Geomorphologic and Stratigraphic Evidence of Ongoing Transpressional Deformation Across Lake Azuei (Haiti)

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Abstract

he boundary between the North American and Caribbean plates cuts EW across the island of Hispaniola. Relative motion on this part of the plate boundary is transpressional and tectonic deformation is partitioned between a NW-SE fold-and-thrust belt and two E-W left-lateral faults 150 km apart. The southern fault, the Enriquillo-Plantain Garden Fault (EPGF), is well defined in western Haiti but looses its morphological expression as it nears Lake Azuei in eastern Haiti. Since the sedimentation rate is high for this 20 km-long lake, Holocene deformation should be recorded in its upper stratigraphy and bottom morphology. To test this hypothesis, we analyzed 200 km of subbottom (CHIRP) profiles collected in 2017 that imaged the upper 2 - 10 m of sediments. This dataset is complemented with other sonar data, including 140 km of echosounder profiles (Moknatian et al., Rem. Sensing 2017) and 65 km of CHIRP profiles (Wang et al., Tectonics 2018). Morphological and stratigraphic information extracted from the combined dataset are compiled into a detailed geological map, which reveals: 1) Gas-charged sediments occur across most of the flat lake floor. However, where the gas front is deeper, the CHIRP data show the rhythmic stratigraphy characteristic of turbidites; 2) Turbidite beds fold up along the edges of the lake floor, documenting the ongoing deformation of the basin margins; 3) In the southern part of the lake, en echelon folds are trending EW, a trend compatible with fault-propagation folds developing ahead of a S-dipping oblique-slip EPGF. We find no evidence of fault scarp or stratigraphic offset in that same area, as might be expected from a sub-vertical EPGF; 4) Deeper penetration seismic reflection profiles acquired concurrently with the CHIRP reveal that the west side of the lake is occupied by a NW-trending monoclinal fold, possibly the expression of a SW-dipping blind thrust fault at depth. Vertical faults across that monocline are associated with subtle breaks in slope. Careful mapping of these slope breaks shows that these faults strike NW-SE, subparallel to the monocline; 5) A < 2 kyr-old paleoshoreline is uplifted 1-2 m across the monocline and soft-sediment deformation suggestive of liquefaction also affects that area. A large earthquake on the presumed underlying blind thrust fault could explain these two features.

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http://projectlakeazuei.org

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ABSTRACT

The North American - Caribbean plate boundary cuts EW across the island of Hispaniola **(Figure 1, top)**. Relative motion is transpressional and, overall, deformation is partitioned between a NW-SE fold-and-thrust belt and two E-W left-lateral faults 150 km apart. The southern fault, the Enriquillo-Plantain Garden Fault (EPGF), is well defined in western Haiti but poorly defined as it nears Lake Azuei in eastern Haiti **(Figure 1)**. Holocene deformation is well recorded in Lake Azuei upper stratigraphy and lakebed morphology. We analyzed 200 km of subbottom (CHIRP) profiles collected in 2017 that imaged the upper 2 - 10 m of sediments **(Figure 2)**; this dataset is complemented 140 km of echosounder profiles (Moknatian et al., 2017) and 65 km of CHIRP profiles (Wang et al., 2018). Morphological and stratigraphic information extracted from the combined dataset is compiled into a detailed geological map (Figure 3).

This compilation reveals:

1. Gas-charged sediments occur across most of the flat lake floor. However, where the gas front is deeper, the CHIRP data show the rhythmic stratigraphy characteristic of turbidites..
2. Turbidite beds fold up along the edges of the lake floor, documenting the ongoing deformation of the basin margins (**Figures 3-2, 3-3, 3-4**)
3. Deeper penetration seismic reflection profiles reveal a NW-trending monoclinic fold in the western part of the lake (see poster T31D-0269 at right). The front of the monocline is segmented, and possibly offset by one or more tear faults.
4. In the southern part of the lake, a right-stepping en echelon folds trend EW. This geometry is compatible with fault-propagation folds developing ahead of a S-dipping oblique-slip fault which may be associated with the EPGF (**Figures 3-5, 3-6**). We suggest that this deformation is due principally to the compressional rather than the shear component of transpression.
5. We find no evidence of fault scarp or stratigraphic offset in that same area, as might be expected from a sub-vertical EPGF (**Figure 3-6**).
6. Soft sediment deformation occur on the surface of the monocline (**Figure 3-9**). These probable liquefaction features are located next to a < 2 kyr-old, 11 m-deep paleoshoreline which is uplifted 1 to 2 meters (*Cormier et al., 2018*) (**Figures 3-3,3-4, 3-5, 3-6**). A large earthquake on a presumed SW dipping blind thrust fault underlying the monoclinic fold could explain both these features. If this interpretation is correct, it suggests that this structure is seismically hazardous.
7. A fan delta is prograding into the southern basin, overprinting the possible trace of the EPGF (**Figure 3-7**).

References

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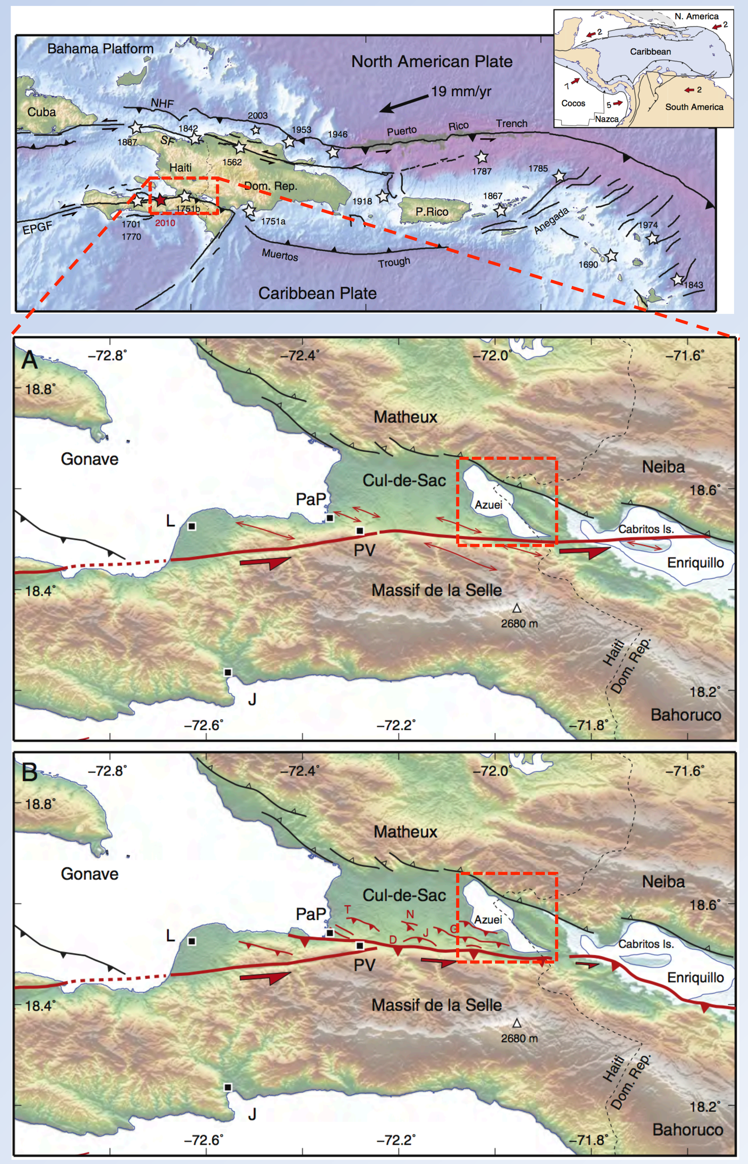


Figure 1. Tectonic context (*after Symithe & Calais, 2016).* Two models have been proposed regarding the nature of the EPGF near Lake Azuei.

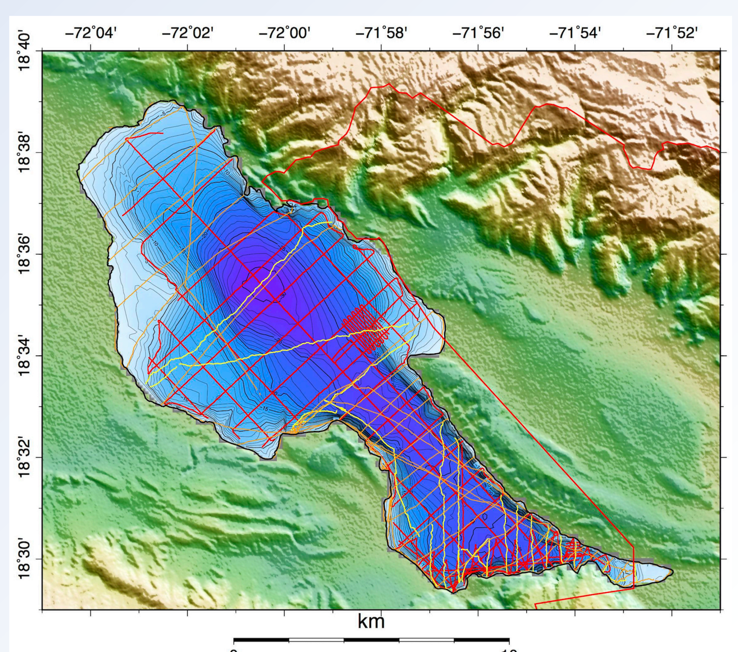


Figure 2. Bathymetry of lake Azuei, with 1 m depth contours. Map is compiled from our 2017 CHIRP survey (red lines), a 2013 echosounder survey (orange lines, *Moknatian et al., 2017*), and a 2013 CHIRP survey (yellow lines, *Wang et al., 2018*).

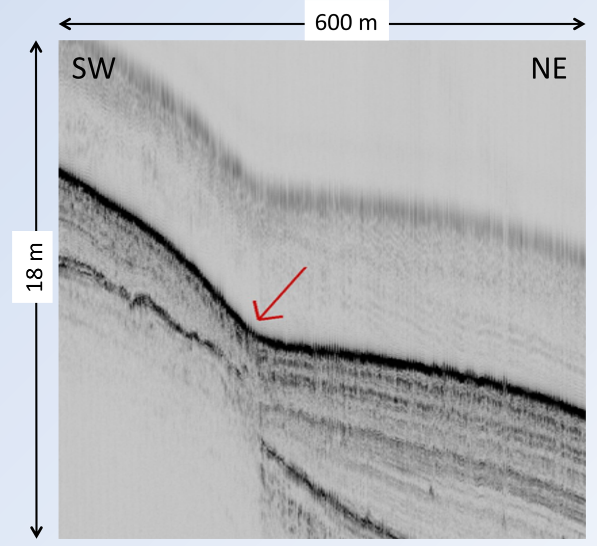


Figure 3-1 Fault, profile 402

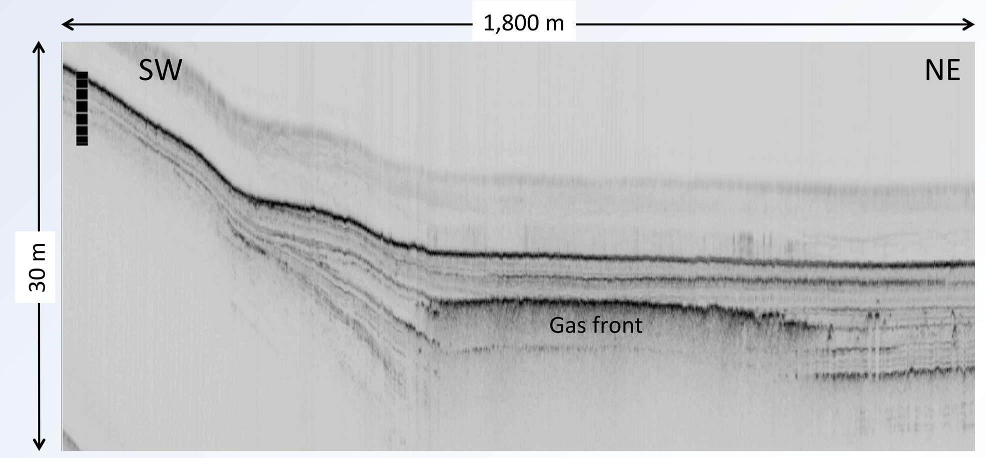


Figure 3-2 Bump near base of slope is not present in deeper strata, suggesting it results from form of mass wasting (not folding). Profile 401.

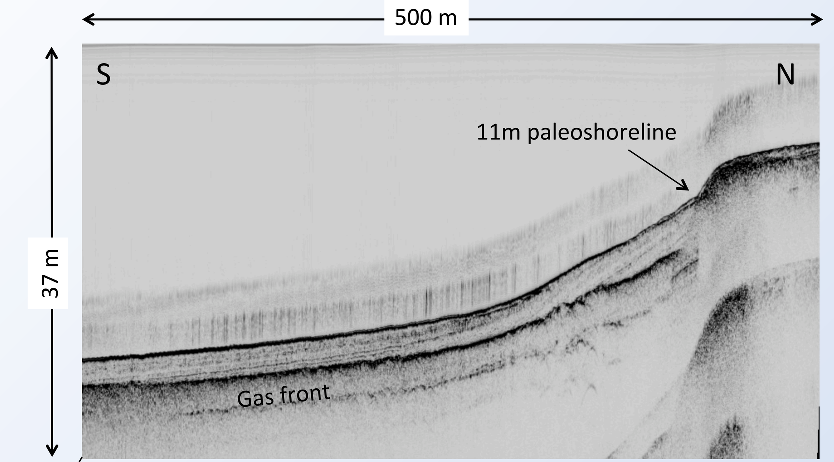


Figure 3-3 Paleoshoreline at 11m depth. Basin turbidites are folding upward at edge of basin. Profile 708.

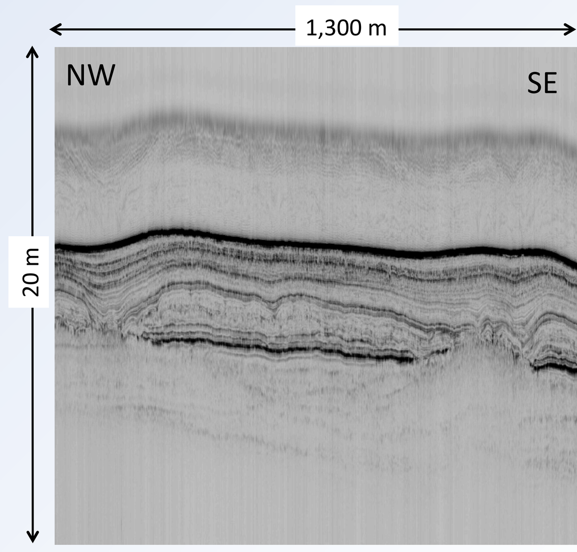


Figure 3-9 Soft-sediment deformation, profile 301

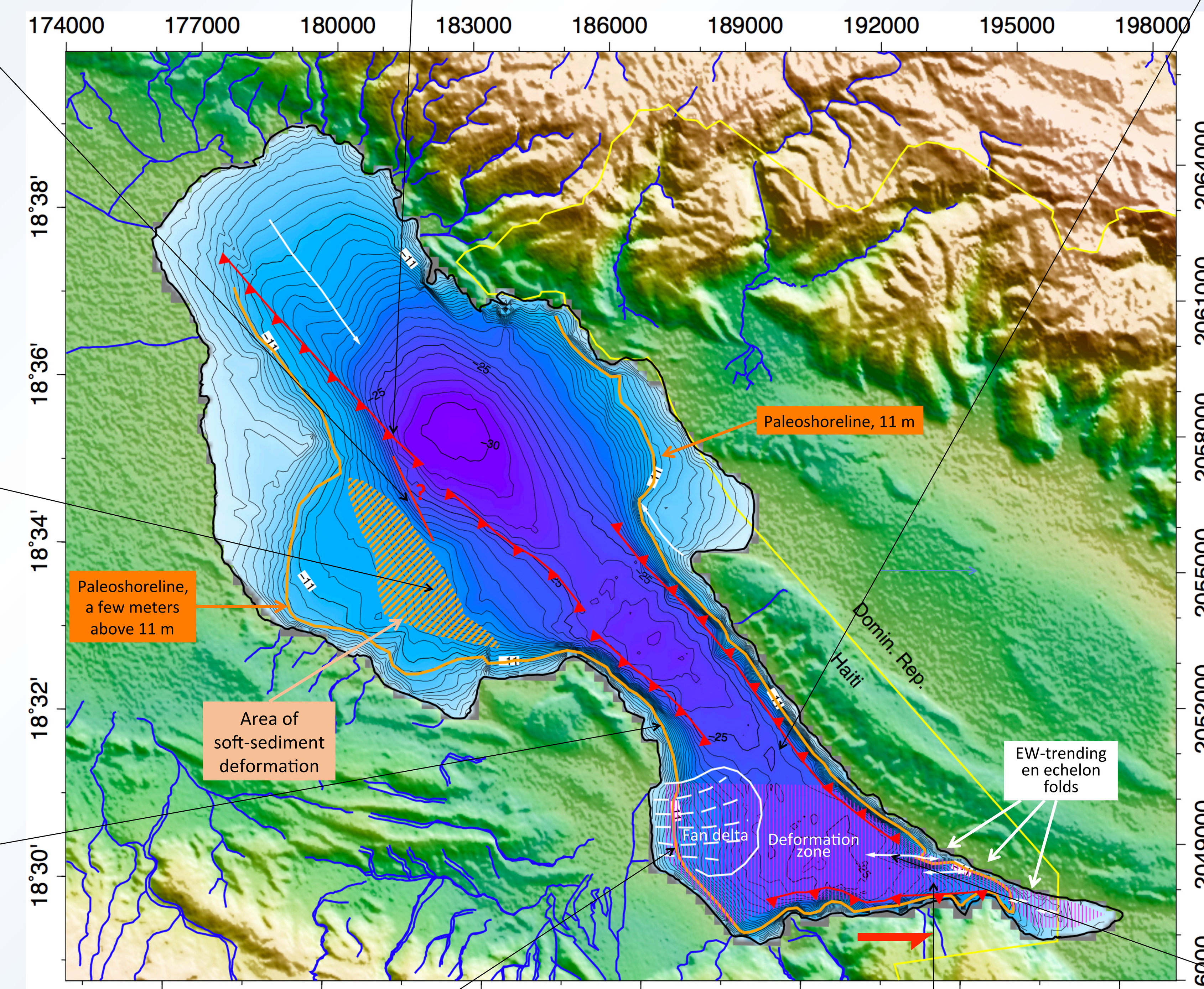


Figure 3: Geological features interpreted from CHIRP and multichannel seismic reflection profiles.

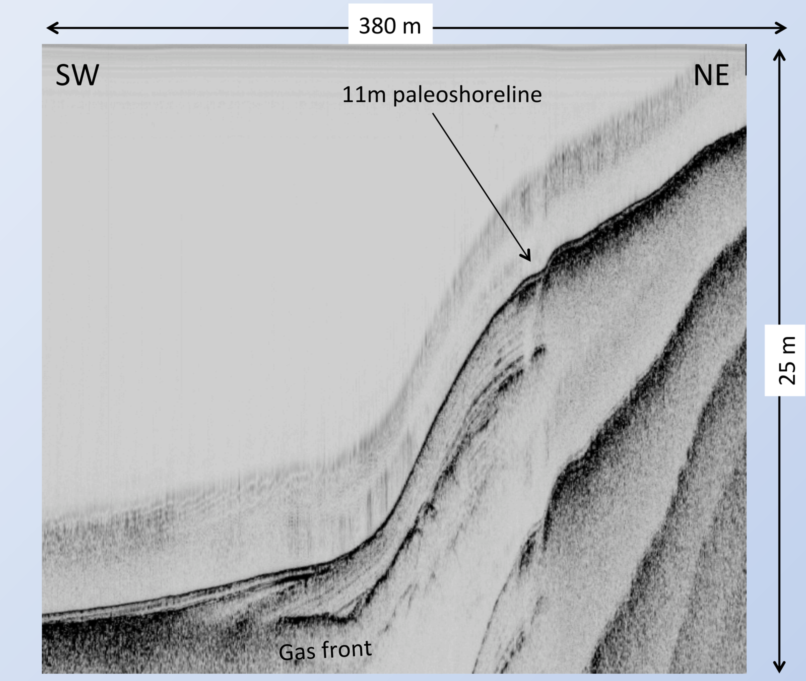


Figure 3-4 Paleoshoreline at 11m depth. Basin turbidites are folding upward at edge of basin. Profile 702.

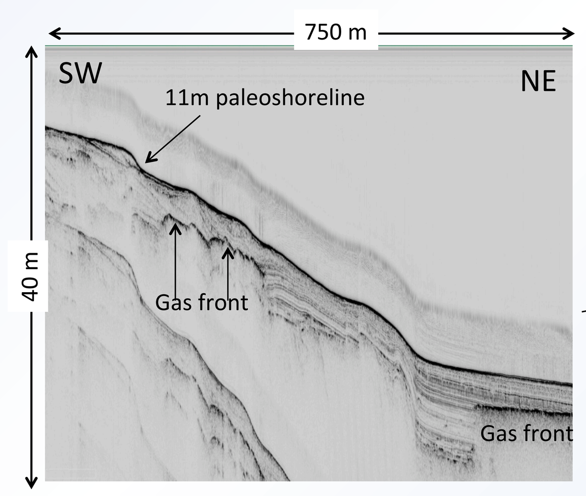
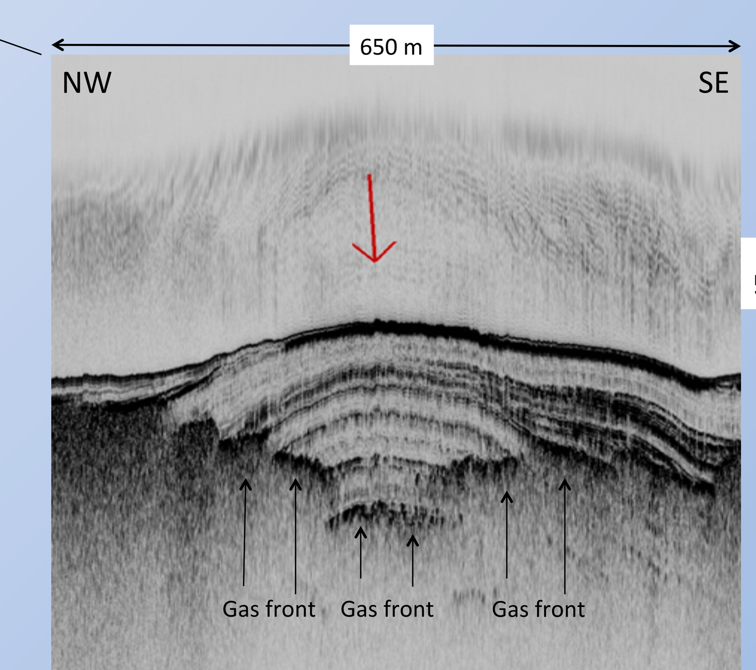


Figure 3-8 Faulted slope, profile 706

Figure 3-5. The latest turbidites are pinching upward on the flank of a young fold. Profile 802.



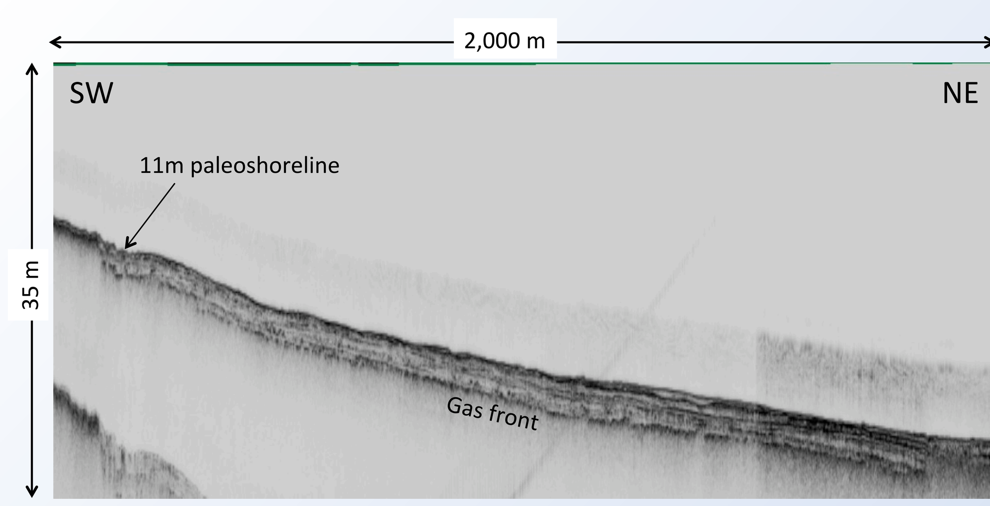


Figure 3-7 Irregular stratigraphy of fan delta, profile 706

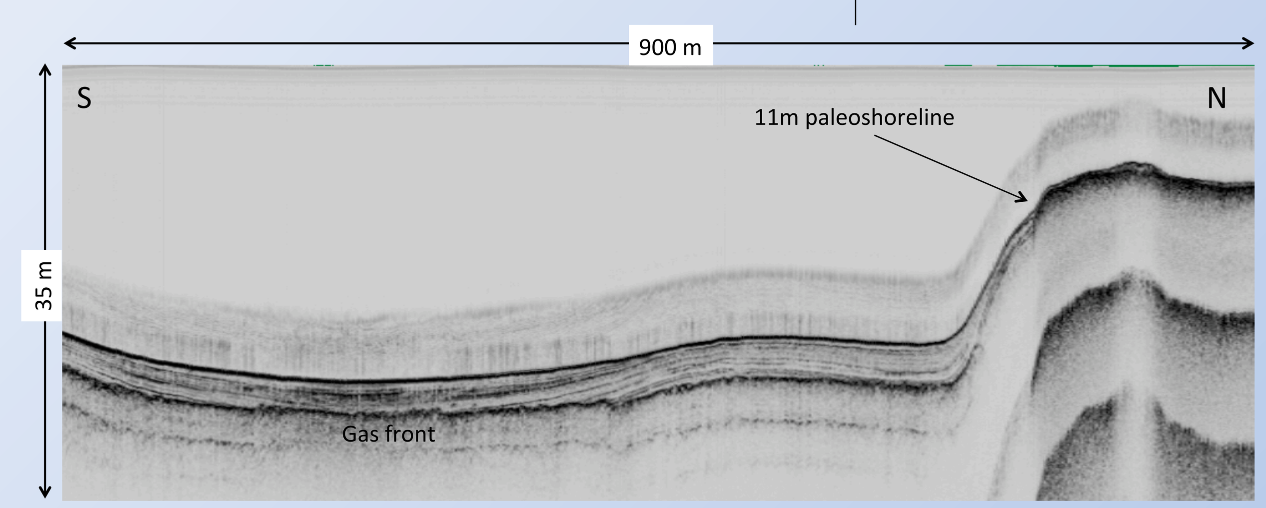


Figure 3-6 Two folds, profile 803

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