EARTHQUAKE GEOLOGY IN COASTAL AREAS

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Abstract

Earthquake geology, or paleoseismology, is the investigation of individual earthquakes from their geological signatures such as those produced directly along the rupture plane, and those produced indirectly (landslides and mass wasting deposits) in the vicinity of faults. Earthquake geology has been widely applied to major continental faults over the past decades while very few studies have been developed at sea. Seismic risk assessment in densely populated coastal regions such as southern Italy or many other mega-cities all around the world, necessarily has to study seismogenic faults at sea where they are often associated with a tsunamigenic potential

While paleoseismology has become a primary tool for seismic hazard evaluation on land, only few paleoseismological studies have been attempted on submarine fault systems mainly because of the limited resolution of the available geophysical techniques used at sea. Technological advances in the field of Marine Geology, such as accuracy of positioning and new generations of sonar systems led to carry out earthquake geological studies in submerged areas at a resolution comparable to those on land. One of the main advantages of conducting paleoseismological studies in the marine environment is that submarine geophysical data provide complete spatial coverage of fault structures, both horizontally and vertically. Moreover, sedimentation is more continuous and sedimentation rates are generally higher than in onshore alluvial/fluvial settings, which are commonly characterized by hiatuses. This allows for regional stratigraphic correlations, a clear advantage for assessing the geological effects of each earthquake in an entire region. Furthermore, the absence of obstacles such as buildings and dense vegetation allow the acquisition of dense grids of regularly spaced geophysical data necessary for 3-D reconstructions.

The objectives of each paleo-seismological study both at sea and onland are mainly related to (i) reconstructing location, geometry and nature of active faults; (ii) estimating slip rates on single fault strands; (iii) reconstructing recurrence time of major seismic events. For the seismogenic faults at sea, these objectives may be addressed through an integrated/multi-scale marine geological/geophysical approach that involved the combined analysis of geological (sediment samples) and geophysical data that allow observations in a scale range spanning from tens of Km (MCS seismic) to centimetres (CHIRP sub-bottom data and high resolution morpho-bathymetric images of the seafloor).

As in the sub-aerial environment, major submarine seismic events may trigger mass wasting and gravity flows that accumulate at the base of submarine slopes,

and potentially, some tsunami deposits along the shorelines. As for land paleoseismology, a careful stratigraphyc analysis is critical. Radiocarbon ages can be obtained from monospecific planktonic foraminiferal samples above and beneath suspected seismic related deposits such as large-scale (mass wasting, gravity flows, pale-shore lines) and small-scale (sand-injections, carbonate crusts) deposits. Correlation with earthquake catalogues is essential to understand if the high energy events are related to seismic activity.

In the recent past ISMAR projects have started to apply earthquake geology in two different geodynamic settings: the Marmara Sea on the North Anatolian Fault and the Calabrian Arc in the Ionian Sea but this methodology can be applied to any seismogenic fault at sea.