

Interactive comment on “SILLi 1.0: A 1D Numerical Tool Quantifying the Thermal Effects of Sill Intrusions” by Karthik Iyer et al.

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Dear Reviewer 2,

Thank you for your constructive review which helped us better evaluate the presented model and make suitable changes where required. A point-by-point answer to the review is as follows (line numbering according to revised manuscript):

1. A little background and context to the modelling around intrusions would help the reader to see more clearly the novel aspects of this model (for example, perhaps some broader discussion early on as to the wider affects of intrusions on organic rich sedimentary successions, particularly with respect to hydrocarbon prospectivity (although not the primary focus of this paper will certainly be of significant interest to the field and

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indeed requires some finer background detail in line with the time spent on thermo-genic gas, PETM etc). Suggested Refs to broaden background: Archer et al (2005); Rodriguez et al (2005, 2006) – especially for comparison with the 2D models within, alongside some comparison of other modelling methods in refs already noted. Perhaps also Schofield et al 2015 or Muirhead et al 2017 for a broader view on organic matter alteration adjacent to intrusions). Specifically, why is this modelling method more applicable than/or add to the other modelling?

- We have enhanced the introduction on modelling of sill intrusions by adding a short segment on the effects of intrusives on hydrocarbon prospectivity as suggested with the relevant references (Lines 52-59: “Magmatic intrusions are also of particular interest for hydrocarbon prospectivity and can impact petroleum systems in positive and negative ways (Archer et al., 2005; Monreal et al., 2009; Peace et al., 2017). High temperatures in the thermal aureole around such intrusions may induce maturation and hydrocarbon generation in immature, shallow strata that may have not been productive under normal burial. On the other hand, pre-emptive maturation of hydrocarbons around an intrusion may result in loss of hydrocarbons if a suitable reservoir has not yet formed. Additionally, pre-existing oil in a reservoir may crack to gas in the vicinity of magmatic intrusions resulting in degradation of a potential prospect.”). We have also modified the introduction so that it better conveys the motivation behind the model and its strengths (Lines 84-93: “The motivation behind the model and manuscript is to make a standardized numerical toolkit openly available that can be widely used by scientists with varying backgrounds to test the effect of magmatic bodies in a wide variety of settings using readily available data such as standard well logs and field measurements. The model incorporates relevant processes associated with heat transfer from magmatic intrusions such as latent heat effects, decarbonation reactions and organic matter maturation and also accounts for background maturation and erosion by systematically reconstructing the entire present-day sedimentary column from the input data. Lastly, the model results can be easily compared to the two most widely used aureole proxies in sedimentary rocks, vitrinite reflectance (VR) and total organic carbon

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(TOC) data.”).

2. The correlation of modelled and actual TOC and VR is compelling, however the manuscript would benefit from some more detail about how the data is refined e.g. lines 384-386 and how this ties back to the methods above. Although TOC and VR have been typically used as a measurement around sills for decades – how does this correlate to other maturity parameters such as mineralogical markers, biomarkers?

- We have elaborated on how we refine the input TOC data in the manuscript if this data is not known (Lines 424-429: “Initial average TOC data for the sedimentary layers away from the sill intrusion is not known but can be roughly estimated using present-day values, i.e. the TOC values will be higher than current values as TOC is thermally broken down close to the intrusion. The initial input TOC data is subsequently refined so that a better match of the model results to the observed data is obtained, thereby highlighting how the model can be used to constrain initial conditions within the sedimentary column (Figure 9).”). In order to do so, we first estimate the TOC content, if it is not measured, by using a higher than present day value since TOC is thermally broken down with time. If the values do not result in a good fit to present-day TOC values than the initial input values are subsequently refined until a good fit is obtained. We have also stated that the user can correlate other, ‘non-standard’ maturity parameters themselves using its correlation to the temperature-time evolution from the model results if this correlation is known (Lines 280-282: “Similarly, correlation to other maturity parameters such as mineralogical markers or biomarkers (e.g. Muirhead et al. (2017)) can be performed by the user using the time-temperature evolution from the model if so desired.”).

3. The extent of the thermal aureoles of sills can be measured using TOC and VR (as discussed, among many other parameters). In the Model Input section these are displayed as ‘optional’. Organic matter will frequently thermally alter in very different manners to mineralogical material and surely one or other parameter must be used to help gauge the full thermal impact of the sill? Clarity over the use of VR and/or TOC

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would help the reader.

- Present-day measured TOC and VR values are ‘optional’ in terms of user-input to the model since these values are not always measured or available. This does not inhibit the user from running the model.

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