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# The Microstructure of Pyrite Blackening in Fossil Shells

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# The Microstructure of Pyrite Blackening in Fossil Shells

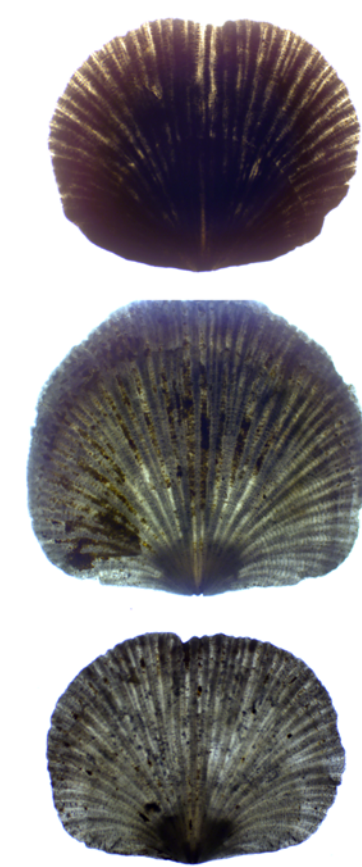
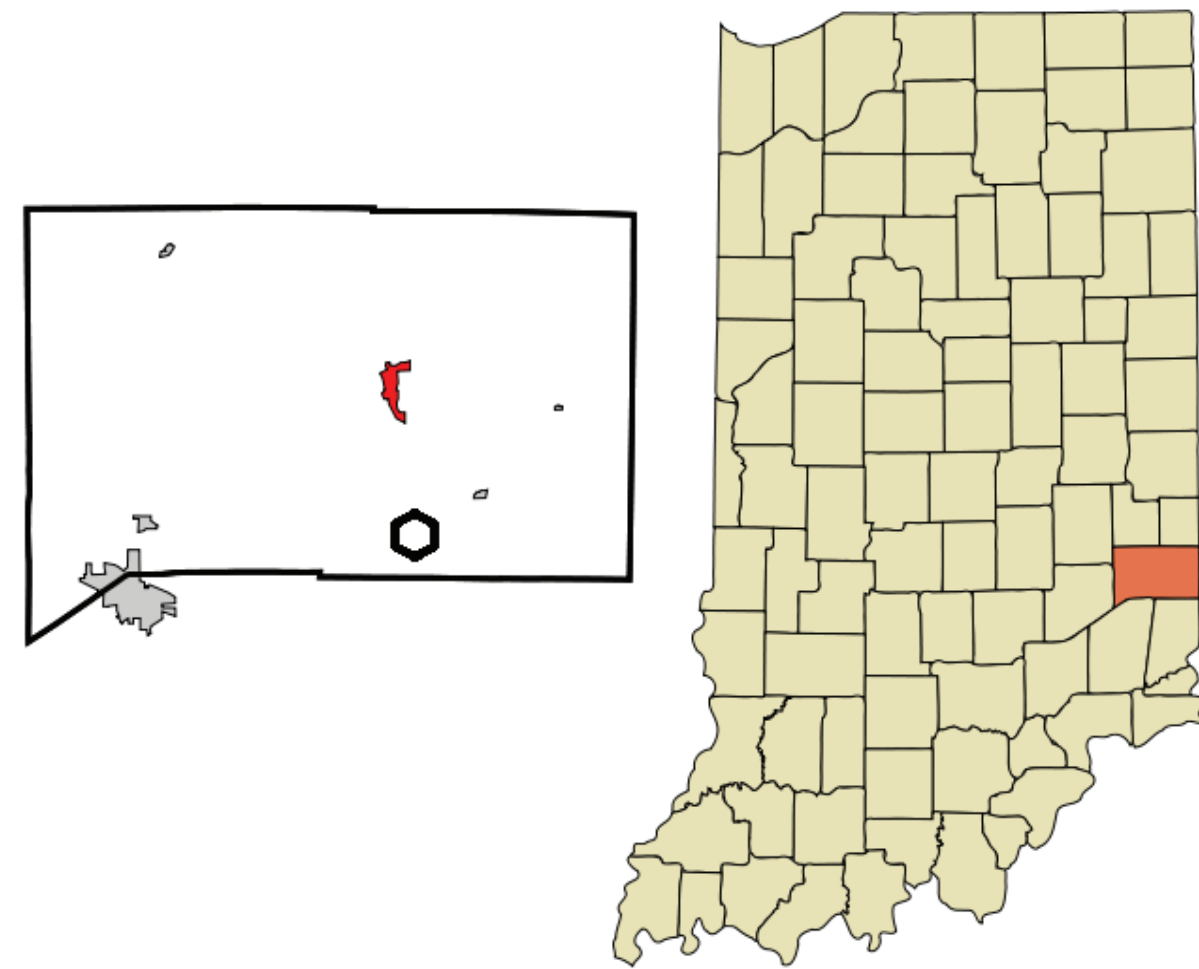
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## Abstract

The Waynesville formation is part of the stratigraphic succession of Indiana bedrock which allows us to look back on environmental conditions during the late Ordovician period, 450 million years ago. Due in part to a fossil record which is overwhelmingly dominated by a single species, the Waynesville formation functions as an outdoor laboratory illustrating various preservation processes operating on directly comparable shells. Shell blackening during preservation has been a particular point of interest. Based on the correlation of shell blackening with occurrences of shell fragmentation and abrasion in large brachiopods, the shell blackening seen in Upper Ordovician (Cincinnati) brachiopods has previously been identified as a sign of long residence on the sea floor, and has been attributed to the accumulation of iron sulfides and organics in microborings. This in turn suggests extremely low oxygen microenvironments within the shells. The results of this study are broadly consistent with prior hypotheses.

## Methodology

Specimens were collected from an exposed outcrop in Franklin County in southeastern Indiana. Shells and shell fragments are largely un lithified and dominate quickly weathered matrix. They are collected in blocks and separated in the laboratory.



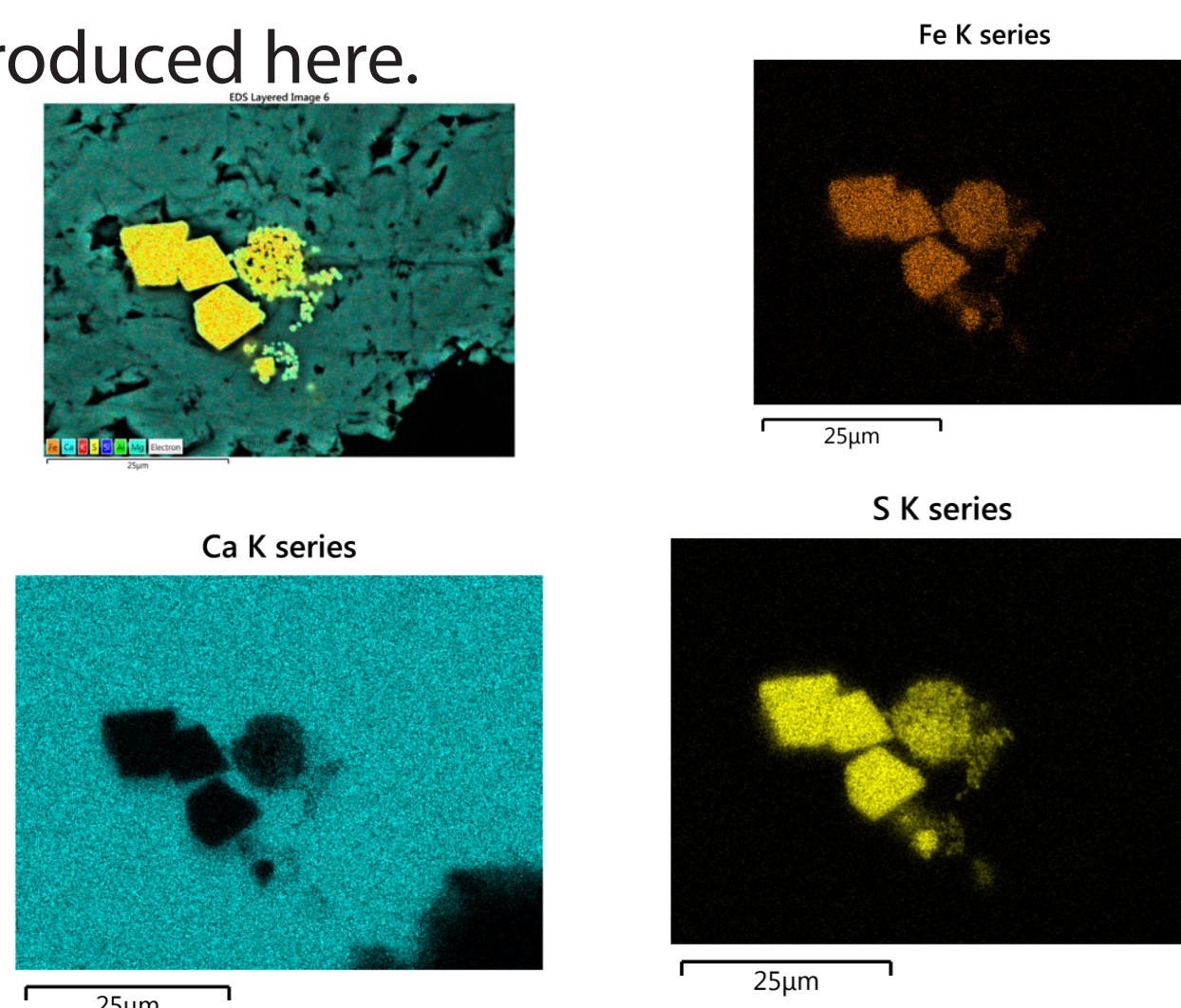
It had been previously observed that ossicles in fragments of brachiopods and other fossils commonly contain finely-disseminated dark material. The dark areas were located in skeletal pores characteristic of the fossil group, in microborings and along growth-line boundaries.

To document the mineralogical basis of blackening, the pattern of its progression through shells, thin sections were prepared from the collected specimens, which were ranged by perceived degree of exterior blackening (shown at left). Thin sections were prepared and imaged by optical microscope to expose specific dark areas.

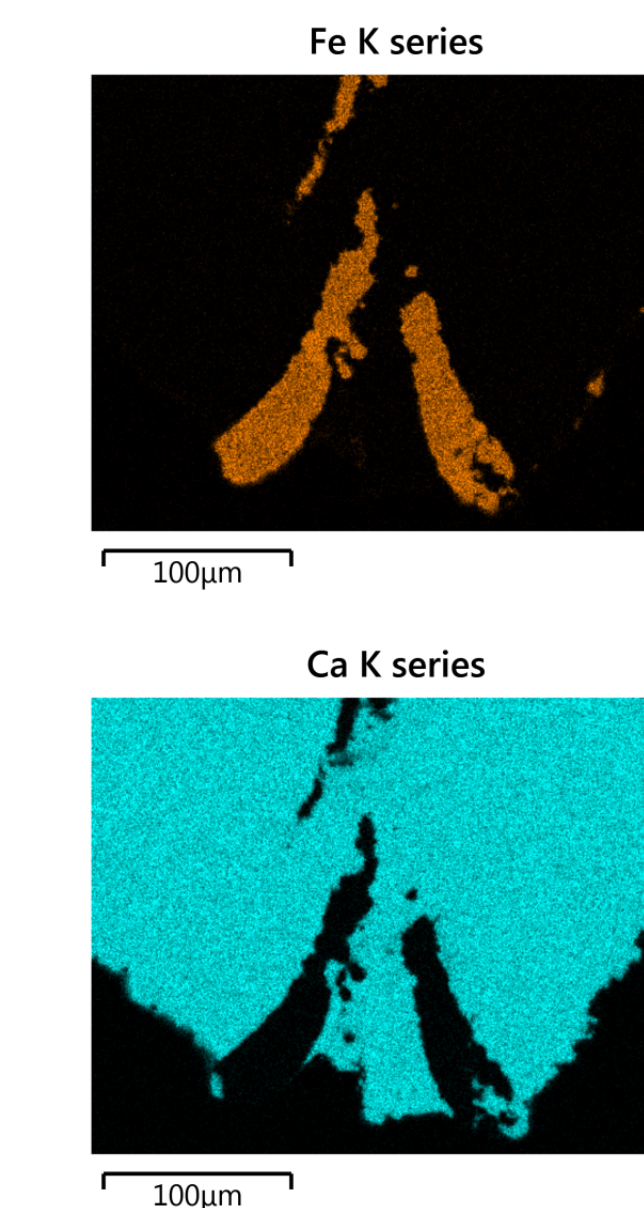
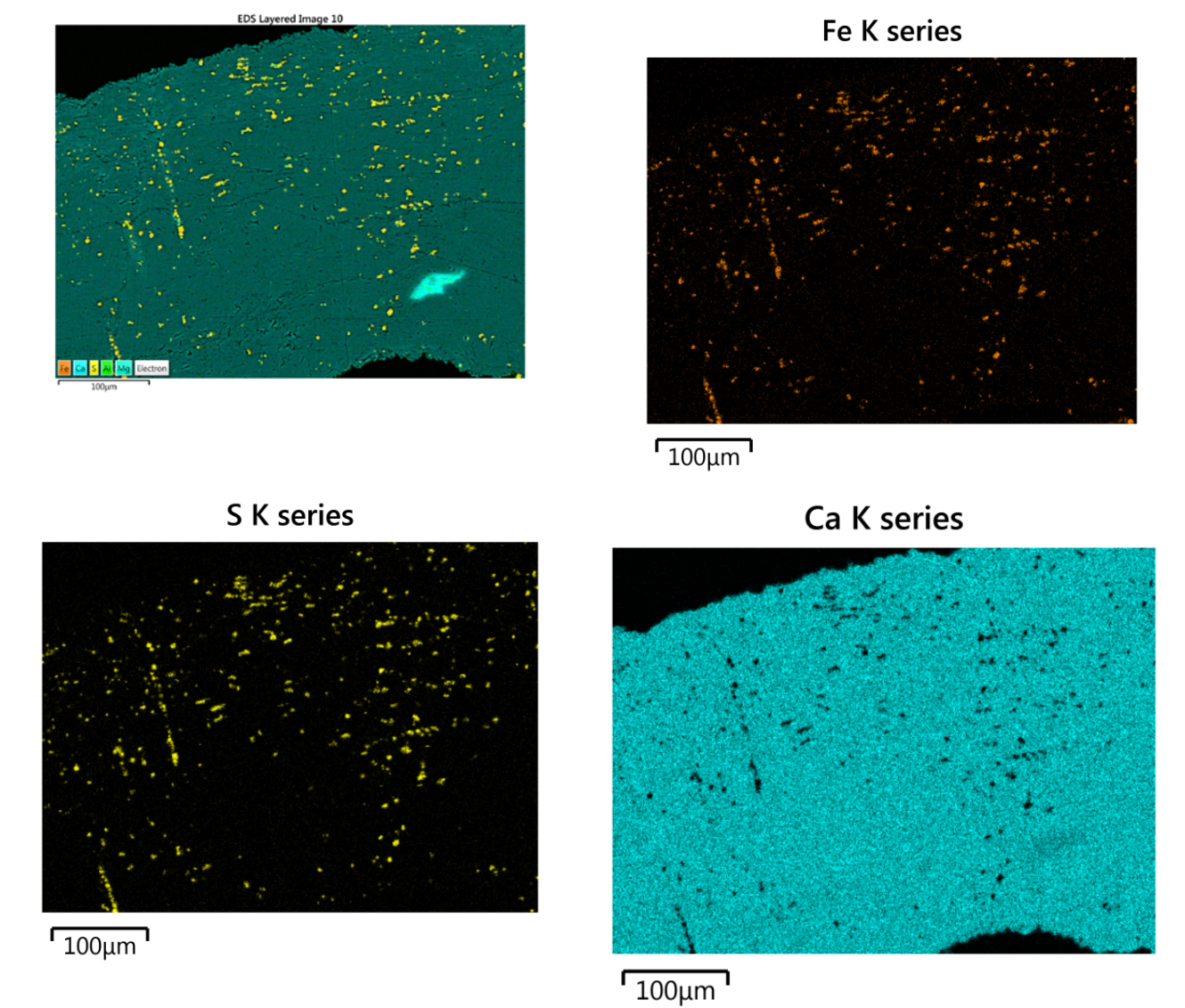


The optical images were used to select areas for SEM elemental maps representative of both light and darkened areas of the shells. Selected elemental maps are reproduced here.

Here early pyritization is clearly visible in the development of pyrite crystals of the characteristic shape, the presence of iron and sulfur, and the absence of calcium.



In the site to the right highly diffuse pyritization is indicated, possibly occurring along growth lines at all depths of the shell.



The site to the left exhibited characteristic pyrite invasion from a ridge into the interior along one face, possibly exploiting a shell pore.

## Conclusions

A progressive degree of pyritization of shells correlated with shell blackening. In the lightest shell this was usually confined to shell punctae, but in darker shells advanced to growth lamellae. Progression is structurally controlled. Dysoxic conditions may have occurred to surrounding decay of organic material, consistent with stable, long term residence on a sea floor.

## Reference

KOLBE SE, ZAMBITO IV JJ, BRETT CE, and WILSON RD, Brachiopod shell discoloration as an indicator of taphonomic alteration in the deep-time fossil record, PALAIOS, 2011, v. 26, p. 682-692.