[PS]Sequence Stratigraphic Approach on a Prograding Shoreline Sequence*

Senthil Velan Yuvaraj[1] and J.E. Evans[1]

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[1]Geology, Bowling Green State University, Bowling Green, OH. (ysenthilvelan@gmail.com)

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Abstract

The Pictured Cliffs Sandstone (Upper Cretaceous) of the northern San Juan basin (southwestern Colorado) shows multiple transgression-regression cycles. The stratigraphic section shows seven sets of parasequences within a mega-sequence. These parasequences are up to 25 m thick and are identified mostly as prograding storm-dominated shoreface. These parasequences consists of three meso-scale sequences: a) offshore turbidite sequence b) offshore transition zone distal tempestite sequence and flood deposits c) shoreface swaly stratified sandstone or amalgamated tempestites and cross-bedded sandstone. The meso-scale sequences consist of 11 different architectural elements, which can be further classified into 4 distal tempestite elements, 3 proximal tempestite elements, 4 turbidite elements, 1 flood deposit element, and 1 tidalite element.

The sand bodies in each of these parasequences show coarsening- and thickening-upward sequences representing shift in environment from deep-water to shallow-water environment representing high-frequency transgressive episodes. These are identified by systems tracts and stratal surfaces recognized in the outcrop section. The Pictured Cliffs Sandstone mostly represents HST, which are recognized by overall shallowing-upward sequence. TST (recognized by deepening-upward sequence) and LST (recognized by reworked delta platform) are also identified in the outcrop section.

Four well data (2 well core and 3 well log data) were analyzed to determine the subsurface lithofacies. Gamma-ray and density log from Well-1 were calibrated using well core data. Log patterns and trends were determined for gamma-ray logs to provide insights on facies assemblages and depositional environments. The well logs and outcrop section were correlated using pattern matching technique. Similar parasequences found in the outcrop study were also identified in the gamma-ray logs. In general, these well data show good correspondence with outcrop section with the exception of 1 well data. This suggests variations in thickness and continuity of sand bodies both parallel and perpendicular to the transgressive shoreline.

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Senthil Velan Yuvaraj and James E. Evans

Department of Geology, Bowling Green State University, Ohio 43403

Introduction

The Pictured Cliffs Sandstone (Upper Cretaceous) of the northern San Juan basin is interpreted as a prograding shoreline sequence deposited during the last regression of the Western Interior Seaway. Stratigraphic sections show multiple sets of parasequences, each representing a shift in environment from deep water to shallow water. In these instances, sequence stratigraphic approach using architectural element analysis reveals transgressive-regressive cycles within the Pictured Cliffs Sandstone due to complex interaction between eustasy, tectonics, and sediment supply. The basin-scale architecture, continuity, and variation in thickness of the sand bodies were determined using well data south of the exposed outcrop.

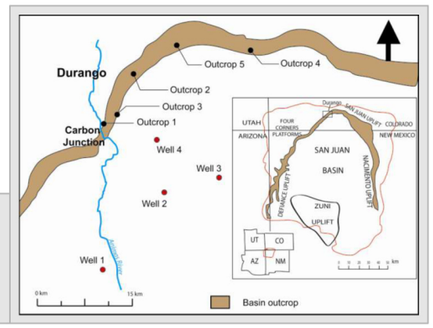

Figure 1. Study area showing the outcrop sections and well locations, and structural features in San Juan Basin. Modified from Law (1992).

Methods

- Identifying bounding surfaces and classification of architectural elements
- Identifying and interpreting parasequences by grouping meso-scale sequences
- Calibration of well logs using well core and correlation of well logs by identifying patterns
- Interpreting systems tracts and stratal surfaces in outcrop section and well logs

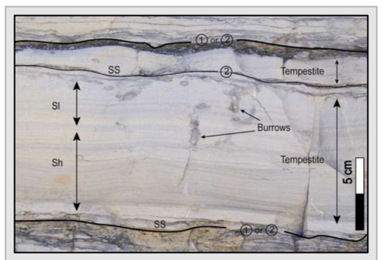

Figure 2. Photograph of a tempestite architectural element observed in the field. Numbers in circle represent the order of bounding surfaces.

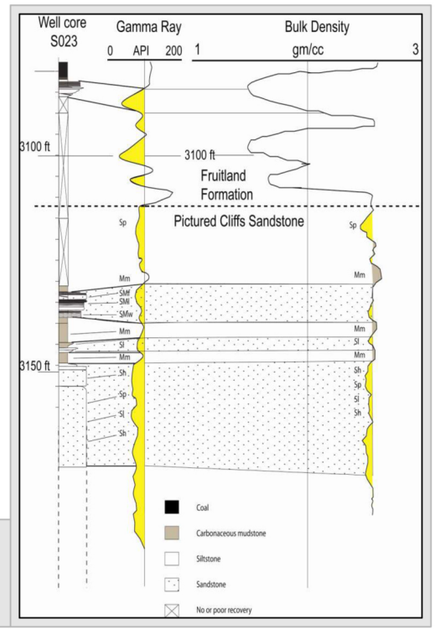

Figure 3. Calibration of the subsurface facies model by matching well core data to the gamma-ray and density log of Well 1.

Results

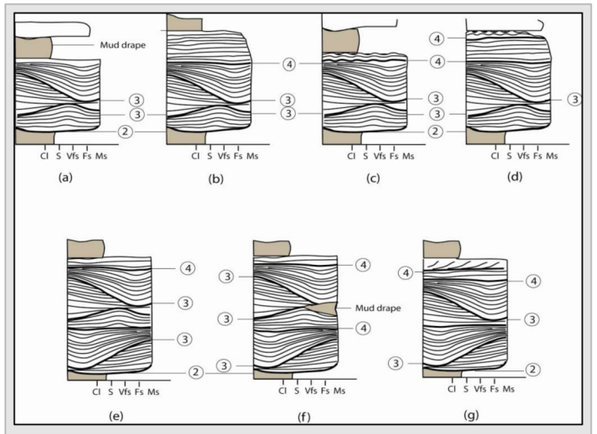

Figure 4. Variation in tempestite assemblage (classification of architectural elements). The numbers in the circle represent the order of bounding surfaces. Distal tempestites shown in a – d. Proximal tempestites shown in e – g. Figure not to scale.

- Eleven architectural elements are identified based on bounding surfaces and variations in lithofacies assemblages.
- Three meso-scale sequences are identified representing a) offshore, b) offshore transition zone, and c) shoreface.
- Seven sets of parasequences are identified in the outcrop section mostly representing highstand systems tracts.

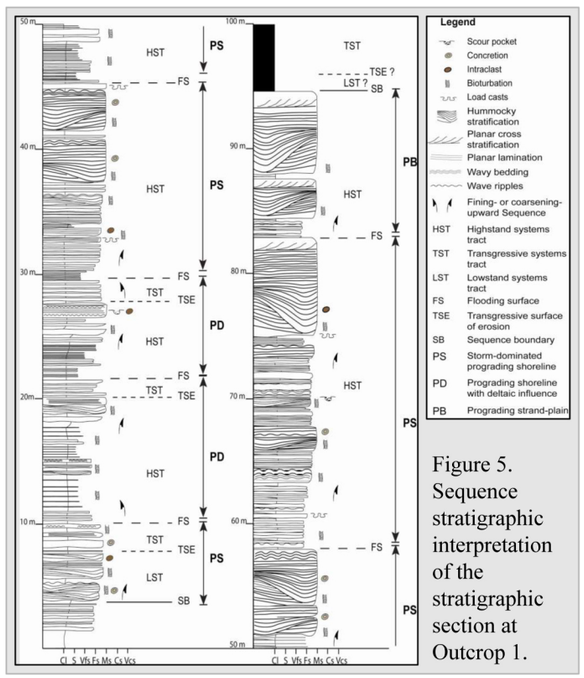

Figure 5. Sequence stratigraphic interpretation of the stratigraphic section at Outcrop 1.

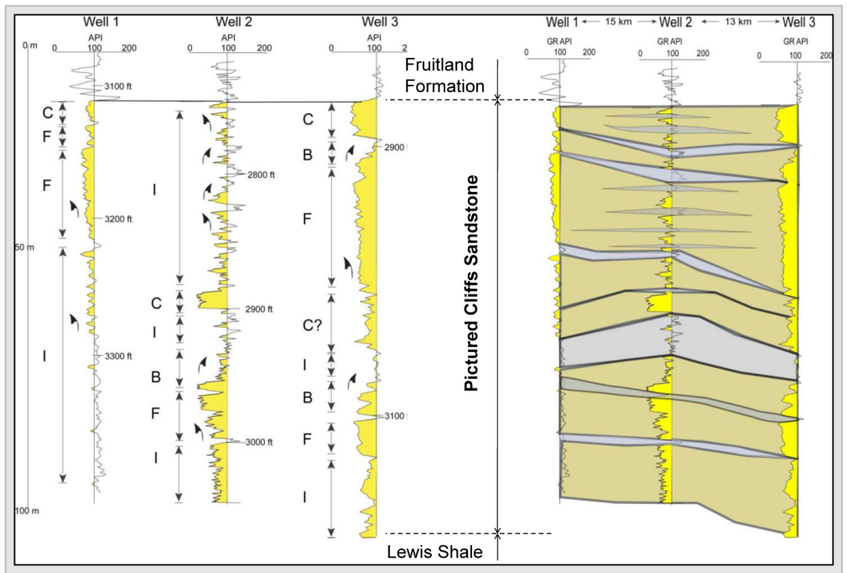

Figure 6. Gamma-ray logs from Wells 1, 2, and 3 with log patterns defined (left) and correlated using the patterns (right). Key to symbols: C=Cylindrical, B=Bell, F=Funnel, I=Irregular, Yellow = sand bodies, Tan = Correlation of sandstone, Grey = Shale.

- Well 1 and 3 show a general funnel shaped pattern which represents shallowing-upward or highstand systems tracts, and the bell shaped patterns represent transgressive systems tracts.
- The abrupt tops in these patterns represent flooding surfaces.
- Well 2 mostly show irregular pattern representing high variability in the continuity of these systems tracts and stratal surfaces.

Conclusion

- Stratigraphic sections of the Pictured Cliffs Sandstone show seven sets of parasequences within one mega-sequence.
- Parasequences are interpreted to be storm-dominated prograding shorelines with distal-deltaic influence.
- Sequence stratigraphy reveals multiple sets of highstand systems tracts and flooding surfaces which represents multiple transgressive-regressive episodes within a prograding shoreline sequence.
- Well log correlation suggests that these systems tracts are discontinuous across the basin and show high variability in thickness.

Acknowledgments

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