Biomineralization mechanisms in foraminifera and corals and their paleoceanographic implications

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Foraminifera and corals $CaCO_3$ shells are highly valuable for paleoceanographic reconstructions. However, their complex biomineralization process, often cause significant deviations from expected chemical and isotopic equilibrium. Our new observations on the calcification mechanisms in foraminifera and corals are based on various microscopic techniques including light, fluorescent, spectral, confocal and electron microscopy. They show several basic features that are common for both groups: Crystal nucleation and growth are mediated by an organic matrix. The shells consist of two types of crystals, primary and secondary, which have different chemical compositions (usually more enriched in trace elements). The solution from which calcification proceed is seawater, which may be slightly modified in its ionic composition. This seawater calcification reservoir is maintained at high pH. The calcification reservoir is behaving as a semi-closed system with respect to trace elements distribution coefficients. Seawater in the calcification reservoir is replaced by intensive vacuolization in foraminifera and by tissue pumping in corals. The implications of these observations for paleoceanography are far reaching. The “good news” is that for their secondary calcification (responsible for more then 90% of the $CaCO_3$ in their shell), foraminifera and corals start with ambient seawater as their initial ingredient. Apparent ddistribution coefficients arising from this semi-closed reservoir can be modelled. Primary calcification in both groups is strongly controlled by the organism in close association with the organic matrix. The primary crystals may significantly deviate from equilibrium (especially with respect to trace elements and stable isotopes in foraminifera). The proportions between these two components and their apparent different solubility may determine the overall chemical and isotopic composition of the shell.

Rapid sea-level, ice-volume and radiocarbon excursions during a Heinrich event at Huon Peninsula

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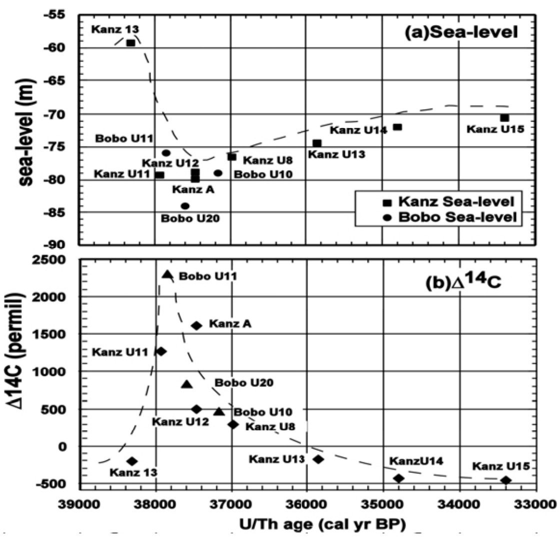
We have previously demonstrated a connection between the ages of OIS-3 coral terraces at Huon Peninsula and the timing of North and South Atlantic ice-rafted debris layers and hence Heinrich events. In addition, coral radiocarbon analyses revealed large radiocarbon peaks at the same time periods which can best be explained by the stop-start behaviour of the thermohaline circulation. One of the better documented ^{14}C peaks occurs at ≈38 ka and was derived from corals of terrace IIa, a prominent reef both at Bobongara and Kanzarua. In the figure, we have plotted the sea-level curve and excess ^{14}C on the same time scale. The phase relationship between the various events is as follows: Just before 38.3 ka and sea-level



is at its peak. Terrace IIa crest is in place. Over the next 1000 years the sea level drops by over 20 m. The radiocarbon levels rise rapidly and reach their peak within 500 years at 37.8 ka. Presumably, the Gulf-stream slowdown occurs before 38.3 ka and by 37.8 ka the circulation is again active. The radiocarbon levels drop to previous values within about 2000 years and decline further over the next 3000 years, possibly indicating a vigorous re-start to the circulation. The data demonstrate the rapidity of the sea-level changes and by implication the rapidity with which ice-sheets can partially disintegrate and recover. Equally sharp is the 230% excess atmospheric radiocarbon pulse.

References

Yokoyama Y., Esat T.M. and Lambeck K. (2001), *Earth Planet. Sci. Lett.* **193,** 579-587.
Yokoyama Y. et al., (2000), *Radiocarbon* **42**, 383-401.