GLY6519-0111(23401) - Stratigrphy/Timescale

Jump to Today

Stratigraphy and Timescales
GLY6519 (Credits: 3)

Spring Semester, 2020

Dr. R.G. Hatfield - Office WH 220
Room: WH 218
M, W Period 8 (and into period 9) (3pm – 4.15pm)
Office Hours by Appointment: rhatfield1@ufl.edu

No class Mon Jan 20th (MLK)

Useful Readings:

1. Gradstein, J. Ogg, M. Schmitz and G. Ogg, Editors, The Geologic Time Scale, Elsevier (2012). [Adobe Digital Editions from UF Library]

Specific papers will be assigned for class discussion throughout the course.

Grading:

Mid-Term in-class test 20 %, participation in class and specific paper discussions 20 %, individual in-class presentations 30 %, and final assignment 30 %.

Details about the individual in-class presentations (30 %) and final assignment (30 %) details can be found at the end of this syllabus. During the course we will also spend time discussing specific papers. These informal discussions will be led by both the instructor and the students on a rotational basis and each student will lead 1-2 discussions throughout the duration of course.

Synopsis:

The course aims to cover all facets of stratigraphy, and explore how these facets come together to produce our ever more precise geologic timescales.

"Stratigraphy is 90% of Geology"
- John Imbrie

"To place all the scattered pages of Earth history in their proper chronological order is by no means an easy task"
- Arthur Holmes

“One can derive some very good and very interesting conclusions if the chronology is right”
- Nick Shackleton

The quest for improved time control to estimate rates of geologic and paleoenvironmental processes, and the placement of events in Earth history into chronological order, is central to the Earth Sciences.

Prior to 150 Ma, stratigraphy and age control relies on biostratigraphy (codified as geologic stages) and radiometric (U-Pb and Ar/Ar) ages, leading to important limitations in precision of global stratigraphic correlation.

Since 150 Ma, the situation is ameliorated by polarity reversals, where reversals represent global time-lines. In modern geologic timescale construction, absolute (radiometric) ages, isotopic/chemo- stratigraphies, and biostratigraphies (that define geologic stages) are linked to this reversal template through magnetic polarity stratigraphy in sediments and sedimentary rock sequences.

Oxygen isotope stratigraphy provides the traditional chronological tool for marine sediments over the last few Myrs, augmented by radiocarbon ages for the last ~50 kyr and Ar/Ar geochronology. It has become evident that the marine oxygen isotope records are not controlled entirely by global ice volume but are perturbed by water temperature and chemistry, radiocarbon ages depend on ^{14}C production and reservoir effects, and Ar/Ar chronology is not a panacea being influenced by standard-age issues and other uncertainties. Augmenting these traditional chronostratigraphies, are two relatively new high-resolution stratigraphic tools: (1) Astrochronology is based on the tuning of environmental (climate) records to astronomical solutions for orbital precession, obliquity and/or eccentricity that force environmental change. Astrochronologies have provided stratigraphic precision at precessional (~20-kyr) scale for parts of the Miocene and Oligocene, and for Pliocene through Quaternary time and have provided eccentricity (~400-kyr) cycle calibration back into the Triassic. (2) Geomagnetic paleointensity stratigraphy utilizes the fact that the intensity of the Earth's field varies rapidly (at a rate of about 5% per century for the few hundred year historical record). These changes are probably global, as non-global variations are thought to average out on centennial timescales. The high variability provides an unprecedented level of stratigraphic resolution.

In the future, the combination of astrochronologies and isotope chronologies with global-scale high-resolution geomagnetic records promises to yield chronostratigraphic precision capable of resolving the leads and lags (forcing) within the global climate system, and thereby facilitating the study of millennial-scale climate change. The ultimate goal is to generate stratigraphies in sediments that rival the resolution afforded by layer counting chronology in Quaternary ice cores.

Topics

Over the semester we will cover a range of topics. Some of these topics will concern the fundamentals of different chronometers, others will deal with the application of these tools to address stratigraphic questions.

1) What is stratigraphy, and why is it important?

2) History of time estimates in geology

3) The development of the traditional Geologic Timescale and its hierarchy (Era, Period, Epoch, Stage etc.), a look at the Pre-Cambrian and the Phanerozoic.

4) The type section concept and GSSPs (Global Stratotype Section and Point)

5) Biostratigraphy (principles, successes and limitations)

6) Magnetic polarity stratigraphy and the geomagnetic polarity timescale

7) Stable isotope stratigraphy (oxygen and carbon)

8) Astrochronology and cycle stratigraphy

9) Dating young materials: Radiocarbon, U-series, dendrochronology, varves, ice cores

10) Strontium isotope stratigraphy

11) Sequence stratigraphy and eustatic sea level, completeness, lithostratigraphy, event stratigraphy, logging

12) Radiometric dating (Ar/Ar and U-Pb)

13) Linking the facets of stratigraphy to generate timescales

14) The challenge of the ice core record (GRIP, GISP, Vostock and EPICA) and future prospects for improving stratigraphic and timescale resolution.

Learning Outcomes:

On completion of the course students will be able to:

- Navigate the geologic timescale and have an appreciation of different divisions and what defines them
- Identify and discuss different chronometers and their application and limitation to dating earth materials
- Be conscious of the uncertainties that are involved in the current iteration of the geological timescale
- Appreciate that no one chronometer or type section is a panacea. Stratigraphy is an evolving topic that is constantly being refined by the inclusion of new observations and new tools.

Assignment

Prepare a ~15 minute oral presentation on a topic of your choice that is relevant to an issue that interests you in stratigraphy and/or timescale construction (30 %). Also please prepare an extended abstract (max length 5 pages of text, plus up to 5 figures) and hand it to me by Friday Mar. 20, and be prepared to give your presentation after that date. I will provide feedback on the extended abstract and a final version is due on the last day of class, Wed. Apr. 22nd. Please cite references in your abstract and provide a list of cited references (5-10 references should be sufficient).

The presentations and abstracts will be graded on the basis of (a) imagination in choice of topic, and relevance of topic to current research in stratigraphy and/or timescale construction, (b) insight and depth of research into the subject matter, (c) clarity of oral presentation and of extended abstract.

Choose something (a) that interests you, (b) that you think is topical and/or controversial, and (c) that is closely tied to the topic of this course. A good way to find a topic is to scan recent issues of "GSA Today", "Nature", “Science”, "Geology", "Tectonics", "Scientific American", “American Scientist", “EOS” etc., or look through AGU abstracts, available on-line through American Geophysical Union. Find something that interests you. The reference list of the article will then lead you to other articles, and thereby help you to research the topic.

As you do your research, do not hesitate to ask me for feedback. If you are unsure whether a particular topic is suitable, please don’t hesitate to ask me!

Course Summary:

Date	Details