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Static stress drop as determined from geodetic strain rates and statistical seismicity

Alessandro Caporali (1), Salvatore Barba (2), Michele Carafa (2), Roberto Devoti (2), Grazia Pietrantonio (2), and Federica Riguzzi (2)

(1) University of Padova, Dipartimento di Geoscienze, Padova, Italy (alessandro.caporali@unipd.it), (2) Istituto Nazionale di Geofisica e Vulcanologia INGV, Roma, Italy

Two critical items in the energetic budget of a seismic province are the strain rate, which is measured geodetically on the Earth's surface, and the yearly number of earthquakes exceeding a given magnitude. Our study is based on one of the most complete and recent seismic catalogues of Italian earthquakes and on the strain rate map implied by a multi-year velocity solution for permanent GPS stations. For each of 36 homogeneous seismic zones we use the appropriate Gutenberg Richter relation, which is based on the seismicity catalogue, to estimate a seismic strain rate, which is the strain rate associated with the mechanical work due to a co-seismic displacement. We show that, for each seismic zone, the volume storing most of the elastic energy associated with the long-term deformation, and hence the seismic strain rate, is inversely proportional to the static stress drop. The GPS-derived strain rate for each seismic zone limits the corresponding seismic strain rate, and an upper bound for the average stress drop is estimated. We show that the implied regional static stress drop varies from 0.1 MPa to 5.7 MPa for catalogue earthquakes in the moment magnitude range [4.5 - 7.3]. The stress drop results are independent of the regional a and b parameters, and heat flow, but are very sensitive to the assumed maximum magnitude of a seismic province. The data do not rule out the hypothesis that the stress drop positively correlates with the time elapsed after the largest earthquake recorded in each seismic zone.