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Stable Carbon Isotope Chronostratigraphy of Dolomitized Reservoirs from Outcrops and Subsurface Core of the Mississippian Madison Limestone, Wyoming and Montana

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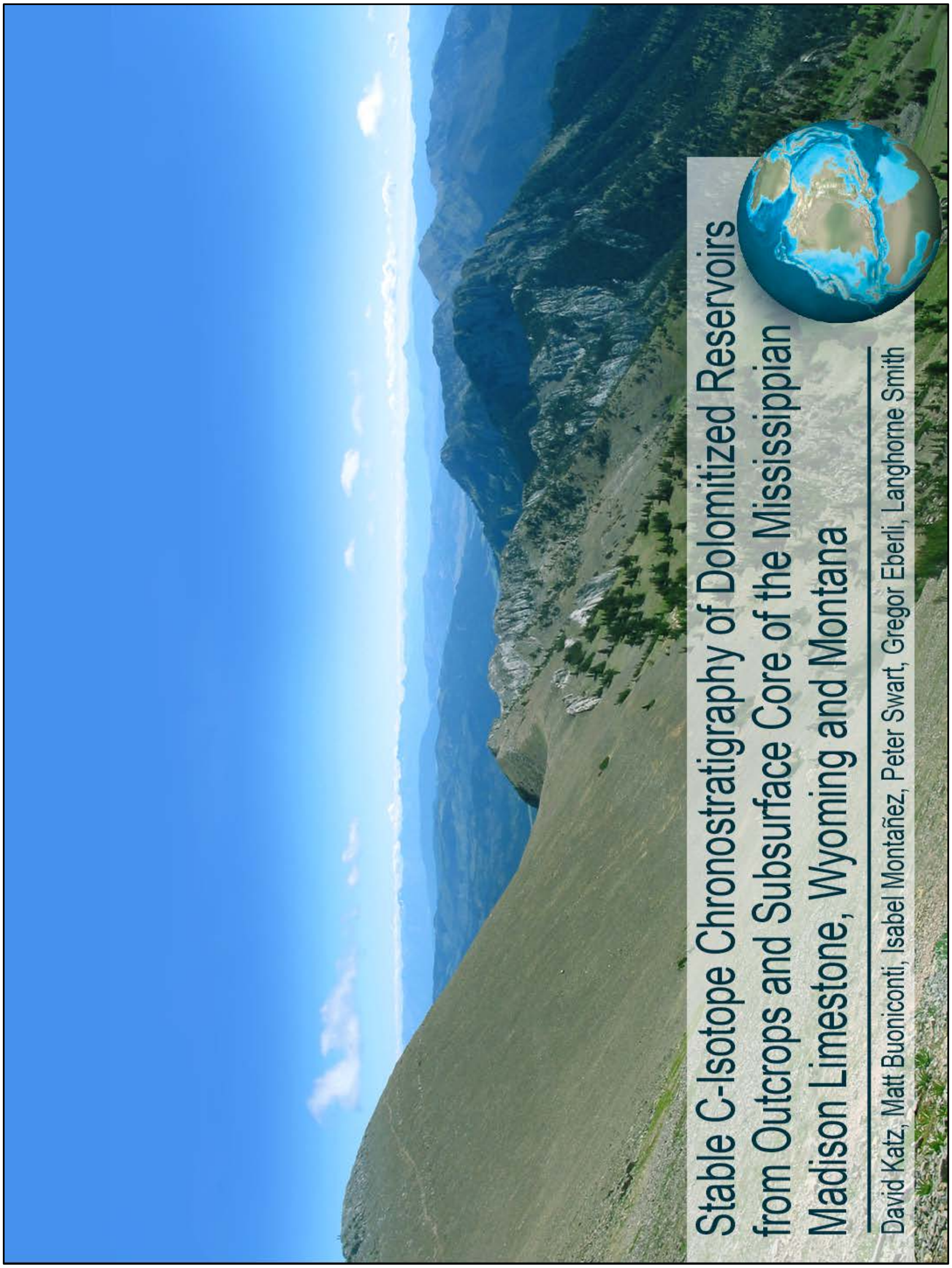
ABSTRACT: Coupling of carbon isotope stratigraphy with strontium isotope analysis and biostratigraphy of the Mississippian Madison Limestone defines a chronostratigraphic framework that constrains surface to subsurface high-resolution sequence stratigraphy and provides considerable insight into the nature, origin and evolution of facies variability across the Madison ramp in dolomitized reservoirs during the Early Mississippian. The $\delta^{13}C_{carb}$ values from twelve outcrop and three subsurface cores distributed across inner ramp to slope facies exhibit an overall rise and subsequent fall throughout the Kinderhookian and lower Osagean reaching maximum values of up to +7.5‰ PDB; these secular variations have also been correlated with the same values documented from lower Mississippian successions in Belgium and the Urals. The peak in $\delta^{13}C$ values coincides with least radiogenic carbonate $^{87}Sr/^{86}Sr$ values near the Kinderhookian-Osagean transition and is defined as a maximum flooding surface. Several shorter-term fluctuations in δ^{13}Ccarb values are superimposed on this longer-term trend and are also recorded in subsurface carbonates of the inner Madison ramp.

We interpret the long-term increase of the $\delta^{13}C$ values and coincident decrease of the $^{87}Sr/^{86}Sr$ as a product of increased productivity and preservation of organic matter in ocean basins with decreased continental weathering rates due to flooding of previously exposed land masses during sea-level rise. The subsequent decrease of $\delta^{13}C_{carb}$ values and concomitant increase of the $^{87}Sr/^{86}Sr$ are interpreted as a product of limited productivity and oxidation of organic matter with accelerated continental weathering rates due to exposure of land masses during sea-level falls.

There is also a local transramp spatial variation of the $\delta^{13}C_{carb}$ which is attributed to increased environmental restriction proximal to land, suggesting that facies of the inner ramp were covered by stranded and aged water masses with the potential for dolomitizing massive volumes of sediment across hundreds of kilometers. Nevertheless, the secular variations in seawater $\delta^{13}C$ have been successfully applied as a chronostratigraphic tool to subsurface core which has resulted in considerable improvement of our knowledge regarding the lateral distribution and timing of depositional facies and evolution of dolomitized Madison reservoirs.

Speaker Biography: David received his Bachelor's Degree in Geology from Hamilton College, Upstate New York where he then decided to pursue a Master of Science in Modern carbonate diagenesis and geochemistry at the Colorado School of Mines. For his PhD at the University of Miami's Rosenstiel School of Marine and Atmospheric Science he focused on the integration of carbonate diagenesis and geochemistry with sequence stratigraphy and sedimentology of the Mississippian Madison Limestone; his thesis focused on three aspects of the Madison, 1) hydrothermal diagenesis associated with degradation of reservoir quality around Laramide basin margins, 2) application of C-isotopes as a chronostratigraphic tool, and 3) geochemical origins of porous dolomite reservoirs. David spent his first 7 years of employment with the Carbonate Research and Development Team and Carbonate Technical Services Team at Chevron's Energy Technology Company in San Ramon, CA where he focused on development geology and reservoir characterization of Pricaspian Basin Supergiant conventional carbonate fields. He now works for Whiting Petroleum Corporation in Denver, CO as Senior Petrographer and Sedimentologist; current projects include reservoir characterization of the Bakken and Three Forks Formations, and the Permian Basin. He is also responsible for helping coordinating activities and maximizing the capabilities of Whiting's Rock Laboratory.



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