Importance of biogenic opal in the biological pump

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About two decadal time-series moored sediment trap experiment has revealed that particulate organic carbon (POC) flux in deep sea of the Western Pacific subarctic gyre (WPSAG) and its ratio against surface primary productivity are higher than the global average. Thus, it has been concluded that primary productivity in the WPSAG plays a major role in decrease of surface pCO2 and in absorbing atmospheric CO2. However, based on measurement of primary productivity and seasonal drifting sediment trap experiment in the comparison study of biogeochemistry between WPSAG and the Western Pacific subtropical gyre (WPSTG), it was revealed that POC flux at the bottom of surface mixed layer (the export flux) and primary productivity at the oligotrophic WPSTG are comparable to those at eutrophic WPSAG. On the other hand, it was verified that POC flux in deep sea of the WPSAG is about two times higher than that of WPSTG. It means that POC in the WPSAG is vertically transferred efficiently between shallow depth and deep depth, which layer is known as “twilight zone”, without significant attenuation. However, this higher “transfer efficiency” in the WPSAG cannot be explained by the grazing pressure (the carbon demand of metazoans and prokaryote) because the grazing pressure in the WPSAG is higher than that in the WPSTG. The transfer efficiency for particulate inorganic carbon (PIC) was also higher in the WPSAG than WPSTG. Thus, this higher “transfer efficiency” is not either explained by seawater chemistry because saturation depth of CaCO3 in the WPSAG is ~ 100 m for aragonite and ~ 150 m for calcite and much shallower than those in the WPSTG (~ 600 m for aragonite and ~ 800 m for calcite). It is noteworthy that the biggest difference in settling particles between the WPSAG and WPSTG is biogenic opal: biogenic opal flux and concentration in the WPSAG is much higher than that in the WPSTG. When biogenic opal is produced by diatom, transparent exopolymer (TEP) is also produced resulting in the increase of aggregation of particles and formation of giant settling particles. As a result, POC can be vertically transferred to the deep without significant biological / chemical / physical decomposition or attenuation. It is supported by the fact that multiple regression analysis shows that correlation coefficient between POC and biogenic opal is much higher than that for CaCO3 in the deep sea of WPSAG. Thus, it can be concluded that biogenic opal plays an important role in the biological pump for absorbing atmospheric CO2.