Clim. Past Discuss.,
https://doi.org/10.5194/cp-2020-48-AC2, 2020

Climate of the Past Discussions

Interactive comment on "Exploring a link between the Middle Eocene Climatic Optimum and Neotethys continental arc flare-up" *by* Annique van der Boon et al.

Annique van der Boon et al.

avanderboon.work@gmail.com

Received and published: 22 June 2020

We thank the reviewer for their kind words and support of our manuscript.

[Author reply to comment 1 by Reviewer 2]: We agree with the reviewer there are many different and conflicting tectonic and petrogenic models for Eocene volcanism in Iran. A thorough review of all of the geologic settings of these different areas of Iran is a huge task that is deserving of a study in its own right. We mainly intend to show in this study that there is a huge increase in volcanism in Iran during the Eocene in all of these regions, regardless of their tectonic history and petrogenesis, which is why we do not discuss all the petrologic models in detail. To give some more background information,

we will add to the Introduction:

Geologic settings of the Eocene volcanic regions in Iran differ. Extensive magmatism in the Lut block is regarded by Pang et al. (2013) to be the result of post-collisional convective removal of the lithosphere and not directly related to subduction. Volcanism in the Sabzevar zone is linked by Moghadam et al. (2016) to lithospheric delamination, possibly assisted by slab-breakoff. In the Talesh/Alborz region, there are conflicting theories on the formation of the volcanic rocks. Asiabanha & Foden (2012) mention a post-collisional transition to a continental arc in their title, but then describe the volcanism as back-arc volcanism. Van der Boon (2017) gives an overview of proposed conflicting settings for volcanism in the Alborz. It is striking that in most of the areas in Iran, the flare-up is linked to an extensional setting (e.g. Verdel et al., 2011), which makes it different from other flare-ups (e.g. Ducea et al., 2015; Ducea and Barton, 2007).

[Author reply to comment 2 by Reviewer 2]: We fully agree with the reviewer that more detailed research on this topic could strengthen or invalidate our results, and we hope that our study encourages further study on the Iranian Eocene volcanics and their CO2 emissions. Here we describe the state-of-the-art regarding the dating of the volcanic deposits. There is currently not a lot of data available on Eocene melt inclusions in Iran, there are only very few that are focused on mineralisation, so this kind of work could provide more insights into settings of Eocene volcanism, ideally on a similar large scale as we present our dating.

In order to bridge the gap between the scales, we thus have to rely on the scarce information that is available on magmatic volumes and related CO2 content, and only the well-studied Deccan traps have estimates for this. We thus use what is available, and that is unfortunately only information from the Deccan traps. To our knowledge, there have been no studies that constrained the amount of CO2 per volume of arc volcanic rocks. We note that that is also a more difficult task, due to the varied nature of the different rock types in arcs (i.e. nearly every type from mafic to felsic, while LIPs

consist mainly of basalt).

To comply with the reviewer's comment, we will modify lines 132-133 to: "Due to the absence of quantifications of the relation between the erupted volumes of volcanic rocks and emission of CO2 in continental arcs, we make a comparison with the Deccan traps, for which this relation has been calculated." As mentioned in lines 139-140, this likely results in a minimum estimate for the amount of CO2 related to Eocene volcanic activity in Iran.

[Author reply to comment 3 by Reviewer 2]: The study of Soreghan et al. 2019 is very intriguing but at the same time highly speculative. For example, Lee and Dee (2019) discuss the Soreghan et al. paper, and state that individual eruptions might manifest as short-term cooling events superimposed on an otherwise warmer baseline. This is more consistent with the paradigm. The Eocene in Iran consists of many units that contain volcaniclastic rocks that have been interpreted as the result of explosive eruptions that might potentially cause some degree of dimming (e.g. Asiabanha et al., 2012; Asiabanha and Bardintzeff, 2013). Many of the Eocene volcanic units in Iran are mapped as 'Eocene volcanics' and thus not allow us to precisely quantify the amount of pyroclastics and ignimbrites, as Soreghan et al. (2019) have done. Also eruption magnitudes are not estimated for Eocene volcanic rocks in Iran, and there have been no reports of large calderas besides one in Tafresh (Ghorbani & Bezenjani, 2011). Most importantly, however, we here test for a link between a phase of global warming through volcanic CO2 forcing rather than a cooling through volcanic aerosol formation. For these reasons, we at this point choose not to discuss this issue.

[Author reply to comment 4 by Reviewer 2]: This comment is similar to comment 2 of Reviewer 2. Please see our response at comment 2.

Interactive comment on Clim. Past Discuss., https://doi.org/10.5194/cp-2020-48, 2020.