

Interactive comment on “The Bortoluzzi Mud Volcano (Ionian Sea, Italy) and its potential for tracking the seismic cycle of active faults” by Marco Cuffaro et al.

Anonymous Referee #2

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Summary

The author presents an examination of the here named Bortoluzzi Mud Volcano (BMV) with the aim of demonstrating its potential for tracking the seismic cycle of active faults. The analysis is undertaken through the integration of numerous geological, geochemical and geophysical data. The primary conclusion is that the BMV could present a suitable site for installation of a cable submarine multiparametric station to study the potential relationship between subsurface vertical fluid migration and the seismic cycles of active faults. The manuscript offers an impressive integration and analysis of various data types which are well presented in the results section, however, some

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work is needed in the figures and figure captions to make the data clearer for the reader. The premise of understanding how fluid migration and seismic faults are associated as a way to mitigate natural hazards is a very interesting and relevant question. However, the mechanisms behind how seismicity specifically results in fluid and mud expulsion are currently almost entirely absent in the manuscript. The nature of the conduit, whether exploitative through faults or self-generative in the form of hydraulic fracture pipes, is poorly described or debated and the figures (seismic specifically) are not clear in their presentation of the faults that have propagated through the salt and act as leakage pathways. Why did any faults propagating upward not detach in the salt and if any faults did propagate through the salt why have they not annealed over time due to the mechanical behavior of salt? If there is to be a relationship between fluid and mud remobilization, seismic cycles and underlying faults then the discussion must first present a balanced argument that clearly demonstrates that the migratory pathway is exploitative. Only then can the authors build a stronger argument for the conclusion that the BMV of all offshore mud volcanoes presents the best site for future monitoring of fluid expulsion associated with seismic cycles. It is my opinion that the core premise of the manuscript is good, the data and results are strong. I recommend this paper for publication but only after major revision to the points raised above and also in the comments below.

Comments and recommendations

The first paragraph is a very generic introduction for a mud volcano paper. A core aspect of the paper is the relationship between mud volcanoes (or focused fluid flow in general) and seismic cycles. I recommend that the authors focus more on known relationships between mud volcanoes and seismicity and how seismicity can trigger mud volcanism. Is this through a mechanism of seismic pumping or sheering and overpressuring of a source layer.

Avoid weak or unsupported statements e.g. Page 2 line 33 starting 'We believe, in fact..' and Page 2 lines 18-20, which is an important statement that is uncited, so reads

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as conjecture.

While it is admirable and scholarly how extensive the use of citations is, in many instances it is beyond what is necessary and in fact breaks up and detracts from the main text with sometimes two to three lines of citations. Please wherever possible reduce the citations throughout.

While the BMV has been described in prior studies there are a couple of problems with immediately naming the structure the BMV by the start of the methods and results: firstly, you are already imposing an interpretation before laying out the evidence that ultimately leads to the diagnostic that this is a MV; Second, one of your main conclusions is that the BMV is in fact an MV, but the impact of this conclusion is completely removed by imposing the conclusion prior to presenting the evidence. I recommend refraining from calling this structure an MV and building your argument through the results, ending with a summary of the diagnostics (both your own and those already published) that allow you to name this structure the BMV.

I recommend modifying the structure of the method and data and results into a single method and data section and a separate results section. While I appreciate this must have been a conscious stylistic decision, due to the fact you are presenting information from so many different data types, constantly jumping between the two makes the reading experience disjointed and impedes real integration of all the different data.

Interpretation is often mixed with results. Perhaps it would help the reader to have an interpretation section at the end of the results. For the author this would avoid mixing observations and interpretation and would present an opportunity to more seamlessly integrate more than one data type in an interpretation. This would also make the manuscript more enjoyable and understandable for the reader.

The discussion is broken up into two parts. The first part is the origin and activity of the BMV. I enjoyed the section on the present activity of the BMV, which used backscattering and geochemical analysis to demonstrate that the mud volcano is currently quies-

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cent but provides a conduit for dewatering deeper layers. However, my recommendations for the rest of this section are as follows: 1) the first part of the discussion should first demonstrate that the BMV is in fact a mud volcano; 2) At present the morphology section doesn't pose a question to be answered but rather states what was observed from the results. The geometry of a mud volcano is typically governed by two main factors, the viscosity of the extruding mud and the geometry of the connecting conduit. The scatter you see in the graph of height vs diameter is primarily related to this. Consider, what does the morphology (such as height and slope angle) tell us about the either the type of conduit or the fluidity of the extruded mud? Is this a mud cone or mud pie? What does the evidence of palaeo flows tell us about the episodicity of this mud volcano and what governs the changes in pressure that give this episodicity? These are simple questions that when answered will elevate the first part of the discussion. Finally, in the drainage process section, what is the origin of the fluid and mud? Do you have any constraints on the age/origin of the extruded mud from either seismic observations of depletion zones or core samples? Samples of hypersaline water are indicative of a fluid source at least as deep as the Messinian evaporites. However, it is currently unclear if the mud is also pre-salt in origin. This is important for our understanding of the process for how the mud has been mobilized, e.g. fluidization vs liquefaction.

I would recommend having a native English speaker read over the manuscript prior to any resubmission. Some sentences are unnecessarily long and would benefit from being broken down or made more concise. One key point per sentence with the subject of the sentence at the start.

Annotations in figures are sometimes a little lacking, with text size often too small, certain annotated lines too thin or a colour that is hard to see and basic annotations including north arrows, colour bars and scale bars sometimes missing (examples given below).

Specific comments

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Page 1, Line 8 – weak sentence with the use of probably. Whether the faults are seismically active or not is a fundamental part of the paper.

Page 1, Line 15-17 – once again this is a weak sentence with too much use of words including may ‘contribute, potential and feasible, in favour’. Please be clearer, assertive and concise in what you want to say. This is supposed to be one of your main conclusions.

Page 2, Lines 12 – 15 – an example of a sentence that would benefit from being split in two. I suggest a full stop after the first set of citations and then a separate sentence above the amount of methane emitted from known mud volcanoes.

Page 2, Line 18-20 – This sentence needs citations, otherwise it is an unsupported statement.

Page 2, Line 24 – delete ‘In other words,’ at the start of the sentence. Start with ‘The faults. ...’.

Page 2, Line 22 – Weak start to sentence. Remove ‘We believe, ...’ And start with ‘The activity of some of these. ...’

Page 3, Line 9 – As you ascertained from the analysis of the BMVs geometry compared to other recorded MVs, it is in fact a relatively small mud volcano. Therefore, please do not refer to it as a ‘large mud volcano’.

Page 5, Line 20 – You state that seismic events were selected within a distance of 12 km from the transect track. Please explain in the methods why you chose a distance of specifically 12 km.

Page 6, Line 16 – Please annotate/highlight examples of the small scale mass-wasting features listed here in Fig. 3.

Page 6, Line 19 – Please highlight in Fig. 3 where ‘this well-defined flat area of 26 km²’ is.

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Page 7, Line 3 – Can you please justify why you have selected this data set of 232 mud volcanoes?

Page 7, Line 4 – How have you defined the diameter and height of the BMV? This should be explained in the methods with reference to a figure showing these parameters. From the data currently presented it is not clear how you interpret the base of the MV in order to measure its height. An awareness of the imaging artefacts at the margin and beneath the MV should also be demonstrated. How do you interpret the conduit? These are often much narrower than the area of acoustic noise.

Section 3.4.2 – The seismic facies of the units is briefly described, but the acoustic character of the bounding reflections is not described. What is the polarity? What is the acoustic impedance contrast? Is there variability in acoustic character along the horizon? This information gives further insight into the velocity and origin of the sediments.

Page 9, Line 8 – Please ensure all heading and sub-headings are capitalized where appropriate. Please check for other examples.

Page 9, Line 16 – Is there a more technical term that can be used than cloudy facies. Is this term standard? I struggle to understand what you mean.

Page 14, Line 5 – Please reference the statement about an association between over-pressure and the MSC. See Bertoni et al., 2015 and Al-Balushi et al., 2016.

Figure 1 – Please change the grey and grey dashed line colours to something that is brighter and stands out more. They are currently hard to see.

Figure 2 – Please add the north arrow.

Figure 3 – In Fig. 3b contours and contour numbers are at times almost impossible to see. Consider white for the text and thicker white lines for the contours. In Fig. 3a & 3b, more annotation and description in the caption of morphological features is needed. What are the detailed diagnostics from these maps for the BMV?

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Figure 4 – This figure would benefit from further subdivision into sections a-e. In Fig. 4a, the text size is too small, the units are missing, the scale bar is missing (also in 4b), the lines in the map are too thin and ‘Rim’ is not labelled on the bathymetric profile. 4b needs more annotation. What is meant by ‘breaking’? Other than being nice to look at without further annotation or comment in the caption it is not clear what the 3D perspective adds. Please use a different line track labelling than a-a’ and b-b’ because a and b are used for subdividing the figure.

Figure 5 – This figure needs to be completely reworked with much more interpretation added to both the figure and caption. At present it tell the reader, especially one who doesn’t work often with this data type, very little. The caption for 5a is too sparse and 5b reads in a way that suggests that there is massive fluid expulsion, although I think the author wants to state the opposite. Also, please be careful of using terms like ‘massive fluid expulsion’. Unless you can quantify what you mean by ‘massive’ I suggest avoiding.

Figure 6 – Please add the north arrow.

Figure 7 – The text sizes vary throughout the figures. Please be consistent. Please add to Fig 7a a scale bar, north arrow and colour bar. The chirp profiles in Figs. 7b-d are quite zoomed out and so it is difficult to track any horizons. You have an un-interpreted version of this figure in the supplementary material, so please add line interpretations for horizons and also a more zoomed in view of the stratigraphy. What do the dashed lined represent?

Figure 8 – The region of extrusion is shrouded by artefacts, so how have you defined the boundary of the MV? This boundary looks more like the margin of a zone of artefacts and doesn’t truly depict the margins of the MV.

Figure 9 – In the caption, should chirp profile be labelled left rather than right? This figure would also benefit from being broken into subsections, each of which is described in the caption.

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Figure 10 – The figure is well presented. Fig, 10d is too zoomed in to interpret.

Figure 11 – Good

Figure 12 – Nice figure. It would be good if it were integrated into the main body of text more as it is the final conceptual model.

Interactive comment on Solid Earth Discuss., <https://doi.org/10.5194/se-2018-118>, 2018.

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