Review of the article Variability of geothermal gradient across two differently aged continental volcanic passive margins: The Southwest African and the Norwegian margins by Gholamrezaie et al.

This paper represents an interesting addition to the research focused on cooling histories of continental margins and their controlling factors. Although I have enjoyed reading it, it can be further improved to reach good quality. Below are my key points suggesting revisions of specific items. Given the extent of suggested revision, it can be classified as moderate.

General comment:

Paper needs to demonstrate more awareness of previous work. While the previous work on specific chosen margin examples is cited a bit better, the paper seems to work in relative isolation from studies done on thermal histories and their controlling factors.

Specific items:

Abstract:

Line 11 – make a full term and place LAB into parentheses. Otherwise your reader has to wait until she gets to page 7 to understand what you mean.

Text:

Introduction:

p. 1, lines 16 and 21: Order your citations according to the publication year. Do this in the entire manuscript.

p. 1, line 21: Use original references instead of relatively modern ones wherever applicable to honor the scholars who came up with certain idea originally. Do this in the entire manuscript.

p. 2: When you are introducing the thermal history of both the oceanic crust and lithospheric mantle, you need to use the knowledge from the pioneers of this research: Parsons and Sclater (1977), Stein and Stein (1992), Goodwillie and Watts (1993), Watts and Zhong (2000)

Method:

p. 3: Tab. 1 needs a bit of explanation either in figure caption or, preferably, in the text. The reason for this is that you are making a claim that both margins have a very similar configuration of crust (p. 2, lines 29-30) but Tab. 1 indicates a large difference in characterizing the average thermal conductivities of oceanic crust, and a distinct difference between the conductivities of high-velocity bodies. Such a difference should have an impact on the thermal history of these two study areas.

p. 4, line 24: Make sure that your figures are cited in ascending order in your text. Here you are making a jump from Fig. 1 directly to Figs. 4 and 7.

p. 4, lines 25-27: It would be better to compare "apples and apples". Instead of comparing thermal gradients of 1 km-thick layers, you are comparing those of layers which are progressively 1km thicker than each previous one. I know that you can still see the downward-decreasing gradient using this approach, but aren't we supposed to compare the most directly comparable things when we do the research based on a comparison?

p. 5, Fig. 1 caption: Here you wrote a caption, which could make an impression that you are calculating thermal gradients for six 1km-thick layers. Make sure that this caption is in accordance with your text on p. 4, lines 25-27.

Exploited models:

p. 5, lines 9 and also 11: You can use older original references, rather than a random choice of younger ones. It would show your command of literature and understanding, which studies brought the original knowledge and which ones were just developing it further. Suggestions: use some of the articles by Huismans and Beaumont and some of the articles with Manatschal co-authoring, for example

p. 6, lines 3 and 10-12: Use just 2-3 references for specific knowledge item. You will save some space. Make sure that you choose the original ones for the idea.

p. 6, line 16: Here you are describing a similar character of both margins. However, this could be a good place to discuss those differences in thermal conductivities from Tab. 1 to lay down the groundwork for your later discussion about reasons for 2 different thermal histories. Here you can also touch on different thickness and distribution of sedimentary cover …etc. Honestly, when I look at your Fig. 11 a, the two margins look rather different. Thicknesses of adjacent oceanic crusts are very different. Thicknesses and geometries of sediments – very different, volumes and geometries of high-velocity bodies – very different, geometry of thinning in the crystalline continental crust – very different. If you do not make a thorough comparison, your reader may think that you have found very similar margins where one can see what the different time for the dissipation of rifting/breakup-controlled transient does to their present-day thermal regime. However, your case requires much more thinking involved in the comparison of the two margins because the ratio of various interacting factors in control of their present-day thermal structure is different.

p. 6, line 26: "… COB after Pawlowski (2008)…" should be rather described as "COB determined from ….this and this constraining data (Pawlowski, 2008)…"

p. 10: You also have one more problem to discuss, if you want to compare the two chosen margin examples, because they are not "apples and apples". While the S Atlantic one is a pure rifted margin, the Norwegian one has a large transform margin segment dividing the Møre and Vøring rifted margin segments. The two Norwegian margins are also characterized by being tectonically and thermally affected by multiple rifting events, instead of a single one that evolved into the breakup in S Atlantic case. How do you filter out these two effects in the case of Norwegian example to be able to compare the two case margins with respect to their controlling factors such as the LAB geometry, thermal blanketing by young sediments and thinning geometry of the continental crust?

Results:

p. 13, line 18: replace "theses" by "these"

p. 14 and 15, Fig. 8 and 9 captions: This caption describes already a third version of your thermal gradient calculation, now letting your reader think that they are calculated at a set of six depth levels, the deepest one being 6 km deep. Make sure that your manuscript carries a unified story of your thermal gradient calculation and display.

p. 16: The Norwegian Margin: Here you need to do more than the descriptions of geological reasons for gradient distributions that you have here. The reason is that when you want to compare various geological reasons for such complex (and not equilibrated yet) Møre-Vøring thermal field, you need to know that:

It is the deformation history that has a controlling role on the tectonic and thermal development, as concluded from a comparison of Møre and Vøring neighbor margins in Norway (Fernandez et al., 2005). The differences of the magma-rich Vøring margin from magma-poor Møre margin are:

1) the occurrence of the extra rifting event at the beginning of the rifting history;

2) two times thicker underplated body underneath the distal margin;

3) 30 km thicker original Caledonide lithosphere;

4) a slightly smaller stretching factor;

5) larger thickness of adjacent oceanic crust; and

6) a 10 km thinner lithosphere underneath the distal margin.

These differences were attributed to different rifting histories, including the enhanced heat transfer from the oceanic crust adjacent to the Møre margin to continental crust of the Vøring margin through the contact provided by transform and occurrence of the ridge jump responsible for the separation of the Jan Mayen micro-continent initially adjacent Møre margin (Fernandez et al., 2005).

The cumulative length of rifting events at a magma-rich Vøring margin is long. The extension initiated here in late Permian and ended by Paleocene/Eocene break-up, comprising late Permian-Triassic, late Jurassic-Early Cretaceous, Late Cretaceous-Paleocene extensional events (Ziegler, 1989; Brekke, 2000; Skogseid et al., 2000; Gernigon, 2002; Van Wijk and Cloetingh, 2002).

The regional crustal stretching and subsequent crustal necking in the Vøring scenario is characterized by the last activity timing shift towards the stretching axis (Geoffroy, 1994, 2005; Schlindwein and Jokat, 1999). Unlike the S Atlantic example, in the Vøring example the crustal stretching and stretching/necking transition took about 204 Ma, although characterized by discontinuous extension. The extension initiated in late Permian in outboard locations and continued until the Paleocene/Eocene boundary in inboard locations (Ziegler, 1989; Brekke, 2000; Skogseid et al., 2000). The Paleocene was characterized by the emplacement of traps that buried the pre-existing Late Cretaceous normal fault patterns (Geoffroy, 1994; Gernigon, 2002). The transition from crustal stretching to necking then took place rather quickly, during Paleocene/Eocene transition, culminating with the break-up (Gernigon, 2002; Van Wijk and Cloetingh, 2002). While the Mesozoic stretching rate was as low as $7*10\text{-}16s^{-1}$, taking place during 75 Ma (Gernigon, 2002), the Paleocene/Eocene stretching-necking transition was exceptionally fast (Hinz and Weber, 1976; Roberts et al., 1979).

This comment reminds me that you probably need to discuss more about the main controlling geological facts at your S Atlantic margin as well – to make sure that one understands why there is such a big difference between the two chosen case margins: e.g., thicknesses and geometries of sediments – very different, volumes and geometries of high-velocity bodies – very different, geometry of thinning in the crystalline continental crust – very different.

Interpretation and Discussion:

p. 17, line 10: write “field” instead of “filed”

p. 21, lines 21-23: It is difficult to make a claim that other scholars make only such simple assumptions is you read papers like Hutchinson (1085), Evans et al. (1991), Person and Garven (1992), Bertotti and ter Voorde (1994), ter Voorde and Bertotti (1994), Gvirtzman et al. (1997), Mancktelow and Grasemann (1997), Ehlers and Chapman, 1999, Lin et al. (2000), Ehlers et al. (2001, 2003), Armstrong et al. (2003), Green et al. (2004), Coolbaugh et al. (2005), to name a few, where people study temperature profiles changing in space and time (and, sometimes, not just using a heat conduction approach but also an added heat convection due to fluid flow).

The same applies to p. 21, lines 24 and 26-28. Make sure that you show the awareness of the knowledge brought by others.

Conclusions:

p. 22, lines 8-11: Don’t you want to discuss the effect of oceanic crust transferring some heat into the adjacent distal margin? You have two case examples with dramatically different thickness of oceanic crust and one of the examples has a transform margin segment in it (that one should have done something to the thermal history of the continental margin, as we can see from publications such as Nemcok et al. (2012), Henk and Nemcok (2016)).

Reference list:

Not all citations are ordered alphabetically (see p. 24, Noack and Naeser).