Seasonality in the Mediterranean Sea: a calibration study using paired single specimen $\delta^{18}O$ and Mg/Ca measurements of *G. ruber alba*

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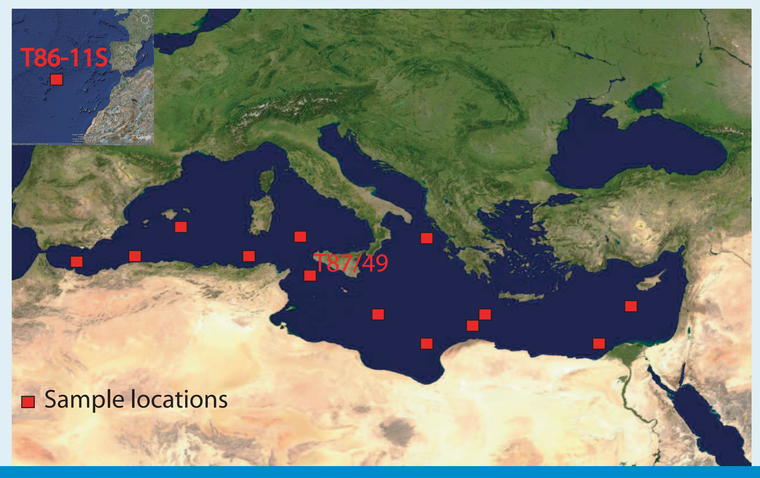
Introduction

Seasonality is increasingly recognised as an important parameter of the climate system. We investigated a novel approach for reconstructing seasonality using paired $\delta^{18}O$ and Mg/Ca measurements on single planktic foraminifera *G. ruber alba*. The Mediterranean Sea was selected for calibrating and testing this approach, because seasonality will be a dominant factor in this basin due to its semi-enclosed properties. A central North Atlantic site was used in order to assess the applicability of the method in an open ocean setting.

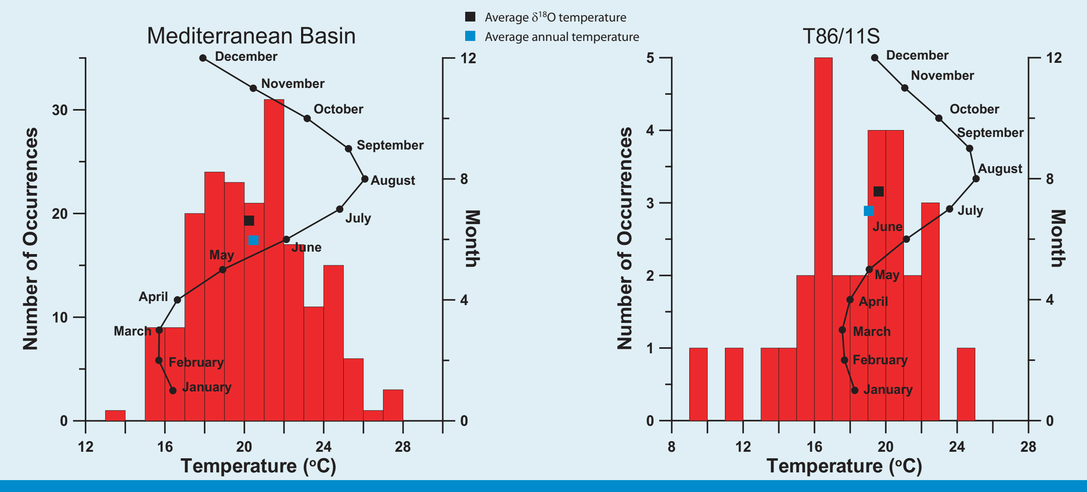
Sample Locations

- 13 boxcores from the Mediterannean Basin and 1 from the Atlantic Ocean are used
- 7-34 single Specimen *G. ruber alba*'s are measured per station for stable isotope analyses
- 15-47 single specimen *G. ruber alba*'s are measured at station T86-11S and T87/49 for laser ablation Mg/Ca analyses



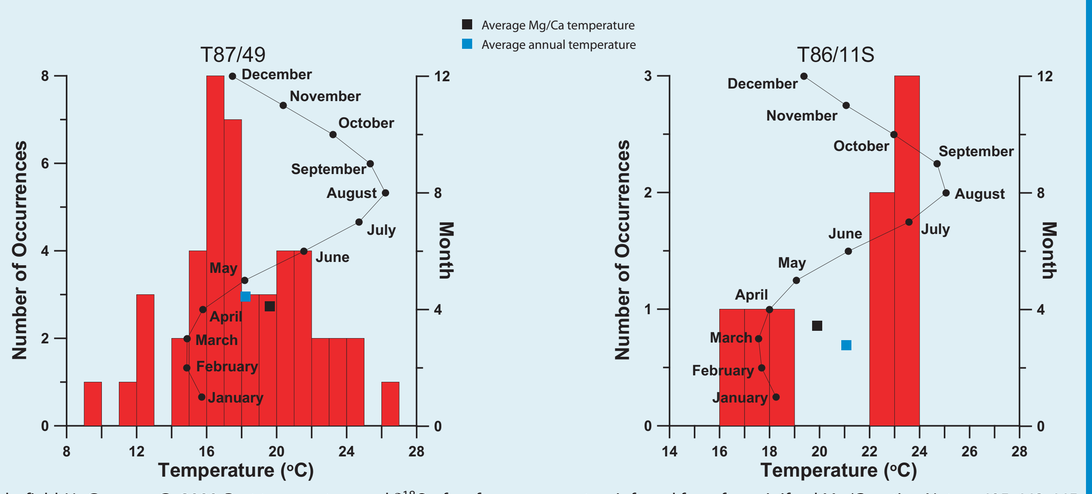
$\delta^{18}O$

- Temperature is calculated with:
  $T = 16.9 - 4.38(\delta^{18}O_c - \delta^{18}O_w) + 0.1(\delta^{18}O_c - \delta^{18}O_w)^2$
- $\delta^{18}O_w$ is calculated with the relation between $\delta^{18}O_w$ and salinity in the Mediterannean basin and Atlantic Ocean
- Monthly temperature and salinity values for each station are obtained from the World Ocean Atlas 01



Mg/Ca

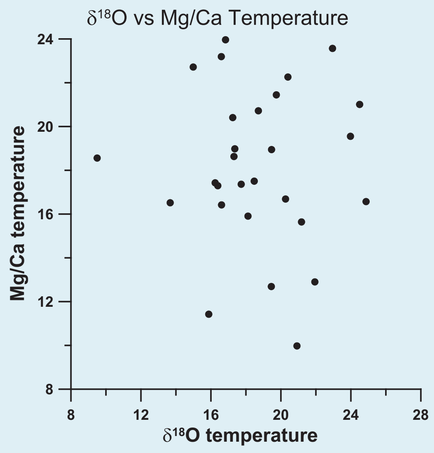
- Temperature is calculated with the formula of Elderfield and Ganssen (2000): $T = 10\ LN(1.92\ Mg/Ca)$
- Multiple measurements on a single foraminifera are averaged
- Intra-test variation varies between 0.03 and 4.22 mmol/mol (0.06 and 9.81 °C)



Elderfield, H., Ganssen, G., 2000, Past temperature and $\delta^{18}O$ of surface ocean waters inferred from foraminiferal Mg/Ca ratios, Nature 405, 442-445

$\delta^{18}O$ vs Mg/Ca Temperature

- Inter-test $\delta^{18}O$ and Mg/Ca temperature variation concurs with seasonal variability, however no correlation is observed
- Calculated temperatures can be influenced by fluctuations in salinty, $[CO_3^{2-}]$ and/or symbiont activity
- Fluctuations in salinity and $[CO_3^{2-}]$ can explain 2.6-11.7% and 0.92-11.7% respectively of the observed variation



Conclusions

$\delta^{18}O$ temperature variations in single specimen *G. ruber alba* reflect measured sea surface (0-50 m) temperatures at both sites. This suggests that single specimen measurements of $^{18}O/^{16}O$ isotopes from *G. ruber alba* allows the reconstruction of seasonality. The variations observed in single specimen analyses of Mg/Ca show a similar variability in reconstructed temperatures. However, when comparing Mg/Ca and $\delta^{18}O$ based temperatures no correlation is observed, indicating an offset in one or both temperature proxies. Mg/Ca measurements show large intra-test variability, which cannot be linked to changes in ambient seawater chemistry, but might be connected to fluctuations in symbiont activity during test formation. An assessment of the mechanisms behind this offset and the intra-test Mg/Ca variation together with its possible influence on the oxygen isotopes is therefore needed to improve the reconstruction of seasonality.

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