



# Isotope-Assisted Environmental Investigations

Earth Systems provides specialist expertise in the application of stable isotope techniques to tackle a range of anthropogenically induced environmental challenges. Stable isotope techniques are particularly useful for pollution tracing in aqueous and terrestrial environments, environmental monitoring, atmospheric pollution tracing, assessment of CO<sub>2</sub> sequestration efficiencies, and coal seam gas reservoir characterisation.

Most elements consist of more than one stable isotope due to their capability to possess small variations in their atomic mass. The relative abundance of stable isotopes can be determined by isotope ratio mass spectrometry (IRMS), yielding isotope ratios. Different sources and processes can cause a change in the isotopic composition of a compound, and isotope ratios can therefore be used for fingerprinting.

The advantage of environmental tracers such as isotopic signatures is that these fingerprints are already incorporated in the environment, avoiding the costly application of artificial tracers. Stable isotope techniques can provide insights into pollutant sources and pollutant pathways, reservoir and baseline characterisation, and in some cases can be used as a quantitative tracer of industrial emissions.

## SERVICES PROVIDED

Environmental isotopes constitute a major innovative contribution to the assessment of environmental footprints and the fate of industrial pollutants. It is crucial to interpret isotopic results with knowledge of other physical parameters, chemical parameters and mass balance information to verify and quantify potential sources and sinks. Stable isotope techniques possess the potential to be applied to a wide range of environmental issues:

- The oxygen and hydrogen isotopic compositions of water can reveal water sources, groundwater recharge regimes, and document the influences of processes such as evaporation.
- The nitrogen and oxygen isotopic composition of nitrate can identify the sources of nitrate such as agricultural fertilizers, waste water treatment effluents, sewage, atmospheric nitrate deposition, soil water nitrate as well as processes such as denitrification.
- The sulfur stable isotope ratios can reveal sulfur sources and related processes (e.g. bacterial sulfate reduction) and can be used to trace transport and fate of industrial sulfur emissions.
- Isotopic compositions (e.g. of nitrogen, carbon, sulfur) of lake



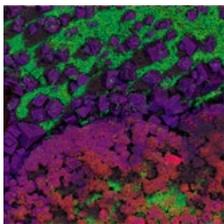
sediments, lichen records and plant tissue document the extent of anthropogenic alterations over time.

- Stable isotopic composition of strontium and neodymium can identify sources of river sediments.
- Carbon stable isotopes of methane can be used for the determination of the degree of methanogenesis, and to identify origins and distribution of coal seam gas (CSG).

## PROJECT EXPERIENCE

Earth systems provides expertise for many applications of isotope investigations, including:

- Geochemical and isotopic baseline and reservoir characterisation for oil, gas, and mine sites.
- Tracing water sources and aquifer connectivity using stable water isotopes.
- Tracing nitrate, sulfate and phosphate sources in rivers.
- Tracing industrially derived nitrogen, sulfur and carbon emissions in aqueous and terrestrial environments.
- Quantifying industrial contributions to atmospheric nitrogen and sulfur deposition.
- Assessing the environmental footprint of industrial emissions applying stable isotopes techniques to bio-indicators.
- Monitoring CO<sub>2</sub> storage at CO<sub>2</sub> sequestration sites.
- Implementation of stable isotope techniques for the development long-term monitoring strategies for assessing environmental impacts.



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