Referee: Roger LeB. Hooke

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General:

Lorenz and his team have made some spectacular contributions to our understanding of the mechanics of movement of the sliding stones on Racetrack Playa. However, rocks sitting on piles of mud, piles of mud lacking rocks but in some cases with imprints of rocks, and piles of mud apparently splashed out downflow from rocks are not explained by their observations.

The present paper presents details of the rock movements described by Norris et al (2014), a paper authored by four of the five authors of the present paper. The writing in the Norris et al. paper is significantly better than that in this paper, and the images in Norris et al. are quite superior to those in this paper. In my opinion, it is sufficient to know that movement by ice shove is indisputably demonstrated by the data presented in Norris et al., and the details of the day and hour that a rock moved and the wind speed, presented in the present paper, are not of sufficient interest to warrant publication. If data on wind speed, rock mass, rock speed, and ice thickness (and perhaps other variables) were available for a single movement event, on the other hand, an analysis might prove to be worthwhile.

A potentially redeeming feature of the present paper is the analysis (Lines 150-175) of the force exerted by an ice sheet against a rock at the point of fracturing of the ice. However, this analysis is incomplete (see comments below), and the relation of the ice sheet size to the Characteristic length is unclear. If this line of inquiry were fleshed out the paper could be an interesting contribution.

Specific comments:

Line 21. Given the frequency with which movement has been documented over the past 65 years, I think "exceptionally" is too strong. "Rare" should be sufficient.

Line 22. This, too, is too strong a statement. Maybe you could say, "To the best of our knowledge…"

Line 28. "…only a subset move…" This is your observation, but if I remember correctly, observations by Reid (1995) and Stanley (1955) suggest that it is not always the case that some rocks become decoupled.

Lines 151-155. Sohdi (1983) is not available to me and the other references cited here do not address the question of the buckling load. However, Sodhi (1982) gives:

$$L = \left[\frac{Eh^3}{12(1-\mu)\rho_w g}\right]^{1/4} \quad (1)$$

where E is the effective modulus of elasticity, h is the ice thickness, μ is Poisson's ratio (should be ν but I can't find ν in my equation editor), ρ_w is the density of water, and g is the acceleration of gravity. This makes more sense than your equation in Line 155 because it includes the ice thickness, which must play a role in determining whether ice cracks as it is shoved against a rock by wind. If L and h are in meters, this reduces to (Fransson, 2009, p. 18):

$$L \approx 14h^{3/4} \quad (2)$$

However, L is measured by loading an ice sheet vertically and measuring the deflection. *Thus, it is not at all clear to me how L is related to the ice sheet dimension, as stated in Line 154.*

In Line 159 you adopt $L \approx 0.2$ m which, according to (2) above implies $h \approx 0.003$ m. Pretty thin.

References

Fransson, L., 2009, Ice handbook for engineers, version 1.2. Luleå University of Technology, 31 p.

Sohdi, D.S., Kato, K., Haynes, F.D. and Hirayama, K., 1982, Determining the characteristic length of model ice sheets. Cold regions Science and Technology, v. 6, p. 99-104.

Technical corrections

Line 31 "~~The~~ Racetrack…"

Line 36. "…dolomite*, but with* ~~and~~ a few …"

Line 37. "…end*s* of trails …).

Line 44. "..~~extreme~~…".

Line 45. "never" So far as you know!

Line 47. "…for ~~the~~ rock movement…".

Line 72. "…popping…sheet." Awkward phraseology.

Line 73. "*R*ock…"

Line77. " of ~~of~~ ~~2-6~~ cm/s ~20 – 60 mm/s…" It is my understanding, although I can't, off hand, find it formally stated, that preferred SI length measures are m, mm, μm, etc. Also (from Wikipedia). "The value of a quantity is written as a number *followed by a space* (representing a multiplication sign) and a unit symbol; e.g., 2.21 kg…"

Line 82. "…material ~~is~~ *are* also…"

Line 83. "…move ~~by~~ a…"

Lines 93-98. Perhaps more detail than necessary here.

Line 98. "…~~appearent~~ apparent…"

Line 109. Rock size is also an "element of randomness."

Lines 62-135. I think this section could be reduced by 50%. It's enough to know that you saw rocks moved by ice. I'm convinced. Repeated examples do nothing to make me more convinced, and become boring.

Line 139. "…by *a* remarkable ~20*0* mm snowfall on *the* 23rd *of*…"

Line 156. "…P~1500…" should be "…P ≈ 1500…" "~" mean proportional to. "≈" means approximately equal to.

Lines 159-162. "This is the appropriate…friction." This is quite awkward phraseology.

Line 170. "…~~might~~ may…"

Line 172. Many readers will not know what the coral experiment was.

Line 181. "…moved *in*…"

Line 185. "…occasions *that* we…"

Line 186. "…movement *here* suggest…"

Lines 201-202. "…*cap*able *of* ~~to~~ sustain*ed* ~~persistent~~ observation.…"

Line 275. "(c) an*d*…"

Line 277. "…~20 *mm perpendicular to the fiducia*l line relative…"

Line 284. I see only two trails.

Line 288. "…~10 m to the north…" One rock seems to have vanished and the other moved just off the trail. I don't see what you are describing.

Fig. 3. In the version of this figure that I downloaded, the words on image c are not legible and I can't see anything in the 4 yellow circles. In image e it would help to insert an arrow pointing to the ice edge. I can't see any trails in image f.

Line 305. "…an*d* is seen…"

Line 317. "…near*ly* vertically…"

Fig. 5a. Need North arrow.

Line 330. "…Fig. 4~~a~~, and…"