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Compound specific isotope and enantiomer analyses to better understand the impacts of marine microbes on oceanic carbon export

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Phytoplankton form the base of marine food webs in the epipelagic and contribute substantially to suspended and sinking particulate organic matter (POM) throughout the water column, thus sequestering carbon in the deep sea through the biological carbon pump. Bacterial biomass additionally contributes significantly to these particle pools. The fate of this material – for instance, the depth at which it is remineralized – ultimately affects global climate and the carbon cycle. However, it has been difficult to link the biological origins of POM, such as proportional contributions of phytoplankton and bacteria, to its fate, due largely to significant alternation processes occurring as the POM sinks or is advected downward. To more closely examine the origins of POM, we present the results of multiple geochemical and isotopic measurements of sinking particles from sediment traps and size-fractionated particles from in situ filtration between the surface and 500 m at Ocean Station Papa, collected during NASA EXPORTS (EXport Processes in the Ocean from RemoTe Sensing). From these particles, we examine the carbon isotope composition of amino acids from proteins, the relative concentration of D and L enantiomers of alanine, and the carbon isotope composition of phytol, cleaved from chlorophyll. In combination with our previous results of amino acid nitrogen isotope analysis, we use the D and L enantiomer ratios and the essential amino acid carbon isotope “fingerprints” to estimate the proportional contribution of bacteria to three different POM size fractions and particles in sediment traps over depth. We additionally use the $d^{13}C$ value of phytol to identify material of photosynthetic origin from the upper vs. lower euphotic zone. Finally, we employ multivariate analysis to distinguish different sources of POM in near-surface waters and to identify the POM pools in which these materials persist at depth. From this, we aim to determine which sources of carbon are the most important to POM in the mesopelagic, thus fueling midwater communities and contributing to carbon sequestration.