

Redesigning "The History of the Earth" one case at a time: Faculty working group efforts in a non-major introductory class.

The Historical Geology Working Group

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Science Teaching Fellow: Jennifer Stempien

• **A GEOL 1020 working group was needed to:**

- **Create key learning goals that can be used in courses that teach history of earth and life**
- **Identifies shared learning goals/objectives for supplemental material (interactive simulations, demonstrations, assessment questions, etc.).**
- **Collaborate on teaching techniques and materials.**

4 Historical Geology Professors

- Provide insight into current status of the course
 - Material being covered
 - Perceived student ability

1 Science Teaching Fellow

- Keeps discussion on track
- Takes notes – log the progress of the group
- Sends reminders
- Compiles results from observations/assessments

Attaining consensus on learning goals via faculty working groups one in one-hour weekly meetings is challenging!

- Difficult to establish momentum – need core group consistently participating and gaining expertise
 - High level of comfort with idea and utility of learning goals takes time!
- Faculty want products!
 - Difficult to see immediate impact of tedious negotiation of learning goals!
- Faculty schedules and commitments overlap with meetings

Solution: 3-day intensive summer learning goals workshop

Geol - SEI Workshop Immediate Goals:

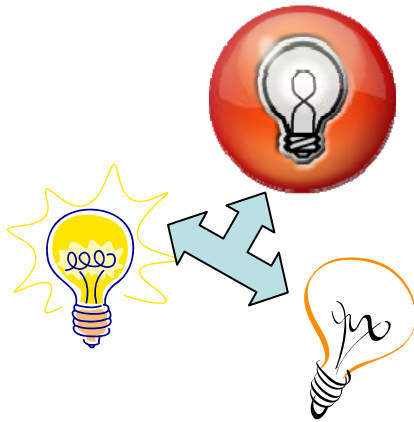
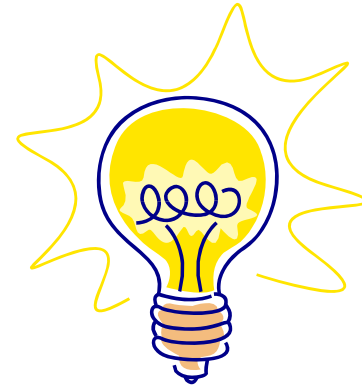
Goal	Outcome
To design overall course goals that reflect three major issues on learning: attitudes, understanding main ideas, and thinking skills regarding introductory geology.	Faculty attain consensus on overall course goals in the three main issues.
To design topic levels learning goals that can be address and implemented through a variety of paths.	<ul style="list-style-type: none">• Faculty attain consensus on topic-level learning goals for the key ideas discussed in the workshop.• Link individual learning objectives to “potentially consensus” topic goals.

Geol - SEI Workshop Take-away Goals:

Goal	Outcome
Faculty understand the use of learning goals.	<ul style="list-style-type: none">• Faculty should be able to justify the use of learning goals and their necessity for creating an integrated and well-designed course.• Faculty will consider the hidden knowledge that is necessary to solve a geologic problem and the potential learning difficulties.
Faculty should be comfortable in designing, implementing, and assessing learning objectives and topic –level learning goals.	<ul style="list-style-type: none">• Faculty will be able to create their own “mini-topic” lesson plan that will include learning goals and the desired outcomes.• Faculty are able to illicit student thinking to determine student difficulties (e.g. assessment) and be able to take proper action to address the difficulties.

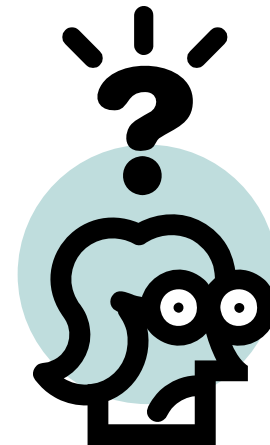
There are no set guideline when creating learning goals/objectives, however there are three criteria that were used in creating learning goals:

1. What's important for students to understand about this topic/idea and why?



2. How is this topic/idea related to other ideas covered in the course?

3. Is there enough guidance for students to be able to process new idea/material to create “expertise”? (I.e. Is hidden knowledge necessary to make sense of it all?)



Big Ideas and Intermediate Course Level Goals for Intro to Historical Geology (GEOL 1020)

Workshop discussion led to a proposed historical course different from the traditional.

Traditional: Typically follows layout from textbook. Emphasizes breadth, not depth. Usually can only cover from up to Cretaceous, 65 million years ago.

CU GEOL 1020: Used case studies as examples of key ideas instead of trying to cover all of geologic time and moving backward through Earth history.

Part I Materials, Processes, and Principles

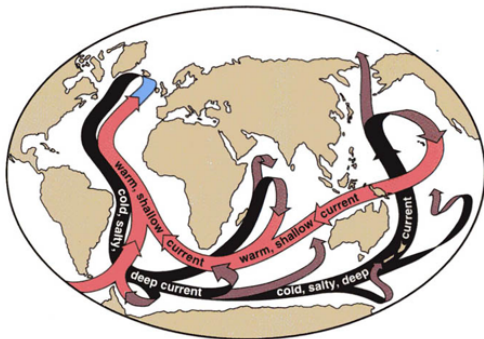
1. Earth as a System
2. Rock-Forming Minerals and Rocks
3. The Diversity of Life
4. Environments and Life
5. Sedimentary Environments
6. Correlation and Dating of the Rock Record
7. Evolution and the Fossil Record
8. The Theory of Plate Tectonics
9. Continental Tectonics and Mountain Chains
10. Major Chemical Cycles Part

II The Story of Earth

11. The Hadean and Archean Eons of Precambrian Time
12. The Proterozoic Eon of Precambrian Time
13. The Early Paleozoic World
14. The Middle Paleozoic World
15. The Late Paleozoic World
16. The Early Mesozoic Era
17. The Cretaceous World
18. The Paleogene World
19. The Neogene World
20. The Holocene

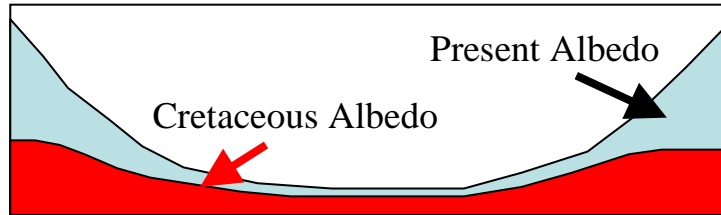
1. What assumptions and governing paradigms are necessary to interpret earth history? (**uniformitarianism, rock record is representative although incomplete, use of the scientific method**)
2. How do we sort out which geologic features (bodies of rock, folds, faults, surfaces of erosion, etc) are oldest and which are youngest? (**relative ordering, up indicators in sedimentary layers, unconformities**)
3. How do we tell how old is old and how young is young once we have the geologic features in the right order? (**fossil succession, relative geologic time, absolute dating, geologic time scale**)
4. What are the multiple lines of evidence for Pleistocene glaciation and what does that evidence tell us about the extent, magnitude, and frequency of the glacial periods? Why does climate cool and ice sheets advance in the northern hemisphere, why did those sheets retreat, and why do the sheets' extent (and hence climate) vary through time? (**evidence on North America for Pleistocene glaciation, the marine oxygen isotope proxy record, orbital and climatic controls on glaciation**)

Redesigning Intro to Historical Geology (GEOL 1020) to focus how spheres have interacted and over geologic time using case studies.



Shifting plates affect ocean circulation
(Solid Earth/ Tectonics)

Increase of albedo (Climate)



Ex. How does the Earth evolve from a greenhouse world to an ice house world?



Change in vegetative cover
(Life Through Time)

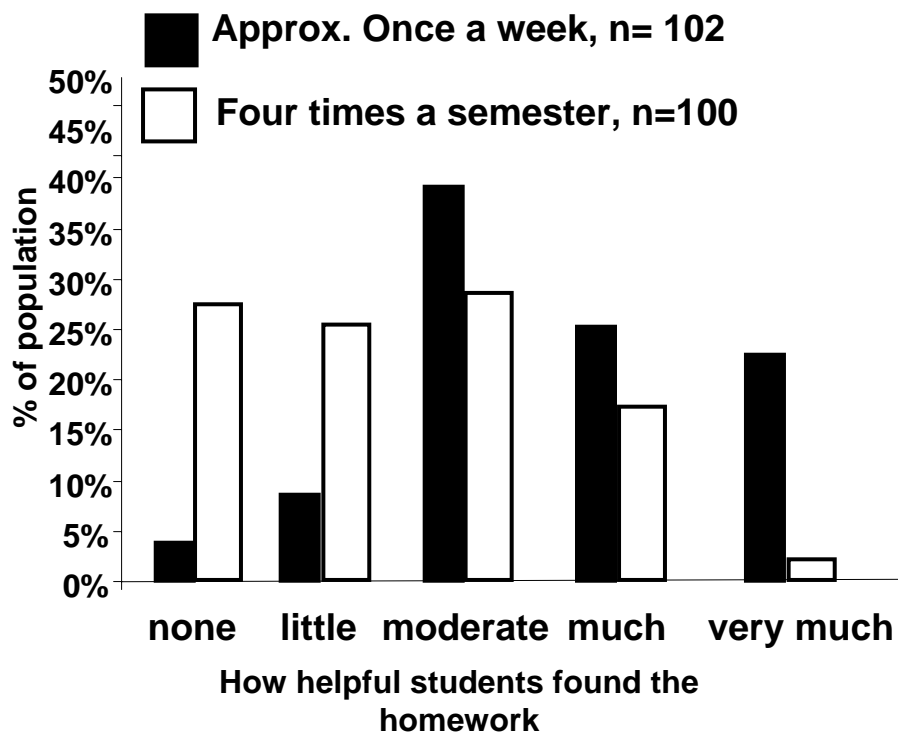
- 4 instructors
- 65% agreement at lecture-level objectives

Increase burial of organic carbon
(Surficial Process)

A well-planned redesigned course cannot happen in one semester. It takes small steps over multiple semesters.

	Writing/editing intermediate course level learning goals	Identifying "case studies"/ideal time periods	Clicker questions	Homework	In-class activities
Summer 2007 workshop					
Fall 2007 (1 faculty)					
Spring 2008 (2 faculty)					
Spring 2009 (2 faculty)					

- Out of 107 unique lecture goals developed from Fall 07-Spring 08 there is overlap in all intermediate themes
- 65% of individually derived lecture-level learning goals among multiple faculty that have participated with the SEI between.
- Students may not like them, but they value frequently assigned homeworks more than a few.



Comparison of two sections of same introductory course:

- Faculty have shared material in the past
- Covered similar topics in lecture
- Tasks and ideas in homeworks similar
- >75% of students in both sections reported spending 1-2 hours on a single homework.

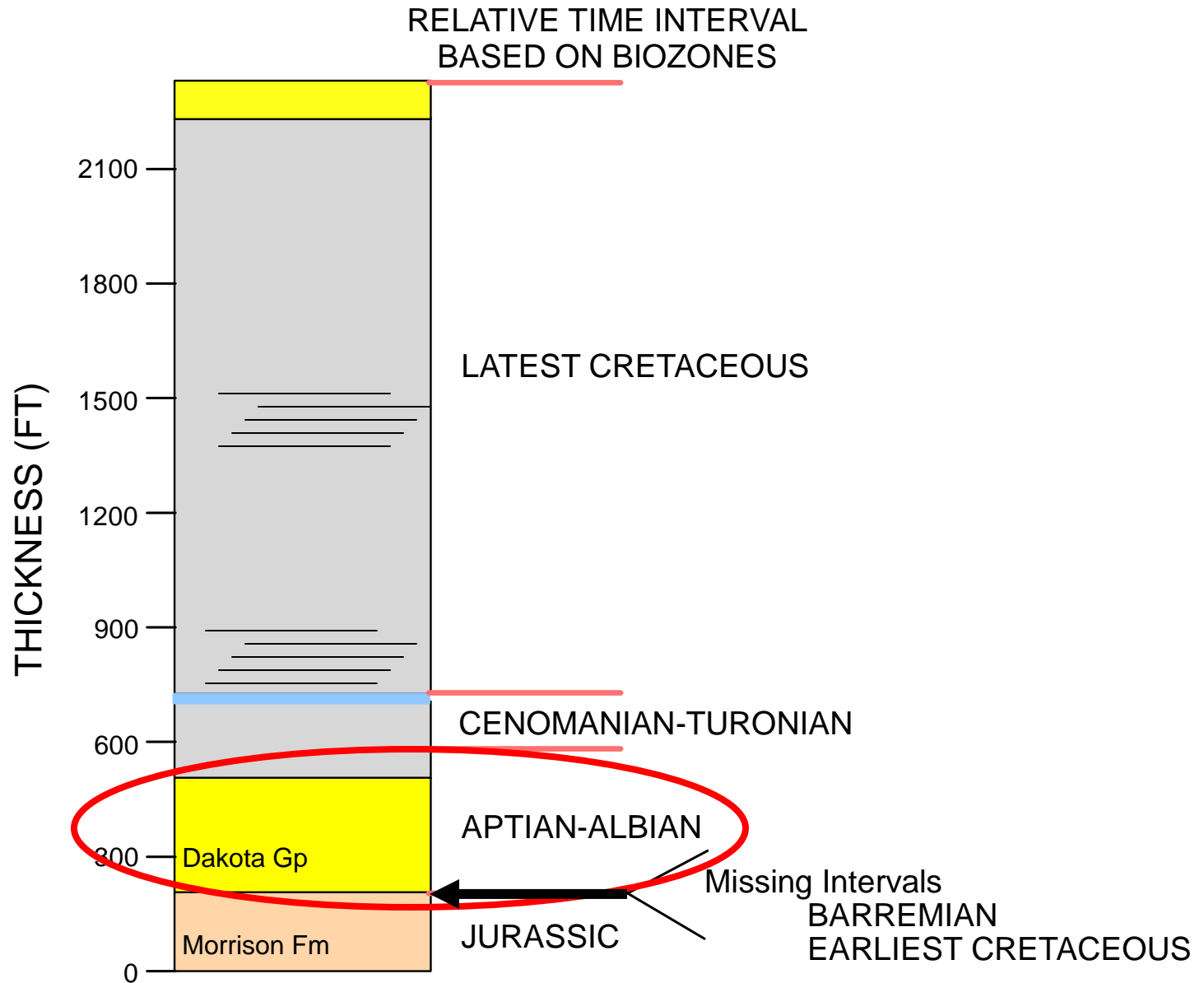
First version of a concept assessment for the new GEOL 1020 course was developed.

- Consists of 20 questions in five topics; early earth, uniformitarianism, climate, plate tectonics, and life through time.
- Some questions were used from the Geoscience Concept Survey while others were composed by STF and faculty and tested by interviewing students in both spring and fall semester.
- The CU GEOL 1020 concept assessment was administered to Fall 2008 section with 82 individual responses. Positive learning gains were observed in 70% of students.
- There were positive gains in 75% of the assessment questions. Individual questions that did not see positive learning gains were spread throughout the assessment, not concentrated in one topic.

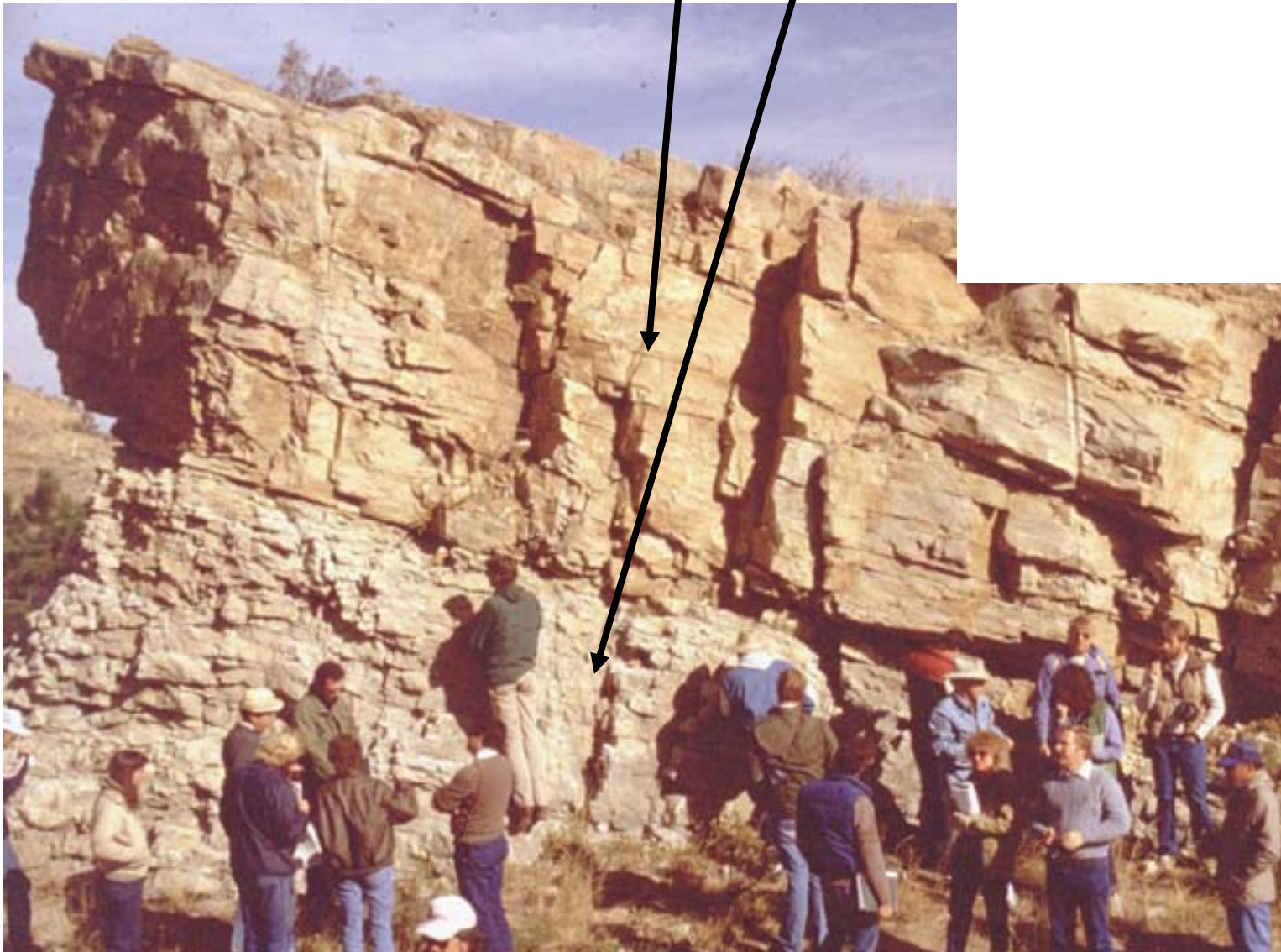
Example of lecture using clickers with learning goal/objective:

“Analyze and interpret ancient transgression and regressions from a vertical sequence of sedimentary rocks, multiple vertical sequences from different places, and maps of ancient environments.”

Cretaceous Rocks at Boulder, CO



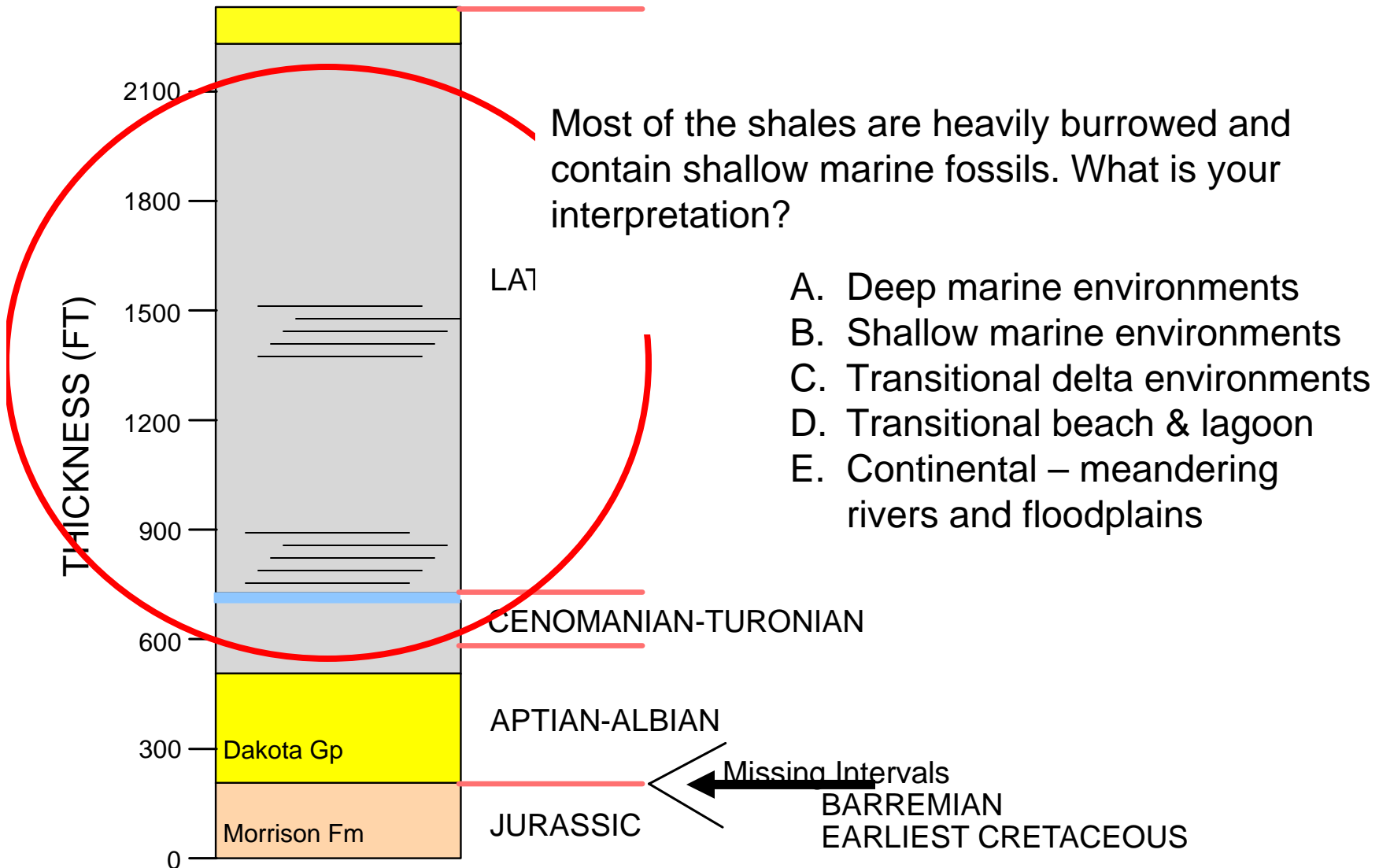
The Dakota sandstones consist of sandstones with bidirectional cross bedding and a mixture of shales and siltstones with burrows and brackish water fossils. What is your interpretation?



- A. Deep marine environments
- B. Shallow marine environments
- C. Transitional delta environments
- D. Transitional beach & lagoon
- E. Continental – meandering rivers and floodplains

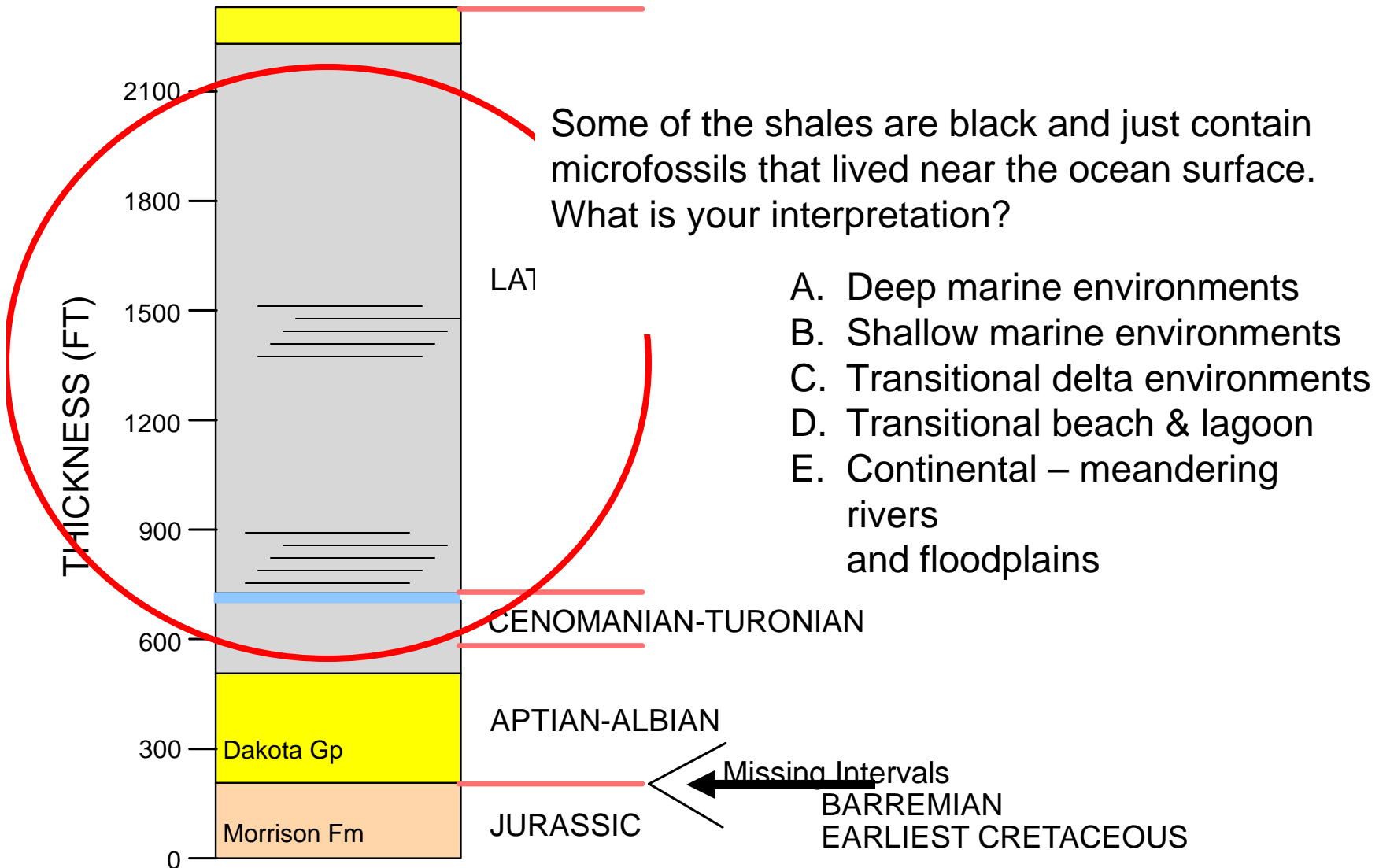
Cretaceous Rocks at Boulder, CO

RELATIVE TIME INTERVAL
BASED ON BIOZONES



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