Solid Earth Discuss., 5, C50–C52, 2013
www.solid-earth-discuss.net/5/C50/2013/

Solid Earth Discussions

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

Anonymous Referee #1

Received and published: 21 March 2013

General comments

I do not recommend publication of this paper because what's good in it was already known 40 years ago and the author does not refer to that work. There are also many other problems with it, which are listed below.

Specific comments

Allan Cox's 1973 book "Plate tectonics and Geomagnetic Reversals" (Freeman, San Francisco) is a collection of the papers establishing the subject with his introductory comments. Section VIII is still worth reading, and it includes McKenzie (1969: Speculations on the consequences and causes of plate motions, Geophys. J. Roy. Astron. Soc. 18, 1-32) who dealt with the thermodynamics and said "Thermal convection in some form is the only source of sufficient energy". His estimate for slab pull was 12.5*sin(phi)*10^12 N/m, where phi is the angle of dip. It is of the same order of mag-

nitude as Harper's (1975: Geophys. J. Roy. Astron. Soc.) 7.5*10^12 N/m, which was, I think, the first paper finding slab pull to be more important than ridge push. (Forsyth & Uyeda's work was later, but independent.) Swedan's 5*10^12 N/m is of the same order of magnitude as McKenzie's or Harper's. Of course slabs differ greatly in age of subducting lithosphere and significantly in subduction speed. Both age and speed affect slab pull, as shown by various authors.

Swedan also gives ridge push of 1.61*10^12 N/m, again of the same order of magnitude as earlier work. That is of course about 1/3 of his own slab pull, so I do not understand why he implies (p.137 l.3 and l.22, p.139 l.3) that ridge push is what drives plate tectonics. In line 3 he also says it will "fracture plate tectonics". Surely he means "fracture plates", but I find that hard to believe because the Antarctic plate is almost completely surrounded by midocean ridges and it has no large intraplate earthquakes, unlike every other plate bearing a continent.

p.136 l.19 It is claimed that the natural carbon cycle initiated the warming and glacial periods. I think that's a side issue for this paper, and a lot more work would be needed to substantiate the statement. Is it being claimed that the carbon cycle is why we have had glacial periods in the last 2.5 Ma, and from 360-260 Ma, 450-420 Ma, 800-635 Ma, and 2400-2100 Ma,but not in between? The carbon cycle must have been very different over 2000 Ma ago, and I'm under the impression there were no land plants at 635 Ma. Or is Swedan claiming that the glacial- interglacial changes over tens of thousands of years are driven by the carbon cycle, not the Milankovich cycles? But here and elsewhere I wonder why surface temperature changes of order 10 degrees are significant for plate tectonics, which is driven by temperature differences of order 1000 degrees between the mantle and the upper surface of a plate.

p.138 l.9 If the mantle is the system then its surroundings include the core as well as the plates.

p.138 l.20-21 The mantle is not a closed thermodynamic system - matter leaves it to

become oceanic crust an returns to it at subduction zones.

p.139 l.13 Why is surface evaporation constant? Surely it's less in glacial periods than interglacials.

p.140 l.5-7 It seems to be claimed that if the cold reservoir of a heat engine changes its temperature but the hot one does not, then the heat flow through it does not change. Surely the temperature difference across the engine changes, and that alters the rate of heat flow.

p.140 l.25 Why "steady and sustained force", when the previous paragraphs explains why Swedan thinks it's unsteady?

p.149 l.24-25 Astronomical parameters do not remain constant with time, as Milankovich showed long ago.

p.155 l.4-5 "plate tectonic cycle is moving faster". How much faster, over what time scale. Observational evidence?

Technical corrections

In many places I suspect "plate tectonics" should be "plates". Plate tectonics is a process, plates are parts of the Earth.

p.137 l. 11-14 What does "which" in this sentence refer to? As written it is "lithosphere" but that is probably not what Swedan meant.

p.140 l.18 for "pint" read "point".

p.140 l.22 for "sheer" read "shear".

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