UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

Geodynamics

2425-1-F7401Q120

Aims

The objective of the course is to provide advanced knowledge on the geodynamic processes that drive plate tectonics, on the evolution of geodynamic environments in space and time, and on the interactions between terrestrial exogenous and endogenous geodynamic processes. The course also aims to teach the fundamentals of a multidisciplinary approach for the quantitative interpretation of geological/geophysical data through numerical models and/or analytical solutions.

Contents

LECTURES / EXERCISES

- The drivers of plate tectonics
- Mechanics and kinematics of plates
- Interactions between deep and surface geodynamic processes
  FIELD ACTIVITIES
  Transect through the Alps or the Apennines

Detailed program

LECTURES / LABORATORY

- The drivers of plate tectonics
  o Thermodynamics and structure of the Earth: review of energy transfer and dispersion on a planetary scale, conduction and convection, Earth's thermal gradient, main petro-thermo-mechanical discontinuities of

the Solid Earth (crust, lithosphere, upper mantle, lower mantle, core). Birth and development of plate tectonics theory and hypotheses regarding its main drivers.

- Mechanics and kinematics of plates
  o Motion of rigid plates on the Earth's surface: Euler poles, Euler vectors, and plate boundaries.
  o Rheology of rocks and continuum mechanics: review of rheology, constitutive laws of visco-elasto-plastic deformation, brittle-ductile transition in the crust and mantle, strength profiles of oceanic and continental lithosphere, definition of geodynamic environments and architecture of plate boundaries in convergent, divergent, and transform tectonic settings. Intra-plate deformation mechanisms. Evolution of topography and surface flows in relation to deep tectonic forces. Introduction to geodynamic modeling (mass, momentum, and energy balance equations).
  o Kinematic reconstructions: use and integration of geological datasets and geophysical models for the generation of maps and paleotectonic reconstructions.

- Interactions between deep and surface geodynamic processes

o Actions and feedbacks between plate tectonics and mantle flow: local and regional mantle flows and their effects on regional tectonic deformation, definition and quantitative characterization of isostatic and dynamic topography (using numerical/analytical models for Airy isostasy and visco-elasto-plastic lithospheric flexure).
o Actions and feedbacks between plate tectonics and gravitation: tidal effects on the seismic/tectonic cycle, gravitational effects of other planets on plate tectonics, effects of plate tectonics on Earth's rotation (true polar wander).
o Actions and feedbacks between plate tectonics and climate: effects of erosion, transport, and deposition of sediments on tectonic deformation in orogenic and basin environments at different latitudes (e.g., fluvial and glacial processes). Effects of ice sheet formation/melting on tectonic deformation and magmatism in various geodynamic settings (using numerical/analytical models for glacial isostatic adjustment - GIA - and visco-elasto-plastic lithospheric flexure).

FIELD ACTIVITIES
Transect through the Alps or the Apennines (4 days of fieldwork, not necessarily consecutive).
In the field, the geodynamic evolution of the orogenic system will be studied based on the tectonic context and the exposed rocks, characterizing their petrography and ductile and brittle deformation structures over time and space. Outcrop-scale observations will be integrated with geological and geophysical data and models on a regional scale to understand the drivers of the observed geodynamic system.

Prerequisites

Basic knowledge of structural geology, geophysics, and petrography.

Teaching form

- 28 hours of lectures in person, Delivered Didactics (4 ECTS – 28 hours – 7 hours/ECTS)
- 24 hours of lab activities in person, Interactive Teaching (2 ECTS – 24 hours – 12 hours/ECTS)
- 24 hours (4 days) of field activity in person, Interactive teaching (2 ECTS – 24 hours (4 days) – 12 hours/ECTS)

Textbook and teaching resource

Lecture slides provided by the teacher and available on the course's e-learning page. Scientific articles provided by the instructor and available on the course's e-learning page.
Consultation of the following materials is recommended for further study and supplementation:

- Turcotte and Schubert, Geodynamics, Cambridge University Press
- Gerya, Introduction to Numerical Geodynamic Modeling, Cambridge University Press

Semester

First Semester

Assessment method

Oral exam: discussion on the topics covered in lectures/laboratory and the report on field activities.

Office hours

By prior email contact

Sustainable Development Goals