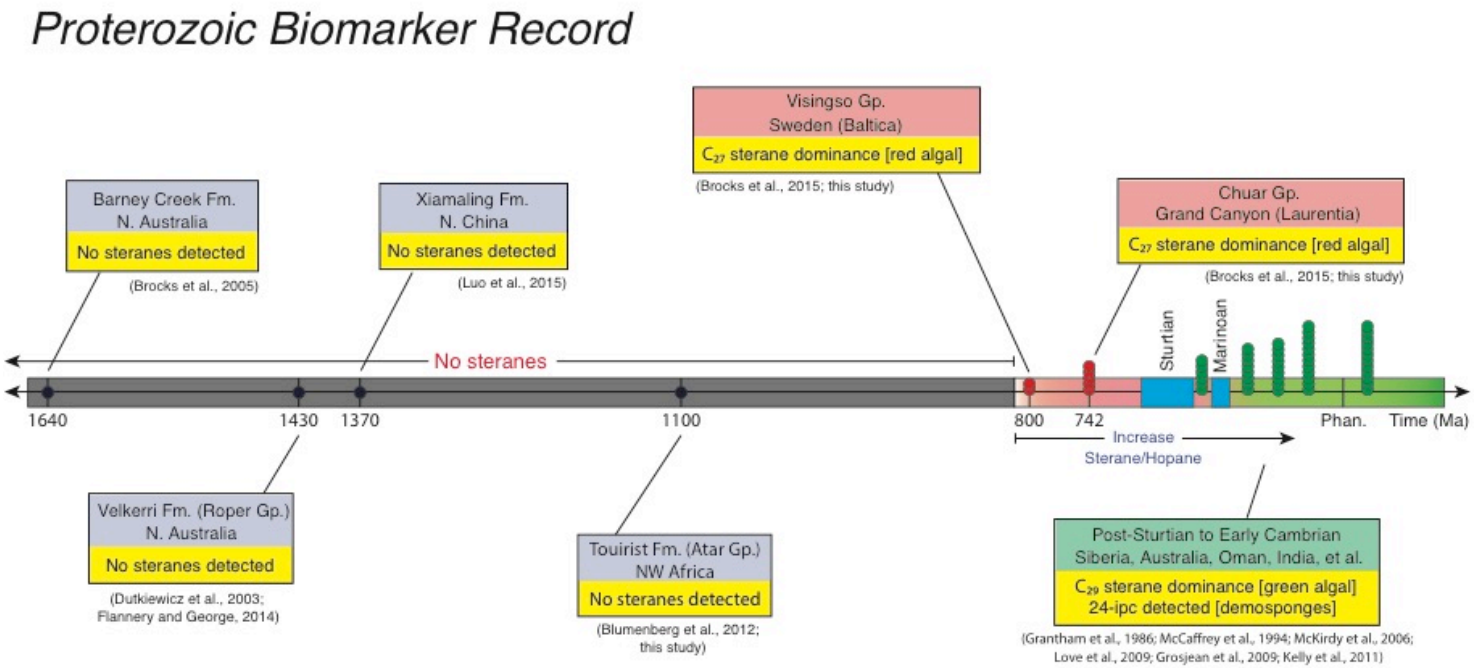
tracking the rise of eukaryotes—geochemical proxies & genomic perspectives

Christopher Dupont
NASA Astrobiology Institute
J. Craig Venter Institute

tracking the rise of eukaryotes – geochemical proxies

- Limited number of thermal inmature Proterozoic unit
- Poor constraints on when the transition to extensive eukaryotic export productivity
- Biomarker records provide local signals



tracking the rise of eukaryotes – geochemical proxies

- Limited number of thermal inmature Proterozoic units
- Poor constraints on when the transition to extensive eukaryotic export productivity
- Biomarker records provide local signals

Can we use Zn isotopes to track
Eukaryotes Rise to Prominence?

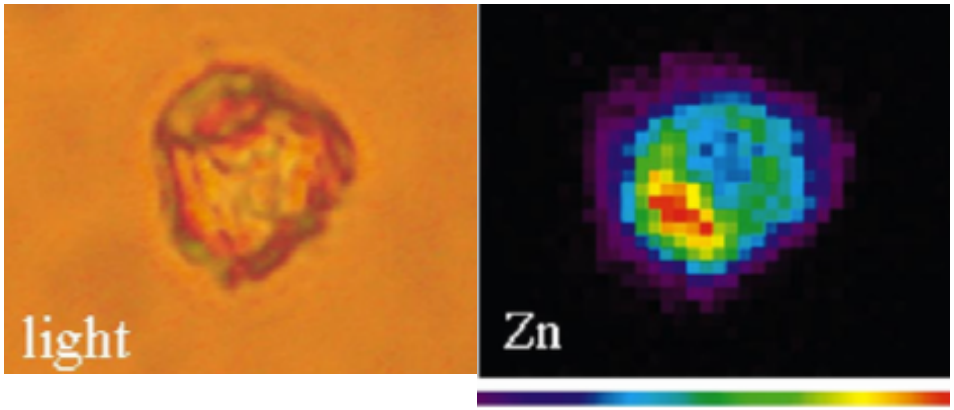
biological zinc requirements

Modern Phytoplankton Zn : C (µmol/mol)

Eukaryotes : 102 ± 20 (Ave) - (Twining et al., 2003; 2004)

Cyanobacteria : 17 ± 14 (Ave.) - (Nuester et al., 2012)

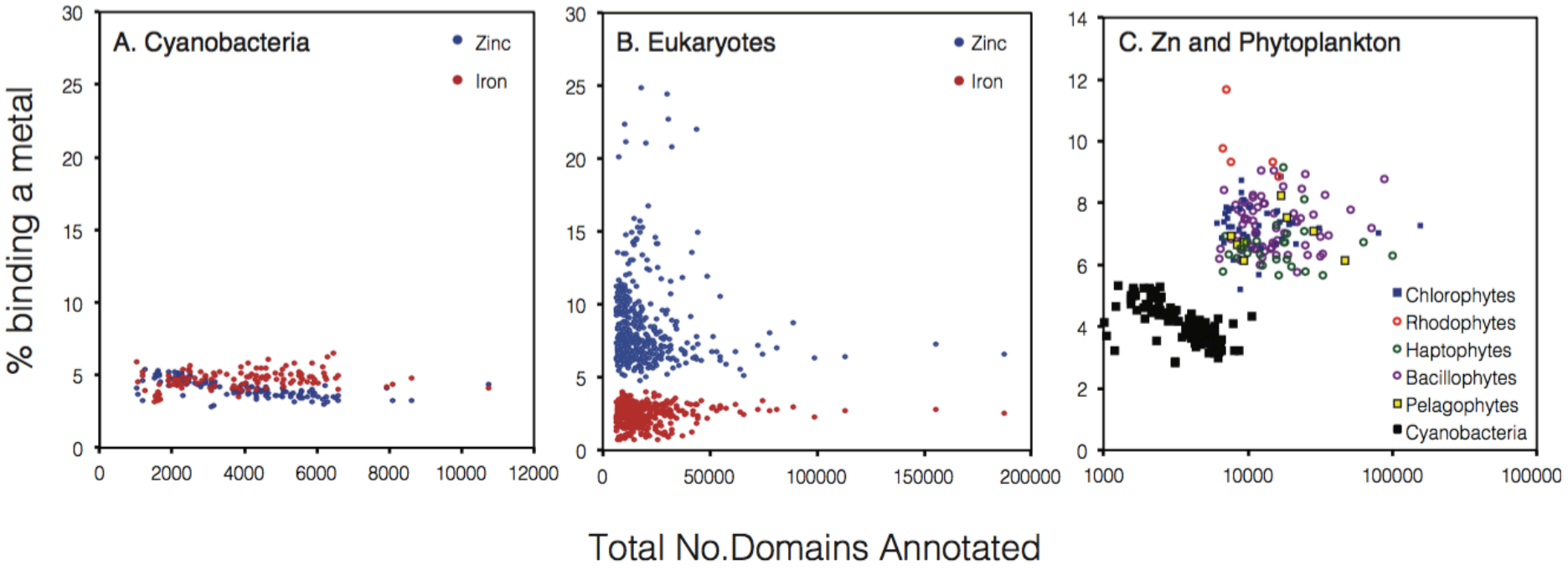
Much of this difference comes from proteins (e.g Zn Fingers) found within the nucleus



SXRF element maps of a centric diatom - *Southern Ocean*

Twining et al., 2003; 2004

A Census of Zinc Binding Protein Domains (Structural Bioinformatics & Whole Genome Sequences)

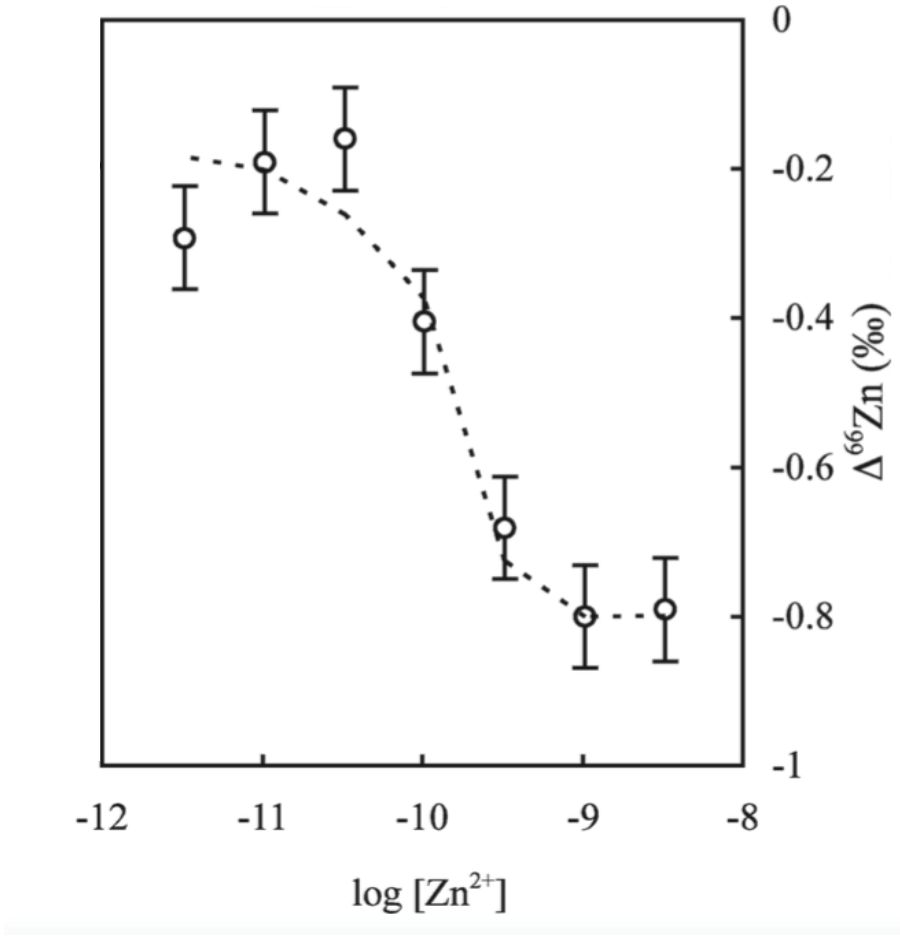


- Database: SCOP; Cyano-GEBA; MMETSP
- Whole genome sequences of known cyanobacteria and eukaryotes
- Determine the number of metal binding domains coded for in each proteome
- Zinc is one of the most abundant inorganic co-factor in eukaryotic enzymes – a fundamental genetic difference from prokaryotes

(Terry Tang et al., – *in review*)

tracking the rise of eukaryotes – geochemical proxies

Can we use Zn isotopes to track Eukaryotes Rise to Prominence?

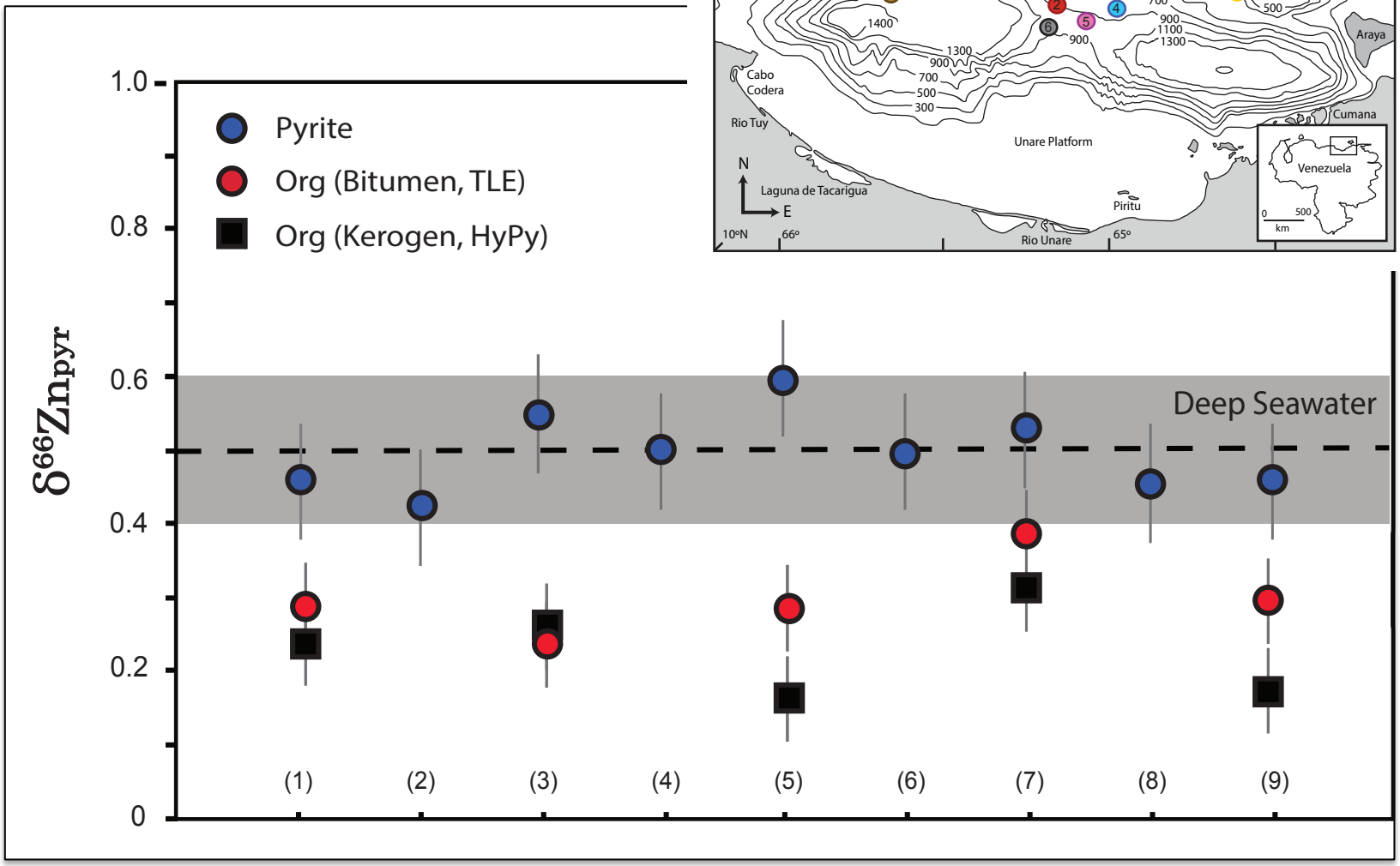


A Culture Study
(John et al., 2007)

Magnitude of
Δ^{66}Zn (SW-ORG)
dependent on
Zn bio-availability

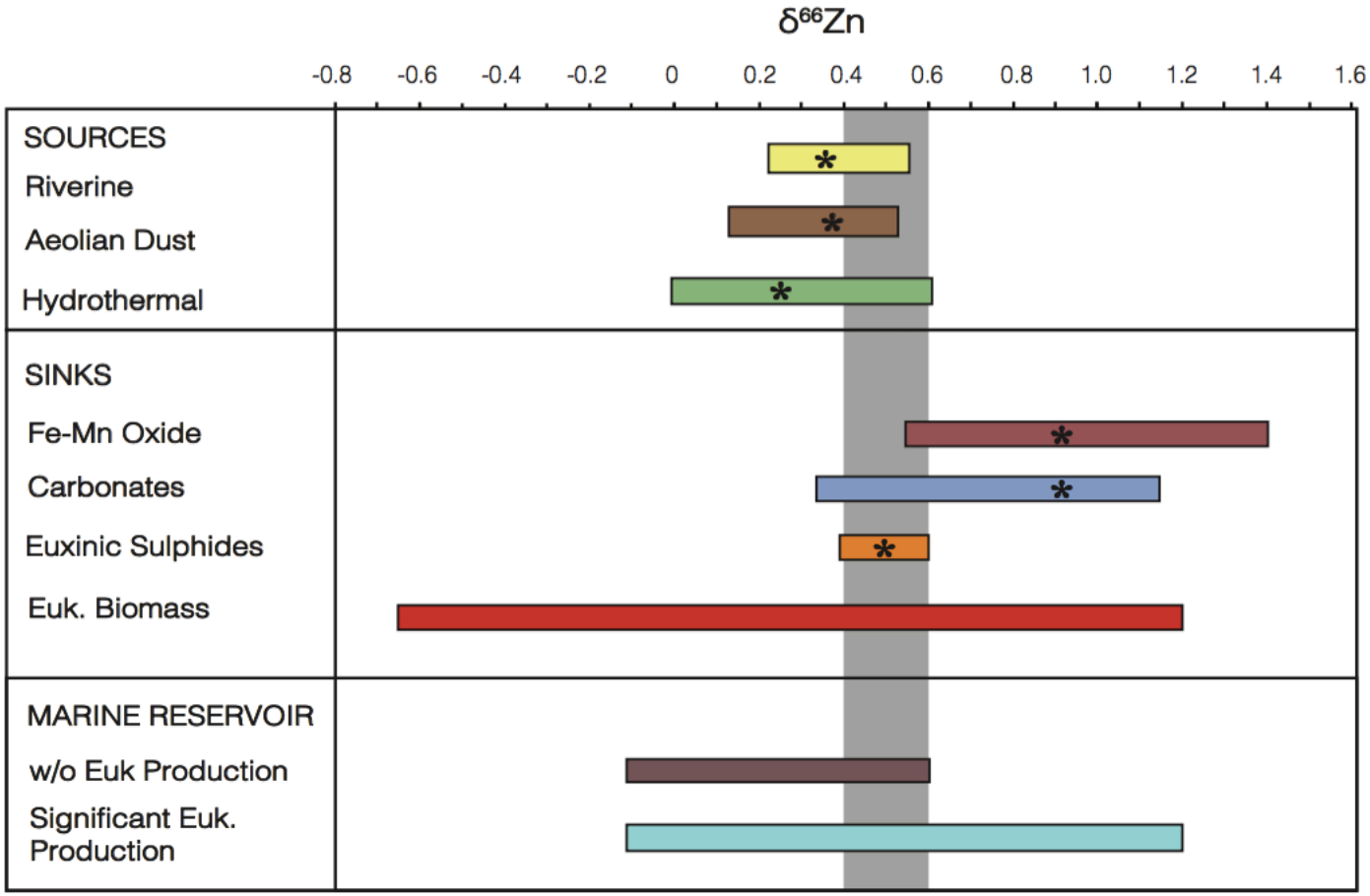
tracking the rise of eukaryotes – geochemical proxies

Core Top Calibration
Cariaco Basin (Euxinic)



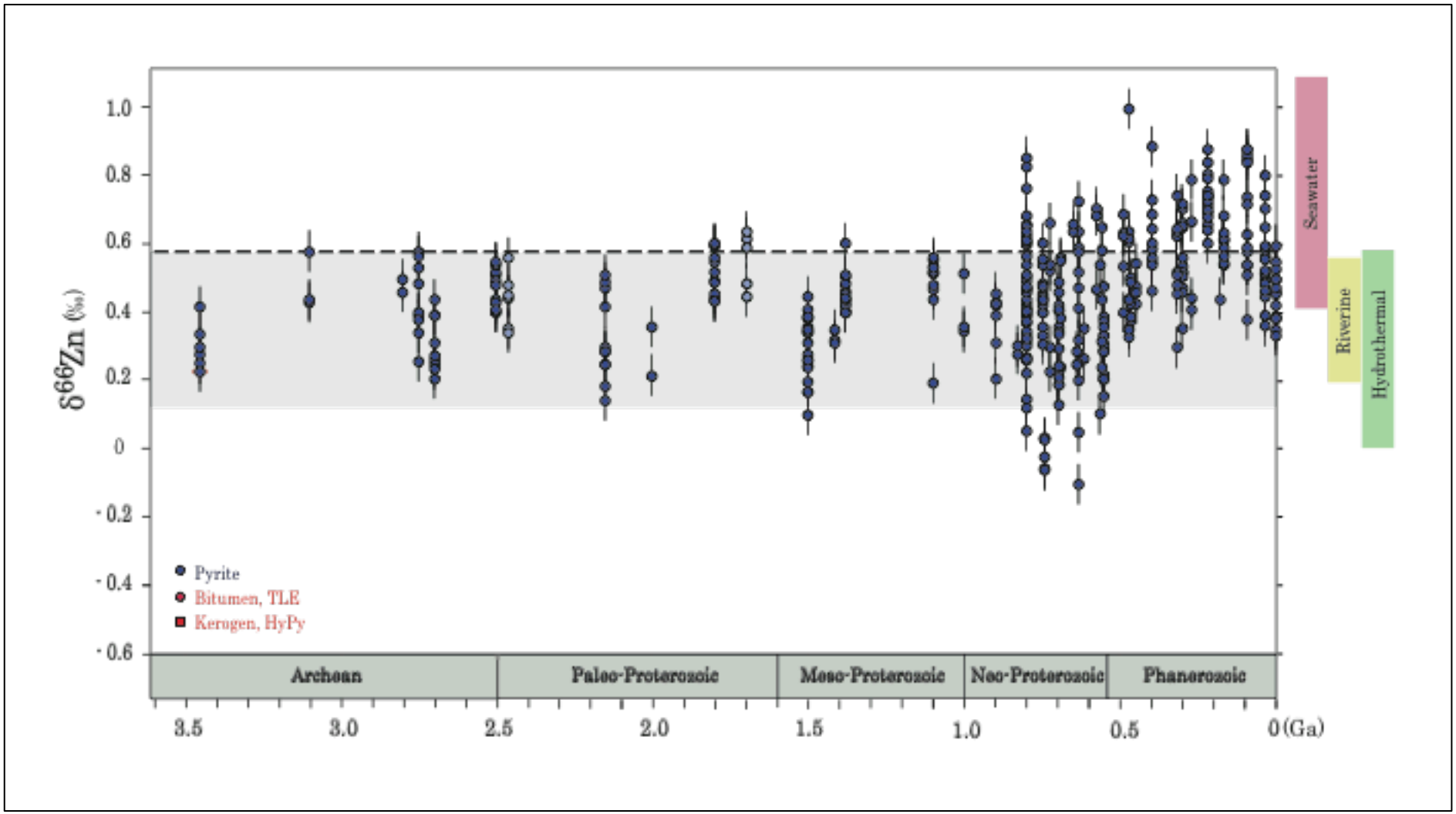
tracking the rise of eukaryotes – geochemical proxies

Can we use Zn isotopes to track Eukaryotes Rise to Prominence?



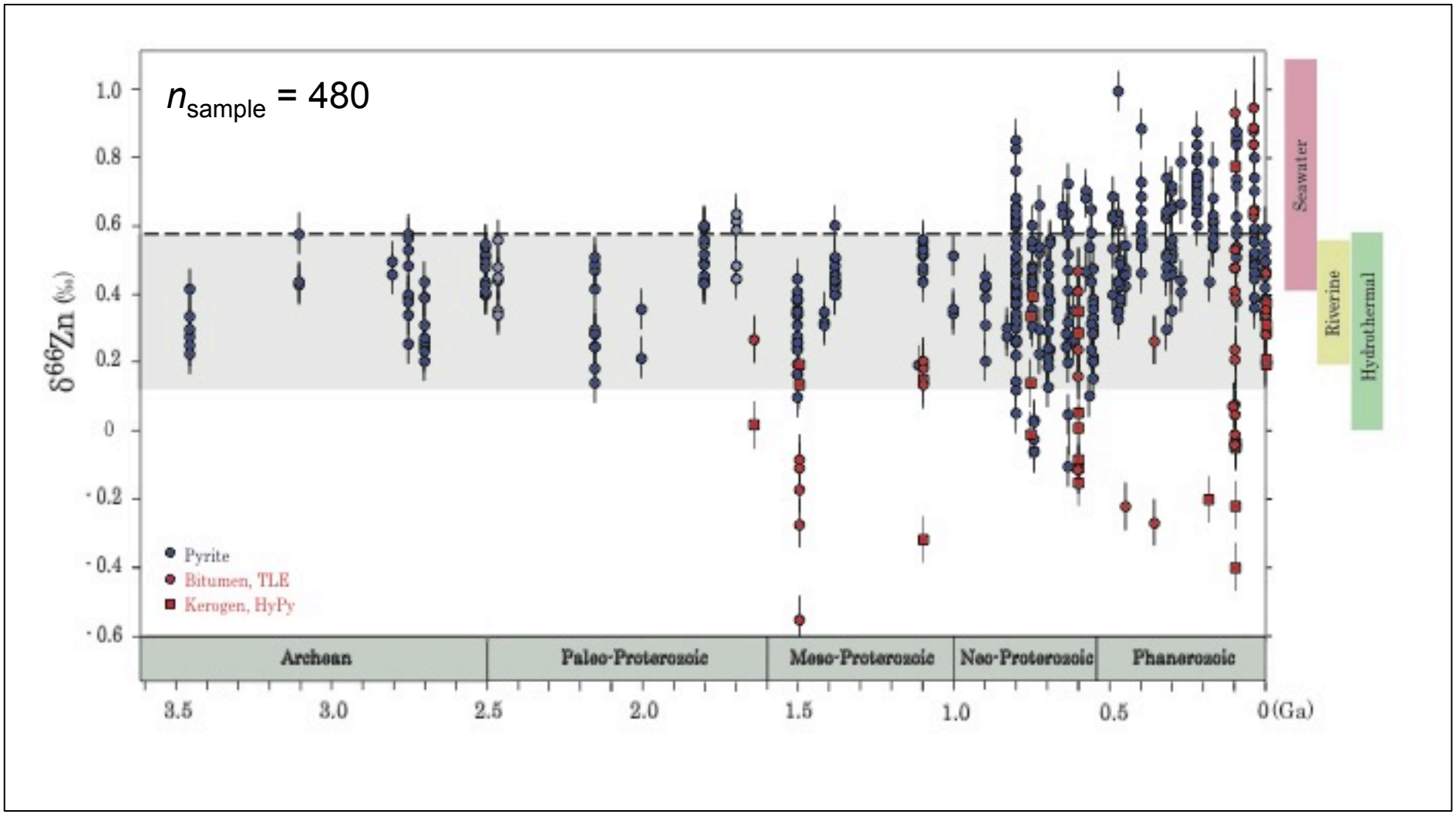
tracking the rise of eukaryotes – geochemical proxies

A Mid Neoproterozoic Ecological Revolution



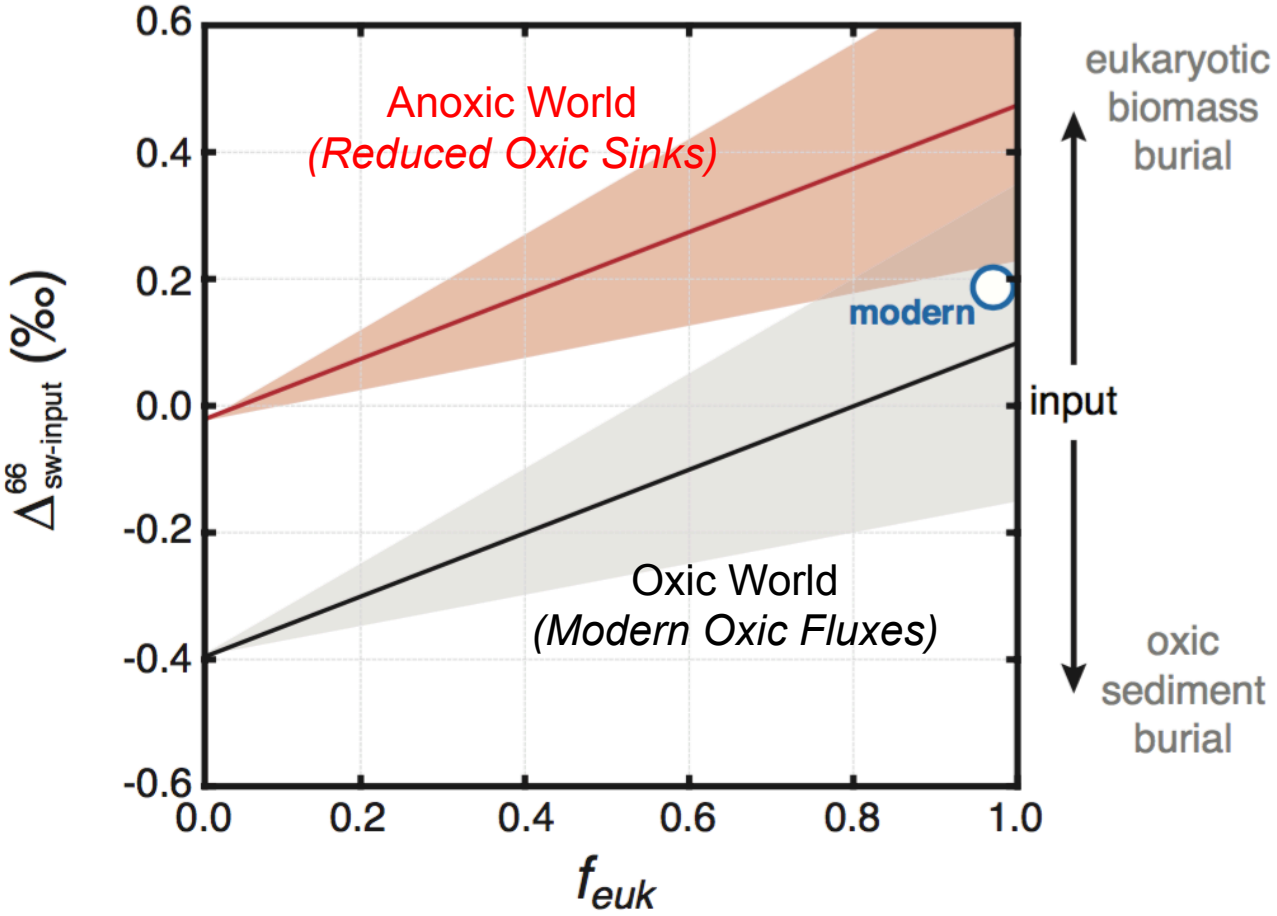
tracking the rise of eukaryotes – geochemical proxies

A Mid Neoproterozoic Ecological Revolution



tracking the rise of eukaryotes – geochemical proxies

Can we use Zn isotopes to track Eukaryotes Rise to Prominence?



$$f_{euk} = \frac{Euk}{Euk + Sulph}$$

tracking the rise of eukaryotes – geochemical proxies

1) Zn isotopes provide a powerful method of tracking ecological shifts between cyanobacterial and eukaryotic productivity

2) 800 Ma Ecological Revolution
   - 80 Myrs before the onset of Cryogenian Snowball events
   - Coincident with the onset of significant carbon cycle perturbations