

## Syllabus: Geocryology in a warming world [DRAFT V0]

(GEOG 5006 'Special Topics in Geography of the Environment')

**Instructor:** Stephan Gruber

Hours: By appointment.

Email: [stephan.gruber@carleton.ca](mailto:stephan.gruber@carleton.ca)

**Prerequisites:** GEOG 4108 'Permafrost' or permission of the Department

**Meeting location:** Online: <https://carleton-ca.zoom.us/j/6352134267>

**Meeting times:** Mondays and Wednesdays, 13:05–15:25

**First meeting:** May 8, 2023

**Last meeting:** June 16, 2023 (this is a Friday!)

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### Registering for this course

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The course requires departmental approval to register so students will have to request an override which is done on the registration page.

Students from **another Ontario graduate school** can attend via the Ontario Visiting Graduate Student program; an exchange program exists for students from the University of Ottawa.

Graduate students from **outside Ontario** need to apply for special student status <https://carleton.ca/registrar/special-students/>. There is a \$55 fee for this application and after special student status has been received, registration is via Carleton Central. The **fees** for Summer 2023 will be around **\$660 for domestic** special students and **\$3060 for international** special students: [https://central.carleton.ca/prod/pkg\\_online\\_fee\\_assess.p\\_main](https://central.carleton.ca/prod/pkg_online_fee_assess.p_main).

### Questions

- Content – Stephan Gruber, [Stephan.Grubert@carleton.ca](mailto:Stephan.Grubert@carleton.ca)
- Registration – Erin Johnston, [Erin.Johnston@carleton.ca](mailto:Erin.Johnston@carleton.ca)

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### Content

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This course builds understanding of processes and phenomena in permafrost and seasonally frozen soil with special emphasis on the ground thermal regime and disequilibria caused by climate change and disturbance. The ground thermal regime, including the surface energy balance, translates climate change and disturbance into ice loss at depth. This ice loss causes most relevant effects of permafrost thaw. The focus on quantitatively understanding the transient ground thermal regime is at the heart of understanding permafrost change and integrating between Earth sciences and atmospheric science.

The course will draw on fields such as geomorphology, glaciology, geotechnics, and micrometeorology. Methods and tools for quantitatively studying processes and phenomena will be introduced and help solidify understanding via written assignments. The course will consider three differing scales and have a written assignment for each:

- **From the water molecule to a soil sample:** How can the relevant characteristics of frozen ground at the scale of a sample be explained by the peculiar properties of the water molecule?
- **From a soil sample to a landform:** How can typical landforms and phenomena found in permafrost and seasonally frozen ground be explained with the characteristics of frozen ground?
- **Variation in depth, space, and time:** How can surface and subsurface information together with temporal changes in the atmosphere explain the changing ground thermal regime?

The course consists of online lectures, reading assignments, exercises to train the application of methods and tools, and project work presented in seminar style.

Data analysis and simulation experiments are important for understanding the transient ground thermal regime. This course will provide you with tools and give guidance as to their use and their customization to a given problem.

This is an advanced course that requires solid basic knowledge of permafrost environments.

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### **Class format, delivery, and technology**

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This is an online course using a blended approach that will include synchronous meetings via Zoom combined with lecture videos, reading, calculation and simulation assignments and other asynchronous course work provided online.

In our synchronous Zoom meetings, we will review and discuss the asynchronous learning and address open questions. Students will work on individual assignments in breakout groups as a way to encourage team learning.

The course will use the learning management system **Brightspace** and can be accessed from a web browser on most internet-enabled devices, including laptops, Chromebooks, tablets, and smartphones, by going to: <https://brightspace.carleton.ca>.

**Brightspace Support** is available 24 hours a day, 7 days a week, 365 days a year via phone, email, chat at <https://carleton.ca/brightspace/students>, and in the course under 'Help'. For help with general technical problems, please visit Carleton's **Information Technology Services** at <https://carleton.ca/its/contact>.

We will use **R** and/or **Python** for data analysis and visualization, as well as **Microsoft Excel** (simple data analysis) and **Docker** (virtualization). Students must have access to a computer that can run this software and have installed it before the first course meeting.

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**Course schedule (draft - subject to change)**


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#	DOW	Date	Zoom time	Theme prepared for and discussed in Zoom meeting
1	Mon	May 08, 2023	13:00–15:30	Introduction and framing of the course
2	Wed	May 10, 2023	13:00–15:30	Ground thermal regime and simple model representations
3	Mon	May 15, 2023	13:00–15:30	Phase change
4	Wed	May 17, 2023	13:00–15:30	Subsurface characteristics (present landforms)
	Mon	May 22, 2023	13:00–15:30	No meeting: Victoria Day / Journée nationale des patriotes
5	Wed	May 24, 2023	13:00–15:30	Modelling heat transfer and phase change in the ground
6	Mon	May 29, 2023	13:00–15:30	Present and discuss water essays
7	Wed	May 31, 2023	13:00–15:30	Atmosphere-ground interaction
8	Mon	Jun 05, 2023	13:00–15:30	A broader look at permafrost models
9	Wed	Jun 07, 2023	13:00–15:30	Temperature observation: instruments, strategy, analysis
10	Fri	Jun 09, 2023	13:00–15:30	Present and discuss simulation assignments

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**Learning outcomes**


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The following learning outcomes summarize the overarching expectations of student's abilities at the end of this course.

**To pass this course, you must demonstrate the ability to:**

- (a) **apply** key concepts, theories, and methods in Geocryology to a given problem; connect these theories and methods with basic science;
- (b) critically **discuss** the limitations of your work or that of others;
- (c) **create, apply** and **evaluate** computer-aided tools to solve typical problems;
- (d) **communicate** in a concise, accurate, traceable, and effective manner; and
- (e) **discuss current topics** in Geocryology.

This implies a good understanding of: (i) the physical properties of water and how they give rise to the phenomena studied in Geocryology and Glaciology, (ii) the ground thermal regime and its changes over time, (iii) the processes and phenomena affecting the interaction of climate and subsurface, (iv) permafrost as a geologic or geotechnical material, (v) landforms that are typically found in permafrost landscapes and how they are caused by the physical properties of water, and (vi) permafrost thaw and how it is driven by climate change and disturbance.

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**Grades**


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**The final grade** is determined from the arithmetic average of marks obtained in **three written assignments**, each graded out of 100 marks. These will have various proportions of scientific writing and of calculation exercises that require preparation of suitable figures from your data.

You are encouraged to collaborate with others during the sessions to obtain shared data and discuss open issues, but you must submit your own individually written assignments, containing your own analyses, computer code and words. Assignments must be supplied electronically (PDF, code) via BrightSpace.

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## Preparation

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This course **builds on the basic understanding of permafrost** as delivered in GEOG 4108 'Permafrost' at Carleton University. The topics covered there include distribution, thermal characteristics, and properties of permafrost in Canada as well as the origin of geomorphological features and hazards associated with permafrost aggradation and degradation.

Use these two textbooks to **refresh or acquire the basis learning** that we will build on. It is important that the concepts and terms presented there are familiar to you, even though some processes may remain unclear. This normal, don't be discouraged by not completely understanding the considerable amount of reading suggested below.

If you have not taken GEOG 4108, please take this **preparation before** the current course very seriously. Trying to follow this course and learn the basics about permafrost at the same time will get you into problems.

### The Periglacial Environment, Wiley

If you have the **4th edition (French, H.M. 2018)** review Chapters 2 'Periglacial Climates', 4 'Ground Freezing, Permafrost and the Active Layer', 5 'Permafrost Distribution and Stability', 6 'Ground Ice and Cryostratigraphy', 7 'Aggradational Permafrost Landforms', 8 'Thermokarst Processes and Landforms', 16 'Urban and Social Infrastructure', 17 'Transportation and Resource Development'.

If you have the **3rd edition (French, H.M. 2007)** review Chapters 3 'Periglacial Climates', 5 'Permafrost', 6 'Surface Features of Permafrost', 7 'Ground Ice', 8 'Thermokarst', 14 'Geotechnical and Engineering Aspects', and 15 'Climate Change and Periglacial Environments'.

### The Frozen Earth: Fundamentals of Geocryology, Cambridge University Press, by Williams, P.J. and Smith, M.W. 1989.

Review Chapters 3 'Climate and Frozen Ground', 4 'The Ground Thermal Regime', 5 'The Forms of the Ground Surface 1: Slopes and Subsidences', 6 'The Forms of the Ground Surface 2: Structures and Microtopography of Level Ground', and 7 'Thermodynamic Behaviour of Frozen Soils.'

## Academic regulations

The following section reviews the most important academic regulations at Carleton University. Please refer to the official version of the Academic Regulations of the University at <http://calendar.carleton.ca/undergrad/regulations/> if you require further information. The official document takes precedence over this syllabus.

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## Copyright

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Student or professor materials created for this course (including presentations and posted notes, labs, case studies, assignments and exams) remain the intellectual property of the author(s). They are intended for personal use and may not be reproduced or redistributed (hard-copy or electronically/online) without prior written consent of the author(s).

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## Instructional Offences

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The University Senate defines plagiarism as “*presenting, whether intentional or not, the ideas, expression of ideas or work of others as one’s own.*” This can include:

- reproducing or paraphrasing portions of someone else’s published or unpublished material, regardless of the source, and presenting these as one’s own without proper citation or reference to the original source;
- submitting a take-home examination, essay, laboratory report or other assignment written, in whole or in part, by someone else (**this includes computer code**);
- using ideas or direct, verbatim quotations, or paraphrased material, concepts, or ideas without appropriate acknowledgment in any academic assignment;
- using another’s data or research findings;
- failing to acknowledge sources through the use of proper citations when using another’s works and/or failing to use quotation marks;
- handing in "*substantially the same piece of work for academic credit more than once without prior written permission of the course instructor in which the submission occurs.*"

Plagiarism is a serious offence, which cannot be resolved directly with the course’s instructor. The Associate Deans of the Faculty conduct a rigorous investigation, including an interview with the student, when an instructor suspects a piece of work has been plagiarized. Penalties are not trivial. They range from a mark of zero for the plagiarized work to a final grade of "F" for the course, and even suspension from all studies or expulsion from the University. For more information, see the page on Academic Integrity (<https://carleton.ca/registrar/academic-integrity/>).

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## Academic Accommodations

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Carleton provides academic accommodation (<https://students.carleton.ca/course-outline/#survivors-of-sexual-violence>) to students for reasons of disability, religious observance, pregnancy and/or parental leave, sexual violence, and student activities.

Providing accommodations simply means providing alternatives to students who cannot perform the essential requirements of their academic programs due to the reasons mentioned above. At no time does academic accommodation undermine or compromise the learning objectives that are established by the academic authorities of the university.

This section provides only a brief overview of the accommodations policy and process. Please contact Equity and Inclusive Communities (<http://carleton.ca/equity>) for a full explanation.

**Religious Observation:** A request should be made in the first two weeks of the academic term, or as soon as possible where the scheduling of an event or activity conflicting with a religious

obligation does not appear in the course outline or calendar. A list of multi-faith holy days is accessible through (<https://carleton.ca/equity/accommodation/religious-observances/>). Instructors can also contact Equity Services to confirm the eligibility of a religious event or practice.

**Pregnancy and/or Parental Leave:** Requests for parental leave must be made in writing to the Registrar's Office, or in the case of graduate students, to the Office of the Dean of Graduate and Postdoctoral Affairs. A student who is pregnant may request a temporary modification to her program (e.g., laboratory or field work). The student should meet with the instructor(s). The department chair/director and the faculty dean can assist in the discussion. An Equity Services advisor can also be consulted if a student has questions about pregnancy and/or parental leave.

**Students with Disabilities:** Carleton is strongly committed to providing access and accommodation for all individuals with identified and duly assessed disabilities. The university has a [Senate-approved policy on academic accommodation](#) that forms part of its human rights policy. The policy promotes efforts to accommodate students with disabilities so that they will have the opportunity to meet learning outcomes and be fairly evaluated in their performance. In no case, however, does academic accommodation negotiate away, lower, or remove the academic standards and learning outcomes of any course or program, rule, regulation, or policy at the university.

Some students with disabilities may require special accommodations for tests and exams. In these cases, students must present you with a signed accommodation form from the Paul Menton Centre detailing their accommodation needs well in advance of the date of an exam.

**Survivors of Sexual Violence:** As a community, Carleton University is committed to maintaining a positive learning, working and living environment where sexual violence will not be tolerated, and where survivors are supported through academic accommodations as per Carleton's Sexual Violence Policy. For more information about the services available at the university and to obtain information about sexual violence and/or support, visit [carleton.ca/sexual-violence-support](https://carleton.ca/sexual-violence-support).

**Accommodation for Student Activities:** Carleton University recognizes the substantial benefits, both to the individual student and for the university, that result from a student participating in activities beyond the classroom experience. Reasonable accommodation must be provided to students who compete or perform at the national or international level. Please contact your instructor with any requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist. For more details, see [the policy](#).

### Contacts

<p><b>Equity Services</b> 503 Robertson Hall 613-520-5622 <a href="mailto:equity@carleton.ca">equity@carleton.ca</a> <a href="https://carleton.ca/equity">carleton.ca/equity</a></p>	<p><b>Paul Menton Centre</b> 501 University Centre 613-520-6608 <a href="mailto:pmc@carleton.ca">pmc@carleton.ca</a> <a href="https://carleton.ca/pmc">carleton.ca/pmc</a></p>
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