Diagenetic loss of organic matter in core sediments and its implications for paleo-productivity estimates

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Particulate amino acid content of an IMAGES core (MD01-2379) collected from ca. 500 m water depth offshore Northwest Australia was analyzed in order to study organic matter degradation and preservation through glacial/interglacial cycle. Nannofossil biostratigraphy of this 41.85 m long core suggests the core bottom age of 0.26 - 0.46 Ma. Peak to peak comparison between amino acid content and the SPECMAP oxygen isotope profile yields the core bottom age of about 0.52 Ma, and eventually, a sedimentation rate of about 8 cm/kyr.

Total acid hydrolysable amino acid (THAA) concentration is the lowest in the deeper part of the core, and the highest just below the topmost layer. The glacial - interglacial change related fluctuations in THAA are clearly visible in the upper half of the core, while in the lower half, fluctuations are less prominent. However, they are more prominent even in the lower half of the core in terms of total acid hydrolysable hexosamine (THHA), which is due to relatively higher stability of HA over AA in the process of diagenesis. Relative mole content of non-protein AA is maximum at about 12 m depth, and not at the core bottom, which is contrary to the observation made in core sediments from a subtropical location (Hess Rise), where slow but continuous degradation of organic matter (OM) continued to occur in deeply buried sediments, and therefore non-protein AA content became highest at the core bottom. It implies that bioturbation and/or some other process led to maximum degradation of particulate OM before it was buried below the bioturbated layers. In absence of bioturbation, accumulation of non-protein AA, which are degradation products of protein AA like aspartic acid and glutamic acid, would take place resulting in higher non-protein AA content in deeper layers. OM is closely associated with organic matrix inside and around the shells of calcareous plankton, because aspartic acid concentration is relatively high (19.1 mol.%). Aspartic acid is a necessary component of the template on which calcareous shell of plankton develops. Low glucosamine/galactosamine ratio (less than 4 mole ratio) suggests that microbial OM is also present in sediments but in low amount, because it does not lower the aspartic acid content of sediments considerably.

Some of the samples in lower half of the core show unusually high AA/HA ratio due to very low AA and relatively high glucosamine, one of the two HA, concentrations. This is an indication of relatively higher stability against enzymatic degradation of glucosamine over AA in very old sediments. The variations in AA content with depth can be mathematically expressed using a natural logarithmic regression equation ($AA = -298.6 \ln \text{depth} + 1328.9$; $R2 = 0.86$, $n = 90$). It means that labile component like AA are lost from deeply buried sediments in a logarithmic manner. Therefore, primary productivity estimates based on the organic carbon content of long cores must take a logarithmic degradation/preservation factor into account to compensate for this loss of labile OM.