

Reply to comments by Reviewer: K. Krainer

The authors would like to acknowledge the reviewer for his constructive remarks and critics. His suggestions of form/writing will be directly integrated in our revised version. We will ensure that the text is revised by a native English speaker. We address here his questions and doubts.

General remarks

But what does the basal boundary reflector indicate? Is this the bedrock surface or unfrozen, fine-grained sediment containing high amounts of water?

Our answer: This is a critical question. The drop in the radar wave velocity observed along the basal bounding reflector in the downward direction is likely to be related to a significant increase in the amount of water. The latter would be indeed permitted by the presence of wet, fine-grained sediments resting at the base of the massive ice body (more than by quartzite-dolomite bedrock, which permittivity is quite low).

Figures 1, 2, 3, 8 and 9 are too small, e.g. on Figs. 8 and 9 the text is unreadable.

Our answer: We will consequently reshape the figures. The number and arrangement of figures will also be modified to some extent according to the other Reviewer's comments.

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Line 14: are you sure that the massive ice core is embedded in diamicton and not underlain by diamicton (lodgement till)?

Our answer: In the lower part of the rock glacier, the internal structure revealed by the GPR measurements changes somewhat: the velocity decreases, the reflectors are less numerous and distinct. Furthermore, this change in the internal structure corresponds to a morphological change on the surface (overlapping of the lower part by the central part, occurrence of neat scarp, as described in our manuscript). This could result from a two-phases construction of the rock glacier: (1) first the deposit of diamictons, and (2) the embedding of a glacier into the diamictons, before the subsequent creep of the whole assemblage. This type of scenario was observed for other rock glaciers (e.g., Monnier et al., 2011). That being said, the massive ice core may be embedded in diamicton in the lower part and underlain by diamicton in its upper part (lodgement till).

Page 3599

Line 19: what means epistemological challenge???

Our answer: We meant that the existence or not of glacier-derived, ice-cored rock glacier represent a debated and at times polemical issue, and that there is, therefore, a challenge in geomorphology for settling on a widely-accepted definition for rock glaciers. We suggest modifying the sentence to: "Beyond these terminological debates, the identification and understanding of massive ice-cored rock glaciers has important implications related to both recent and future environmental changes. Ice-cored rock glaciers may gain increased hydrological importance as glaciers disappear, and the formation of glacier-derived rock glaciers may represent the final stage of glacier decay that allows for prolonged ice storage in alpine basins."

Page 3600

Line 14: what is a glacial heritage??

Our answer: We will write: "inherited glacial features".

Line 16: at the weather station??

Our answer: Yes, “at the meteorological station of Bourg-Saint-Maurice”.

Line 21: what is a pristine and bulged appearance??

Our answer: We meant “intact” or “domed”. The rock glacier does not seem decayed.

Line 21: what are archetypal ridge- and furrow surface features??

Our answer: We will write “exhibiting numerous transverse ridges and furrows”. It is clearer.

Line 22/23: The blocks on the surface are composed of quartzite and limestone (or do you mean metamorphic limestone = marble?? quartzite is metamorphic quartzose sandstone)

Our answer: More precisely, the lithology alternates between quartzites (Trias), dolomites (Trias), and marbles (Trias and Jurassic). We will clarify it.

Line 24: Is the upper part identical with the rooting zone??

Our answer: Yes the upper part could be called ‘rooting zone’. We will indicate it into brackets.

Page 3601

Line 1 and 2: I do not understand this sentence

Our answer: From morphological and sedimentological points of view, these two crests are distinct from the surrounding areas (that are included in the rock glacier). The sentence will be rewritten more clearly.

Line 7: do you mean transverse ridges?

Our answer: Yes.

Line 11: transverse ridges??

Our answer: Yes.

Line 18: what do you mean of material size? The grain size of the surface layer??

Our answer: Yes.

Lines 27 – 29: unclear

Our answer: We will write: “In summertime, and even more so during the fall, the furrow is systematically colder than the ridge.”

Page 3602

Line 7: what are late lying snow banks??

Our answer: Late-lying snow banks are snow banks that remain until summer. This term is often used in the literature. It could be replaced simply by ‘snowpatch’, which according to the Frozen Ground Glossary of the IPA (<http://nsidc.org/fgdc/glossary/english.html#S>) is a ‘*Relatively small area of snowcover remaining after the main snowmelt period*’.

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Line 5: what are late winter conditions

Our answer: Spring conditions: snow is still present; however meteorological conditions are milder and more clement for fieldwork.

Page 3608

Line 18, heading: do you mean integrated interpretation??

Our answer: Yes.

Line 20: An optimal interpretation??

Our answer: Yes.

Line 4: what is a dipping syncline structure, to where does it dip?? A syncline indicates deformation by compression, is this the case??

Our answer: Our choice of the term “dipping-syncline” may not be the most adequate. Terms like “concave” (as used by Krainer et al., reference of the next comment), “trough-shaped” as suggested by the Reviewer, or only “synclinal” (especially for the transverse profiles) seem more appropriate and clearer. And yes, in the longitudinal direction, the syncline form can be explained by compression processes (see further).

Line 20: Krainer et al described similar reflectors from an active rock glacier with a massive ice core from the Dolomites (northern Italy)

Our answer: We noticed it and will cite this reference.

Page 3612

Line 17/18: Do you mean that the ice core of the rock glacier is underlain by finegrained, water-saturated sediment (eventually a lodgement till)??

Our answer: See answer at the beginning of this reply.

Line 22: what means morphologically decayed??

Our answer: Apparently relict.

Page 3613

Line 6: what is a ruiniform appearance??

Our answer: Ruiniform = dismantled, very eroded.

Line 7 to 16: unclear

Our answer: We will modify this whole section; the mentioned part may be rephrased as follows: “Compression occurred inside the advancing glacier, especially due to the pre-existing diamicton that acted as a topographic barrier in the lower part of the slope. This may explain the marked concavity of the layers within the massive ice core and the very dense net of transverse ridges on the surface. The latter were either created by deformation of the superficial blocky layer or from up-lifting of englacial debris along emerging shear planes. The latter hypothesis would require, however, finer scale GPR investigations to be validated.” (The end of the paragraph was deleted).

Page 3614

Fig. 2: these are aerial photographs!!

Our answer: Yes. We will mention it.

Fig. 4: Natural exposure of massive ice overlain by approximately 1 m thick debris layer (active layer). Where is the backpack??

Our answer: An arrow will be added.