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Interactive comment on "The internal structure and composition of a plate boundary-scale serpentinite shear zone: The Livingstone Fault, New Zealand" *by* Matthew S. Tarling et al.

Telemaco Tesei (Referee)

telemaco.tesei@durham.ac.uk

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Tarling and co-workers present an excellent description of the Livingstone Fault in the South Island of New Zealand. This manuscript is very interesting because it presents data and observations from outcrops along a strike of several tens of kilometers, which is not common. Albeit most of the work focuses on a single outcrop, it is nevertheless important to document the lateral continuity and structure of fault zones that can be highly heterogeneous. These informations on fault structure and composition are presented in the context of nearby terranes and are presented in a effective way. Outcrop-scale observations are then well integrated with micro and nano-structural analysis to

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form a nice global picture of a large serpentine-bearing fault. The mechanics of scaly serpentinite faults presented by Tarling et al. is consistent with previous literature on the subject but also highlights some structural complexity of the fault zone. In particular, the documentation of processes at the contact with the wall rocks of different composition and the potential rheological influence of non-serpentinitic blocks within the fault core are important evidence brought about in this manuscript. I think the manuscript needs only very minor revisions before being accepted for publication.

Telemaco Tesei Durham University

Comments: I reckon that references should be in chronological. Labels within field figures are all very small and difficult to read.

Page 2, line 16 and following. There are several more studies that document with some detail the processes and the structure of serpentine-bearing fault zones. Some potential additions to the list: Maltman, 1978; Williams, 1979; Twiss and Gefell, 1990; Alexander & Harper, 1992; Gates, 1992; Bailey et al., 2000, Hirauchi and Yamaguchi, 2007, Bellot, 2008, Melosh, 2019. In the following lines: it might be worth mentioning with some more details what these studies say about the structure and deformation of serpentinite-bearing faults. Limiting the discussion to the characteristic scaly fabric is a bit over simplistic. In the discussion, it might be useful to highlight the differences with the previous knowledge about serpentinite faults.

Page 8, line 30: there is a question mark after “Vannucchi et al., 2003” what does it means?

Page 9, line 19. See also Melosh, 2019, G3

Page 10, line 4: How did you identify these minerals? how large are the grains?

Page 10; line 16: The temperature range in which chrysotile and lizardite are stable is much wider than 300-350°C. The absence, or instability, of antigorite may well set the high temperature boundary, but not the lower boundary. Since two close terranes

have zeolite facies (T<200°C) and Prehnite-Pumpellyte facies (T<300°C) metamorphic imprint, it is possible that the Livingstone fault was active at temperatures lower than 300°C.

Page 11, line 5: I think a paper in revision does not qualifies as previous literature. line 8-10: this is a very interesting observation. Do you have an estimation of the thickness of the mantle section in the other outcrops of the ophiolite adjacent to the Livingstone fault? I would be interesting to understand this change in thickness. For instance, are there any changes in kinematics or amount of displacement that could account for this change in thickness of the deformed mantle portion?

Page 12, line 12: "...P-T conditions". Maybe a reference or two are necessary here. line 21. from the sentence it looks like that the references talk about pressure solution producing the scaly fabric of serpentinites. They are only some examples of work about pressure-solution weakening of faults in general. Maybe add "similarly to what happens in other faults"? or something similar. line 34: it might be worth to metionting that the association of serpentinites /ultramafics with tremolite (and chlorite and talc) is well documented in the literature (e.g. Cronshaw 1923; Nishiyama 1990; Boschi et al., 2006; Bach and Klein 2009 among many others). In particular at the contact with different lithologies (rodingites but also metasediments).

Page 13, line 24. This statement about overpressure induced by metasomatic reactions is a bit vague. I would suggest to either remove it or present the evidence for such a phenomena (I don't think Fig. 6a is enough).

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