

Innovative pyrolysis for the reconstruction of organic matter sources, carbon sequestration and microplastics pollution

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Organic compounds such as lipid biomarkers are important indicators to study ecosystem functions, environmental and climate changes. They are “molecular fossils” produced by formerly living organisms, preserved in environmental archives (e.g. soils, sediments, sedimentary rocks, petroleum), and provide a record of paleoenvironmental changes beyond monitored periods. Most biomarker applications focus on solvent extractable compounds, which correspond to only ~1-10% of the organic material, but provide a wealth of information about past environments.

Re-emerging techniques such as pyrolysis-gas chromatography-mass spectrometry (Py-GC-MS) enable us to take a closer look at the remaining macromolecular organic material. While Py-GC-MS analysis leads to significant loss of the molecular information due to secondary reactions, it reveals unique information about composition and sources of labile as well as more recalcitrant organic matter in the environment.

I will present recent applications where we combine traditional lipid biomarker analyses with Py-GC-MS approaches to trace organic matter sources/provenance, transport and deposition, with implications for long-term carbon burial and sequestration in diverse marine and terrestrial environments.

Among a few case studies as examples, I will demonstrate how we used Py-GC-MS analyses to quantify marine and terrestrial organic matter sources and transport in offshore Antarctica, including how this research revealed the discovery of synchronous mid-Holocene marine and terrestrial deglaciation in the Ross Sea, Antarctica. Also, how we quantified terrestrial and marine carbon transport offshore New Zealand due to a major earthquake and its impact on long-term carbon preservation and sequestration.

Pyrolysis-GC-MS is also increasingly used to study microplastic pollution in the environment, based on the molecular composition of plastic polymers. I will present examples spanning airborne microplastic analysis and its application, and the reconstruction of microplastic pollution in a lake in New Zealand.