HGS General Dinner Meeting

Monday, February 14, 2011

Westchase Hilton • 9999 Westheimer
Social Hour 5:30–6:30 p.m.
Dinner 6:30–7:30 p.m.

Cost: $28 Preregistered members; $35 non-members & walk-ups

To guarantee a seat, you must pre-register on the HGS website and pre-pay with a credit card.
Pre-registration without payment will not be accepted.
You may still walk up and pay at the door, if extra seats are available.

Chunming Xu
Shell

The Art and Science in the Borehole Image Interpretation of Deepwater Gravity Flow Sediments

High-resolution borehole images (BHIs) provide fine-scale rock fabric data that may be critical to the understanding of reservoir geology and production performance. However, interpreting deepwater gravity-flow sedimentary systems based on borehole images and dipmeter logs in widely spaced subsurface penetrations is often considered "artistic", particularly when the log data and/or the geology are uncertain.

In order to improve the scientific interpretation and effectively include valid geology in the reservoir models, multiple BHI interpretation case studies have been conducted for various geological objectives. These include the sedimentary environments and reservoir architectures in the oil and gas fields in the Gulf of Mexico and the Arkoma basin, Oklahoma. The integrated petrophysical and sedimentary facies interpretation of the BHI and

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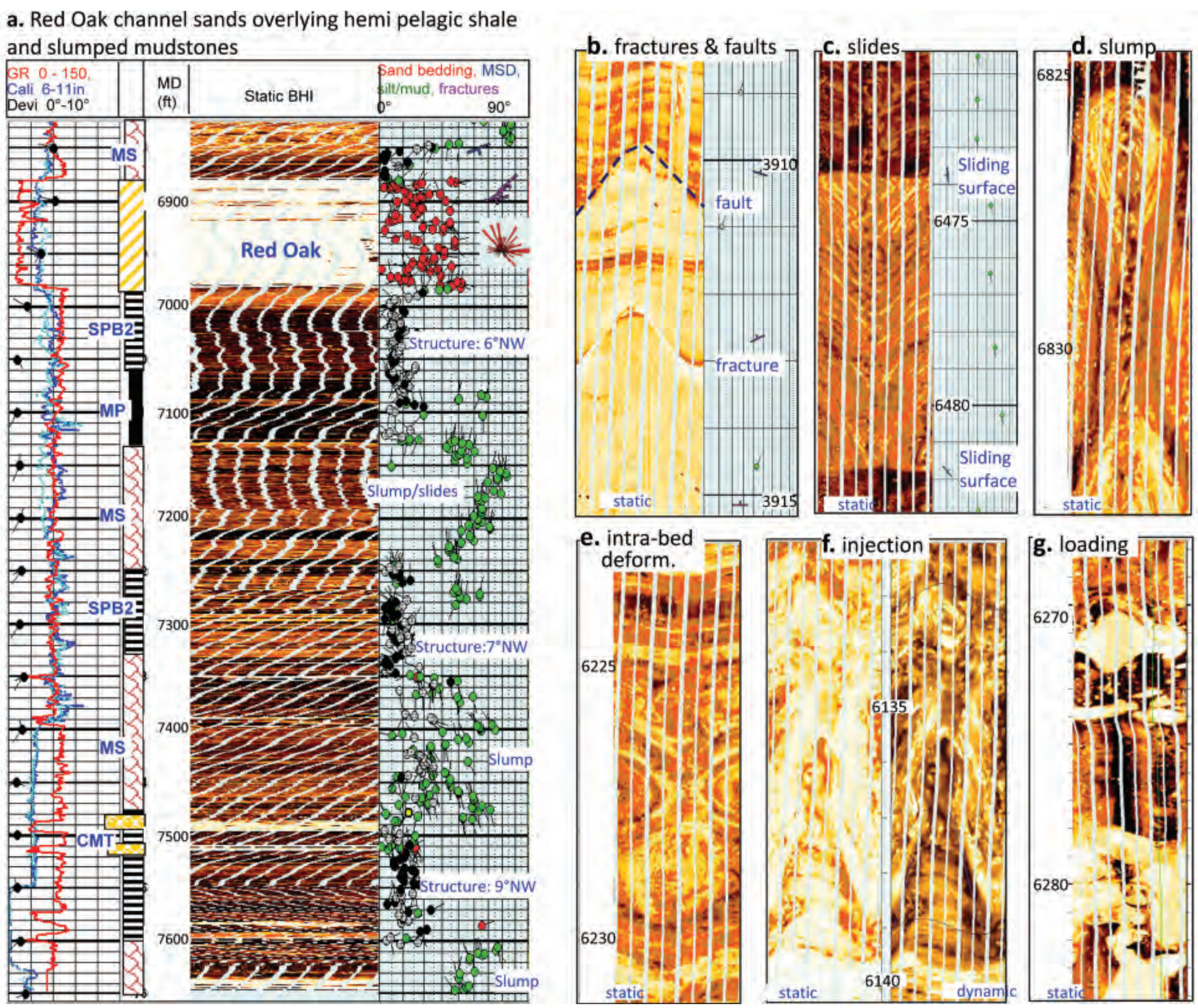

Figure 1

conventional logs were calibrated in the core wells, particularly in the Gulf of Mexico. This established the proper interpretation methodology and identified the BHI data limitations and interpretation pitfalls. This learning process is necessary to reduce the uncertainty in multi-well field studies without cores.

Some of the BHI data were independently interpreted by several BHI specialists of different backgrounds before the core calibration work. These comparisons demonstrate how the degree of art and science varies in the BHI interpretation with the interpreter more than with the data or the actual geology. Although it may be difficult to scientifically prove an interpretation correct or incorrect even with a core calibration, a good interpretation should not be judged only by its geological story but also by how transparent and adequate it is for the end-users to understand the basis of the story. Over-interpretation of the BHI data and lack of petrophysical integration are the two most common causes for poor geological interpretations.

Figure 1. Different deformation and remobilization structures in the deepwater gravity flow sediments in the Red Oak Field, Oklahoma. a) BHI interpretation in Well #6 (of the 12 wells studied) shows that the Red Oak sandstones overlie pelagic shale and slumped mudstones (mass transport). The dip results illustrate slump structures of different scales in the mudstones, but the Red Oak channel sandstones and the debrites (CMT) are not deformed. The facies symbols between the log and depth tracks are illustrated by the facies legend in Figure 2. Figures b to g are examples taken from different intervals in the same well. They are: b) post-depositional fracture and fault showing truncation of hanging wall and footwall beds; c) low-angle surfaces truncating the high-angle tilted thin-bedded sediments both above and below the surfaces, interpreted as slides; d) slumped thin-bed sediments showing an over-turned fold; e) small-scale intra-bedded soft sediment deformation; f) near-vertical sand flow penetrating the low-angle beds, possibly due to water escape or sand injection; and g) sand breccias possibly resulted from loading of in-situ sand beds into the mudstone.

Figure 2 The Red Oak channel complex in Well #1 (of the 12 wells studied) is characterized by a thin layer of channel-basal conglomerates, followed by massive clast-rich sandstones (Figure 3a) and scour-and-fill sandstones with inclined bedding (Figure 3b). Debrites and cogenetic turbidites are deposited in the middle of the channel fills (Figure 3c). The tracks are 1) GR with orange shade for sand; 2) classified facies (legend on the upper right) and measured depth in feet; 3) array induction resistivity logs (AIT) in ohmm (10 in to 90 in depth of investigation); 4) NPHI and RHOB logs; 5) static image with the darker colors presenting more conductive (muddy) lithology and lighter colors for more resistive; and 6) manually picked and classified dips (same in all other figures): inclined sand bedding dips in red, scour surfaces (yellow), shale/silt bedding and structural dip (green), deformed bedding (blue), computer-generated mean-square-dip (black), and fractures (flat "T"-shaped symbols). The black square brackets on the right side indicate the intervals with

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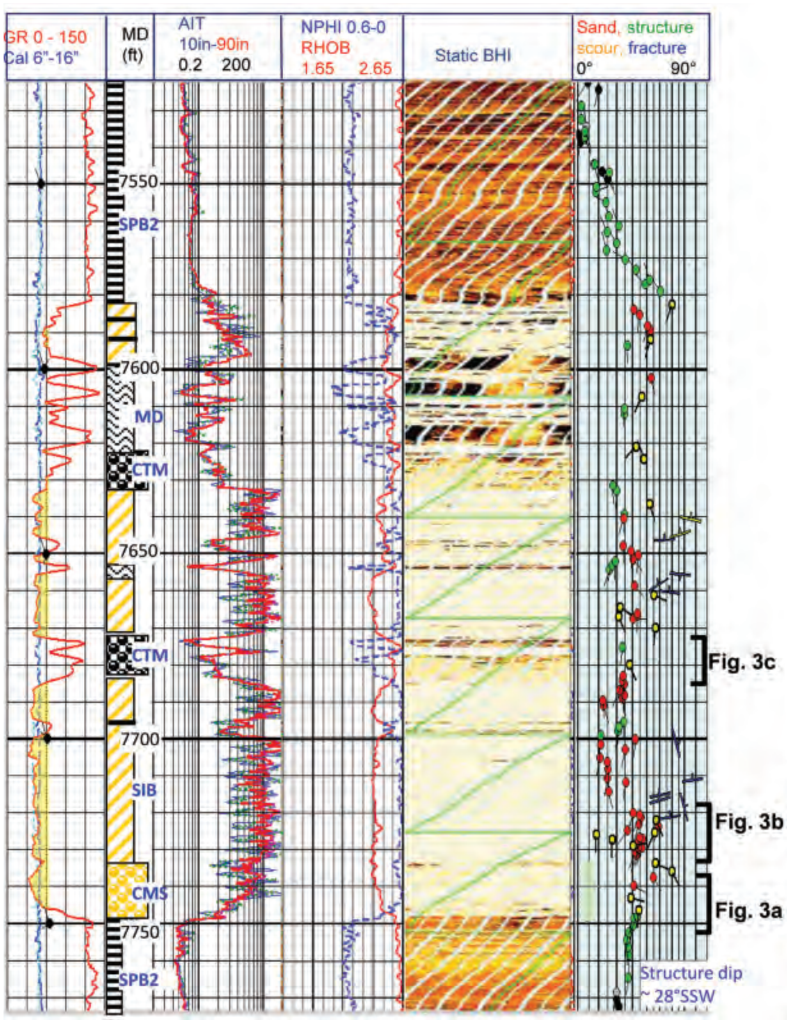

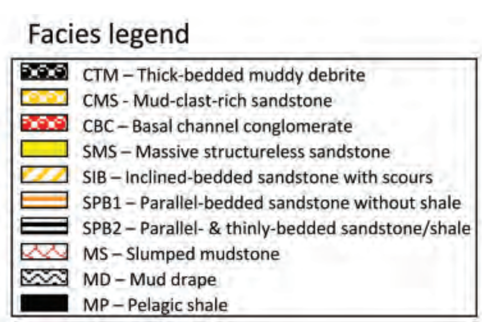

Figure 2

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enlarged figures. The structural dip is almost constant at about 28°SSW in the Red Oak interval. It is overlain by post-Red Oak muddy deposits with an upward-decreasing dip trend.

Figure 3a) The basal Red Oak channel fills of conglomerates and clast-rich conformable sandstones overlie the thin-bed levee facies. b) Stack of scour-and-fills with multiple inclined-bedding sets bounded by scour surfaces. The black scales on the right of figures 3a and 3b show the thickness variation of the massive sands and inclined-bedding sets in the scour-and-fill elements. c) A debrite layer within the Red Oak channel fills showing a muddy-upward profile and transition boundaries with the underlying and overlying co-genetic sandstones. d) Multiple thin muddy debrites and co-genetic sandstones interbedded with hemi-pelagic shales in a distal environment. ■

Biographical Sketch

CHUNMING XU has worked on geological interpretation of borehole images since 1992. After joining Shell in early 2006 as a production geologist in the Integrated Reservoir Modeling team, he has led the development and deployment of BHI technologies in global Shell.

Mr. Xu has published a number of articles on seismic interpretation of thrust tectonics, BHI log interpretation for shoreline sandstone stratigraphy, deepwater gravity flow facies characterization and sedimentology, carbonate porosity and permeability quantification, fractures, and deformation bands.

Mr. Xu received his B.S. in geophysics in 1982 from Jianhan Petroleum College, China. He spent his early ten years with PetroChina as a geophysicist working on seismic interpretation, prospect evaluation and thrust tectonics in northwestern China and the Canadian Rockies and foothills. He then worked for fourteen years with Schlumberger as a geologist before he joined Shell.

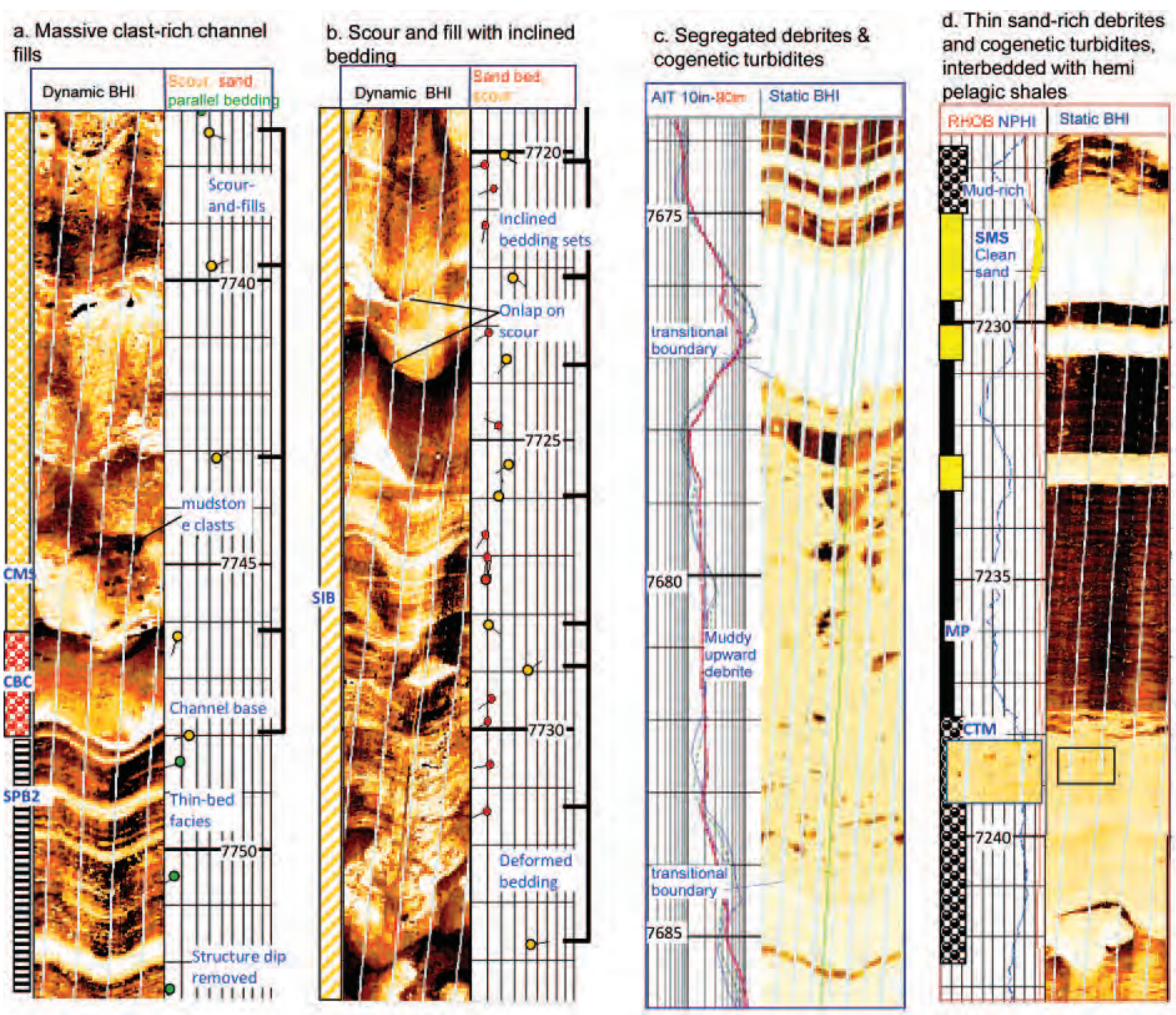

Figure 3