RESPONSE TO RC1

Original comments of RC1 are in black below and our answers are highlighted in blue

This paper presents an analysis of the seismic activity of the Cordón Caulle volcano before and during its large eruption of 4 June, 2011. The data processing includes mainly the detection and classification of the seismic events, the hypocentre relocation using a refined velocity model, the determination of focal mechanism of the main events and the evaluation of the b-value as a function of time. Using the results of this data processing and other types of observations, a detailed chronology of the unrest and eruptive sequences, divided in 7 phases, is proposed.

The seismic activity during the unrest and pre-eruptive periods is interpreted in light of the 'top-down model' of precursory seismicity by Roman and Cashman (2018). During the eruption itself, several phases, explosive, effusive, declining and resurging, are identified and the corresponding behaviour of the seismicity is analysed.

It is important to present the seismic observations associated with such a large eruptive event. The manuscript is generally well written and clear. It will deserve publication in SE when two main issues and some minor ones are clarified.

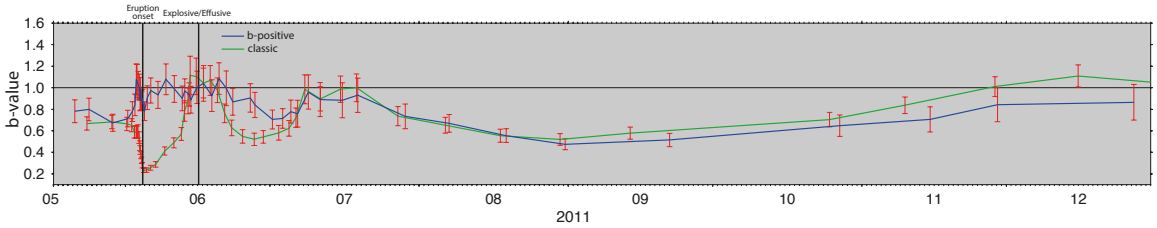
We are grateful to RC1 for his dedicated review and positive evaluation of our manuscript. Below we assess each of his comments and suggestions, most of which were implemented in the new version and greatly improved the clarity and quality of the paper.

First, a large part of the analysis and interpretation is based on the temporal variations of the b-value. According to fig. 2D, this parameter varies between 0.3 and 1.2 approximately, which is a huge interval that I've never seen in the literature. The largest variations occurred in a few days at the beginning of the eruption. In contrast with the unrest period, the eruptive phase is characterized by a strong tremor which may have modified the magnitude completeness Mc of the catalogue. This point should be discussed thoroughly. I suggest the authors to use more robust methods that are not dependent on the estimation of Mc. For example:

B-Positive: A Robust Estimator of Aftershock Magnitude Distribution in Transiently Incomplete Catalogs
van der Elst, NJ
JOURNAL OF GEOPHYSICAL RESEARCH-SOLID EARTH
Volume126, issue2, Article Numbere2020JB021027
DOI10.1029/2020JB021027
Published FEB 2021

Inverse Migration of Seismicity Quiescence During the 2019 Ridgecrest Sequence
Marsan, D ; Ross, ZE
JOURNAL OF GEOPHYSICAL RESEARCH-SOLID EARTH
Volume126, Issue3, Article Numbere2020JB020329
DOI10.1029/2020JB020329
Published MAR 2021

We greatly appreciate this comment of R1 that stimulate us to reanalyze the computation and interpretation of the b-value time series. As suggested, we implemented the b-positive method of van der Elst (2021) considering the positive magnitude differences of successive seismic events instead of their actual magnitudes. The new b-value time series replaces the old one in panel E of the new figure 3 (old Fig. 2). As seen in the figure below, both time series are generally similar in their temporal evolution, mostly after the explosive/effusive transition.



The most significant differences can be appreciated between the final unrest phase and after the eruption onset: in particular, the rapid decrease of b-value right before the eruption to unrealistic values near 0.2 is no longer visible and we think that this was an artifact caused by the increase of the magnitude of completeness Mc as the number of large earthquakes was rapidly increased. We still observe a rapid decrease of b before the eruption and then a recover to higher values but this is preceded by an increase of b at the end of the enhanced unrest phase.

We modified the description of the method for computing the b-value time series in section 3.3.3. Given the differences between both b-value time series, mostly before the eruption, we also modified the description of results along section 4.

Furthermore, the authors interpret the b-value variations as due to stress variations in the structure. However, if we use the relationship found by Scholz (2015) between b and s1-s3, we'd calculate variations of several hundreds of MPa for the deviatoric stress associated to the b-value variations obtained in the present paper. This point should be clarified and its physical implication should be discussed.

Based on the new b-value time series we now include an explicit discussion in section 5.2 and 5.3 regarding changes of differential stress using the relationship of Scholz (2015). Since temporal b-value variations are relatively smooth in our new version, estimated changes in differential stress are quite realistic between <50 to 300-400 MPa and help to understand the general shift of the system from compression before the eruption to relaxation after its onset.

Second, the authors discuss the behaviour of the harmonic tremor that appeared during the effusive phase. They refer to a previous paper of their research group (Bertin et al., 2015) which presents a very elementary analysis of particle motion of the tremor and which indicates that horizontally polarized P-waves are dominant in the wavefield. This observation is very intriguing. They conclude that the source is very shallow and due to the oscillation of volcanic layers excited by the magma flow. This conclusion and interpretation are poorly founded. The wave polarization analysis should be carried out with much more details and using several stations, following for example the approach of Haney et al. (2020). Alternative source mechanisms should be discussed

because the model of Omer (1950) can hardly account for harmonic tremor with regularly spaced spectral peaks.
We are also grateful to this comment that allows us to perform a deeper analysis of the quasi-harmonic tremor signal. We follow the method of Matsumura (1981) and performed a polarization analysis of stations PHU, QIR and ANT that complement and expand the analysis of Bertin et al. (2015). This analysis reinforces their main conclusion as to that the polarization azimuth is sub-parallel to the direction between each station and the vent. We include a new figure in the Supplementary Material showing the results of this analysis and modified the text in section 4.3.3 in accordance. We also discuss alternative source mechanisms for the tremor than Omer (1950) in section 5.3.

Third, the final unrest phase and the onset of the eruption are critical periods. I suggest to present an enlargement of fig. 2 from the end of May to beginning of June in order to present with more details the behaviour of the seismic activity and other parameters of interest.

We agree with R1 that an enlargement of the critical period right before and after the eruption onset can be beneficial for the reader. Therefore, we created a new figure 3 showing the time series for number of events per day, local magnitude, b-value and location depth for the time window may 21 to June 15.

Minor comments.
Figure 1. The labels of the main map and of the inset are mixed. Separate them and indicate that red rectangle shows limits of main map.
Done

Line 132-134. The results of the analysis of wave polarization with Matsumura's method are not presented in the paper. Show them.
We now include these results as part of the supplementary information.

Line 156. The sentence is not clear.
Done

Line 169. The magnitude of completeness may have changed during the study period. In order to convince the readers that the b-value is well defined, several Gutenberg-Richter diagrams should be displayed for large, medium or small b-values. See also first main comment.
As explained before, we now implemented the b-positive method of van der Elst (2021), which eliminates the problem of changing Mc through time, therefore we think that including GR diagrams is not necessary.

Line 334. Are the depths of 3.8-6.4 km the depths of the 2 point sources or a range of depth common of these sources?
This was confusing, so we modified the text: The source of deformation has been modeled by two deflating point sources at depths of 3.8 and 6.1 km (Jay et al., 2014, Wendt et al., 2016).

Fig 5 and other. Squares and crosses representing polarities in beach balls are not visible.

We do not agree and think that these symbols are sufficiently visible. Modifying these figures will be too much work for only a minor improvement of the visibility of these symbols, something that we would like to avoid

394. Suppress ‘during’.
Done

403. Explain your arguments.
Following your suggestion as commented before, we now include a deeper analysis of the tremor polarization in this section.

452. Suppress ‘Oscillation of’.
Done

489. Replace ‘seismicity’ by ‘events’.
Done

538. The top-down model is verified for volcanoes after repose intervals of some decades. This is the case of Cordon Caulle. This could be mentioned.
Done

599 & 636. Into by In
Done

628. Replace ‘has’ by ‘as’.
Done

660. ‘a stabilization of b-value to pre-eruptive conditions’: what do you mean?
That the b returned to values similar to those registred before the eruption. We clarified this in the text.

665-667. How do you interpret this LP seismicity in September-November?
As a new pulse of magma rising through the conduit. We include this in the text

785. pages are 221-239.
Done

826. Singer or Asinger?
Singer of course, thanks!

835. 2016
Done