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Solid Earth Discussions

Interactive comment on "Energy of plate tectonics calculation and projection" *by* N. H. Swedan

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General comments:

There are many misspellings (e.g. "mantel") and odd word associations (e.g. "the plate tectonics"). The author shows no knowledge of the literature on the problem of the energy of the Earth's interior and the driving forces of plate tectonics. The authors attempt to characterize the thermodynamic behavior of the Earth is very difficult to follow, and numerous nontrivial contradictions with contemporary thought are not discussed. Many statements have dubious meaning or credibility. For example:

Ln 20-22: It is unclear to me how surface topography increasing the surface area of the Earth is thermodynamically important.

Ln 22-29: The attempt to link heat loss of the Earth to atmospheric thermodynamics is

dubious since the heat loss of the Earth is negligible compared to the solar budget.

Ln 24-26: Asserting that the arrangement of continents on the surface of the earth is such that heat loss is somehow optimized is unsubstantiated. Furthermore, that transport of Earth's "internal" heat, whether to space or the atmosphere, occurs primarily by radiation and not conduction is also unsubstantiated.

Ln ∼67: Although the author seems to agree that plate tectonics is driven by heat loss of the earth related to lithospheric cooling, this heat loss is attributed to the latent heat of solidification. This is a major contradiction with contemporary thought, and it is unclear what roles the author attributes to conductive cooling and density changes associated with temperature changes in the lithosphere or convective mantle generally.

Comments on the primary suggestion of the work:

The author suggests that the force driving plate tectonics is a pressure generated by partial melting near ocean ridges (Ln 53-55). This is almost certainly incorrect. Although it is correct that partial melting will generate a pressure, melting is not an isochoric process and pressure associated with the volume expansion on melting will be quickly relieved by a displacement of surrounding mantle below the ridge. Thus, along with a local decrease in mantle temperature, some work done by the expansion related to the enthalpy change on melting (dH=dQ+VdP) will go into gravitational potential energy, which might be roughly modeled as a positive topographic anomaly above ridges and may be on the order of a few hundred meters at most for 'normal' seafloor. Most relief will occur over the timescales of the solidification of oceanic crust (<0.1 Ma, or a few kilometers from the ridge). I fail to understand how it is mechanically feasible to suggest that such a stress generated in hydrostatic mantle will be converted to a sustained stress on plates. In comparison, the topographic relief related only to conduction over the age of the lithosphere is on the order of 3 km and occurs over thousands of kilometers. If this gravitational potential energy is available to drive plate tectonics, it is negligible.

I do not recommend publication.

Interactive comment on Solid Earth Discuss., 5, 135, 2013.