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Abstract

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Applying Deltaic and Shallow Marine Outcrop Analogs to the Subsurface

A fundamental problem in subsurface reservoir characterization is determining the continuity of flow units and flow barriers (i.e. sandstones, shales and cements). In any given field, there will typically exist a combination of field wide-elements, elements that may extend between wells, but not across the entire field, and elements that do not extend between wells.

Our outcrop analog data bases provide:

1. Regional and field-scale studies of reservoir and non-reservoir elements associated with shallow marine, deltaic reservoir types.
2. Detailed 3D facies architectural studies of small-scale, intra-well heterogeneity (cements and "stochastic" shales) in specific depositional sub-environments (e.g delta front facies) that may be incorporated into reservoir models.
3. Conceptual re-evaluations of shoreline and deltaic facies models that may be applied by geologist interpreting or correlating seismic, well log or core data.

The subsurface geologist must use facies models and sequence stratigraphic concepts to correlate well data. We show several examples of deltaic reservoirs depicted as consisting of horizontal layers (layer-cake). Our outcrop examples suggest that sandstones within the delta front dip seaward. This fundamentally challenges reservoir models that invoke flat versus dipping beds and we demonstrate how this can be applied to correlation of core and well log data sets. Our regional-scale stratigraphic results study also suggest very different exploration models in the search for basin-distal reservoir sandstones.

From the perspective of general facies models, historically, "shorefaces: have been assumed to form homogenous, uniform reservoirs that require little effort to produce. These assumptions have not turned out to be valid in the production behavior of many so-called "shoreface" type reservoirs. We show that many wave-dominated shorefaces are actually delta front deposits. Our new model for wave-influenced coastlines suggests a distinct facies asymmetry with homogenous beach and shoreface sands accumulating on the updrift side of the river mouth with significantly more-heterogenous facies on the downdrift side. We have applied this facies model to the re-interpretation of Cretaceous "shoreface" deposits in Wyoming, New Mexico, and Utah and these examples should be applicable to other subsurface deltaic reservoirs.

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Martian River Deltas and the Origin of Life

There remains significant debate as to whether there were persistent water flows, significant precipitation and standing water bodies during the early Noachian history of Mars. Recent Mars Global Surveyor (MGS) Mars Orbiter Camera (MOC) images of meandering channels associated with a Noachian-age, lacustrine delta within Holden NE Crater show evidence for persistent water flows.

The topmost layer shows clear evidence of meandering streams associated with four depositional lobes. The channels record a complex history of migration, avulsion and bifurcation, forming a distributive pattern with up to 5 orders of branching. Several channels show a distinct transition from initially straight, to highly sinuous followed by classic chute cutoffs.

Relatively smooth, and more brightly reflective layers deeper in the crater fill may represent more-flat lying lacustrine bottom sets, and could speculatively be evaporitic. The transition from smooth lower layers that lack channel belts, to straight channels to meandering channels suggest a progressive evolution of the sedimentary fill.

Our analysis of the surface features, as well as estimates of accumulation rates of the underlying 150 meters of strata within the crater fill, suggests that Holden NE Crater may have contained a lake that persisted for a few thousand to possibly as long as a few million years. This supports the hypothesis that early Mars was both warmer and wetter during the Noachian. In addition, these sediments represent a probable watery habitat that should be investigated for evidence of possible extinct Martian life.

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Education:

1989 Ph.D. - McMaster University, Hamilton, Ontario, Canada
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Experience:

2005- Professor – University of Houston
2004 Technical Program Chair - AAPG National Conference
1998-2005 Associate Professor/Professor – University of Texas at Dallas
1997-98 Senior Research Geologist - ARCO, Plano, Texas
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1989-91 Project Geologist - Alberta Research Council, Edmonton, Canada
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1981-84 Explorationist - Esso Resources Canada Ltd., Calgary, Alberta

Publications and Awards:

Authored or co-authored 40 scientific papers and over 100 abstracts.
2005 AAPG SW Section Distinguished Educator Award.
2004 Best Oral Presentation, CSPG Annual Meeting. Certificate of Merit, AAPG. Professional Service Award, Dallas Geological Society.
2002 Houston Geological Society, Best Oral Paper Award. Frank Kottlowski Memorial Presentation Award, AAPG/EMD.
2001 AAPG A.L. "Al" Cox Award, best poster.
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Research Interests:

Sequence stratigraphy of shallow marine and fluvial depositional systems, deltaic sedimentology (terrestrial and martian), reservoir characterization, interplay between structure and stratigraphy and applications to exploration and production.