Facies Reconstruction of the Ingleside and Casper Formations: a Mixed Carbonate-Siliciclastic System*

Kajal Nair¹, Sven Egenhoff¹, and John Singleton¹

Search and Discovery Article #51447 (2017)**
Posted December 26, 2017

*Adapted from poster presentation given at AAPG Rocky Mountain Section Annual Meeting, Billings, Montana, June 25-28, 2017
**Datapages © 2017 Serial rights given by author. For all other rights contact author directly.

¹Colorado State University, Ft. Collins, CO, United States (kajaln@colostate.edu)

Abstract

The mixed carbonate-siliciclastic succession of the Pennsylvanian-Permian Ingleside and Casper Formations were deposited along the flanks of the Ancestral Front Range because of Late Paleozoic tectonism and eustatic sea level changes. Extending from central Colorado to southeastern Wyoming, the Ingleside and Casper Formations are composed of carbonate intervals representing relative sea level rises and siliciclastic intervals representing relative sea level falls. Outcrop and drill core data from the Ingleside and Casper Formations were combined to measure fourteen stratigraphic sections. A north-south transect of the measured sections extends from Albany, Wyoming south to Boulder, Colorado. East-west transects extend within Albany, Wyoming and from Larimer, Colorado east to Welds, Colorado. General thickness of the formations increases towards the north and east. Stratigraphic intervals vary laterally from intervening carbonates and siliciclastics in the north to pure sandstones in the south. Deepening upwards carbonate facies transitioning from grainstones to mudstones represent a marine environment. Siliciclastic facies transitioning from shallow-marine massive sandstones to eolian cross-bedded sandstones represent an increasingly arid environment. Laterally continuous shale stringers lie adjacent to shelf carbonates and shoreface cross-bedded sandstones. Pure carbonate or siliciclastic units are rare, with siliciclastic grains observed in carbonate beds and carbonate components observed in siliciclastic beds. Mixing of the two sediment components indicates a constantly active carbonate factory. The model explaining carbonate-siliciclastic mixing in this system therefore differs from the common reciprocal sedimentation model, which suggests the complete cutoff of carbonate production during lowstand periods. The results of this study can be used to produce an idealized depositional model to facilitate field recognition of an environment that consists of an eolian dune field extending into a siliciclastic foreshore, a transitional shoreface, and an offshore carbonate ramp. This model will contain regressive siliciclastic facies and transgressive carbonate facies, with eolian sandstones representing maximum regressions and basinal shales representing maximum transgressions. Proximal eolian sandstones have been productive in the Casper Formation and would hold the maximum reservoir potential in such a system because of high intergranular porosities and permeability.

References Cited


Facies Reconstruction of the Ingleside and Casper Formations: a Mixed Carbonate-Siliciclastic System

Kajal Nair, Sven Egenhoff, John Singleton
Colorado State University

Abstract

The mixed carbonate-siliciclastic succession of the Pennsylvanian-Permian Ingleside and Casper Formations was deposited along the flanks of the Ancestral Rocky Mountains in southwestern Wyoming. Offshore carbonate mudstones were deposited in the trough or basin, while siliciclastic sandstones were deposited in nearby intervening shelf areas. Outcropping and drill core data from the Ingleside and Casper Formations were combined to measure thirteen stratigraphic intervals that extend from Owl Canyon, Wyoming south to Rosedale, Colorado. East-west transgressions are observed within the Ingleside, Wyoming and Casper, Colorado areas. Thicknesses of the formations are variable and range from 150 m to 300 m. Deepening intervals contain regressive siliciclastic facies and transgressive carbonate facies, with eolian sandstones representing maximum regressions and carbonate mudstones representing maximum transgressions. Proximal eolian sandstones would likely be cemented and result in tight reservoirs. Carbonate mudstones to wackestones, typically displaying isolated cavities that are partially or completely filled with cements or exudate minerals.

GEOLOGICAL BACKGROUND

The Ancestral Rocky Mountain deformation along western Laurinea occurred as a result of intercontinental stresses associated with the subduction of the western margin of Laurinea beneath Gondwana. Synchronous with the tectonism, the Late Paleozoic was a time of southern hemisphere orogeny, which contains widespread Ordovician-Devonian igneous rocks. Major river or wind systems were carrying sediments westward across the North American continent from the Appalachians. This was accompanied by a fall in relative sea level and a gradual change in climate from humid with alternating semi-arid intervals to more arid conditions. Climate at this time resulted in deposition of cross-bedded, eolian sandstones that make up the upper parts of the Ingleside and Casper Formations.

DETRITAL ZIRCON GEOCHRONOLOGY

Sandstone samples were collected from the base and top of the Ingleside Formation at the Owl Canyon sections for zircon geochronology. U-Pb analyses of detrital zircons demonstrate that the provenance of sandstones varied significantly, with 2400-2700 Ma and 1500-1800 Ma being the dominant ages derived from the sandstones. This suggests that the older grains were likely shed from anerial dust deposition, while the younger grains were derived from more recent sources. The presence of older detrital zircon populations suggests that the Ingleside Formation was deposited in a mixed carbonate-siliciclastic system.

OBJECTIVES

- Develop a detailed depositional model for the Pennsylvanian-Permian Ingleside and Casper Formations in order to predict carbonate production and sandstone distribution patterns in this sedimentary system.
- Determine how levels changes affect the system and could influence reservoir geometries in similar mixed systems.
- Identify sources of the sandstones that make up the Ingleside Formation using detrital zircon geochemistry.

FACIES ASSOCIATIONS

- **Eolian Sandstones**: Trough cross-bedded sandstones showing high-angle dips and climbing translatent stratification.
- **Foreshore Deposits**: Thin-bedded sandstones showing horizontal stratification.
- **Shoreface Deposits**: Massive, bioturbated sandstones.
- **Shallow Marine Shales**: Siltstone with some siliciclastic and fossil content, and an infilled vug.
- **Offshore Carbonate Mudstones and Packstones**: Dark red, Anisotropically bedded siliciclastic mudstones.
- **Offshore Carbonate Grainstones and Packstones**: Cross-bedded carbonates with abundant bioclasts, indicating a mixed carbonate-siliciclastic system.
- **Offshore Carbonate Mudstones**: Massive, bioturbated sandstones.
Facies Reconstruction of the Ingleside and Casper Formations: a Mixed Carbonate-Siliciclastic System

Kajal Nair, Sven Egenhoff, John Singleton
Colorado State University

Stratigraphy
The base of the successions are generally identified by a decrease in grain size as the coarse gravelly substrate deposits of the Muir Formation grade into fine grained, mixed carbonate-siliciclastic deposits. Offshore carbonate deposits range from fossiliferous granules and packstones to pure muds. Fossil content in the carbonates units increases towards the southeast. In general, carbonate units are more mud-rich and less problematic for recovered algal fossils. Recently, some of the stratigraphic units have been reinterpreted as high energy deposits with wave and tide sandbars within the succession, often extending for several miles and extending across two or three formations.

The top of the successions are marked by a carbonate-mudstone interval that suggests changes in the Grotton Formation. South of the Clovis area, the top of the successions are marked by either sandstone or sandy breccia conditions.

Acknowledgments
Many thanks to Christine Keene-Demars at the USGS Denver for insights into the special section geochronology project and for providing me with CL images of the Grotton cycles. E would like to express my deep appreciation to John Singleton for his support and encouragement throughout this study. Also, thanks to Andy Ausin, Evan Strickland, and Karlee Schuler for being the most enthusiastic field geologists and assiduously with me for field work for this study. I am deeply grateful to Mike Bemмер for all her efforts in ocean geochronology, and thank spoon and John Singleton for their constant support during the study.

References