An Investigation of Cerium Anomalies in the Cretaceous Western Interior Seaway

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Background

Mid-Cenomanian Event (MCE) and Ocean Anoxic Event 2 (OAE-2)

- Cretaceous carbon cycle perturbations: comparable $\delta^{13}C$ excursions, widespread marine anoxia, shared lithologies, temperature maximums, and organic carbon burial[1, 5, 6, 9]
- OAE-2 Caribbean Large Igneous Province and/or High Arctic Large Igneous Province triggering: $^{187}Os/^{188}Os$, Hg/TOC, and εNd evidence[2, 13, 14]
- Increased weathering and accelerated hydrologic cycle response to elevated pCO_2[12,14]
- However, evidence for MCE comparable chronology absent or contradictory[1, 5, 6, 13]

Os-isotope Systematics

- Two sources of osmium to seawater, $^{187}Os/^{188}Os$ varies:[2, 11, 14]
  1. Weathering of radiogenic continental crust: $^{187}Os/^{188}Os$ ~ 1.4
  2. Hydrothermal alteration of basaltic rock: $^{187}Os/^{188}Os$ ~ 0.14 - 0.2
- Correct for ^{187}Re β^- decay to recover ancient seawater $^{187}Os/^{188}Os$ (Os_i)[11]

Iona-1 Core

- Well-characterized core representative of Southern Western Interior Seaway[3, 4, 10; *Figure 1*]

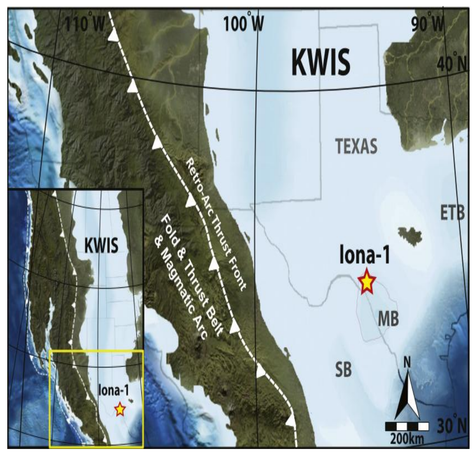

Figure 1. Approximate locations of Iona-1, High Arctic Large Igneous Province, and Caribbean Large Igneous Province (from Eldrett et al., 2014)

Results

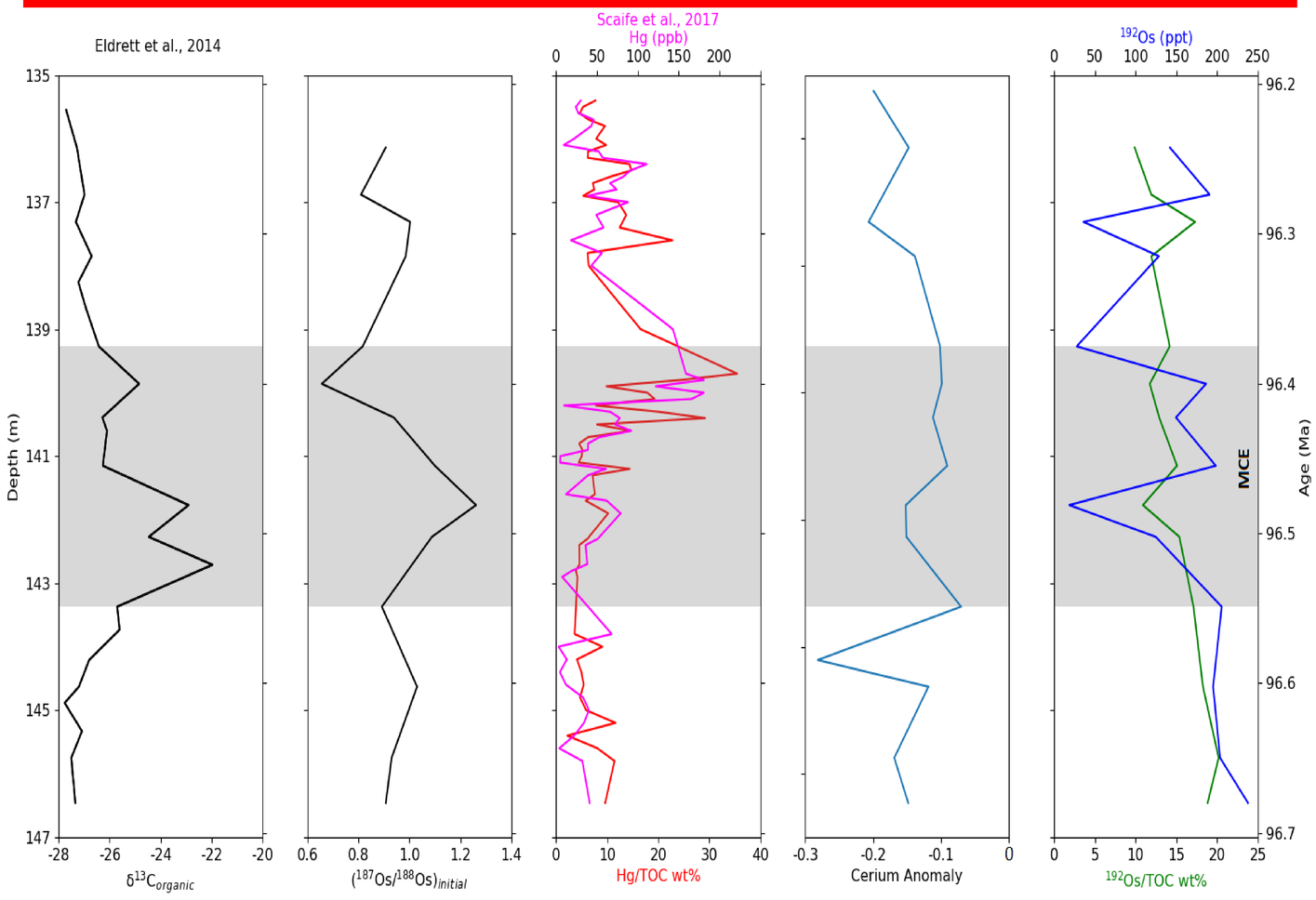

Figure 2. Iona-1 chemostratigraphy: a. δ13C_{org} excursions define event b. seawater Os_i c. Hg (ppb) and Hg / TOC wt% (Scaife et al., 2017) d. ^{192}Os (ppt) and ^{192}Os / TOC wt%

Results (continued)

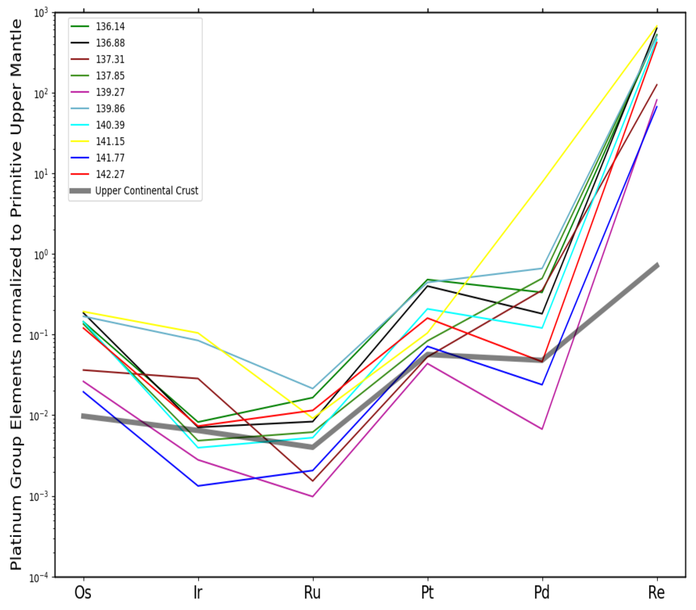

Figure 3. CI-normalized platinum group element and rhenium abundances (PUM: Becket et al., 2006; UCC: Chen et al., 2016

Discussion

Hypothesis 1: Weathering response independent of volcanic activity

- Abundant evidence for increased weathering Ocean Anoxic Event 2; first evidence Mid-Cenomanian Event
- OAE-2: Plenus Cold Event $\delta^{18}O$ maximum, temperature minimum, and decreased weathering rates
- MCE: comparable cold event *may* correspond with sea-level fall
- Though very unlikely, low Os_i could reflect low weathering rates due to glaciations

Hypothesis 2: Seawater Os_i reflects large igneous province activity

- Ocean Anoxic Event 2 preceded by mantle-like Os_i; expected analagous for Mid-Cenomanian Event
- However, excursion to Os_i minimum corresponds with Hg and Hg/TOC enrichments*Figure 2*
- Delayed, muted unradiogenic excursion implicates High Arctic Large Igneous Province?

Conclusions and Future Work

- $^{187}Os/^{188}Os$ records of Mid-Cenomanian Event and Ocean Anoxic Event 2 fundamentally different
- Countenance both hypotheses until more data constrain chronology of Mid-Cenomanian Event:
  1. Os_i determinations across proto-Atlantic *sensu* Du Vivier et al., 2014; 2. εNd studies of MCE in Iona-1; and 3. Further study of existing platinum group element data

Citations

1. Coccioni and Galeotti, 2003: *Palaeogeography, Palaeoclimatology, Palaeoecology*; 2. Du Vivier et al., 2014: *Earth and Planetary Science Letters*; 3. Eldrett et al., 2014: *Geology*; 4. Eldrett et al., 2017: *Climate of the Past*; 5. Friedrich et al., 2009: *Marine Micropaleontology*: 6. Giraud et al., 2013: *Cretaceous Research*; 7. Jarvis et al., 2017: *European Geosciences Union General Assembly*; 8. Jarvis et al., 2018: *European Geosciences Union General Assembly*; 9. Jenkyns, 2010: *G³*; 10. Minisini et al., 2018: Sedimentology; 11. Peucker-Ehrenbrink and Ravizza, 2012: *Geologic Time Scale 2012*; 12. Pogge von Standmann et al., 2013: *Nature Geoscience*; 13. Scaife et al., 2017:*G³*; 14. Turgeon and Creaser, 2008: *Nature*; 15. Voigt et al., 2004: *Paleoceanography*