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The integration of stress, strain, and seismogenic fault data: towards more robust estimates of the earthquake potential in Italy and its surroundings

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Italy is an earthquake-prone country with a long tradition in observational seismology. For many years, the country's unique historical earthquake record has revealed fundamental properties of Italian seismicity and has been used to determine earthquake rates. Paleoseismological studies conducted over the past 20 years have shown that the length of this record - 5 to 8 centuries, depending on areas - is just a fraction of the typical recurrence interval of Italian faults - consistently larger than a millennium. Hence, so far the earthquake potential may have been significantly over- or under-estimated.

Based on a clear perception of these circumstances, over the past two decades large networks and datasets describing independent aspects of the seismic cycle have been developed. INGV, OGS, some universities and local administrations have built networks that globally include nearly 500 permanent GPS/GNSS sites, routinely used to compute accurate horizontal velocity gradients reflecting the accumulation of tectonic strain. INGV developed the Italian present-day stress map, which includes over 700 datapoints based on geophysical in-situ measurements and fault plane solutions, and the Database of Individual Seismogenic Sources (DISS), a unique compilation featuring nearly 300 three-dimensional seismogenic faults over the entire nation. INGV also updates and maintains the Catalogo Parametrico dei Terremoti Italiani (CPTI) and the instrumental earthquake database ISIDe, whereas OGS operates its own seismic catalogue for northeastern Italy.

We present preliminary results on the use of this wealth of homogeneously collected and updated observations of stress and strain as a source of loading/unloading of the faults listed in the DISS database. We use the geodetic strain rate - after converting it to stress rate in conjunction with the geophysical stress data of the Stress Map - to compute the Coulomb Failure Function on all fault planes described by the DISS database. This may be seen as an indicator of the rate at which the regional stress is transferred to each fault; as its sign can be positive or negative, the Coulomb Failure Function rate should ultimately indicate the rate at which every fault for which sufficient geodetic data are available is loading or unloading elastic energy.

A better understanding of the relationships among geodetically-documented strains, present-day stress, active faulting and seismicity for the entire country should enable us to outline regions where the current strains explain well the known seismicity and to single out areas where stress is consistently building up but are historically quiescent. In such areas the lack of seismicity may result from a limited earthquake coupling – i.e. current strains are consumed aseismically - or from the incompleteness of the earthquake record. Our results may ultimately contribute to the assessment of time-dependent seismic hazard in Italy, thus complementing the time-independent approach used for conventional seismic hazard maps.