Quantitative analysis of earthquake swarms with advanced seismological data analysis tools

(*Proposer: Dr. Piero Poli)*

Earthquake swarms are magnitude-unordered seismic sequences driven by a transient forcing (fluid redistribution, aseismic slip or combination of the two) that superimpose the long-term tectonic loading. They lack of constitutive governing laws in terms of duration and moment release, cannot be described by classic physical models as Omori-Utsu and Båth law, and sometimes the Gutenberg-Richter model do not reproduce satisfactorily the frequency-magnitude distribution of earthquakes. However, earthquake swarms are increasingly recognized as an important part of the seismic cycle in all tectonically active region, although not yet routinely included in seismic hazard assessment study. They occur in fluid-permeated volumes and usually herald physical and rheological discontinuities of faults, where a complex interplay between seismic and aseismic deformation occurs. Therefore, assessing the relative contribution of earthquake swarms in faults is fundamental to understand how stress accumulate or is released during the seismic cycle, and in ultimate analysis how large earthquakes may occur. The analysis of spatial and temporal occurrence and size distribution of earthquakes in swarm sequences is diagnostic to single out the relevant source process behind their occurrence. In order to shed new light into the physics of earthquake swarm occurrence, in this project we will: i) Produce novel observables by means of artificial intelligence and data mining applied to seismological and geodetic data from near fault observatories, and ii) Model the derived observations, during episodes of aseismic deformation in the Italian region and worldwide. In more details, the project target to investigate relevant swarm sequences occurred in the Italian territory and/or worldwide in the past years. To that scope, it will be produced high resolution seismic catalogs by using machine learning methods and template matching approach. These new and high-resolution catalogs will permit to track the spatial and temporal evolution of swarms which is a byproduct of the transient external forcing (e.g. aseismic slip, fluids, combination of the two). Moreover, our new catalogs will be used to extract repeating and near-repeating earthquakes, which indicates persistence of seismic sources and are a perfect tracker of aseismic deformation, and will thus be used as analogue of in situ strain meter to precisely estimate the slip budget in seismogenic faults. Our novel seismological observation will be also used to parse geodetic data using novel stacking methods, able to estimate the aseismic deformation in faults. Moreover, the modeling of kinematic and source scaling properties (e.g. spatio-temporal migration, duration, and moment released) of the studied swarms will help us to infer the physics of the processes driving the seismicity and will be compared with worldwide compilation of swarm source scaling.