

Osmium Isotope Chemostratigraphy of the Mid-Cenomanian Event in the Cretaceous Western Interior Seaway

Liam Lauckner

Department of Earth and Atmospheric Sciences, University of Houston

Introduction

- First $^{187}\text{Os}/^{188}\text{Os}$ chemostratigraphic profile covering the Mid-Cenomanian Excursion (MCE) in the Cretaceous Western Interior Seaway (KWIS)
- A shift towards unradiogenic $^{187}\text{Os}/^{188}\text{Os}$ values during the MCE mirrors the Os_i record of Ocean Anoxic Event 2 (OAE-2)

Methods

Methods

- Samples powdered using a ceramic mortar and pestle²
- Osmium isolated from samples: solvent extraction, back extraction, and microdistillation²
- Osmium measured as OsO_3^- on a Triton Plus thermal ionization mass spectrometer³

Geologic and Geochemical Background

Cretaceous Period Conditions

- Cretaceous conditions – sea-level highstands, high atmospheric and oceanic temperatures, and extensive volcanic activity
 - Favored the occurrence of ocean anoxia⁶
- MCE resembles and precedes the extensively studied OAE-2¹

Chemostratigraphy of Ocean Anoxic Events

- Recognized by $\delta^{13}\text{C}$ excursions^{3,4,6}
- Unradiogenic initial seawater-derived $^{187}\text{Os}/^{188}\text{Os}$ (Os_i) signature may suggest large igneous province (LIP) activity (i.e. OAE-2)^{4,6,8}

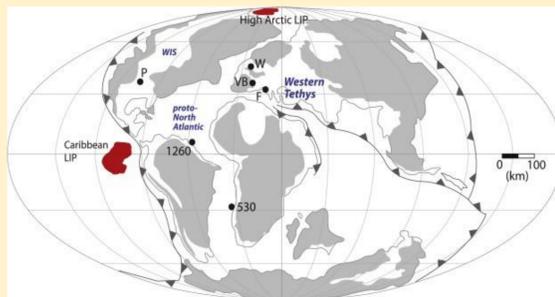


Figure 1 – Map of Cretaceous paleogeography and location of LIPs⁴

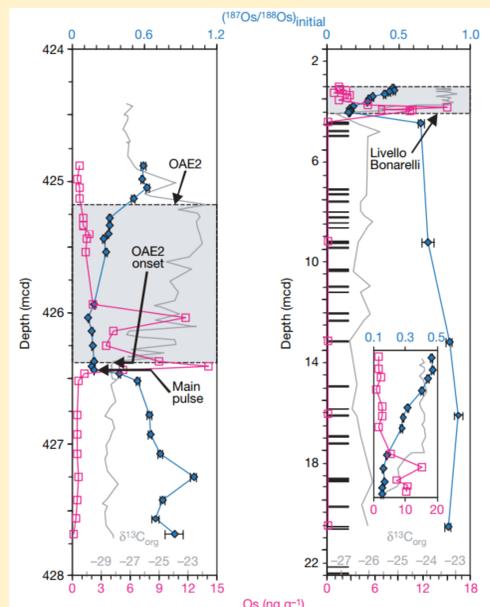


Figure 2 – Os_i , Os (ng/g) and $\delta^{13}\text{C}$ ⁸

Rhenium-Osmium Systematics

- Re and Os: compatible, chalcophile and siderophile; osmium more compatible⁷
- ^{187}Re decays to ^{187}Os by beta decay; half-life is 41.3×10^9 years^{3,7}
- Os_i can be determined if age is known⁷

Iona-1 Core and Eagle Ford Formation

Iona-1 Samples

- 16 shales - ~13m-long section of Eagle Ford Formation recovered by Iona-1 research core⁵
- Complete record of the Late Cretaceous in the KWIS⁵
- $\delta^{13}\text{C}$, total organic carbon weight % and trace element data previously determined⁵

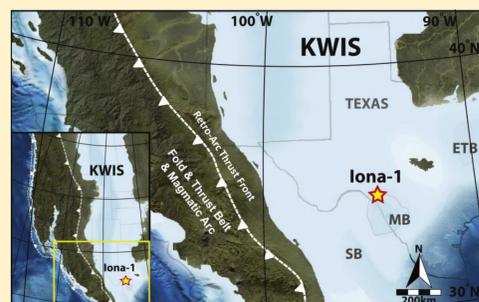


Figure 3 – Location of Iona-1 well⁵

$^{187}\text{Os}/^{188}\text{Os}$ and Os (ng/g) Profile for the MCE

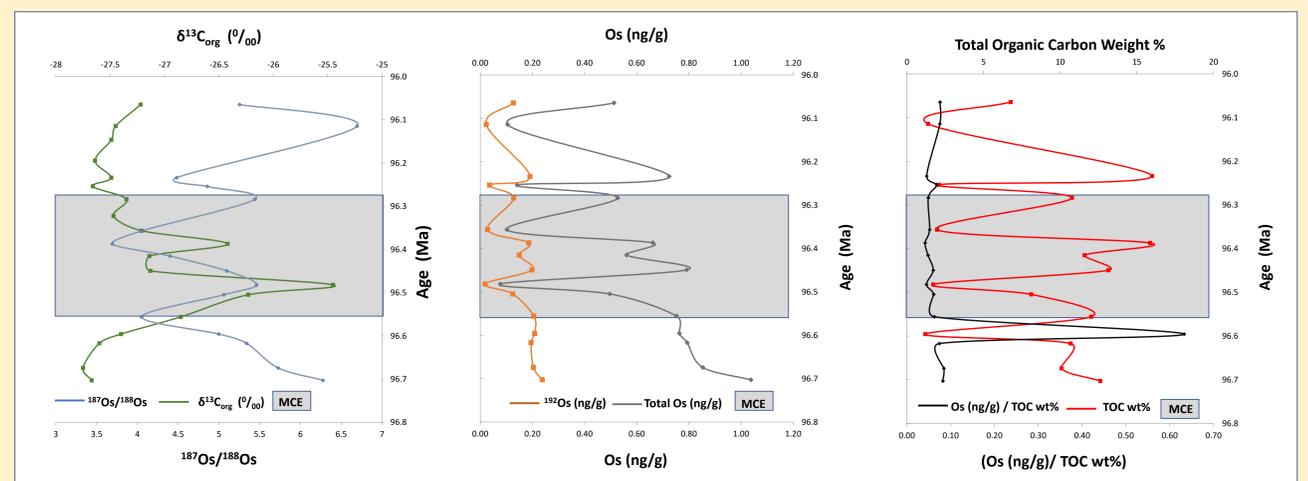


Figure 4 – $^{187}\text{Os}/^{188}\text{Os}$ and $\delta^{13}\text{C}$

Figure 5 – Total Os (ng/g) and ^{192}Os (ng/g)

Figure 6 – TOC wt% and ^{192}Os (ng/g) / TOC wt%

Discussion

- Possible Shift in $^{187}\text{Os}/^{188}\text{Os}$ during MCE towards unradiogenic (lower) values
- No discernable enrichment in osmium during MCE; dramatic enrichment prior to MCE

Conclusions

Conclusions

- The $^{187}\text{Os}/^{188}\text{Os}$ profile superficially resembles the Os_i profile from OAE-2
- Unlike OAE-2, Os is not enriched throughout the MCE
 - MCE was a more limited event

Future Work

- After Re has been measured, Os can be calculated
- More samples from above and below the MCE will be measured
- Other geochemical information (e.g. Mo, U and V concentrations) should be integrated with the current data

References

- Cocconi, R., and S. Galeotti, 2003, The mid-Cenomanian Event: prelude to OAE 2: Palaeogeography, Palaeoclimatology, Palaeoecology, v. 190, p. 427-440.
- Cohen, A. S., and F. G. Waters, 1996, Separation of osmium from geological materials by solvent extraction for analysis by thermal ionisation mass spectrometry: Analytica Chimica Acta, v. 332, p. 269-275.
- Creaser, R. A., D. A. Papanastassiou, and G. J. Wasserburg, 1991, Negative thermal ion mass spectrometry of osmium, rhenium and iridium: Geochimica et Cosmochimica Acta, v. 55, p. 397-401.
- Du Vivier, A. D. C., D. Selby, B. B. Sageman, I. Jarvis, D. R. Gröcke, and S. Voigt, 2014b, Marine $^{187}\text{Os}/^{188}\text{Os}$ isotope stratigraphy reveals the interaction of volcanism and ocean circulation during Oceanic Anoxic Event 2: Earth and Planetary Science Letters, v. 389, p. 23-33.
- Eldrett, J. S., D. Minisini, and S. C. Bergman, 2014, Decoupling of the carbon cycle during Oceanic Anoxic Event 2: Geology, v. 42, p. 567-570.
- Jenkyns, H. C. C. Q., 2010, Geochemistry of oceanic anoxic events, v. 11.
- Peucker-Ehrenbrink, B., and G. Ravizza, 2012, Chapter 8 - Osmium Isotope Stratigraphy, The Geologic Time Scale: Boston, Elsevier, p. 145-166.
- Turgeon, S. C., and R. A. Creaser, 2008, Cretaceous oceanic anoxic event 2 triggered by a massive magmatic episode: Nature, v. 454, p. 323-326.
- Xin-Yuan, Z., H. C. Jenkyns, A. S. Gale, D. J. Ward, and G. M. Henderson, 2016, A climatic control on reorganization of ocean circulation during the mid-Cenomanian event and Cenomanian-Turonian oceanic anoxic event (OAE 2): Nd isotope evidence: Geology, v. 44, p. 151-154.