Per Il Corso di Dottorato In Scienze Chimiche ed Ambientali (DISCA); svolge principalmente, ma non unicamente, la propria attività nelle macro-aree 03 – Scienze Chimiche, 04 – Scienze della Terra e 05 – Scienze Biologiche.

**ACTIVE TECTONICS AND EARTHQUAKE GEOLOGY: SAVING LIVES AND INVESTMENTS FOR A SUSTAINABLE WORLD**

**Instructor**

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**Introduction**

As lived and seen recently with the recent earthquakes of eastern Turkey in early February 2023, these natural events can have a devastating impact on human lives, constructions and even on nature. In fact, earthquakes are a real threat to our built environment and their prediction or forecasting, as practiced for the weather in temperate regions so well, is still a utopia so far. Therefore, a significant way of reducing their impact is to build safer buildings and dwellings for people. In that sense, buildings need to be constructed following certain seismo-resistant standards or codes to stand up during large earthquakes, for which the level of threat –the hazard in the equation of risk-, needs to be constrained at the best we currently can. This leads that faults generating tectonic earthquakes need to be recognized on ground surface or in the subsoil and characterized in terms of their seismogenic potential. This potential is expressed as the maximum probable earthquake and its return time or period for each fault or fault segment. These studies most commonly find a very significant limitation. The recorded instrumental seismicity of a given region is usually bounded to the last 120 years at most –time in which the seismological instrumentation has developed-. And large and destructive events actually recur in much longer time intervals of several hundred years to several thousand years. This is overcome by enlarging the time window of observation to historical times. In the case of Italy, which is a country with a very complete long historical record of earthquakes among the longest in the world, of around a millennium, historical seismicity has come much in help. But as in many tectonically active regions of the world, “the book of geology” must be opened and studied in many occasions. Widening the seismic history of a fault or a set of them into the recent geologic past is known as “Geology of Earthquakes”, which relies on geological methods. This short course intends to provide to the course attendant an overview of all this process of estimating the seismic hazard of a given region.

**COURSE OBJECTIVES**

* Revise the different possible sources of earthquakes and their association with geologic faults. Discuss the theory of earthquake generation, as well as the relation between size of earthquakes and fault ruptures;
* Transfer knowledge on how the seismic history of a region is obtained by integrating instrumental, historical and pre-historical seismicity;
* Examine and identify earthquake-related landforms and the impact of earthquakes on nature;
* Evaluate how seismic hazard studies are carried out;
* Illustrate how paleoseismological investigations are performed and what objects can be analyzed in such a way.
* Determine the importance of geological studies into a seismic hazard assessment (SHA).

**SPECIFIC LEARNING OUTCOMES**

1. Determine and improve the degree of knowledge of the course audience in relation to plate tectonics and its major association to Earth surface processes;
2. Understand that destructive earthquakes are related to geologic faults, which accommodate strain in the crust driven by plate tectonics;
3. Learn how to identify Quaternary faults via specific landforms and landscapes and how the environment can be affected by earthquakes;
4. Understand how to build a seismic history in a region from different sources of data gathering and the importance of the geological studies for any seismic hazard assessment (SHA);
5. Learn that a safer constructed environment preserves human life and that earthquakes naturally may severely impact landscape and the environment.

**LECTURE TOPICS:**

1. Earthquake and seismicity: Elastic rebound theory; Seismic waves and type of waves; Tectonic, cryogenic (“calving”) and volcanic earthquakes; Induced Seismicity (explosions, fracking, etc.)

2. Earthquake parametrization: Location (hypocenter, epicenter); Magnitude (Ml, Ms, mb, Mo); Intensity (Mercallí modified; Mercalli, Cancani & Sieberg, EMS-98. ESI-2007); Macroseismicity

3. Brittle deformation: Faults: normal, reverse, strike-slip, oblique; Active Fault; Capable Fault; Geologic Fault vs slope instability

4. Neotectonics: Active (Quaternary) fault Morphology: normal, reverse, strike-slip, oblique; Fault mapping; Kinematics and average slip rates from morphology and GPS; Stress field determination (Microtectonics); Fault Segmentation; Seismogenic Characterization (Potential)

5. Modern complementary methods of morphotectonic characterization: LIDAR mapping; Shallow seismic reflection; GPR; Electric Tomography; Radon gas profiling; GNSS o GPS

6. Seismic history and Seismogenic Characterization: Seismicity window: Instrumental, Historical and/or Archeoseismological, Pre-Historic; Seismic history of faults or segments; Seismogenic Characterization; Relationships: Magnitude vs rupture length, Magnitude vs coseismic displacement, Magnitud vs rupture area

7. Paleoseismology: Geological record of earthquakes and tsunamis; (Paleo) Liquefaction; Paleoseismic Methods: Trenches, pits, cores; Excavation and interpretation of paleoseismic trenches; event magnitude and recurrence (seismic history); Seismic cycle.

Recommended Readings will be freely provided to participants from external hard disk or recommended websites.

Learning Resources, such as websites, will be provided for specific topics.

Additional Reading Lists will be provided for each topic covered.

Required equipment: Laptop computer and video projection equipment, with internet access. Board and markers are desirable for supplementary explanations and clarifications!

Class Format: Class will meet for a 3 hour time block for 4 days, in a week, for lecture and discussion, for a total of 12 hours.