

# CEST Stable Isotope Laboratory

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# EA/IRMS

## Elemental Analyzer- Isotope Ratio Mass Spectrometer



EA/IRMS- Measurement of  $^{15}\text{N}/^{14}\text{N}$  and  $^{13}\text{C}/^{12}\text{C}$  isotopes of bulk solid materials using high temperature combustion + IRMS:

- Biological tissues:** Plant material, leaves, wood, muscle, and collagen.
- Environmental/Geological samples:** Soils, marine and lake sediments, coal, and bulk rocks.
- Animal/plant products:** Food and beverage items like honey, wine, and oils.

# EA Isolink/IRMS

## Isolink Elemental Analyzer- Isotope Ratio Mass Spectrometer



EA Isolink/IRMS- Measurement of  $^{18}\text{O}/^{16}\text{O}$  and  $^2\text{H}/^1\text{H}$  isotopes of bulk solid materials using high temperature thermal conversion + IRMS:

- Biological Materials:** Tissues & keratin, human or animal hair, nails, and bones and plant materials, such as Wood, cellulose, leaves, and seeds.
- Food Materials**
- Oils:** Olive oil and other plant/essential oils.
- Organic Compounds:** polymers/plastics, and resins.
- Geological and Environmental Materials:** Carbonates and phosphates
- Sediments:** Lake and marine sediments
- Soils:** Organic and inorganic soils
- Hydrological Samples:** Water (precipitation, groundwater, surface water).
- Energy and Chemical Materials:** Fuels (oil, coal, kerogen, and petroleum) and salts (nitrates and phosphates.)



# Sercon Integra2 EA/IRMS

## Sercon Elemental Analyzer- Isotope Ratio Mass Spectrometer



Measurement of  $^{34}\text{S}/^{32}\text{S}$  isotopes of bulk solid materials using high temperature combustion + IRMS:

- Organic matter:** Plant tissues, soils, animal bone collagen, and hair.
- Inorganic compounds:** Sulfates and sulfides.
- Elemental sulfur**

# Why use EA/IRMS?

**Food Authenticity:** Verifies the origin, geographic region, and organic nature of agricultural products.

**Ecology & Biology:** Evaluates dietary shifts, food web dynamics, and animal migrations via bulk tissue analysis. S isotopes are highly effective for identifying pollution sources, reconstructing ancient climates, tracking migration, and evaluating food webs.

**Archaeology:** Reconstructs the paleodiets and migration routes of ancient humans and animals.

**Geosciences:** Analyzes total organic matter and bulk soil samples to monitor biogeochemical cycles.

**Paleoclimate & Early Life:** Reconstructing ancient atmospheric oxygen levels. For example, a unique phenomenon called Mass-Independent Fractionation (MIF) in rocks older than 2.4 billion years proves the early Earth had an oxygen-free atmosphere.

**Environmental & Pollution Tracking:** Identifying whether atmospheric sulfate originates from natural marine emissions, volcanic activity, or anthropogenic sources like fossil-fuel combustion.

**Geology & Mining:** Tracing the origins of ore deposits, understanding the formation of hydrothermal fluids, and evaluating the migration and alteration of petroleum.

# Gas Bench/IRMS

## Gas Bench- Isotope Ratio Mass Spectrometer



Measurement of  $^{13}\text{C}/^{12}\text{C}$ ,  $^{18}\text{O}/^{16}\text{O}$ , and  $^2\text{H}/^1\text{H}$  isotopes of bulk solids and liquids:

- Carbonates:** Solid powders, such as limestone, foraminifera, teeth, or bioapatite.
- Water & Liquid Samples:** Liquid water or other fluids, such as fruit juice and wine.
- Direct Gas Samples:** Air, breath samples, or dissolved inorganic carbon (DIC).
- Organic Matter:** Dissolved organic carbon (DOC) in liquids.



# Why use Gas Bench/IRMS?

## **Food & Beverage Authentication:**

Verifying the geographic origin and authenticity of fruit juices, wines, and spirits by testing the natural isotope variations of the water within them.

## **Paleoclimatology & Geology:**

Analyzing solid carbonates, sediment cores, and speleothems (cave formations) to reconstruct ancient climates and historical ocean temperatures.

**Hydrology:** Tracing the water cycle, tracking meteoric water lines, and mapping groundwater origins.

**Metabolic Studies:** Using  $^{18}\text{O}$ -enriched water tracers to measure energy expenditure in animal and human metabolic studies.

**Archaeology:** Sourcing marble and analyzing fossilized teeth or bones to determine ancient human diets and animal migration patterns.

## **Atmospheric and Dissolved Gases:**

**Greenhouse Gas Monitoring:** Measuring the isotopic composition of atmospheric trace gases like  $\text{CO}_2$  and  $\text{N}_2\text{O}$  to differentiate between natural and anthropogenic (human-caused) sources.

## **Ecology & Biogeochemistry:**

Analyzing headspace gases to track respiration, denitrification, and nitrogen fixation in soil core or water samples.

# GC/IRMS

## Gas Chromatograph Isotope Ratio Mass Spectrometer



Compound-specific measurement of  $^{13}\text{C}/^{12}\text{C}$ ,  $^{15}\text{N}/^{14}\text{N}$ , or  $^2\text{H}/^1\text{H}$  in volatile and semi-volatile organic compounds:

Lipids, alkanes, and amino acids.

**Food & Beverages:** Wine, honey, and flavor extracts.

**Synthetic or performance-enhancing drugs,** such as steroids.

**Geochemical Samples:** Petroleum, crude oil fractions, and sediment extracts.



# Why use GC/IRMS?

## **Food Authenticity and Traceability:**

Adulteration detection identifies counterfeit products by comparing the isotopic signatures of specific sugars in honey or amino acids in vanilla and fruit juices against known botanical standards.

**Geographical Origin:** Traces the regional sourcing of wines, olive oils, and other commodities based on local soil and water isotope variations.

## **Environmental and Earth Sciences:**

Compound-Specific Isotope Analysis (CSIA) can track the degradation of organic pollutants, such as benzene or MTBE, in groundwater to prove natural attenuation rather than synthetic dilution.

**Paleoclimatology:** Analyzes the isotopic composition of plant waxes and lipid biomarkers in sediments to reconstruct past climates and vegetation shifts.

**Forensics:** Trace Evidence. Differentiates chemically identical materials, such as specific explosives, synthetic drugs, or fibers, based on the unique isotopic ratios of their precursor materials.

**Biomedical and Metabolic Research:** Tracer Studies use non-radioactive stable isotope tracers to map metabolic pathways in humans and animals, evaluating substrate oxidation and nutrient absorption without radiation risks.