Molecular stratification and progressive recalcitrance of marine dissolved organic matter from the surface to the hadalpelagic Atacama Trench

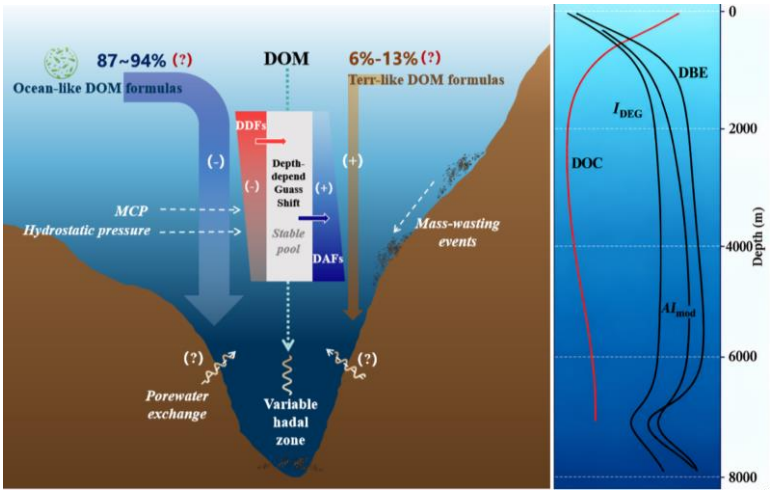
Hongwei Chen[1], Quan Shi[2], Osvaldo Ulloa[3], Xinxin Li[1,*]

[1]Department of Ocean Science and Engineering, Southern University of Science and Technology, Shenzhen, 518055, China

[2]State Key Laboratory of Heavy Oil Processing, China University of Petroleum-Beijing

[3]Department of Oceanography, University of Concepción, Concepción, 4030000, Chile

[*] **Corresponding author: lixinxin@sustech.edu.cn**

Abstract

Dissolved organic matter (DOM) in the ocean mediates global biogeochemical cycles through microbial transformation and the transfer of chemical energy. However, DOM characteristics in the hadal zone (≥ 6000 m) remain poorly characterized. Herein, high-resolution Fourier transform ion cyclotron resonance mass spectrometry (FT-ICR MS) was used to characterize the molecular composition of DOM across the entire water column (~8000 m) of the Atacama Trench. The results showed a main divergence in DOM characteristics between the surface and deep ocean. The hadal DOM, however, exhibited inconsistent variability with depth, likely due to topographic processes. A coherent but statistically insignificant shift toward greater DOM recalcitrance with depth was observed, evidenced by increasing levels of polyphenols, highly unsaturated compounds, and CRAM, declining levels of peptides and carbohydrates, and increasing degradation and aromaticity indices. While the terrestrial DOM formulas contributed about 6 – 13%, assessment of terrigenous DOM using frequency of t-Peaks formulas and Terr-molecular formulas should be approached cautiously. The depth-deficient and depth-accumulating formulas showed a systematic shift in the Gaussian-like distribution of aromaticity index frequencies, suggesting a depth-continuum model of DOM transformation across the entire ocean water column. These findings on DOM characteristics across the full oceanic depth, especially the first characterization of hadalpelagic DOM, are significant for our understanding of global DOM distribution and biogeochemistry.