Using deep-living radiolarians as a means to measure changes in organic flux to the deep-sea

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The processes responsible for glacial interglacial the changes in atmospheric CO2, recorded in ice cores, are still uncertain. There is general agreement, that the deep ocean is the most probable reservoir to receive CO2, removed from the atmosphere in glacial times. Changes in the efficiency of the oceans biological pump could provide part of the answer but it is difficult to measure such changes. Marine biologists have determined that mesopelagic organisms, living 200 -1000m deep, are responsive, both geographically and temporally, to changes in organic flux from surface waters. Few of these organisms have hard parts that are preserved in deep-sea sediments, but of those that do, radiolarians are the most abundant and diverse group. Radiolarians, as trophic generalists, are responsive to changing organic flux so quantitative measurements of mesopelagic radiolarian assemblage flux changes could provide a qualitative measure of changes in organic flux from the surface.

Work, on four northwest Pacific cores shows glacial (70k to 12k) flux of a mesopelagic assemblage is greater than that of an epipelagic (<200m) assemblage, while the reverse is true for the Holocene.

The magnitude of these assemblage changes, within the total radiolarian fauna is large, with the epipelagic assemblage rising from 10% of total radiolarian flux in the glacial to between 30 and 60% in the Holocene while mesopelagic assemblage flux falls from 30 to 60% of total radiolarian flux in the glacial to near 10% in the Holocene.

The glacial increase of mesopelagic flux, relative to the Holocene, indicates that mesoplagic radiolarians were consuming more carbon in glacial times than in the Holocene. These dramatic radiolarian assemblage changes, from Pleistocene to Holocene, are accompanied by rising opaline silica flux, suggesting higher primary productivity. This suggests that the decrease in carbon export from glacial to Holocene, indicated by the radiolarian data, is caused, not by changes of primary productivity, but more likely by changes in heterotrophic community structure.

The purpose of this completed study was to compare glacial (70K-12K yrs.) with Holocene (12-0K yrs.) mesopelagic and epipelagic radiolarian flux patterns. Strong, consistent and anti-correlated patterns of epipelagic and mesopelagic assemblage flux have emerged which indicate greater organic carbon export in glacial than in Holocene time. What causes these patterns is unknown. One possibility is that environmental factors suppress epipelagic heterotrophs (including radiolarians) in glacial times, allowing more organic flux to settle into the deep-sea and fuel expanded mesopelagic heterotrophic production. These records are not long enough to determine how consistent this anti-correlated pattern is. We also don’t know if it is present in other oceans.

This proposal seeks answers to two questions. First, do epipelagic and mesopelagic flux patterns maintain their anti-correlated pattern through a full glacial cycle in the northwest Pacific and secondly what epipelagic and mesopelagic assemblage flux changes are recorded in Antarctic sediments and are they also anti-correlated? The Antarctic is important because of the large reservoir of unused major nutrients stored in its surface waters. The first question can be answered by measuring epipelagic and mesopelagic flux in 150 samples through the last glacial cycle in three northwest Pacific cores probably IODP core 883D and V20-122 and V20-124; 01-2416 might be substituted for 883D if samples are made available by German scientists for this core has better age control and a higher sedimentation rate.

Progress has been made toward answering the second question, through an Indian Ocean core, raised from south of the Polar Front, that beautifully records a detailed record of epipelagic and mesopelagic species variations. Here I have measured radiolarian/gm (these measurements will be converted to flux) of an abundant surface living species group, the *Antarctissa* group, and an abundant mesopelagic species *C. davisiana*. They clearly show anti-correlated behavior but the anti-correlation is not perfect so one can't say that a suppression of heterotrophic epipelagic consumption is the sole cause of mesopelagic flux changes. The patterns of the two groups are very different. We know the record of C. davisiana is dominated by periods of about 40K while the epipelagic group is clearly not.

Although there are few one point peaks, because of sedimentation rate changes when the data is plotted against time there are intervals that need more samples. An additional 50 samples in this core would be ample in fact it may be more than enough but 50 samples will allow me to also explore two nearby cores that have the potential to duplicate the beautiful record of this core.