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Upper Ordovician chronostratigraphic correlation between the Appalachian and Midcontinent basins

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Study of a subsurface core (named F688) from northern Indiana provides integrated data sets linking Katian chronostratigraphic records of the Appalachian and Midcontinent basins. The F688 core shows a variety of shallow- and deep-water facies containing numerous, well-preserved and zonally significant fossil species and diagnostic chemostratigraphic patterns. The succession belonging to the Cincinnatian Regional Stage in the F688 core is 210 m thick. Detailed benchtop examination of the succession revealed several phosphatic intervals, rich brachiopod faunas, multiple graptolitic horizons, and at least two tephras. Elemental analysis was conducted at 60 cm spacing quantifying lithofacies composition. Based on these results, the succession was assigned to six previously defined lithostratigraphic units (Kope, Waynesville, Liberty, Whitewater, Elkhorn, and Fort Atkinson formations). This lithostratigraphic succession shares components with both the Appalachian and Midcontinent basins, suggesting deposition near their shared margin. Twenty samples yielded abundant, well-preserved, low-diversity conodont assemblages with long-ranging taxa that clearly demarcate the position of the Ordovician–Silurian boundary at the top of the succession in the core. More than fifty palynologic samples, targeting graptolite-bearing intervals, were processed for chitinozoans and produced important new insights. The Kope Formation contains the chitinozoan species *Belonechitina kjellstromi*, *Hercochitina downiei*, and *Clathrochitina* sp. nov., co-occurring with a graptolite assemblage suggestive of the *Geniculograptus pygmaeus* Zone. Samples from the overlying Waynesville Formation produced graptolites indicative of the upper *G. pygmaeus* to *Paraorthograptus manitoulinensis* zones co-occurring with the long-ranging chitinozoan species *Belonechitina micracantha* and *Plectochitina spongiosa* as well as several new species of the genera *Tanuchitina* and *Hercochitina*. Higher in the core, the Liberty, Whitewater, Elkhorn, and Fort Atkinson formations yielded chitinozoan species characteristic of the upper Katian biozones of Anticosti Island and Nevada, such as *Tanuchitina anticostiensis*, *Hercochitina longi*, and *Eisenackitina ripae*. Results of $\delta^{13}C_{carb}$ analysis reveal partial preservation of the Kope, Waynesville, and Elkhorn excursions. A tephra in the rising limb of the Waynesville Excursion yielded needle-shaped clear zircons that will provide a high-precision U-Pb age. The Fort Atkinson Formation is overlain by the Brassfield Formation containing Silurian conodonts and $\delta^{13}C_{carb}$ values suggesting an Aeronian age.

Chronostratigraphic data from our study of the F688 core resolves longstanding uncertainty about correlations between strata of Katian Age in the Appalachian and Midcontinent basins. Integration of core F688 with our other regional chronostratigraphic data in the Midcontinent Basin demonstrates that the Fort Atkinson Formation of the Indiana and Illinois subsurface is age equivalent to the Fernvale Formation of Tennessee, Arkansas, and Oklahoma. Across this area, the Fernvale is overlain by graptolitic shales of the uppermost *P. manitoulinensis* to basal *Dicellograptus complanatus* graptolite zones. By contrast, the type Fort Atkinson Formation of Iowa is interpreted to occur completely within the younger *D. complanatus* Zone. These regional correlations taken as a whole suggest that the uppermost Katian (all of Ka4) and all but the uppermost Hirnantian are missing throughout much of the Appalachian Basin. By contrast, the Midcontinent Basin contains a much more complete upper Katian and Hirnantian succession. Our comprehensive approach is correcting temporal miscorrelation and providing robust chronostratigraphic context for study of biogeochemical events, which will further enable us to disentangle proxy data and identify the processes that drove the Katian diversity peak and culminated in the Late Ordovician mass extinction.

ABSTRACT

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