

# ***Collation and Synthesis of Five Projects in the Mississippian Madison Formation***

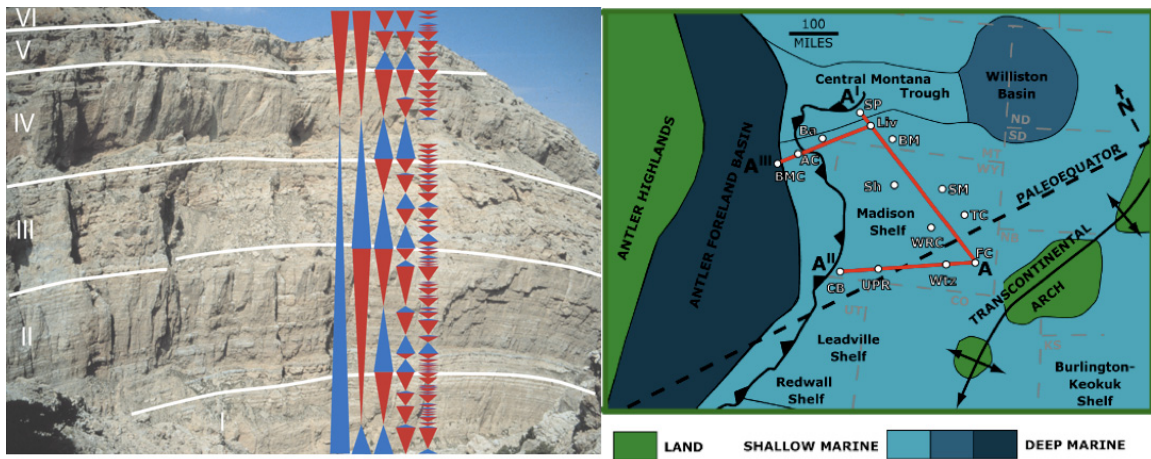
*Gregor P. Eberli and Peter K. Swart based on the studies and in collaboration with Layaan Al Kharusi, Matthew R. Buoniconti, David A. Katz, Langhorne "Taury" Smith, and Hildegard Westphahl*

## **Project Objectives**

- Integrate the results of the sedimentologic, sequence and chemo-stratigraphic and tectonic analyses for a comprehensive model of the Madison ramp.
- Relate the results of the large regional studies to potential exploration plays and summarize the implications of local heterogeneities to production scale problems in the Madison ramp and carbonates in general.
- Outline the distribution, genesis, and petrophysical variability of reservoir quality dolomite within the Madison Formation.

## **Rationale**

Taking the results of Sonnenfeld (1996) as a starting point, the CSL conducted five major studies in the Mississippian Madison Formation that addressed questions regarding a) the evolution of a carbonate ramp in a foreland basin setting, b) the sequences stratigraphic architecture in response to eustasy and diachronous subsidence, c) the formation and distribution of early and late diagenetic products in particular of reservoir-quality dolomite on the Mississippian ramp, d) causes and controls on petrophysical and reservoir heterogeneities within outcrop analogs and subsurface strata, and e) the relationship between high-resolution sequence stratigraphy and fracture patterns. The



*Figure 1. (Left) Madison Formation at Sheep Mountain Anticline with third-order sequence boundaries in white and the different orders of sequence stratigraphy indicated in transgressive (blue) and regressive (red) hemicycles. (Right) Location of the studied sections (white dots) and the regional cross-sections (red lines) constructed by Matthew Buoniconti and David Katz for the tectono-stratigraphic and geochemical investigations of the Madison shelf strata.*

studies produced a wealth of results that are published in three dissertations, five journal publications numerous abstracts. Integrating the data sets is expected to reveal additional interconnections of processes and improve the results of the individual studies.

## Overview of the Completed Studies

Matt Buoniconti extended the established sequence stratigraphic framework of the Madison Formation of Wyoming to the correlative Mississippian carbonate ramp, ramp margin, and basin strata of the central Montana trough and Antler foreland basin. The integrated sequence stratigraphy and geochemistry study of David Katz (2008) improved our knowledge of the formation and distribution of early and late dolomite. He traced the

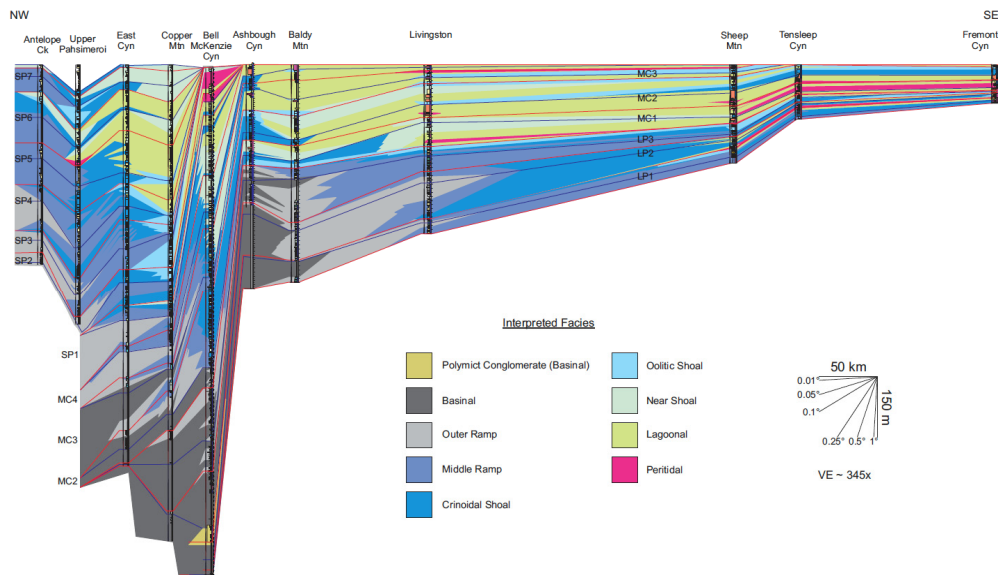


Figure 2. Super-regional cross-section from extreme updip localities in Wyoming to extreme downdip locations in the Antler foreland basin of Idaho illustrating the overall architecture of the Madison Group and succeeding Scott Peak succession (Buoniconti 2008).

secular variations in the  $\delta^{13}\text{C}$  values across the Madison shelf and refined the stratigraphic correlation between the measured sections. The detailed reservoir characterization by Westphal et al (1999) show how reservoir quality dolomite is related to the regional high-resolution sequence stratigraphic framework and how late stage hydrothermal diagenesis introduces lateral heterogeneity. Smith et al. (2004) explored this relationship in an exploration-scale study by testing the hypothesis that the reservoir quality dolomite occurs preferentially in the transgressive portions of sequences and cycles. Layaan Al-Kharusi (2009) documented how the fracture pattern also follows the high-resolution sequence stratigraphic framework.

## Scope of Work

Although each of the studies in the Madison relied on the results of earlier and contemporaneous studies, the strength of all these data sets becomes clear after the completion of the three dissertations. In addition, rocks and samples collected in the studies described above were exploited in subsequent studies, in particular for petrophysical analysis of dolomites. These spin-off studies include the influence of the

dolomite texture on acoustic velocity and the examination of porosity and permeability of the dolomites and coeval limestones. Some of these studies are published but some are not. There is a need to collate all the publications and reports. Thus, we plan to produce a Sedimenta CD with all this information. To facilitate the navigation to the different findings, a synthesis of the results will be included that will summarize and highlight the major results. Furthermore, a reference list of all publications that were produced by other groups during the last 10 years will be included to provide a comprehensive overview of the current knowledge of the Mississippian strata on the Madison shelf.

### **Deliverables**

A volume of the Sedimenta Series on the Madison shelf with:

- a) all the publications and dissertations of CSL students and scientists over the last 10 years,
- b) a synthesis paper summarizing the results and implications, and
- c) a comprehensive reference list of all the papers published in the last 10 years on the Madison.

### **References**

Al-Kharusi, L.M., 2009, Correlation between High Resolution Sequence Stratigraphy and Mechanical Stratigraphy for Enhanced Fracture Characteristic Prediction. Unpub. Ph.D. dissertation, University of Miami, Coral Gables, 158pp. <http://etd.library.miami.edu/theses/available/etd-11162009-190652/>

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