GEO 303 Spring 2015

Sedimentary Geology and Geochronology

with emphasis on the Turkana Basin

This course introduces current perspectives on the origins and evolution of the Turkana Basin, Kenya. Students will learn how to apply fundamental geological concepts to sediments and rock units to provide a foundation for the chronology and context for events in human evolution. Emphasis is given to sedimentation, stratigraphy, volcanism, and tectonics, as they apply to local geology, including training in field methods. Modern terrestrial processes and landscape evolution are examined using features present in the Turkana Basin. Consideration is also given to broader geologic events spanning the Cretaceous to the present. Geologic concepts are linked to modern and ancient environments, archaeology, and paleoanthropology in northern Kenya. It is a field-based course involving visits to important geological and fossil sites. Graded work includes fieldwork assignments, quizzes, and a final exam.

A few short excursions and one multi-night field trip are planned as part of this module. Trips to nearby fossil- and artifact-bearing locations and the habitats discussed in the course will expose students to the geological and paleoenvironmental context of important discoveries of the Turkana Basin. Lab and field exercises will acquaint students with key methods of paleoecological and paleoenvironmental reconstruction. Students should be prepared to spend time outdoors for this module and have adequate packs for carrying notebooks, water and other supplies. Lab exercises will showcase analytical methods that reveal prehistoric organisms' diet or locomotion, and give examples of physiological changes that coincided with major shifts in prehistoric climate and environment. Hands-on examination of prehistoric stone tools from Plio-Pleistocene sites around Lake Turkana will teach students how human ancestors adapted technologically to the environments around them.

Instructor: Dr. Craig Feibel feibel@eps.rutgers.edu
Office & Phone: Department of Anthropology, Rutgers University, 131 George Street, New Brunswick, NJ, 08901 - +1 848-932-9345
Will be generally available to students for office hours during the module.

Teaching Assistants: There will be one graduate student TA and one undergraduate student TA available at the facility for the duration of the semester.

Class Meetings: Monday - Saturday, 8:00 am - 12:00 pm, and 2:30 - 5:30 pm

Text: There is no assigned textbook for this course; assigned readings will be given digitally to the students at the beginning of the course. The readings will be useful for clarifying concepts discussed in class and for supplying additional examples from those presented in lecture. Students will find that reading the material before attending lecture will make the lecture easier to follow. Other documents, review sheets, class announcements, etc, will be downloadable from the class Blackboard site (https://blackboard.stonybrook.edu).

COURSE LEARNING OBJECTIVES

The objectives of this course are to teach you to:

1. Knowledge and major concepts: Students will learn about:
    - -the spatial and temporal scales at which Earth's processes operate.
    - -Earth's systems and complex interactions.
    - -how Earth and humans are inextricably linked.
    - -the fossil record and its distribution through time.
    - -how to use evidence to evaluate earth science concepts and draw conclusions.

2. Skills: Students will develop their abilities to ...
    - -read, visualize and interpret spatial representations of field geological / geographic data.
    - -distinguish among evidence (data), models, assumptions, hypotheses, theories, interpretations, and predictions / recommendations.
    - -reason with and/or evaluate multiple working hypotheses.

3. Habits and attitudes: Students will
    - -employ appropriate learning skills for the sciences, including evaluation of data, reasoning and questioning.
    - -consider science as an ongoing endeavor that embraces curiosity, creativity and societal needs, and is not just a set of facts.
    - -recognize and experience two approaches used in the Earth system sciences, including:
        - --historical, descriptive, systems-oriented approaches;
        - --experimental approaches.
    - -ask "How do we know?", "Why do we accept it?", and "What is the evidence for ...?"

This course satisfies the following requirements of the **DEC**:
Category E- Natural Sciences

This course satisfies the following requirements of the **SBC**:
Study the Natural World (SNW):

1. Understand the methods scientists use to explore natural phenomena including observation, hypothesis development, measurement and data collection, experimentation, and evaluation of evidence.
2. Understand the natural world and the major principles and concepts that form the basis of knowledge in the natural sciences.
3. Assess scientific information and understand the application of scientific data, concepts, and

models in the natural sciences.
4. Make informed decisions on contemporary issues involving scientific information.

-In this class, via field practicals and lab experiments (see details below), students will have hands-on practice with the methods scientists use to explore natural phenomena, will gain direct understanding of the natural world and the major principles and concepts that form the basis of knowledge in the natural sciences, learn how to assess scientific information and understand the application of scientific data, concepts, and models, such that at the end of the module they will be able to make informed decisions on contemporary issues involving scientific information.

PREREQUISITES

This course is part of a 5-course themed cluster (field school) and there are no prerequisites except permission from the instructor and/or study abroad office. Lectures will cover the basic concepts that are required to understand the material. A science background is not necessary for the successful completion of the course.

COURSE REQUIREMENTS

Grading:

-Sketch Map	5 pts
-Localities Quiz	5 pts
-Camp Map	10 pts
-Slope Profile	5 pts
-Minerals and Rocks Quiz	5 pts
-Orienteering Exercise	10 pts
-Orienteering GPX	5 pts
-Turkwel Map	5 pts
-Turkwel River Exercise	15 pts
-Stratigraphic Section Exercise	15 pts
-Climate Quiz	5 pts
-Final Exam	15 pts?
-Field Component	(15 pts)?
-Written	(65 pts)
-ID & Practical	(35 pts)

Final Exam – the final will consist of three components, a Field Component based on performance on the Lothagam Field Trip, a Written Component of questions based on lectures, experiences and observations during the course, and an ID & Practical Component demonstrating ability to identify and relate significance of hand specimens of minerals, rocks and fossils, as well as ability to use basic field equipment.

COURSE POLICES

Classroom etiquette:

While students are in class, they are expected to give their full attention to the lecture. Reading, talking, eating, texting or browsing on cell phones, leaving or packing up to leave before the professor has dismissed the class are inappropriate classroom behaviors and disruptive to other students. Also, please make sure that your watch alarms, pagers, and cell phones do not go off during class.

Attendance and preparation of assignments:
Students are expected to attend all classes; if you expect to miss one or two classes, please email your TA, who will inform to me. Unexcused absences will lower your grade. Computer glitches (such as computers that die, hard disks that crash, flash drives that are lost, etc) will not be accepted as excuses for failure to do assignments on time, to study for exams, etc.

Policy Regarding Missed Exams:
Generally, makeup examinations are not given (and the score for the missed exam is entered as zero "0"). If you would like to be considered for a makeup examination, the following conditions must be met: 1. You should have a legitimate excuse for having missed the original exam, e.g., illness, family emergency. 2. You must inform me within 48 hrs before or after the scheduled exam date that you cannot take the exam. If the above conditions apply, then you will be allowed to do a makeup exam.

Americans with Disabilities Act:
If you have a physical, psychiatric/emotional, medical or learning disability that may impact on your ability to carry out assigned course work, please contact the Disability Support Services office in the Educational Communications Center (ECC) Building, room 128 (632-6748). DSS will review your concerns and determine, with you, what accommodations are necessary and appropriate. All information and documentation of disability is confidential.

Academic Integrity:
Each student must pursue his or her academic goals honestly and be personally accountable for all submitted work. Representing another person's work as your own is always wrong. Faculty are required to report any suspected instances of academic dishonesty to the Academic Judiciary. Faculty in the Health Sciences Center (School of Health Technology & Management, Nursing, Social Welfare, Dental Medicine) and School of Medicine are required to follow their school-specific procedures. For more comprehensive information on academic integrity, including categories of academic dishonesty, please refer to the academic judiciary website at http://www.stonybrook.edu/uaa/academicjudiciary/

Critical Incident Management:
Stony Brook University expects students to respect the rights, privileges, and property of other people. Faculty are required to report to the Office of Judicial Affairs any disruptive behavior that interrupts their ability to teach, compromises the safety of the learning environment, or inhibits students' ability to learn. Faculty in the HSC Schools and the School of Medicine are required to follow their school-specific procedures.

Syllabus

Day 1- Introduction
Morning: Initial Assessment; Bush sense and safety; Field Notes
Afternoon: Geology Walk- Nachukui Formation strata West of Camp

Day 2- Mapping & Sedimentology I
Morning: Spatial concepts; compass basics; pacing; map components; sketch maps.
Exercise 1: Sketch Map of TBI Turkwel

Afternoon: Sediment, processes and products; weathering, transport and deposition

Day 3- Mapping & Sedimentology II
Morning: GPS setup and use; waypoints and tracks; topography, contours; Brunton pocket transit, attitude, geological mapping
Afternoon: Sedimentary rocks, depositional environments, post-depositional modification.
Orienteering Contest

Day 4- Modern Sedimentary Processes / Stratigraphy I
Morning: Turkwel River Fluid flow, sedimentary structures, sequences.
Exercise 2: Fluvial Processes of the Turkwel River
Afternoon: Stratigraphic principles, physical stratigraphy, unconformities; stratigraphic cross-sections and geological history

Day 5- Modern Sedimentary Processes II / Turkana Basin Geologic History I
Morning: Aiyangiyang Depression- Aeolian processes, closed depressions, soil formation; taphonomy and fossil preservation
Afternoon: Cenozoic record; rift development, Omo and Turkana Group sequences

Day 6- Kabua Gorge Trip
Morning: Travel to Kalakol River.
Afternoon: Investigate Holocene Lake beds, volcanics and border fault.

Day 7- Rest Day

Day 8- Tectonics and Volcanism / Stratigraphy II
Morning: Fundamentals of structure and faulting; evolution of East African Rift System; rift volcanism and tephra
Afternoon: Stratigraphic approaches; practical aspects of stratigraphic sections, measurement, Munsell colors, contacts

Day 9- Stratigraphic Sections / Geochronology and Tephrostratigraphy
Morning: Exercise 3- Description and measurement of sedimentary strata at Epim
Afternoon: Chronostratigraphy, isotopic dating, magnetic polarity stratigraphy; tephra and geochemical fingerprinting

Day 10- Climate and Environments / Lothagam
Morning: Local, regional and global patterns; temporal development; forcing arguments
Afternoon: Introduction to research history, geology and significance of Lothagam

Day 11-12- Lothagam Field Trip
Fly-camp overnight at Lothagam Hill. Depart early AM, transit to Lothagam, establish camp. Overview of Miocene, Plio-Pleistocene and Holocene stratigraphic components. Observation and field description of strata.

Day 13- Showing What You Learned
Morning: Study
Afternoon: Final Exam

Day 14- Class Over: Rest Day Before Next Module

Assignments

Sketch Map – initial spatial analysis and diagrammatic graphical representation of features in and around camp.

Localities Quiz – partial test for placement of prominent Turkana Basin localities.

Camp Map – reprise of initial spatial analysis of camp, introducing quantitative tools for distance and angle measurements. Report/publication quality standards of scaled graphical representation.

Slope Profile – field exercise introducing quantification of topography with Jacob's staff and Brunton compass.

Minerals and Rocks Quiz – identification of local materials and their components

Orienteering Exercise – practical field test integrating compass and GPS operation in traversing complex terrain.

Orienteering GPX – Download, integration and presentation of GPS files from exercise.

Turkwel Map – map compositing to establish drainage basin context for ensuing field exercise.

Turkwel River Exercise – three-component field exercise to describe and measure fluvial dynamics in the Turkwel River, relate modern sedimentary structures to bedforms, and to interpret Modern, Holocene, and Pliocene fluvial strata.

Stratigraphic Section Exercise – a field exercise to measure and describe, in both written and graphic formats, the Holocene sedimentary sequence at Epim.

Climate Quiz – lecture based queries on orbital controls, climate dynamics, and Earth-Life System interactions.

Readings

Readings for individual lectures will be distributed as PDFs/photocopies before or at the beginning of the module. Students are expected to have read the papers before the day that topic is covered and come prepared with questions for discussion sessions.

Historical Background
Lewin, R. 1987. *Bones of contention*. Simon and Schuster, New York. 348 pp. Chapters 9 & 10

Geology of Kenya
National Museums of Kenya. 1984. *Kenya's place in geology*. NMK, Nairobi. 39 pp.

Turkana Basin Geology

Feibel, C. S. 2011. A geological history of the Turkana Basin. *Evolutionary Anthropology* 20(6): 206-216.

Field Notes

Behrensmeyer, A. K. 2012. Linking researchers across generations. In: Canfield, M. R. (ed.) *Field Notes on Science & Nature*. Harvard University Press, Cambridge. pp. 89-108.

South Turkwel

Ward, C.V., Leakey, M. G., Brown, B., Brown, F., Harris, J. and Walker, A. 1999. South Turkwel: A new Pliocene hominid site in Kenya. *Journal of Human Evolution* 36: 69-95.

Mapping

Compton, R. R. 1985. *Geology in the field*. J. Wiley & Sons, New York. 398 pp. Chapters 1, 2 & 5

Sedimentology

Feibel, C. S. 2001. Archaeological sediments in lake margin environments. In: Stein, J. K. and Farrand, W. R. (eds.) *Sediments in Archaeological Context*. University of Utah Press, Salt Lake City. pp. 127-148.

Feibel, C. S. in press. Facies and Pliocene paleoecology. In: Sponheimer, M. Lee-Thorp, J. Reed, K. Ungar, P. (eds.) *Early Hominin Paleoecology*. University of Colorado Press.

Stratigraphy

Brown, F. H. and Feibel, C. S. 1986. Revision of lithostratigraphic nomenclature in the Koobi Fora region, Kenya. *Journal of the Geological Society*, London 143: 297-310.

Tectonics and Volcanism

Haileab, B., Brown, F. H., McDougall, I. and Gathogo, P. N. 2004. Gombe Group basalts and initiation of Pliocene deposition in the Turkana depression, northern Kenya and southern Ethiopia. *Geological Magazine* 141: 41-53.

Geochronology and Tephrostratigraphy

Feibel, C. S. 1999. Tephrostratigraphy and geological context in paleoanthropology. *Evolutionary Anthropology* 8: 87-100.

Climate and Environments

Feibel, C. S. 1999. Basin evolution, sedimentary dynamics and hominid habitats in East Africa: an ecosystem approach. In: Bromage, T. and Schrenk, F. (eds.) *African Biogeography, Climate Change, and Human Evolution*. Oxford University Press, Oxford. pp. 276-281.

Potts, R. 2012. Environmental and behavioral evidence pertaining to the evolution of Early Homo. *Current Anthropology* 53: S299-S317.

Lothagam

Feibel, C. S. 2003. Stratigraphy and depositional history of the Lothagam sequence. In: Leakey, M. G. and Harris, J. M. (eds.) *Lothagam: The Dawn of Humanity in Eastern Africa*. Columbia University Press, New York. pp. 17-29.