Hiranya Sahoo

Hiranya Sahoo is currently a Ph.D. candidate at the University of New Orleans. After receiving his M.S. degree in geology, he attended IIT, Bombay, receiving a Master in Technology degree in Geo-exploration. He was a Schlumberger fellow during this time. His dissertation research at UNO is on the sequence stratigraphy and channel architecture of the Cretaceous Blackhawk Formation in the Wasatch Plateau, Utah. A preliminary report was presented at a poster session at the 2010 AAPG. In addition to our support, Hiranya also has a graduate scholarship from the New Orleans Geological Society.

Sequence stratigraphy and coastal-plain channel architecture of the Cretaceous Blackhawk Formation, Wasatch Plateau, Utah

OBJECTIVE:

Using photomosaics, measured sections, GPR (Ground penetration radar) and LIDAR (Light detection and ranging) data, this study aims to characterize various scales of lithological heterogeneity and sequence stratigraphic variability in the coastal-plain deposits of the Cretaceous Blackhawk Formation along the eastern Wasatch Plateau, central Utah, which is an outcrop analog for producing tight-gas reservoirs in the adjacent Uinta and Piceance Basins of Utah and Colorado.

Based on initial data, the proposed research hypothesizes that coal-precursor peat compaction controls the channel amalgamation thus sweet-spot development at least at a local scale.

REGIONAL CONTEXT:

Being contiguous and perpendicular to the extensively studied Book Cliffs, the Wasatch Plateau in central Utah (Fig. 1A) superbly outcrops the Cretaceous Blackhawk Formation in a coastal-plain complex comprising fluvial-channel sandbodies encased within coastal-plain mudstones, in addition to numerous coal seams, which can be traced as caps of the basinward marine parasequences. Here, the Blackhawk Formation is generally mud- and coal-prone, and shows transition from marginal marine coastal-plain character at the lower part to more continental-fluvial nature at the upper part (e.g. Adams and Bhattacharya, 2005).

The study area is adjacent to the Uinta and Piceance Basins of Utah and Colorado (Fig. 1B) that significantly contributes to current US tight-gas production with an enormous projected resource potential (Nehring, 2008).

METHOD & PRELIMINARY RESULTS:

This high quality outcrop study will use integrated dataset including 1) detailed measured sections, 2) Cliff-face photomontages for detailed facies-architectural analysis, 3) GPR data (from behind cliffs) for investigating internal bedding geometry and continuity in 3D, 4) LIDAR data (2km-by-2km area) that will be "ground-truthed" by measured sections, to map channel-body in 3D, 5) Well logs (gamma and resistivity) from USGS and Utah Geological Survey, and 6) Subsurface coal thickness data from local coal mine companies.

Architectural element analysis (Fig. 3) on preliminary outcrop dataset collected during summer-2009 from a ~100-m-thick section along a cliff-face (~500-m of dip-section and ~150-m of strike-section, thus generating a pseudo-3D view; Fig. 2) documents well-developed, large-to-small-scale heterogeneity within and among fluvial elements that, at a larger field-scale, demonstrates spatial variability of high net-to-gross, amalgamated channel-sandbodies to low net-to-gross, isolated channel-sandbodies. Detailed sedimentological investigation (e.g. grain size, sedimentary structures, paleocurrents, trace fossils) reveals various depositional sub-environment and their paleocurrent patterns. GPR data shows internal bar-geometry within channel-fill sandbody.

Of particular interest is an initial field observation suggesting a correlation between coal and overlying channel sandbody thickness. The findings show that channels are amalgamated over thicker coals, but isolated in areas overlying thinner coals (Figs. 2 and 3). Published literatures (e.g. Hunt et al., 1996) emphasize that coal-precursor peat compaction can fundamentally affect the amalgamation of fluvial packages and their stacking pattern through differential subsidence. The high compaction-factor of coal-precursor peat can generate additional accommodation to sustain long-lived channels leading to amalgamation of channelized sandbodies (i.e. sweet spot development). Our preliminary observation supports this idea and is consistent with findings in coal-bearing basins of other parts of the world (e.g. Rajchl and Uličný, 2005; Michaelsen et al., 2000). Therefore, coal thickness variation, at a range of spatio-temporal scales, can critically control sweet spot development and other compartmentalization at the field scale. However, this is a new perspective particularly to the Wasatch Plateau and Book Cliffs that needs further investigation through comprehensive field documentation of the coal-bearing Blackhawk Formation in the Wasatch Plateau.

SUITABILITY:

1. Implications to Mississippi Delta:

The Mississippi delta, having an area of ~ 30,000 km^2, constitutes one of the largest Holocene delta plains in the world, profoundly influencing the socio-economic prosperity of southern United States (particularly the Gulf Coast region). However, some alarming observations like high sea-level rise up to 10 mm/yr, shoreline erosion, and coastal subsidence of ~ 10-15 mm/yr expose the vulnerability of this coastal region, and thus put this deltaic region on the spotlight (Shinkle and Dokka, 2004; González and Törnqvist, 2006). Recent study (e.g. Törnqvist et al., 2008) categorically emphasized peat compaction as one of the single most dominant factors for high subsidence rate of organic-rich Holocene substrate of the Mississippi delta. Therefore, coal-precursor peat compaction study and channel amalgamation in relation to coal thickness variation of the Blackhawk Formation in Wasatch Plateau will be insightful to understand the interplay between clastic sediment input and peat compaction in this deltaic region. Hence, this study can critically contribute to improved understanding of the profound stratigraphic complexities linked to peat compaction that can significantly help in coastal restoration and planning program in Louisiana and the Gulf coast region.

2. Relevance to tight-gas reservoir development and production:

Fundamental to improved exploration and exploitation strategy of tight-gas reservoirs is the critical assessment of their reservoir heterogeneity that constrains them as subtle, low net-to-gross, and highly compartmentalized reservoirs (Schmoker, 2002). The preliminary dataset captures this heterogeneity, and thus illustrates the first-approximation for subsurface tight-gas reservoir development and production (Fig. 3). As a suitable reservoir analog, this proposed research, which aims to yield more sedimentologic and stratigraphic details, will offer new insights to tight-gas prospect evaluation and production, particularly for the adjacent Uinta and Piceance Basins that constitute one of the core areas of significant unconventional gas production from tight-gas reservoirs in US (Nehring, 2008).

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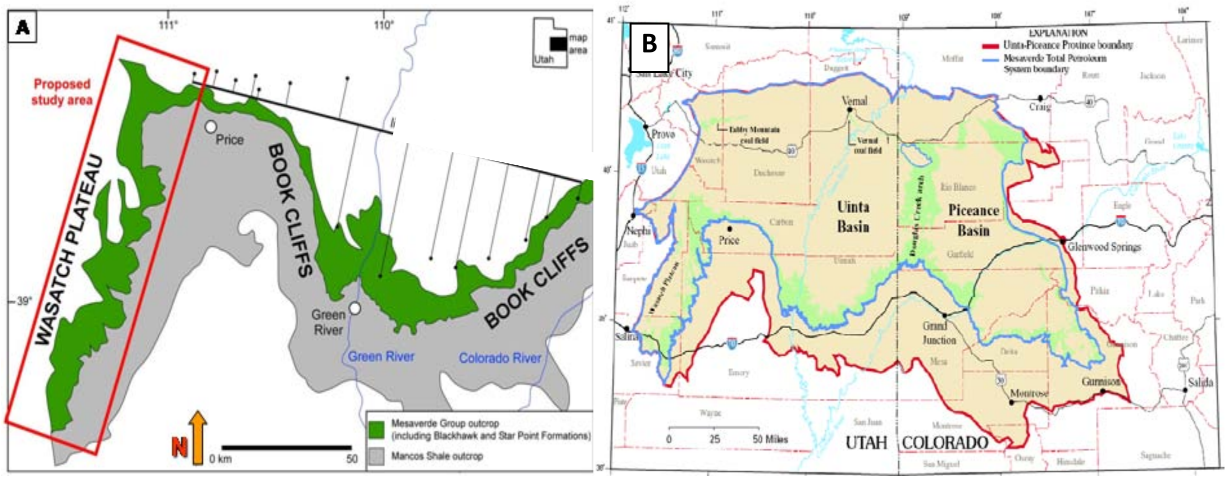

Figure 1. A) Location of study area marked as red box in the Wasatch Plateau orienting perpendicular to the Book Cliffs in central Utah. The Upper Cretaceous Blackhawk Formation (belongs to Mesaverde Group, green color) has been outcropped in the study area. **B)** Map showing the location of study area (Wasatch Plateau, southwest of the map) adjacent to the Uinta and Piceance Basins in the Uinta-Piceance Province of Utah and Colorado. Note that shaded green color illustrates Mesaverde Group outcrops in the Wasatch Plateau, Uinta, and Piceance Basin.

Figure 2. Photomosaic of cliff section in the depositional dip direction, Cottonwood Creek, Wasatch Plateau, Utah. The superbly exposed section shows amalgamated to isolated sandbody and their geometry. Note the coal layers at the lowermost part of the section.

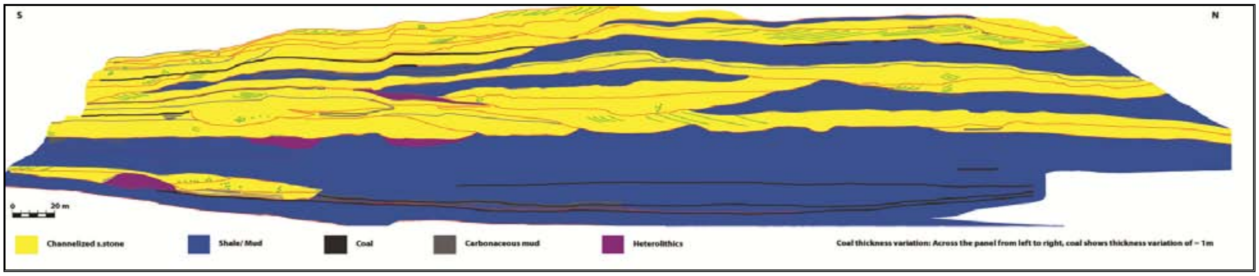

Figure 3. Bedding diagram of above cliff section in fig. 2. In lower part of panel, coal layer (black color) on left side is 1.8 m thick that gradually thins to 1 m at rightmost side (variation of 0.80 m across the panel). Panel demonstrates high net-to-gros amalgamated channel sandbody (yellow color) at left to low net-to-gross isolated sandbody (yellow color) towards right. This indicates that channel amalgamation is likely controlled by underlying coal-precursor-peat compaction.