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Taphonomic Comparisons of Two Laurentian Upper Ordovician Epeiric Sea "Small Shelly Faunas"

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The Ordovician Exposed: Short Papers and Abstracts

for the

12th International Symposium on the Ordovician System

June 3-17, 2015 at James Madison University

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Cover Photo: Sandbian carbonate succession of the uppermost Big Valley, McGlone, McGraw and lowermost Nealmont formations exposed in the North Fork Quarry near Riverton, West Virginia Germany Valley. Field stop of the conference field trip. Photo by John Haynes extinction event, most of those stenotropic species were eliminated, and only those eurytopic species survived and occupied most of the preferred habitat.

Taphonomic comparisons of two Laurentian Upper Ordovician epeiric sea "small shelly faunas"

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The Elgin Member of the Upper Ordovician (Katian) Maquoketa Formation of Iowa contains phosphorite beds consisting of millimeter-scale phosphatic fossils, primarily steinkerns. Similar beds occur in the coeval strata of the classic Cincinnatian Series around the Cincinnati, Ohio area. Initial sampling of the phosphate-rich beds of the Maquoketa allows comparison between the faunal composition and taphonomy of these beds and collections from the more extensively sampled Cincinnatian strata. We isolated these fossils by dissolution of bulk samples in acetic acid and examined the same strata in thin section to study the fossils in context.

The Maquoketa diminutive phosphatized fossils have been interpreted as evidence of dwarfed faunas indicative of environmental stress, such as anoxia, which may have also contributed to phosphogenesis. An alternative explanation for the small size is that phosphogenesis was size-selective and that phosphatic particles were concentrated by reworking as less-durable shell material was destroyed. These hypotheses can be tested by examining the fauna for "normal" sized elements.

Insoluble residue from sampled phosphate-rich strata in both field areas yields abundant molluscan steinkerns, as well as crinoid columnals, conodonts, scolecodonts, bryozoan zooecia steinkerns and other fossils associated with a normal marine fauna. In Cincinnatian occurrences, the composition of the phosphatic assemblages is variable but is a reflection of the variability of faunal composition seen in these strata rather than an indication of an unusual fauna associated with extreme conditions; most are associated with diverse marine assemblages. Insoluble residues from both areas yield steinkerns that precipitated in small pores within larger skeletons. This phenomenon can be seen in thin section, where phosphate is present within certain parts of the larger preserved skeletons. The maximum size of the steinkerns of the Maquoketa is larger than those of most Cincinnatian occurrences, although size is variable in Cincinnatian occurrences. In Cincinnatian strata the abundance of small phosphatic fossils correlates with evidence for reworking; heavily reworked beds yield the most residue. Examined in thin section, the sampled strata of the Maquoketa appear to be heavily reworked and represent an extreme end-member of this concentration of durable phosphatic material.

Detailed examination using an SEM and associated XRF elemental mapping reveals that the phosphatic steinkerns of both localities are very similar in their taphonomy. Both consist of botryoidal growths of carbonate fluorapatite (CFA). The botryoidal growth appears to have nucleated on the walls of the original shell, first forming a lining of variable thickness. Some steinkerns have secondary botryoidal growths on the outside of the steinkern indicating continued precipitation of CFA after destruction of the original shell. This secondary precipitation suggests that reworking played a role not only in concentrating the phosphatic material but also in encouraging continued precipitation of CFA.

The size of the available pore space appears to have played a role in encouraging the precipitation of CFA. In thin section the CFA is limited to smaller parts of larger shells, such as the apices of gastropods and did not precipitate on the inside of the larger, more open spaces within the shell. Many of the phosphate-filled spaces are also sediment-filled, suggesting that subdivision of the larger space into smaller pores enhanced the precipitation of CFA. The difference in the maximum size of the steinkern achieved in the different assemblages suggests that geochemical factors affected size limits.

The most distinctive aspect of phosphate-rich Ordovician strata of mid-Laurentia is the degree of reworking that concentrated the durable small fossils. Details of taphonomy also suggest that phosphate precipitation was an iterative process enhanced by reworking, and that small pore spaces enhanced this mineralization, thus selectively preserving certain sizes and parts of the larger fauna.

Field and petrographic evidence for late diagenetic silicification of Cambrian and Ordovician carbonates of the Shenandoah Valley, Virginia

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A number of isolated hills and ridges of erosionally-resistant Cambrian-Ordovician carbonate bedrock are evident throughout the Shenandoah Valley. A common feature of many of these hills is the local abundance of silicified carbonate rock residuum that is derived from and mantles the overlying the bedrock. Occasionally, outcrops of silicified bedrock provide an opportunity to sample the rock *in situ*. These "cherts", and other silica-rich rocks reveal several common factors of silica replacement of original carbonate rock. While most models of chert formation in carbonates favor early (eogenetic) diagenesis within the sedimentary environment, the model proposed here is one of late (mesogenetic) diagenesis associated with hydrothermal fluid migration induced by tectonic deformation, or associated with the intrusion of igneous dikes and plugs of Mesozoic or Eocene age, or both. Several lines of commonly observed petrographic evidence favoring mesogenetic silicification of these carbonate rocks include: 1) progressive replacement of anhedral to subhedral dolomite grains with microcrystalline quartz and growth of authigenic K-feldspars; 2) zoned quartz overgrowths on euhedral quartz grains that likely formed as primary chemical precipitates, possibly within voids; 3) clasts of brecciated chalcedony- bearing chert floating in a matrix of dolomite that has been altered to microcrystalline quartz; 4) co- occurrence of iron oxides accompanying silica precipitation. Field evidence also supports a model of late diagenetic silicification associated with deformation or hydrothermal alteration. Nodular siliceous masses in carbonates more commonly occur in isolated zones found along or adjacent to faults rather than as stratigraphically-bedded chert. In these zones, silica replacement of carbonate is often associated with outcrops showing evidence of intense local deformation, and the replacement likely results from localized pressure solution of siliceous minerals in the carbonate matrix being re- precipitated as microcrystalline quartz, or as replacement due to migration of hydrothermal fluids. Further geochemical characterization of these samples may shed light on the compositions of diagenetic fluids that resulted in the silicification of the original carbonate rocks.

A New Type of Cool-water Carbonate Buildups: Middle Ordovician *Moyeronia-Angarella* "Reefs" of the Siberian Platform

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Stromatolite bioherms and biostromes are typical organic buildups for the Lower and the lowermost Middle Ordovician of the Siberian platform. However, closer to the end of the Middle Ordovician for a very short time a new and very specific type of organic buildups appears in the succession. The buildups are so far known only from a single locality on the right bank of the Moyero River about 0,5 km upstream of the mouth of its right tributary Bugarikta River on the northeastern part of the Tungus basin near the Anabar Land. The buildups are represented by 8 individual bioherms up to 2-2.5 m high and about 5-12m