Scales of Connectivity: Strategies for Modeling Source to Sink Pathways and Sand Body Distribution across Linked Depositional Systems*

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Abstract

This research presents a multi-scale model coupling linked nonmarine-shallow marine systems using the Cretaceous outcrops in southern Utah, USA (John Henry Member of the Straight Cliffs Formation, Kaiparowits Plateau; Figure 1). The Cretaceous Western Interior Basin of western North America is commonly cited as an archetype ancient retroarc foreland basin. At least parts of this basin, including the study area, represent somewhat atypical conditions of high sediment supply balanced with overall high accommodation. Multiple studies have documented the complex evolution of distinct but linked depositional systems in the study package. Key sedimentary facies include thick, regressive shoreface parasequences in close association with transgressive tidal and lagoonal facies, coal mires and estuarine facies, and fluvial systems characterized by highly variable lateral and vertical stacking patterns (Figure 2).

Discussion

In an initial analysis of possible approaches to modeling at the basin scale, we investigate gross sediment volume partitioning through time as compared to predictions from sequence stratigraphic and basin evolution models. This first-order analysis includes preliminary evaluation of what 'rules' and variables control sediment partitioning along linked depositional systems. We then address how these controls might serve as inputs for modeling of source to sink relationships in ancient systems, with implications for petroleum systems including improved prediction of migration pathways and key reservoir facies.

The second phase of research employs preliminary models that builds on the analysis of what 'rules' and variables control sand partitioning within and across distinct but linked depositional systems in this ancient foreland basin. We begin with a reservoir scale model of the sand distribution in the fluvial-dominated outcrops. This reservoir scale model is then coupled with downstream tidally influenced channels and shallow marine deposits in part controlled by varying shoreline trajectories. The objectives of this modeling study are to reconstruct 'source to sink' relationships and dynamics of sediment transport and storage mechanisms within the basin, to assess regional connectivity of sand bodies, and the potential impact on basin-wide fluid migration.

Reference Cited

Shanley, K.W., and P.J. McCabe, 1993, Alluvial architecture in a sequence stratigraphic framework; a case history from the Upper Cretaceous of southern Utah, USA, *in* S.S. Flint, and I.D. Bryant, (eds.), The geological modeling of hydrocarbon reservoirs and outcrop analogues: Special Publication of the International Association of Sedimentologists, v. 15, p. 21-55.

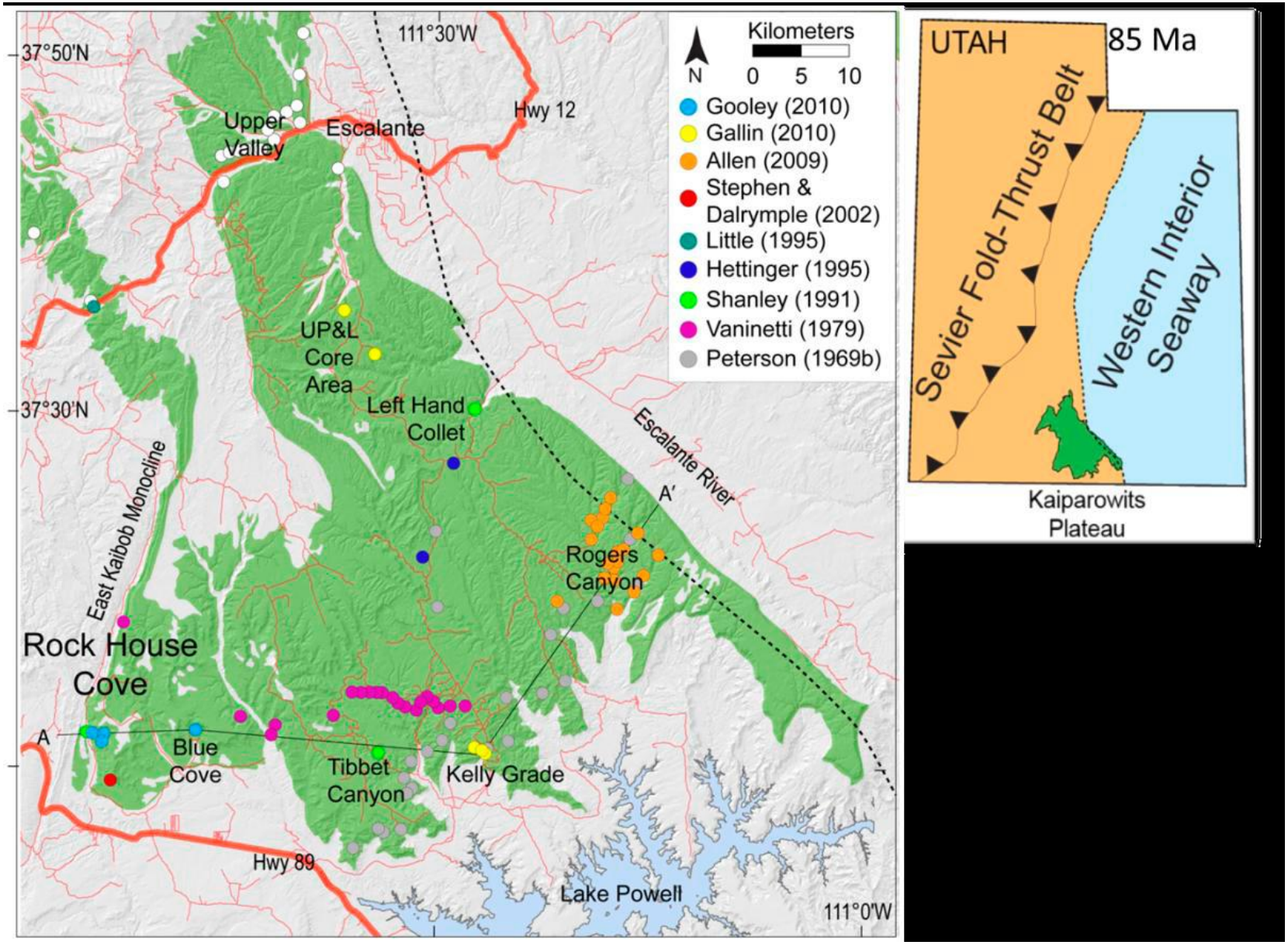

Figure 1. Location map of the Kaiparowits Plateau, outcrops of the Straight Cliffs Formation shown in green. Field areas including previous work are highlighted with dots. Cross Section from A-A' shown in Figure 2.

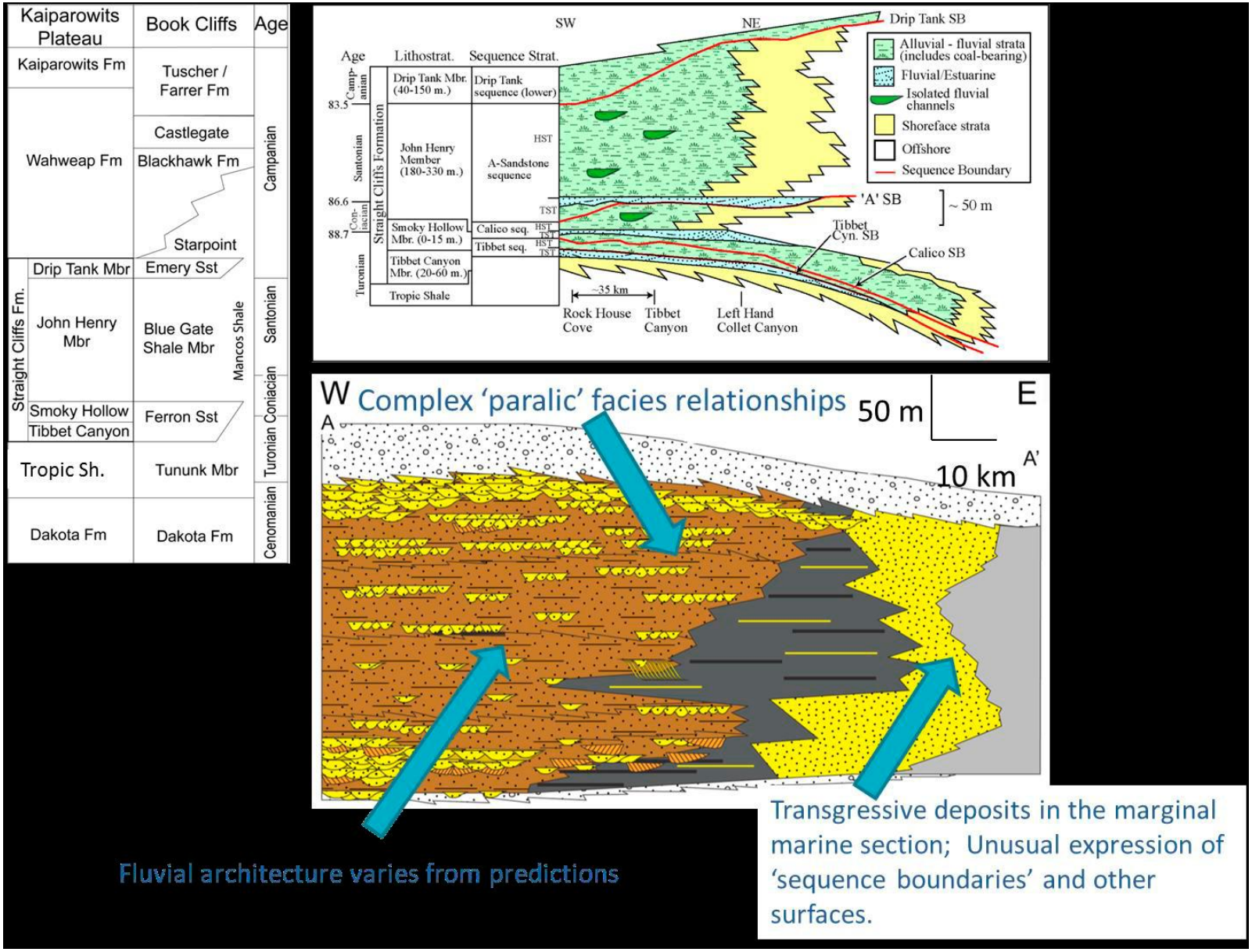

Figure 2. Stratigraphy of the Straight Cliffs Formation, top right after Shanley and McCabe (1993); bottom right from this study.