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Curriculum Proposal Cover Sheet - University-Wide Undergraduate Curriculum Committee

Contact Person(s) **Karen Rose Cercone**	Email Address **kcercone@iup.edu**
Proposing Department/Unit **Geoscience**	Phone **724-357- 7650**

Check all appropriate lines and complete all information. Use a separate cover sheet for each course proposal and/or program proposal.

1. Course Proposals (check all that apply)

_____ New Course _____ Course Prefix Change _____ Course Deletion

_X_ Course Revision _X_ Course Number and/or Title Change _____ Catalog Description Change

Current course prefix, number and full title: ***GEOS 351 Historical Geology***

Proposed course prefix, number and full title, if changing: ***GEOS 204 Historical Geology***

2. Liberal Studies Course Designations, as appropriate

_X_ This course is also proposed as a Liberal Studies Course (please mark the appropriate categories below)

_____ Learning Skills _X_ Knowledge Area _____ Global and Multicultural Awareness _____ Writing Intensive (include W cover sheet)

_____ Liberal Studies Elective (please mark the designation(s) that applies – must meet at least one)

_____ Global Citizenship _____ Information Literacy _____ Oral Communication

_____ Quantitative Reasoning _____ Scientific Literacy _____ Technological Literacy

3. Other Designations, as appropriate

_____ Honors College Course _____ Other: (e.g. Women's Studies, Pan African)

4. Program Proposals

_____ Catalog Description Change _____ Program Revision _____ Program Title Change _____ New Track

_____ New Degree Program _____ New Minor Program _____ Liberal Studies Requirement Changes _____ Other

Current program name:

Proposed program name, if changing:

5. Approvals	Signature	Date
Department Curriculum Committee Chair(s)	Kenneth S. Coles	3/31/2014
Department Chairperson(s)	[signature]	4/24/14
College Curriculum Committee Chair	Anne Kondo	10/17/14
College Dean	[signature]	10/20/14
Director of Liberal Studies (as needed)	[signature]	11/7/14
Director of Honors College (as needed)		
Provost (as needed)		
Additional signature (with title) as appropriate		
UWUCC Co-Chairs	Gail S Sechrist	11/11/14

Received
OCT 23 2014
Liberal Studies

Part II. Description of Curricular Change

1. SYLLABUS OF RECORD

I. Catalog Description

GEOS 204 Historical Geology (3c-3l-4cr)
Prerequisite: Grade of C or better in GEOS 201

An introduction to the historical development of geology as a scientific discipline and an overview of the methods used by geologists to reconstruct the Earth's past history. The rock and fossil record will be studied in lecture, lab and field outcrops to discover how our planet formed, how plate tectonic activity shaped ocean basins and continents, how geologic processes created economic resources, and how the history of life is recorded by ancient rock deposits. Includes required field trips on weekends.

II. Course Objectives

By engaging in class learning activities and laboratory exercises, the students will:

Objective 1:
Explain the history of geology as a science and how early geologists first deciphered the Earth's age and history based on fossil and rock evidence.

Expected Student Learning Outcomes 1 and 2
Informed and Empowered Learners

Rationale:
The Earth's geologic time scale serves both as an outstanding example of past scientific research (Informed Learners) and as a powerful tool for placing current earth processes such as sea level and climate change into a larger context. By grasping the extent of geologic time and the rate at which human impacts have occurred, students will be empowered to make better decisions about environmental issues as citizens (Empowered Learners).

Objective 2:
Reconstruct past geologic events by applying critical thinking principles and knowledge of the uses and limits of relative and absolute age dating methods to moderately complex successions of rocks and geologic structures.

Expected Student Learning Outcomes 1 and 2
Informed and Empowered Learners

Rationale:
Students will gain both a deep understanding of how rocks, fossils and archeological artifacts can be given accurate dates (Informed Learners). They will also master the spatial analysis and quantitative methods required to apply dating principles to geologic sequences so they can decipher for themselves the order and pace of geologic events (Empowered Learners).

Objective 3:

Identify the processes of organic evolution (natural selection, speciation, extinction, evolutionary trends, evolutionary convergence, etc.) and appreciate the importance of geologic factors in driving the evolutionary process.

Expected Student Learning Outcomes 1 and 2

Informed and Empowered Learners

Rationale:

The Earth's fossil record documents how life has adapted to environmental change in the past (Informed Learners). By analyzing this vast repository of knowledge, students will gain the ability to predict how natural selection might operate on current organisms as our environment changes in the future (Empowered Learners)

Objective 4:

Describe how present-day mountain belts and continents have evolved through time as a result of tectonic processes, using the local Appalachian Mountains as a primary example.

Expected Student Learning Outcomes 1 and 2

Informed and Empowered Learners

Rationale:

The Earth's landscape is a result of lithospheric interactions driven by its internal heat. By mastering the elements of plate tectonic theory, students will be able to interpret what current mountain belts and rock structures tell us about the Earth's past history (Informed Learners). They will also gain a solid foundation in analyzing patterns of tectonic deformation in order to explore for fossil fuels or determine areas of future seismic risk (Empowered Learners).

Objective 5:

Recognize cycles and trends in plate tectonics, organic evolution and environmental change and how these have determined the current distribution of fossil fuels, fertile soils, mineral deposits, renewable energy and other critical global resources.

Expected Student Learning Outcomes 1, 2 and 3

Informed, Empowered and Responsible Learners

Rationale:

Students will gain a deep understanding of how the Earth's geologic history has shaped the global distribution of resources (Informed Learners), enabling them to analyze the role played by geology in determining the course of future political, social and economic trends (Empowered Learners) and also giving them a solid foundation for making future choices as citizens of the nation and the world (Responsible Learners).

III. Course Outline

Lecture Schedule

A. The History of Geologic Time (3 hours)
The development of the time scale by Nicolai Steno, James Hutton, Charles Lyell, Adam Sedgcwick, Roderick Murchison and others.

B. The Geologist's Tool Box (10 hours)
The discovery of plate tectonics, absolute age dating of rocks, organic evolution and the fossil record, using stratigraphic principles to identify different styles of mountain building

C. Exam 1 (1 hour)

D. The Archean and Proterozoic Eras (8 hours)
Earth's origin and earliest biosphere, Paleoproterozoic Era: major changes in the atmosphere and biosphere, The Mesoproterozoic Era: successful and failed rifting on every side, The Neoproterozoic Era: tropical glaciation and the emergence of animals

E. The Early Paleozoic Eon (5 hours)
Supercontinent break-up and rift to drift tectonics, Early Paleozoic rocks in North America: the great American carbonate bank, early Appalachian mountain-building events

F. Exam 2 (1 hour)

G. The Middle and Late Paleozoic Eons (7 hours)
The Rise of Life on Land, The Middle and Late Paleozoic orogenies of Laurentia, Late Paleozoic supercontinents, climate change and the terminal Permian crisis

H. Mezosoic and Cenozoic Eons (7 hours)
The Gondwana Sucession and events of the early Mesozoic, The Jurassic: a time of transition, The Greenhouse World of the The Cretaceous: Chalk seaways blanket the continents, The K-T boundary mass extinctions: The Alvarez Hypothesis and controversy, The Paleogene Period: major western orogenies and the end of Greenhouse conditions, The Neogene Period: causes and consequences of north polar glaciation

I. Final exam (2 hours during final exam period)

Lab Schedule

Week 1	Introduction
Week 2	Using sedimentary facies to infer past depositional environments
Week 3	**Field Exercise:** Sedimentary facies of Conemaugh Group
Week 4	Interpreting geologic history from geologic maps and structure sections
Week 5	Structural evolution of the Appalachian Mountains (Part 1)
Week 6	**Field Exercise:** Allegheny Front and Valley & Ridge Province, Altoona, PA
Week 7	LAB MID-TERM EXAM
Week 8	Structural evolution of the Appalachian Mountains (Part 2)
Week 9	**Field Exercise:** Regional Appalachian Field Trip (includes weekend travel)
Week 10	Classification of fossils: stromatolites to mollusks
Week 11	Classification of fossils: mollusks through plants
Week 12	Using fossils and facies to track geologic change through time
Week 13	**Museum Visit:** Carnegie Museum of Natural History
Week 14	LAB FINAL EXAM

IV. Evaluation Methods

The final class grade will be determined from the following assessments:

Lecture Exam 1	20 %
Lecture Exam 2	20 %
Final Lecture Exam	20 %
Field Journal	10%
Lab Midterm Exam	15 %
Lab Final Exam	15 %
Total	100 %

V. Example Grading Scale

The final grade will be assigned based on the semester average using the scale: 90-100%=A; 80-89%=B; 70-79%=C; 60-69%=D and below 60%=F.

VI. Attendance Policy

The attendance policy will conform to IUP's undergraduate course attendance policy.

VII. Required Textbook(s), Supplemental Books and Readings.

Text:

Stanley, Steven, 2014, Earth System History (4th Ed): W.H.Freeman and Co., 608 pp.

Supplemental Reading:

Maley, Terry S., 2005, Field Geology Illustrated: Mineral Land Publications, 704 pp.

VIII. Special Resource Requirements.

Students must have a hand lens, sleeping bag, field boots, and waterproof field notebook. Approximately $30 will be required for meals and camping during the 3-day field trip.

IX. Bibliography

The following resources will be used to develop the course curriculum:

Benton, Michael, 2005, When Life Nearly Died: The Greatest Mass Extinction of All Time: Thames & Hudson, 336 p.

Cowan, Richard, 2013, History of Life (5th Ed): Wiley-Blackwell, 312 p.

Cutler, Alan, 2004, The Seashell on the Mountaintop: How Nicolaus Steno Solved an Ancient Mystery and Created a Science of the Earth: Plume, 240 p.

Douglas, Erwin & James, Valentine, 2013 , The Cambrian Explosion: The Construction of Animal Biodiversity: Roberts and Company, 416 p.

Futuyma, Douglas, 2013, Evolution (3rd Ed): Sinauer Associates, Inc, 656 p.

Hazen, Robert, 2013, The Story of Earth: The First 4.5 Billion Years, from Stardust to Living Planet: Penguin Books, 320 p.

Macdougall, Douglas, 2012, Why Geology Matters: Decoding the Past, Anticipating the Future: University of California Press, 304 p.

Repchak, James, 2003, The Man Who Found Time: James Hutton And The Discovery Of Earth's Antiquity: Perseus Books, 256 pp.

Stow, Dorrik, 2010, Vanished Ocean: How Tethys reshaped the World: Oxford University Press, 288 p.

Wilson, John & Clowes, Ron, 2009, Ghost Moutains and Vanished Oceans: North America from Birth to Middle Age: Key Porter Books, 256 p.

Winchester, Simon, 2009, The Map That Changed the World: William Smith and the Birth of Modern Geology: Harper Perennial, 368 p.

2. SUMMARY OF PROPOSED REVISIONS

1. Objectives – the course objectives were revised from the original syllabus of record and aligned with the Expected Undergraduate Student Learning Outcomes (EUSLO) and Common Learning Objectives found in the criteria for a laboratory Natural Science course.

2. Syllabus, lab activities, and learning objectives of the course were adjusted from its previous role in the program as a junior/senior level elective to a new status as a required freshman or sophomore course with a single pre-requisite class (GEOS 201).

3. JUSTIFICATION/RATIONALE FOR THE REVISION

Originally, Historical Geology was a 100-level class and formed half (4 credits) of our traditional two-semester freshman-year experience for majors. During our last curriculum update (2007-2008), the department re-arranged the freshman-year experience into a front-loaded intensive initial semester (GEOS 201 & 202, 6 credits) designed to allow students a more flexible entry into many different upper-level courses. Most traditional entering freshmen then took a subsequent course focused on modern surficial processes (GEOS 203, 4 credits) while Historical Geology was transformed into an upper-level controlled elective (GEOS 351).

Over the past five years, we have found that this change created two issues:

1. Many transfer students would take GEOS 201 in the spring (rather than the fall as traditional entering freshmen did), but they then had limited options the following fall because GEOS 203 was offered only once per year, in the spring. Students often were unable to schedule any geology classes for that term, or could only schedule a single one, which required them to stay additional semesters to finish their degrees.

2. Our student learning outcomes assessment data suggests that one of our critical program learning outcomes (understanding of geologic time and organic evolution) is not being met to our satisfaction under the present curriculum. The department's assessment committee recommended that additional opportunities to learn about the Earth's geologic history be made available to freshmen and sophomores in order to address this deficiency. See Appendix 1, Analysis of Student Learning Outcomes and Appendix 2: Proposed Curriculum Map for Geoscience Student Learning Goals for more details about our analysis of our current and proposed program curriculum.

In order to improve both our time-to-degree for transfer students and our student learning outcomes, we want to return Historical Geology to its prior role as a lower-level majors course. Offered as GEOS 204, the course is primarily intended for Geoscience majors and minors, primarily at the freshman and sophomore level. It will also provide an additional Liberal Studies science course that can be used by affiliated disciplines such as Biology or Anthropology, similar to GEOS 201 and 203. We intend to offer either GEOS 203 or GEOS 204 in all regular semesters, alternating as instructor availability and field trip logistics dictate.

4. INFORMATION FOR LIBERAL STUDIES APPROVAL

A. Sample Assignment and Grading Rubric

Historical Geology Field Journal Assignment (100 points)

Each student will keep a scientific field journal during this class to record observations and conclusions made during all three field exercises. Your field journal should be sturdy and professional; a "Rite-in-the-Rain" or similar journal is highly recommended. You may re-use a journal that contains notes from previous geology classes if you wish.

At each field site we visit, students must record their own observations and conclusions, supported by detailed drawings and/or diagrams showing the features that were seen there. In addition, each site should have clear location information so that you could find your way back to that rock outcrop if needed in the future. Field notes that simply 'copy down' the concepts discussed by the teacher at the end of each field visit will receive 'below average' grades. If required field trips are missed for any reason other than a documented medical or personal emergency, a score of 0 will be assigned for the missed field journal entries.

Grading Rubric	Excellent (23-25 points)	Above Average (19-22 points)	Satisfactory (15-18 points)	Below Average (0-14 points)
Quality and thoroughness of written field observations	Written information is detailed and complete. Lists of observed features are used when appropriate.	Written information is clear and no major features are left out of descriptions.	Written information is brief, less clear and sometimes leaves out important aspects.	Written information is confusing, limited in scope or completely missing for some sites.
Quality and thoroughness of field sketches and diagrams	Multiple sketches and diagrams are used to depict the geologic features at each location.	Sketches and diagrams occupy enough space to clearly show relations between important features	Sketches and diagrams are used, but do not clearly show the relationships at each site.	Sketches and diagrams are either incorrect, very confusing or missing for important sites.
Evidence of sound geological reasoning for all field conclusions	A clear transition is recorded from observations to conclusions at all or most field sites.	Some relationship is noted between observations and conclusions at all or most field sites.	Conclusions are sometimes stated without any noted justification (IE, ('Teacher said it")	Conclusions are incorrect, unclear or missing on many field entries.
Neatness and ability to re-use field notes at a later date to return to the same location	Notes are very easy to read, with sufficient white space left to add future notes. All locations are clearly marked with info on routes & parking added.	Notes are clear with some white space left for future information. All locations are described well enough for future visits to be made.	Notes are crowded and/or written in a very small hand. Not much space is left for future notes. Most locations are noted at least briefly.	Notes are hard to decipher due to poor penmanship or blotting (rain-smears). Field locations are incorrect, confused or missing entirely.

Liberal Studies General Information Questions

1. Only one offering of this course will be made each academic year, but it may be taught by different instructors in different years. The course syllabus and laboratory exercises have been developed jointly by the department faculty members who will teach this course for the foreseeable future. After each offering, faculty members will share their syllabus as well as their in-class, laboratory and field exercises by placing all materials on the department's shared network drive. Instructors also plan to organize the three-day class field trip jointly for the next few years, ensuring equivalent learning experiences in each offering. Because student learning assessment will be done at the end of this course, actual student outcomes can be analyzed to make sure that offerings continue to meet the learning objectives of the course.

2. Although many of the fundamental principles of Earth history were discovered by white male scientists during the 18th and 19th centuries, this course will also cover the significant work of Mary Anning (discoverer of many marine reptile species), Florence Bascom (the first woman hired by the United States Geological Survey), Marie Tharp (co-discoverer of mid-ocean ridges), Inge Lehmann (the seismologist who discovered the Earth's inner core) and Tanya Atwater (pioneer in North American marginal plate tectonics). Contributions by ethnic and racial minority geoscientists will also be discussed where possible, particularly in the historical development of plate tectonic theory, where 'outside' perspectives from the southern hemisphere played an important role in over-coming the initial establishment hostility.

3. This class will assign a non-fiction book of geologic field illustrations to help students better visualize spatial relations and learn to recognize them in field outcrops. Field work is critical to many different branches of geologic research as well as to students preparing for careers in the energy and environmental remediation industries, and IUP has long been recognized for the strong field component of its geoscience education. At the freshman and sophomore level, it is important for students to develop their ability to think spatially and develop a mental library of possible relationships that they may observe at each field outcrop (depositional, structural, man-made features, etc.). Too often, geology courses simply expose students to rock outcrops and allow 'natural selection' to occur so that those students who already have good spatial analysis skills and/or better intuition about possible relationships succeed, while other students remain baffled by the unfamiliar nature of the work. In this course, an inexpensive paperback collection of field illustrations will be used extensively in lecture, lab and the field to help students identify visual elements of each outcrop and develop the ability to analyze the geologic information they contain.

4. This course is not intended or designed for a general student audience. It is specifically crafted to address a knowledge deficiency identified by student learning outcome assessment data early in the academic careers of our geoscience majors. However, because this course focuses on age dating, organic evolution and stratigraphic techniques that can be used to study the past, it may be a useful resource for allied fields such as Biology and Anthropology, and we therefore would like them to be able to list this course as a Liberal Studies Science Option. Students in this course will have already gained a freshman-level understanding about fundamental geologic concepts and processes (radioactive decay, earth structure, plate tectonic theory, etc.) through their work in the pre-requisite class GEOS 201. No other prior knowledge will be necessary.

PREVIOUS SYLLABUS OF RECORD

I. Catalog Description

GEOS 351 Historical Geology 3c-3l-4cr

Prerequisite: Grade of C or better in GEOS 202 and GEOS 203

An introduction to the historical development of geology as a scientific discipline, and a review of the major global events in Earth's history and the methods employed in reconstructing the geologic history of regions and continents.

II. Course Objectives

At the end of this course, students will be able to:

1. Summarize the history of geology and many of the individuals who contributed significantly to the growth of the discipline.

2. Integrate the various types of information (rock types, fossil assemblages, and geochemical data) utilized in reconstructing any area's geologic history.

3. Explain how and why global climate has changed over Earth's history, providing specific information and cogent arguments on the mechanisms and controls that govern the phenomenon.

4. Provide a chronology of the major events in the evolution of the Earth System (lithosphere, atmosphere, and biosphere), citing specific supportive evidence for what happened when, and why.

III. Course Outline

<u>Lecture</u>

Part A (14 academic hours): The Precambrian Earth

1. Earth's origin and the Hadean Eon: The Plutonist-Neptunist controversy.
2. Archean conditions and Earth's earliest biosphere; evidence from South Africa
3. The Paleoproterozoic Era: major changes in the atmosphere and biosphere
4. The Mesoproterozoic Era: successful and failed rifting on every side
5. The Neoproterozoic Era: tropical glaciation and the emergence of animals

Exam 1 (1 academic hour)

Part B (13 academic hours): The Paleozoic and Early Mesozoic Eons

1. The Cambrian-Silurian controversy and Paleozoic rocks of Great Britain
2. Early Paleozoic rocks in North America: the Great American Carbonate Bank
3. The Middle and Late Paleozoic orogenies of Laurentia
4. Late Paleozoic events and the terminal Permian crisis
5. The Gondwana Succession and events of the early Mesozoic

Exam 2 (1 academic hour)

Part C (13 academic hours): Late Mesozoic and Cenozoic

1. The Jurassic and Cretaceous Systems: the contributions of William "Strata" Smith
2. The Greenhouse World of the The Cretaceous: Chalk seaways blanket the continents
3. The K-T boundary mass extinctions: The Alvarez Hypothesis and controversy
4. The Paleogene Period: major western orogenies and the end of Greenhouse conditions
5. The Neogene Period: causes and consequences of north polar glaciation.

Final exam during final exam period.

Laboratory Exercises (3 academic hours each)

Week 1: Earth's early times: reconstructing the Archean world
Week 2: Early Paleoproterozoic Events: oxygenation of the atmosphere
Week 3: The Mesoproterozoic Eon: rifting and orogenies on a grand scale
Week 4: The Neoproterozoic "snowball Earth"
Week 5: The Cambrian Explosion: birth of the Phanerozoic Eon
Week 6: The Early Paleozoic Earth: Life and times in the Cambro-Ordovician
Week 7: Middle Paleozoic events: troubled times for Laurentia
Week 8: The Carboniferous: vast coal swamp in the tropics and near the poles
Week 9: The terminal Permian crisis: When life nearly died!
Week 10: The early Mesozoic Era: Life and times on Pangaea
Week 11: Release time for weekend field trip
Weekend Field Trip: A tour of the Paleozoic and Early Mesozoic of the central Appalachians.
Week 12: The K-T boundary: asteroid impact and other complications
Week 13: The Eocene-Oligocene transition; "Paradise lost"
Week 14: Holocene events: life on the Ice Front

IV. Evaluation Methods

Lecture - 3 exams (100 points each)	300 pts.
Lab write-ups and field notebook	200 pts.
Participation in lecture, lab, and field trips.	50 pts
Total=	550 points

V. Example Grading Scale

The final grade for this course will be determined using the following schedule:
A=90-100%; B=80-89%, C=70-79%, D=60-69%, F=<60%

VI. Attendance Policy

The attendance policy will conform to IUP's undergraduate course attendance policy.

VII. Required textbooks, supplemental books and readings

Stanley, S.M. *Earth System History.* New York: W.H. Freeman & Co., 2004.

VIII. Special resource requirements

There are no special resource requirements for this course.

IX. Bibliography

In addition to the required textbook and supplemental readings from current literature, the following will be used to develop the course curriculum:

Alley, R.B., 2002, The two-mile time machine: ice cores, abrupt climate change, and our future: Princeton University Press, 240p.

Benton, M.J., 2003, When life nearly died: the greatest mass extinction of all time: Thames & Hudson, London, 336p.

Conway-Morris, S., 2000, The crucible of creation: the Burgess Shale and the rise of animals: Oxford University Press, New York, 276p.

Cowan, R., 2005, History of Life, 4^{th} Edition: Blackwell Publishing, Oxford, 324p.

Gould, S.J., 1990, Wonderful Life: the Burgess Shale and the nature of history: W.W. Norton, 352p.

Hallam, A. and Wignall, P.B., 2003, Mass extinctions and their aftermath: Oxford University Press, UK, 332p.
Imbrie, J. and Imbrie, K.P., 2005, Ice ages: solving the mystery: Harvard University Press, 224p.
Keller, M. 1999, Argentine Precordillera: sedimentary and plate tectonic history of a Laurentian crustal fragment in South America: Geological Society of America Special Paper 341, 131p.
Kesler, S.E. and Hiroshi, O., 2006, Evolution of early Earth's atmosphere, hydrosphere, and biosphere – constraints from ore deposits: Geological Society of America Memoir 198, 331p.
Koeberl, C. and MacLeod, K.G., 2002, Catastrophic events and mass extinctions: impacts and beyond: Geological Society of America Special Paper 356, 749p.
Prothero, D.R., 1993, The Eocene-Oligocene transition: paradise lost: Columbia University Press, 291p.
Schopf, J.W. (ed.), 2002, Life's origin: the beginnings of biological evolution: University of California Press, 224p.
Uwe, W.R. and Gibson, R.L., 2006, Processes on the early Earth: Geological Society of America Special Paper 405, 402p.

Part III. Letters of Support or Acknowledgment

Letters of Support were requested from the Anthropology, Biology, and Geography Departments. The responses are attached to the associated program revision proposals.

APPENDIX 1: Analysis of Student Learning Outcomes

Note: The following document was created and submitted to the dean and provost in Fall 2013 as part of our five-year program review annual updates. It therefore only included SLO data from 2012-2013, but committee reports analyzing SLO data from previous years came to similar conclusions.

Geoscience Student Learning Outcomes Assessment Overview: 2012-2013

Part 1: GCI Concept Inventory and Critical Thinking Assessment Exercise

Overview of the Assessment Instrument and Process

Our student learning assessment program begins with a simple concept inventory assessment to measure how well students are learning fundamental concepts in Geoscience. The multiple-choice questions on this IUP-developed instrument were taken from the nationally benchmarked concept inventory developed by Julie Libarkin and colleagues as part of the Geoscience Concept Inventory project (Libarkin et al, 2011: Revisiting the Geoscience Concept Inventory: A call to the community: GSA Today v. 21 p. 26-28.) The critical thinking exercises in the second part of this instrument were developed internally by the IUP Geoscience Department. The entire assessment instrument is attached as Appendix One of this document.

To measure learning over the freshman year experience, the instrument is given at the start of the fall semester and the start of the spring semester to all students enrolled in GEOS 201. This administration captures most of our majors before they have taken any geoscience classes. The exceptions are students who enter IUP with significant math deficits and are advised to take GEOS 101 (a non-major survey course) while they enroll in remedial math courses. The instrument is given a second time at the end of the spring semester to all students enrolled in GEOS 203. This captures most majors at the end of their first year in the program; for students with math deficits, this will instead occur at the end of their second year in the program. To capture students at the end of the entire program, the instrument is given to all students in the capstone class GEOS 480 Geoscience Seminar. This captures all majors except for Earth & Space Science majors who are not required to take that class.

Analysis of 2012-2013 Concept Inventory Results

The Geoscience SLO Committee (KR Cercone, JC Lewis and KL Farnsworth) met on July 8, 2013 to review assessment data for 2012-2013 and compare it to data from the initial year of assessment using the same instrument (2011-2012). This year's version of the concept inventory was revised slightly to replace four questions that proved to be problematic on the 2011-2012 version of the instrument. The number, scope and difficulty of concept inventory questions remained the same to allow year-to-year comparison of the aggregated results. Results for each concept inventory question and critical thinking exercise are tabulated in the accompanying Excel file (Geoscience Student Learning Outcomes 2012-2013).

GCI Concept Inventory Average Score for All Geoscience Majors
(results from different sections of the same course are combined)

	GEOS 201 (Start of program)	GEOS 203 (End of first year)	GEOS 480 Majors (End of program)
2012-2013 Average (n)	**53% (34)**	**61% (21)**	**68% (13)**
2011-2012 Average (n)	55% (18)	67% (21)	83% (10)

Critical Thinking Exercise Average Score for All Geoscience Majors
(results from different sections of the same course are combined)

	GEOS 201 (Start of program)	GEOS 203 (End of first year)	GEOS 480 Majors (End of program)
2012-2013 Average (n)	**56% (34)**	**64% (21)**	**70% (13)**
2011-2012 Average (n)	74% (18)	95% (21)	95% (10)

Both concept learning and critical thinking assessment outcomes improved across the freshman year experience and continued to improve through the capstone course experience, although the learning gains were not as pronounced as in the previous year of assessment. This was especially noticeable in the critical thinking exercise. The first critical thinking question remained the same as 2011-2012 (absolute age dating curve), while the second critical thinking question was changed to an organic evolution question rather than the climate change question used in 2011-2012. This may account for the significantly lower averages seen across the board in this year's critical thinking scores, as a lack of familiarity with organic evolution was one of the assessment findings from our first year of student learning outcome analysis. This leads us to repeat our main recommendation from the 2011-2012 SLO assessment cycle: our students need more exposure to concepts of historical geology and evolution in the curriculum.

The committee also discussed the format of rotating between different critical thinking exercises, based on the unexpected disparities in outcome. The format of rotating between three topics with only two given in any one year was originally designed to keep the time required for student learning assessment short so as not to interfere with the normal lab exercise in the classes being surveyed. Based on the uneven outcomes between the two years of data collected so far, the committee recommends that all three critical thinking exercises be included each time we administer the instrument so we can better compare data between annual student cohorts.

Larger pools of geoscience students were captured in 2012-2013, so that we could begin to analyze student learning outcomes in different programs of study (Geology, Environmental Geology, Energy Resource Geology and Earth & Space Science Education). Because GEOS 201 students take the Concept Inventory and Critical Thinking Instrument during the very first lab of their first geology class, their scores reflect their pre-existing knowledge about geology before coming to campus as well as their intrinsic aptitude for scientific thinking.

Student Learning Outcome Pre-Test Results for Different Program Tracks
(All Students Tested at the Beginning of the Freshman Introductory Class)

Degree Track	GCI	Critical Thinking	n
Geology	58%	57%	10
Environmental	59%	50%	8
Energy	48%	61%	11
Earth Science Education	46%	51%	5
Non-majors	52%	54%	24

It appears that both the Energy Resources track and Earth Science Education track bring in students with slightly less familiarity with geologic and scientific knowledge, although critical thinking skills appear to be similar among students in all of our programs. The committee has no specific recommendation to make in regard to this difference; we will continue to monitor student learning outcome differences between incoming students to see if the trend continues.

With higher numbers of seniors graduating this year, it was also possible to examine senior learning outcomes by track.

Student Learning Outcome Post-Test Results for Different Program Tracks (All Students Tested at the End of the Senior Capstone Class)

Degree Track	GCI	Critical Thinking	n
Geology	70%	69%	6
Environmental	61%	69%	5
Energy	- NA -	- NA -	0
Earth Science Education	75%	78%	2
Non-majors	- NA -	- NA -	0

Students taking the broader and more interdisciplinary Environmental Geology track did not appear to do as well on the concept inventory as other students. This could reflect the type of students most attracted to the pre-professional nature of an environmental degree (IE, not students seeking to continue on for graduate study). However, it could also be the result of a broad range of possible controlled electives, including many non-geology courses, which environmental geology students can select to complete their program. The committee recommends that the department re-examine the range of controlled electives to determine whether a more narrow focus on upper-level geology coursework might produce better student learning outcomes for pre-professional degree tracks.

Part 2: Senior Capstone Presentation Rubrics

Overview of the Assessment Instrument and Process

Each spring, all seniors in the GEOS-Geology, GEOS-Environmental and GEOS-Energy Resources tracks present the results of an independent research project in a Geological Society of America style presentation as part of IUP's annual Geoscience Day. These talks are illustrated with professional-quality PowerPoint slides and are attended by an audience of the entire department faculty, many other undergraduate students and departmental alumni and friends. Students are assessed by each faculty member using a rubric developed at IUP to capture both class-specific elements of research effectiveness for their grade and student learning outcome data related to the program's overall learning goals (ie, program competencies). Our rubric is attached in Attachment B.

Analysis of 2012-2013 Capstone Rubric Results

One difficulty with assessing senior capstone classes in a small department is that the number of graduating seniors is usually small and also varies considerably from year to year. For example, in 2011, all four graduating seniors had high QPA's and three of the four did very lengthy research projects (>1 year) with their faculty advisors. The larger graduating classes in 2012 and 2013 had a more typical distribution of QPA's and more of them did a typical 1-year or less length research project. Rubric scores are fairly consistent between the two most recent years, indicating that across the spectrum of student achievement levels, learning outcomes are remaining stable. While these outcomes are satisfactory (almost all would fall within in the "B" range if they were grades), there is still room for improvement in outcomes for many students in the programs.

Average Outcomes	Critical Thinking (5 pts)	Quantitative Analysis (5 pts)	Content Knowledge (10 pts)	Oral Commun. (10 pts)	Written Commun. (10 pts)	Combined Average (40 pts)
2010-2011 seniors (n=4)	5.0	5.0	9.0	9.3	9.0	37.3
2011-2012 seniors (n=10)	4.2	4.2	8.1	8.6	8.2	33.3
2012-2013 seniors (n=13)	4.2	4.3	8.1	8.4	7.9	32.8

In 2009, the Geoscience Department significantly revised our curriculum based on preliminary SLO data that showed a consistent weakness in critical thinking and quantitative analysis. The new curriculum, which created a much stronger emphasis on critical thinking (the new GEOS 201, GEOS 203 and GEOS 470) and quantitative analysis (the new GEOS 202) was rolled out gradually to students beginning in the 2009-2010 academic year. The graduating seniors assessed in 2013 took most, but not all, of the courses in the new curriculum but show roughly the same outcomes as the students who graduated under the old curriculum. We will continue to monitor this level of achievement and modify our curriculum again if the desired impacts are not achieved by our 2014-2016 program review year.

Curriculum and Other Recommendations based on Student Learning Outcome Data

1. The Geoscience Department should revise our major programs of study to incorporate historical geology as a required rather than elective course for all students. This course should occur early in each academic program, at a freshman or sophomore level.

2. The Department should consider reducing the broad range of non-geology coursework that students may currently elect to take to fulfill their Controlled Electives, as it may be contributing to lower learning outcomes for some degree programs.

3. To improve future student learning assessment data, all three critical thinking exercises should be included each time the concept inventory is given to students. This will require participating faculty in GEOS 201, GEOS 203 and GEOS 480 to provide a longer period of time during labs for SLO assessments to be completed by their students.

APPENDIX 2: Proposed Curriculum Map for Geoscience Student Learning Goals
**Role of GEOS 204 Historical Geology (if approved as requested) shown in bold underlined text*

LEARNING GOAL (Bloom's taxonomy)	**CORE COURSES** (knowledge, understanding, and application)	**UPPER-LEVEL CLASSES** (application, analysis, synthesis, and evaluation)
I. Students will develop the tools needed to analyze and solve problems in earth science.		
A. Quantitative tools	Calculus 121 and 131, Quantitative Methods in Geoscience	Geophysics, Geochemistry, Hydrogeology, Structural Geology, Geomorphology
B. Critical thinking	Foundations of Geology, Quantitative Methods, Surficial Processes, **<u>Historical Geology*</u>**	All GEOS courses
II. Students will master these foundational content areas in geoscience.		
A. Plate tectonic theory	Foundations of Geology	Plate Tectonics
B. Organic evolution	**<u>Historical Geology*</u>**	Paleontology
C. Environmental change	Surficial Processes	Environmental Geology, Coastal Processes
III. Students will develop specific professional skills needed for field and lab research.		
A. Rock & mineral identification and interpretation	Foundations of Geology, Surficial Processes, **<u>Historical Geology*</u>**	Ig & Met Pet, Sed Pet, Sed/Strat, Volcanology, Field Geology / Field Workshops
B. Spatial data analysis and map interpretation	Foundations of Geology, Surficial Processes, **<u>Historical Geology*</u>**	Geomorphology, Structural Geology, Field Geology / Field Workshops
C. Computer spreadsheet analysis, statistics or mathematical modeling	Quantitative Methods in Geoscience	Hydrogeology, Geochemistry, Geology of Oil & Gas, Paleontology, Geophysics
IV. Students will develop effective scientific communication skills.		
A. Oral communication	Quantitative Methods in Geoscience (informal)	Research Methods, Seminar, Student Teaching (formal)
B. Written communication	English 101 and 202	Research Methods, Seminar, Student Teaching, /W/ courses