

Stable Isotope Analyses in the Isotope Laboratory of the University of Lausanne

The stable isotope laboratory has facilities for the routine analyses of the stable isotope compositions of H-, C-, N-, O-, and S-isotopes, including but for special requests only, compound-specific analyses of organic matter.

Routine analyses include:

- (1) H- and O-isotope analyses of water using the **Picarro**, but in exceptional cases this is also possible with the H-Device, GasBench II, or TC-EA.
- (2) C- and O- isotope analyses of carbonates, carbonate in phosphate and dissolved inorganic carbon (GasBench II linked to the **Delta PlusXL**).
- (3) H-isotope analyses of hydrous silicates and bulk organic matter using the TC-EA linked to the **Delta PlusXL**.
- (4) O-isotope analyses of phosphate, sulfate, nitrate, and bulk organic matter using the TC-EA (and **Delta PlusXL**) but where the samples require chemical preparation before (analyzed as Ag_3PO_4 , BaSO_4 , or AgNO_3).
- (5) C-, N-, or S-isotope analyses of bulk organic matter, whole rock samples, nitrates, or sulfides and sulfates using an EA linked to the **Delta V**.
- (6) O-isotope analyses of silicates and oxides using a CO_2 -laser extraction line and fluorination linked to the mass spectrometer (**MAT 253**).

For further information on these routine analyses please contact the responsible persons for the equipment and for mass spectrometer reservations (see the contacts given on the reservation schedules – click on the image of the respective mass spectrometer):

- Jorge Spangenberg for the **Delta Plus XL** and **Delta V**
- Benita Putlitz for the **MAT 253**
- Laurent Decrouy for the **Picarro**
- or Torsten Vennemann (director of the facilities) for any one of these

Given the large number of users for the facilities, it is our policy that each user can reserve the machines for their analyses **a maximum of two months in advance** and for **not more than three days per week**. Please see below for further guidelines.

Other analyses include compound-specific (GC or GC-IRMS) stable isotope analyses of organic compounds and volcanic, atmospheric or fluid inclusion gases, off-line preparation of gases from carbonates, atmospheric CO_2 , N_2 , water or water vapor, including fluid inclusion extractions of these gases in a vacuum system. For these special type of analyses contact Jorge Spangenberg (compound-specific analyses and organic geochemistry) or Torsten Vennemann (vacuum extraction of gases and fluid inclusion analyses).

Two general types of analyses are done in our laboratories (with different prices for these analyses):

- (a) **internal** analyses with samples prepared by researchers of Lausanne/Geneva
- (b) and (c) collaborative analyses for **external** users or commercial societies.

(a) internal analyses within ELSTE

- We request a short proposal, detailing the problem, what data are already available, what the isotope analyses are expected to contribute, and how many samples are to be run. This short proposal is to be transmitted to the respective contact persons listed for each type of reservation on the Stable Isotope Laboratory site of the Institute of Earth Sciences (Cc to the director, Torsten Vennemann, please).
- Reservations of the equipment will then be made by the contact persons (responsible). **Reservations can be made a maximum of two months prior to analyses and a maximum of three days per week can be reserved for any one project.** If the time schedule allows, short-term reservations can also be made a day or so in advance of the analyses. **Experienced users** can also run the samples over the weekend by themselves (see below).
- Samples must be ready for analysis and must be prepared according to our instructions by the researcher him- or herself. The researcher is also responsible for weighing in the samples for analyses. Experienced users, familiar with the measurements (PhD students and post-doctoral researchers for example) are encouraged to learn the techniques and to run the samples by themselves too.
- Analytical data are to be reduced by the researcher of the project (according to our instructions).
- It is expected that the analytical expenses are covered by the researchers of the project, the PhD students or their directors. For users within ELSTE the internal price applies, given that the samples are prepared by the users themselves; for the costs please see our price list on the internet (see also below).
- If the analyses are done in collaboration with a responsible of the laboratory, and the responsible is also involved in the scientific discussion of the data obtained in our laboratory, the responsible in charge of the analyses is to be included as co-author on the publications using the data.

(b) external scientific collaboration:

- We request a short proposal, detailing the problem, what data are already available, what the isotope analyses are expected to contribute, and how many samples are to be run. This short proposal is to be transmitted to the respective contact persons listed for each type of reservation on the Stable Isotope Laboratory site of the Institute of Earth Sciences (Cc to the director, Torsten Vennemann, please).
- Reservations of the equipment will then be made by the contact persons (responsible). **Reservations can be made a maximum of two months prior to analyses and a maximum of three days per week can be reserved for any one project.**
- Samples must be ready for analysis and must be prepared according to our instructions by the researcher him- or herself.
- Analytical data are to be reduced by the researcher of the project (according to our instructions).
- It is expected that the analytical expenses are paid for by the researchers of the external collaborations; external prices are applicable, in particular if the samples still have to be prepared and weighed in by ourselves. Internal prices apply only if the project is done in close collaboration with any one of the

responsibles of the laboratory. Please see our price list on the internet (also given below).

- If the analyses are done in collaboration with a responsible of the laboratory, that is if the responsible is also involved in the scientific discussion of the data obtained in our laboratory, the responsible in charge of the analyses is to be included as co-author on the publications using the data.
- Academic institutions are given priority while other institutions are considered case by case.

(c) Commercial contracts:

The same points as those listed under (b) above apply. But in addition the following points are relevant:

- Final analyses and supporting documentation are sold to commercial clients (see our price list for external prices)
- Our laboratory is responsible for analytical quality
- After completion of the project, all remaining sample material will be sent back.

For any additional information regarding the Stable Isotope Laboratory of the University of Lausanne, please contact Torsten Vennemann.

Price List for Routine Analyses in the Stable Isotope Laboratory of the University of Lausanne

Internal prices cover the analytical costs and are the basis for collaborative studies or studies where the student/researcher performs the complete analyses. **External** prices are for analytical service without scientific collaboration and include costs for analytical personnel.

Contacts: Prof. T. Vennemann (Tel: 021 692 4464; Torsten.Vennemann@unil.ch); Dr. J. Spangenberg (Tel : 021 692 4365 ; Jorge.Spangenberg@unil.ch); Dr. Benita Putlitz (Tel: 021 692 4443; Benita.Putlitz@unil.ch).

Type of analyses	Minimum amount of sample	Average analytical error (in permil)	Price per sample external in CHF	Price per sample internal in CHF
$^{18}\text{O}/^{16}\text{O} + ^{13}\text{C}/^{12}\text{C}$ Carbonates classical method	10 mg	$\pm 0.1\text{‰}$	80	25
$^{18}\text{O}/^{16}\text{O} + ^{13}\text{C}/^{12}\text{C}$ Carbonate via Gasbench	0.05 mg	$\pm 0.1\text{‰}$	40	15
$^{13}\text{C}/^{12}\text{C}$ Water- DIC via Gasbench	100-200 μl depends on HCO_3^- concentration	$\pm 0.2\text{‰}$	40	15
D/H and $^{18}\text{O}/^{16}\text{O}$ Water, Picarro	0.2 ml	$\pm 0.4\text{‰}$ and $\pm 0.07\text{‰}$	50	20
$^{18}\text{O}/^{16}\text{O}$ Water, Equilibration via Gasbench	0.5 ml	$\pm 0.15\text{‰}$	50	15
D/H Water, H-Device	0.5ml	$\pm 0.7\text{‰}$	50	15
$^{13}\text{C}/^{12}\text{C}$ Elemental Analyser Soils, sediments, org. substances	ca. 2 mg depends on concentration	$\pm 0.2\text{‰}$	60	20
$^{15}\text{N}/^{14}\text{N}$ Elemental Analyser Soils, sediments, org. substances	ca. 10 mg depends on concentration	$\pm 0.3\text{‰}$	60	20
$^{34}\text{S}/^{32}\text{S}$ Elemental Analyser Sulphates, sulphides, sediments, org. substances	ca. 2 mg depends on concentration	$\pm 0.3\text{‰}$	60	20
D/H TC-Elemental Analyser Hydrous minerals (Waters)	ca. 10 mg depends on concentration	$\pm 2\text{‰}$	70	20
$^{18}\text{O}/^{16}\text{O}$ TC-Elemental Analyser Org. substances (Waters)	ca. 10 mg depends on concentration	$\pm 0.5\text{‰}$	70	20
$^{18}\text{O}/^{16}\text{O}$ TC-Elemental Analyser Phosphates; sulphates	1-2 mg	$\pm 0.3\text{‰}$	70	20
$^{18}\text{O}/^{16}\text{O}, ^{17}\text{O}/^{16}\text{O}$ Silicates/oxides, CO_2 -Laser based	1 mg	$\pm 0.1\text{‰}$	150	50
$^{13}\text{C}/^{12}\text{C}$ Compound-specific (GC-IRMS)	Depends on sample type	$\pm 0.3\text{‰}$	On request	75 ^a
D/H Compound-specific (GC-IRMS)	Depends on sample type	$\pm 4 \text{‰}$	On request	100 ^a

^a Cost for analysis only: no sample preparation or pre-concentration of the sample. Such sample preparation can be done but at additional costs.