

Christos S. Zerefos (Referee)

Human volcano relationships have been discussed in a number of papers in the past. They include interaction with colors and at sunsets of large volcanic eruptions. Poetry has not been used so far and the paper presents a beautiful selection of poetry analyzed in an innovative way. A quantitative analysis is quite convincing and useful in an emerging new era that brings closer science and art.

We thank the reviewer for this positive feedback!

David Pyle (Referee)

This paper explores the question of what poetry written about volcanoes reveals about the relationship between humans and volcanoes, using a small selection of English language poems written since 1800. While the idea is certainly interesting, and the qualitative analysis does bring out some themes for discussion, my concern as a reader is that the analysis is obscured by the small number of poems under study, and the way they have been selected. The analysis looks at 34 poems, written since 1800, predominantly by white male Anglophone poets. The time distribution is biased towards the present day. Of the twelve 19th century poets, two are women; and only 1 is a native of a volcanic land (Hallgrimson, Iceland). From the 20th century selection, five are women (one of whom is a volcano scientist); and six are natives of volcanic lands (Chile, Nicaragua/El Salvador, Hawaii).

We recognize these limitations. The choice of Anglophone poets is intentional (p.5 l.39) and its limitations are acknowledged (p.22 l.33). This of course affects the volcanic land native/non-native demographics. The same goes for the historical period, as justified starting on p.5 l.42. The gender bias is indeed present, and we now explicitly acknowledge it (p. 6 l.29).

It is not clear that the authors used a systematic approach to locating poems: was the ‘manual internet search’ simply on google? (and what were the search terms?); or did they use any of the databases of poems that might be accessible through library catalogues?

We actually first used three databases: poetry foundation, poetry society, and poetry archive – then we conducted more specific Internet searches to fill decade gaps. We have now clearly detailed this methodology in the manuscript (p.6 l.7). We thank the reviewer for highlighting the need for a more thorough description of our search methodology.

Do the internal biases within the selections render invalid the idea that the poems can be used to ‘tell us about changing perceptions of volcanoes’? What do we know, for example, about the first-hand experiences that the various writers had of volcanoes, or of volcanic activity? My instinct is that a more focussed analysis of a body of work that was better defined in terms of time and location, and considered critically in terms of the nature and experience of the author might provide additional insights into the research question.

We believe they do not – we have clearly stated the limitations of our study, and our conclusions rest on them. However, we are very interested in expanding the study in future work. For example, we had already mentioned our intention to work on the first- vs. second-hand experience of volcanoes (p.23 l.1).

Detailed points.

1. There is a body of relevant work which the authors don’t cite but might consider. Analysis of poetry from Montserrat: Donovan, A et al., 2011, Rationalising a volcanic crisis through literature: Montserratian verse and the descriptive reconstruction of an island, *Journal Of Volcanology And Geothermal Research*, 2011 Jun 15(3-4), pp.87- 101. Skinner, J, 2011, A Distinctive Disaster

Literature: Montserrat Island Poetry under Pressure, in *Islanded Identities, Constructions of Postcolonial Cultural Insularity, Cross/Cultures*, Volume: 139, https://doi.org/10.1163/9789401206938_004 Victorian Disaster Poetry: Altick, RD (1960) Four Victorian Poets and an Exploding Island, *Victorian Studies*, Vol. 3, No. 3 (Mar., 1960), pp. 249-260 (12 pages), <https://www.jstor.org/stable/3825498> 2.

We thank the reviewer for bringing these works to our attention. We have now cited them in the Introduction.

2. Introduction: there are over 1400 ‘active volcanoes’ and 50 – 60 in eruption in any given year (Smithsonian GVP catalogue; <https://volcano.si.edu/>); the areal footprint of an eruption doesn’t scale in a simple way with VEI; and the reporting of past eruptions was much more about where they occurred, than their size: every burst of activity at Vesuvius was reported from the eighteenth century and on; meanwhile, the effects of the ‘great eruption of Tambora’ was barely known about until decades later.

This is a good point, and we have now incorporated it on p.3 l.7

3. Page 3 line 42 – see also: Hamilton, J., 2012, *Volcano: nature and culture*. Reaktion Books, London, 2012; Alexander, D., 2016, *The portrayal of disaster in Western fine art*, *Environmental Hazards*, Volume 15, Pages 209-226, <https://doi.org/10.1080/17477891.2016.1173007> 4.

We thank the reviewer for suggesting these works – we have referenced them.

4. Page 4 line 4 – ‘vog’ is a localised or tropospheric phenomenon; most of the sunset colours are a consequence of stratospheric particulates.

Indeed. We thank the reviewer for catching this mistake, which we have now rectified.

5. Page 5, line 17 – it would be of considerable value to also have an appendix to the paper that lists the poems in this study.

We created a DOI that contains this information. It is open access, and is now more clearly signposted in the manuscript.

6. Results and discussion: it would be worthwhile analysing where and by whom the poems were written?

Yes, that will be the subject of a follow up study. We have already started gathering the relevant information, and we are looking forward to developing this research further once this first study is published.

7. Page 11, line 27 – it’s not quite true that La Soufriere ‘dominates’ the physical landscape of St Vincent; it can hardly be seen from most of the island. I’d agree that it dominates the metaphorical landscape.

Thank you for pointing out the need for clarification, we have now specified the metaphorical connotation of that sentence.

8. Page 15, line 13 – it is interesting that you chose to focus on the Christian element of the tale of St Telemachus' death; a more obvious volcano link comes from the opening lines 'HAD the fierce ashes of some fiery peak / Been hurl'd so high they ranged about the globe?' which refer to the eruption of Krakatoa.

We coded everything in the poem, as can be seen in the supplementary material. In this section we are just providing examples of the different emerging categories. For "spiritual", St. Telemachus contains a representative one, which we chose to highlight.

9. Page 17, line 8; page 19 line 11 – in 1816 Byron would not have known that the dismal weather had a volcanic cause; this didn't become known until decades later, and the eruption of Krakatoa. Here the 'mountain-torch' is a reference to the way that Byron imagined a volcano might light up the gloom.

We agree that thus point needed clarification, which we have now provided. We found it interesting that, although Byron didn't know the cause, he felt this way about the consequences.

10. Table 5 – this is a curious list. Tambora and Krakatoa are both in the southern hemisphere (but had global effects); and the list of eruptions is (surely) far from complete – even at a threshold of VEI 5 (e.g. Cosiguina, Nicaragua, 1835; El Chichon, Mexico, 1982), What about Hekla? And other major eruptions of Vesuvius?

Yes, this is not a complete list of all volcanic eruptions that occurred over the considered time span, not even with a VEI 5 threshold. We compiled this list keeping in mind the impact (including the mediatic resonance) that these eruptions would have had. For example, as the reviewer notes, two eruptions occurred in the southern hemisphere, but had global effects, and in fact they were written about by poets. We have added the El Chichon and Hekla eruptions to the list. We have also rephrased the Table caption, which was misleading.

11. It might be appropriate to follow standard procedure for citing poems, by referring to the line numbers in the excerpts?

Given that this study is submitted for consideration to a Geoscience journal, and that all cited excerpts are provided in-text, we have not made this addition.

Anonymous Referee #3

General comments

1. The title does not reflect well the study: it is too general for the collection of poems considered. As the authors indicate, they had to impose several constraints (time period, language, paper length, preferred writing-style, etc), resulting in a collection of only 34 poems, which is a very limited pool of poems for such an ambitious title. In addition to the importance of the language/culture restriction, limitation underlined in the conclusion of the manuscript, the time period considered (1800 - present), selected because it coincides with the emergence and development of volcanology, might also have a strong impact on the final results. In Europe/US (where the majority of the artists come from), this period coincides with many scientific discoveries and social changes (related to the industrialisation) compared with previous centuries, which modified in particular spiritual/religious beliefs and human-Nature relationship, two themes which are considered in this study. Hence, the results regarding the temporal evolution of the various categories, would have likely been different if the time period considered would have included centuries prior to the 19th. For these reasons, the title should be more specific (or the pool of poems studied extended).

We have expanded the title to read: “In my remembered country: what poetry tells us about the changing perceptions of volcanoes between the XIX and XXI centuries”. This will help the potential reader quickly gauge their interest in the study. Further details can be found in the abstract.

2. The manuscript (particularly introduction and methodology) would benefit from various clarifications:
 - what is the exact object of the study ? Is the study about the perception of active volcanoes or of all volcanoes ? The introduction develops several arguments related to active volcanoes, however some of the poems considered concerns non-erupting volcanoes (eg as mentioned in the section about “Landscape”)

It is the perception of all volcanoes – nowhere do we state that that we focus on either erupting or active volcanoes. We have however specified so in Section 2.1.

- Please clarify throughout the manuscript that the results are about the poets’ perception of the interaction between Men-volcano (although it can be generalised to a certain extent) For example the way the RQ is formulated does not give an active role to the poets’ subjectivity (“RQ: what does poetry written about volcanoes reveal about the relationship between humanity and volcanoes?”, p5, 130-31), contrarily to the aims of the study given just before (“understand the way in which poets have interpreted the relationship between humans and volcanoes” (p5, 126-27))

In order to reconcile this apparent discrepancy, in Section 2.1 we have now specified that we consider poets to be representatives of humankind.

Specific comments

p3, 113-19 Please clarify the main message of this paragraph. Is it to justify the choice of “significant eruption” (Table 5)? The eruptions impacting the most human societies are not necessarily those with bigger VEI, but that population can be affected significantly by small eruptions and associated hazards. With the development of medias, transportation, etc, information about an eruption -even small- can also reach much more people. Please in the introduction give explicit examples of various ways in which volcano and the link humanity-volcano can be perceived ? This could be done re-writing the section

This paragraph is indeed meant to lean into the choice of eruptions presented in Table 5. However, we are still in the introduction section here. We are not claiming that eruptions with bigger VEI impact human societies the most (or the most human societies), just that their aerial impact footprint are larger. We have expanded this paragraph to comment on the impact of small eruptions, and to highlight the role of communication means (p.3 l.17).

p4, 11-9 (“We can conceivably use art pieces to guide us in our understanding of how volcano-human relations have changed through time. [...]”), highlighting what the artworks demonstrates of the volcano-artist interaction, rather than eg describing the painting and the physical phenomenon.

We have added a couple of references to clarify this point.

p8, 140-42 “However, as outlined by Morse et al. (2002), our methodological coherence, sampling strategy, and saturation of emergent codes ensures the reliability, and thus repeatability, of our approach in this qualitative analysis.” Although I agree this approach would give similar results if the same two authors were to repeat the experiment, how can you ensure the results would be similar if the study would be carried out by two (or more) people, with potentially different backgrounds, etc and hence likely to interpret the poems differently ?

Thank you for raising this important point. With qualitative research, different strategies in comparison to quantitative research must be adopted in order to ensure the credibility of the study findings. As you point out, it may be that other researchers arrive at slightly different conclusions, however this is the nature of all research. What we have done in this study is to maintain a ‘decision trail’, so that the reader (and any future researchers) can follow our analysis and the clear and transparent decisions that we have provided. However, we take your point that ‘repeatability’ might not be the most appropriate word here, and so the text has been changed to account for this and now reads: “... our methodological coherence, sampling strategy, and saturation of emergent codes ensures the reliability and trustworthiness of our approach in this qualitative analysis.”

p11, 110 “the poets perceived very clearly their [the volcanoes’] relationship with humanity”;
p21, 132-33 “with humans ultimately of neither benefit nor concern to the volcanoes that they write about”: In several instances throughout the manuscript, such as in these examples, the authors personify the volcanoes. Please could you modify the manuscript such that it is clear in

your analysis that the only subject(s) is/are the poet/humans and that all human emotions assigned to volcanoes are only perceptions. In the first example above, the sentence could be modified to eg “the poets perceived very clearly how humanity relates to volcanoes” (ie volcanoes are objects)

We have rephrased as suggested to make it clearer.

p11, 113-14 “poetry acts to position volcanoes as an awesome part of our shared landscape, perhaps explaining in part why humans were first drawn to them before they became valued for more tangible goods”: I suggest you suppress this assumption. Overall, population settlements are unlikely to have been drawn primarily by the beauty of an area. The people attracted by the spectacle given by active volcanoes are usually not the people who live nearby, and potentially risk their life and their families’, livelihood, properties, etc.

We chose the term “awesome” carefully, because it designates something (in our case volcanoes) that inspires awe and is overpowering – not necessarily something that is beautiful.

p20, 121-22 “many communities are willing to accept the associated risks of living near a volcano, in order to experience the cultural and societal benefits” Could you precise if that is for active volcanoes ? During the 1995-pst eruption of Soufriere Hills, Montserrat, 75% of the population left the island which would contradict the statement above. Those who stayed, did not for the cultural and societal benefits, but mostly for either economical reasons, or because they could not imagine losing their roots.

It applies to both active (now précised) and inactive volcanoes. Economic reasons are also societal benefits, and “could not imagine losing their roots” is a cultural benefit, as we have explored in our analysis.

p22, 124-25: “the emergent unidirectional nature of this relationship, this study also challenges us to re-consider the importance of humanity in our interactions with volcanoes. Unlike many other elements of our natural environment that have a strong sense of cultural and social identity attached to them (for example, glaciers, rivers, and rainforests)” Please include in your introduction a short paragraph (perhaps at the very beginning of the paper) mentioning studies (possibly as yours) about interactions between other natural elements and humans

It would not be correct to include this in the introduction; this aspect emerged through the study, and we did not start with a pre-conception that that might happen. As such, we believe that this belongs where it is, in the conclusions. We have added references to three studies about interactions between other natural elements and humans.

p22, 128 “by anthropogenic climate change” Anthropogenic climate change is not the only way humans affect the environment.

That was only an example, and we have now specified that.

p22, 128-31 “Indeed, aside from humans, volcanism is itself a key driver in shortterm climatic variations (Robock, 1991), with the net result a cooling at the Earth’s surface due to the scattering of incoming solar radiation by secondary sulphate aerosols formed from volcanic eruptions (ColeDai, 2010).”: Please suppress, this is outside of the topic.

Point taken, we have removed that sentence.

p23, 17-9 “We hope that this study has demonstrated that poetry is a powerful medium through which to consider perceptions of our natural environment, and that the results might better inform our communication with communities living nearby active volcanoes. Please suppress “We hope [...] that”, there is no need to demonstrate that, however could you indicate more practically how the results could be used to work with communities?

We removed “We hope”. Additionally, we provided a practical example of how the results could be used to work with communities (p.23 l.10).

Technical corrections

p3,111 “Certainly, they do not leave us indifferent” Please suppress this comment: that is the authors’ opinion, however it can surely not be applied to everybody, even those leaving near an active volcano.

It can be vastly applied indeed. We added a reference that supports our statement.

p3, 133 “yet while these works have great merit” Please suppress, it sounds condescending

We did not mean to be condescending. We have suppressed that in order to avoid any misunderstandings.

p3, 135 “volcanic activity clashes with human life” There is probably a less informal term than “clash” eg impact, affect, etc

We changed “clashes” to “conflicts”.

p8, 139 “ described here represents a somewhat subjective approach” Please suppress “somewhat”

We cannot suppress “somewhat”, as that would introduce an error: there are also objective elements in the analyses – e.g. the identification of very concrete themes (plants, animals...)

p18, 13 “respectful of the human space” No need to change your interpretation, but isn’t it just a way to show that humanity can’t be at peace, even when everything else is ‘purified’ by fire ?

We respectfully disagree with this interpretation. Moreover, there is no fire in volcanoes.

Figures 1 and 4: It would improve their readability (in particular the years) and help the comparisons between categories, if you would merge the various subfigures in one figure. For example you can use a color per category. Please also indicate what decades were not represented.

After preparing a new figure following the reviewer's suggestion, we feel that readability is much better in the current version.

p21, l6-8: This might in part be explained by the tensions between poetry and religion that had manifested themselves throughout the Victorian age. Also, society and arts were impacted by WWI and WWII.

We thank the reviewer for the insight, but we feel that this takes the explanation too far. We were just offering one example. We do however welcome further research of course.

p21, l23 “that there is a strong sense of identity associated between humans and volcanoes”: Could you rephrase more clearly please ?

The meaning has been extensively explained before in Section 3.2, which is entirely dedicated to this theme and contains several examples.

Major changes

We expanded the title to read: “In my remembered country: what poetry tells us about the changing perceptions of volcanoes between the XIX and XXI centuries”.

We expanded on the limitation of the study, including national origin, gender, and language of poets). We recognize that we cannot generalize their interpretation of volcano-human relationships to all humankind, and we have now reframed that to say that it is representative of their society and culture.

We better detailed our methodology

We referenced several additional papers

We expanded our list of considered eruptions, and better explained how it was selected

1 **In my remembered country: what poetry tells**
2 **us about the changing perceptions of**
3 **volcanoes [between the XIX and XXI centuries](#)**

4
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13

1 **Abstract**

2

3 In this study we investigate what poetry written about volcanoes from 1800 to the
4 present day reveals about the relationship between humanity and volcanoes,
5 including how it evolved over that time frame. In order to address this research
6 question, we conducted a qualitative content analysis of a selection of 34 English-
7 language poems written about the human-volcano interactions. Firstly, we identified
8 the overall connotation of each poem. Then, we recognized specific emerging
9 themes and grouped them in categories. Additionally, we performed a quantitative
10 analysis of the frequency with which each category occurs throughout the decades
11 of the dataset. This analysis reveals that a spiritual element is often present in poetry
12 about volcanoes, transcending both the creative and destructive power that they
13 exert. Furthermore, the human-volcano relationship is especially centred around the
14 sense of identity that volcanoes provide to humans, which may follow from both
15 positive and negative events. These results highlight the suitability of poetry as a
16 means to explore the human perception of geologic phenomena. Additionally, our
17 findings may be relevant to the definition of culturally appropriate communication
18 strategies with communities living nearby active volcanoes.

19

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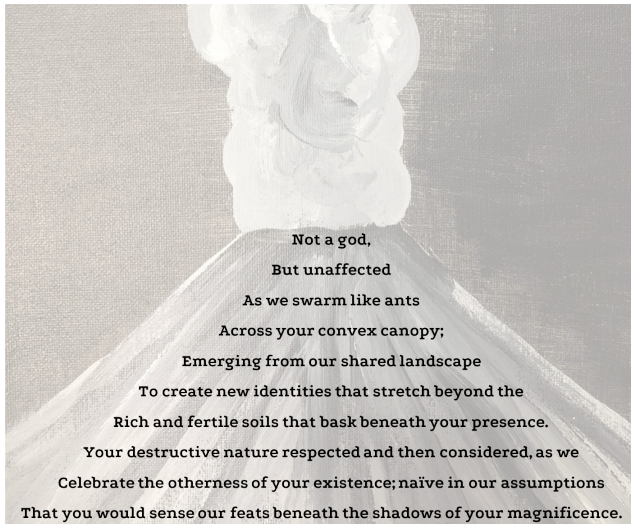
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22 **Graphical Abstract**

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1 **1. Introduction**

2
3 We live on a geologically active planet, and volcanoes are one of the most visually
4 impressive geological features of our world. Whereas most geologic phenomena
5 (e.g. orogeny, erosion) occur slowly over a timescale of millions of years, being *de*
6 *facto* invisible to us humans, volcanic activity is a fast process that can radically
7 change the natural landscape within a matter of hours, directly affecting the nearby
8 communities. There are 150 active volcanoes in the world, and at any given time,
9 about 20 of them are erupting (Durant et al., 2010;Venzke, 2013). The range of
10 volcanic activity is broad (effusive to explosive), and so is the spectrum of feelings
11 they inspire (from awe to fear). Certainly, they do not leave us indifferent_(see e.g.
12 Esperanza et al., 2008).

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13
14 The areal impact footprint of eruptions depends on their Volcano Explosivity Index
15 (VEI). In past times, only large eruptions affecting people (i.e. occurring in inhabited
16 areas) would have been reported and become known worldwide. Large eruptions
17 (VEI>4) statistically occur every few years, and have footprints of tens of kilometres
18 (Brown et al., 2015). Small eruptions (VEI<4) can also significantly affect local
19 population, but before the development of modern means of communication their
20 occurrence would have frequently gone unreported beyond national boundaries. At
21 the beginning of the 19th century there were 10 million people worldwide living within
22 100 km of volcanoes that have erupted during the Holocene (Siebert et al., 2011);
23 nowadays, that number has increased to 800 million.

24
25 Volcanoes constitute a fundamental part of the Earth system, recycling elements
26 from the mantle to the surface and the atmosphere. But cohabiting with them comes
27 with a unique set of challenges and rewards for local communities. Understanding
28 how people perceive volcanoes is fundamental in shaping effective scientific
29 communication strategies, including in times of crises (see e.g. Nave et al.,
30 2016;Donovan et al., 2018;Avvisati et al., 2019). These perceptions may in turn be
31 affected by a variety of factors, including: scientific knowledge, spiritual beliefs, oral
32 history, and personal experience (direct or indirect), which vary widely in space and
33 time across different cultures and historical periods.

34
35 Monitoring people's perception of volcanoes is difficult. Psychologists sometimes
36 work with local communities in the aftermath of eruptions (Paton et al., 2000;Sword-
37 Daniels et al., 2018;Paton, 2019), yet these works mainly focus on a very small,
38 specific part of the human-volcano interaction (i.e. the instances in which volcanic
39 activity conflicts with human life), and therefore paint a partial, skewed view of this
40 relationship. Additionally, these interventions have only become common practice in
41 recent times, and therefore cannot shed light on the evolution of the relationship
42 between humans and volcanoes over time

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1 A potential medium through which a more nuanced and expansive dataset of this
2 relationship can be established is the arts. The arts might be thought of as ubiquitous
3 expressions of human nature, and have often been inspired by volcanoes, with
4 notable examples including paintings by Turner (Daly, 2011), Warhol (Sigurdsson,
5 2015), and Munch (Olson et al., 2007). We can conceivably use art pieces to guide
6 us in our understanding of how volcano-human relations have changed through time
7 (Hamilton, 2013; Alexander, 2016). For example, previous research has shown how
8 the colours of sunsets painted by famous artists can be used to estimate
9 stratospheric particulate concentrations in the Earth's past atmosphere, revealing
10 that ash and gas released during major volcanic eruptions enhanced sunlight
11 scattering, making sunsets appear redder, as reflected by the paintings that were
12 produced in the aftermaths of such events (Zerefos et al., 2014). Similarly, studies
13 have been conducted which have: dated volcanic eruptions through Neolithic cave
14 paintings (Schmitt et al., 2014), investigated the extent to which artists have used
15 volcanoes to represent societal upheaval and transformation (Sivard, 2011), and
16 even demonstrated how drawing volcanoes can be used to empower children in
17 informal learning environments (Weier, 2004). These examples concern mainly
18 drawings and paintings, aside from which there has been a relative paucity in
19 research that investigates how the arts might be used to shed light on changing
20 perceptions of volcanoes, and how this information can be directly useful in the
21 communication of volcanic hazards and risk in the modern era.

22
23 In this study, we begin to address this gap in the literature by choosing to focus on
24 another form of art: poetry. While attempts to define what is and what is not poetry
25 can be contentious (see e.g. Ribeiro, 2007), here we take poetry to be any written
26 form that is composed by the line. We consider prose to be differentiated from
27 poetry, in that prose is instead composed by sentences and is written with standard
28 grammatical structure. This line-by-line composition of poetry means that it is able to
29 convey meaning in a concise manner, which in turn lends itself to analysis and
30 interpretation. Poetry provides a powerful medium through which to interpret human
31 behaviours and perceptions, and an analysis of poetry as data has been used to
32 provide understanding on topics ranging from living with HIV (Poindexter, 2002) and
33 dementia (Zeilig, 2014), to attitudes relating to environmental change (Illingworth and
34 Jack, 2018) and compassion fatigue in nurses (Jack and Illingworth, 2017). In this
35 study, we aim to build on this research, using poetry as a medium through which to
36 investigate perceptions of human-volcano interactions. Donovan et al. (2011) and
37 Skinner (2011) have also used poetry to gain insight on the human perception of a
38 specific, erupting volcano (Montserrat). Instead, we aim to conduct a wider study.

39
40 By conducting a detailed qualitative content analysis for a selection of volcano
41 poetry, this study aims to understand how poets have interpreted the relationship
42 between humans and volcanoes from the beginning of the nineteenth century to the
43 modern day. In Section 2, we discuss the methodology that was utilised in this study,
44 outlining why this approach was adopted and establishing its validity and reliability.

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1 Section 3 contains a discussion of how categories and themes emerged from our
2 analysis, and how this relates to the research question defined in Section 2. Finally,
3 Section 4 contains the conclusions of this study, along with future directions for
4 further research.
5

6 **2. Methodology**

7

8 The methodology that we have adopted in this study involved treating poetry as data,
9 allowing for text to be analysed with respect to attitudes relating to volcanoes. While
10 several other methods exist for the analysis of textual data (e.g. ethnography,
11 phenomenology, grounded theory, etc.), we have chosen qualitative content analysis
12 because of its ability to highlight both the context and the content of the chosen text,
13 which for a subjective medium such as poetry is essential.

14 The methodology that is adopted in this study largely follows that of Illingworth
15 (2019), insofar as the qualitative content analysis of the poetry is guided by these six
16 steps: formulation of research questions; selection of poetry to be analysed;
17 definition of codes and categories to be applied; outline and implementation of
18 coding process; determination of trustworthiness; and analysis of results. The first
19 five of these steps are outlined below, with the analysis of the results presented in
20 Section 3.

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22 We note here that the poems that were analysed in this study are presented
23 according to the following format: 'Poem Name' by Author Name (Year of
24 Publication), and that links to the full texts of all these poems can be found in Soldati
25 and Illingworth (2019).
26

27 **2.1 Formulation of research question**

28

29 By performing a qualitative content analysis on poetry that has been written about
30 volcanoes, but critically not for the purpose of research, this study aims to better
31 understand the way in which poets, as representatives of society and culture they
32 live in, have interpreted the relationship between humans and volcanoes (both active
33 and not). For the purposes of this study, this has been formulated into the following
34 Research Question (RQ):
35

36 RQ: what does poetry written about volcanoes reveal about the relationship between
37 humanity and volcanoes?
38

39 **2.2 Selection of poetry to be analysed**

40

41 We began by selecting poetry that mentioned or featured volcanoes in some
42 capacity. In doing so we set ourselves three constraints. Firstly, the poetry must be
43 written in English, or else have an author-sanctioned English translation; this

1 constraint was because English is the only common language that is shared by the
2 authors of this study. Secondly, the poems must have been written from 1800
3 onwards; this constraint was introduced to make the list more manageable for
4 analysis purposes, and because this was when many consider volcanology to have
5 first been fully established as a scientific discipline through the research of Ben
6 Franklin, James Hutton, Alexander von Humboldt, and others (Sigurdsson, 2000).
7 Finally, where possible, we aimed to find at least one poem per decade, in order to
8 try and better capture any change in attitudes from the early nineteenth century to
9 the present day. Given these constraints, we looked for poetry that mentioned the
10 word 'volcano' or 'volcanoes' and which, in the first instance, came from recognised
11 poets and/or well-established poetry journals, in the following three databases:
12 Poetry Foundation, Poetry Society, and Poetry Archive. Additionally, we reached out
13 to the volcanology research community through the volcanology listserv
14 (volcano@lists.asu.edu) asking for further suggestions. Finally, we performed a
15 manual Google search to fill in decade gaps.

Deleted: performed a manual Internet search for poetry that mentioned the word 'volcano' or 'volcanoes' and which, in the first instance, came from recognised poets and/or well-established poetry journals.

Field Code Changed

16
17 At this stage, we had a list of 53 poems, spanning every decade from the 1800s to
18 the 2010s. The two authors then independently read these poems and filtered them
19 according to two further criteria: only poems that were 100 lines or less were to be
20 considered, and any poet could only have one of their poems considered for further
21 analysis. The line limit was introduced in order to make the analysis more
22 manageable, and a limit of one poem per poet was introduced to allow for a wider
23 selection of voices to be considered, and also to improve the validity of the approach
24 in terms of the triangulation of data (see Section 2.5). In instances where there were
25 multiple poems from a single poet, we agreed upon the one that we both found to be
26 the most aesthetically pleasing, prior to any formalised content analysis. Poems that
27 were removed because of length included 'The last days of Herculaneum' by Edwin
28 Atherstone (which is over 500 lines long), while poets with more than one poem
29 included Emily Dickinson (six poems, for whom 'I have never seen "Volcanoes"' was
30 chosen) and PB Shelley (two poems, for whom 'The Cloud' was chosen). Following
31 the application of this further selection criteria, 41 poems remained available for
32 analysis. Of those, seven were written by women. The higher representation of male
33 poets is merely due to the higher number of male poets who wrote about volcanoes
34 over the considered time span.

35
36 At this stage, both authors independently read each of the poems and categorised
37 them as being either 'Positive', 'Negative', 'Positive & Negative', 'Neutral', or 'Invalid'
38 in their portrayal of volcanoes from a human perspective (in line with RQ), the results
39 of which can be seen in Table 1.

40
41 Performing this analysis enabled each of the authors to better familiarise themselves
42 with the poetry, and also highlighted any further poems that needed to be removed
43 from the study, because they were 'Invalid', i.e. those poems that did not concern the
44 relationship between volcanoes and humanity. Following this individual analysis (the

1 rows corresponding to 'AS' and 'SI' in Table 1), the two authors met up to exchange
2 their analyses and agree upon a broad classification of the poems in terms of
3 connotation ('Both' in Table 1). This broad categorisation was useful for three
4 reasons. Firstly, it revealed several differences in how the poems had been
5 individually categorised, highlighting how these differences could be discussed and
6 developed, thereby helping to improve the trustworthiness of the subsequent in-
7 depth content analysis by ensuring investigator triangulation (see Section 2.5).
8 Secondly, it revealed that this broad categorisation of the connotations of the poems
9 as either: 'Positive', 'Negative', 'Positive & Negative', or 'Neutral' was too broad to
10 offer any in-depth analysis with respect to the RQ. Finally, this approach revealed
11 additional poems that should be removed from the study because they did not
12 obviously concern the relationship between volcanoes and humanity. For example,
13 'Inside the Ghost Volcano' by Will Alexander (1998) was removed at this stage
14 because the volcano was being used as an abstract metaphor from which no
15 perspective of the perceived relationship between volcanoes and humanity could be
16 directly observed. In total a further 7 poems (the 'Invalid' column in Table 1) were
17 removed following this step, resulting in a total of 34 poems on which to perform a
18 more in-depth content analysis. This further selection criteria meant that two
19 decades were now absent from our study (1940 and 1960). However, given that
20 every other decade from the 1800s onwards was still present we were satisfied that
21 we had a sufficient temporal representation of poems to conduct a detailed content
22 analysis with respect to the RQ.

23

24 **2.3 Definition of codes and categories to be applied**

25

26 A conventional approach to qualitative content analysis was adopted in this study,
27 with preconceived categories being avoided, and categories being determined by the
28 implementation of the coding process instead (see Section 2.4). While in some
29 instances a directed content analysis might be more appropriate, this methodology is
30 usually used in those instances where an existing theory would benefit from further
31 description (Hsieh and Shannon, 2005). As the research question to be addressed in
32 this study is unique, a directed approach is inappropriate. Similarly, a summative
33 content analysis (i.e. one in which the frequency of words and/or phrases was only
34 quantitatively assessed) would fail to fully account for the context of the poetry
35 alongside its content.

36

37 **2.4 Outline and implementation of coding process**

38

39 Both authors individually read each of the 34 poems, and assigned codes to sections
40 of the text (Table 2). As each new code emerged we individually went back through
41 the poems that had previously been coded to check whether these also contained
42 any lines that could be labelled with any newly emergent code. After coding all of the
43 poetry in this manner, we independently read all of the poems in full again and made

1 sure that each of them had been coded accurately and that a saturation of emergent
2 codes had been reached, thereby improving the trustworthiness of the approach
3 (see Section 2.5). As can be seen from Table 2, this resulted in a total of 28 codes (9
4 for SI and 19 for AS). We then read each of the poems again to make sure that no
5 coding had been missed.

6
7 Following this independent coding process, the two individual codebooks (one for AS
8 and one for SI) shown in Table 2 were combined in order to search for emergent
9 categories. This categorisation of the individual codes was initially done by SI, before
10 being modified by AS, and then ratified by both SI and AS, with both authors
11 agreeing upon the five emergent categories (and corresponding codes) shown in
12 Table 3: 'Landscape', 'Identity', 'Destruction', 'Spiritual', and 'Creation', each of which
13 will be discussed in detail in Section 3. After these codes had been grouped as such
14 we went back through each of the individual occurrences (e.g. the 61 segments of
15 poetry that were categorised as 'Landscape') to make sure that they did indeed
16 belong in this category.

17
18 In this combination of codebooks to search for emergent categories, we found that
19 some of our early individual coding had been done erroneously, e.g. in 'Ice Child' by
20 John Haines (1999), the following section was coded as 'Identity' by SI and
21 'Destruction' by AS; however, in the merger of our codebooks we decided that a
22 more appropriate category was actually 'Landscape', which as can be seen from
23 Table 3 was not associated with either of these codes:

24
25 we find your interrupted life,
26 placed here among the trilobites
27 and shells, so late unearthed.

28
29 Following this categorisation, each of the five categories shown in Table 3 were
30 further examined for any theme(s) that expressed underlying meaning in relation to
31 RQ, the results of which are presented in Section 3.7.

32 33 **2.5 Determination of Trustworthiness**

34
35 At each stage of the qualitative content analysis that was adopted in this study, the
36 individual codes and categories were re-examined in order to confirm that they
37 accurately captured the poetry in relation to RQ. Each author carried out this coding
38 independently, until there were no further codes or categories found to be emerging
39 from the data, i.e. until descriptive saturation had been reached (Lambert and
40 Lambert, 2012). Triangulation as a validation strategy (Flick, 2004) was achieved by
41 using data drawn from different times and places (the poems) and conducting an
42 analysis using two different investigators (the authors). This use of systematic
43 sampling, triangulation and constant comparison, and proper audit and
44 documentation (see Section 2.2 and 2.4) combined to ensure both the reliability (i.e.

1 the consistency with which this analysis would produce the same results if repeated)
2 and the validity (i.e. the accuracy or correctness of the findings) of this approach
3 (Leung, 2015). Given that the analysis of the poetry as described here represents a
4 somewhat subjective approach, the reliability of the findings might be called into
5 question. However, as outlined by Morse et al. (2002), our methodological
6 coherence, sampling strategy, and saturation of emergent codes ensures the
7 reliability, and trustworthiness, of our approach in this qualitative analysis.

Deleted: thus repeatability

9 **3. Results and Discussion**

10

11 As can be seen from Table 3, five major categories emerged from the thematic
12 coding of the poems used in this study. We will now discuss each of these emergent
13 categories, how they relate to RQ ('what does poetry written about volcanoes reveal
14 about the relationship between humanity and volcanoes?'), and how these findings
15 compare to other research that has been conducted into the changing perceptions of
16 volcanoes (Section 3.1 - Section 3.5).

17

18 Following a discussion of these categories we present a quantitative analysis of the
19 poems in terms of how the frequency of these emergent categories have changed
20 over time (Section 3.5), followed by a presentation of the overall theme that emerged
21 from conducting this analysis, and how this relates to RQ (Section 3.6).

22

23 **3.1 Landscape**

24

25 Landscape is the most recurrent of the five emergent categories, being present in
26 every poem that was analysed, regardless of when it was written. Here volcanoes
27 serve primarily as a backdrop; they are part of the environment where the poem is
28 set, typically a prominent feature that dominates the landscape. For example, in
29 'Hunched Back Volcano' by Genevieve Taggard (1914), the poet paints a particularly
30 vivid image of an active volcano, anthropomorphised as having a passionate
31 (erupting) mouth (crater), set against a backdrop of stars:

32

33 Red is the mouth of Pele, passionate
34 Against the fires of the kindling stars:
35 Fire to fire moves: the heavens wait

36

37 By contrast, in 'Mount Broadshield' by Jónas Hallgrímsson (1841) the volcano is now
38 quiet and peaceful - an image highlighted by the presence of snow - though it still
39 dominates the landscape with its (regal) presence:

40

41 Queen of all our country's mountains,
42 crowned with snow sublime and pure!
43 Once you poured from fiery fountains

1 floods of lava down the moor.

2

3 In 'Flowers from the Volcano' by Claribel Alegría (2013), the volcanic crater,
4 presumably at least temporarily inactive, becomes part of the human landscape,
5 representing the place where the flower growers of the poem now live:

6

7 Farther up, in the crater
8 within the crater's walls
9 live peasant families
10 who cultivate flowers
11 their children can sell.

12

13 Even in its absence, the volcano can still dominate the landscape. For example, in
14 'Road Trip' by Vijay Seshadri (2016), it is not the volcano itself which provides the
15 poem's setting, but rather the beaches that came from its erosion, with their black
16 sand and tide pools excavated in its obsidian lava:

17

18 Tomorrow or the day after or the day after that,
19 on the volcano beaches fringed with black sand
20 and heaped with tangled beds of kelp,
21 by the obsidian tide pools that cradle the ribbed limpet
22 and the rockbound star,

23

24 These poems also capture the effect that volcanoes have in changing the landscape,
25 such as in 'Peace' by D H Lawrence (1929), which provides a description of an
26 effusive eruption; firstly, as it occurs:

27

28 Brilliant, intolerable lava
29 Brilliant as a powerful burning-glass
30 Walking like a royal snake down the mountain to-
31 wards the sea.

32

33 And then, after the eruption has ceased:

34

35 Peace congealed in black lava on the doorstep.
36 Within, white-hot lava, never at peace
37 Till it burst forth blinding, withering the earth;
38 To set again into rock
39 Grey-black rock.

40

41 These descriptions of the changing landscape also highlight how the language that is
42 used by poets in their descriptions can both reinforce and counteract scientific
43 terminology and understanding. The likening of lava to glass is scientifically
44 accurate, as both lava and glass are examples of a silicate melt. In contrast to this,

1 the use of colour in this passage, whilst evocative, is not actually grounded in reality:
2 lava does indeed turn into black or grey-black rock as it cools down, but is never
3 white-hot. The colour choice may have been dictated by a contrast (black vs. white)
4 or by the idea, pushed further than it actually occurs in reality, that the hotter
5 something gets the closer it gets to white (with lava typically stopping at red-orange),
6 and the idea of hot, molten lava still persisting within a cooled, solid outer crust does
7 in fact accurately reflect the inward cooling process of lava flows. This is of course
8 not to say that poems should ensure scientific accuracy at the cost of their
9 aesthetics; we draw attention to these scientific inaccuracies only to highlight that we
10 are not interested in how accurately these poems capture volcanic behaviour, but
11 rather what the poetry can tell us about the relationship between humanity and
12 volcanoes. This use of poetry, mirrors that which Aristotle observed in the *Poetics*,
13 i.e. that whilst history deals with specific events, poetry deals with general truths
14 (Yanal, 1982).

15
16 The fact that volcanoes feature so prominently as a setting in these poems highlights
17 that the poets perceived very clearly how humanity relates to volcanoes. Similarly,
18 the language used in the poetry acts to position volcanoes as an awesome part of
19 our shared landscape, perhaps explaining in part why humans were first drawn to
20 them before they became valued for more tangible goods such as precious metals
21 and stones (Fisher et al., 1998), as well as soil fertility.

Deleted: their relationship with humanity

23 3.2 Identity

24
25 Volcanoes are often used to represent or highlight part of the poet's identity. They
26 are present in their childhood memories, as well as in family history or cultural
27 heritage. Identity is the second most recurrent category (after 'Landscape'), missing
28 from only two of the analysed decades: the 1860s and 1880s. This ubiquity is
29 extremely revealing of the profound tie between humans and volcanoes; here the
30 volcanoes are not merely passive elements of the landscape, but rather active
31 agents. Even when they are standing still, their presence is so impactful as to be
32 defining for the poet, as evidenced in 'Punctuation Marks' by Phillip Nanton (1992),
33 set on the author's native island of Saint Vincent (Saint Vincent and the Grenadines),
34 whose landscape is metaphorically dominated by the active volcano La Soufrière:

35
36 Come nearer, focus on one dot of an island
37 I was born there, on the rim of a volcano
38 on the edge of a large full stop
39 where the sand is black
40 where the hills turn a gun-barrel blue
41 where the sea perpetually dashes at the shoreline
42 trying to reclaim it all.
43

1 Similarly, in 'Flowers from the Volcano' by Claribel Alegría (2013), the poet's home
2 country of El Salvador is remembered nostalgically, its personal resonance defined
3 by the situation of its volcanoes:

4
5 Fourteen volcanos rise
6 in my remembered country
7 in my mythical country.

8
9 In this poem, the volcanoes represent not only the literal volcanoes in that region, but
10 also the eruption of violence brought about by the civil wars of the 1970s and 1980s
11 across El Salvador, Nicaragua, and Guatemala, and how they too came to form a
12 part of the poet's life and identity.

13
14 This personalisation of the volcano is continued in 'Sonnet 5' by Pablo Neruda
15 (1959), for whom volcanoes become the distinctive feature of his native Chile,
16 elevated to the same rank as the love / lover which the poet found there:

17
18 and on through the streets like a man wounded,
19 until I understood, Love: I had found
20 my place, a land of kisses and volcanoes.

21
22 In many of these instances of identity, the volcano takes centre stage in a formative
23 childhood memory, such as in 'What For' by Garrett Hongo (1982), where the poet
24 expresses the extent to which his childhood identity was itself defined by the
25 presence of volcanoes:

26
27 I lived for the red volcano dirt
28 staining my toes, the salt residue
29 of surf and sea wind in my hair,
30 the arc of a flat stone skipping
31 in the hollow trough of a wave.

32
33 In contrast to this, 'Axis' by Ray Gonzalez (2015) captures the way in which a
34 particular volcano is a matter of family history, a mythical entity that the poet himself
35 did not experience personally, but which is nonetheless present in the defining
36 stories of his heritage:

37
38 The volcano in my grandmother's Mexican village
39 smothered the town, though the girl escaped because
40 the axis of revolution sent her family into exile,

41
42 Here this identity is not necessarily a positive one: the forced exile of the poet's
43 grandmother is remembered as an environmental revolution which they were

1 powerless to avoid, but which became a defining aspect of both the grandmother
2 and her grandson's assumed identity.

3

4 Identity is a nuanced concept, and has both positive and negative connotations
5 associated with it. However, what is evident from these poems is that these
6 associations are typically not purely adverse, and even when they are they form
7 important societal ties that have come to define both past and current generations.
8 Although the destructive impacts of volcanoes are well documented and recognized,
9 many of the possible societal and cultural benefits are not always fully considered
10 (Kelman and Mather, 2008), and the emergence of identity as a key category across
11 the majority of the analysed poems serves to further highlight this disparity.

12

13 **3.3 Destruction**

14

15 This category considers those poems that make reference in some part to the
16 destructive power of volcanoes, in relation to humankind. Poems that were
17 categorised as such include those that make reference to physical damage of
18 societal assets or destruction to human beings, such as is evident from this extract
19 from 'Blankets of Blood' by Arthur Rimbaud (1872):

20

21 Oh my friends! —My heart knows its own brothers!
22 Dark strangers, what if we were to leave? So leave! Leave!
23 O misfortune! How the earth melts upon us,
24 How I shake as it melts on me and you,

25

26 These poems also consider those that make reference to physical damage or
27 destruction to property or land that is owned and/or cherished by humans, such as in
28 this passage from 'Peace' by DH Lawrence (1929):

29

30 Forests, cities, bridges
31 Gone again in the bright trail of lava.
32 Naxos thousands of feet below the olive-roots,
33 And now the olive leaves thousands of feet below the
34 lava fire.

35

36 This category also includes those poems that highlight the mental anguish of people
37 caused by the negative effects of volcanoes, either directly through their eruptions or
38 indirectly through the oppressive nature of living within close proximity to them, as
39 can be seen in this extract from 'Negotiations with a Volcano' by Naomi Shihab Nye
40 (1995):

41

42 We need dreams the shape of lakes,
43 with mornings in them thick as fish.
44 Shade us while we cast and hook—

1 but nothing else, nothing else.

2
3 The permeating sense of fear that is evident from this extract acts as a powerful
4 testament to the severe mental anguish that experiencing a volcanic eruption and/or
5 living near an active volcano can have on local residents, capturing these negative
6 mental health effects in a manner that does not diminish them in comparison to more
7 tangible examples of volcanic destruction. Research into the mental health impacts
8 following volcanic eruptions have shown that nearby residents are at an increased
9 risk of experiencing symptoms of post-traumatic stress disorder (Gissurardóttir et al.,
10 2019) and mental stress due to the loss (or threat of loss) of property (Horwell et al.,
11 2015). Indeed, such research has also highlighted the importance of implementing
12 psychosocial interventions with volunteers, both during and after a volcanic eruption,
13 in order to alleviate severe mental health risks (Espinoza et al., 2019). By
14 highlighting the mental distress that volcanoes can cause to humans, these poems
15 serve to highlight why this should not be neglected when considering the potential
16 impacts of volcanic activity.

17
18 Finally, this category also considers those poems in which volcanoes are responsible
19 for the fatality of human beings, as can be seen in these lines from 'Flowers from the
20 Volcano' by Claribel Alegría (2013):

21
22 Eternal Chacmol collects blood,
23 the gray orphans
24 the volcano spitting bright lava
25 and the dead guerrillero
26 and the thousand betrayed faces,
27 the children who are watching
28 so they can tell of it.

29
30 Here 'Chacmol' likely refers to a distinctive form of Mesoamerican sculpture
31 associated with sacrifice, and in this poem, the poet asks us to reflect on the role of
32 the volcanoes in shaping the landscape of Central America. Through death, several
33 of these poems invite us to consider how such sacrifices can result in new creation
34 (see Section 3.5), but they also serve as a reminder to the reader of the vast power
35 that these volcanoes possess, encouraging us humans to both respect and, at times,
36 fear their presence.

37
38 Given the severe destruction that volcanoes can wrought, as highlighted by this
39 emergent category, these poems might suggest that communities would not choose
40 to live in such environments of their own volition. However, when such destructive
41 incidents occur in the poetry, they rarely appear in isolation, and instead tend to
42 appear alongside other categories which represent potential benefits, not least
43 'Identity' (Section 3.2) and 'Creation' (Section 3.5). This contrast of categories
44 implies that in many instances the poets were intending to capture a mutuality of

1 both potential hazards and benefits. This interpretation further supports the findings
2 of other studies which have highlighted that many communities choose to expose
3 themselves to the negative consequences of volcanic hazards, so that they might
4 enjoy the benefits and opportunities that arise within the human–volcano system
5 (see e.g. Bachri et al., 2015; Stoffle et al., 2015).

6

7 **3.4 Spiritual**

8

9 As can be seen from Table 2 and Table 3, this category emerged from a single code,
10 which both authors independently labelled as such. This category represents those
11 poems that were considered to make reference to aspects of volcanoes that were of
12 spiritual significance. Some of the poems that were coded in this category make a
13 specific mention of religious figures, such as these references to Christ in 'Etna' by
14 Emily Pfeiffer (1889):

15

16 Martyr of mountains, shall I say, the Christ,
17 Bearing earth's sorrows, for its trespass made
18 Sin, that her sons may reap the fair increase
19 Of smiling fields? The offering hath sufficed:

20

21 And also, those in 'St Telemachus' by Alfred Tennyson (1892):

22

23 In the great name of Him who died for men,
24 Christ Jesus! For one moment afterward
25 A silence follow'd as of death, and then
26 A hiss as from a wilderness of snakes,
27 Then one deep roar as of a breaking sea,
28 And then a shower of stones that stoned him dead,
29 And then once more a silence as of death.

30

31 Given the selection of English-language poems for this study, there is a strong
32 weighting towards poems that make reference to biblical figures from Christianity,
33 although other religious figures, such as the Buddha and several Mesoamerican
34 deities also feature, especially in those poems which were originally written in
35 another language, and yet for which an author-sanctioned translation exists (see
36 Section 2.2). For example, in 'A tale for Puuooo' by Taeko Jane Takahashi (2002),
37 we hear how:

38

39 Pele the goddess pierced and
40 thrust, spilling lava into
41 Royal Gardens subdivision.

42

1 Here, Pele is the goddess of volcanoes and fire in the Hawaiian religion, where she
2 is also considered to be the creator of the Hawaiian Islands. In some instances, the
3 volcano itself is considered to be the chief religious figure or deity, such as in these
4 lines from 'Ice Child' by John Haines (1999), in which the volcano is explicitly
5 referred to as a now dormant god:

6
7 Under the weight of this mountain—
8 once a god, now only restless stone,
9 we find your interrupted life,
10 placed here among the trilobites
11 and shells, so late unearthed.
12

13 Or in 'Burning Island' by Gary Snider (1970), in which the volcano is given the status
14 of a spiritual creator and protector:

15
16 Volcano belly Keeper who lifted this island
17 for our own beaded bodies adornment
18 and sprinkles us all with his laugh—
19

20 At times this spirituality manifests itself with the poet (or their protagonist) appealing
21 to the volcano for either forgiveness or clemency, such as in 'Negotiations with a
22 Volcano' by Naomi Shihab Nye (1995), where the author pleads for mercy with the
23 volcano as they might do with another deity or spiritual figure:

24
25 Forgive any anger we feel toward the earth,
26 when the rains do not come, or they come too much,
27 and swallow our corn.
28 It is not easy to be this small and live in your shadow.
29

30 These lines also demonstrate how this associated spirituality serves to create an
31 'otherness', i.e. that volcanoes and humans might occupy the same landscape but
32 they are vastly different entities in terms of both temporal and spatial scales. The
33 separation that is imposed by this emergent spirituality also highlights potential
34 difficulties for cohabiting. There is at times a perceived unidirectional flow of power
35 that makes establishing a truly symbiotic relationship seem improbable, as can be
36 seen in the following lines from 'Ice Child':

37
38 Was it God—the sun-god of the Incas,
39 the imperial god of the Spaniards?
40 Or only the priests of that god,
41 self-elected—voice of the volcano
42 that speaks once in a hundred years.
43

1 The interpretations of volcanic eruptions have been shown to be interconnected with
2 the understanding of tradition by different religions and religious figures (see e.g.
3 Gaillard and Texier, 2010). The poems that feature in this category further
4 demonstrate that there is clearly a spiritual connection between volcanoes and
5 humans, whilst also serving to highlight the spiritual reverence in which volcanoes
6 are held, and the distance that this can introduce. By considering the spirituality of
7 volcanoes, these poems also ask us to contemplate the persistence of the spiritual
8 life system within a particular territory, aligning with previous research which has
9 shown how when humans push these boundaries in order to exploit them, the
10 system can become disrupted (Vitale, 2017).

11
12

13 3.5 Creation

14

15 The final category to emerge from this analysis is one of 'Creation'. Poems that
16 feature in this category demonstrate how volcanoes can act as a creative (as
17 opposed to, or in addition to being a destructive) force. For example, 'Darkness' by
18 George Byron (1816) [unknowingly](#) explores the aftermath and potential
19 consequences of the 1815 eruption of Mt Tambora, Sumbawa, Indonesia, an event
20 whose subsequent volcanic winter resulted in the infamous 'year without a summer'
21 (Stommel and Stommel, 1979), [as it would have been later discovered](#). Yet, despite
22 the overall negative connotations of this poem, Byron still recognizes that prior to this
23 eruption living alongside volcanoes was a positive experience, a source of happiness
24 even:

25

26 Happy were those who dwelt within the eye
27 Of the volcanos, and their mountain-torch:

28

29 Another poem that demonstrates the creative potential of the volcano is 'Burning
30 Island' by Gary Snider (1970), in which the poet asks us to consider the fertile soils
31 that volcanoes provide, enabling a peaceful and profitable co-habitation:

32

33 As we hoe the field
34 let sweet potato grow.
35 And as sit us all down when we may
36 To consider the Dharma
37 bring with a flower and a glimmer.
38 Let us all sleep in peace together.

39

40 Many residents who live near volcanoes view eruptions as agents of change, often
41 change for the good (Dove, 2008), which can in turn influence the extent to which
42 they perceive the hazard and risk of living near to volcanoes. 'Burning
43 Island' highlights the potential benefits of living in volcanic regions, where the rich
44 volcanic soils can support highly productive agriculture (Rampengan et al., 2016).

1 However, it also draws attention to the fact that the benefits of this relationship would
2 appear to be unidirectional – volcanoes do not benefit from cohabiting the landscape
3 with humans.

4

5 Continuing with notions of cohabitating, this category features those poems that
6 demonstrate how such a relationship can be peaceful. For example, in 'Peace' by
7 DH Lawrence (1929) the concept of placatory cohabitation is explored in the very
8 first lines:

9

10 PEACE is written on the doorstep
11 In lava.

12

13 Here the potentially destructive lava gets all the way to the house, yet stops on the
14 doorstep, respectful of the human space. However, even here the potential dangers
15 of this cohabitation are clearly apparent: is this message from the volcano a genuine
16 offering of peace, or a warning shot across the bow; a reminder to humans of their
17 position in the hierarchical relationship that emerges through a consideration of the
18 'Spiritual' (Section 2.4)? 'Negotiations with a Volcano' by Naomi Shihab Nye (1995)
19 further explores the fragile nature of this cohabitation, explicitly wishing for the
20 volcano to remain dormant, and offering to be peaceful themselves if this wish is
21 granted:

22

23 We would be happy if you slept forever.
24 We will tend the slopes we plant, singing the songs
25 our grandfathers taught us before we inherited their fear.
26 We will try not to argue among ourselves.

27

28 In considering the potential for a creative and peaceful cohabitation of the landscape,
29 this category demonstrates how such a relationship is conditional, and is reliant on
30 the volcanoes to 'behave' in a certain manner towards (or with respect to) humanity.

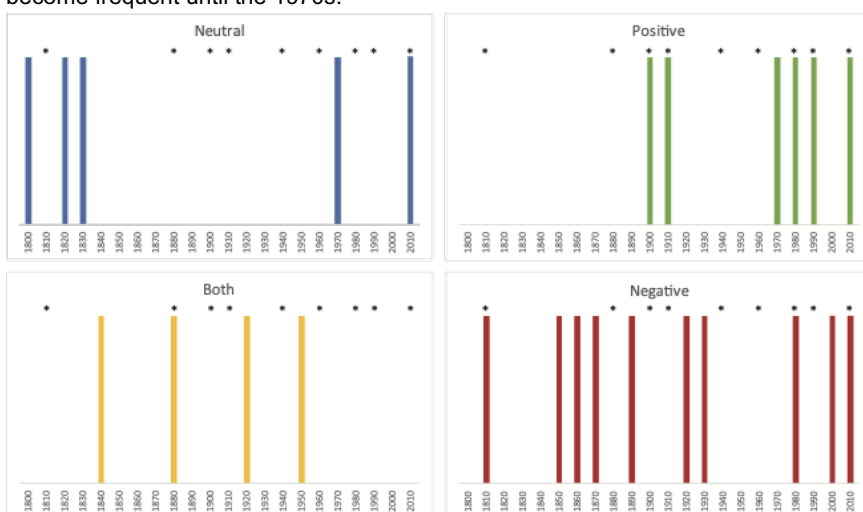
31

32 **3.6 Quantitative Analysis**

33

34 After performing this qualitative content analysis, we quantitatively analysed how
35 both the connotation of volcanoes ('Neutral', 'Positive', 'Negative', 'Both') as well as
36 the frequency of the five emergent categories evolved through time in our dataset. In
37 order to do so, we aggregated our dataset by decade, and normalized the identified
38 connotations and categories to the number of poems in which they were represented
39 (Table 4). Furthermore, we considered the major eruptions which occurred in the
40 Northern Hemisphere (where the majority of the poets used in this study lived)
41 across the considered time frame (Table 5), and correlated these with the
42 connotations and categories of the dataset. The purpose of this quantitative analysis
43 was not to apply a statistical interpretation of the volcano-human interactions of the

1 analysed poetry; rather it was read alongside the qualitative analysis in support of
 2 the emergent theme (Section 3.6) that arose from a consideration of these poems.
 3
 4 As can be seen from Fig. 1, poems in which volcanoes have either a 'Neutral' or
 5 'Both' a positive and negative connotation, and therefore do not express a partial
 6 value judgement, can be found consistently throughout the time span considered
 7 (i.e. from the 1800s to the 2010s). The same can be also said for poems where
 8 volcanoes are depicted with an overall 'Negative' connotation. In contrast, a
 9 'Positive' representation of volcanoes only emerges in the 1900s, and does not
 10 become frequent until the 1970s.



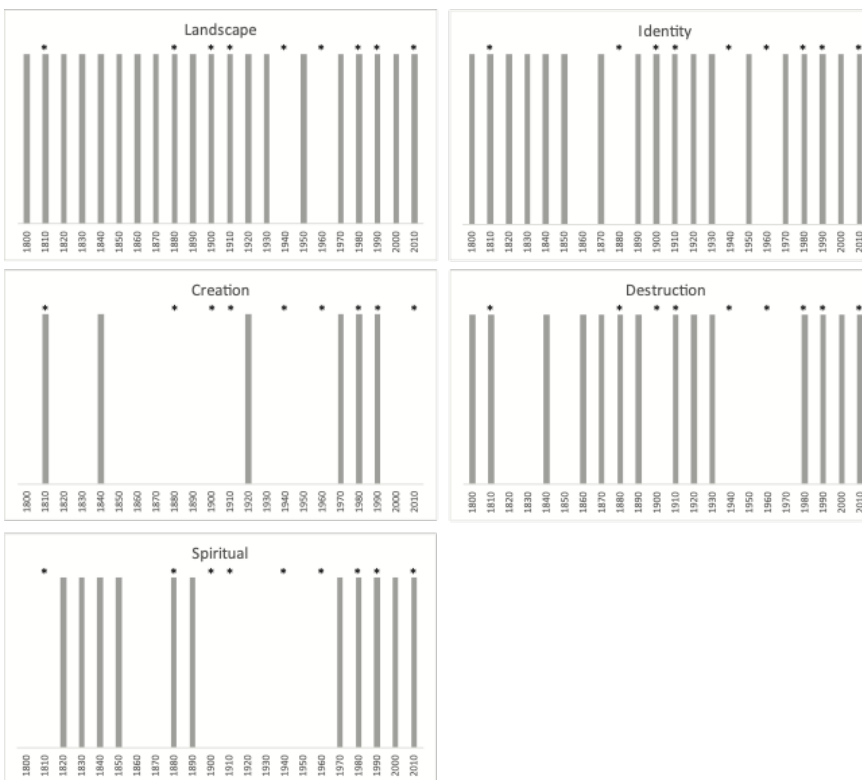
11
 12 *Figure 1. Connotations ('Neutral', 'Positive', 'Negative', or 'Both') of the considered*
 13 *poems, arranged chronologically and aggregated by decade. Asterisks indicate*
 14 *major eruptions (as shown in Table 5).*

15
 16 Plotting major eruptions alongside the associated connotations of the selected
 17 poems (Fig. 1) does not reveal any obvious correlation. This can be attributed to the
 18 fact that the vast majority of the analysed poems do not focus on specific volcanic
 19 eruptions, but rather that they consider human-volcano interactions more generally.
 20 One notable exception is the poem 'Darkness' by George Byron (1816), which as
 21 discussed in Section 3.5 [is grounded in](#) the eruption of Mount Tambora in 1815, and
 22 the subsequent 'year without summer'. During this eruption, volcanic ash was
 23 injected high into the stratosphere, where it circled the globe and persisted for a
 24 considerable time, visibly filtered the sunlight, and causing a negative thermal
 25 anomaly of at least half a degree Celsius in the Northern Hemisphere, as well as a
 26 famine that ultimately killed over 70,000 people (Brohan et al., 2016). This event
 27 inspired artists in all fields (e.g. Turner's famous sunset paintings, and Mary
 28 Shelley's *Frankenstein*), with Byron's poem also bearing witness to this event:

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I had a dream, which was not all a dream.
The bright sun was extinguish'd, and the stars
Did wander darkling in the eternal space,
Rayless, and pathless, and the icy earth
Swung blind and blackening in the moonless air;
Morn came and went—and came, and brought no day,



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Figure 2. Emerging categories in the considered poems, arranged chronologically and aggregated by decade. Asterisks indicate major eruptions (as shown in Table 5).

At the categories scale (Fig. 2), we see that the volcano-human interactions in relation to the 'Landscape' occur in all represented decades (as discussed in Section 2.2 the 1940s and 1960s are not represented in this analysis). The notions of 'Identity' that are associated with these interactions are almost as ubiquitous, with the only exceptions being the 1860s and 1880s.

1 As can be seen from Fig. 2, the 'Destruction' in the volcano-human interactions of
2 the selected poetry is represented more frequently across the considered time period
3 than the 'Creation' of such interactions. There is also somewhat of a correlation
4 between 'Destruction' and each of the major volcanic eruptions that happened in this
5 period, with the 1900s being the only decade which featured a major volcanic
6 eruption in the Northern Hemisphere (Table 5) and which did not feature a poem that
7 considered the destructive nature of volcano-human interactions (again noting that
8 the 1940s and 1960s are not represented in this analysis). This would indicate that
9 even if poets were not writing about specific volcanic events, their attitudes might
10 have been affected by them (and the social and economic impacts that these large
11 volcanic events resulted in), leading to poems that more readily considered the
12 'Destructive' rather than 'Creative' nature of such interactions.

13

14 The 'Spiritual' category occurs across the considered time period, with a notable gap
15 in the first half of the twentieth century. This might in part be explained by the
16 tensions between poetry and religion that had manifested themselves throughout the
17 Victorian age (because of the constraints in the selection of the poetry discussed in
18 Section 2.2, the majority of the poems from this era came from either British or
19 American writers), with religion becoming increasingly personal and secular as
20 society became more democratic (Fraser, 1986). Similarly, the re-appearance of this
21 category in later poems corresponds to the emergence of a new Romantic
22 movement that began in the 1960s, in which people (and poets) began identifying
23 themselves as 'spiritual but not religious' (Thomas, 2006), which could explain the
24 re-emergence of 'Spirituality' in the poetry of this period.

25

26

27 **3.7 An emergent theme**

28

29 In considering the five categories identified in this analysis of the poetry, a clear
30 theme emerges with respect to [the RQ](#) (what does poetry written about volcanoes
31 reveal about the relationship between humanity and volcanoes?): that there is a
32 strong sense of identity associated between humans and volcanoes.

33

34 An analysis of these poems has revealed that humans and volcanoes occupy the
35 same 'Landscape', and that whilst there is a certain reverence associated with their
36 'Destruction', there are also many positives associated with living alongside them.
37 Surprisingly however, these positives are mainly linked to notions of 'Identity' (e.g.
38 family histories and cultural heritages) rather than the physical benefits of 'Creation'
39 (e.g. fertile soils). These poems also highlight that this is a unidirectional relationship,
40 in part because of the distancing brought about by the associated 'Spirituality' or
41 otherness of the volcanoes, with humans ultimately of neither benefit nor concern to
42 the volcanoes that they write about.

43

1 This emergent theme is further supported by the quantitative analysis discussed in
2 Section 3.6, where over the time period considered there is a relative ubiquity of the
3 'Identity' to emerge from the poems. Similarly, despite the major cultural and societal
4 changes that have occurred over this time period, attitudes towards the human-
5 volcano interaction have not noticeably shifted in favour of one category or another;
6 the volcanoes have remained an ever present, suggesting that they are impervious
7 to these changes and further highlighting their unidirectional relationship with
8 humanity.
9

10 4. Conclusions

11
12 The purpose of this study was to investigate what poetry written about volcanoes
13 reveals about the relationship between humanity and volcanoes. By conducting a
14 qualitative content analysis of a selection of poems written from the 1800s to the
15 present day, a series of themes emerged that characterised this relationship. The
16 volcanoes as 'Landscape' and 'Identity' were seen as dominant, with consideration
17 also given to the 'Destruction' and 'Spirituality' associated with these human-volcano
18 interactions, and to a lesser extent their potential for 'Creation'. The main theme to
19 emerge, both from these categories and the poems themselves, is that there is a
20 strong sense of identity associated with volcanoes by humans (e.g. in terms of family
21 histories, cultural heritage etc.), and that it is the humans (and not the volcanoes)
22 that are affected by this relationship. A quantitative analysis of the frequency with
23 which these categories occurred throughout the decades of this dataset supported
24 the findings of this qualitative analysis, thereby further improving the validity and
25 reliability of the main finding of this study, i.e. that the relationship between humanity
26 and volcanoes is unidirectional and focused on identity.
27

28 The outcomes of this study support other research findings which have
29 demonstrated that many communities are willing to accept the associated risks of
30 living near volcanoes, including active ones, in order to experience the cultural and
31 societal benefits (i.e. 'Identity') that they afford (see e.g. Schmincke, 2004;Kelman
32 and Mather, 2008). Furthermore, by asking us to consider the emergent
33 unidirectional nature of this relationship, this study also challenges us to re-consider
34 the importance of humanity in our interactions with volcanoes. Unlike many other
35 elements of our natural environment that have a strong sense of cultural and social
36 identity attached to them – for example, glaciers (Gagné et al., 2014), rivers
37 (Macklin, 1999), and rainforests (Roosevelt, 2013) – volcanoes are unlikely to be
38 affected by e.g. anthropogenic climate change. Indeed, aside from humans,
39 volcanism is itself a key driver in short-term climatic variations.
40

41 The main limitation for this study is that only English-language poems were
42 considered. This means that there is likely a bias towards certain attitudes or
43 behaviours, especially those that were found to emerge from the 'Spirituality'

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1 category. Future research could, and should, include poetry written in multiple
2 languages to account for this limitation, as doing so would reveal a broader
3 understanding of how poets interpret human-volcano interactions, especially for
4 communities from the Southern Hemisphere.

5
6 In addition to future studies considering a wider variety of languages and cultures,
7 such work might also consider how different attitudes towards human-volcano
8 interactions are captured by those poets who have physically encountered a volcano
9 versus those who are relying on second-hand testimony. Furthermore, by outlining
10 how poems can be used as a form of data to provide further insight into how human-
11 volcano interactions are perceived, this study suggests that a similar approach might
12 also be adopted for other geoscientific events or phenomena.

13
14 This study has demonstrated that poetry is a powerful medium through which to
15 consider perceptions of our natural environment, and that the results might better
16 inform our communication with communities living nearby active volcanoes. **For**
17 **example, it could provide more appropriate (i.e. locally sourced) language to engage**
18 **the communities in conversation.** It is in fact critical that local cultural and religious
19 beliefs be taken into account when communicating volcanic hazard, as demonstrated
20 by several social volcanology studies (Cashman and Cronin, 2008;Donovan,
21 2010;Lavigne et al., 2008;Paton et al., 2008). We welcome interested readers to get
22 in contact with us for participation in the next stage of this research, in which we
23 hope to broaden our analysis beyond the constraints of the English language.

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1 **Data Availability**

2

3 The poems that were selected for the analysis, along with their coded categories, are
4 available through Soldati and Illingworth (2019;
5 <https://doi.org/10.17605/OSF.IO/2D5K6>).

6

7 **Author Contribution**

8

9 AS and SI worked together to conceive the design of this study, conduct the
10 research and analysis, and write the paper.

11

12 **Competing interests**

13

14 Author SI is the chief executive editor of *Geoscience Communication*.

15

16 **Acknowledgements**

17

18 We would like to thank members of the Volcanology community who provided us
19 with several poems to consider for our dataset. Furthermore, we would like to thank
20 Alana Weir who provided useful comments to an earlier draft of this manuscript.

21

22

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1 **Tables**

2
 3 Table 1: classification of the 41 poems according to their portrayal of the relationship
 4 between volcanoes and humanity as either 'Positive', 'Negative', 'Positive &
 5 Negative', 'Neutral' or 'Invalid'. Here the rows represent who the coding was
 6 performed by ('AS' - Arianna Soldati; 'SI' - Sam Illingworth; 'Both' - Arianna Soldati
 7 and Sam Illingworth).

Coder	Positive	Negative	Positive & Negative	Neutral	Invalid
AS	5	8	7	10	11
SI	13	16	0	9	3
Both	9	12	5	8	7

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 9
 10 Table 2: the codes that emerged from an individual content analysis of the 34
 11 poems, arranged according to the number of times they occurred ('AS' - Arianna
 12 Soldati; 'SI' - Sam Illingworth). *The number of occurrences is not limited to one per
 13 poem.

Code	Coder	Description	Occurrences*
Landscape	AS	Simple description of volcanoes as part of the environment	30
Human	AS	Referring to fellow human beings	28
Destruction	AS	Associated with destruction	24
Spiritual	AS	Evoking a spiritual connection or being	23
Destruction	SI	Something that brings / is associated with destruction	15
Creation	SI	Associated with new life and fostering life	13
Plants	AS	Reference to plants / flowers	13

Spiritual	SI	Associated with spiritual / religious feelings and/or presence	12
History	AS	Bringing a historical perspective	12
Death	AS	Associated with death	12
Animals	AS	Reference to animals	11
Identity	SI	Associated with a sense of identity for a person / people	8
Fear	SI	Something to be feared / afraid of	8
Cohabiting	SI	Living alongside the volcano (both positive and negative consequences)	8
Natural Beauty	SI	Described as something beautiful and/or awesome.	7
Setting	SI	The volcano is a neutral setting for the poem	6
Universe	AS	Reference to stars/planets	5
Force / Power	AS	Evoking the strength of the volcano	5
Childhood	AS	Reminiscing of childhood	4
Peace	AS	Relating to peace/absence of war	3
Positive Metaphor	SI	The volcano is used as a positive metaphor / simile	2
Creation	AS	Evoking the creation of land or life	2
Rocks / Minerals	AS	Reference to the rock/mineral element of landscape	2

Wish	AS	Expressing a desire, wish	2
Time	AS	Encompassing the passage of time	2
Quiet	AS	Related to a feeling of stillness, quiet	2
Pain	AS	Related to physical pain	1
Fear	AS	Related to a feeling of fear	1

1
2 Table 3: the categories that emerged from the coding process, alongside their
3 corresponding codes, and arranged according to the number of times they occurred
4 ('AS' - Arianna Soldati; 'SI' - Sam Illingworth). *The number of occurrences is not
5 limited to one per poem. **This code originally had both positive and negative
6 connotations.

Category	Corresponding Codes (Author)	Occurrences*
Landscape	Landscape (AS); Natural Beauty (SI); Universe (AS); Rocks/Minerals (AS); Force / Power (AS); Animals (AS); Plants (AS); Setting (SI)	61
Identity	History (AS); Heritage (AS); Humans (AS); Identity (SI); Childhood (AS); Positive Metaphor (SI); Time (AS)	49
Destruction	Death (AS); Pain (AS); Destruction (S); Destruction (AS); Fear (SI); Cohabiting** (SI); Fear (AS)	36
Spiritual	Spiritual (AS); Spiritual (SI)	25
Creation	Creation (SI); Creation (AS); Wish (AS); Cohabiting** (S); Peace (AS); Quiet (AS)	8

7
8 Table 4. Poem connotation and categories by decade. In this table each decade was
9 considered to have an associated connotation if at least one poem written in this
10 decade was considered to be either 'Neutral', 'Positive', 'Negative', or 'Both'.
11 Similarly, a particular decade was assumed to be associated with an emergent
12 category if at least one of the poems that were written in that decade was
13 categorised as such.

Decade	Connotation				Categories				
	Neutral	Both	Positive	Negative	Landscape	Identity	Creation	Destruction	Identity
1800	x				x	x		x	
1810				x	x	x	x	x	
1820	x				x	x			x
1830	x				x	x			x
1840		x			x	x	x	x	x
1850				x	x	x			x
1860				x	x			x	
1870				x	x			x	
1880		x			x			x	x
1890				x	x	x		x	x
1900			x		x	x			
1910			x		x	x		x	
1920		x		x	x	x	x	x	
1930				x	x	x		x	
1940									
1950		x			x	x			
1960									
1970	x		x		x	x	x		x

1980			x	x	x	x	x	x	x
1990			x		x	x	x	x	x
2000				x	x	x		x	x
2010	x		x	x	x	x			x

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Table 5. Some of the major eruptions from the 1800s to the present day. These are defined as those eruptions having had either a Volcanic Explosivity Index (VEI) greater than three, and having occurred in the Northern Hemisphere, where the majority of the authors of the considered poems lived, or having had a global impact and resonance. Data taken from the Global Volcanism Program (Venzke, 2013).

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Volcano	Eruption Year
Tambora	1815
Krakatoa	1883
La Soufrière, Pelée, Santa Maria	1902
Novarupta	1912
Paricutin	1943-54
Vesuvius	1944
<u>Hekla</u>	<u>1947-48</u>
Surtsey	1963
St Helens	1980
<u>El Chichon</u>	<u>1982</u>
Redoubt	1989

Pinatubo	1991
Eijafjallajokull	2010

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