Comments Mike Heap:

Prior to acceptance in Solid Earth Discussions, I asked the corresponding author to change the references in accordance to the Solid Earth format. I see that this was not done. This should be changed.

- Done

2. The paper is littered with small English mistakes. I find this surprising since I know at least two of the co-authors are native English speakers. I have corrected some of the grammatical errors in my comments below.

- Done

Line 26: "As a consequence of this: : :"

- Done

Line 29: After "infrared" I would add "temperature" in parentheses.

- Not necessary since it is made clear in line 32

Line 33: I would be more specific with "larger events". Are you talking about rockfalls or eruptions?

- *"Rockfalls"*; done

Line 37: I prefer "newly-exposed lava dome" to "newly formed cliff".

- Done

Line 38: I would mention that it is only a proxy for the seismic energy.

- Done

Line 52: Do you mean 3850 m? Or 3.850 m?

- Done. *"3,850m."*

Lines 66-74: This paragraph explains that other lava domes around the world are also cyclic. Is this needed? Can it not be summarised in a sentence? The introduction consistently refers, in great detail, to other volcanoes. I would focus it a little better.

- Done: *"Many other lava domes have shown similar behaviour to Volcán de Colima: Soufrière Hills on Montserrat, West Indies (Loughlin et al., 2010; Ryan et al., 2010); Mount St. Helens, USA (Smith et al., 2011); Santiaguito dome, Guatemala (Rose & Pattern, 1972); Mount Unzen, Japan and Shiveluch, Kamtchatka (Barmin et al., 2002)."*

Line 87: "Varley et al. (2010) studied the events that occurred between February and September 2005 in detail: : :"

- Done

Line 99: A recent paper in Solid Earth showed that rocks from Volcán de Colima can quickly regain their permeability following an explosive event. This should be cited here. Kolzenburg, S., M.J. Heap, Y. Lavallée, J.K. Russell, P.G. Meredith, and D.B. Dingwell, 2012.Strength and permeability recovery of tuffisite-bearing andesite. Solid Earth, 3, 191–198.

- Done

Line 102: "occurs when magma intrudes into: : :"

- Done

Line 111: I dislike the word “done” in a scientific paper. There are many instances of this. I would prefer “performed”, “undertaken”, “implemented”: : :anything but “done”.

- Done; *“carried out”*

Line 121: Remove “itself”.

- Done

Line 125: “The dome category can be classified as between: : :”

- Done

Line 127: Change “what” to “that”.

- Done

Line 132: “Lose” not “loose”.

- Done

Line 133: “Obviously one can trigger the other.”

- Done

Line 133: Change “at” to “which”.

- Done

Line 136: Change “slowly growing” to “slow-growing”.

- Done

Line 137: I would remove “Larger volumina or if larger portions: : :” and replace with “If larger volumes: : :”

- Done

Line 139: I was under the impression that a BAF is a type of pyroclastic flow. This sentence implies that this may not be the case. I would be more specific here.

- The structure has been improved. We changed to the following: *“Small volume collapse or collapse from slow-growing domes will most commonly lead to rockfall events. If larger volumes from a faster growing dome are affected, pyroclastic density currents may be generated. In this case a continuum between rockfalls and density currents would be observed. Generally speaking, the transport properties may change as a response to the morphology along the path. The deposition of coarse material and/or entrainment of ambient air will significantly increase the mobility of the density current.”*

Line 139: “Speaking”, not “spoken”.

- Done

Line 143: Change “this” with “it”.

- Done

Line 145: This is a bold statement. Is there not a reference for this?

- We think this is really obvious and has already been stated. However, we have rewritten this sentence: *“The effusion rate is a critical parameter for determining the style of activity and hence the hazards associated with an erupting volcano.”*

Line 153-161: This is another large paragraph describing monitoring at a different volcano. While I think that such discussion is important, perhaps not in so much detail.
This paragraph begs the question "Can this system work at Colima?" Are the resources in place for this?

- Paragraph has been shortened and re-written. It is important to know that continuous dome monitoring is crucial for assessment of the volcano's activity status. As this paper shows, monitoring at Volcán de Colima is carried out: *"For this reason, continuous monitoring of dome activity at active volcanoes such as Volcán de Colima is crucial; it provides important information for hazard mitigation as can be seen at other active volcanoes such as Merapi, Indonesia (Hort et al., 2006)."*

Line 164: Can you be more specific about what "cigar-shaped" means? What is cigarshaped exactly?

- Done: *"Signals were generally symmetric with a slowly increasing amplitude to a peak near the middle of the event, then a similar slow decrease again."*

Line 167: By "centred" do you mean "average"?

- Yes, sentence has been rephrased: *"Their duration varied between 50 s and more than 200 s with an average peak frequency of 5 Hz."*

Line 168: Change "distant" to "from".

- Done

Line 170: More detailed discussion describing monitoring at another volcano. I think this type of discussion should be set in the context of Colima. Can this also be performed at Colima? If not, why not? I feel that the introduction would benefit from a bit of an overhaul. It lacks focus.

- Passage l. 159 – 172 has been overhauled.

Line 176: It might be useful to mention that these are in North America.

- Has been removed

Line 180: Another instance of "done". Also, do you mean "authors", not "others"?

- Done. *"Performed"* instead of *"done"*. No, we mean *"others"*

Line 192: Another instance of "done".

- Done. Changed to *"has been undertaken"*

Line 200: Change "larger" to "higher".

- Done

Line 205: Change "being" to "was".

- Done

Line 217: You have a paragraph in the previous section that starts with "Several studies have recently investigated the characteristics of seismicity generated by rockfalls." I'm confused as to the organisation of the introduction. Why not group this together?

- Was not grouped together with the previous paragraph as we wanted to have it in this one. However, it has been rewritten and shortened.

Line 218: Another instance of "done". Also, I would add ": : :at Volcán de Colima" to the end of this sentence.

- Sentence has been deleted

Line 219: Hang on. The first sentence says ": : :limited work on rockfall seismicity has been done". The second sentence says ": : :Much of the previous work deals mainly with the seismic analysis of rockfall or block and ash flow events". For me, this is an oxymoron. Later you add "Rockfalls at Volcán de Colima can be readily identified by their seismic signal". Do we know? Or don't we know?

- Whole paragraph has been re-written.

Line 222: ": : :frequency of rockfalls" can also mean their number. Can you reword this to be more specific please?

- Done; changed to: *"…on the analysis of the number of rockfall events…"*

Line 224: Why?

- Done; *"A detailed seismic analysis of rockfall signals at Volcán de Colima has not been included in this paper since it was not necessary for the purpose of our study."* Not sure what else we can add.

Line 241: Change "is using" to "uses".

- Done

Line 251: Between 1 and 15 what?

- Done; Hz

Line 253: No need for a capital "V" in volcano.

- Done

Line 271: What percentage of the total number of rockfalls does this represent? If I look at Figure 10 I see that there were about 12000 rockfall events at Volcán de Colima between that time. I think it would be useful to mention this here. And perhaps include
Figure 10 a little earlier in the paper. You should also comment on whether 86 out of 12000 rockfall events is an appropriate number to sample. How were these 86 chosen exactly?

- We re-arranged this paragraph and made it clear that the 86 rockfall events we used are just from those 8 field days we had in 2011. The 12,000 rockfalls in Fig. 10 however are from the whole year of 2010. But we mention this later in the text.
- The 86 rockfalls were used to develop a methodology that allows us to estimate the volume of a rockfall event. This methodology has then been applied on the 12,000 rockfalls in 2010. We therefore see no reason to bring Fig. 10 earlier.
- Re-arranged paragraph: *"A field campaign at Volcán de Colima was conducted on 8 field days during March and April 2011 with 86 rockfall events monitored which represents about 7% of the total number of rockfalls in the mentioned period. Observations were made from a base about 2.3 km from the volcano to the west, within the Playón, the relatively flat floor of a collapse caldera (Fig. 1, 2)."*

Line 276: Before and after what? The rockfall event? Be specific.

- Before and after rockfall events; *"The volume of individual rockfall events was estimated through a comparison of sets of high-resolution photos of the dome before and after rockfall events (Fig. 3)."*

Line 284: How were they "digitally sharpened"?

- Using open source software paintnet; *"The raw photos were digitally sharpened by using the open-source software paintnet, which allowed blocks larger than 20 cm to be easily recognized and defined."*

Lines 293-294: What are the errors on "2300 m" and "1050 m"? What impact does this have on the volume estimate? Doesn't this also assume that all the rocks are in exactly the same place on the volcano?

- We recalculated distances. They are now set to 2,225 ± 10 m and 1,020 ± 10 m respectively. An error of ± 10 m for both values will affect the final rock volume by less than 0.4% and will be included in our final error calculation. Yes, we are assuming that all rocks are in exactly the same positions. Changing both distances from 2,300 m and 1,050 m to 2,225m and 1,020 m meant we had to do a recalculation. Due to this causing only minimum change to rockfall volumes (< 0.6%), our final magma extrusion rate results were not affected.
- Paragraph has been changed to: *"The horizontal distance between observer and dome was 2,225 ± 10 m; the vertical distance was 1,020 ± 10 m. Errors of ± 10 m affect the final result of the rock volume in question by less than 0.4% and will be consideredin our final error estimation."*

Line 299: Remove "itself".

- Done

Line 301: Change "supposed to be" to "approximated to".

- Done

Line 301: Change "show" to "share".

- Done

Line 304: How exactly is "h" measured? How accurate is this?

- Done: *"Figure 4a) shows the geometry; l is the real length of the rock, whilst the apparent length h is measured directly from the photographs (with an average error of 25%, see discussion)."*

Line 307: Sigma is usually used to denote stress. I would use something else.

- Done, changed to epsilon

Line 307: Please comment as to the extent that beta and delta are approximately equal. "a" and "b" are not parallel. So, the bigger the rock, the larger the error.

- Done: *"Lines a and b (Fig. 4, b)) are assumed to be parallel for our calculations, however the deviation from being parallel will increase with rock size resulting in an error term proportional to size (see discussion for error calculation);"*

Line 309: Helicopter flights are required to assess the geometry of the blocks? This is not such a cheap method. Since the method is very approximate, is there not an easier solution? What are the errors if you assume they are spheres? Or cubes?

- We were using photos that have been taken during previous flights. The analysis has now been carried out and no further flights are required. Anyway, we had the flight data, so why not use it? Furthermore, at an earlier stage, we had an empirical correlation of rock axes with Newtons' gravitational laws included in this paper; as the method of evaluating flight pictures worked fine for us, we didn't see a point of including it any further.
- However we slightly changed the sentence to: *"Analysis of photos taken during previous flights has been carried out and no more flights are required."*

Lines 287-323: I would actually remove the geometrical method to find the real length of the rock. I'm unconvinced that it's more accurate, given the assumptions and errors, than just measuring the length of the rocks from the photographs. The key point here is the average geometry of the blocks. It would be interesting to see a table with the volume estimates using your 1:2:3 geometry, a sphere, and a cube.

- We would argue against the need of doing this. We are convinced that our method is not less accurate than just assuming the rocks are spheres or cubes. Using spheres or cubes will generate large errors as well.

Line 328: Do you mean 28000 m2? Or 28 m2?

- Done; 28,000 m^3

Line 329: The resolution is 20.25 m2? Your photographs can identify rocks that are 20 cm in diameter. Will you not miss most of the smaller rockfall activity if you use the thermal camera?

- The thermal cam was not used to identify rockfalls, we knew the exact time of their occurrence because of our field campaign. Due to this, we were able to measure temperature differences at the cut off area. Some small rockfalls however show delta T values of 0 degrees. This is of course due to the low resolution of the camera. We however do not base our final rockfall volume and magma ascent rate calculations on the thermal measurements.

Line 342: Hang on. ": : :in the case of very small rockfalls (volume of only a few cubic meters) it was not always possible: : :" The resolution on your thermal images is 20.25 m2, I would suspect that it's difficult to identify a rock smaller than 100 m in diameter.

- Yes, it is difficult to identify single rocks on thermal images. However we did NOTuse thermal images to look at rocks, we looked at the cut off area at the dome. The lower threshold of identifying a delta T was above 1 m^3. We could not identify rock masses that small within the thermal images. But we knew the position on the dome where the rockfalls occurred and analysed the appropriatepixel(s) with Irbis (thermal image analysis software). We had two rockfalls of a very small size (1-2 m^3) generating a delta T of 1^0C and 2^0C. Significantly larger delta Ts were then reached at a lower rockfall volume threshold of 6 m^3. (delta T > 10^0C)

Line 349: Remove "in the end".

- Done

Lines 359-363: I read through this text and looked at the pictures numerous times, and I still can't figure out what's going on. Firstly, are you sure that you're following the correct rock? The rock in C1 is at 106 _C. As it rolls down the slope (since there is no time difference between the pictures we will have to take your word that it is "during" the rockfall event) it is now 402 _C (even though this temperature does not appear on the scale). How did it get hotter? Following the rockfall event the temperature in C1 is now 305 _C. However, could this not be the very hot rock next to C1 in panel "b"? Perhaps this is the one that fell? Panel "c", for me, shows that the rock broke into many pieces during its descent. However, there is no discussion of this in the paper. Did you observe the rocks breaking? How would this impact your volume estimates? In conclusion, I'm not convinced of the worth of the thermal imagery. First, this is a specialist tool. Second, the resolution isn't as high as the photography. Third, it seems difficult to be sure what's going on (unless you have corresponding photographs). Further, in Figures 5 and 6 you have temperature data for suspiciously low volume rocks. How accurate is this?

- Answer: In C1, the focus is not on a rock but on the area of the dome where rockfalls are generated. Hence, the temperature of 106°C is the average dome surface temperature in this area. Temperatures of rockmasses in b) CII are that high as hot material from the dome interior is now exposed in these rockmasses. In c) CI, temperature is that high as material from the dome interior is now exposed to air. Dome interior has changed to become dome surface.
- Yes, rocks usually always broke up into many pieces during their descent. This should not have any effect on our volume calculations, as these are based on photographs taken before each event.

- The smaller the rockfall volume becomes, the less accurate is the relation to temperature difference. For large rockfalls, there seems to be a linear correlation between temperature and rockfall volume, however, this is not the case for small events.
- The thermal data is an extra element to compare; the ONLY method for rockfall volume estimation being considered is the calibration of the seismicity using the photographs.
- See also our abstract: *"[…] It was therefore possible to calibrate the seismic signals using the volumes estimated from photographs, and the count of rockfalls over a certain period was used to estimate the magma extrusion flux for the period investigated. […]"*

Lines 375-380: Please discuss this method in more detail. This energy is the energy of the received waveform and assumes that attenuation is equal for each event (big ones, small ones, near ones, far ones).

- Paragraph has been re-arranged;
- *"The seismic investigation of rockfalls, however, brought an additional challenge: the fact that some rockfalls occur together with small eruptive events, leading to the superposition of the rockfall and eruption signals. 15 out of the 23 events with their volume estimated using photographs, however, did not coincide with an eruption, allowing straightforward analysis of the seismic signal.*
  Because rockfall signals are complex, it is not possible to calculate precisely the corresponding energy release. Thus we used the integral of the associated signal squared, – or the sum of the squares of the samples multiplied by the sampling interval, as a proxy of the energy release. Analysis and calculations were carried out with the Matlab package Seismo_volcanalysis (Lesage, 2009). Fig. 8 shows a typical seismic rockfall signal of Volcán de Colima together with its spectrogram."

Line 389: So, the bigger the rock, the larger the temperature difference between the external surface and the surface in contact with the dome? Nowhere is this simple relationship described. Does it make sense?

- Done. Yes; "*This result implies a relationship between the rockfall size and either the area exposed of the hot dome interior, or the depth into the dome uncovered, where higher temperatures would be expected. Due to the large pixel size it is impossible to determine which of the two possibilities explains the temperature rise, but it would have been dependent upon the geometry of the displaced rocks."*

Line 426: Why March?

- This is the month with most field data collected. Line has been added in paper: "*In the second method, individual seismic energies E' were estimated for March 2011 events, during which most field data was obtained."*

Line 428: I would describe this as a "proxy for the energy of the received signal".

- Done: *"After analysing and comparing the results of the two methods, it appears that the estimated proxy for the energy of the signal E' is much more accurate."*

Line 441: "20 C".

- Done

Line 448: Change "can" to "could".

- Done

Line 459: I thought this was the discussion. I think this section on extrusion rate should form the first subsection of the discussion section.

- We wanted to show this in this chapter as it is about magma extrusion rate; for this reason we briefly want to show and explain our results

Line 472: I would reword the start of this sentence.

- Done: *"Plotting volume versus duration produces a R^2 value of 0.8; for this analysis, nine days of observation in March 2011 were used."*

Line 474: What is "D"? The duration?

- Yes, see text: *"As a result of applying Eqn. 4, we get Eqn. 5 which allows the constraint of the volume of eruption related rockfalls using their duration D:"*

Lines 480-481: "21,000 m3", 20.000 m3". I assume the authors mean "20 000 m3". Can this be corrected?

- Done

Line 487: I can't see how this method is more accurate. Can the authors elaborate?

- Not believe to be necessary. The text should now clarify that it is clearly more accurate to apply the methodology to the seismic raw data rather than to divide into 3 groups.

Line 494: Can you add a sentence describing whether this small subset of the total number of rockfall events is representative?

- Done: *"Of 86 rockfalls recorded visually, 23 were suitable for volume estimates. This can be regarded as representative for several reasons: the full range of rockfall sizes is covered (between 1 $m^3$and almost 200 m^3); rockfall numbers correspond to between 20% and 60% of the entire day count during the 12 field days, carried out during a phase of high rockfall activity. Data was then used for comparison with other measured parameters."*

Line 502: You mean 1 mm on the picture?

- Yes; *"For our calculations, we assumed an error of 3° for the slope angle, 1 mm on the before rockfall pictures (20 cm true length) for the length of individual rock axes (in the zoomed photograph) and taking into account that rocks are usually not all parallelepiped."*

Line 517: How exactly was 35% calculated?

- We did several calculations and numerical simulations and assumed following errors:
  - Error of 1mm when measuring rock lengths on photographs affects rockfall volume by 25%
  - Error in dome slope angle of ± 3° affects rockfall volume by 12%
  - Error in horizontal and vertical distances between Playón and dome affects rockfall volume by 0.4%
  - Error of assuming rocks being cuboids affects the rockfall volume by 13%
  - Error arising by the minimum detectable rocksize (< 20 cm axis length) affects rockfall volume by 3%
  - Error in the proxy estimation of seismic energy could affect the volume by another 16%
- → final error: $\sqrt{25\text{^}2 + 12\text{^}2 + 0.4\text{^}2 + 13\text{^}2 + 3\text{^}2 + 16\text{^}2} = 35$
- → final error: 35%
- We added a line: *"After consideration of all possible error sources, a maximum possible relative error of 35% in the magma extrusion rate has been determined by calculation of the root mean square of combined relative errors."*

Line 526: What estimate did Lavallée et al. (2012) provide?

- 0.02 m^3s^{-1}

Line 531: The authors should comment on whether this method can be applied to other volcanoes worldwide.

- Done, *"With similar conditions, that is the possibility of close-up rockfall observation, and a suitably closely located seismic station, the methodology presented here should be adaptedto other volcanoes."*

Line 566: I feel that the end of the discussion requires a sentence akin to "While we appreciate these obvious flaws, we contend that our practical and simple method provides a reliable approximation for the magma extrusion rate at volcanoes that continuously shed their lava dome through rockfall: : :"

- Done: " *[...] While we appreciate these obvious flaws, we contend that our practical and simple method provides a reliable approximation for the magma extrusion rate at volcanoes that continuously shed their lava dome through rockfall activities."*

Figure 6: By "Cut Off Temperature" do you mean delta T?

- Yes; caption has been changed to: *"Relationship of rockfall volume and temperature difference ΔT measured at the area of origin; R^2 is 0.88."*

Figure 8: What is the scale on the y-axis of "a"? Amplitude?

- Yes, Figure has been corrected

Figure 11: Remove the commas in the y-axis. And in the figure caption.

- Done

Figure 12: The energy proxy is now called "Es". And the units are different. Remove the commas in the y-axis

- Done

Comments Silvio de Angelis

1. How have seismic data been analysed? It would be nice if details of seismic data processing were provided in one place. For instance, what type of filtering is applied to the data and why. Why seismic units are "seismic network counts" rather than m, m/s, or m/s**2? This is trivial data processing but it would help comparison with other volcanoes.

- No extensive seismic analysis has been carried out as it was not necessary for the purpose of this paper. Before seismic raw data was processed with the Seismo_volcanalysis toolbox as described in the paper, data was filtered with a highpass filter to remove oceanic noise. Lower corner frequency was set to 1 Hz.
- Conversion from counts to m/s has been carried out, Eq. 4 has been changed respectively
- Line has been added: *"With V in m^3 and E' calculated from seismic velocity (in ms^{-1}). This analysis was only possible for rockfalls without simultaneous eruptive or ash-venting events. A range of E' from 0.007– 0.6 was obtained for rockfalls analysed in this study."*

2. The issue of saturation of the seismic signal (short-period, 16-bit stations) for larger events should be discussed as most of the methods discussed in this paper could not be applied if seismic signals become "clipped".

- None of the rockfall signals of the seismic raw data has been saturated, not even for the largest rockfall events.

3. Was any attempt made to calibrate the seismic energy based methods using different seismic stations? This would be a nice addendum to the paper, and relatively quick to perform. It would be interesting if it could be verified that relations similar to those found for EZV4 hold true at other stations. Calibrating the method for use with other seismic stations is crucial as the authors propose the technique as a monitoring tool. It would be appropriate, before stating the good potential of the technique as a monitoring tool, to assess such potential in all respects.
Please, be aware that calibrating the method for other seismic stations requires:
- Considering site amplification (e.g. using spectral ratio of coda of regional earthquakes)
- Considering path effects (distance/frequency dependent signal attenuation)

- No attempts have yet been made. In the interests of length it was decided to limit the seismic analysis for this paper. It is being considered for a future paper.

4. It would be nice to see one of the signals that have are not used because coincident with explosive events. Is there anything that can be done to "deconstruct" these waveforms to separate the explosion part (likely a VLP signal) from the mass wasting phenomena (likely in the 3-9 Hz band)?

- Again, this would be in a future paper.

Why does the frequency domain representation of the seismic signal allow precise determination of the rockfall duration? Rockfalls are pretty obvious in the time domain too, and they some of the easiest signals to identify from visual inspection.

- we used frequency domain only for signals that were superimposed by eruption signals

Some of the references in the text are not exact. E.G. Ryan, 2010 should be Ryan et al., 2010. There are a few others in the text. Please, revise and fix.

- Done

- Abstract. Remove the bit about hazard management. Not really relevant here. The results in this paper do not provide an actual, immediate, tool for immediate hazard assessment and (risk) management.

- Done

- page 4, lines 18-19. Is this relevant to the paper?

- No, has been rephrased: *"This represented the most intense period of activity since the 1913 Plinian eruption."*

page 4, line 23. What are small aspect ratio bodies? Wide and relatively flat? Explain further.

- Has been rephrased: *"At high viscosities, the erupted magma tends to remain close to the vent rather than forming lava flows, leading to relatively tall extrusions. The shape of a dome is controlled by the interplay of ascent rate (affecting the cooling history and thereby the viscosity) and magma properties (composition, bubble and crystal content, each affecting the rheological properties)."*

- page 5, lines 28-29. Rephrase. The word "dome" used 5 times in the same sentence.

- Done

page 6, line 6. The equations cited do not seem to exist.

- Corrected. They did not exist, was an error.

- page 12, line 2. Give details of sharpening and/or other digital imaging processing procedure. This seems necessary as the authors state that sharpening allows resolving details down to 20 cm ("blocks larger than 20 cm"). From the text seems that sharpening is necessary. If this is the case, it should be explained how it was performed.

- Sharpening allowed us a more precise evaluation of our image data. We used the open source software paintnet.
- Sentence has been rephrased: *"The raw photos were digitally sharpened by using the open-source software paintnet, which allowed blocks larger than 20 cm to be easily recognized and defined."*

Comments anonymous referee #1

There is no mention of the effect of weather on rockfall activity. It is intuitive that the stability of the dome will be influenced by very heavy rain and observations support this at Montserrat. I don't think this need affect the validity of this work but it would be interesting if the authors addressed the issue. Was any weather data collected? Was there anecdotal evidence of increased rockfall numbers during tropical storms? Should rockfall numbers from these times be excluded from statistics or is the assumption that they would have happened anyway over the next few days?

- There is weather data collected at Colima. Rain will certainly affect stability of the dome and influence rockfall events. This might result in the rockfall occurring earlier in time but since there was active effusion an increase in the number and magnitude of events is unlikely for this region of the dome. Of course phreatic activity is generally more likely during the rainy season and could largely affect rockfall frequency and intensity; however, Volcán de Colima shows no evidence of having a hydrothermal system and the edifice is generally well-drained.
- We added some lines: *"Also severe weather conditions such as intense rainfall can influence gravitational stability of a dome. Rainwater can infiltrate cracks and build up pressure by vaporization (e.g. Taron et al., 2007). This might result in the rockfall occurring earlier in time but since there was active effusion at Volcán de Colima, an increase in the total volume of material involved in rockfalls is unlikely. We cannot rule out a variation in the magnitude-frequency distribution of rockfall events, but this should not affect effusion rate estimates."*

In section 5.3 it would be interesting to discuss the possibility of using the rockfall signals that coincide with eruptive events. This would increase the number of usable events and might be possible using a filter if the seismicity associated with the eruptive behaviour is long period, as suggested on page 18. If all the rockfall signals were filtered similarly then the ratio found between E' and V may well be preserved. If not it would be interesting to know. This would be a better method than the duration relation, if it worked.

- Yes, there certainly is the scope for further seismic analysis but in the interests of length, this will be considered for a future paper

In section 5.3 or elsewhere the problem of saturation should be explicitly discussed.
Energy estimations are going to be next to useless for the most significant events if these become large. Perhaps could use the nearest broadband instrument or install better telemetry at EZV4? The dependence upon a single station could also be a problem if this is proposed as a monitoring tool. Could briefly mention the possibility of calibrating other stations retrospectively using data from EZV4 if this station was down.

- None of the rockfall signals of the seismic raw data has been saturated, not even the largest rockfall events.

Equation numbers are not correct. Equation numbers in the text have no corresponding equations while those equations shown have numbers that are not referred to anywhere.

- Done

References to Varley et al 2010 need to say whether they are to 2010a or 2010b.

- Done

Should be a reference to a paper describing the RESCO network.

- We don't think a reference is needed. However we changed the sentence to: *"For accurate rockfall monitoring at Volcán de Colima the seismic network RESCO (Red Sismológico de Colima) is sufficient."*

4:1 Rose > Rose and Pattern

- Done

4:8 Ryan > Ryan et al

- Done

4:11 Smith > Smith et al

- Done

4:23 Not sure what small aspect ratio means - perhaps better to describe shape that is meant.

- Done; has been rephrased, see comments above

5:21 no need for though

- Done

5:23 no need for itself

- Done

6:1 no be

- Done

6:10 perhaps state more clearly that there is a continuum between rockfalls and density Currents

- Done: *"Small volume collapse or collapse from slow-growing domes will most commonly lead to rockfall events. If larger volumes from a faster growing dome are affected, pyroclastic density currents may be generated. In this case a continuum between rockfalls and density currents would be observed. Generally speaking, the transport properties may change as a response to the morphology along the path. The deposition of coarse material and/or entrainment of ambient air will significantly increase the mobility of the density current."*

7:2 Hort et al 2006 not 2005

- Done

10:3 Shearer, 2009 missing

- Done

10:11 Arambula>Arumbula-Mendoza

- Done

10:22 Hutchinson et al 2013 not 2012

- Done

11:12 of > from

- Done

13:17 not sure what hr is doing there

- hr is part of the full model name of the thermal camera we used

14:27 looks from the numbers as if C1 is masked by ash from lower down but C2 isn't.

- yes, in b) C1 is masked by ash. However this does not influence our results as we didn't use this stage of the rockfall for our evaluations.
- A line was added: *"In picture b), C1 and C2 show relatively low temperatures due to the ash generation during the rockfall event which disturbs temperature recording of the thermal cam."*

Calder et al 1999 not in text Cortes et al 2010 not in text Marquez et al 1999 not in textSaucedo et al 2010 not in text

- Done

Figure 5 would be more useful if zoomed into top of dome.

- Already has a reasonable large zoom. We chose this zoom level to show the rock fall trace in c). Also, more zoom would make the picture pixelated due to low resolution of thermal cam (640x480) compared to photographs.

Figure 6 Cut off temperature should be temperature difference.

- done