

EGU21-4114

<https://doi.org/10.5194/egusphere-egu21-4114>

EGU General Assembly 2021

© Author(s) 2022. This work is distributed under the Creative Commons Attribution 4.0 License.



Estimate of earthquake power dissipation from exhumed ancient faults (Gole Larghe fault zone, Italy).

Francesco Lazari¹, Angela Castagna², Stefan Nielsen³, Ashley W. Griffith⁴, Phillip Resor⁵, Rodrigo Gomila¹, and Giulio Di Toro^{1,6}

¹Università degli studi di Padova, Scuola di Scienze, Geoscienze, Italy (francesco.lazari@gmail.com)

²Former PhD Student at the School of Geography, Geology and the Environment, Leicester University (United Kingdom)

³Department of Earth Sciences, University of Durham, Durham, United Kingdom

⁴School of Earth Sciences, Ohio State University, Columbus, USA

⁵Department of Earth and Environmental Sciences, Middletown, Wesleyan University, USA

⁶Sezione di Tettonofisica e Sismologia, Istituto Nazionale di Geofisica e Vulcanologia, Rome, Italy

Several earthquake source parameters cannot be estimated from the analysis of seismic waves, instead, they may be derived from field surveys and experimental studies. Among these parameters, the fault strength evolution ($t_f(t)$ in MPa) and the frictional power dissipation ($Q' = t_f(t) V(t)$ in MW m⁻², with V being the slip rate) during seismic slip control the moment release rate, the temperature increase in the slip zone and therefore the activation of coseismic fault dynamic weakening mechanisms. Frictional melts (preserved as pseudotachylytes) along the slip zone can be the result of relatively high Q' . In fact, shear heating is proportional to Q' : the higher Q' , the higher the heat production rate and, consequently, the faster the temperature increase in the slip zone and the steeper the temperature gradient in the boundary rocks (Nielsen et al., 2010). [PR1] The tonalite rocks used in this study come from the Gole Larghe Fault zone (Southern Alps, Italy), and they are made of minerals with different individual melting temperatures. The presence of a steep temperature gradient (high Q') with closely-spaced isotherms at the boundary walls, will cause the minerals to melt uniformly near the sliding surface (i.e. independently of their melting points), resulting in a relatively smooth pseudotachylyte-wall rock boundary. On the other hand, a gentle temperature gradient (low Q') with widely-spaced isotherms will mainly melt those minerals with low melting points, generating higher micro-roughness.

To consider these different scenarios, we collected samples of natural pseudotachylytes belonging to 'wavy' faults, together with samples of injection veins (tensile cracks with $Q' \rightarrow 0$). A 'wavy' fault presents shear cracks from compressional (high Q'), neutral, and extensional (low Q') domains along strike. We performed a series of experiments using a rotary shear apparatus (i.e., SHIVA, Di Toro et al., 2010) to produce artificial pseudotachylytes at increasing slip rates and normal stresses corresponding to values of increasing Q' , ranging from 5 to 25 MW m⁻². The micro-roughness is then measured from optical and scanning electron microscope images obtained both from natural and artificial samples for comparison. We found that in the experimental samples, the micro-roughness is inversely proportional to Q' , as predicted by the theoretical model. Natural samples

show similar trends with the higher micro-roughness present in the injection veins where $Q' \rightarrow 0$. This study demonstrates the robustness of the relation between and fault micro-roughness in both natural and experimental samples. However, further investigations are required to calibrate this methodology to estimate quantitatively the frictional power dissipated during natural earthquakes.