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Solid Earth
Discussions

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.

Anonymous Referee #1

Received and published: 18 April 2019

Review of Tarling et al.'s Solid Earth manuscript titled "The internal structure and composition of a plate boundary-scale serpentinite shear zone: The Livingstone Fault, New Zealand"

General comments (overall quality)

This excellent manuscript documents the complex macro- and micro-structures of the Livingstone Fault, a >1000 km long serpentinite shear zone exposed on the South Island of New Zealand. The mechanical behaviour of serpentinite likely plays a major role in controlling the rheology of major faults, including plate boundaries. In particular, serpentinite is very likely to be present along subduction-zone plate boundaries where

the subducting plate descends beneath the forearc mantle. The extent to which a subducting plate induces flow in the mantle wedge may depend in part on the rheologic coupling across a serpentinite shear zone. This important study provides important insight into how serpentinite deforms at elevated temperature and pressures, and on the scale of tens to hundreds of metres. This is a very well-written paper that strongly merits publication in Solid Earth after considering my minor comments below. I note that the paper is exceptionally well illustrated with clearly annotated field photos and photomicrographs. The field photos are spectacular!

Specific comments (individual scientific questions/issues)

Page 2 (Introduction) – I recommend the authors add a sentence or two providing specific examples of other serpentinite-bearing shear zones around the world.

Page 9 (sections 4.3.1), Figures 9 and 10, and throughout the text – I recommend the authors specify, to the extent possible, the type(s) of serpentine minerals present in the different serpentinites. Reading between the lines, the massive serpentinite described in section 4.3.1 is likely composed of chrysotile + lizardite (+ magnetite); antigorite and other forms of serpentine are rare.

Page 10, line 15-16. I recommend expanding the first sentence "... with an estimated ambient temperature during shearing of 300-350 °C" to articulate the constraints on the estimated temperatures, citing appropriate references. The assemblage lizardite + chrysotile can occur over a broader temperature range, but perhaps the general absence of brucite and antigorite is being used to narrow the temperature estimate.

Page 13, line 24 – What is the evidence that metasomatic reactions "can generate in-situ fluid overpressures?" Would this not depend on the specific metasomatic reaction (e.g., cation exchange vs. dehydration reaction)?

Technical corrections (typos, etc.)

Page 3, line 5 and 14 – The rocks between the Western and Eastern Provinces are referred to as the Median “Batholith” in the text and the Median “Tectonic Zone” in Figure 1. I recommend using one or the other for consistency.

Page 2, line 23; page 9, line 20; page 11, line 16 - The question marks in cited references should be deleted and appropriate references added where necessary.

Page 21, Figure 1 – Several of the colours chosen for the geologic map are very similar making it difficult to distinguish some of the units (Dun Mountain terrane versus Median Tectonic Zone) particularly when similar coloured units are juxtaposed (e.g., contact between Dun Mountain terrane and Brook Street terrane). I recommend selecting different colours to ensure the geologic map can be easily interpreted.

Page 32, Figure 12 – “(Chapter 4)” should be removed from box (iv)

Page 27, Figure 7 – This detailed geologic map should be published at the largest size possible (i.e., full page width). At its current size most of the details are not legible.

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