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Solid Earth Discussions

Interactive comment on "Fluid-mediated, brittle-ductile deformation at seismogenic depth: Part I – Fluid record and deformation history of fault-veins in a nuclear waste repository (Olkiluoto Island, Finland)" *by* Barbara Marchesini et al.

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We are sorry to hear that our first reply regarding the evidence in support of the progressive narrowing of BFZ300 and its interpretation as a Type II deformation zone did not convince the reviewer. We try now to better explain out thoughts. For the sake of clarity, we report the first comment by the reviewer, followed by our explanation.

Review: "...the authors consider that the studied shear zone is narrowing implying that the damage zone is representative of an early stage of brittle deformation, which is

followed by ductile/brittle deformation localized in the core of the shear zone. This assumption strongly controls the interpretation of the data and the elaboration of the fluid circulation/deformation model. As an alternative, one could consider that the fault zone is widening rather than narrowing. In this case, the damage zone represents a more recent expression of the fault zone than the core zone that has experienced a longer history of deformation. Note that this proposition is in line with the lower temperature and pressure recorded by the fluid inclusions in the damage zone compared to the core zone of the fault, suggesting progressive exhumation of the shear zone during deformation. Please consider this alternative and provide evidences to discard (or favor?) it."

Author: Quartz veins documented in the damage zone and in the fault core are all formed by Qtz I and we consider them as expression of the same initial stage of deformation by hydrofracturing and fluid venting, because of convincing meso- and microscale evidence. In the field, Qtz I from the damage zone has the same translucid appearance (Fig. 2b-c) as quartz from the Qtz I vein in the fault core (Fig.3). Microstructural analysis also confirms their resemblance, as indicated by their similar grain size and comparable grain boundary morphologies. This notwithstanding, Qtz I from the damage zone exhibits a lower degree of crystal plastic deformation (undulose extinction) than Qtz I from the core. The latter is indeed characterised by bulging and intra- and intercrystalline bands of recrystallized and nucleated new grains (Fig. 6), which we interpret as being due to the effect of later strain in the fault core all the way to the emplacement of a second generation of quartz vein (Qtz II), which, indeed, is only found in the middle part of the fault core, side by side with the Qtz I vein. Finally, as already mentioned, the last reactivation of the system is documented by the emplacement of Qtz II, which is exclusively localized along the principal slip boundaries of the fault core. In summary, Qtz II is demonstrably the later quartz type emplaced within BFZ300 and the fact that it is only found in the core requires strain to have progressively localized from a larger volume of rock (including the Qtz I-filled damage zone) into a narrower volume. Qtz II thus forms a discrete vein that emplaced along the core

Qtz I vein, mostly exploiting the Qtz I vein-host rock interface to further dilate the rock and inject.

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