**Isotope Mapping in Provenance Applications**

**GEO4301 I00 – Undergrad**

**GEO5144 – Grad**

**PROFESSOR :**

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**TIME AND LOCATION:**

|  |  |  |  |
| --- | --- | --- | --- |
| Friday | 1pm - 3 :50pm | MRN121 | Lecture |

**COURSE DESCRIPTION:**

Isotope variations can be used to trace provenance of organic and inorganic materials from tracing the movement of water through the global hydrological cycle to tracking monarch butterflies migration. This course will discuss how different traditional isotope systems (H, C, N, O, S, Sr, and others) vary in the environment at regional to global scales. This course will illustrate how improved understanding of spatiotemporal isotopic variation in Earth systems is leading to innovative approaches to solve problems in hydrology, climatology, ecology, forensics and biogeochemistry. The course is highly interdisciplinary and open to geoscientists, biologists, geographers, environmental scientists, archeologists and forensic chemists.

**LEARNING OUTCOMES:**

1. Understand the basic principle of stable isotope geochemistry (vocabulary, isotope fractionation, kinetic fractionation, equilibrium fractionation, Rayleigh distillation)
2. Understand the basic principle of mass spectrometry (schematic of a mass spectrometer, interferences, IRMS, ICP-MS, MC-ICP-MS) and analyze samples for stable isotope ratios (group project)
3. Use the spatiotemporal pattern of oxygen and hydrogen-isotope compositions of water to understand the hydrological cycle.
4. Use the spatiotemporal pattern of oxygen, hydrogen, sulphur and strontium isotope to trace provenance of organisms and materials including tap water, migratory animals and human migration and to authentify materials
5. Use the stable carbon, oxygen, and strontium isotope compositions of Earth’s biosphere, atmosphere and hydrosphere to identify changes in Earth’s carbon and water cycles at geological and Anthropocene time-scales.
6. Use the stable carbon, nitrogen and sulphur isotope composition to track ecosystem processes and human diet.
7. Learn about exciting novel non-tradiational isotopic systems and their environmental applications
8. Improve critical thinking skills by reviewing literature related to isotope geochemistry
9. Improve oral presentation skills by leading a presentation and discussion
10. Improve scientific method and writing skills by formulating and solving a hypothesis from collecting sample to presenting data

**EVALUATION:**

|  |  |
| --- | --- |
|  | **Grade** |
| **In-class attendance and participation** | **20%** |
| **Peer review** | **20%** |
| **Paper discussion presentation and moderation** | **20%** |
| **Canada isotope database presentation** | **20%** |
| **Forensic final paper** | **20%** |

**IMPORTANT INFORMATION:**

**Assignments** should be givenon time generally due on Friday at 1pm on paper or by email [cbataill@uottawa.ca](mailto:cbataill@uottawa.ca)(20% of the grade will be removed per late days).

**Attendance and participation:** Ask questions during lectures. Participate during applications and paper discussion.

**Peer review:** Two papers will be given every week for reading. This reading is **mandatory**. Pick one paper every week and provide a one page peer-review paper due at the beginning of class each week or at [cbataill@uottawa.ca](mailto:cbataill@uottawa.ca). See deadlines on schedule and <https://authorservices.wiley.com/Reviewers/journal-reviewers/how-to-perform-a-peer-review/step-by-step-guide-to-reviewing-a-manuscript.html> for instructions about peer-review.

**Paper discussion (Group of 2):** Choose a topic and two data papers (no review paper) that relates to your own research or interest and that uses spatiotemporal isotope geochemical data. The topic should use at least one isotopic system that **has not** been viewed in class. See deadlines on schedule and brightspace for detailed instructions.

**Canada isotope database presentation (Group of 2):** You will be working for 6 weeks on a dataset gathering O, H, C, N, and S isotopes data in tap water and hair across Canada. Your goal is to understand the dietary, geological, climatic or other environmental factors controlling these isotopic variations. This project will require to use your laptop with excel and ArcGIS. See deadlines on schedule and brightspace for dataset and instructions

**Forensic final paper:** You will need to use isotope data to provide a forensic report to the Canadian Royal Mounted Police about a cold-case. See deadlines on schedule and brightspace for dataset and instructions.

**SCHEDULE:**

|  |  |  |  |
| --- | --- | --- | --- |
| Date | Lecture (1h30) | Application (1h30) | Assignment due |
| September 6th | Introduction to Isotopes in Biogeochemical Systems | Exercises on isotope fractionation |  |
| September 13th | Introduction to Isoscapes and Spatial Statistics | Introduction to ArcGIS and interpolation |  |
| September 20th | Introduction to Mass Spectrometry | Veizer Laboratory  Geochemistry Laboratory  AMS Laboratory | Drawing your best Mass Spectrometer |
| September 27th | Oxygen and Hydrogen Isotopes in Hydrosystems | Oxygen and hydrogen isotope in tap water and hair across Canada | Peer review 1 |
| October 4th | Oxygen and Hydrogen Isotopes in Hydrosystems | Oxygen and hydrogen isotope in tap water and hair across Canada | Peer review 2 |
| October 11th | Carbon, Nitrogen and Sulphur Isotopes in Hydrosystems and Ecosystems | Carbon,Nitrogen, and Sulphur Isotope in human hair across Canada | Peer review 3  Provide topic and 2 papers selected for discussion |
| October 18th | BREAK | | |
| October 25th | Carbon, Nitrogen and Sulphur Isotopes in Hydrosystems and Ecosystems | Carbon,Nitrogen, and Sulphur Isotope in human hair across Canada | Peer review 4 |
| November 1st | Strontium isotopes In Hydrosystems and Ecosystems | Non-traditional isotopes Paper discussion 1  (Clement) | Peer review 5 |
| November 8th | Group presentation | |  |
| November 15th | Non-traditional isotopes Paper discussion 2 | Non-traditional isotopes Paper discussion 3 |  |
| November 22nd | Non-traditional isotopes Paper discussion 4 | Non-traditional isotopes Paper discussion 5 |  |
| November 29th | Non-traditional isotopes Paper discussion 6 | Non-traditional isotopes Paper discussion 7 |  |
| December 6th |  |  | Forensic final paper |