Dinosaur Eggshell and Bird Eggshell Comparison using Scanning Electron Microscopy

A Thesis

Presented in Partial Fulfillment
of the requirements for the
Degree Bachelor of Arts
in Earth Sciences

by

Lee Martin

The Ohio State University
June 2012

Approved by

TABLE OF CONTENTS

ABSTRACT

Eggshell fragments from four extant birds and two Cretaceous dinosaurs were studied for their chemical components. Eggs from the birds yielded high C, O, Mg, Al, and Na values. Dinosaur eggs from the Two Medicine Formation of Montana and the Xiaxia Formation of Henan, China, shared high values of Si, Al, O, Ca, Mg, K, and Na. In addition, material from Henan, China, shared high values of Ce and V. Compositional differences between the bird eggs and the dinosaur eggs are attributed largely to diagenetic factors affecting the fossils.

ACKNOWLEGEMENTS

I would like to thank his advisor Dr. Loren Babcock for proofreading, advising and encouraging the author in doing and writing about the dinosaur eggs in the OSU collection; Mr. Dale Gnidovec for supplying dinosaur egg samples for use in the study; Dr. Julie Sheets and Sue Welch with help identification and interpretation of SEM data on egg samples; Mrs. Patti Dittoe and Mrs. G. H. Noel of the Orton Hall Geological Library for advice on reference material for the project. Finally the author wishes to thank his parents and friends encourage him through the process of writing the thesis.

INTRODUCTION

Dinosaur eggs discovered in various places around the world during the past two centuries have been studied by scientists and amateurs on macroscopic and microscopic scales. Dinosaur eggs found in situ have provided clues to the paleoenvironments where the eggs were deposited in nests. Dinosaur eggs examined by scanning electron microscopy have allowed detailed analyses of structures within the egg layers (Hirsch, 1996). Most dinosaur nests containing eggs have no embryos preserved although; nests excavated do exist with embryos preserved but those nests are uncommon.

Discovery of dinosaur nests has helped with identification of egg-laying dinosaurs as based on some skeletal remains have been recovered and microstructures based on comparative analysis. One paper (Kolesnikov and Sochava, 1972) includes a chemical analysis of modern bird eggs and dinosaur eggs.

The purpose of this thesis is to compare extant bird eggs with dinosaur eggs to examine if chemical similarities exist, which may lead to chemical identification of what family of dinosaurs laid eggs in Montana and China.

METHODS AND MATERIALS

Dinosaur egg materials for this study are reposited in the Orton Hall Geological Museum of The Ohio State University (catalog numbers 45692 and 50466). Dinosaur egg fragments are from two locations: the Two Medicine Formation (Cretaceous) near Choteau, Montana and the Xiaxia Formation (Cretaceous) near Xiaxia, China. Eggshell of extant birds used in this study are reposited in the Ohio State University Ornithology Lab. The eggshell of extant birds are from representatives of the following taxa: rhea (Rheiformes), hawk (Falconiformes), rail (Gruiformes) and catbird (Passeriformes).

Egg specimens were prepared using forceps to crack eggs. The fragments were left untreated, and adhered to a metal stage using carbon tape. Specimens were then examined in the scanning electron microscope (SEM) under a low vacuum mode. The machine used to study the egg material is a FEI Quanta 250 FEG SEM which is equipped with an Energy Dispersive X-ray (EDX) analyzer. Chemical composition of the eggs were assessed using EDX analysis.

RESULTS AND DISCUSSION

All eggs from extant birds in this study yielded spikes in carbon, oxygen, magnesium, aluminum, sulfur and sodium (Figures 1-5). The aluminum may be a product of contamination during sample preparation. Dinosaur eggs yielded signals in silicon, aluminum and oxygen and calcium, magnesium, vanadium and manganese. Eggshell from Montana (figure 8) showed an extra spike in barium (figure 9) whereas eggshell from China (figure 6) exhibited strong consistent signals of cerium and vanadium (figure 7).

The presence of cerium and vanadium in dinosaur eggshells from Henan, China is interpreted to be the result of post-depositional diagenetic processes. Cerium and vanadium which are rare earths, are mined nearby the egg locality for use in the chemical and steel industries (Browning 1908). Weathering of cerium and vanadium by surface water or groundwater transportation from nearby sources is likely may account for the differences between the bird and dinosaur eggshell are also attributed to diagenetic factors affecting the fossils (Yang 2011).

Initially it was hoped that chemical analyses of dinosaur eggshell would provide information that could assist in identification of the egg processes No clear identifications could be made based on the material studied.

SUGGESTIONS FOR FUTURE WORK

Suggestions for future work on this study would be to collect bone material, run SEM/EDX analyses on the bone in conjunction with sediment and eggshell fragments to see if other correlations may be present.

CONCLUSIONS

Eggshell fragments from four extant birds and two dinosaurs were studied for their chemical components. Eggs from the birds yielded high carbon, oxygen, magnesium, aluminum, and sodium values. Dinosaur eggs from the Two Medicine Formation of Montana and the Xiaxia Formation of Henan, China, shared high values of silicon, aluminum, oxygen, calcium, magnesium, potassium, and sodium. In addition, material from Henan, China, shared high values of cerium and vanadium. Compositional differences between the bird eggs and the dinosaur eggs are attributed largely to diagenetic factors affecting the fossils.

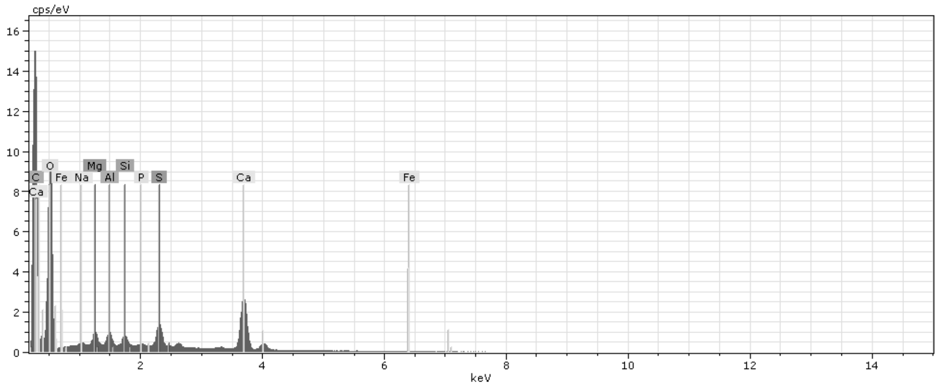

Figure 1. Rhea eggshell chemistry based on SEM/EDX analysis from Columbus, Ohio. Holocene.

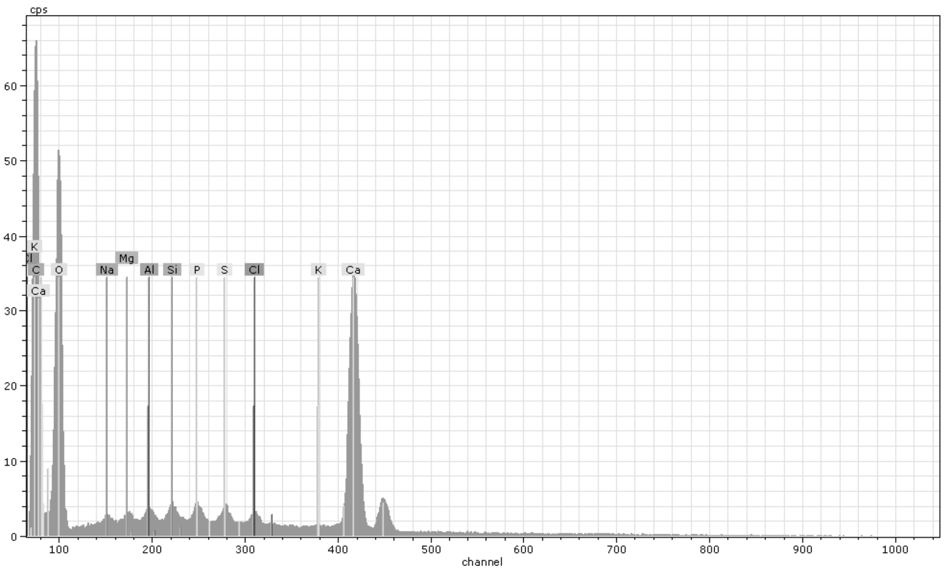

Figure 2. Hawk eggshell chemistry based on SEM/EDX analysis from Columbus, Ohio. Holocene.

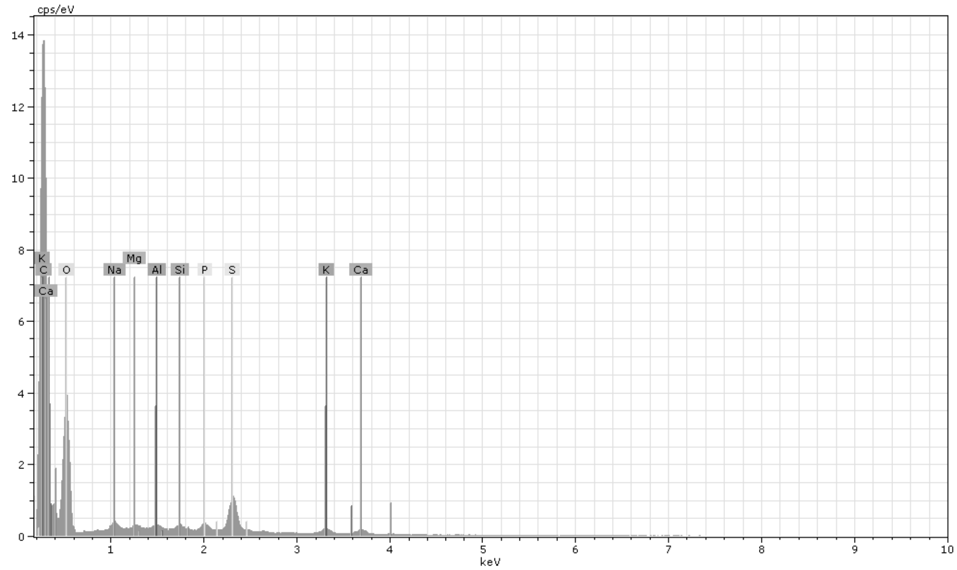

Figure 3. Rail eggshell chemistry based on SEM/EDX analysis from Columbus, Ohio. Holocene.

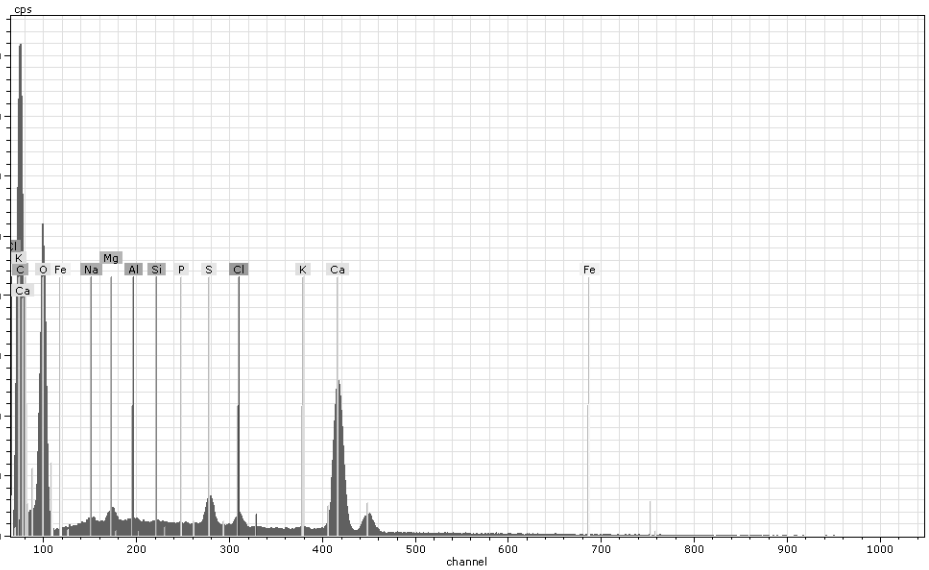

Figure 4. Catbird eggshell chemistry based on SEM/EDX analysis from Columbus, Ohio. Holocene.

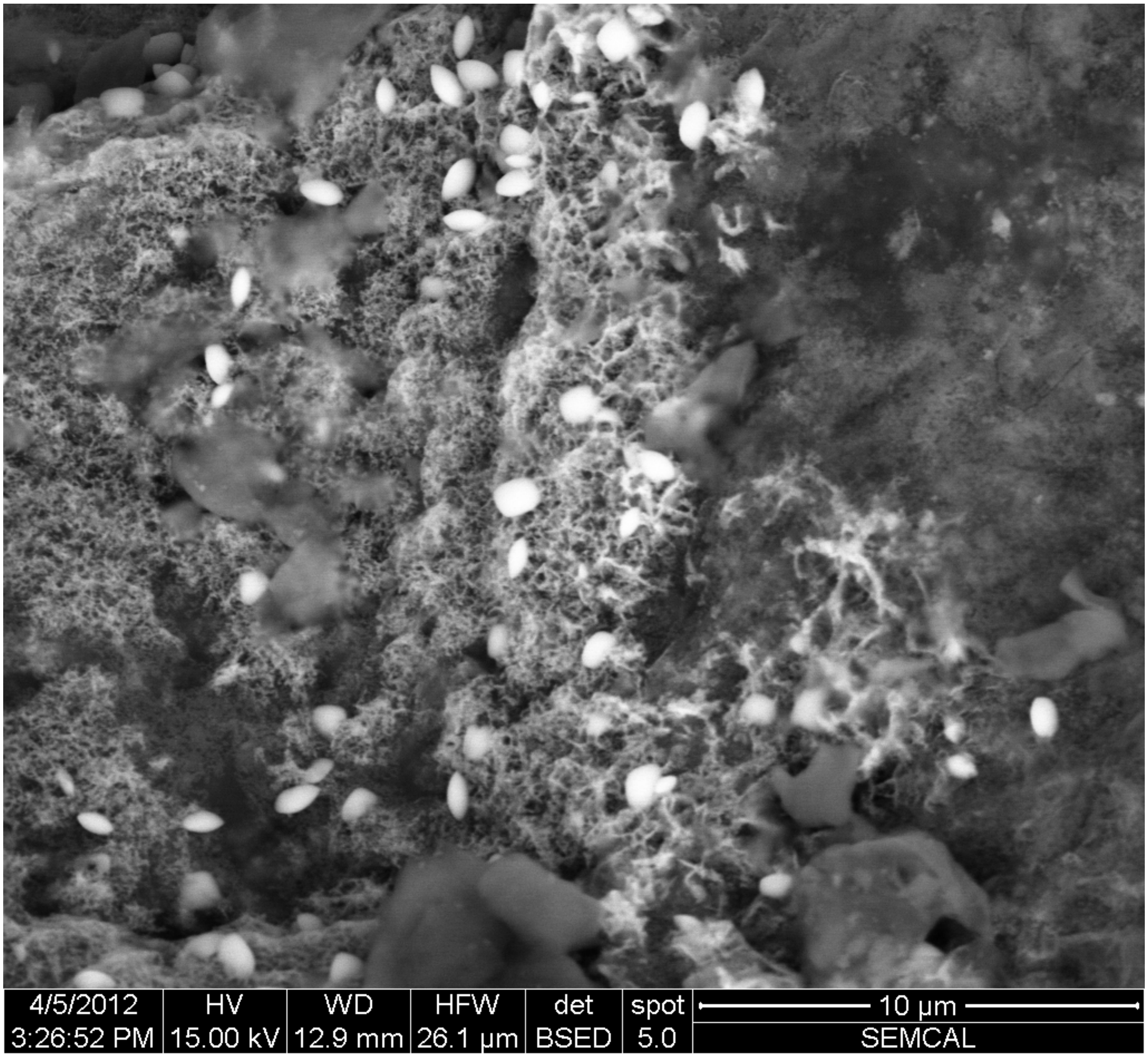

Figure 5. SEM image of dinosaur eggshell showling cerium and vanadium nodules. Xiaxia Formation (Cretaceous), Xiaxia, Henan, China.

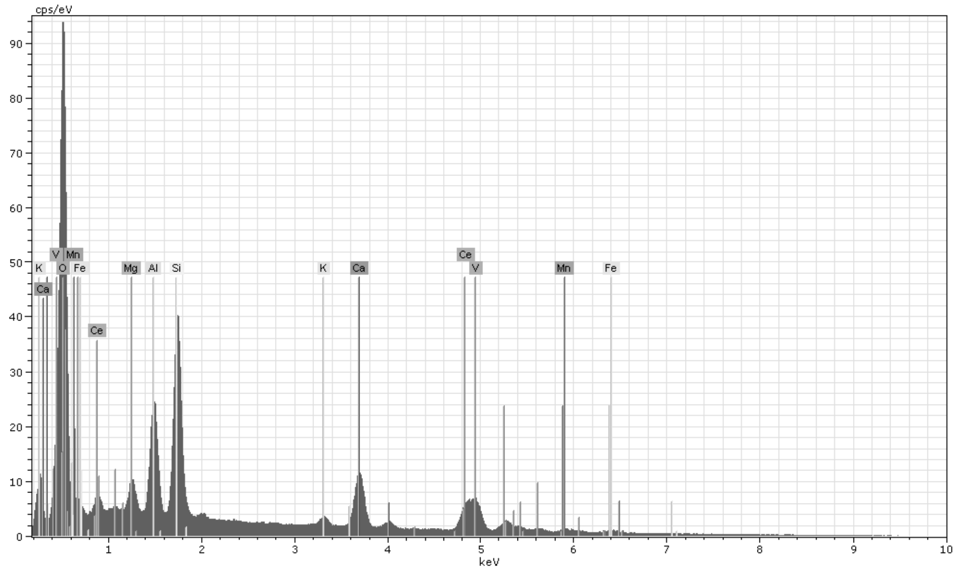

Figure 6. Eggshell chemistry of dinosaur eggshell from Xiaxia Formation (Cretaceous), Xiaxia, Henan, China, showing cerium and vanadium spectral lines.

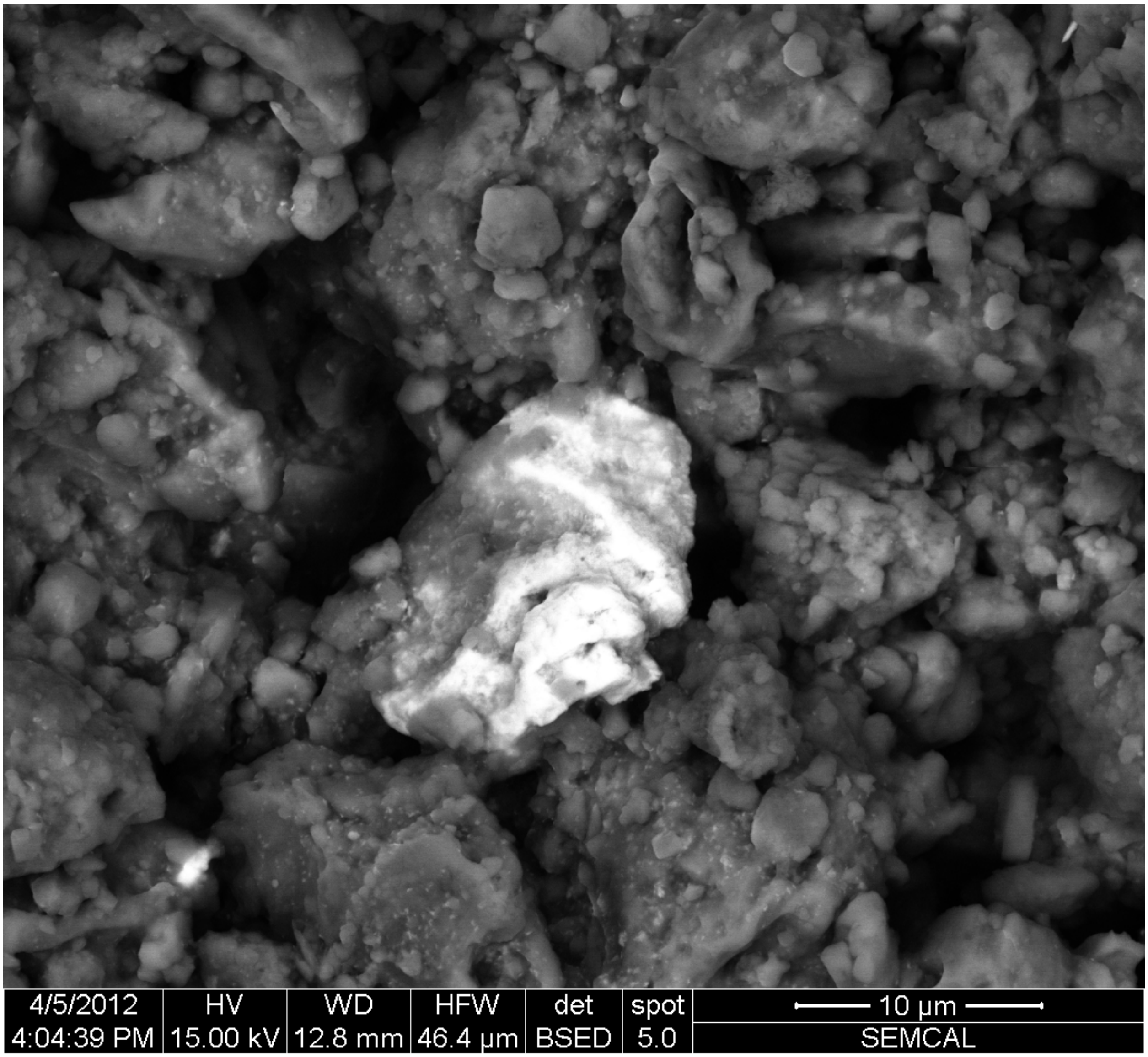

Figure 7. SEM image of dinosaur eggshell showing barium nodule. Two Medicine Formation (Cretaceous), Choteau, Montana.

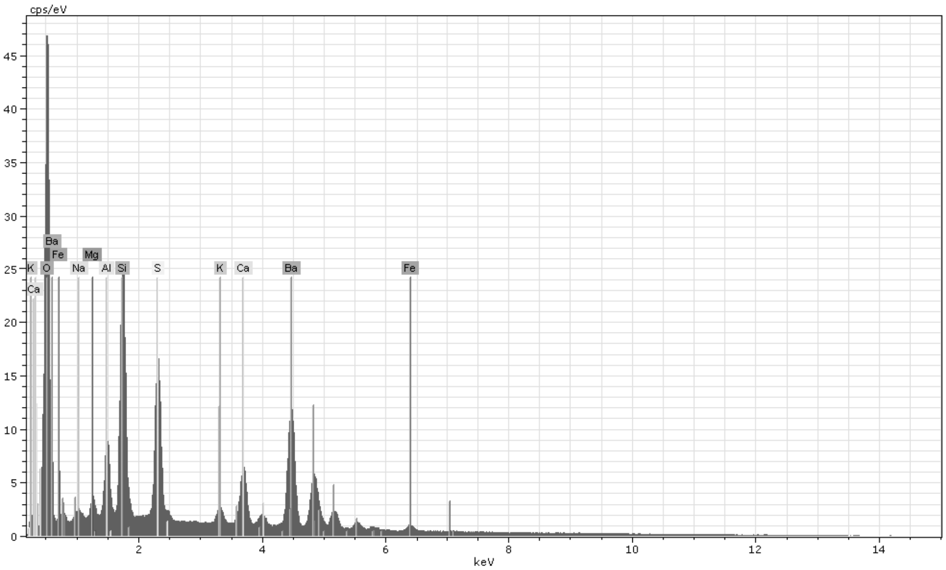

Figure 8. Eggshell chemistry of dinosaur eggshell from Two Medicine Formation (Cretaceous), Choteau, Montana, showing a barium spectral line.

REFERENCES

Browning, P. E. 1908. The increasing importance of the rarer elements. *Science*, 28:548-555.

Hirsch, K. and B. Quinn. 1990. Eggs and eggshell fragments from the Upper Cretaceous Two Medicine Formation of Montana. *Journal of Vertebrate Paleontology*, 10:491-511.

Kolesnikov, Ch. M., and A. V. Sochava. 1972. A paleobiochemical study of Cretaceous dinosaur eggshell from the Gobi. *Paleontological Journal*, 6:235-245.

Yang, B., Bin H., Bao Z. Y. and Zhang, Z. G. REE geochemical characteristics and depositional environment of the black shale-hosted Baiguoyuan Ag-V deposit in Xingshan, Hubei Province, China. *Journal of Rare Earths*, 29:499-506.