I142-P011 **Room: Poster Session Hall** **Time: May 15**

Irreversible thermodynamics for viscoelastic behavior of rocks and temporal seismicity patterns

Yusuke Kawada[1]; Hiroyuki Nagahama[2]

[1] Dept. of Geoenvir. Sci., Grad. Schl. of Sci., Tohoku Univ.; [2] Dep. Geoenvir. Sci., Grad. School Sci., Tohoku Univ.

Irreversible thermodynamics is studied to describe a general constitutive law for viscoelastic behavior of rocks. A general thermodynamic system with n degrees of freedom is defined by n state variables (generalized coordinates) conjugate to generalized forces. The state variables are divided into two groups; k components of strain conjugate to stress and (n - k) internal state variables whose conjugate generalized forces are zero. The internal state variable is regarded as damage parameter or plastic strain. Then, the irreversible process in the neighborhood of the equilibrium is regulated by a Lagrange equation whose general solution becomes a summation of (n - k) orthogonal relaxation modes. Finally a nonlinear viscoelastic constitutive law is formulated as an integral form of a stress-strain relation with exponential response. When (n - k) orthogonal relaxation modes follow a scaling rule for deformation time and relaxation mode and the degree of freedom of the system approaches infinity, the response function of the constitutive law becomes a temporal power-law.

On the other hand, a constitutive law for transient and steady-state behavior of rocks has been previously derived from the laboratory experimental data. This experimentally-based constitutive law is concordant with the general law derived from irreversible thermodynamics. Moreover, our constitutive law predicts forms of the surface displacement subsequent to a mainshock. Time-series of the surface displacement shows a temporal scale-invariant pattern of seismicity and includes the hysteresis effect due to many associated small events. Our model suggests that the temporal seismicity pattern may be prescribed by the fractal property of internal state variables, i.e., the fractal structures of crustal rocks.