Compound specific isotope analysis: from environmental forensics to the study of paleo-degradation

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Compound specific isotope analysis (CSIA) is a tool that has generated considerable interest in the scientific community over the past two decades. This analytical technique was applied in recent environmental samples for the differentiation of sources of contaminants or the study of the biodegradation extent of organic contaminant. In older sedimentary rocks, the loss of source-specific isotopic signal over geological timescales due to extensive diagenetic processes can be viewed as an opportunity to study and disentangle the diagenetic effects transforming the OM within sedimentary systems. In this talk, applications of this analytical tool in both old diagenetically altered and relatively recent samples will be presented in the context of two particular case studies embedded in the broader framework of pan Canadian multidisciplinary projects.

We will first present the application of the dual isotopic measurements ($\delta^{2}H$ and $\delta^{13}C$) on specific polycyclic aromatic hydrocarbons (PAH) in the Athabasca Oil sands region (Alberta, Canada). We used lake sediment cores as natural archives of PAH deposition in order to reconstruct the chronological evolution of their sources of emissions. Dual-CSIA was also applied on specific PAH-source end-members in the region in an attempt to quantify the contribution of natural and anthropogenic sources in the environment using an isotopic mixing model.

We will then go further back in time and develop on the application of this powerful tool to investigate on the evolution of the organic matter over geological timescales in an Ordovician aquiclude proposed as a potential deep geological repository for nuclear waste situated on the eastern flank of the Michigan Basin (Ontario, Canada). Recent work on this aquiclude suggested a paleo-microbial origin for the porewater-CH_4 and CO_2 based on their stable isotope values. We will present detailed isotopic and geochemical stratigraphic profiles of OM and dual-CSIA of specific n-alkanes, with the objective of providing further constraints on the origin of the CH_4 and its relative timing of confinement.