Ph.D. RESEARCH SEMINAR

DEPARTMENT OF EARTH AND ENVIRONMENTAL SCIENCES

DALHOUSIE UNIVERSITY

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"A Quantitative Approach to Model Miocene Foresets on the New Jersey Shelf"

Thursday, September 5, 2019

11:30 a.m.

Milligan Room, 8th Floor Biology-Earth Sciences Wing,
Life Sciences Centre, Dalhousie University

COFFEE AND DOUGHNUTS WILL BE AVAILABLE IN THE MILLIGAN ROOM BEFORE THE SEMINAR

A Quantitative Approach to Model Miocene Foresets on the New Jersey Shelf

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The New Jersey rifted continental margin is a prime location for studying the dynamics of eustatic changes and paleoclimate because: 1) since early Jurassic rifting, the margin has experienced a smooth thermal subsidence, 2) substantial sediment supply since the Oligocene has resulted in a thick (hundreds of meters) record of sediments resolvable in seismic profiles, and 3) the margin has a relatively stable tectonic history since the Oligocene. Therefore, while regional controlling factors have contributed to the shoreline movements of this rifted margin, eustatic change has been the dominant player.

The focus of this study is to understand how stratigraphic sequences of the New Jersey margin have responded to the controlling processes in the shallow water environment, and to define a relationship between sequence development and these processes. The three wells from the 2009 IODP Expedition 313, and a 600 km^2 ultra-high-resolution 3D seismic data I collected offshore New Jersey in 2015 encompass the study area for this research. They are located on top of several clinoform rollovers in the paleo-shelf, which are features sensitive to post-Oligocene eustatic change.

I first introduce a systematic and objective approach I developed to describe individual stratigraphic packages of a clinoform based on their relative spatial positions. This new approach, called Geometric Breakdown Approach, facilitates quantitative analysis of stratal patterns. I test the approach on synthetic data from an analogue modeling and Miocene clinothems imaged on a seismic profile offshore New Jersey. Relatively consistent subsidence and sediment supply in both datasets provides a controlled setting to investigate depositional cyclicity relative to base-level changes.

The Geometric Breakdown approach is further applied to breakdown the Miocene clinoforms into a series of sequences and system tracts in 3D seismic data. The results of seismic amplitude inversion and multi-attribute linear regression process, including acoustic impedance, density, P-wave velocity, and clay volume, are incorporated into the established framework to characterize each sedimentary unit. The final model of the Miocene clinoforms reveals a laterally repeating pattern of petrophysical properties within the sequences formed during the eustatic changes.

The New Jersey margin's Miocene clinoforms have recorded 22 cycles and 76 phases of eustatic changes over 8 Myr. While previous studies suggest a correspondence between 1.2 Myr obliquity modulation cycles and third-order sequences, my spectral analysis of the cyclicity of the eustatic events yields local spectral peaks at 25 Kyr and 40 Kyr in high-frequency spectra. These spectral peaks correspond to the cyclicity observed in insolation due to changes in the axial tilt and precession of the Earth's orbit. Further, stratigraphic records for the Miocene onshore-offshore movements of stratigraphic sequences show a 30% correlation with the mathematically driven insolation log within the studied period. These findings suggest that even short-period orbitally-driven eustatic changes had a direct impact on the Miocene sedimentary record of the New Jersey continental margin.