Exploring the Consistency of Alkenone and Faunal-Based Sea Surface Temperature Reconstructions from the Southwest Pacific during the Pleistocene
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Abstract

Geochemical and biogenic proxies are useful tools for the paleoclimatologist in reconstructing past climate conditions in order to better understand future changes in climate. Because not every proxy is viable at all geographical locations, sea surface temperature (SST) estimates from multiple proxies are often compiled into global or regional climate reconstructions with the implicit assumption that estimates derived from different proxies can be interchanged. However, limited evidence currently exists to support the validity of this assumption. Using paleotemperature data from sediment collected from ODP Site 1125 (22°31’S, 169°09’W), 1365 meters water depth in the Southwest Pacific Ocean. Presently, Site 1125 is located on the north side of Chatham Rise and lies under the northern edge of the Subtropical Convergence (STC), just to the east of the New Zealand micro-continent (Shipboard Scientific Party 2000). Modern mean annual SST is approximately 1.6°C (Hayward et al. 2008).

Methods

Alkenone Paleothermometers

Alkenones are lipid biomarkers derived from hexapod algae, primarily E. huxleyi (Fig. 3c) and pachyderm (Fig. 3b). These lipids are isolated using an accelerated solvent extraction (ASE) and then analyzed by gas chromatography (Herbert et al. 1999). Typical gas chromatograph report (Herbert et al. 1999).

Faunal Paleothermometers

Faunal assemblages are composed of inorganic carbon shells of planktonic foraminifera that are preserved in sediment. Through the Modern Analog Technique (MAT), they are compared to modern-day assemblages around the world of known temperatures (Fig. 4). Hayward et al. (2008) used a number of different planktonic foraminifera species, including N. pachyderma (sinistral), to establish SST estimates for site 1125, and we adjusted that data to fit our own age model.

Results

ODP 1125 Alkenone vs. Faunal Assemblage SST

Our data suggests that these two proxies can be confidently compared and that they provide a consistent view of climate evolution over time. Both proxies display similar linear responses to climate shifts, and are both in phase for the majority of the analysis.

Interpretation

The interchangeability of these two temperature proxies is dependent on which types of climate study one wishes to undertake. These data suggest that the use of these proxies interchangeably should be done cautiously. The correlation between the two proxies is strongly dependent on the specific time interval used (r = 0.64-0.69; [good correlation]) (Fig. 5).

Empirical Studies: Evolution over Time

In the context of time-slice modeling studies, however, it is important to note that the use of these proxies interchangeably could be problematic. For modeling studies, we would not recommend using alkenones in concert with faunal assemblages.

Possible Disagreement for Disagreement

Hypothesis #1: Seasonal Alkenone Bias

DSDP 594 Faunal Assemblage Mean Annual SST vs. Summer SST

Our data suggests that these two proxies can be confidently compared and that they provide a consistent view of climate evolution over time. Both proxies display similar linear responses to climate shifts, and are both in phase for the majority of the analysis.

Hypothesis #2: Movement of the STF

Mean annual faunal SST data from 594 in the older half of the record are within the 1.6°C range suggested by our own age model. After applying a full linear detrend, the autocovariance function, and 225 lags. Only three of the SST records are within error of one another, except during the coldest glacials in the older part of the record.

Conclusions

Alkenone- and faunal-based SST records could be used interchangeably in empirical studies to reconstruct climate evolution over time but could be problematic for modeling studies.

Acknowledgments and References

We would like to thank Marc Robinson for his expertise in analyzing the faunal assemblage data. Kamal Beekuwa for her help with alkenone methodology. John Wilson for his assistance with numerous technical aspects of this project, and many other current and former Lafayette College students for their help in the alkenone data collection process.