

# It's not U, it's Th(em): dating stylasterid corals is complicated

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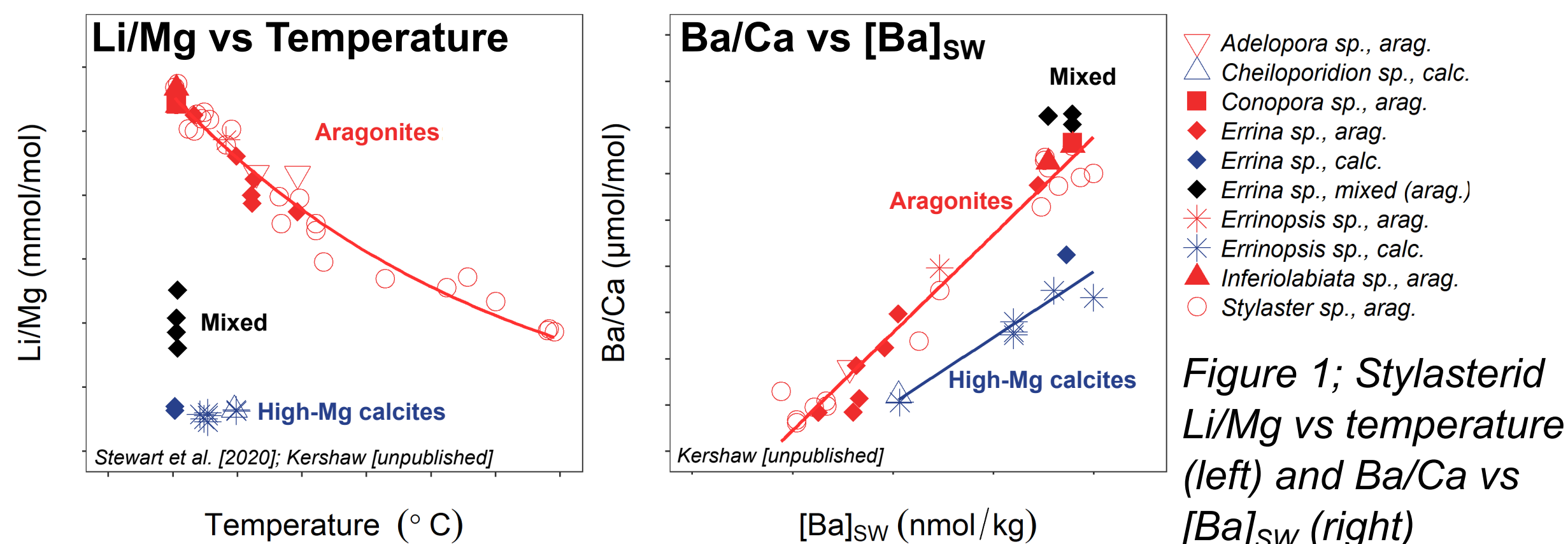
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## Introduction

- Stylasterids are a group of azooxanthellate, hydrozoan corals which build carbonate skeletons from aragonite, high-Mg calcite or a mixture of the two
- Their inorganic skeletal geochemistry shows promise as a palaeoceanographic tool<sup>1,2</sup> (figure 1), if their skeletons can be precisely and accurately dated
- While scleractinian deep-sea corals are routinely dated using U-series methods,<sup>3</sup> no studies have applied this technique to stylasterid skeletons



## Aims

- 1) Investigate U-series dating of stylasterid coral skeletons
- 2) Apply established stylasterid geochemical proxies in palaeoceanographic contexts

## Methods

- Live and sub-fossil stylasterid samples analysed from locations in the Southern, Atlantic and Pacific oceans
- **Element/Ca ratios** measured using a Thermo Element ICP-MS. Samples were oxidatively cleaned prior to measurements
- **Isotopes of U and Th** measured using a Thermo Finnigan Neptune MC-ICP-MS, following established techniques.<sup>3</sup> Prior to analysis, samples were mechanically and chemically cleaned

## Results and Discussion

### Established method produces uncertain ages

- Established methods for dating deep-sea corals use the following equation:<sup>4</sup>

$$\left\{ \frac{\left[ \frac{^{230}\text{Th}}{^{238}\text{U}} \right] - \left[ \frac{^{232}\text{Th}}{^{238}\text{U}} \right] \left[ \frac{^{230}\text{Th}}{^{232}\text{Th}} \right]}{e^{-\lambda_{230}t}} \right\} - 1 = -e^{-\lambda_{230}t} + \left( \frac{\delta^{234}\text{U}_m}{1000} \right) \left( \frac{\lambda_{230}}{\lambda_{230} - \lambda_{234}} \right) (1 - e^{-(\lambda_{230} - \lambda_{234})t})$$

Correction for non-radiogenic Th

- For stylasterids, correction for non-radiogenic <sup>230</sup>Th has a large effect on calculated ages
- This results in large (1000's years) age uncertainties, compared to < 100 years for scleractinian corals

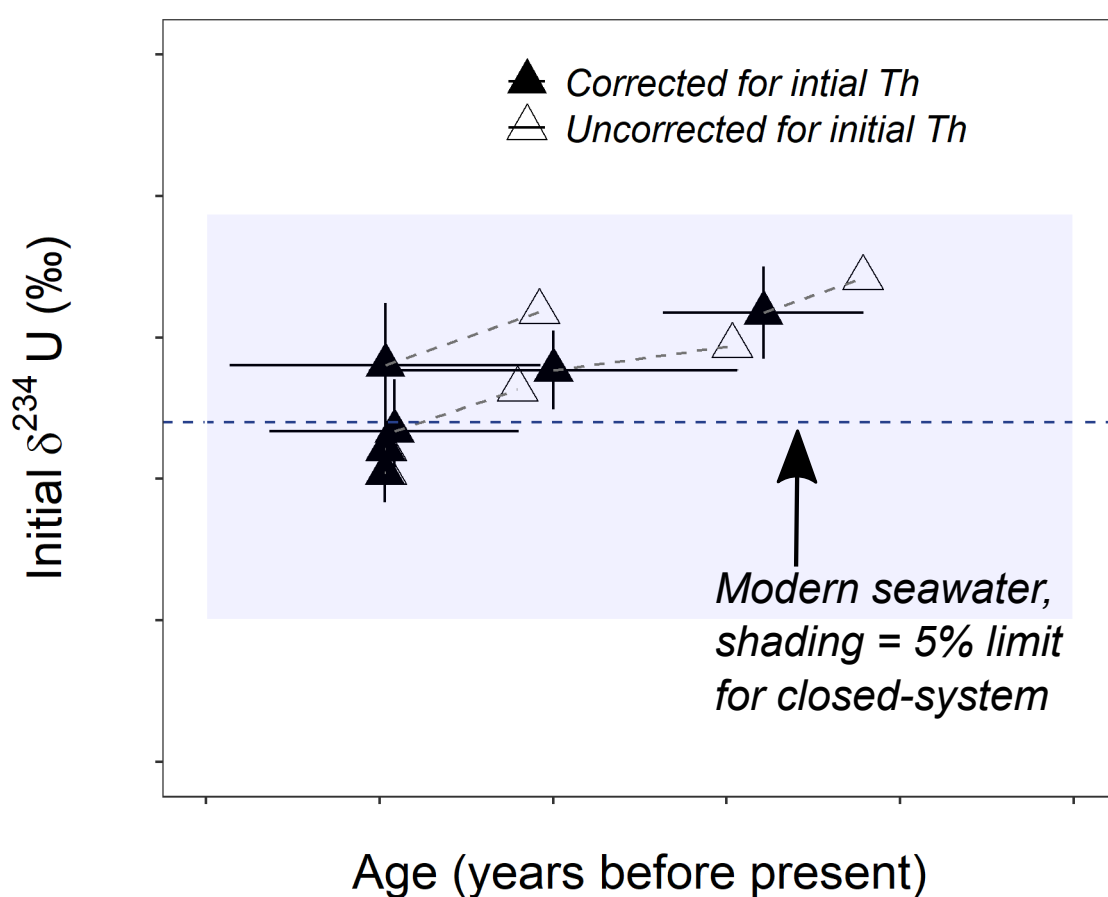


Figure 2; U-series ages of stylasterid samples, note all samples show closed-system evolution

### Due to low skeletal [U] and high [<sup>232</sup>Th]

- Stylasterids have lower U/Ca than deep-sea scleractinian corals
- **Low skeletal [U] results in small amounts of radiogenic <sup>230</sup>Th production**

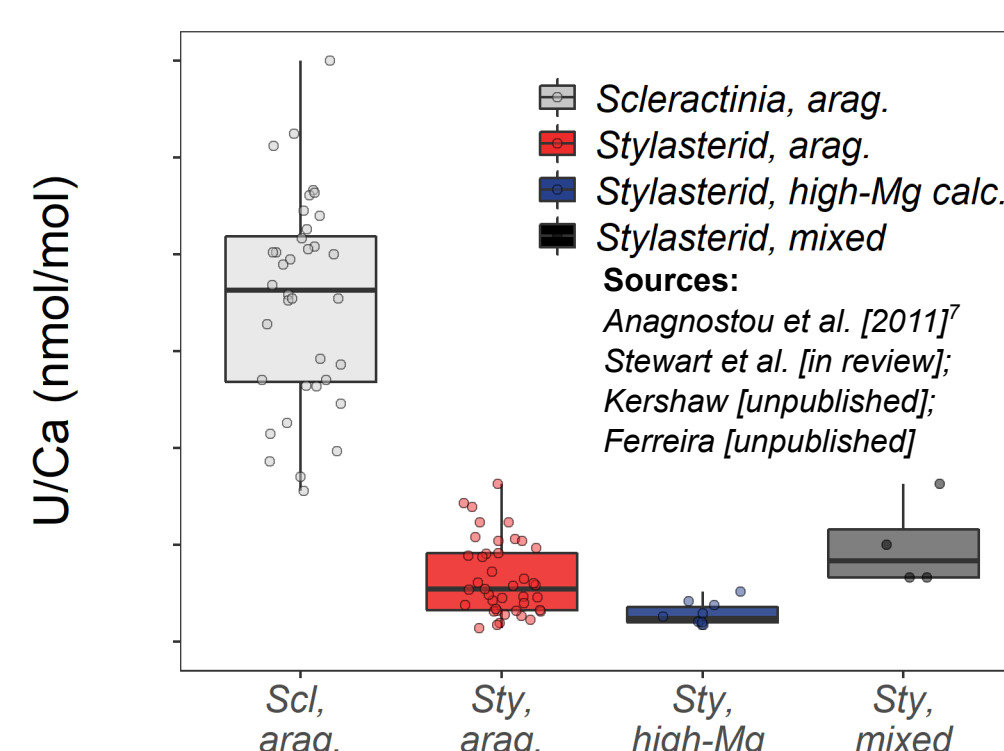


Figure 3; Azooxanthellate coral U/Ca ratios

- Stylasterids skeletons are also porous, and prone to contamination by <sup>232</sup>Th-bearing phases, such as clays (Figure 4)
- **This results in high <sup>232</sup>Th/<sup>238</sup>U, and a large relative correction for non-radiogenic <sup>230</sup>Th**

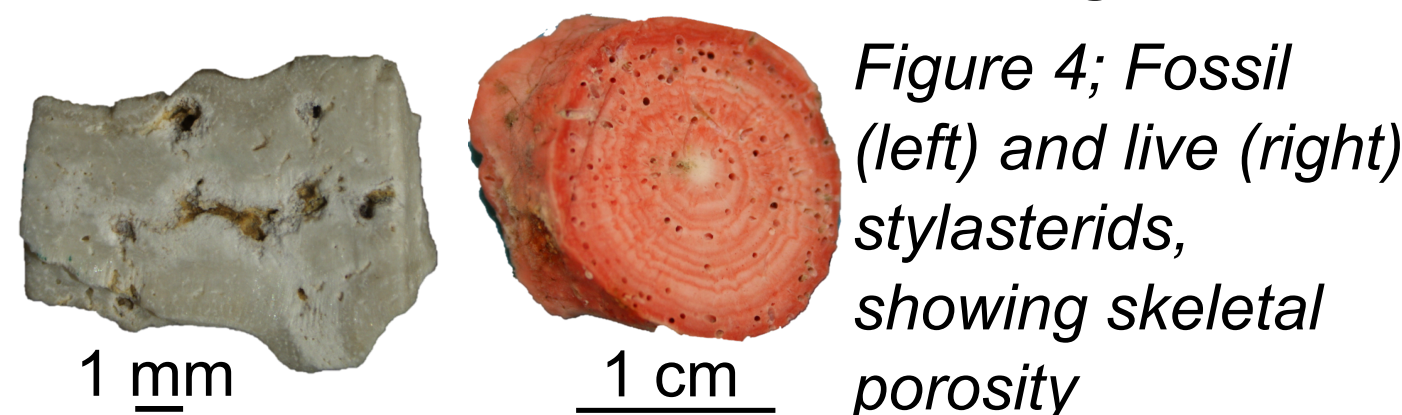


Figure 4; Fossil (left) and live (right) stylasterids, showing skeletal porosity

### Isochron approach could reduce uncertainty

- Measure multiple subsamples from the same coral to provide accurate constraint on initial <sup>230</sup>Th/<sup>232</sup>Th, specific to each coral
- Age uncertainties apparently reduced (100's years), but...
- Isochron significantly over-dispersed (MSWD >> 1), indicating open-system behaviour and/or multiple sources of detrital Th
- Suggests ages and errors are suspect

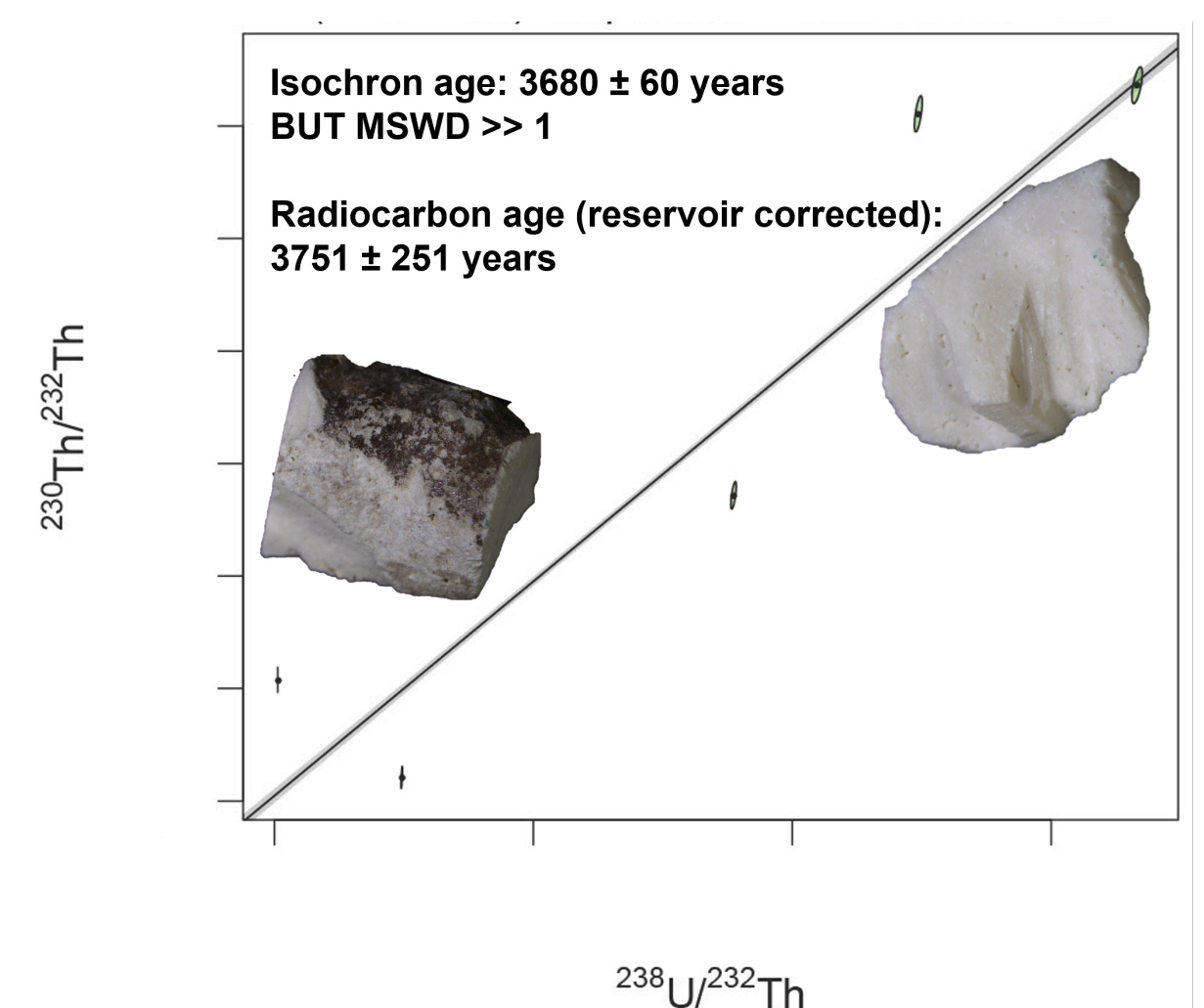


Figure 5; Example of stylasterid isochron. Produced using IsoplotR<sup>5</sup>

## Conclusions

- Low [U] in stylasterid skeletons complicates application of U-series dating techniques
- Substantial relative correction for non-radiogenic <sup>230</sup>Th creates large age uncertainties
- Isochron techniques provide a method to more accurately constrain initial <sup>230</sup>Th/<sup>232</sup>Th ratios and improve chronological precision. Future work will study this method in more detail
- Stylasterids may be of more use as archives of recent oceanographic change,<sup>6</sup> with radiocarbon-dated records a priority for future work

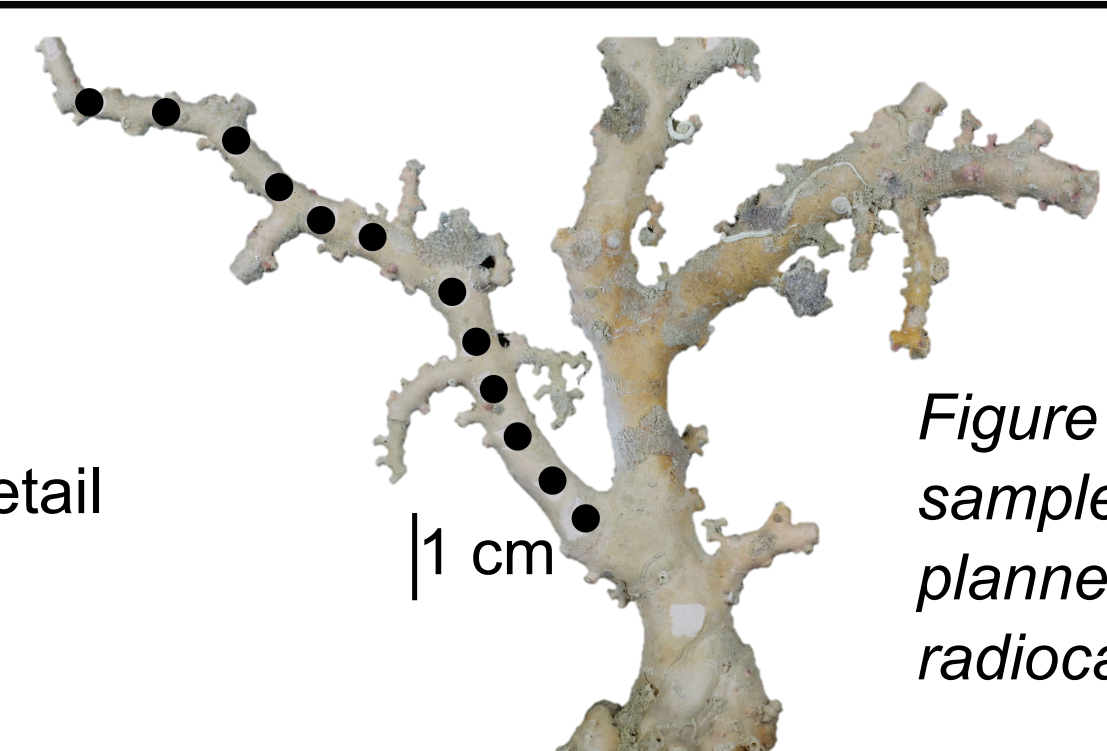


Figure 6; Large stylasterid sample, black dots show planned sampling for radiocarbon record.