CONSTRAINTS ON THE AGE AND CORRELATION OF TWO PROBLEMATIC TELYCHIAN (LLANDOVERY; SILURIAN) STRATIGRAPHIC UNITS IN OHIO AND KENTUCKY: SYNTHESIZING BIOSTRATIGRAPHY, $\delta^{13}C_{carb}$ CHEMOSTRATIGRAPHY, AND SEQUENCE STRATIGRAPHY

Nicholas B. Sullivan[1], Carlton E. Brett[1], Patrick I. McLaughlin[2], Mark A. Kleffner[3], Bradley D. Cramer[4], and James R. Thomka[1]

[1]Department of Geology, University of Cincinnati, Cincinnati, Ohio 45221, USA
[2]Wisconsin Geological and Natural History Survey, Madison, Wisconsin 53705, USA
[3]Division of Geological Sciences, School of Earth Sciences, Ohio State University at Lima, Lima, Ohio 45804, USA
[4]Department of Geosciences, University of Iowa, Iowa City, Iowa 52242, USA

Regional correlation of lower Silurian rock units in the eastern United States has been hindered by many factors, despite numerous outcrops and over a century of detailed study. However, new analytical tools and recent improvements to existing methods, such as $\delta^{13}C_{carb}$ chemostratigraphy, conodont biostratigraphy, and sequence stratigraphy, greatly expand the potential for confident correlation at regional and global scales. These techniques are utilized herein to resolve the stratigraphic relationships of two problematic Telychian (upper Llandovery) rock units: the Waco Member (Alger Shale Formation) of east Kentucky, and the Dayton Formation of Ohio. These units have several lithologic characteristics in common, they are of roughly similar age, they both overlie a major unconformity, and they had not been identified together in outcrops. The presumed equivalence of these units has been an important regional tie linking the various depositional regimes on the Cincinnati Arch and Appalachian Foreland Basin of eastern North America. However, new and published data from these stratigraphic units have cast serious doubt on this correlation. These results are synthesized here, and a refined Telychian stratigraphic framework for this succession is proposed. Comparative studies of the sedimentological and lithologic characteristics of the Waco Member and the Dayton Formation suggest that these are genetically distinct units, representing subtly different facies. In its type area, the Waco Member is composed primarily of fossiliferous green grey shale that overlies a meter-thick basal carbonate bed containing abundant glauconite, pyrite, and frame-building organisms. To the north of its type area, the Waco becomes increasingly calcareous; here the unit divisible into a lower "white" division that is glauconitic and highly fossiliferous, and an upper "orange" division characterized by burrowed firmgrounds and ferruginous dolostones. The Dayton Formation in its type area is sparsely fossiliferous, composed primarily of stacked, light-colored dolostone beds with numerous hardgrounds. However, it should be noted that a stratigraphic unit found in southern Ohio (Adams and Highland Counties), historically referred to "Dayton", bears stronger lithologic and faunal similarities with the Waco of Kentucky than it does with the dolostone unit found in the vicinity of Dayton, Ohio. Previous workers have recognized conodonts indicative of the lower Telychian in the Waco of Kentucky; similar conodont assemblages have been recognized in the "Dayton" of south Ohio. These findings are corroborated by new and published $\delta^{13}C_{carb}$ data collected from these successions that show a positive excursion in this unit, consistent with the lower Telychian Valgu Excursion. In contrast, biostratigraphic studies from the type area of the Dayton Formation in West Ohio have reported

middle to upper Silurian conodonts from the upper part of the unit, indicating that it is substantially younger. At these sections, $\delta^{13}C_{carb}$ values rise steadily through the Dayton, into the overlying Osgood. Interpretation of this trend is problematic, though previous workers have argued that this represents a late Telychian interval of rising $\delta^{13}C_{carb}$ values that occurred just prior to the onset of the Sheinwoodian Ireviken Excursion. The depositional history of these units may be interpreted as the result of prolonged sea-level rise during the Telychian, which onlapped the Cincinnati Arch in a time-transgressive manner. Sea-level rise began during the early Telychian, inundating the lower parts of the depositional basin, where Waco strata and equivalent units were deposited. The complete flooding of the proto-Cincinnati Arch followed in the mid-Telychian, depositing Dayton and overlying strata on topographic high points. During this later transgression, the deeper parts of the basin were marked by the deposition of the Estill Formation, a succession of green, red, and maroon mudstone that overlies the Waco. The relationship between the Dayton and the Estill is difficult to establish at a high level of precision. However, the lower part of the Estill becomes progressively more phosphatic and calcareous toward the type area of the Dayton Formation. This transition is highlighted by geologic cores taken from a transition zone between these depositional regimes, which show successions interpreted as the Dayton Formation overlying the Waco Member. While existing biostratigraphic data indicates a substantial temporal break (1-2 Ma) between the Waco Member and the Dayton Formation, no sedimentological evidence for a discontinuity in the stratigraphic record is known at this time. Though many questions remain, the proposed refinements to the stratigraphic framework may contribute to the goal of a more accurate understanding of the Silurian world.