
MECHANICS RESEARCH COMMUNICATIONS

Elsevier Distinguished Lecture

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Guttenberg Information Technologies Center (GITC) - Room 1100
New Jersey Institute of Technology, Newark, NJ

Webcast URL: <http://live.njvid.net/njit>

Materials Physics of Faults in Rapid Shear and Consequences for Earthquake Dynamics

Field observations of maturely slipped faults show that despite a generally broad zone of damage by cracking and granulation, large shear deformation, and therefore heat generation, in individual earthquakes seems generally to take place with extreme localization to a zone of order 1 mm or less width within a finely granulated fault core. Relevant fault weakening processes during large crustal events are therefore likely to be thermally influenced, although a constraint to be met, from scarcity of pseudotachylite, is that melting within fault zones seems relatively rare, at least in the upper crust. Further, given the porosity of damage zones, it seems reasonable to assume in-situ water presence. The lecture reviews current understanding of the materials physics underlying rapid shear of such fault zones, addressing questions like: Why is there severe localization? What are the dynamic relations between shear stress sustained by the fault and its slip history? How do those relations, taken to provide the boundary conditions on a rupturing interface between elastic regions of the earth, control key features of the dynamics of earthquakes?

The results, applied to modeling of spontaneous slip ruptures, show how faults can be statically strong yet dynamically weak, and operate under low overall driving stress, in a manner that generates negligible heat and meets major seismic constraints on slip, stress drop, and self-healing rupture mode. They also shed light on how fault segments that normally shear stably, so as to not nucleate earthquakes, can nevertheless take part in major events when a high-slip rupture impinges from a bordering segment.

James R. Rice is Mallinckrodt Professor of Engineering Sciences and Geophysics at Harvard University, where he is appointed jointly in the School of Engineering and Applied Sciences and the Department of Earth and Planetary Sciences. Rice was previously on the faculty of Brown University (1965-1981) and was educated in engineering and applied mechanics at Lehigh University (1958-1964). His focus in recent years is on mechanics directed to earth and environmental problems, including fault zone processes, earthquake nucleation, dynamic rupture propagation, meltwater interactions with glacier dynamics, landslide processes, and general hydrologic phenomena involving fluid interactions in deformation, flow and failure of earth materials. His earlier work focused more heavily on inelastic deformation and fracture in mechanical and materials engineering, including elastic-plastic crack propagation in ductile metals, path-independent integral methodology, microscopic mechanisms of deformation and failure, deformation localization into shear zones, and finite-element and spectral numerical methodology in solid mechanics. For further details on professional activities, honors, publications and awards, etc., see esag.harvard.edu/rice/RiceCV.html, and esag.harvard.edu/rice/RicePubs.html.

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