EGUsphere, referee comment RC3
https://doi.org/10.5194/egusphere-2022-153-RC3, 2022

Comment on egusphere-2022-153

Georges Boudon (Referee)

Referee comment on "How volcanic stratigraphy constrains headscarp collapse scenarios: the Samperre cliff case study (Martinique island, Lesser Antilles)" by Marc Peruzzetto et al., EGUsphere, https://doi.org/10.5194/egusphere-2022-153-RC3, 2022

Review of the article egusphere-2022-153:

How 3d volcanic stratigraphy constrains headscarp collapsescenrios : the Samperre Cliff case study (Martinique Island, Lesser Antilles)

by Marc Peruzzetto, Yoann Legendre, Aude Nachbaur, Thomas J.B. Dewez, Yannick Thiery, Clara Levy and Benoit Vittecoq

This article present how remote observations can be used to estimate the surface envelope of an unstable mass on a volcanic cliff. The case of the Sampere cliff on Montagne Pelée that show in the last decades a succession of detabilization was chosen.

The methodology is interesting to delimit an unstable zone in the absence of access to geological data on the ground.

The article is well written and well illustrated. The abstract and introduction present clearly the subject. There are a few typos. I encourage the authors to have a detailed re-reading of the manuscript.

I am not very competent to discuss the methodology used, based on the acquisition of photos and ortho photos, DEM... their compilation and modelling to estimate the geometry of the unstable area and the volume, but I can propose a number of criticisms on the geological data. But It seems to me, however, that the reconstruction and interpretations given are a little speculative and deserve to be a little more substantiated.

The nature of most of the deposits can be confirmed on the field. In the geological reconstruction of the different parts of the cliff, although access is difficult, I think that a study of the collapsed products at the foot of the cliff (while remaining in complete safety), or in the lower parts of the valley would help to better constrain the geological characterisation of the different formations that constitute the cliff. From what I know, I can note that a part of the collapsed products are made up of scoriaceous (low silica andesitic) products belonging to eruptions produced between 36 and 25 ka and corresponding to pyroclastic density currents (formerly called scoriaceous pyroclastic flows or locally St. Vincent type pyroclastic flows because they are comparable to those produced by the historical eruptions of the Soufrière of the island of St. Vincent in the southern part of the Antilles arc). These products are topped by pumice fallout from the Plinian eruptions that have been occurring for 25 ka and probably few fine deposits from lava dome collapses (more abundant in this period). I am a bit surprised by the presence of a lava flow in the upper part of the cliff (lines 187-190) for 2 reasons: i) in the past 36ka period of activity, few if any lava flows were emitted and in no case in this part of the volcano; ii) a lava flow, even if altered, would maintain a certain stability to the cliff and would form large blocks of lava when it collapsed, which are not found in any case in the collapsed products. Some pyroclastic density currents are welded on Montagne Pelée. It is for example the case of a pyroclastic density curents observed in a quarry near Ajoupa Bouillon on the southern flanc of the volcano. These deposits form prisms visible in this quarry. It is also the case of the « dalle soudée » located on the southern flanc of Etang Sec Crater. These deposits result from explosive eruptions that occurred in the last 25 000 years. The authors give the example of the lava flow of Morne Macouba dated at 12 ka. But this lava flow in not really a lava flow but a lava dome built on a slope that give a lava flow (it is a dome flow). No lava dome were produced in the last 25 000 years in this area. If it is really a lava flow, it indicated that all the deposits below belong to the period of activity 127-36 ka.

Independently of this lava flow it is also probable that the deposits in the lower part of the cliff belong to this old period of activity1(27-36 ka) for example the unit LPd that is more resistant that the upper deposits attested also by the numerous cliffs observed on the southern flank of the volcano as for example the Tombeau des Caraïbes. It is what you propose in the article.

It is quite possible that the Co surface could correspond to the floor of the flank-collapse structure formed 127 ka ago. This surface is a discontinuity that can correspond to a ‘’couche savon’’ following the circulation of fluids and favors the instability of the deposits above. But the second phase of the volcano construction (127-36ka) is mainly made up of deposits of ash and blocks pyroclastic density currents associated with collapsed lava domes. These formations in the western part of the volcano are relatively indurated and have been cut by numerous radial valleys forming resistant cliffs that are not very prone to collapse (e.g. Tombeau des Caraïbes). It is therefore likely that the Sampere Valley cliffs correspond to a paleo-valley filled with post 36 ka products, which are less indurated and more prone to collapse.

In the discussion (lines 280-285), you state that it is not possible to characterise the geotechnical properties of the different units on the cliff because it is too dangerous which I understand. On the other hand, if you clearly identify the different units (as you have done for one part and can refine with my proposals), it is possible to acquire these data on deposits of these different units in other parts of Mount Pelee. I can, if you wish, indicate perfectly accessible sites. These data would be very useful to support your hypotheses.

Lines 289-290: I am not sure that hydrothermal alteration at Co and the floor of the 127 ka flank-collapse structure stops after destabilisation. Instead, these discontinuities are zones of fluid flow (hot and cold), which continues the alteration and serves as a favorable « couche savon » for instabilities of the deposits above.

Lines 298-299. I am not sure that all these deposits are welded by high temperature just after emplacement but probably indurated by compaction, diagnetical cementing…

5.2 : cliff destbabilizations… :It is obvious that a significant contrast exists between the lower formations (Co Lpd) and the upper formations (Upd) in terms of compaction, permeability, stability... Deposits from the post 36 ka eruptions fill many valleys on the western flank of Montagne Pelée cut into the Lpd formations and yet this type of destabilisation is not observed. We must therefore look for another explanation, such as a very steep contact between the two which could explain these destabilisations. As mentioned earlier, geophysical, electric, electromagnetic data (e.g. electrical soundings, such as those done at the Soufrière in Guadeloupe) could be collected in other Pelee valleys where this sequence of deposits is present

5.3. Volume estimation : There are a number of unknowns about the geometry of the various contacts which leaves the estimation of volumes very approximate, but it does give a rough idea of the volumes that could destabilise. As a result, the scenarios remain highly speculative.

The approach of the article is interesting, the methodology as well, but a number of improvements are necessary in the identification of the depositional sequences but also in the improvement of the geometry of the different units which in my opinion can only be done by the acquisition of geophysical and geotechnical data on other valleys of the Montagne Pelée that can serve as an analogue to the Sampère cliff. Otherwise the results remain very speculative.

I therefore consider that the approach is interesting, that this type of data is necessary, but that the article can only be published after significant modifications.

Georges Boudon