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

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Author comments to the reply of Referee #2 contains mathematical formulas and calculations. The comments are submitted in pdf format as a supplement file. Please refer to the supplement file to access author comments to the reply of Referee #2.

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



Author comments to the reply of Referee #2

I would like to thank this appointed Referee #2 for replying to author comments. The issues discussed previously and Referee reply will be itemized in the order in which the issues were presented in the reply. In each item, the issue previously discussed and Referee reply will be presented in italics and author comment follows in regular font.

I respectfully request this Journal to provide Referee # 2 reasonable time to reply to these comments if the Referee wishes.

*1) I will respond briefly to a few of the author's responses to my review (referee #2). My comments are noted as "REPLY". Needless to say, the author's responses have not changed my opinion about the paper, but I appreciate the chance to respond to them directly.*
*AUTHOR: This Referee's general understanding of the work presented in the manuscript is, with all due respect, incorrect. Basaltic melting is not the driver of plate tectonics. The heat of mantle convection, Qh, available at the temperature of the hot reservoir temperature, Th, is the driver of the thermodynamic cycle. Some of this heat is lost as, Qc, to the surroundings at the cold temperature, Tc, and the difference, Qh-Qc, is the net thermal energy that can be converted to mechanical work, W. This work is delivered to the tectonic plates. This work, W, is also equal to the latent heat of melting of basaltic rock calculated at mantle's pressure. The heat of convection, as the source of energy that drives plate tectonics, is mentioned repeatedly and has a dedicated symbol, Qh, used in the thermodynamic equations throughout the manuscript. Please see Item 6 for more details.*
*REPLY: This thermodynamic analysis of thermal convection is incorrect. The energy that can be converted to mechanical work is equal to the energy released by potential energy (sinking slabs and rising plumes). The vast majority of this mechanical work is spent deforming the viscous mantle (viscous dissipation). A rather small amount is spent melting rocks, and this amount depends on the relative temperatures of the geotherm and the solidus of mantle rocks. The author is correct (sort of) that the difference in heat transport in hot reservoirs (upwelling plumes) and cold reservoirs (cold slabs) produces net energy – but this is due to the difference in adiabatic decompression and compression at different temperatures, and yields a net cooling. This cooling, however, is balanced by net heating by viscous dissipation. Therefore, the work done to drive plate tectonics (and all deformation in the mantle) is given by the rate of release of potential energy in the convecting system. This is a very different system than is described in this paper. Furthermore, there are many papers that have been written over the past few decades to describe this system. Here are some that come to mind: Conrad, C.P., and B.H. Hager (1999), Effects of plate bending and fault strength at subduction zones on plate dynamics, Journal of Geophysical Research, 104, 17551-17571. Backus,G. E. (1975), Gross thermodynamics of heat engines in deep interior of Earth, Proc. Natl. Acad. Sci. U.S.A., 72, 1555-1558.*

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**Fig. 1.**