Southern Ocean Paleoceanography using diatoms

Diatoms are unicellular algae made up of siliceous cell wall known as “frustule”. They are the major contributor (75%) of Southern Ocean primary productivity and hence the major biogenic phase available in the sediments as siliceous frustules. Higher diatom abundance in the Southern Ocean phytoplankton leads to the formation of circumpolar “siliceous ooze/opal belt” at ~ 60S latitude. This opal belt forms the major diatom archive system which is indicative of surface water conditions and bears the ecological and climatic signal to reconstruct paleoclimate. Generally, 1-10% of the diatoms produced in the surface water reach the sediments due to dissolution in water column and water-sediment interface and lateral transport. Despite this, various studies have shown that the residual sedimentary assemblages are still indicative of surface characteristics in the Southern Ocean. Diatoms therefore are the major tools to infer the past oceanographic and climatic changes in these regions. In Southern Ocean diatoms generally show north–south gradients of increasing or decreasing abundances depending upon their ecological preferences for warmer or colder temperatures. Fossil diatoms experience distribution in gradients from high abundances indicating favourable overlying conditions, to low abundances indicating unfavourable conditions. In addition to diatom abundance, diatom valve size is also known to respond to the varying climatic conditions. For instance there are studies from Southern Ocean suggesting that the sizes of Fragilariopsis kerguelensis (pennate diatom) and Thalassiosira lentiginosa (centric diatom) are larger at the proximity of Antarctic Polar front (APF). Hence the study of the sizes of these two diatoms in a sediment

core can be used to trace the past latitudinal changes in the position of APF. Such studies using Southern Ocean sediment cores have been done and suggest a glacial shift in the Antarctic winter sea-ice limit and Polar Front respectively up to the modern day Polar Frontal Zone of Indian sector of SO. Studies have also revealed that glacial periods north of the Polar Front were characterised by high diatom productivity and larger Fragilariopsis kerguelensis and Thalassiosira lentiginosa sizes. The larger and highly silicified diatoms such as F. kerguelensis and T. lentiginosa may have effectively contributed in transporting biogenic silica and organic carbon to the sea bed.