Oligocene Canyon and Fan Development on the Eastern Scotian Slope

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Introduction

The modern seafloor of the outer Scotian Shelf and upper slope appears highly eroded with deeply incised canyons that were generated in response to lower sea level stands and high sediment input rates during Quaternary glacial and particularly de-glacial periods (Mosher et al., 2004). The following study investigates a section of base Tertiary to recent strata on the eastern Scotian continental margin using seismic reflection and well data. Within this interval there is an unconformity of presumed Oligocene-age exhibiting a canyon system comparable to the modern eastern Scotian Slope. It is the purpose of this study to apply seismic geomorphologic and sequence stratigraphic techniques to help interpret mechanisms of formation of this and other ancient seafloor surfaces to understand Neogene development of the region.

Seismic Interpretation

Seismic facies, seismic sequence stratigraphic and seismic geomorphologic techniques were applied to a pre-stack depth-migrated 3D seismic volume to investigate the geology of a region of the easternmost upper Scotian Slope. Several widespread erosive unconformity surfaces were investigated and compared to erosional morphologies on the present-day seafloor.

Canyon incision appears to have been episodic through the Cenozoic. During periods of low relative sea level, canyons provided conduits for off-shelf sediment transport, slope by-pass and deposition on the continental rise and abyssal plain. Canyon systems appear to have evolved through multiple phases of cut-and-fill; new systems often re-occupying old. Within the Neogene interval an unconformity of presumed Oligocene-age exhibits a large canyon system comparable in extent to the Sable Gully of the modern Scotian Slope. Because of it's age, its formation, cannot be the result of glaciation as is the modern surface (Figure 1).

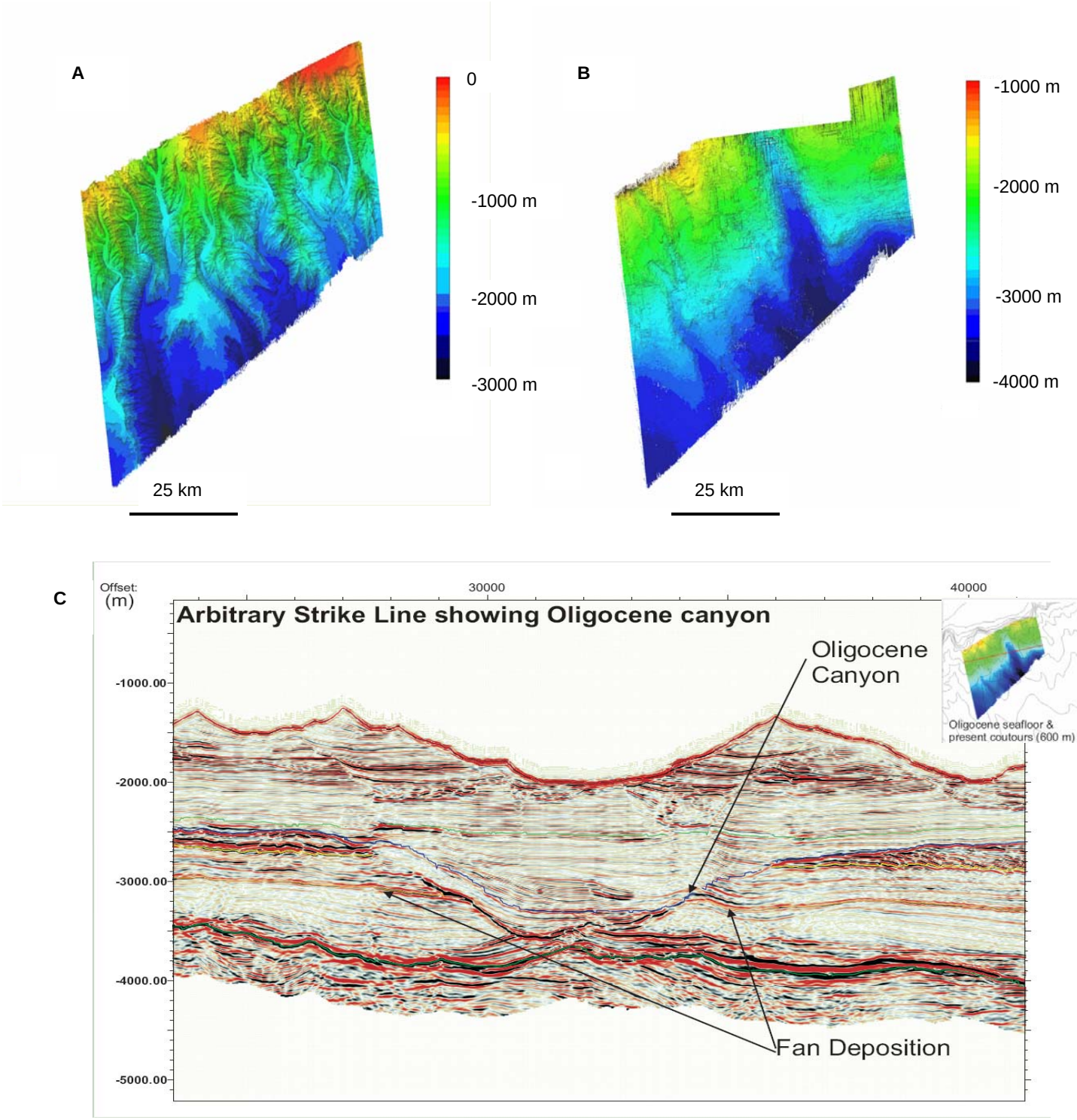

Figure 1: A) The modern day seafloor heavily incised by canyons, valleys and gullies*. B) The Oligocene erosional surface indicates a major canyon system with implications for slope by-pass*. C) Arbitrary strike line showing the relationship of the Oligocene canyon to the modern seafloor. *Colorbars indicate depth below sea level.

This widespread Oligocene erosive surface indicates incision of up to 900m of strata in a canyon that is ~9 km wide. Multiple phases of deposition ultimately led to complete infill of this canyon resulting in a relatively smooth seafloor. A modern canyon system subsequently cut into these infill deposits. The extent of the Oligocene canyon system is beyond the limits of the 3D seismic volume. Extension of this surface through an extensive grid of 2D seismic reflection data indicates it is part of a much larger canyon system; analogous to the modern Sable Gully system that drains much of the central and eastern Scotian Slope and acts as a conduit for slope by-pass.

Conclusions

Canyon formation requires significant removal of slope material to the deep ocean floor. Canyons also act as conduits for sediment transported from other sources to the canyon head after incision. Therefore, as with the modern surface Neogene canyons are likely fundamental to slope sedimentary processes and sediment delivery mechanisms.

The implications of repeated canyon formation on the Scotian Slope indicate a limited residence period of slope sediments with erosion and slope by-pass delivering sediment to the continental rise and abyssal plain. Insight on the depth and extent of the Oligocene surface has implications for the remainder of the Scotian Slope and its future as a prospective hydrocarbon system. This study provides a stratigraphic framework for the eastern Scotian slope that can be used as a model for further research, hydrocarbon exploration and regional comparison.

References

Mosher, D.C., Piper, D.J.W., Campbell, D.C., and Jenner, K.A., 2004, Near-surface geology and sediment-failure geohazards of the central Scotian Slope: AAPG Bulletin, **88**, 703-723.