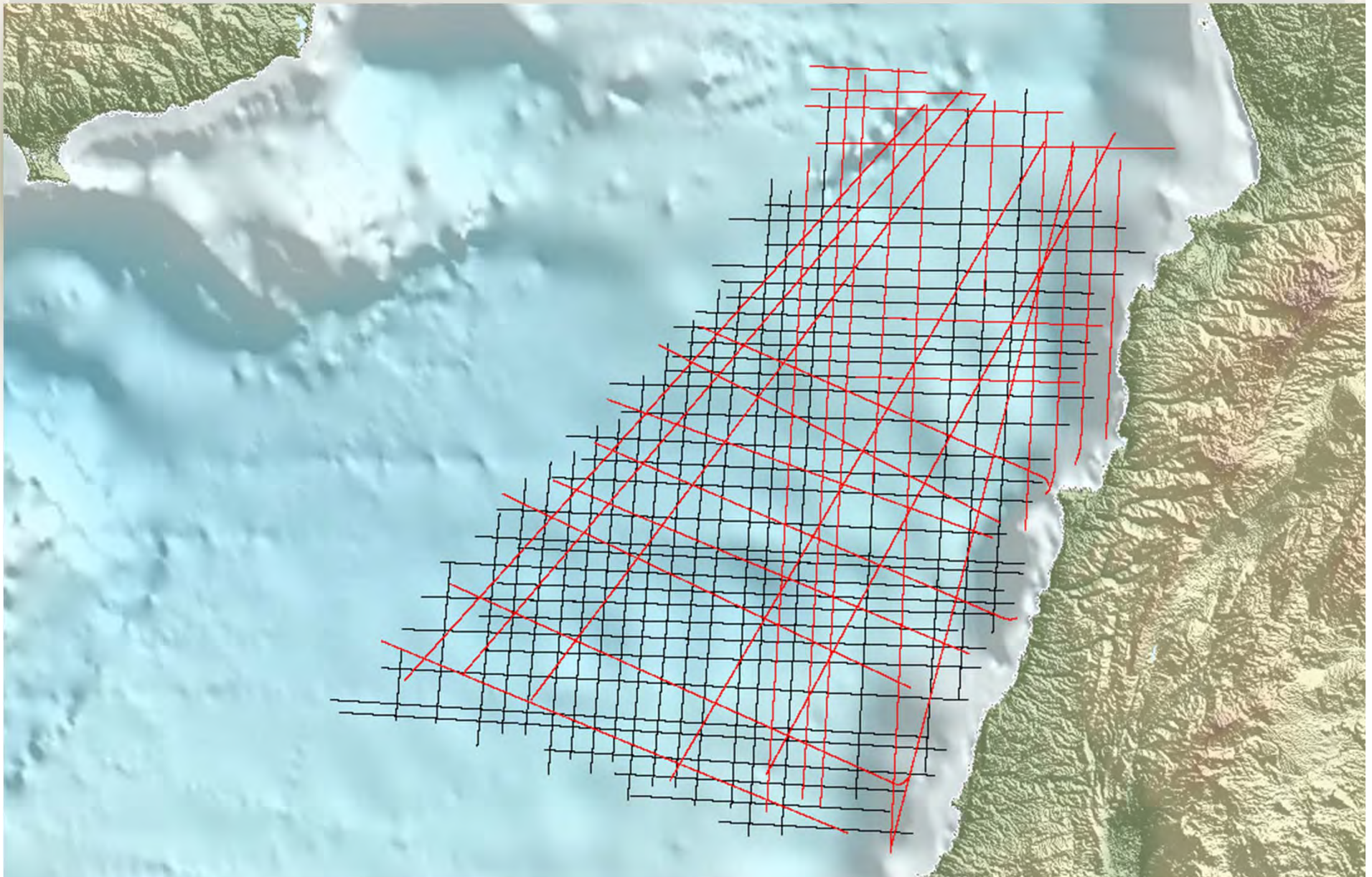






# Lebanon seismic MC2D data

MC2D-2011: 3800km

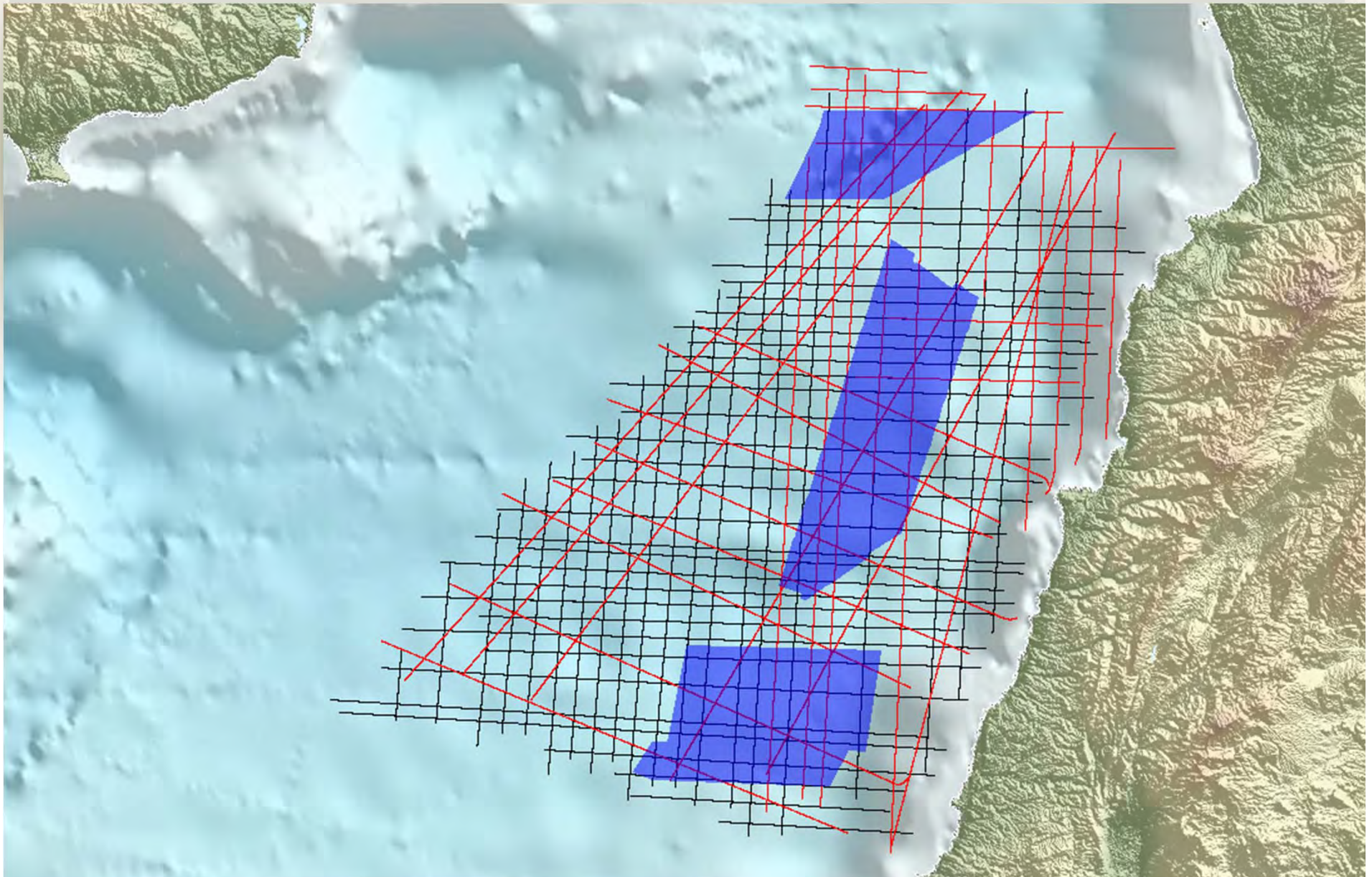






## Lebanon seismic MC3D data

MC3D-2006, MC3D-2007, MC3D-2011: 3500sq.km

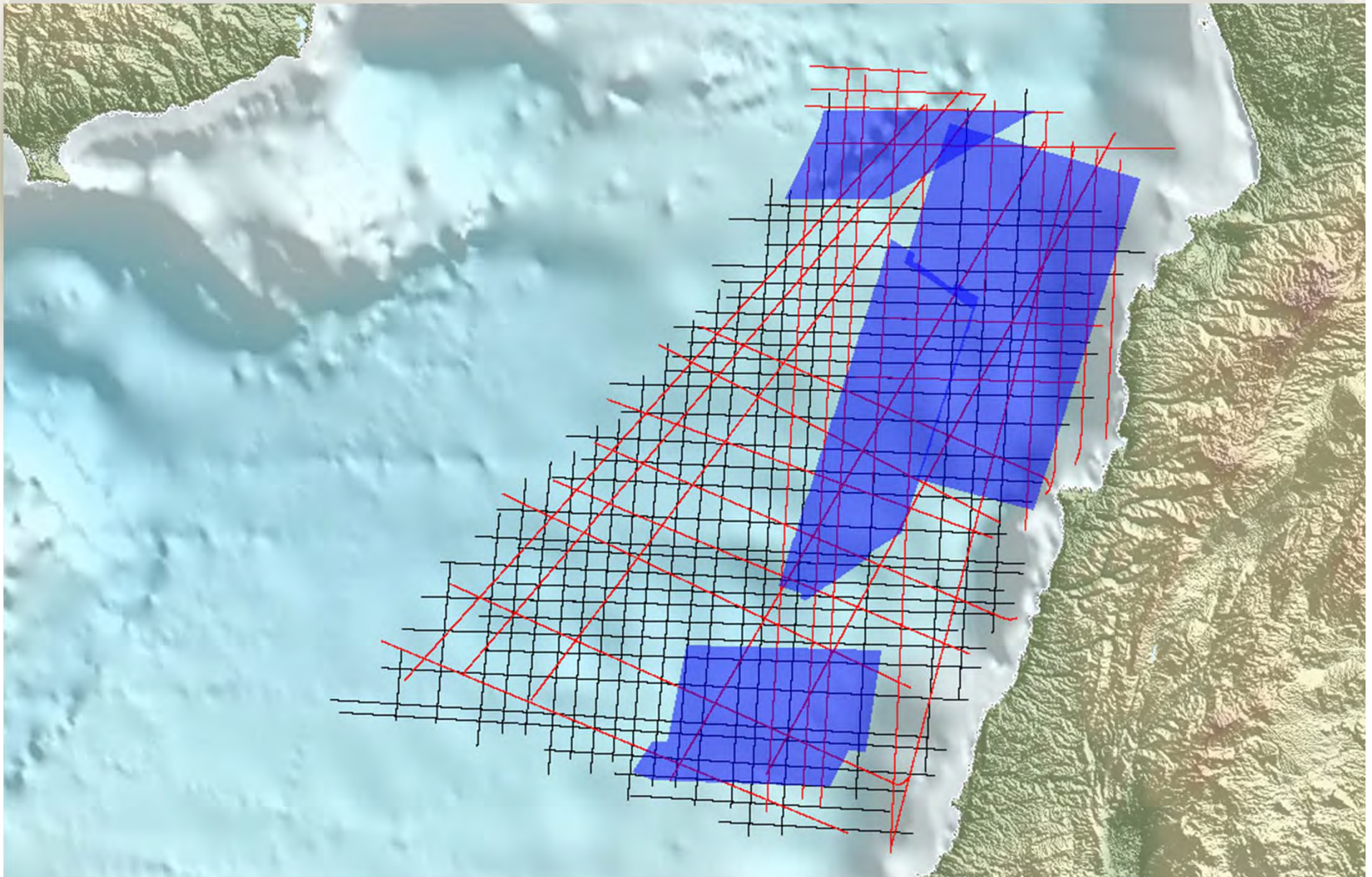






## Lebanon seismic MC3D data

MC3D-2006, MC3D-2007, MC3D-2011, MC3D-2012: 6400sq.km

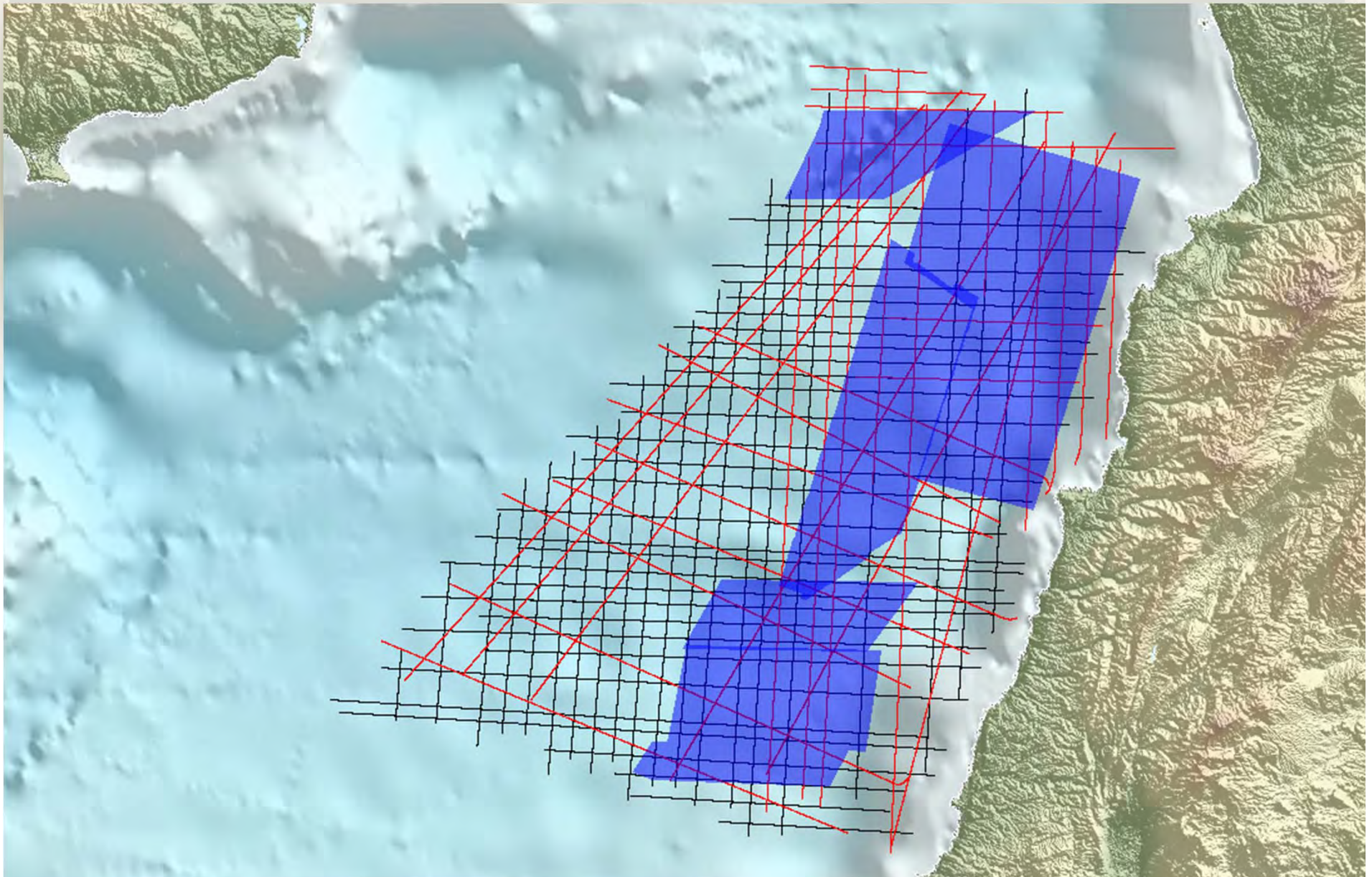






## Lebanon seismic MC3D data

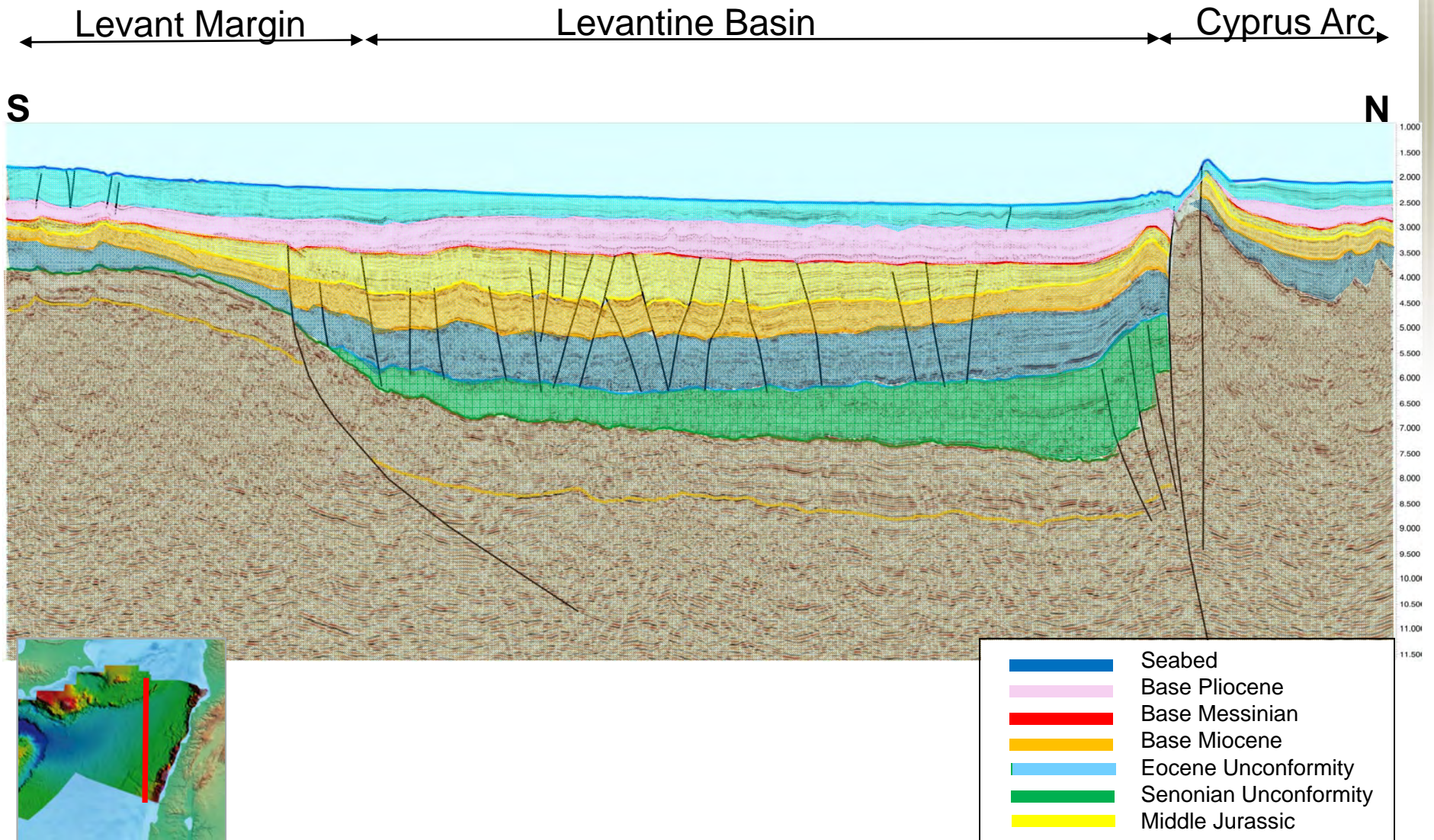
MC3D-2006, MC3D-2007, MC3D-2011, MC3D-2011ex, MC3D-2012: 7150sq.km







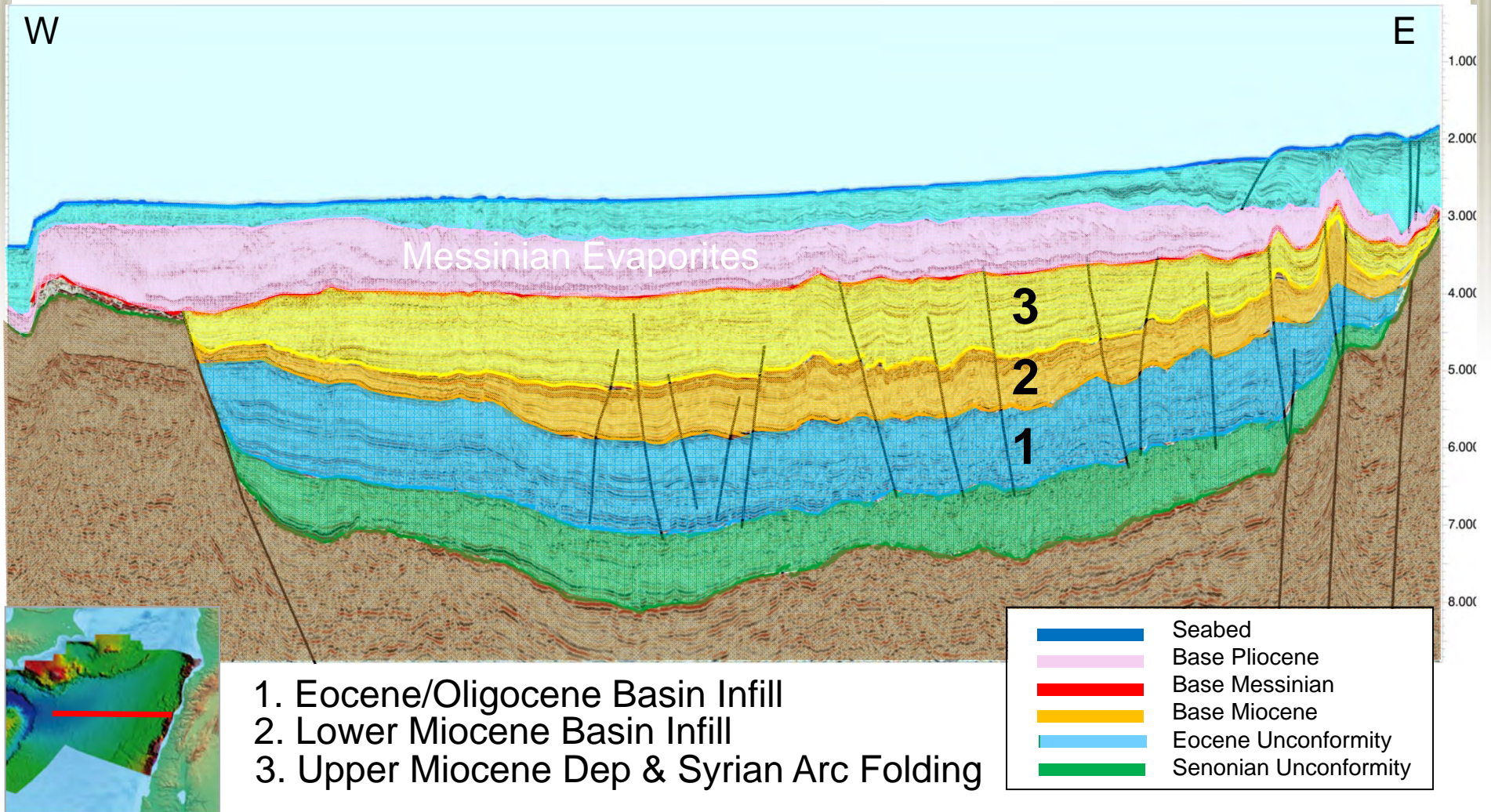
# Levantine Basin, Levant Margin, Cyprus Arc Deformation front





# Levantine Basin

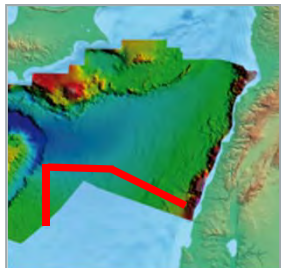
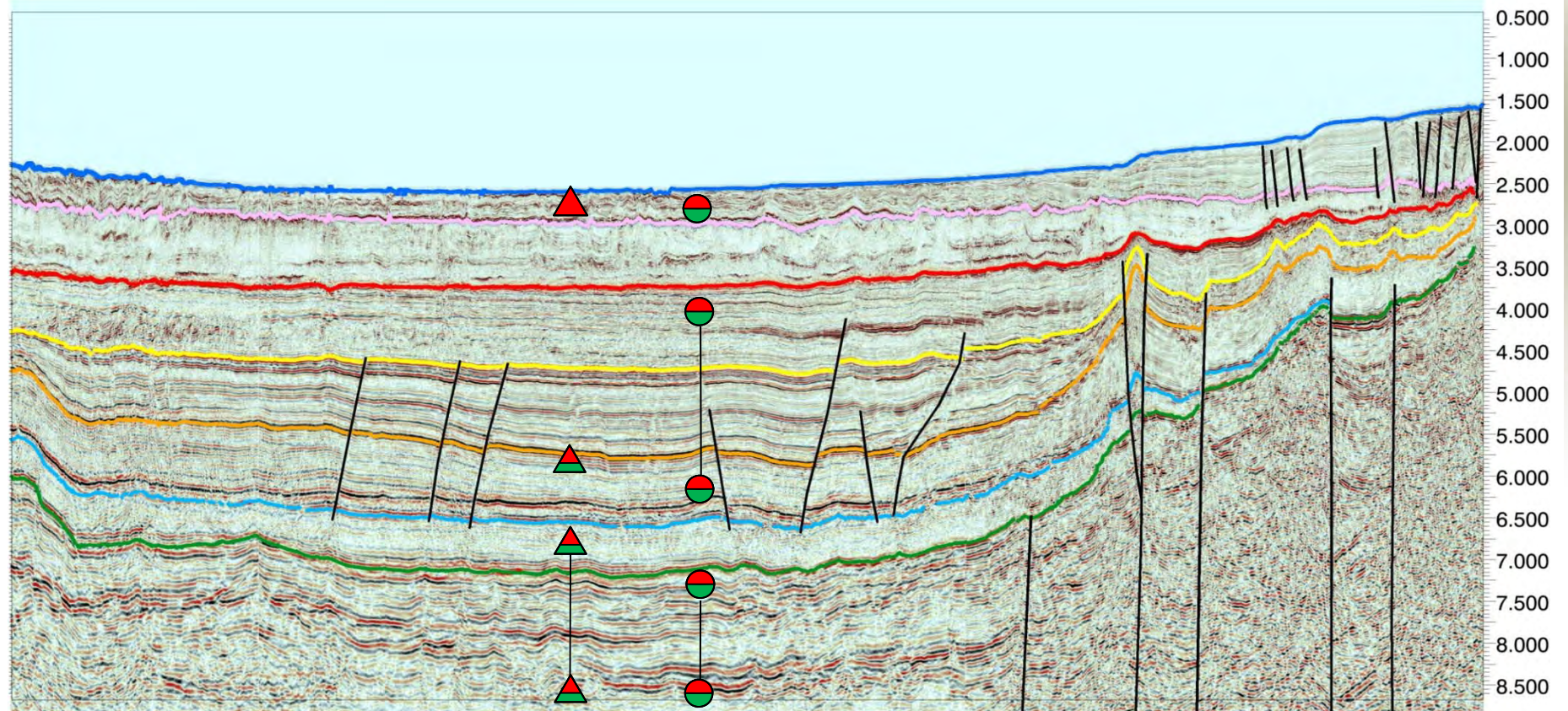
Eastwards increasingly magnitude and younger folding







# Petroleum Systems



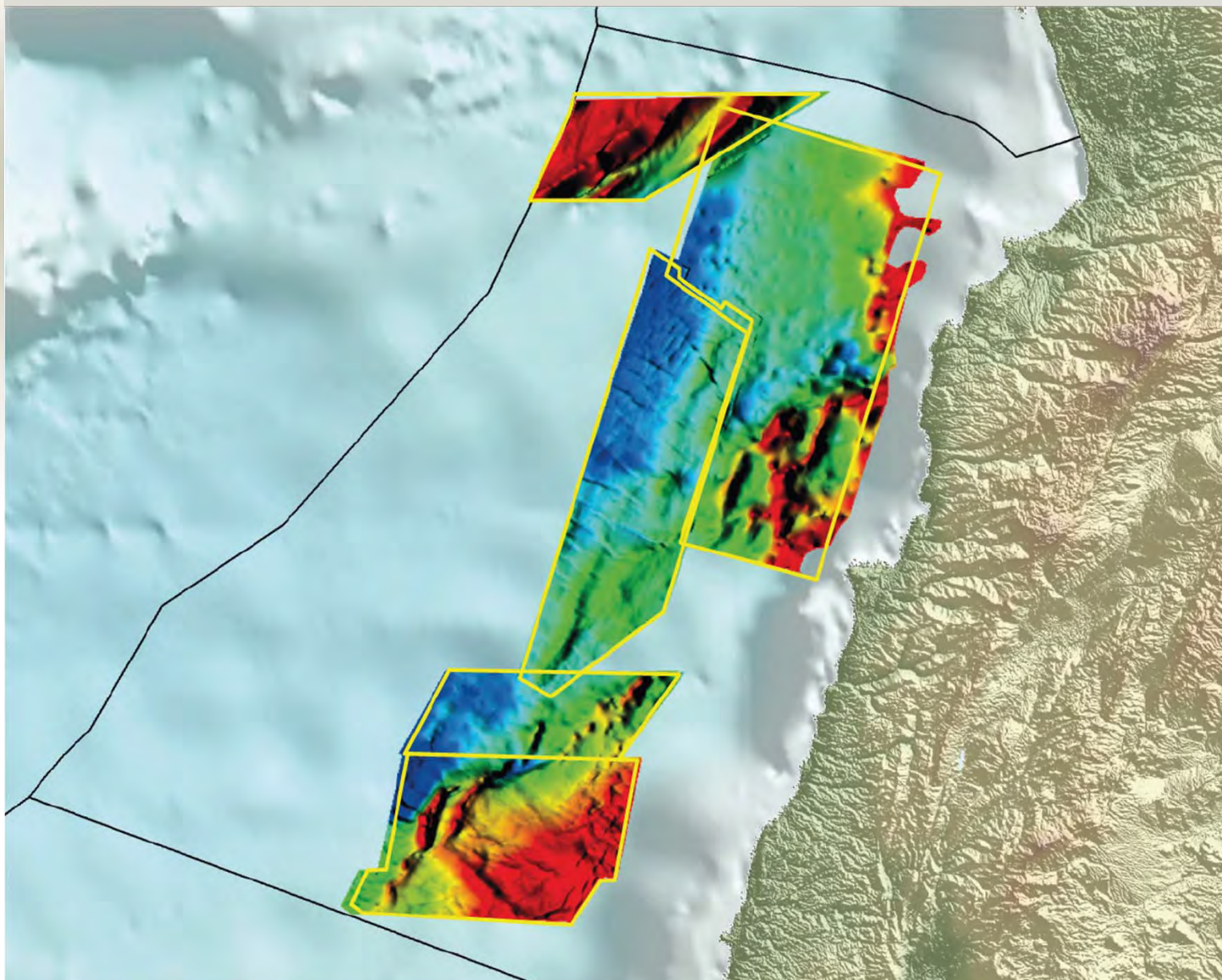
- Seabed
- Base Pliocene
- Base Messinian
- Base Miocene
- Eocene Unconformity
- Senonian Unconformity
- Middle Jurassic

- Gas  
Oil
- Potential Source
- Gas  
Oil
- Potential Reservoir





# Lebanon MegaSurvey

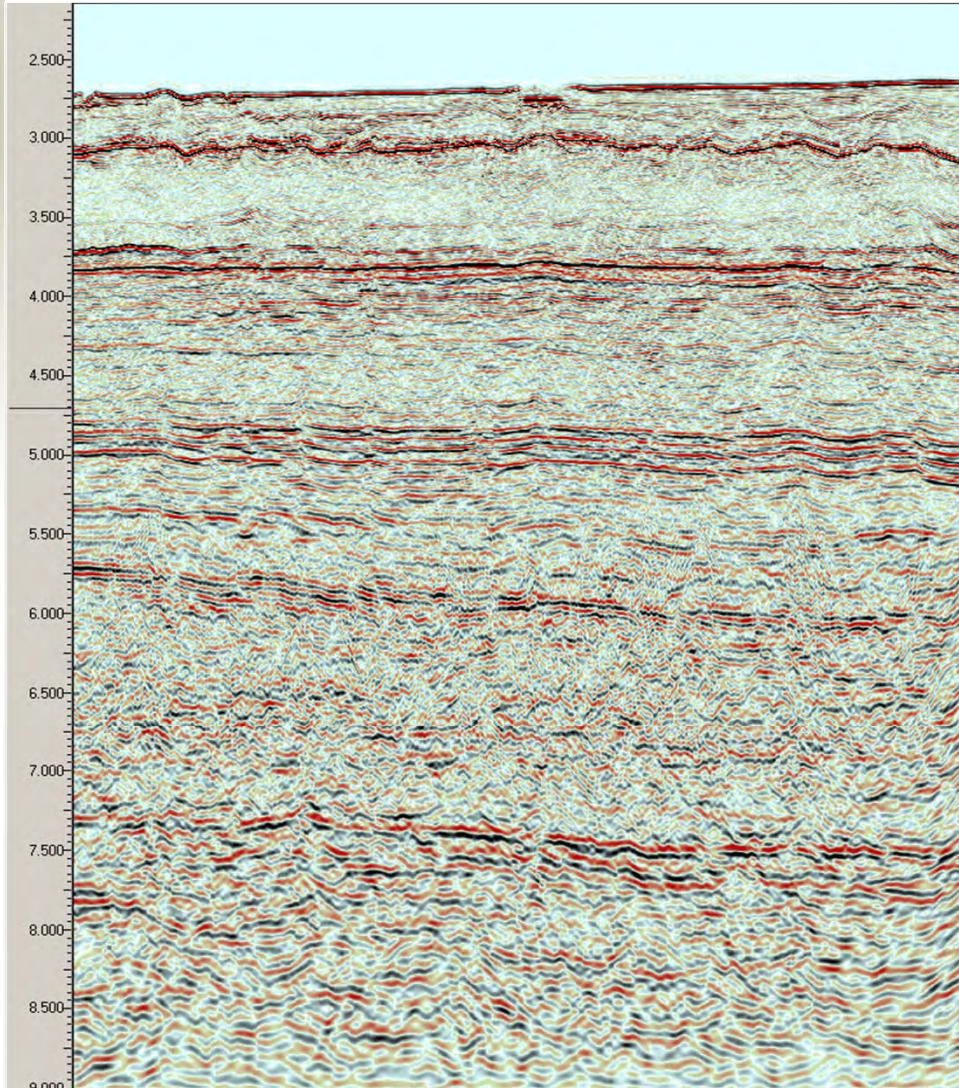




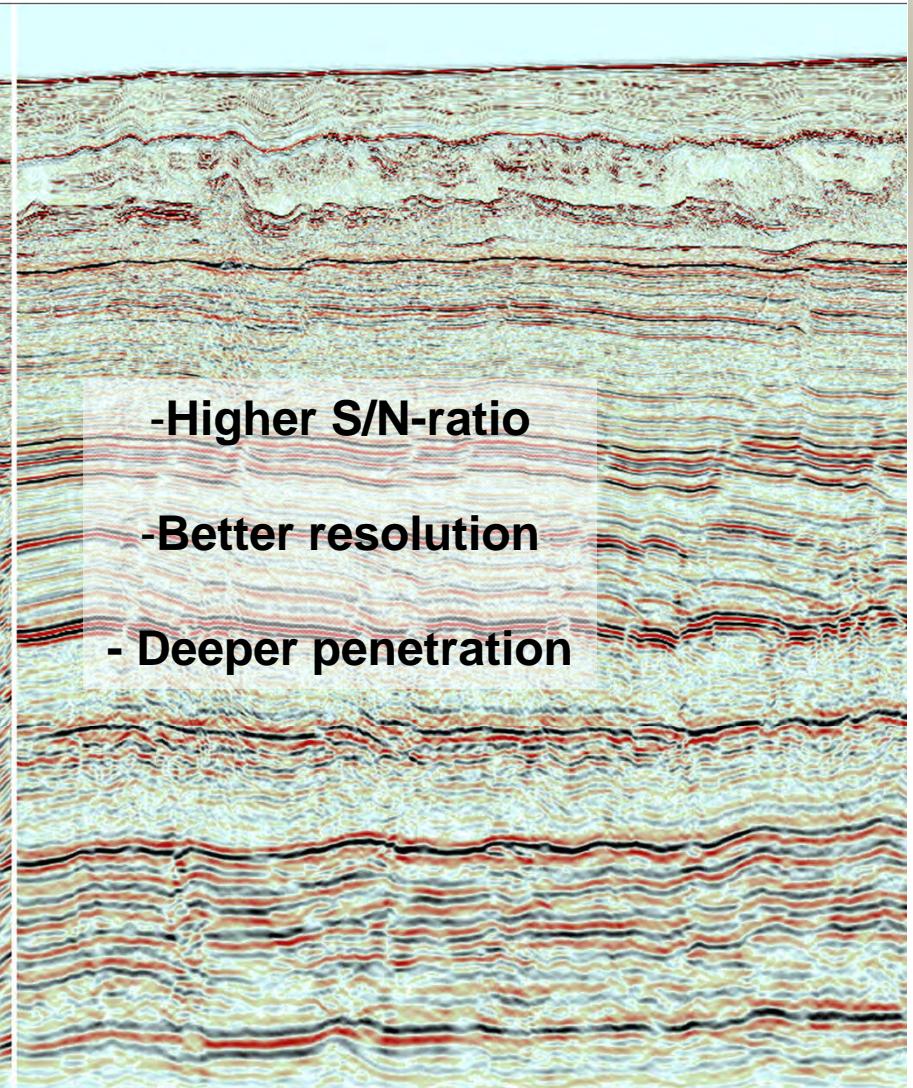


## Dual-sensor versus conventional streamer differences

**Vintage conventional PSTM stack**



**Dual-sensor PSTM stack**







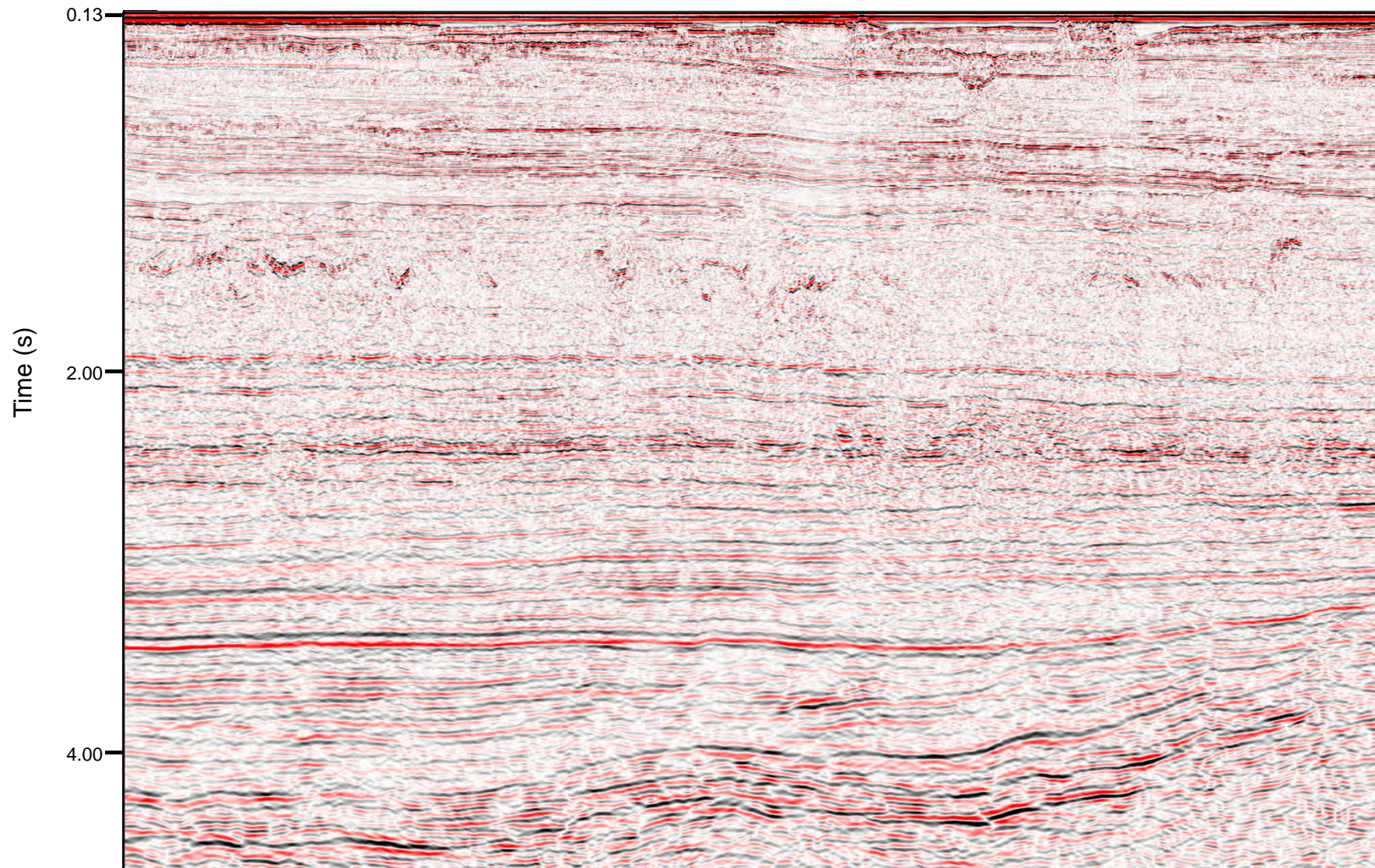
## Dual-sensor versus conventional streamer differences

- **Conventional streamer records pressure only by hydrophones**
- **Dual-sensor streamer records pressure (P) and particle velocity (V) by hydrophones and geosensors**
- **The combination of pressure and particle velocity enables separation of up- and down-going wavefields**
- **The separated up-going wave-field is ghost free**
- **Elimination of receiver ghost gives data with broader bandwidth**





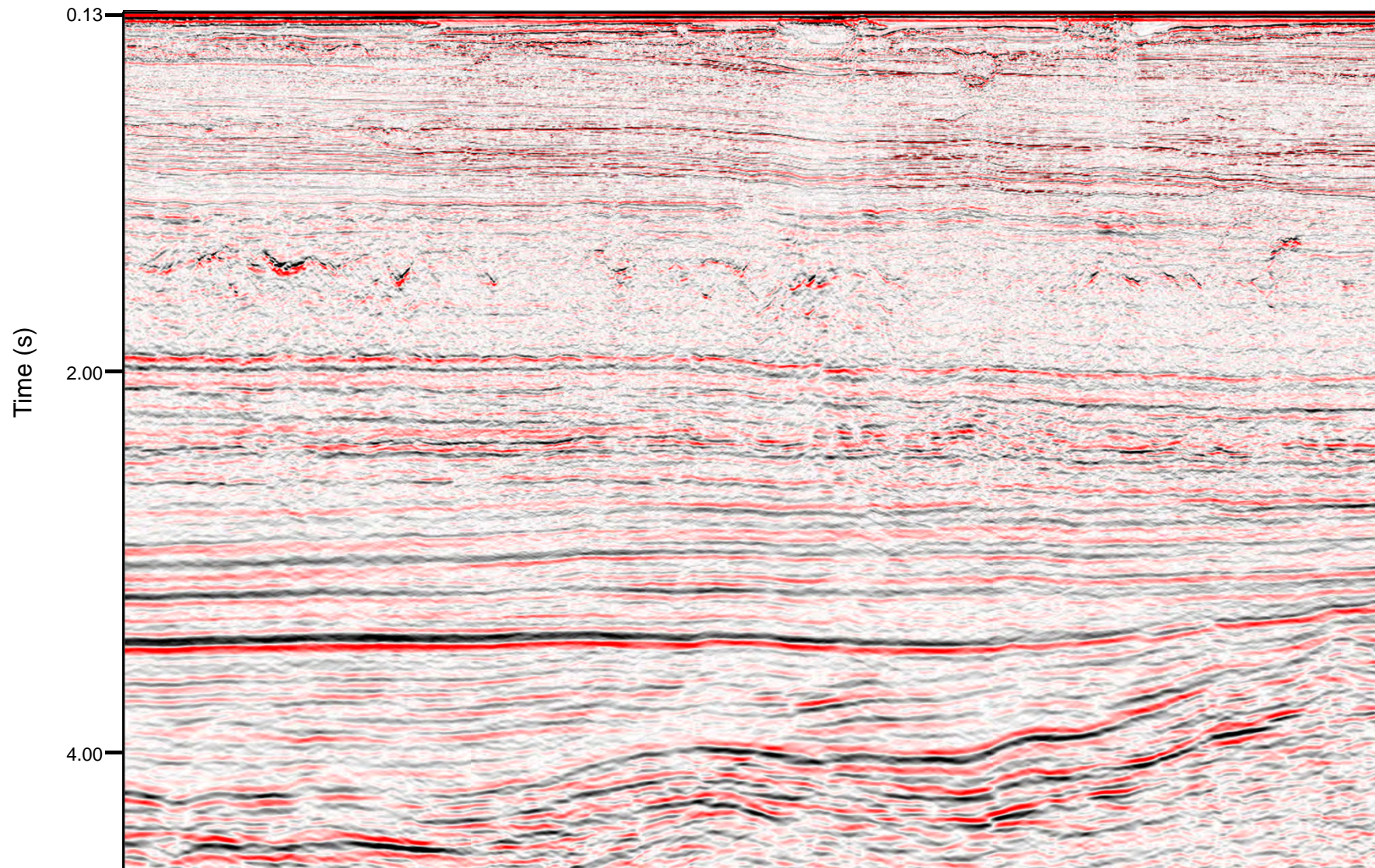
## Conventional source, GeoStreamer example







## GeoSource, GeoStreamer example



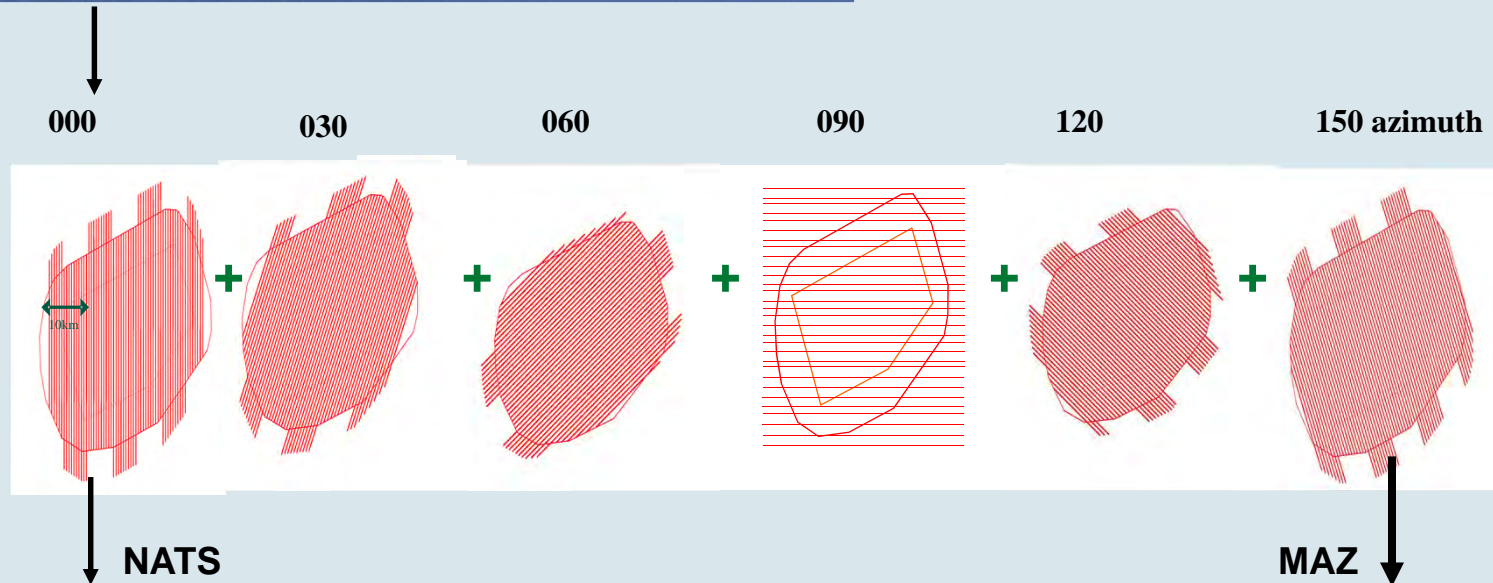


# Multi-azimuth Acquisition - Raven, Egypt

## Ramform Viking



**MAZ: single vessel  
multiple (10) streamers  
multiple passes**







## Summary

- **The MC2D seismic is providing a regional understanding of the tectonic evolution, basin fill and leads.**
- **The MC3D seismic provides detailed mapping and definition of plays and potential prospects.**
- **Merging of the MC3D seismic (MegaSurvey) will increase the understanding of the petroleum systems and the HC potential.**
- **The HC system has been proven in the Levantine Basin and several structural closures could be potential future major discoveries.**
- **Until exploration wells have been drilled, seismic technology to optimize the seismic images and de-risk the subsurface is highly important.**



- **Ministry of Energy and Water of the Republic of Lebanon.**
- **Munib and Angela Masri Institute of Energy and Natural Resources at AUB.**

