Objective and content of Master2 courses taught in Lille

Micropaeontology

Credits: 5 ECTS

Micropaleontology can make significant contributions in a large number of paleoenvironmental and paleoceanographic/paleoclimatic studies. It is also applied in the hydrocarbon industry, both for the exploration and development/production phases (by assisting drilling teams in geosteering).

The objective of the course consists in teaching a number of microfossil groups useful for all their applications in Geosciences. Taxonomic aspects of the most important groups are presented and highlighted based on observations of our teaching collections; the latter will help the student understand and familiarize with the most significant and discriminating morphological characters of each fossil group, but also to become familiar with the use of catalogues and determination keys used by specialists. The fossil groups presented are those that are most important for biostratigraphy and paleoenvironmental reconstructions, such as benthic and planktonic foraminifera, calcareous nannofossils, ostracods, spores and pollen, dinoflagellates, acritarchs, chitinozoans, radiolarians, diatoms and conodonts.

Biogeochronology and applied case studies

Credits: 5 ECTS

The objective of the course is to present different dating tools in Earth Sciences, from biostratigraphy, magnetostratigraphy and cyclostratigraphy to geochronology, the way that these tools are used for the refinement of the Geological Time Scale, for understanding the evolution of sedimentary basins, of resolving tectonic questions and for reconstructing paleoceanographic changes.

Regarding biochronology, the course presents the theoretical background behind the design of the different types of biozonations (contiguous *versus* discontiguous) and of biozones (taxon range, interval zones, acme zones). Examples of biozonations are analysed in the practical classes to understand how biochronology is applied for dating the sedimentary record, with some of its implications (e.g. estimating sedimentation rates). Presentation of ways in which the fossil record may be used for sequence stratigraphic analyses and for understanding the thermal maturity of sediments (geothermometers).

Quantitative Paleontology

Credits: 5 ECTS

The objective of this course consists in apprehending a number of analytical methods applied in the study of fossil assemblages at various temporal and spatial scales.

To achieve this objective, the course includes the teaching of :

- Taxonomic and phylogenetic methods applied in the classification of Life (concepts, principles and methods), including cladistics methods useful to reconstruct the relationships based on

inherited characters and phonetic methods to construct “distance” trees based on the overall similarity and understanding “molecular clocks, with the use of computer software (PAUP, PAST, R packages).

- Analytical methods to study paleobiogeographic patterns with the use of computer software, including concepts and methods of PAE (Parsimony Analysis Endemics), BPA (Brook’s Parsimony Analysis), etc.
- Methods of geometric morphometrics (Procrusts, Fourier transforms) with the use of computer software (TPS series, R packages) and based on different shape parameters (landmarks, sliding semi-landmarks, outline).
- Methods of developing and analyzing paleobiodiversity curves based on specially designed databases, including of analytical methods that allow to explore various biases.

Paleoclimatology - Geobiology

Credits: 5 ECTS

Paleoclimatology

The study of climate change at different time scales (tectonic, orbital, millennial …): the course reviews the forcing mechanisms and interactions of the climate system. Issues related to modelling are also discussed. Examples of paleoclimatic reconstructions are given from the Paleozoic, Cretaceous, Cenozoïc, Quaternaty and Holocene based on environmental records (marine sediments, lake sediments, glacial record, speleothemes, etc.).

Geobiology

The course reviews: 1) biomineralization processes: in order to explain the mineral signatures of early microbial life, the removal of iron from early earth oceans, the recording of geochemical metabolic signatures. 2) The post-mortem alteration (taphonomy) of microorganisms: to understand what morphological, molecular and isotopic features can help the taxonomic/metabolic identification of fossil microorganisms. 3) Microbial metabolic reactions and their geochemical tracers: to decrypt the co-evolutions of environments and life (oxygenation, glaciations, atmospheric CH_4/CO_2) on early Earth (Archean-Proterozoic). A lab session trains students to autonomous use of Raman spectromicroscopy: to identify carbonate biominerals (case of corals) and perform organic matter thermometry (application to oil resources, taphonomy and metamorphism).

The course also reviews aspects of carbonate and siliceous biomineralisation, the evolution of calcite – aragonite and silica cycles throughout the Phanerozoïc, as well as interactions between Cambrian evolution and geodynamics.