Fall Semester, 2009

Stratigraphy and Timescales

GLY 6519 (Credits: 3)

J. Channell

Room: WH 210
Per 6-7 (12.50-2.45) Tuesdays and Per 7 (1.55-2.45) Thursdays

Useful readings:
F. Gradstein, J. Ogg and A. Smith, Editors, A Geologic Time Scale, Cambridge University Press (2004).
Several readings will be assigned for discussion during the semester.

Presentations: Each student will give a 10-15 mins presentation on a paper or group of papers of their choice that they see as particularly relevant to "Stratigraphy and Timescales". Please let me have the abstract for this presentation by end September. Abbstract sould not exceed 5 pages including figures and reference list. Be sure that your abstract is appropriately referenced.

There will be ***guest presentations*** from Jason Curtis (stable isotopes) and Kyle Min (Ar/Ar dating) during the semester. Several department lab visits will be incorporated in the course.

Grading: Mid-Term in-class test 30%, individual in-class presentations: 30%, final exam: 40%.

No class: September 22 and 24 (INVEST meeting in Bremen), October 20 and 22 (IODP meeting in College Station), November 26 (Thanksgiving).

Synopsis

The quest for improved time control, to estimate rates of geologic and paleoenvironmental processes, is central to the Earth Sciences. For the last 150 Myrs, the marine magnetic anomaly record and the approximation of constancy in seafloor spreading rates, provides the template for polarity reversal through time. In modern geologic timescale construction, absolute (radiometric) ages, isotopic/chemo stratigraphies, and biostratigraphies (that define geologic stages) are linked to this template through magnetic polarity stratigraphy in sediments and sedimentary rock sequences.

Superimposed on this chronostratigraphic framework, 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 the 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. (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.

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

Topics to be covered:

1) What is stratigraphy, and why is it important? The case for "catastrophic uniformitarianism". The carpet store analogy, and the life-of-a-soldier analogy.

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 Sections and Points)

5) Biostratigraphy (principles, successes and limitations)

6) Magnetic polarity stratigraphy and the geomagnetic polarity timescale (including marine-terrestrial correlations) and constant spreading rate assumption in timescale construction.

7) Stable isotope stratigraphy (oxygen and carbon)

8) Radiocarbon

9) Sequence stratigraphy and eustatic sea level

10) Lithostratigraphy, event stratigraphy (from impacts, to tsunamis to Heinrich events)

11) Strontium isotope stratigraphy

12) Astrochronology and cycle stratigraphy

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

14) Linking the facets of stratigraphy to generate timescales

15) The challenge of the ice core record (GRIP, GISP, Vostock and EPICA) and future prospects for improving stratigraphic and timescale resolution, including paleointensities and magnetic excursions.