Searching for the K-Pg Iridium Anomaly in Central Arkansas

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Background

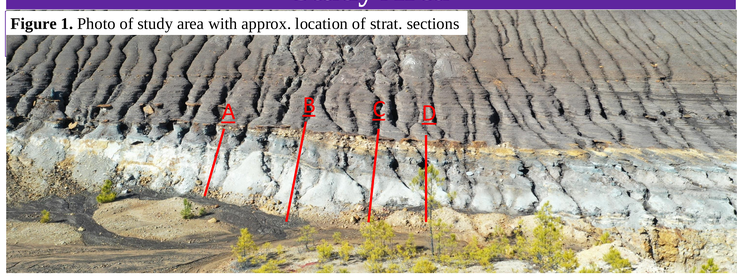
Despite iridium's cruciality in modern industry, it is one of the rarest occurring elements in the Earth's crust, which an average concentration of 10-12 ppb (0.001-0.0012 ppm). Within the crust there exists thin, stratigraphically horizontal upticks in the concentration of iridium. These concentrations arewidely believed to be associated associated with the impacts of large asteroids, which tend to include relatively high concentrations of iridium in their composition. The most well-known of these iridium anomalies is the Cretaceous-Paleogene (K-Pg) Boundary, which was the result of the Chicxulub asteroid impact that is commonly thought to have led a mass extinction. The concentration of iridium within the K-Pg iridium anomaly is variable where it has not been eroded away, but otherwise encompasses the globe.

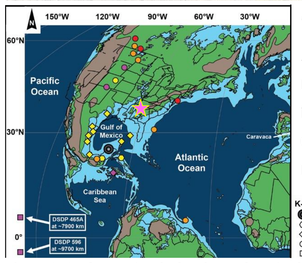
Methods and Materials

- One sample from each unit composing the four stratigraphic sections (totaling 60 samples) were collected in plastic Ziploc bags and allowed to air-dry for one week
- Each sample was ground by hand to using a porcelain mortar and pestle and 0.25 mm sieve
- Approximately 5 grams of each ground sample were placed into thin-film XRF sample cups
- Using a ThermoScientific hXRF, each sample was scanned four times and rotated approx. 70-80 degrees clockwise between each scan
- Twelve samples were analyzed using LA-ICPMS and Iolite visualization and processing software
- Results from LA-ICP-MS/hXRF analysis were assessed using Microsoft Excel
  - If a sample had 50% or more readings above level of detection (LOD) for an element, that element was presumed to exist in sufficient quantity to be considered for chemostratigraphic correlation

Study Area

Figure 1. Photo of study area with approx. location of strat. sections





The studied outcrop is located in Bauxite, Arkansas within an inactive aluminum ore mine currently undergoing reclamation. At the time of the Chicxulub asteroid impact, central Arkansas was a coastal/shallow marine environment. Based on sediment age and composition, the K-Pg boundary, if preserved, may exist there.

Figure 2. Study area (marked with a pink star) relative to the location of the Chicxulub impact structure and concentrations of the K-Pg iridium anomaly at various global locations. (Modified from Goderis, S., et al, "Globally distributed iridium layer[…]")

Results

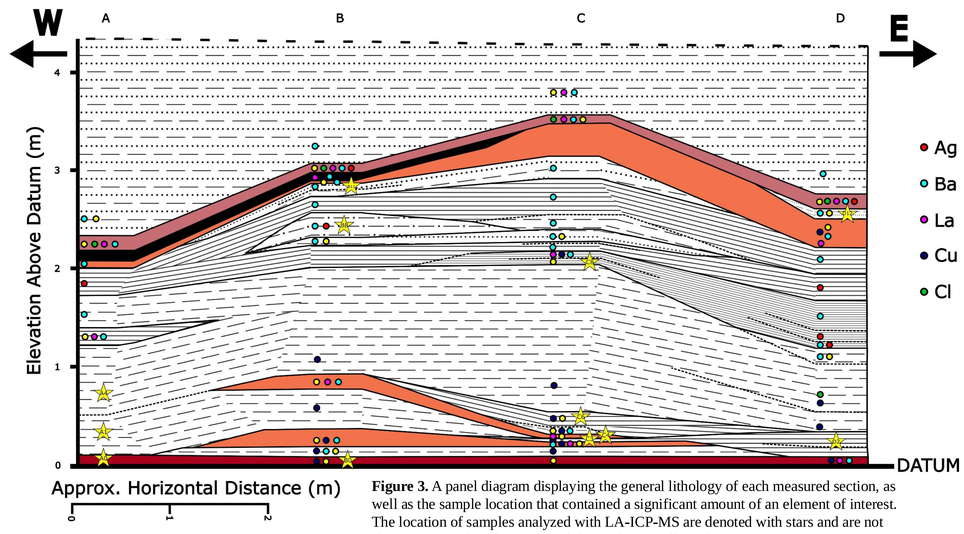


Figure 3. A panel diagram displaying the general lithology of each measured section, as well as the sample location that contained a significant amount of an element of interest. The location of samples analyzed with LA-ICP-MS are denoted with stars and are not chemostratigraphically correlated due to their small number.

Sample	Mean Ir Concentration (ppm)	Relative Standard Deviation (%)
Earth's Crust	0.001	
AL-A0	Below LOD	
AL-A1	Below LOD	
AL-A4	0.009	±11.0%
AL-B0	0.009	±48.8%
AL-B8	0.015	±38.5%
AL-B11	0.023	±13.9%
AL-C3	0.010	±28.7%
AL-C4 (a)	Below LOD	
AL-C4 (b)	Below LOD	
AL-C6	0.018	±63.6%
AL-C8	0.013	±17.1%
AL-D2	0.021	±34.3%
AL-D12	0.011	±53.3%

Table 1: The twelves samples that were tested using LA-ICP-MS yielded some values that were significantly higher than the average crustal abundance.

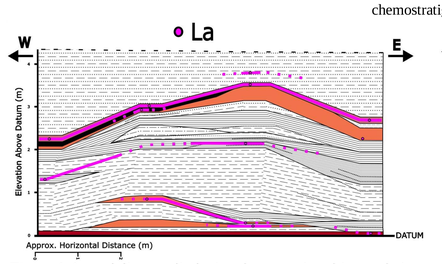


Figure 4. A panel diagram displaying chemostratigraphic correlations based on the location of samples that contained lanthanum

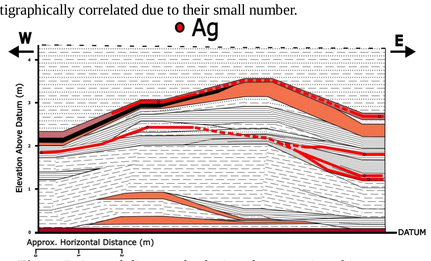


Figure 5. A panel diagram displaying chemostratigraphic correlations based on the location of samples that contained silver

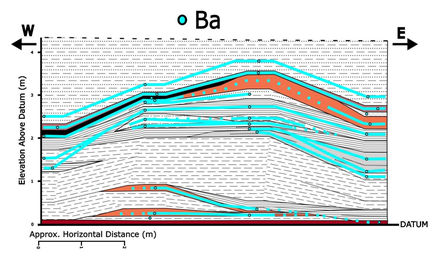


Figure 6. A panel diagram displaying chemostratigraphic correlations based on the location of samples that contained barium

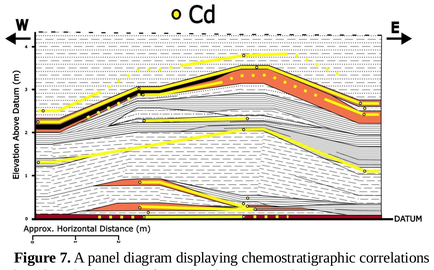


Figure 7. A panel diagram displaying chemostratigraphic correlations based on the location of samples that contained cadmium

Lithostratigraphy

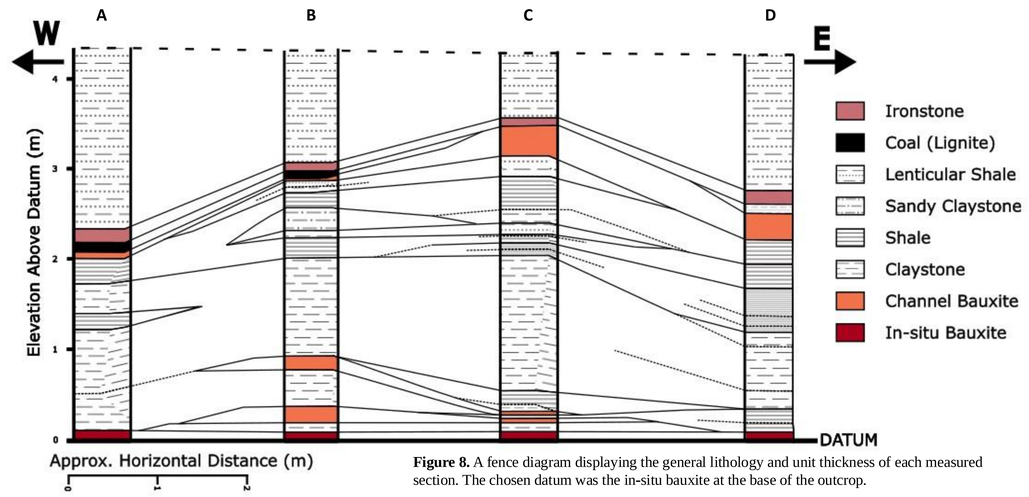


Figure 8. A fence diagram displaying the general lithology and unit thickness of each measured section. The chosen datum was the in-situ bauxite at the base of the outcrop.

Conclusions

The presence of elements like Ba, Cl, and Ca as well as the outcrop's lithology indicate a near-shore to shallow marine depositional environment. The bedding boundary most likely to have preserved the iridium anomaly (and thus constitute the K-Pg boundary) would likely be closer to the base of the section. This supposition is based on the concentration of copper at this location, as well as the relative age of the region's igneous intrusion.

Of the twelve samples analyzed using LA-ICP-MS, only three of the samples had iridium levels below LOD. In an outcrop with a pristinely preserved clay layer denoting the K-Pg boundary, there would be a significant increase in Ir concentration in the units close in age with a sharp peak in the unit composing the boundary. This abrupt peak was not observed in the data obtained by LA-ICP-MS analysis, but sample AL-B11 had an Ir concentration one degree of magnitude greater than the average crustal concentration within the margin of two standard deviations. Based on the depositional environment, the clay layer that accumulated after the impact was likely not preserved in this location, eroding downslope from the uplift and into the ocean.

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Acknowledgements

The authors would like to thank Aluminum Company of North America and McGeorge Contracting for allowing access to the mine and to the outcrop. Additionally, the authors would like to thank Melanie Ertons, M.S. for her guidance and assistance in the field and in the lab.