# 1992年ランダース地震による弾性歪エネルギーの変化と余震の評価
# The change in the elastic strain energy due to the 1992 Landers earthquake and triggering mechanisms of aftershock activity

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Earthquakes are physical processes to release elastic strain energy stored in the Earth’s crust by shear faulting. This quantity is essentially important for understanding earthquake generation. However, we have little knowledge on the quantity, because it is difficult to measure stress in-situ. Recently, Terakawa and Hauksson (2018) developed a method to model and estimate the 3-D absolute stress field from earthquake focal mechanism data, using the reference pore pressure as a single parameter (the reference pore pressure). In this study, we directly investigated changes in elastic strain energy, based on 3-D abosolute stress fields modeled by Terakawa and Hauksson (2018). Then, we tried to propose a new criterion to understand aftershock activity following large earthquakes instead of the change in Coulomb Failure Function (CFF), based on elastic strain energy.

First, we investigated partitioning of changes in shear and volumetric strain energies due to the 1992 Landers earthquake ($M_W$ 7.3). Changes in volumetric strain energy did not depend on the reference pore pressure, or the level of deviatoric stress field. On the other hand, those in shear strain energy was closely related to the parameter. More shear strain energy were released when the background deviatoric stress magnitudes were higher. The elastic strain energy released by the mainshock is consumed as radiated, fracture and thermal energies. The amount of change (decrease) in the elastic stain energy must be at leaset larger than radiatied energy, which can be estimated (e.g., Kostrov, 1974; Ide, 2002). Therefore, the change in shear strain energy plays a crucial role to constrain the the most plausible reference pore pressure and eventually the level of the (absolute) deviatoric stress field.

When a stress field is compressed due to the mainshock, frictional strength as well as volumetric strain energy in the region will increase after the mainshock. This means that an increase in elastic strain energy do not necessarily mean activation of seismicity. The shear and volumetric strain energy are closely related to the average shear and normal stresses acting on faults randomly and isotropically distributed in the crust (e.g., Saito et al., 2018; Matsu’ura et al., under review). Increases in shear and volumetric strain energies have positive and negative effects on triggering aftershocks following the mainshock. In order to understand aftershock activity, we need to correctly consider both effects of the two kinds of strain energies into account. As the elastic strain energy is scalar quantity, we do not have to set any receiver faults, unlike using the change in CFF. In the source region of the Big Bear earthquake ($M_W$ 6.5), which is the largest aftershock following the Landers mainshock, the shear strain energy increased, but the volumetric strain energy decreased. Both changes would have promoted this event. In the region just south of the hypocenter of the mainshock, the total effect from the two kinds of strain energies suggest that seismicity would have become inactive, contrary to the actual activation. Focal mechanism solutions of some of these events were normal faulting with NW-SE tension. We can understand that these events would have reactivated by decrease in fault strength under the stress field characterized by strike-slip faulting with NE-SW compression and NW-SE tension. This suggest that many aftershocks in the region may have been triggered by overpressurized fluids.

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