

Interactive comment on “Nationwide aerial laser scanning reveals relict rock glaciers and protalus ramparts in Slovenia” by Mihaela Triglav-Čekada et al.

Anonymous Referee #1

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TCD – Referee Comment Nationwide aerial laser scanning reveals relict rock glaciers and protalus ramparts in Slovenia Author(s): M. Triglav-Čekada et al. MS No.: tc-2016-86 MS Type: Research article Special Issue: The evolution of permafrost in mountain regions

General comments :

The paper is evidencing the occurrence of 29 relict mountain permafrost features (rock glaciers and protalus ramparts) within the national territory of Slovenia on the basis of a visual but systematic analysis that the authors have carried out from a shaded high resolution (1m) DEM acquired by airborne lidar and made freely accessible the government of Slovenia.

C1

Even if the manuscript is well structured, it represents only little scientific novelty, lacks of some important information and contains numerous inaccuracies. The content of the manuscript could also be resumed in few pages only. The section “3.2 Detailed description” is mostly unnecessary because it repeats what is summarized in tables 1 and 2 or add unimportant information (e.g. “located above the village of...”).

In my point of view the paper does not reach so far what could be expected at an international standard. It could potentially represent a good publication, but has first to be significantly reworked. I suggest to reject the paper in its current version but I could also conceive that the editor is deciding to allow a reconsideration of the paper after major revisions.

Specific comments

First of all one could not be convinced by some of the landforms identified as rock glaciers or protalus ramparts (e.g. RG_10, 11, 13, 14, 17, PR_4, 5) and some others are possibly lacking (e.g. downward of RG_6). The outline of several landforms is also difficult to understand and looks quite approximative (e.g. RG_2, 5, 11, 20). To add in the table a comment on the confidence the authors have had in their identification of each landform (e.g. high, medium, low) could have been worth.

Only a grey-shaded terrain model illuminated from the NW seem to have been used (by this way southern to eastern expositions are better illuminated (more contrast) than northern and western slopes, what could limit the visual detection of landform in the latter.

There is no relationship to any current or former climatic setting, making that nobody has any idea about the possible climatic conditions prevailing when these landforms developed. We need data on climatic conditions in Slovenia as for instance the current estimated (or measured) elevation of the 0°C annual isotherm or the annual mean precipitation.

C2

It would also have been important to characterize each rock glacier by its location outside/within an area glacierized areas during the Last Glaciation or during any stage of the Late glacial epoch.

Are the rock glaciers oriented to the north lower than those oriented to the south ?

Looking on the large range of altitude where the relict rock glaciers have been found, it could be expected that they were not all formed synchronously (several generations) as it has been recognized at least in some regions outside of the main alpine range (but I agree perhaps only published in a grey literature or not published at all). Depending on the orientation there is up to 600 m elevation difference between rock glaciers. According to the rough assumption of a temperature gradient of $-0.5^{\circ}\text{C}/100\text{ m}$, this means up to 3.0°C difference. Are all rock glaciers taking part to the same generation ? This has to be analyzed and discussed.

The introduction should more focus on relict rock glaciers and on elements (e.g. position regarding glacierized areas, generation time) useful for the final discussion. The occurrence of various generations of rock glaciers has to be presented. Are relict glaciers from the LGM known ? from which periods of the Late Glacial ? Only the uppermost generation of relict rock glaciers in the Alps has become relict between the end of the Late Glacier and the beginning of the Holocene. The authors are also sometimes confusing permafrost with ice or rock glacier.

Technical corrections :

The paper contains numerous inaccuracies. I provide here my specific questions for the first pages as example. I did not continue the job for the next pages but many further questions are there pendant.

p.2

I.3 Do the authors really want to talk about "...aerial laser scanning..." enabling "... spatial distribution studies of glaciers..." or do they want to mean rock glaciers ?

C3

I.5 The sentence is not correctly formulated. Prefer something like "Permafrost describes ... and related landforms in mountainous regions can be recognized in a continuum of features from rock glacier complexes to single-ridge protalus ramparts".

The concept of permafrost creep should also be introduced to explain the occurrence of such features.

I.7-9 Do the authors mean that "the other previous theories... describing the possible origins of such features..." are wrong ? The statement is not clear.

How is it possible to distinguish between a relict rock glacier and deposits of a former glacier tongue heavily covered by debris ? How did the authors managed this important point ?

I.8 "... tongue glaciers " or glacier tongue(s) ?

I.9 Rock glaciers are not resembling small glaciers

I.10 Prefer "... and usually a length greater than their width"

I.10 Rock glaciers are existing anywhere so far the slope inclination is permitting the accumulation of debris and mostly not on "the valley floor" (by the way, what is exactly a valley floor?)

I.11 Prefer "single arcuate frontal ridge"

I.11 Are the authors meaning that a protalus rampart front (very steep, $40-45^{\circ}$) is steeper than a rock glacier front (steep) ? Is there any reference for that ? Is the distinction still valid for relict landforms as well ?

I.13-14 Remove "under the definition of permafrost". It does not mean anything.

I.16 "To distinguish it..." - does "it" mean a pronival rampart ?

"... from permafrost creep..." - permafrost creep is a process and cannot be distinguished from a landform.

C4

I.17 Prefer "... in regional permafrost-related landform inventories" (instead of permafrost inventories)

I.19 Prefer "... intact, when they contain significant amount of ice" (instead of permafrost)

I.20 Prefer "... active, when they contain enough ice at depth (instead of enough permafrost or ice) to enable its movement

I.25 Prefer "... and finer grains at depth" (instead of at the bottom) because coarse blocks and voids have also be found at the bottom of a rock glacier (see for instance the borehole data from the Murtèl and Muragl rock glaciers in the Swiss Alps in 1987 (Haeberli, Vonder Mühl, ...) and 1999 (Arenson). And by the way what is to be considered as the bottom of a rock glacier ? The contact with the bedrock or with former existing sediment over which the rock glacier is moving ? The depth of the main shear horizon ?

I.26 Prefer "Inactive rock glaciers still contain ice (instead of small patches of permafrost or ice), but the friction at the depth where a shear horizon could develop has become too large to enable movement".

I. 29 and ff. Vegetation cover depends of the coarseness of the ground surface and is climatically controlled. What is "true" in certain parts of the Alps could be no more valid in other parts of the Alps and obviously in other mountain regions over the Earth. All provided references are describing vegetation cover on rock glaciers in the neighboring Austrian, Swiss and Italian Alps. This has to be mentioned.

p.3

I.1 That 75% of the rock glaciers in the European Alps are becoming relict is a wrong statement. 75% of inventoried rock glaciers in the European Alps are relict, they are not becoming relict. The fossilization of a rock glacier is a long term process. Most relict rock glaciers have become so during the late glacial epoch or in the early Holocene.

C5

This has nothing to do with the current climate evolution.

I.2-3 That intact rock glaciers are mainly exposed to the north, while relict rock glaciers are exposed to the south is again a wrong statement. That more intact rock glaciers are exposed to the north is to be expected due to their lower elevation (if the mountain elevation is not enough high, favourable topographical conditions could be lacking in the same time on south exposures). But there is no reason for relict rock glaciers to be more numerous on southern expositions, except due to some specific local/regional setting (geological structure, glacier extension).

I. 4 That intact rock glaciers are believed to have been formed about 3100 years ago is an inadequate statement, which is based on one of the given references and wrongly generalized to all intact rock glaciers.

...

Figure 2b : this protalus rampart is deriving from a moraine (or a rock glacier) or overrode by it. Is it really a protalus rampart, namely a landform issued from a talus ?

...

p.13, I.17-20. This kind of sentence is incomprehensible (they others along the manuscript): "As limestone and dolomite are both known to be favourable types of rocks with respect to rock glacier formation the spatial distribution of Slovenian rock glaciers and protalus ramparts is primarily correlated to the glacier and periglacial extent in the Alpine Late Glacial, as the majority of Slovenian rock glaciers can be regarded as relict landforms" ! I do not understand at all what the authors are meaning

p.13, I.20-22. That the majority of rock glaciers and protalus is oriented towards the south is not a criterion to affirm that they are relict landform.

p.13, I.23, I.26. "... support the assumption. . ." (not a theory)

...

C6

