

# ***Interactive comment on “Rheological transitions in the middle crust: insights from Cordilleran metamorphic core complexes” by Frances J. Cooper et al.***

**Frances J. Cooper et al.**

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Reviewer comment 1: I agree with the reviews and comments that the manuscript represents a well-written review of the rheological implications derived from structures exposed in three thoroughly studied metamorphic core complexes of the western USA. However, most of the ideas, concepts and partly also the excellent field pictures have been published by the same authors previously. The whole manuscript is more of a synthesis rather than original research and therefore the authors should make clear what the main contribution of this study is and how it is different from other papers previously published.

Response 1: While we agree that many of the ideas and pictures have been published

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previously, this paper makes three important new contributions:

(1) Although we proposed the Localized-Distributed Transition (LDT) in Cooper et al. (2010b) based on work in the northern Snake Range, we were unable to see and map the transition there. Therefore, one of the main contributions in this paper is to document the existence of the LDT in the Whipple Mountains, and to show why it can be difficult to find and document it in other metamorphic core complexes, using the northern Snake Range and Ruby Mountains-East Humboldt Range as examples.

(2) Our paper provides a prediction of and mechanical explanation for the geometry of the detachment, as summarized in Figure 3 and Section 2.

(3) We document that in each of these three metamorphic core complexes, the brittle detachment is late Tertiary (late Oligocene-middle Miocene) in age. Previous suggestions that the detachments initiated in the early Tertiary were based on a misinterpretation of Ar-Ar cooling age "chronotours".

In order to emphasize these new contributions in the paper, we have added a few sentences to the end of the abstract and the Introduction (page 3, lines 25–33) as follows:

"Using field observations, microstructural analyses, and thermobarometric data, we (i) document the exhumation of footwall rocks from the middle crust to the surface in each core complex as they pass through different rheological transitions; (ii) document the exhumed LDT in the Whipple Mountains, show why it is not easily identified in the northern Snake Range, and has not been exhumed in the Ruby Mountains–East Humboldt Range; (iii) present a prediction of, and a mechanical explanation for, the geometry of the detachments in these three core complexes and many like them; and (iv) show that the detachments in all three core complexes formed during the Miocene, and post-date early phases of extension and exhumation in the exhumed mid-crustal metamorphic rocks."

Reviewer comment 2: Figure 5A: No orientation is given. SPO gives nice top to the right shear sense.

Response 2: We have added a statement to the Figure 5 figure caption to say that “All thin sections are oriented with NE to the right”.

Reviewer comment 3: Figure 5C: No orientation is given. Sigmoids and winged inclusions give nice top to the right shear sense.

Response 3: See response to 5A above.

Reviewer comment 4: Figure 5D: No orientation is given. SPO gives nice top to the left shear sense.

Response 4: Again, the section is oriented with NE to the right. In fact, the sense of shear is again top-right, but this photo and the photo in 5F were not intended to represent shear sense, and describing them as doing so might be misleading since we do not show the whole thin section.

Reviewer comment 5: Figure 5F: No orientation is given. What is shear sense here?

Response 5: See response to 5D above.

Reviewer comment 6: Figure 6F: This is not a delta-type porphyroclast inclusion but a winged inclusion. The mechanics of both structures is quite different and should not be confused.

Response 6: We acknowledge that this was incorrectly labeled and have modified the caption to read: “Attenuated fold in sub-detachment Marble Wash calc-mylonites, with a geometry comparable to the winged inclusions found in ultramylonites of the Ruby Mountains-East Humboldt Range footwall (Fig. 7E) (view to NE)”.

Reviewer comment 7: Figure 6F: Nice top right shear sense.

Response 7: We have indicated in the figure caption that the view is to the N, thus

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implying a top-E shear sense.

Reviewer comment 8: Figure 6D and E: Superb examples but because these examples are brilliant everybody will remember that exactly these figures have been published previously.

Response 8: We think the reviewer must be referring to Figures 7D and E, which were previously published in Platt et al. (2015). We have made this duplication clear by referencing the paper in the figure caption.

Reviewer comment 9: Figure 6D: This IS a delta clast.

Response 9: Assuming the reviewer is referring to Figure 7D, we have added the phrase “delta-type” to the figure caption as follows: “. . . fine-grained dynamic recrystallization in tails around feldspar delta-type porphyroclasts”.

Reviewer comment 10: Figure 6E: This IS NOT a delta clast.

Response 10: Again, assuming the reviewer is referring to Figure 7E, we acknowledge that this was incorrectly labeled and have modified the caption and added a reference as follows: “Ultramylonite beneath the main detachment at Secret Pass with winged inclusions (Grasemann and Dabrowsky, 2015)”.

Reviewer comment 11: Figure 6F: Shear sense here is opposite to all other pictures. Is this true? Why?

Response 11: This is correct. The thin section photographs are all oriented with ESE to the left, whereas the field photograph in 6F is looking NE, with NW to the left.

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Interactive comment on Solid Earth Discuss., doi:10.5194/se-2016-135, 2016.

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