GEOL 2920C: The Sedimentary Rock Cycle on Mars & Earth

Spring Semester 2018

When: Monday 1:00-3:20 p.m.

Where: Lincoln Field 105

Instructor: Dr. Ralph Milliken
Box 1846
Ralph_Milliken@brown.edu

Reading/Text: There is no required textbook to purchase for this course, but there will be various research articles that students are responsible for reading. All required reading materials will be distributed in class, via e-mail, or posted on the course website.

Suggested texts to provide background for topics that will be discussed include:


Description: This graduate level course consists of a mixture of instructor and student-led discussions on topics related to the sedimentary rock cycle on Mars as viewed through the lens of how we understand such processes on Earth. Topics will include sediment transport and deposition, erosion processes and rates, lithification and diagenesis, water-rock interaction, and cyclicity in strata, to name a few. A major goal of the course is to assess how the sedimentary rock record of Mars can be used to understand changes in depositional processes and environmental conditions through time. Results from Mars satellite and rover data will be discussed, with an emphasis on fundamental processes as understood from detailed studies of Earth’s sedimentary rock record.

Prerequisites: Undergraduate level sedimentology/stratigraphy, or permission of instructor

Grading:

<table>
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<tr>
<th>Component</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>Article Summaries &amp; Discussion Lead</td>
<td>15%</td>
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<tr>
<td>Homework</td>
<td>10%</td>
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<tr>
<td>Paper Discussion/Participation</td>
<td>50%</td>
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<tr>
<td>Individual Research Project</td>
<td>25%</td>
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<tr>
<td>Total</td>
<td>100%</td>
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Course Goals

This course will cover a wide range of topics related to sedimentary rocks, processes, mineralogy, and geochemistry. However, the expectation is that by the end of the semester each student will have an appreciation for these topics and possess the skills necessary to:

- understand the processes and mechanisms by which sediment is produced, transported, deposited, and accumulated on Mars and how this compares to Earth.

- understand how sediment is converted to rock and how such rocks may preserve information about depositional environments, climate change, and aqueous geochemistry through time.

- understand the role of post-depositional processes (e.g., diagenesis, cosmic ray exposure, etc.) and how such processes may differ from those experienced on Earth.

- appreciate how differences in water abundance and tectonics can give rise to differences in the rock cycle on Earth and Mars.

- critically assess research and articles related to sedimentary rocks and processes on Mars, and to understand potential limitations of Earth-based analogs.

Reading Materials

Required readings for this course will include a number of peer-reviewed journal articles. These will be provided by the instructor if not available through Brown's e-journals. In addition, students leading a discussion can request that the class read an additional article for a given topic if they believe it is merited in order to have a fruitful discussion. In this case, the student leading the discussion should e-mail the class the reference at least 1 week prior to the discussion.

**IMPORTANT:** Students not familiar with basic concepts of sequence stratigraphy are encouraged to read the following articles as this will provide a necessary foundation for discussions in the latter part of the course. Also, the SEPM strata website is an excellent resource for videos and terminology: [http://www.sepmstrata.org](http://www.sepmstrata.org)


DETAILED EXPLANATION OF GRADING AND EXPECTATIONS

HOMEWORK (10% of grade)

In addition to leading discussions students will be responsible for 4 short homework assignments. These will consist of thought-exercises posed as questions, though the questions do not necessarily have ‘correct’ answers. The purpose of these exercises is for the student to integrate the knowledge gained from our discussions into addressing big-picture and thought-provoking questions. An example question could be "How might the lack of widespread subsidence on Mars affect sedimentation in basins?"

- For each homework assignment, students are required to submit their thoughts and comments on the question in written form to the instructor. The response should be typed, not exceed 1 page of single-spaced text, and will be due by the following class period.

PAPER DISCUSSION LEADERS (15% of grade)

Each group discussion will be led by 1-2 students (depending on class enrollment). The discussion leader(s) will be responsible for promoting discussion and providing a brief oral summary of the papers for that week. Discussion leaders will be assigned ~2 weeks in advance of each class. The discussion leader(s) will be responsible for providing written talking points (as a PDF) to help lead the discussion, and this may also include figures from other papers, outstanding questions raised by the results of the paper, or comparison of the results of the paper to other published results with which the student is familiar. Though not strictly required, the discussion leader(s) may also use slides during the discussion period if they desire.

- The student(s) leading the discussion will be responsible for writing up 2-3 pages of talking points & relevant figures/tables for the class. The student is responsible for e-mailing this to the instructor and class 24 hours prior to the class meeting; hardcopies should also be provided at the start of class.

- After each class, the Discussion Leader(s) will summarize the discussion, outcomes, outstanding questions, and other relevant items in a 1 page (single spaced) summary. This will be provided to the class the following week by e-mail and as hardcopies.
DISCUSSION / PARTICIPATION (50% of grade)

As a graduate level course, healthy discussion and delving into the details of a given topic are critical to ensure that every student gets the most out of each class. It is important that each student comes to class prepared (having read the necessary material) and is ready to engage in a thoughtful discussion of the topics at hand. It is expected that each student will participate in all discussions. Discussions should not necessarily focus on specific aspects of papers for a given class period, but rather the discussion should focus on the theme of that class and address broader issues/questions related to that theme or concept, using the papers as a reference point.

- Participation will be assessed in part by each student providing the discussion leader(s) with 1 question about one of the papers that will be discussed. This question should be e-mailed to the discussion leader(s) at least 24 hours in advance of the class meeting. The discussion leader(s) will collate these questions and provide them to the instructor and other students at the start of class.

- Participation will be assessed in part by how well a student responds to questions from the instructor and/or discussion leader(s). The instructor and discussion leader(s) may call on individuals at random to ask questions about the motivation, methods, results, and implications of a paper. Therefore, it is recommended that students take good notes on each paper in order to be prepared for class.

INDIVIDUAL RESEARCH PROJECT (25% of grade)

The purpose of the individual research project is to provide you with an opportunity to explore a topic related to the sedimentary rock cycle that you find of interest. The final product that each student is expected to turn in is a research paper written along the guidelines of articles published in Geophysical Research Letters. The paper should be 4-6 pages (NOT to exceed 6 pages), single-spaced, should contain 3-4 small figures, be written in 11- or 12-point font, have 1-inch margins, and be formatted as 2 columns. The paper should be hypothesis-driven and provide clear examples of how the hypothesis has been tested. When carrying out the research, students should keep in mind that sometimes a null or negative result is just as important as a positive result. Once a topic has been defined each student will need to do some background research, which should include reading peer-reviewed journal articles related to that topic.

Near the end of the semester each student will be required to give a 15 minute presentation to the class in which you will discuss your topic, why you chose it, and the findings of your independent research. Each presentation will be followed by a short period (~5 minutes) in which the instructor and other students are allowed to ask questions. The in-class presentation will account for 10% of your overall grade and the written paper will account for 15%. Students may submit drafts of their papers to the instructor prior to the final deadline if they desire feedback on their progress or results.
• Students will be required to submit a brief description of their potential research topic partway through the semester (see syllabus for exact date). This should consist of ~½ page of text that includes the hypothesis/research objective and how that hypothesis will be tested.

• An independent research topic can be related to a student’s Master’s or Ph.D. research, but it should include a new or novel component that is clearly distinct from that research.

• Start your project early! Do not wait until the last day of the semester!!!
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Class Topics & Reading List

Week 1 (Jan. 29) --- Sediment Production & Weathering (I)
Discussion Leader: R. Milliken


Week 2 (Feb. 5) --- Sediment Production & Weathering (II)
Discussion Leader:


Week 3 (Feb. 12) --- Erosion and Sediment Transport
Discussion Leader:


**Week 4 (Feb. 19) --- ** NO CLASS (Presidents’ Day)

**Week 5 (Feb. 26) --- ** Sedimentary Rocks on Mars: An Orbital Perspective Discussion Leader:


**Week 6 (March 5) --- ** Sedimentary Rocks on Mars: A Rover Perspective Discussion Leader:


Week 7 (March 12) --- Sedimentation Rates & Preservation
Discussion Leader:


Week 8 (March 19) --- NO CLASS (LPSC)

Week 9 (March 26) --- NO CLASS (Spring Break)

Week 10 (April 2) --- Sequences & Rhythmicity in the Rock Record
Discussion Leader:


Week 11 (April 9) --- Lithification & Diagenesis (I)
Discussion Leader:


Week 12 (April 16) --- Basin Scale Processes on Mars (I)
Discussion Leader:


Week 13 (April 23) --- Basin Scale Processes on Mars (II)
Discussion Leader:


Week 14 (April 30) --- Lithification & Diagenesis (II)
Discussion Leader:


Week 15 (May 7) --- Post-Depositional Processes on Mars
Discussion Leader:


FINAL PAPERS DUE: Monday MAY 14, 2018 5:00 p.m.
# Class Topics & Schedule

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<tr>
<th>Week</th>
<th>Topics</th>
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<tbody>
<tr>
<td>1 (Jan. 29)</td>
<td>Sediment Production &amp; Weathering (I)</td>
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<tr>
<td>2 (Feb. 5)</td>
<td>Sediment Production &amp; Weathering (II)</td>
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<tr>
<td>3 (Feb. 12)</td>
<td>Erosion and Sediment Transport</td>
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<td></td>
<td>Homework #1 out</td>
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<tr>
<td>4 (Feb. 19)</td>
<td>NO CLASS</td>
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<tr>
<td>5 (Feb. 26)</td>
<td>Sedimentary Rocks on Mars: An Orbital Perspective</td>
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<td></td>
<td>Homework #1 due</td>
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<tr>
<td>6 (March 5)</td>
<td>Sedimentary Rocks on Mars: A Rover Perspective</td>
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<tr>
<td>7 (March 12)</td>
<td>Sedimentation Rates &amp; Preservation</td>
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<td>Homework #2 out</td>
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<tr>
<td>8 (March 19)</td>
<td>NO CLASS (LPSC) Homework #2 due; Homework #3 out</td>
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<td>Final project description due Friday March 23</td>
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<tr>
<td>9 (March 26)</td>
<td>NO CLASS (Spring Break)</td>
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<tr>
<td>10 (April 2)</td>
<td>Sequences &amp; Rhythmicity in the Rock Record</td>
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<td>Homework #3 due</td>
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<tr>
<td>11 (April 9)</td>
<td>Lithification &amp; Diagenesis (I)</td>
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<tr>
<td>12 (April 16)</td>
<td>Basin Scale Processes on Mars (I)</td>
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<td>Homework #4 out</td>
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<tr>
<td>13 (April 23)</td>
<td>Basin Scale Processes on Mars (II)</td>
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<td>Homework #4 due</td>
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<tr>
<td>14 (April 30)</td>
<td>Lithification &amp; Diagenesis (II)</td>
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<tr>
<td>15 (May 7)</td>
<td>Post-Depositional Processes on Mars</td>
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