Stable Isotope Tools in Earth System Sciences, 5 hp

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<tr>
<th>Course period:</th>
<th>Last day for application:</th>
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<td>September to November 2016</td>
<td>September 1 2016</td>
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<th>Course leader / Address for applications:</th>
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<tr>
<td>Louise Andresen / <a href="mailto:louise.andresen@gu.se">louise.andresen@gu.se</a></td>
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<th>Course description (Advertisement for Ph.D. students):</th>
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<td>The main goal of the course is to offer a broad introduction to the use of stable isotopes (SI) in Earth Systems Sciences (Biosphere, Geosphere, Hydrosphere and Atmosphere). Weekly seminars and discussion forum will give an overview of the major SI of carbon, nitrogen, oxygen, sulfur and hydrogen used in studies of the Earth System. Topics addressed include (a) fractionation and mixing processes that affect isotope distribution, (b) the use of SI as tracers by using either their natural abundance distribution or labelling experiments, (c) modelling of processes at meso- and global scale. Questions related to instrumentation, technology and measurement (IAEA standards) will also be highlighted.</td>
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| Introduction of instrumentation ex. new equipment of the Stable Isotope Facility at Earth Science laboratories (ISOGOT infrastructure). Special requests to instrumentation experience can be discussed also with collaborators in Gothenburg. |

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<th>Responsible department and other participation departments/organisations:</th>
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<tr>
<td>Department of Earth Science, University of Gothenburg</td>
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<th>Teachers:</th>
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<tr>
<td>Louise Andresen</td>
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<td>Tobias Rütting</td>
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| Examiner: Leif Klemedtsson |
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Third cycle education

1. Confirmation
The syllabus was confirmed by the Head of the Department of Earth Sciences 2016-05-31.

Disciplinary domain: Science
Department in charge: Department of Earth Science
Main field of study: stable isotopes in ESS

2. Position in the educational system
Elective course; third-cycle education.

3. Entry requirements
State entry requirements, e.g. Admitted to third cycle education.

4. Course content
Seminar and classroom discussion:
1. Basic knowledge on SI (Fractionation processes, natural abundance of SI).
2. Instrumentation, technology and measurement (IAEA standards).
3. Photosynthesis, C3 C4 plants and CO₂.
4. Atmosphere and GHG isosces.
5. Paleo-climate reconstruction (SI of tree rings, carbonates, fossils, rocks).
6. Dynamics of nitrogen (DON, DIN) studied with ¹⁵N tracing and labelling.
8. Special topics that interest the students will be favoured if possible.

Introduction of instrumentation:
1. Delta Ray ¹³C-CO₂ and ¹⁸O-CO₂ analyser
2. Isotope ratio mass spectrometer (IRMS, ¹⁵N, ¹³C, ³⁵S)
3. Potentially Spinmass (¹⁵N-NH₄ and ¹⁵N-NO₃), NMR and SiMS
5. Outcomes
The intended learning outcomes are the following:

**Basic knowledge on:**
1. stable isotopes in Earth systems and isotopic fractionation.
2. understanding of the instrumentation: IRMS (isotope ratio mass spectrometry), Spin MAS, laser spectrometry and the use of IAEA certified standards.

**Broad knowledge of:**
3. process studies by carbon isotopes in plants, tree-rings, soil and atmosphere using SI.
4. biosphere-atmosphere interaction and GHG studies using SI.
5. isotope methods in Paleo-geology, fossil/rock dating, carbonates and landscape formation.
6. soil nitrogen dynamics in ecosystems, studied with $^{15}$N-tracer techniques.
7. biomarkers and environment and how stable isotopes clarify organisms and sources.

**Specialised knowledge** obtained through: 1) Presentation in seminar form of own isotope related work and 2) of a scientific paper.

6. Required reading
B. Fry: Stable Isotope Ecology. Papers will be selected according to specific interests (presented at course start) and on-line resources provided by course-responsible.

7. Assessment
Weekly activity in the online learning system GUL must be completed combined with active presence in classroom discussion and seminal presentation. A final short essay must be approved.

8. Grading scale
The grading scale comprises Fail, (U), Pass (G)

9. Course Evaluation
The course evaluation is carried out together with the Ph.D. students at the end of the course, and is followed by an individual, anonymous survey at GUL.

10. Language of instruction
The language of instruction is English.