An idea on deformation of the shallow crust

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(1) Mode of mechanical responses of materials has a great diversity but only limited tools from mathematics and physics are available to describe them. As extreme cases, materials are considered to be solid or fluid but this characterization is not inherent to the materials. It depends on the characteristic time of external actions.

Usually, the shallow crust of the earth is considered to be elastic solid and when the idea fails, one introduces fractures in the crust by hand. It is the bad way to treat the problem.

(2) We consider the crust is a system of classical particles having great diversity of size and shape . The interaction between particles is not known and frictional forces cannot shed light on the entangled situation, because we can introduce any frictions at will.

We must begin with more general settings, but, for the particle system, no general theory abailable, which comparable to Boltzmann's theory. The only general theory available is the Onsager's phenomenological theory of irreversible thermodynamics. The important point of the theory is that the process is driven by fluctuations. The fluctuation must be driben by random action, for example, thermal agitation in text book situations. In our case, the fluctuations may be driven by uncorrelated external actions such as rains and earthquakes. Mathematically, physical origins of the fluctuation are irrelevant.

We apply Onsager's idea to our system under uncorrelated perterbation. The most simplified case may be expressed by Langevin's equation which is a special case of Itoh's stochastic differential equatrion. The average behavior of the solution must be diffusion. In our case, the diffusion is not the molecular diffusion nor diffusions mentally depictable. For suffiently long time average, the system will behave as a viscous liquid, but the viscosity is not known in advance.

With the idea given above, we will discuss observations relating to the deformation and magma migration.