Conjugate Margins Conference | Halifax 2008

Core Workshop

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CORE WORKSHOP

Presentations by Stratigraphy

1. THE MONTAGNAIS METEORITE IMPACT STRUCTURE, WESTERN NOVA SCOTIAN SHELF
Lubomir Jansa and Georgia Pe-Piper

2. DEEP SHELFAL CHALK RESERVOIRS OF THE UPPER CRETACEOUS WYANDOT FORMATION, PRIMROSE SALT STRUCTURE AREA, OFFSHORE NOVA SCOTIA
Andrew MacRae

3. PRODELTAIC DEFORMATION FACIES FROM THE ALMA AND TANTALLON FIELDS
David Piper and Georgia Pe-Piper

4. HYPERPYCNAL FLOW DEPOSITS FROM THE THEBAUD FIELD
David Piper and Atika Karim

5. TIDALLY-INFLUENCED DELTAIC RESERVOIRS IN THE UPPER JURASSIC-LOWER CRETACEOUS MICMAC AND MISSISAUGA FORMATIONS (GLENELG AND ARCADIA FIELDS), OFFSHORE NOVA SCOTIA
Andrew MacRae

6. VARIED CARBONATE FACIES FROM THE JURASSIC-CRETACEOUS GIGAPLATFORM MARGIN OF BALTIMORE CANYON TROUGH OFF DELAWARE, USA.
Les Eliuk & Brad Prather

7. REEF MARGIN CARBONATE RESERVOIRS OF THE UPPER JURASSIC-LOWER CRETACEOUS ABENAKI FORMATION (DEEP PANUKE)
Les Eliuk *for* Rick Wierzbicki, Kevin Gillen, Rolf Ackermann, Nancy Harland, Leslie Eliuk, with a contribution by Jeff Dravis

BACK

The Montagnais Meteorite Impact Structure, Western Nova Scotian Shelf

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ABSTRACT

The first of only three known offshore impact structures, Montagnais has a short core from fractured Meguma Group (Cambro-Ordovician) recovered in Union et al. Montagnais I-94. In 1987 a report in Nature (v.327, p. 612-614) was followed up by a 1989 larger article by Jansa, L.F., Pe-Piper, G. Robertson, P.B., and Friedenreich, O. in Geological Society of America, v. 101, p.450-463. Although the effects of meteorite impacts on land has been relatively well studied (including as significant hydrocarbon-bearing structures) those on the 70% of the water-covered earth are much less understood. An underwater extraterrestrial impact crater occurs on the North Atlantic continental shelf, 200 km southeast of Nova Scotia, Canada. The impact, in late early Eocene (51 Ma) produced a complex structure with a submarine crater, a central structural high and an inner topographic ring. The crater is filled with breccia, which exhibits shock deformation features. Lack of enrichment of the melt rocks in siderophile elements compared with basement rocks and a slight enrichment in iridium suggest that the impactor was either a stony meteorite or a cometary nucleus. The diameter of the impactor is estimated to be about 2-3 km.

The cored section is about 400 m below the top of basement in the central uplift of the crater. Megascopically, it resembles Meguma Group metagreywackes and phyllites exposed on land in southern Nova Scotia. The metagreywackes from the core have hairline microfractures and rare undecorated shock lamellae in quartz grains, visible in thin sections. Other evidence for the impact structure was based on petrographic examination of cuttings and included the recognition of thick breccias, melt zones of rhyolitic composition containing calcic plagioclase, and shock-induced features of minerals including isotropization and shock-induced lamellae.

BACK

Deep Shelfal Chalk Reservoirs of the Upper Cretaceous Wyandot Formation, Primrose Salt Structure Area, Offshore Nova Scotia

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ABSTRACT

Chalks of the Upper Cretaceous (Turonian-Maastrichtian) Wyandot Formation form an extensive stratigraphic marker on the Scotian Margin and parts of the Grand Banks. Although not commercial, significant discoveries of natural gas occur at two sites on the Scotian Margin, Eagle and Primrose, where the Wyandot Formation serves as the main reservoir. This core display will show selected examples of the reservoir intervals at the Primrose field.

At Primrose the Wyandot Formation is characterised by well-bioturbated chalk and minor marlstone with a diverse ichnofauna dominated by subhorizontal feeding and dwelling traces (e.g., *Thalassinoides*, *Zoophycos*, *Chondrites*), and body fossils of inoceramid clams. There are some subtle indications that firmground surfaces may occur within some intervals of the chalk. The nature of the ichnofauna and of published rock-eval data (Wielens et al. 2002) implies well-oxygenated bottom conditions at the time of deposition. These are clearly "autochthonous" chalks that have formed in-situ rather than being redeposited "allochthonous" chalks (Ings et al. 2005).

Stratigraphic relationships with the overlying Campanian-Neogene Banquereau Formation indicate these chalks were probably deposited in water depths in excess of 200-300m, and were located outboard of most of the clastic sedimentary input. Despite the significant water depths, they were still inboard of the main continental slope of the Upper Cretaceous, and are therefore described as forming in a "deep shelf" setting.

Porosity within the Wyandot Formation is as high as 20-30%, but, as for most chalks, it is extraordinarily fine-grained. Porosity declines significantly even within the approximately 200m thickness of the unit at Primrose, likely due to compaction-related cementation. It is probably the relatively shallow depths (<1600m) that have allowed the reservoirs to remain significant here (Ings et al. 2005). This issue probably precludes major reservoirs in this interval on the deeper parts of the Scotian Margin, however, were redeposited chalks and early hydrocarbon charge to occur as in the central North Sea, promoting porosity preservation, deeper reservoirs may still be possible.

BACK

Prodeltaic Deformation Facies from the Alma and Tantallon Fields

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ABSTRACT

Conventional core through foresets of Lower Cretaceous deltas at the Alma field and in Tantallon M-41 show a wide range of sediment deformation facies. In particular, facies that have shallow-water sedimentological features (tidal-flat structures, wave ripples) occur in blocks of sizes ranging from centimeters to metres overlying a zone of sedimentary mylonite, with highly deformed sediments interpreted as the deforming base of a submarine landslide. Failure to recognise the allochthonous nature of these sediments has led to misinterpretation of the depositional environment and has consequences for the connectivity of sandstone bodies. The range of observed allochthonous facies will be illustrated with core from Alma and Tantallon.

BACK

Hyperpycnal Flow Deposits from the Thebaud Field

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ABSTRACT

Hyperpycnal flow deposits, or "delta-front turbidites", are becoming increasingly recognised as important components of some deltaic systems. The presence of Bouma T_{abce} or T_{bce} sequences in sandstones, with unidirectional climbing current ripples and basal flute marks are the most diagnostic sedimentological evidence of prodeltaic hyperpycnal flows (Bhattacharya and Tye, 2004; Hampson and Howell, 2005; Myrow et al. 2006). Such beds may be capped by wave-generated oscillatory ripples and the tops are commonly strongly bioturbated. Laminae of phytodetritus are common in the sandstones and the T_e division commonly has a high organic content (Rice et al. 1986). Delta-front turbidites show distinctive ichnological suites (MacEachern et al. 2005) because of rapid event deposition and changes in oxygenation and salinity. Some coarse-grained cross-bedded sandstones have been interpreted as deposits of predominantly by-passing prodeltaic hyperpycnal flows (Edwards et al. 2005) and turbidite channels and lobes are interpreted as significant components of shelf facies models (Pattison, 2007). Hyperpycnal mud turbidites are also recognised in prodelta settings (Leithold and Dean, 1998), with sedimentological characteristics summarized by Piper and Stow (1991). Delta-front turbidites show many similarities to sandstone beds termed tempestites, which are interpreted to result from storm resuspension of littoral sand. Myrow et al. (2002) have demonstrated that well sorted sandstone beds showing Bouma sequences and basal unidirectional flute marks have climbing ripples with convex-up and sigmoidal foresets that are characteristic of mixed wave and current motion.

These concepts will be illustrated by selected core, principally from the Thebaud field. Thick bedded reservoir sandstones from fields such as Thebaud appear to be inner shelf hyperpycnal deposits (facies 9), forming graded sandstone beds decimeters to metres thick, with Bouma Ta-Tc sequences, abundant phytodetritus, detrital intraclasts of mudstone and siderite, and minor bioturbation at the top of beds. This facies passes stratigraphically upward into tidally influenced river-mouth and river-channel sandstones (facies 4) and downward into thinner graded sandstone beds with interbedded mudstone (facies 0). More highly, bioturbated thin bedded sandstones (facies 2) in places show hummocky cross-stratification, concentration of shells at the base of beds, and wave-ripples, suggestive of storm reworking. In the Glenelg field, tidally-influenced hypopyncal silts interbed with hyperpycnal sands and both change character distally. The recognition of hyperpycnal flow deposits has important implications for reservoir geometry and diagenesis.

BACK

Tidally-influenced Deltaic Reservoirs in the Upper Jurassic-Lower Cretaceous Micmac and Missisauga Formations (Glenelg and Arcadia Fields), Offshore Nova Scotia

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ABSTRACT

The sedimentary and ichnological signatures of tidal environments are well known from modern and ancient settings, but they are often tricky to recognize within core. This core display will demonstrate some of the diagnostic traits of tidal rhythmite deposits and associated trace fossils in a deltaic setting at the Arcadia (MicMac Formation) and Glenelg (Upper Missisauga Formation) fields. These two sites represent the approximate location of the front of the delta system in the Sable Subbasin in the Late Jurassic and Early Cretaceous, respectively.

At Arcadia J-16, core 2 consists of a succession of "massive" and crossbedded medium sandstones interbedded at metre-decimetre scale with distinctly rhythmically-bedded (mm-cm scale) fine sandstone and mudstone. The rhythmites show varying degrees of overprinting by bioturbation, from none to moderate, showing how rapid deposition and/or exclusion of much of the biota is often a prerequisite for rhythmite preservation. The fauna is low diversity and dominated by simple vertical or horizontal burrows (mostly Skolithos, Planolites, and occasionally Teichichnus). The rhythmites show clear indications of diurnal inequality and spring-neap cycles, including "crossover", that unambiguously identify them as being produced by tidal processes. At the acme of some cycles the current became strong enough to generate current ripples.

At Glenelg N-49 the cored interval consists of medium-coarse dune-crossbedded or unstructured sands with coarse rip-ups and rare preserved mud drapes. These are interbedded at metre-decimetre scale with fine, occasionally rippled sand-mud rhythmites. Unlike the rhythmites at Arcadia, diurnal inequality is not evident, and although there are thickness variations consistent with spring-neap cycles, the cycles are incomplete, suggesting that this site experienced a different current regime. The succession generally fines upwards, and is capped by bioturbated sands (Diplocraterion & Skolithos), rooted mudstones (tidal flat?) and coal, together interpreted as a channel fill. Below the channel is an interval of finer sand-mud rhythmites with rare bioturbation, reactivation surfaces, and current ripples that is interpreted as a more distal setting, perhaps in front of a distributary mouth, but still relatively sheltered from wave processes and influenced by tides.

Both of these sites demonstrate that throughout the long history of the succession of delta lobes referred to as the "Sable Delta", there were intermittent periods when tidal processes were locally significant, and these can be used to infer the proximity of the delta front at the time.

BACK

Varied Carbonate Facies from the Jurassic-Cretaceous Gigiplatform Margin of Baltimore Canyon Trough off Delware, USA

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ABSTRACT

In 1984 three wells operated by Shell tested various types of Jurassic-Cretaceous carbonate shelf and margin plays in deep water offshore New Jersey. Eleven cores were recovered: OCS-A 0336 cores R1-4, OCS-A 0337 cores C1-3 and OCS-A 0317 cores H1-4. Representative core intervals on display are keyed to seismic morphology and show litho-biofacies from three geometrically and stratigraphically separate shelf edges:

Oxfordian-Kimmeridgian prograded margin (R1+2) and slope (C3), Late Kimmeridgian-Berriasian aggraded margin capped by pinnacle reefs (C2, H3+4), then an extensive deeper-water mounded sponge-rich interval of Berriasian and Valanginian age (R2, C1, H2) and finally a back-stepped Barremian-Aptian reef margin (R1) on prodeltaic shales. Alternatively cores can be facies grouped into deeper-water upper slope microbial(?) mound (C3) and reef complex (R3–foreslope? + R4-reef framework & sands) of the prograded margin, shelf-edge shallow-water skeletal sands (H3+4, C2) in the aggraded margin, and deep-water carbonates capping a drowned shallow-water shelf (R2, C1, H2) then mid-Cretaceous shallow-water shelf-edge oolite (R1).

Previously unpublished paleoenvironmental models by Edwin Ringer and Harvey Patten illustrate the depositional facies relationships. No analogue is perfect, but older (and with the 1999 Panuke gas discovery many more recent) Nova Scotia (NS) shelf-edge wells also sample the Jurassic-Cretaceous gigaplatform margin. Though similar enough to apply the same formational terminology, and a very similar vertical depositional progression including 'drowning', the Baltimore Canyon wells in general sample much more carbonate-sand-rich beds. Whereas the NS margin wells sample muddier but much more reef framebuilder-rich beds. The basins have some major difference but these biofacies differences may indicate a "sampling" bias; possibly shallow-water J-K reefs simply grew in slightly deeper water. The best depositional model will integrate both data sets. Degree of dolomitization remains a significant difference.

This presentation is repeated (with slight modification) by permission from the Canadian Society of Petroleum Geologists 2005 Core Conference and with permission of Royal Dutch-Shell.

BACK

Reef Margin Carbonate Reservoirs of the Upper Jurassic – Lower Cretaceous Abenaki Formation (Deep Panuke)

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ABSTRACT

The purpose of this presentation is to show the facies, diagenesis, and fracture interpretation of the fractured and dolomitized margin of the Abenaki carbonate platform at Deep Panuke. Core from F-70, H-08, and PI-1B will be displayed.

The Deep Panuke gas reservoir was discovered in 1999, 250 km offshore of Halifax Nova Scotia. Gas is trapped in dolomite and limestone at the margin edge of the Jurassic aged Abenaki carbonate complex. Analysis of well test data had indicated that platform margin edge wells were connected to a highly permeable reservoir, assumed to be fractured or vuggy dolomite/limestone.

In 2004, data was obtained on the high permeability reservoir, when 24 meters of core was recovered from the F-70 well bore. The F-70 core encountered foreslope and reefal limestone and fractured vuggy dolomite in the upper portion of the reservoir. The core was examined and facies described in detail by Les Eliuk. Thin sections were examined and a diagenetic interpretation provided by Jeff Dravis.

The core and associated FMI image from F-70 was interpreted by Kevin Gillen. Data from his interpretation and interpretation of all of the FMI data by HEF Petrophysical were used by Rolf Ackerman (Beicip Inc.) to build a discrete fracture network model of the reservoir. The parameters and insights gained have been used to constrain the flow simulation model of the reservoir.

NOTE: Repeated with only minor modification by permission from Canadian Society of Petroleum Geologists 2005 Core Conference in Calgary Alberta. Additions have been made to Eliuk's section on depositional setting and that will be the emphasis of the 2008 display. Also a brief appendix has been added with information on cores from Panuke PI-1A and H-08. Panuke M-79 has a 5m core in the basal Scatarie Member rich in quartz grains and ooids that will not be shown.

BACK

NOTES

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