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Review of *Solid Earth Discussions* Manuscript: *Boninite and boninite-series volcanics in northern Zambale: Doubly-vergent subduction initiation along Philippine Sea Margins,* by Perez, A. et al.

Reviewed by Scott A. Whattam: Submitted: 20-March-2018

c/o Editor

Dear Editor,

I have now finished my review of the aforementioned *SED* Manuscript which I provide below.

MS DESCRIPTION & SYNOPIS

On the basis of new field, geochemical, and mineral chemistry constraints, the manuscript explains the relevance of newly discovered high-Si boninites comprising the Zambales ophiolite as it pertains to subduction initiation scenarios for the region.

BROADER IMPACT

The ms will be of great interest to those working on the tectonic evolution of the western Pacific region as it provides key chemostratigraphic evidence to link NE-dipping subduction initiation (SI) to SW dipping SI at the IBM forearc circa 50-45 Ma.

PRESENTATION & SCIENTIFIC INTERPRETATION

Overall the text is well-written and free of grammatical errors; suggestions for improvement of the text are provided in minor instances and listed under “specific points” below. One point is that “the” needs to be used more often but it would be a daunting task to indicate everywhere in the ms this is required. Most of the figures are of high-quality; an exception is Fig. 6 which way “too busy”; there is too much data plotted on the figure. Would suggest plotting perhaps only data from this study. As well, there are some symbols in the plots which are not identified in the legend. For example in the first panel (MgO vs. SiO2, these different plots should be labelled a, b, c) the solid triangles are not described.

The main problem I have with the ms concerns the treatment of the tectonic configuration at and after subduction initiation (SI) and the concept of the "doubly-vergent" SI. This (doubly-vergent SI) is mentioned in the title and addressed in the final section of the manuscript. However, the data provided in this ms (essentially geochemical) cannot address this. I think the authors should probably just drop this section altogether or consider/provide alternative models for SI. An alternative title could be: *Boninite and boninite-series volcanics in the northern Zambales ophiolite: Implications for subduction initation along Philippine Sea Plate margins*. For example, there is no mention of a possible plume-induced SI scenario yet Figure 10a shows the Oki-Daito Plume smack in the middle (beneath) the WPB at (and probably just before?) subduction initiation. I believe that Wu et al. posit that the WPB formed as the result of plume emplacement pretty much at the same time or just before SI. An explanation for the cause of doubly-vergent subduction is not provided in the ms; I find the similar timing of SI on either sides of the WPB very difficult to explain without a plume-induced origin. Evidence for this (plume-contaimnation and hence a possible plume-induced SI scenario) would be in the form of isotopes from the proto-arc basalts and boninites which should record plume-contamination if there was a plume-induced origin (I am pretty certain that IBM FAB do not record evidence of plume-contamination). In any event, the SI scenario at the WPB appears to be similar to that of the Late Cretaceous along the Caribbean Large Igneous Province (CLIP). Whattam and Stern (2015) suggested that SI was likely plume-induced and resulted in subduction along a great portion of the periphery of the CLIP. The difference for this ms however, was that evidence for plume contamination was shown. Even if the authors do not address the doubly-vergent SI, the ms is still of great value as it documents a chemostratigraphy/chemotemporality identical to that of the IBM forearc.

SPECIFIC POINTS

1. Page 1, Abstract: Line 15: as this is the first discovery of hi-Si boninite in the Zambales ophiolite, this should be explicitly stated.

2. Page 1, Abstract: Line 18: place "the" before "Zambales ophiolite"; this has to be done in many instances throughout the ms

3. Page 1, towards bottom of the abstract: Perhaps should state that work on the Coto Block was done by others and not by this study; I had to subsequently look through the ms to see if work was done on both the Coto and Acoje blocks

4. Page 1, Line 31: would insert "and vice versa" at end of first sentence

5. Page 2, Line 2: after "plume-induced subduction initiation" should reference Whattam and Stern (2015) and Gerya et al. (2016) (I believe Whattam and Stern (2015) were the first to specifically coin this)

6. Page 2, Line 6: Don't understand what "Challenge No. 11" means

7. Page 2, Line 7: Would replace "including" with "with the exception of"

8. Page 2, Line 23: replace "verified" with "suggested"; we believe this to be the case, yes, but can't outright verify it

9. Introduction focuses almost exclusively of subduction initiation (SI) at the IBM; relevant, but SI has also been discussed elsewhere; as well, different ideas of how SI transpires → e.g., spontaneous vs. induced (Stern, 2004)

10. Page 3, Line 27: don't understand what "transitional" MORB means; transitional to MORB and IAT? If so, state this. As well, the IBM FAB which may be analogous to Coto Block MORB-like lavas, have characteristics intermediate to and which overlap MORB and IAT (e.g., Whattam et al., submitted). For example, whole-rock chemistry documents a an arc-like Ti-V ratio <20 and evidence of melting of an source more oxidized than MORB (higher Fe3+/FeT, Brounce et al., 2015). More on relation between Coto Block lavas and FAB later.

11. Page 4, Line 7: sentence ending with "transition zone" needs references.

12. Page 4, Line 24: I believe boninitic basalts was also mentioned earlier? These need to be defined at first instance (i.e., lavas which record MgO >8 wt. % and TiO2 <0.5 wt. % as per IUGS boninite definition but SiO2 <52 wt. %)

13. Page 5, Line 17: Again, confused as to whether paper included Coto Block; Maybe state in first sentence of this paragraph that study was conducted on Acoje Block (only)

14. Page 5, Line 24: change "lost weight" → weight lost

15. Page 5, Line 31: Spell out GSJ/AIST

16. Page 6: Section 5.1: This section is very "dense" and difficult to read. I suggest making a table showing the different lithologies and their mineralogy and textures, and then significantly shortening the written description here

17. Page 6, Line 15: Should of probably brought this up earlier, but similar to point 12 above, perhaps all the different categories of boninite (low-Si, high-Si, basaltic etc.) should be explained in the introduction or at least at an earlier point in ms

18. Page 6, Line 20: I think this is the first mention of Ogasawara? Mention where this is- Japan → part of IBM forearc?

19. Page 6, Line 24: change is → are

20. Page 7 Line 6: Insert "A" before peculiar

21. Page 7, Line 15: These LOI are very high. And what rock types exhibit these values? All or just high-Si boninites? These should be in the Table in Supp. Doc., correct? So put Supp. Doc. X at end of sentence. Maybe a plot of LOI versus various potentially mobile elements (e.g., MgO, K2O, Na2O, Ba) is warranted? Or at least some sort of statement like “though the LOI are high our petrologic arguments are based primarily on trace elements known to be immobile up to greenschist-facies conditions”. Are any filters being applied to your samples? For example, using only samples which yield 98-102 wt.% oxides or ones with <3 % LOI?

22. Page 7, Line 18: What is primary? And I note here that primary is used later on but not defined. Do you mean primary lavas such that exhibit high MgO, high Mg# (~≥65), high Cr and high Ni?

23. Page 7, Line 22: I think a reference is needed after “boninitic basalts”. Maybe Pearce and Robinson, or Reagan et al. (2017)? Not sure.

24. Page 7, Line 23: As mentioned at the beginning, Figure 6 is very “busy”. Would suggest plotting only samples from this study.

25. Page 7, Line 24: change second “and” → or

26. Page 7, Line 29: pristine? You mention above LOI values of 4-7 wt.%.

27. Page 7, Line 31: ug/g? usually reported in ppm

28. Page 8, Line 3: replace within with → between

29. Page 8, Line 15: Change so reads: Compositions of Zambales boninite…..are marked by low incompatible trace element abundances…

30. Page 8, Line 23: replace times with → x

31. Page 8, Line 25: insert boninite between Zambales and ophiolite

32. Page 8, Line 32: descending order is unclear; perhaps describe from base → top which is probably standard convention

33. Page 9, Line 6: Is unclear how can be classified as moderate-Fe tholeiites without the Miyahsiro plot overlain by Arculus’ low-med-high Fe series fields

34. Page 9, Line 20: Haugen (2017): Is this a MSc or PhD thesis (not indicated in references).

35. Page 10, Line 4: I think a paragraph at least is warranted to explain how the modelling was done using MELTS (supplementary document probably appropriate).

36. Page 10, Line 5: Ghiorso and Gualda (2015) not in references

37. Page 10, Line 16: change “in the base” to → at the base

38. Page 10, Line 17: break sentence; add ";" after "at depth"

39. Page 10, Line 20: change slightly deviate → deviate slightly

40. Page 10, Line 24: change does → do

41. Page 10, bottom of page: Would change Section 6.2 title to → Slab contributions

42. Page 10, bottom of page: Would include more up-to-date references for boninite petrogenesis

43. Page 11, Line 7-8: OK, but they are equally LREE-depleted. What is the explanation for the spoon-shaped REE patterns? I think for the "classical" U-shaped signatures that the explanation is high-degree partial melting (which produces low MREE) which is subsequently slab-fluid modified to produce LREE enrichment; not sure of explanation for the high HREE

44. Page 11, Line 13: Maybe explain at beginning of section that Ba/Th is a marker/gauge of shallow slab-contributions and reference (Pearce et al., ?) Why Ba liberated at shallow conditions? Low temperature (I think); low P as well?

45. Page 11, Line 14: insert "increasing" after "mirrored by"

46. Page 11, Line 15: reference Fig. 8b after Th/Yb

47. Page 11, Line 16: what is decoupled?

48. Page 11, Line 18: Insert "A" before "high U/Th ratio"

49. Page 11, Line 19: change ratio → ratios; change by → if; add "to source" at end of sentence

50. Page 11, Line 21: the La/Th vs. Sm/La is not shown so have to indicate this

51. Page 11, Lines 30-31: Why mention slab melts? This is not mentioned previously and I don't think anyone familiar with boninite petrogenesis would consider slab melts as part of the equation.

52. Page 11, Line 2: change so reads: transitional between MORB and IAT

53. Page 12, Line 3: Change "in" → on the basis of

54. Page 12, Lines 3-4: Confusing sentence; why mention distinct from Mariana BAB?

55. Page 12, Line 5: Another confusing sentence; have to get point across that depletion in REEs, TiO_2, Zr and Y of Acoje relative to Coto documents the progressive depletion of…what about LILE enrichments? These should increase from Coto → Acoje

56. Page 12, Line 10: Can't readily see where Coto lavas plot in Ti/V space but this is a very important point as FAB can be distinguished by MORB on the basis of Ti/V which is arc-like (>20) and by virtue of elevated Fe^{3+}/Fe_T indicative of a more oxidized (arc-like) source. Suggest you state what the Ti/V

ratios of the Coto lavas are and compare these with those of IBM. Are they similar or not?

57. Page 12, Section 6.4. See the Presentation and Scientific Interpretations section

58. Page 13, Line 12: insert “above a west-dipping subduction zone” after (Ishizuka et al., 2011)

59. Page 13, Lines 15-20: sounds perhaps like a plume-induced SI scenario

60. Page 14, Lines 6-8: Why feasible? No explanation for this (doubly-vergent subduction)

61. Page 14, Line 11: Change north-verging → NE-verging