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Integrating bio-, chemo- and sequence stratigraphy of the Late Ordovician, Early Katian: A connection between onshore and offshore facies using carbon isotope analysis: Kentucky, Ohio, USA

Allison Young (1), Carlton Brett (1), and Patrick McLaughlin (2)

(1) Department of Geology, University of Cincinnati, United States (younga9@mail.uc.edu), (2) Indiana Geological Survey, University of Indiana, United States (pimlaug@iu.edu)

A common problem in stratigraphic correlation is the difficulty of bridging shallow water shelf carbonates and down ramp shale-rich facies. This issue is well exemplified by the Upper Ordovician (lower Katian) Lexington Limestone of Kentucky, USA and adjacent dark shale facies in the deeper water Sebree Trough, an elongate, narrow bathymetric low abruptly north of the outcrop belt in the Ohio subsurface. Chronostratigraphic schemes for this interval have been proposed on the basis of conodont and graptolite biostratigraphy, mapping of event beds, and sequence stratigraphy through facies analysis. The relation of the siliciclastic rich offshore records of the "Point Pleasant-Utica" interval, well known to drillers because of its oil and gas potential, with the up-ramp shallow water carbonate dominated equivalents of the Lexington Formation is complicated by convoluted nomenclature, a major, abrupt change in facies, and disparity in the availability and completeness of records. Current genetic models of organic rich shale intervals, such as the Point Pleasant-Utica interval, are still lacking in detail, and will greatly benefit from detailed correlation with shallow water settings where more is understood about paleoclimatic conditions. In order to understand the development and evolution of this Late Ordovician Laurentian basin, it is important to understand the age relationships of depositional processes occurring at a range of depths, particularly in the less well studied epeiric sea setting of the "Point Pleasant-Utica" interval of Ohio and partial lateral equivalent, Lexington Formation of central Kentucky.

The outcrop area of central Kentucky, exposed by the later uplift of the Cincinnati Arch, hosts numerous world-class exposures of the Lexington Formation, nearly all of which are representative of the highly fossiliferous, shallow-water marine platform carbonates. These successions display well differentiated depositional sequences, with sharp facies offsets, and mineralized surfaces. They also contain well studied fossil assemblages and event beds, which at the scale of an outcrop, allow for detailed paleoenvironmental interpretation. The offshore record of this interval, known almost exclusively from a few drill cores, displays an abrupt transition to distal, siliciclastic dominated facies, recording a more dysoxic and organic rich interval. Internal correlation of these shales has relied mostly on limited graptolite biostratigraphic and geochemical analysis. Here we seek to establish age relationships across a major facies transition between these two interrelated paleoenvironmental settings using high resolution whole rock carbon isotope analysis to integrate new and previous work on lithostratigraphy, biostratigraphy, and sequence stratigraphy of a series of cores and outcrops. Results to date demonstrate the persistence of carbon isotopic patterns (including the globally recognized GICE positive carbon isotopic excursion) permitting extension of correlation into basinal facies where tracking of stratigraphic sequences becomes difficult. A complicated relationship across the region is emerging involving both rapid facies transitions and submarine erosional cutout of units toward the center of the Sebree Trough. This study demonstrates the utility of an integrated stratigraphic approach for establishing high resolution regional correlations allowing for interpretations across a major facies transitions.