GEOMICROBIOLOGY:

GEO 381G & GEO 341G: FALL 2011

Instructor:	Philip Bennett pbennett@mail.utexas.edu	**Officer Hours**: EPS 2.204 MW12-3:00	**Phone**: 1-3587
Details	**Lecture**: EPS 1.102 Tues./Thur. 2:00-3:30	**Lab/** Time and Place TBA	
First Class	**Thursday Aug. 25, 2011**		
Web Page	**TBA**		

Overview:

This course is an introduction to the interactions between bacteria and minerals in the subsurface, and the geologic significance of subsurface microbial activity. This is a seminar style course with an emphasis on readings from the current literature and applied laboratory techniques, and we will look primarily at the prokaryotes of interest to geologist and geochemists. Examples of specific topics include 1) cell physiology; 2) microbial growth and metabolism; 3) subsurface microbial ecology; 4) carbon utilization and cycling; 5) sulfur metabolism; 6) metal metabolism; 7) carbonate diagenesis; 8) silicate diagenesis; 9) origins of life; and 10) methane oxidation. The course will utilize a mixture of lectures, seminar discussions, laboratory exercises and field trips, relying on both textbooks and journal articles as sources. The course is intended for graduate students with basic undergraduate coursework in biology and chemistry.

Course Requirements and Grading:

Grading will be based on a final project report (35%), lab participation (15%); a class presentation/lecture (25%); and class participation (25%). Each student will facilitate at least one discussion session in addition to presenting their final project, and part of the participation grade will be based on that component. Students are required to maintain a lab and field notebook of observations and experimental results, and that will be the basis of the lab grade.

Textbooks and supplemental reading:

Primary:: .Konhauser, K. (2007) *Introduction to Geomicrobiology* Blackwell

Secondary: Chapelle, F.H. (2001) *Ground-Water Microbiology and Geochemistry*, 2nd Ed.;
Ehrilich, H.L. (1996) *Geomicrobiology*, 3rd Ed.,
Madigan, M.T. et al., *Brock Biology of Microorganisms*, 8th Ed.;

For most of the course, the first class period each week will be a lecture/discussion of the current topic, with the lectures intended to supplement the reading and provide background for the journal articles. The second weekly meeting will be either seminar discussion of current papers, or a laboratory session to introduce a particular technique. Part of your grade will be based on evidence of your having completed the assigned reading.

Final Projects:

There is a single final project due on the last day of class. The topic can be related to your research if that is appropriate, or you can choose from several current "hot topics" in geomicrobiology. In addition to a written report, you will be expected to prepare and present a 30 minute *lecture* on your topic. Potential topics are anaerobic methane oxidation, origins of life, hyperthermophiles, acidophiles, electrode growth, and arsenic biogeochemistry.

Honor Code:
The core values of The University of Texas at Austin are learning, discovery, freedom, leadership, individual opportunity, and responsibility. Each member of the university is expected to uphold these values through integrity, honesty, trust, fairness, and respect toward peers and community

Field Trip:
As part of the course I will be leading a field trip to Yellowstone National Park, and to Lower Kane Cave, Wyoming. The purpose of the trip is learn field techniques in geomicrobiology and microbial geochemistry, get face to face with the incredible Yellowstone hot spring environments, and to participate in geomicrobiology research in some very interesting spots. The field trip is NOT required, but it will be a valuable experience and a center piece of the course, so I hope you can all make it.

The tentative field trip schedule is:

Sunday	19-Aug	Travel to Billings, pick up vans, drive to Norris Campground
Monday	20-Aug	Sampling in Norris and Ojo Caliente (Norris Campground)
Tuesday	21-Aug	Sampling in Norris and Ojo Caliente (Norris Campground)
Wednesday	22-Aug	Sampling at Mammoth (Mammoth Campground)
Thursday	23-Aug	Drive to Lovell and Kane Cave (Horseshoe Bend Motel)
Friday	24-Aug	Kane Cave and Spence Cave (Horseshoe Bend Motel)
Saturday	25-Aug	Thermompolis, and Spence Dome oil field (Horseshoe Bend Motel)
Sunday	26-Aug	Drive to Billings, Depart for Austin

Transportation will be by commercial airline to Billings, then rental vans from there to our field locations. The major costs of the trip (airfare, rental vehicle) will be covered by the department, but some food (and beverage) costs and your personal purchases are on you. We will be staying in campgrounds for the first 4 nights, and at a nice little motel for the last three nights. Tents and group camping equipment are available from the department, but each of you will need to bring a sleeping bag, caving clothing, and your personal gear. It could be cold in Yellowstone – in fact, it could snow on us at Norris, so be sure you are prepared for cold weather. The cave is not a tight squeeze, there is a bit of a squirm right at the entrance, but after that it is wide open. You will need to bring for that two sources of light with one of them a LED headlamp, coveralls, and boots that you do not mind getting almost terminally muddy.

GEOMICROBIOLOGY LECTURE SCHEDULE:

WEEK	TOPIC	READING
8/26	**COURSE INTRODUCTION**	
8/31	**THE ORIGIN OF LIFE** Definitions, tree of life, domains, molecular evidence of early life ***Discussion:*** *Evidence of life in the Archean*	**Chap. 1, 7**
9/7	**MICROBIAL ECOLOGY, DIVERSITY AND PHYLOGENY** subsurface habitats, Molecular biology, genetics, and 16S rDNA phylogeny	**Chap. 1, 6**
9/14	**SELECTED TOPICS IN CELL BIOLOGY** Cell membranes, periplasm and cytoplasm, gram-negative/positive, Archaea, ribosomes and RNA, Chemiosmosis, Glycolysis **Discussion:** Cell walls as geologic surfaces	**Chap. 1,2**
9/21	**Field Trip to Yellowstone and Lower Kane Cave**	
9/28	**MICROBIAL METABOLISM AND BIOENERGETICS** Metabolic processes, thermodynamics, metabolic guilds, competition Microbial growth kinetics and strategies **LAB**: Microscopy, Gram Stain and DAPI cell counts,	**Chap. 2,6**
10/5	**CYANOBACTERIA AND PHOTOTROPHY**	**Chap. 2**
10/12	**SULFUR METABOLISM: PROTEOBACTERIA** Sulfur and sulfide oxidation, lithotrophs and phototrophs, Sulfur and sulfate reduction, metal sulfides	**Chap. 2**
10/19	**METHANE: METHANOTROPHS AND METHANOGENS** Methanogens and methanotrophs, MMO v. ANME, **OUTLINE OF FINAL PROJECT DUE**	**Chap. 4/5**
10/26	**CARBONATE GEOMICROBIOLOGY** Calcite and dolomite dissolution and precipitation, Biomineralization LAB**: ESEM examination of carbonates**	**Chap. 4/5**
11/02	**METAL METABOLISM AND SORPTION:** Fe, Mn, U as electron acceptors, iron oxidizers, metal sorption on cells	**Chap. 2.4, 3**
11/9	**ARSENIC METABOLISM:** Arsenic and Antimony as electron acceptors, the *ars* operon and detoxification **FIRST DRAFT OF FINAL PROJECT DUE**	**Chap. 2, 3**
11/16	**SILICATE GEOMICROBIOLOGY** Silicate diagenesis and silica sunscreens	**Chap. 3,4**
11/23	**SILICATE GEOMICROBIOLOGY** **LAB**: ESEM examination of silicates	**Chap. 3,4**
11/25	***THANKSGIVING HOLIDAY (THURS)***	
11/30	**STUDENT PRESENTATIONS**	

PRIMARY JOURNALS

Applied and Environmental Microbiology
Extremophiles
FEMS Microbiology
FEMS-Microbial Ecology
Geomicrobiology Journal
Microbial Ecology

ONLINE RESOURCES

Ehrlich, H.L. (1996) Geomicrobiology 3rd Ed.
http://80-www.netlibrary.com.content.lib.utexas.edu:2048/ebook_info.asp?product_id=12612

Ehrlich, H.L. (2002) Geomicrobiology 4th Ed.
http://80-emedia.netlibrary.com.content.lib.utexas.edu:2048/reader/reader.asp?product_id=79216

Elsas, J. D. van (1997) Modern Soil Microbiology
http://80-emedia.netlibrary.com.content.lib.utexas.edu:2048/reader/reader.asp?product_id=12797

Dennis, P. J.; Godfree, A. F.; Stewart-Tull, D. E. S. (1997) Aquatic Microbiology
http://80-emedia.netlibrary.com.content.lib.utexas.edu:2048/reader/reader.asp?product_id=55662

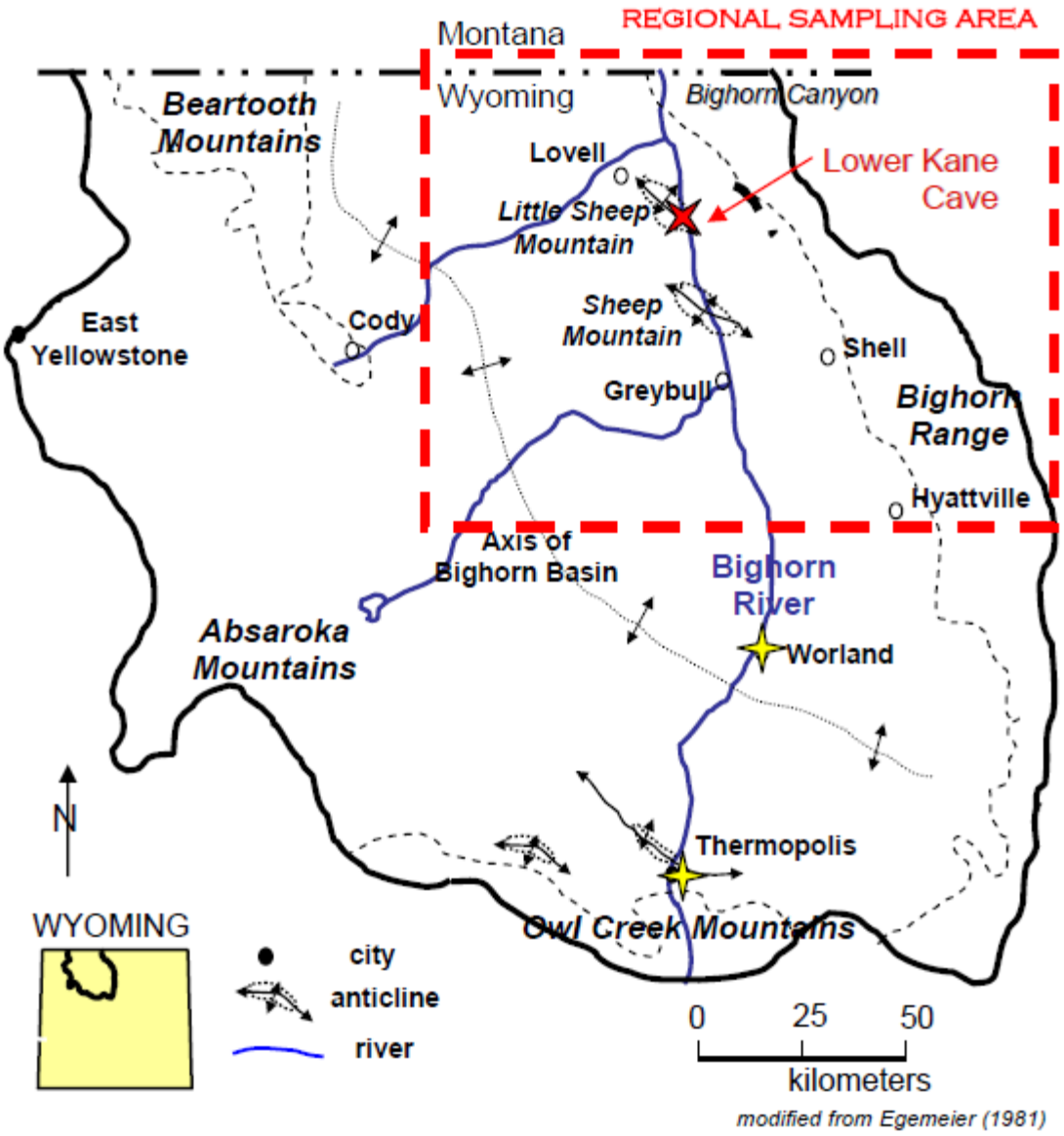


Figure 2.1: Study Area within the Bighorn Basin, showing the location of Lower Kane Cave (marked with a red star) and selected important structural features. The regional sampling area demarcated in red is shown in Figure 3.1 with the locations of Sr sampling sites marked. The yellow stars mark sampling sites at Thermopolis (this study) and Worland (Frost and Toner, in press) that lie outside the regional study area.

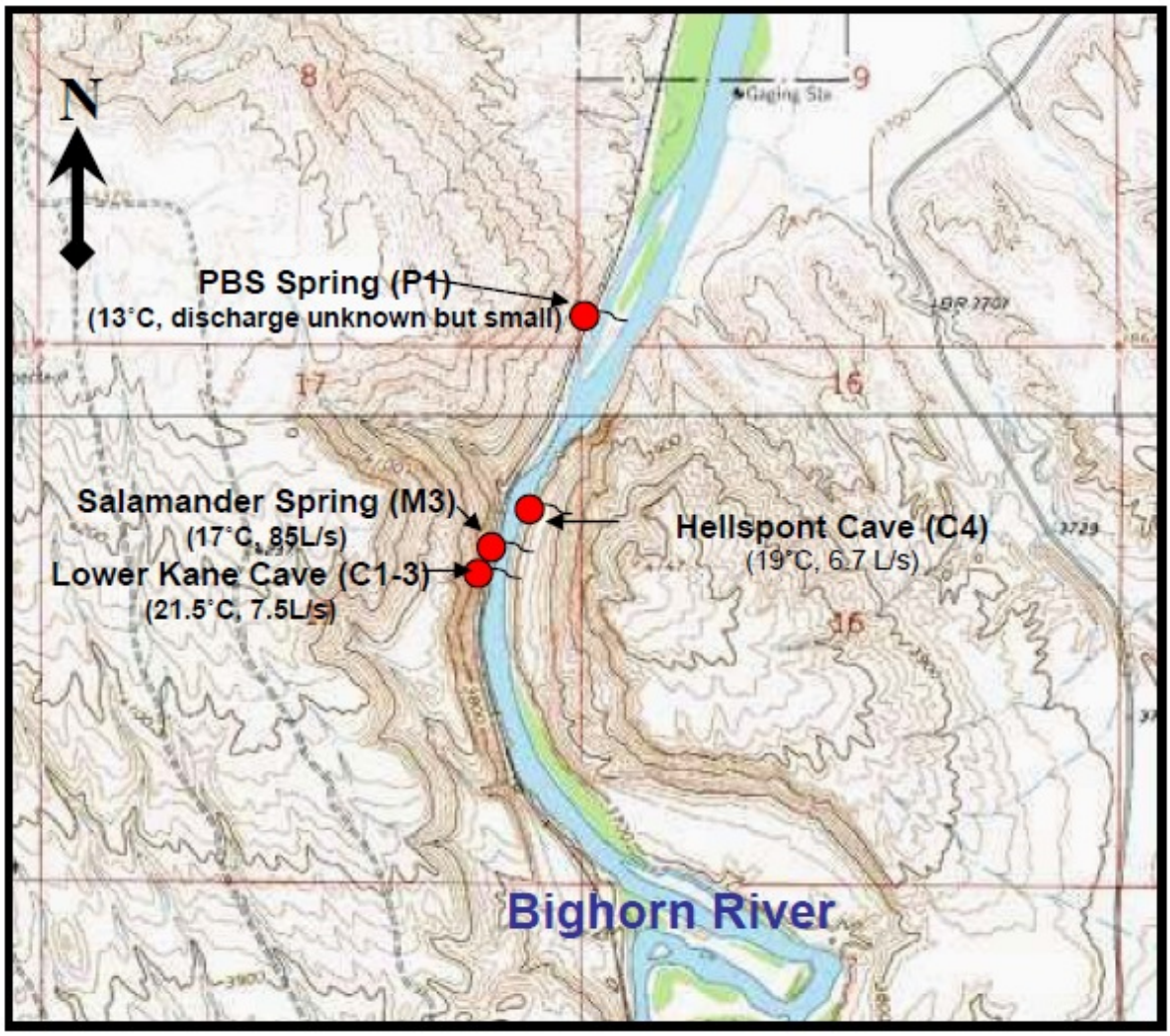
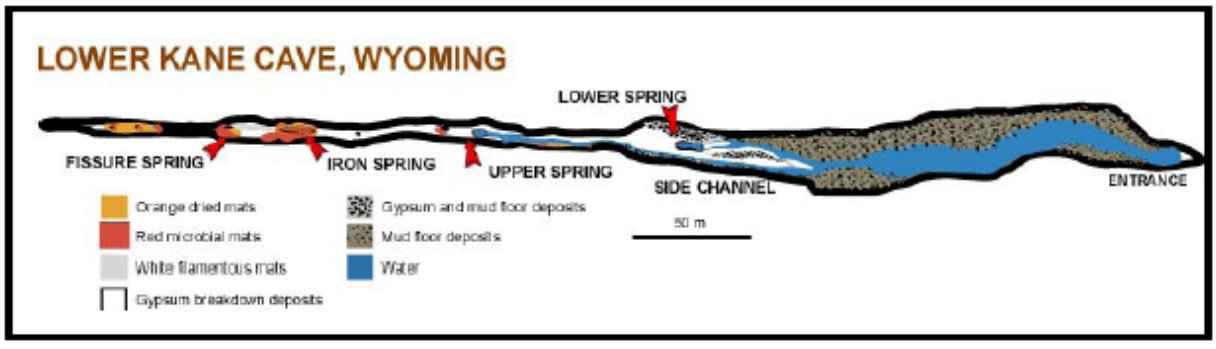
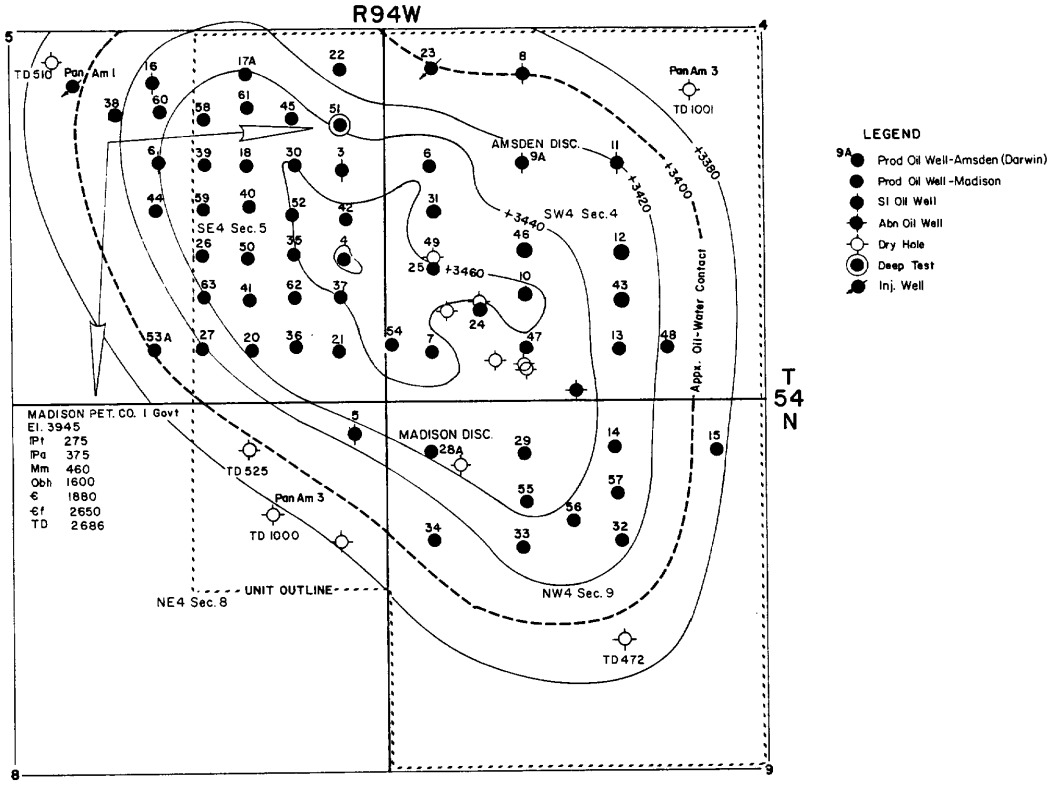


Figure 4.4: Topographic map of the canyon through Little Sheep Mountain showing the location of springs and caves. The squares outlined in red on the map and numbered are sections in the Township and Range location system, and are a mile square. Temperature data from this study, discharge data from Egemeier (1981).

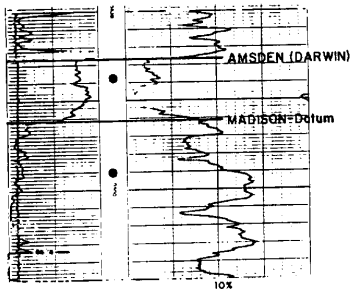


Age	Unit	Thickness	Lithology	Aquifer
Quaternary	Quaternary Undivided	0-100	Alluvium	
Cretaceous	Mowry Shale	330	Shale	
	Thermopolis Shale	400-500	Shale	
	Cloverly Fm	80-250	Siltstone	
Jurassic	Morrison Fm	370-560	Siltstone	
	Sundance Fm	370	Siltstone	
	Gypsum Spring Fm	130-200	Gypsum	
Triassic	Chugwater Fm and Dinwoody Fm Undivided	500-600	Siltstone	
Permian	Phosphoria Fm	80-240	Limestone, Shale	Phosphoria / Tensleep
Pennsylvanian	Tensleep Ss	80-150	Sandstone	
	Amsden Fm	160-220	Shale	
Mississippian	Madison Limestone	630-850	Limestone with paleokast zone in upper half	Madison
Devonian	Jefferson Fm	200	Limestone with shale units	
Ordovician	Bighorn Dolomite	300-410	Dolomite	
Cambrian	Gallatin Fm	200-530	Shale with interbedded limestone and sandstone units	
	Gros Ventre Fm	500-600		
	Flathead Ss	0-300	Sandstone	Flathead
Precambrian	Precambrian Undivided		Igneous and Metamorphic	

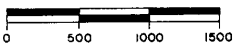
Figure 2.2: Stratigraphic Section of the Bighorn Basin. Modified from Doremus (1986).



2310NS 990WE Sec. 5



Prod Zone: Amsden 427-461 (open hole)
Madison 462-554(open hole)



W.G.A.

SPENCE DOME

BIG HORN COUNTY, WYOMING
DATUM – MADISON
CONTOUR INTERVAL – 20'