GEOL 30040: Sedimentary Environments

MODULE COORDINATOR: Dr Aggeliki Georgioupoulou

CREDITS: 5	**MODULE LEVEL**: 3	**SEMESTER**: I

PRE-REQUISITES/PRIOR LEARNING:

Basic sedimentology concepts on textural and compositional maturity of sandstones, basic fluid dynamics and how sedimentary structures are formed.

OVERVIEW OF MODULE:

This module addresses the sedimentology of the main Earth surface "clastic" environments (non-marine, i.e. terrestrial, shallow marine and deep marine) and the nature and products of volcanic eruptions. The module builds on the process understanding delivered by GEOL 20010, illustrating the distinctive record of different surface environments and considering how and why surface environments change and what they leave behind. Practical exercises illustrate some of the key tools used to reconstruct ancient environments. The module also covers volcanic eruption mechanisms and products (lava flows, airfalls, pyroclastic density currents and lahars), volcanic hazard assessment, and the reconstruction of ancient volcanic provinces.

LEARNING OUTCOMES:

On completion of this module students should be able to:

1. Relate facies associations, sedimentary structures and bed geometries to processes of deposition for the main Earth surface environments;
2. Collect and interpret graphic logs from outcrops and cores;
3. Measure, process, display and interpret palaeocurrent information;
4. Assess the provenance and porosity make-up of sandstones;
5. Understand the eruption and dispersal of lava flows and volcaniclastic sediment around active volcanoes.

ASSESSMENT:

Continuous Assessment: 20%
(Assessment of practical 1-6)

Assignment: 10%
(Assessment of practical 7)

Assignment: 10%
(Assessment of practical 8)

Examination: 30%
(Mid term examination assessing all material from weeks 1-6)

Examination: 30%
(End of semester examination assessing all material from weeks 8-12)

LECTURES:

Lecture 1: Introduction *(Dr A. Georgiopoulou)*
controls on sedimentation, facies and depositional environments, accommodation space vs sediment supply – key variables controlling environmental change. Facies and Walther's Law.

Lecture 2: Desert Environments 1 *(Dr A. Georgiopoulou)*
Controls on desert conditions. Hot and cold deserts. Recap on Aeolian stratification types and bedforms. Dune internal structure and preservation. Interdune deposits.

Lecture 3: Desert Environments 2 *(Dr A. Georgiopoulou)*
Impact on changing water table. Bounding surfaces and supersurfaces. Erg centre vs. erg margin. Aeolian stratigraphy. Rotliegendes deposition in the North Sea.

Lecture 4: Rivers 1: channel patterns and deposits *(Dr A. Georgiopoulou)*
River channel patterns (morphologies) and channel associations. Controls on morphology. Braid bars and deposits. Sinuous/meandering channels.

Lecture 5: Rivers 2 *(Dr A. Georgiopoulou)*
Floodplain processes, palaeosoils, channel migration and avulsion. Floodplain processes, palaeosoils, channel migration and avulsion. Controls on alluvial stacking patterns. Response to change of base level.

Lecture 6: Alluvial Fans *(Dr A. Georgiopoulou)*
The role of tectonics and climate, alluvial fan geometry. Controls on fan size. Deposits of alluvial fans and links to gradient /size. Ancient fangromerates and vertical cycles.

Lecture 7: Lakes *(Dr A. Georgiopoulou)*
Diversity of modern lakes. Clastic, chemical and biochemical sedimentation, coals, sapropels, evaporites. Rythmites and varves. Ancient lake environments.

Lecture 8: Estuaries *(Dr A. Georgiopoulou)*
Significance. Wave- and tide-dominated end members. Context in relation to Holocene sea level changes. Ancient examples of wave- and tide-dominated estuaries.

Lecture 9: Deltas 1 *(Dr A. Georgiopoulou)*
Location and variability of modern deltas. Delta classification and terminology. Outflow dynamics and mouth bar progradation. Delta top processes. Delta lobe switching.

Lecture 10: Deltas 2 *(Dr A. Georgiopoulou)*
Stratigraphic record of delta progradation. Delta from instability, growth faulting and mud "lumps". Impact of sea level change on delta evolution and vulnerability.

Lecture 11: Linear Clastic Shorelines *(Dr A. Georgiopoulou)*
Beach processes. Transgressive barrier islands and their stratigraphic record. Strandplains and cheniers. Lowstand detached shorelines, forced regressions and ravinement.

Lecture 12: Clastic Shelf *(Dr A. Georgiopoulou)*
Wave-dominated shelves, storm-driven circulation: tempestites. Models for storm-influenced sedimentation. Transgressive vs. prograding shelves. Ichnofabrics.

Lecture 13: Deep Sea Flows *(Dr A. Georgiopoulou)*
Gravity-driven sediment transport, flow initiation models. High- and low-density turbidity currents. Flow efficiency concept. Lateral changes in deposits. Channelised turbidity currents.

Lecture 14: Deep-sea channels and fans *(Dr A. Georgiopoulou)*
Deposits and models. Impact of grain size and feeder system. Controls on deep water deposition. Are they like underwater rivers? Models on fan growth and decay.

Lecture 15: Glacial Processes 1 *(Dr A. Georgiopoulou)*
Ice flow mechanics. Ice ages. Glacier erosion, transport and deposition. Subaerial glacial environments (fluvial, lacustrine).

Lecture 16: Glacial Processes 2 *(Dr A. Georgiopoulou)*
Marine-based glaciers, ice shelves and trough mouth fans, ice rafted debris and their importance. Geohazard.

Lecture 17: Introduction to Volcaniclastic processes *(Dr A. Georgiopoulou)*
Links between volcanology and sedimentology. Sites of volcanism and contrasting styles of eruption. Main magma properties. Eruption frequencies. Context of effusive basic and acid eruptions. Types of volcanoes.

Lecture 18: Eruption columns and destabilisation *(Dr A. Georgiopoulou)*
Pyroclastic flows: Eruption column stability and collapse. Origin of flows and surges. Mechanisms of flow emplacement. Distribution and character of flow deposits – laminar or turbulent? Ignimbrites, low-concentration base, ground, and ash cloud surges. Flow uncoupling.

Lecture 19: Fragmentation *(Dr A. Georgiopoulou)*
Fragmentation mechanisms and terminology for volcaniclastic fragments. Hydrovolcanic vs. magmatic fragmentation. Geometry of eruption columns. Dispersal and fragmentation. Classification of eruption types. Characteristics of fall deposits. Proximal vs. distal fallout. Lateral distribution of fallout.

Lecture 20: Volcanic hazards *(Dr A. Georgiopoulou)*
Avalanches, sector collapse and lahars. Caldera collapses.

PRACTICAL CLASSES *(2 hours)*

Practical 1: Palaeocurrent Data I *(Dr A. Georgiopoulou)*
Basic correction for structural dip using a stereonet. Way-up evidence problem.

Practical 2: Palaeocurrent Data II *(Dr A. Georgiopoulou)*
Re-orientation of cross-bed data in areas with plunging folds.

Practical 3: Palaeocurrent Data III *(Dr A. Georgiopoulou)*
Using palaeocurrent data to reconstruct palaeoenvironments.

Practical 4: Sandstones in thin section *(Dr A. Georgiopoulou)*
Pore types and controls on porosity development using samples from the Corrib gas field.

Practical 5: Core logging techniques *(Dr A. Georgiopoulou)*
Core logging techniques and depositional interpretation.

Practical 6: Environmental change from space *(Dr A. Georgiopoulou)*
Interpretation of depositional history using Google Earth imagery of the Coco River Delta.

Practical 7a: Seismic and core record of the British Irish Ice Sheet *(Dr A. Georgiopoulou)*
Bedforms and deposits on the shelf and deep sea relating to BIIS.

Practical 7b: Seismic and core record of the British Irish Ice Sheet contd *(Dr A. Georgiopoulou)*
Bedforms and deposits on the shelf and deep sea relating to BIIS. Student report follows.

Practical 8: Volcanic hazard exercise *(Dr A. Georgiopoulou)*
Three hour extended practical class. Use of historical and stratigraphic data to reconstruct prior eruption history of a volcanic island and identify potential future hazards. Student report follows.