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

Anonymous Referee #2

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This paper presents an argument that the plate tectonics is driven by basaltic melting at mid-ocean ridges. The argument is a bit incoherent and difficult to follow, but it seems that the author is arguing that a large pressure builds up at mid-ocean ridges due to melting and then re-freezing of magma in oceanic crust. The author then argues that this process is sensitive to Earth's surface temperatures, which are rising due to climate change, and thus plate tectonic rates should accelerate in the future.

I do not think that this paper presents a viable physical mechanism for plate tectonics. First, any pressure buildup at the ridges could be accommodated by viscous flow in the asthenosphere (beneath the tectonic plates), rather than a force exerted on the plates. Second, it is unclear to me how the physics of melting can produce such a large pressure – this is not clearly explained. Third, the paper ignores a vast body of scientific advances in our knowledge of plate tectonics that has been developed over the past 50 years (it only cites 8 papers). Fourth, the thermodynamic arguments can't

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be correct because they predict maximum magma partial melting of 53% based on the “Carnot theoretical efficiency of the tectonic engine” (sentence in the conclusions) – this is clearly incorrect because the degree of partial melting depends on mantle temperatures and the (depth-dependent) solidus of mantle rocks, neither of which are used to compute the partial melting. Fifth, plate tectonics is governed by mantle convection (that fact is ignored here),which occurs at rates that depend on the temperature difference between the mantle interior and the surface, which is $\sim$1400 degrees C – this means than a few degrees C of surface warming will make little difference to plate tectonic rates.

Basically, I find that the physical model that is described here is physically impossible, and it is poorly described as well. I am not adverse to new ideas for plate driving forces, but to be convincing these ideas need to be well-described and physically plausible, neither of which is achieved here. The rich background in this field also cannot be ignored. For these reasons, I recommend rejection.

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