



UNIVERSITY OF CALGARY  
FACULTY OF SCIENCE  
DEPARTMENT OF GEOSCIENCE  
COURSE OUTLINE  
WINTER 2015

1. **Course:** Geology 693.05, Ichnology

Lecture Sections:

L01: MoWeFr, 11:00-11:50, ST 064

Instructor, Dr. A. Sohrabi, Office ES 150, Tel. No. 403-220-6446, e-mail address, [asohrabi@ucalgary.ca](mailto:asohrabi@ucalgary.ca),

Office Hours: MoWeFr, 1:00 pm to 3 pm.

Geoscience Department ES 118, 403-220-5841, [geoscience.ucalgary.ca](http://geoscience.ucalgary.ca), [geoscience@ucalgary.ca](mailto:geoscience@ucalgary.ca)

2. **Prerequisites:** Geology 449 or Geophysics 449, and Geology 461 or Geophysics 457. See section 3.5.C in the Faculty of Science section of the online Calendar ([www.ucalgary.ca/pubs/calendar/current/sc-3-5.html](http://www.ucalgary.ca/pubs/calendar/current/sc-3-5.html))

**Antirequisite:** Credit for both Geology 593 and 693 will not be allowed.

3. **Grading:** The University policy on grading and related matters is described sections [F.1](#) and [F.2](#) of the online University Calendar. In determining the overall grade in the course the following weights will be used:

Seminar Presentation	25%
Laboratory work	20%
Project report	30%
Final Examination	25%

Grading Scheme

A+	95 – 100%
A	86 – 94%
A-	80 – 85%
B+	77 – 79%
B	73 – 76%
B-	70 – 72%
C+	67 – 69%
C	63 – 66%
C-	60 – 62%
D+	55 – 59%
D	50 – 54%
F	<50%

Each piece of work (assignment, laboratory report, or final examination) submitted by the student will be assigned a percentage score. The student's average percentage score for the various components listed above will be combined with the indicated weights to produce an overall percentage for the course, which will be used to determine the course letter grade [bearing in mind that grade F will result if the student does not pass the final exam].

4. **Missed Components of Term Work:** The regulations of the Faculty of Science pertaining to this matter are found in the Faculty of Science area of the Calendar in [Section 3.6](#). It is the student's responsibility to familiarize himself/herself with these regulations. See also [Section E.6](#) of the University Calendar

5. **Course Materials:**

Ichnology: Organism-Substrate Interactions in Space and Time, Luis A. Buatois, M. Gabriela Mángano 2011.

6. **Examination Policy** No electronic or written aids (e.g. cell phones, tablets, computers, PDAs, notes, textbooks) will be allowed during writing of any exams. Non-programmable calculators will be permitted to answer quantitative questions on exams, if applicable, and

permission to do this will be clearly indicated on the examination paper. Students should also read the Calendar, [Section G](#), on Examinations.

7. **Writing across the curriculum statement:** In this course, the quality of the student's writing in laboratory reports will be a factor in the evaluation of those reports. See also [Section E.2](#) of the University Calendar.

8. **OTHER IMPORTANT INFORMATION FOR STUDENTS:**

(a) **Misconduct:** Academic misconduct (cheating, plagiarism, or any other form) is a very serious offence that will be dealt with rigorously in all cases. A single offence may lead to disciplinary probation or suspension or expulsion. The Faculty of Science follows a zero tolerance policy regarding dishonesty. Please read the sections of the University Calendar under [Section K](#). Student Misconduct to inform yourself of definitions, processes and penalties.

(b) **Assembly Points:** In case of emergency during class time, be sure to FAMILIARIZE YOURSELF with the information on [assembly points](#).

(c) **Academic Accommodation Policy:** Students with documentable disabilities are referred to the following links: Students with Disabilities: <http://www.ucalgary.ca/pubs/calendar/current/b-1.html> [B.1](#) and Student Accessibility Services: <http://www.ucalgary.ca/access/>.

(d) **Safewalk:** Campus Security will escort individuals day or night (<http://www.ucalgary.ca/security/safewalk/>). Call 220-5333 for assistance. Use any campus phone, emergency phone or the yellow phones located at most parking lot pay booths.

(e) **Freedom of Information and Privacy:** This course is conducted in accordance with the Freedom of Information and Protection of Privacy Act (FOIPPA). As one consequence, students should identify themselves on all written work by placing their name on the front page and their ID number on each subsequent page. For more information see also <http://www.ucalgary.ca/secretariat/privacy>.

(f) **Student Union Information:** [VP Academic](#) Phone: 220-3911 Email: [suvpaca@ucalgary.ca](mailto:suvpaca@ucalgary.ca).  
SU Faculty Rep. Phone: 220-3913 Email: [sciencerep@su.ucalgary.ca](mailto:sciencerep@su.ucalgary.ca); [Student Ombudsman](#)

(g) **Internet and Electronic Device Information:** You can assume that in all classes that you attend, your cell phone should be turned off unless instructed otherwise. Also, communication with other individuals, via laptop computers, Blackberries or other devices connectable to the Internet is not allowed in class time unless specifically permitted by the instructor. If you violate this policy you may be asked to leave the classroom. Repeated abuse may result in a charge of misconduct.

(h) **U.S.R.I.:** At the University of Calgary, feedback provided by students through the Universal Student Ratings of Instruction (USRI) survey provides valuable information to help with evaluating instruction, enhancing learning and teaching, and selecting courses ([www.ucalgary.ca/usri](http://www.ucalgary.ca/usri)). Your responses make a difference – please participate in USRI Surveys.

Department Approval: Original Signed

Date: December 19, 2014

Associate Dean's Approval for

Alternate final examination arrangements: Original signed

Date: December 22, 2014

UNIVERSITY OF CALGARY  
DEPARTMENT OF GEOSCIENCE  
COURSE OUTLINE

GEOLOGY 693.05

ICHOLOGY

TERM: Winter 2015  
PREREQUISITE(S): Consent of the Department  
ANTIREQUISITE(S): Credit for both Geology 6593 and 593 will not be allowed.  
Instructor, Dr. A. Sohrabi, Office ES 150, Tel. 403-220-6446, e-mail: [asohrabi@ucalgary.ca](mailto:asohrabi@ucalgary.ca),  
Office Hours: MoWeFr, 1:00 pm to 4 pm.

LECTURE :	L01	MWF	11:00-11:50	ST 064
LAB(S):	B01	F	13:00-15:50	

Course Objectives: GEOLOGY 693.05 concentrates on the principles of Ichnology. Ichnology is the branch of geology that focuses on traces of organismal behaviour (such as burrows, borings, trails, and tracks), bioturbation (disturbing of stratification by burrowers) and bioerosion (degradation of hard substrates by boring). This course deals with conceptual framework of ichnology with focuses on characteristics and preservation of trace fossils, ethology of trace fossils, and taxonomy of trace fossils. The course will cover trace fossils applications to the ichnofacies concept and paleoenvironmental interpretations of the sedimentary record. Ichnology of marine clastic environments and also sequence stratigraphy will be addressed in this course.

RESERVE READING ROOM: N/A  
MARK DISTRIBUTION: A. Composition of Final Grade

Seminar Presentation	25%
Laboratory work	20%
Project report	30%
Lab 1-2	(15%)
Lab 3-4	(15%)
Final Examination	25%

Students who are absent from the midterm exam or final laboratory exam because of illness or other unforeseen circumstances may be granted an excused absence by the Course Coordinator (midterm exam) or Lab Coordinator (final laboratory exam) upon presentation of adequate documentation (a completed Physician/Counsellor Report form <http://www.ucalgary.ca/registrar/PDFs/physcoun.pdf>) for illness; equivalent documentation for other circumstances). There will be no “make-up” examinations for excused absences. The weight assigned to the midterm examination will be transferred to the final examination.

Similarly, students who are unable to submit laboratory reports or assignments on time because of similar circumstances will be required to submit the same type of documentation to the Lab Coordinator in order to be considered for a time extension.

B. Components of Course for Which a Passing Grade is Essential

Students must achieve a passing grade (minimum of D+) on both the lecture portion of the course (average of the midterm and final exams) and the laboratory portion of the course to qualify for a passing grade overall.

C. Grading Scheme

A+	95 – 100%
A	86 – 94%
A-	80 – 85%
B+	77 – 79%
B	73 – 76%
B-	70 – 72%
C+	67 – 69%
C	63 – 66%
C-	60 – 62%
D+	55 – 59%
D	50 – 54%
F	<50%

*Tentative Class Schedule, Winter 2014*

**GLGY 693.05/693.05 – ICHNOLOGY**

**Time:** Monday, Wednesday & Friday: 11:00-11:50

**Location:** ST 064

**Instructor:** Dr. Akbar Sohrabi, ak.sohrabi@gmail.com

**Course Schedule:**

Lecture:

<b>Week</b>	<b>Lecture Topics</b>	<b>Location</b>
1	Course Overview introduction to Ichnology	SS-012
	Neoichnology	SS-012
2	Taxonomy of trace fossils	SS-012
	Paleobiology of trace fossils	SS-012
	Facies concepts and Ichnofacies	SS-012
3	Ichnology in biostratigraphy	SS-012
	Ichnology of marine clastic environments	SS-012
	Ichnology of continental environments	SS-012
4	Ichnology and sequence stratigraphy	SS-012
	Ichnology and evolutionary paleoecology	SS-012
	Seminars	SS-012
5	Seminars	SS-012
	Seminars	SS-012
	Seminars	SS-012
6	Seminars	SS-012
	Seminars	SS-012
	Seminars	SS-012

Lab:

<b>Week</b>	<b>Topic</b>	<b>Location</b>
1	Core lab exercise	ES 242 Core Lab
2	Project Work (with intro)	ES 242 Core Lab
3	Project Work	ES 242 Core Lab
4	Project Work	ES 242 Core Lab
5	Project Work	ES 242 Core Lab
6	Project Work	ES 242 Core Lab

## **Grading:**

Seminar Presentation – 20%

Lab work– 20%

Project Report– 30%

Final Exam – 30%

## **Term Project/Report (More detailed instructions to follow):**

Glauconitic and Viking formations core analysis and depositional environment interpretation:

- A) Log “practice” core in our core lab (including strip log, photographs and short summary)
- B) Cores assigned to groups to be documented with strip logs, photographs and short summaries.
- C) Using all data compiled by the class, produce a description and interpretation of the stratigraphic interval of interest.

## **Seminar Topics and Assignments:**

### *1. Controlling parameters on ichnological assemblages 1 (salinity)*

- Pemberton, S.G., Flach, P.D., and Mossop, G.D., 1982, Trace fossils from the Athabasca Oil Sands, Alberta, Canada: *Science*, v. 217, p. 825-827.
- Wightman, D.M., Pemberton, S.G., and Singh, C., 1987, Depositional modeling of the Upper Mannville (Lower Cretaceous), East-Central Alberta: implications for the recognition of brackish-water deposits: in *SEPM Special Publication*, v. 40, p. 189-220.
- Gingras, M.K., Pemberton, S.G., Saunders, T.D.A., and Clifton, H.E., 1999, The ichnology of modern and Pleistocene brackish-water deposits at Willapa Bay, Washington: variability in estuarine settings: *Palaios*, v. 14, p. 352-374.

### *2. Controlling parameters on ichnological assemblages 2 (oxygen)*

- Savrda, C.E., Bottjer, D.J., and Gorsline, D.S., 1984, Development of a comprehensive oxygen-deficient marine biofacies model: evidence from Santa Monica, San Pedro, and Santa Barbara basins, California continental borderland: *AAPG Bulletin*, v. 68, p. 1179-1192.
- Savrda, C.E., 2007, Trace fossils and marine benthic oxygenation, in Miller, W. (ed.), *Trace Fossils—Concepts, Problems, Prospects*: Elsevier, Oxford, p. 149-158.

### *3. Ichnofacies 1 (overview)*

- Pemberton, S.G., MacEachern, J.A., and Frey, R.W., 1992, Trace fossils facies models: environmental and allostratigraphic significance: in *Facies Models*, Geological Association of Canada, St. John's, p. 47-72.
- MacEachern, J.A., Pemberton, S.G., Gingras, M.K., and Bahn, K.L., 2007a, The ichnofacies paradigm: a fifty-year retrospective: in Miller, W. (ed.), *Trace Fossils—Concepts, Problems, Prospects*: Elsevier, Oxford, p. 52-80.

### *4. Ichnofacies 2 (linkage to water depth or other fundamental controls)*

- Ekdale, A.A., 1988, Pitfalls of paleobathymetric interpretations based on trace fossil assemblages: *Palaios*, v. 3, p. 464-472.
- Frey, R.W., Pemberton, S.G., and Saunders, T.D.A., 1990, Ichnofacies and bathymetry: A passive relationship: *Journal of Paleontology*, v. 64, p. 155-158.
- Shultz, M.R., and Hubbard, S.M., 2005, Sedimentology, stratigraphic architecture, and ichnology of gravity-flow deposits partially ponded in a growth-fault-controlled slope minibasin, Tres Pasos Formation (Cretaceous), southern Chile: *Journal of Sedimentary Research*, v. 75, p. 440-453.

### *5. Stratigraphic Applications of Ichnology*

- MacEachern, J.A., Pemberton, S.G., Gingras, M.K., Bahn, K.L., and Defoe, L.T., 2007b, Uses of trace fossils in genetic stratigraphy: in *Trace Fossils Concepts, Problems, Prospects*, Elsevier, New York, p. 110-134.
- Hubbard, S.M., and Shultz, M.R., 2008, Deep burrows in submarine fan-channel deposits of the Cerro Toro Formation (Cretaceous), Chilean Patagonia: Implications for firmground development and colonization in the deep sea: *Palaios*, v. 23, p. 223-232.
- Yang, B., Dalrymple, R.W., Gingras, M.K., and Pemberton, S.G., 2009, Autogenic occurrence of *Glossifungites* Ichnofacies: Examples from wave-dominated, macrotidal flats, southwestern coast of Korea: *Marine Geology*, v. 260, p. 1-5.

### *6. Utility of Individual Ichnogenera in Paleogeographic Interpretations: Macaronichnus*

- Clifton, H.E., and Thompson, J.K., 1978, *Macaronichnus* segregates: a feeding structure of shallow marine polychaetes: *Journal of Sedimentary Petrology*, v. 48, p. 1293-1302.
- Pemberton, S.G., MacEachern, J.A., Gingras, M.K., and Saunders, T.D.A., 2009, Biogenic chaos: Cryptobioturbation and work of sedimentologically friendly organisms: *Palaeogeography, Palaeoclimatology, Palaeoecology*, v. 270, p. 273-279.
- Quiroz, L.I., Buatois, L.A., Mangano, M.G., Jaramillo, C.A., and Santiago, N., 2010, Is the trace fossil *Macaronichnus* an indicator of temperate to cold waters? Exploring the paradox of its occurrence on tropical coasts: *Geology*, v. 38, p. 651-654.

### *7. Ichnological Characteristics of Estuaries*

- Dorjes, J., and Howard, J.D., 1975, Estuaries of the Georgia Coast, U.S.A.: *Sedimentology and biology. IV. Fluvial-marine transition indicators in an estuarine environment, Ogeechee River – Ossabaw Sound, Georgia: Senckenbergiana Maritima*, v. 7, p. 137-179.

- Hauck, T.E., Dashtgard, S.E., Pemberton, S.G., and Gingras, M.K., 2009, Brackish-water ichnological trends in a microtidal barrier island–embayment system, Kouchibouguac National Park, New Brunswick, Canada: *Palaios*, v. 24, p. 478-496.
- Hubbard, S.M., Gingras, M.K., Pemberton, S.G., 2004, Palaeoenvironmental implications of trace fossils in estuary deposits of the Cretaceous Bluesky Formation, Cadotte region, Alberta, Canada: *Fossils and Strata*, v. 51, p. 68-87.

#### 8. *Ichnological Characteristics of Deltas*

- Bhattacharya, J.P., and MacEachern, J.A., 2009, Hyperpycnal rivers and prodeltaic shelves in the Cretaceous Seaway of North America: *Journal of Sedimentary Research*, v. 79, p. 184-209.
- Gingras, M.K., MacEachern, J.A., and Pemberton, S.G., 1998, A comparative analysis of the ichnology of wave- and river-dominated allomembers of the Upper Cretaceous Dunvegan Formation: *Bulletin of Canadian Petroleum Geology*, v. 46, p. 51-73
- MacEachern, J.A., Bahn, K.L., Bhattacharya, J.P., and Howell, C.D., 2005, Ichnology of deltas: Organism responses to the dynamic interplay of rivers, waves, storms, and tides: in *SEPM Special Publication*, v. 83, p. 49-85.

#### 9. *Ichnological Characteristics of Slopes*

- Hubbard, S.M., MacEachern, J.A., and Bann, K.L., in review, The ichnology of slope deposits: *Developments in Sedimentology*, Elsevier.
- Cummings, J.P., and Hodgson, D.M., 2011, Assessing controls on the distribution of ichnotaxa in submarine fan environments, the Basque Basin, northern Spain: *Sedimentary Geology*, v. 239, p. 162-187.

#### 10. *Ichnological Applications: Mass Extinction Recovery*

- Pruss, S.B., and Bottjer, D.J., 2004, Early Triassic trace fossils of the Western United States and their implications for prolonged environmental stress from the End-Permian mass extinction: *Palaios*: v.19, p. 551-564.
- Zonneveld, J.P., Beatty, T.W., and Pemberton, S.G., 2007, Lingulide brachiopods and the trace fossil *Lingulichnus* from the Triassic of Western Canada: Implications for faunal recovery after the end-Permian mass extinction: *Palaios*, v. 22, p. 74-97.

Zonneveld, J.P., Gingras, M.K., and Beatty, T.W., 2010, Diverse ichnofossil assemblages following the P–T mass extinction, Lower Triassic, Alberta and British Columbia, Canada: Evidence for shallow marine refugia on the northwestern coast of Pangaea: *Palaios*, v. 25, p. 368-392.

#### 11. *Ichnological Applications: Hydrocarbon Reservoir Properties*

- Gingras, M.K., Mendoza, C.A., and Pemberton, S.G., 2004, Fossilized worm burrows influence the resource quality of porous media: *AAPG Bulletin*, v. 88, p. 875-883.
  - Pemberton, S.G., and Gingras, M.K., 2005, Classification and characterizations of biogenically enhanced permeability: *AAPG Bulletin*, v. 89, p. 1493-1517.
- Tonkin, N.S., McIlroy, D., Meyer, R., and Moore-Turpin, A., 2010, Bioturbation influence on reservoir quality: A case study from the Cretaceous Ben Nevis Basin, Offshore Newfoundland, Canada: *AAPG Bulletin*, v. 94, p. 1059-1078.