

***Interactive comment on* “Seismic reflection data reveal the 3D structure of the newly discovered Exmouth Dyke Swarm, offshore NW Australia” by Craig Magee and Christopher A.-L. Jackson**

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General Comments

The topic of this paper is the study of a newly discovered dyke swarm offshore NW Australia. The paper uses the seismic reflection method to elucidate the lateral extent, depth, thickness and spacing of dykes identified in 26 VZD's (vertical zones of disruption). The study is significant because of the newly identified dyke swarm and the implications that the timing and extent of this magmatism have on the geological history of the area.

The study is exceptional in its detail, the figures are excellent and the text is very well written. I have some suggestions on how the manuscript could be improved, particularly with respect to quantifying strain, magma volumes, describing errors and discussing how far the measurements can be taken to inform interpretations. I also make a few suggestions about additional context and assumptions behind statements which I think should be explained more fully.

Overall, I find this to be an interesting paper and case study with an exceptional dataset. If my comments can be addressed then I would be happy to support its publication.

Best wishes,

Janine Kavanagh

Specific Comments

A) Geometric dimensions and magma volumes:

1) The word 'length' is used but it took me a while to understand clearly what direction that was exactly. 'Width' is also used and then 'thickness' sometimes too. Please use these words consistently throughout and give a clear definition at the start. I suggest adding 'vertical' or 'horizontal' to the word 'length' to make it without doubt which direction you are describing. Also I suggest always using 'thickness' for the shortest dimension is described. This is then more consistent with existing geological publications of dyke datasets too.

2) Is it possible to give an estimate of the dyke-related magma volume in the area?

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How significant is this in the geological history?

B) Strain estimation:

1) How much strain has the dyking accounted for across the area? How does this compare strain accumulated due to spreading rates during the active period (based on your 'timings' constraints)? Comparing these rates would perhaps enable you to comment on if the dykes were overpressured or not.

C) Impact of errors and limitations on interpretations:

1) The error quantification really seems key to what can and cant be said in this study. It appears the VDZ thickness (for example) generally is thicker than dyke thickness, so please state this early on in the paper. What is the composition of these dykes? Can you use the general thicknesses of dykes in sedimentary basins to see how the VDZ thickness compares? Seems strange to place errors as '+/-' without a bit more explanation.

2) It seems likely VDZ thickness overestimates dyke thickness quite substantially? Is it likely to be consistent e.g. as

D) Applications to other sites:

1) I think something that is missing from the text is a comment about what your study means for reinterpreting datasets where dykes may have intruded and yet cant be imaged? Is there an opportunity to state what proportion of magmatism might be underestimated in relevant comparative regions?

Technical Corrections

Abstract

Line 8 – 'extend laterally for..'

Line 9 – ‘their presumed rapid emplacement,..’

Line 16 – can you give an indication of the quantification of the detail? To what quantity of resolution?

Line 16 – what do you mean the latest? Relative to what?

Line 17 – the word ‘long’ needs some context. Is it the horizontal ‘length’? The vertical ‘length’? Length generally implies to the longest dimension. Are these vertical dykes or blade-like (horizontal) dykes? How deep do they extend?

Please give a general overview of the measurements made.

Introduction

Line 25 – please define ‘rapidly’ quantitatively (or at least give a range of timescales).

Line 27 – ‘We recognise’ – I think you mean in the literature there are 3 dyke swarm geometries. Please rephrase to take yourselves out of the writing.

Line 34 – ‘..emplacement is thought to be primarily..’

Line 34 – ‘extending the host rock rather than through magmatic overpressure’.

Line 36 – ‘drive crustal extension, influencing..’ – I wonder if this really can be stated based on the observations, or could it be said these dykes are a consequence of crustal extension? Seems the latter if the magma passively fills fractures.

Line 39 – ‘syn-emplacement stress conditions’ – please clarify that these stresses could be local or regional

Line 48 –magnetic surveys provide insight too.

Line 53-54 – Kavanagh and Sparks (2011) data also describes vertical variation in dyke geometry, as well as the lateral variation you attribute.

Line 54-57, 67-68 - Phillips et al. (2018), Magee et al. (2019) – how is your paper different to these? Please clarify.

Line 72 – ‘length’ – this needs some orientation in space. Lateral? Vertical? Not both?

Section 2

Please state the composition or compositional range of the magma.

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Section 3

Line 161 – “controls and is reflected in” – isn’t this the same statement repeated? Either ‘controls’ or ‘reflected in’ would be sufficient. I don’t see the difference.

Line 162-163 – “dyke lengths” – I am confused by what you mean by ‘length’. Vertical or horizontal dimension? Clarifying this at the start of the paper would be helpful.

Line 164-165 – “follows a Weibull distribution” – can this point be made as generally as this? These are just two studies you point to, and actually the suggestion is primarily made in the Krumboltz paper only. Please give some context to the statement. I don’t think the statement can be generally made based on just these two papers cited.

Line 166 – ‘dyke geometry and distribution’ seems more appropriate than ‘dyke properties’

Line 170 –remove comma ‘plan view tip-to-top length (L)’

Line 170 –now I understand what you mean by ‘length’. I think it would be clearer if you rephrased throughout the paper as ‘horizontal length’ to be clearer.

Line 173 - Ditto with regard to the use of ‘width’. In the other datasets you referred to in the literature review this dimension was called ‘thickness’ so please be consistent with this and rephrase.

Line 198 – ‘VZD thickness’ would be clearer (rather than relating a width to a thickness, relate a thickness to a thickness)

Section 5

Line 323 – “We therefore consider it unlikely that the VZDs are faults.” If these dykes have not intruded existing faults, then does this suggest the dykes created there own fracture during propagation and were overpressured?

Section 6

Line 391 – ‘breadth, thickness and spacing’

Line 396 – ‘Seismic reflection data thus provide a unique opportunity to examine and

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quantify the 3D structure of a dyke swarm independent of the potential bias introduced by the processes (e.g., erosion) controlling how dyke swarms intersect the surface.' I feel this is overstated. It is possible to access different depths of dyke swarms in the geological record by studying areas at different palaeodepths. The thickness increase of dykes with depth based on seismic data seems too speculative at the moment given the errors associated with the method (particularly in that dimension).

510 – I am not yet convinced that subtle changes in VDZ thickness can be related to dyke thickness changes. The errors appear to be too large.

513 – there is ongoing discussion about the Bardabunga dyke swarm and the origin of the magma. The lateral propagation is a hypothesis, however there is also evidence suggesting vertical propagation. So I don't think Bardabunga can be used so decisively to state dykes in your area propagated laterally.

Figures

Generally of the highest quality. Excellent.

Figure 1 - I like this figure but please remove the 'magma pond' at the base of b-d as it is not needed in your figure and is speculation on the nature of the magma source (suggesting it were entirely molten at once and was a large reservoir, whereas it may also have been transient small batches of distributed melt).

Interactive comment on Solid Earth Discuss., <https://doi.org/10.5194/se-2019-201>, 2020.

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