Editor's Comments dated 12 June 2024

Dear Dr Cassel et al,

Thank you for the prompt reply to my comments.

I am not fully convinced with your response regarding the depositional environment of SDRs. Most direct observations of SDR-like features (i.e., from offshore drilling/dredging or from analogues exposed in the field) suggest that inboard ones are emplaced in subaerial or shallow water environment, while outboard ones might form in shallow marine setting (e.g., Direen and Grawford, 2003/https://doi.org/10.1144/0016-764903-010; and reference therein).

In any case, this is a very debated topic and since the additional arguments that you've provided will be publicly available to the readers, I am happy to see this latest version of the manuscript published.

I will inform the Support Team of my decision, which will be in touch regarding the manuscript production.

Congratulation for this nice piece of work and thank you for choosing to publish in our special issue.

Mohamed Gouiza

Response by Authors to Editor's Comment of 12 June 2024

We understand your concerns that many readers may only be familiar with the sub-set of SDRs that form at sea-level.

A fundamental problem may be what is meant by the term SDRs. The term is shorthand for volcanic seaward dipping reflectors (the volcanic is usually omitted) and sensu-stricto it is a purely descriptive term. The most investigated SDRs are of course the spectacular thick ones with long flow lengths which formed subaerially or near sea-level (e.g. Voering, Moere, Demerara Plateau, Pelotas). These SDRs come immediately to mind when one reads the word SDRs – but magmatic extrusives displaying SDR characteristics also form in deep marine environments particularly at margins with normal magmatic addition.

We have modified the text and added appropriate references to make this point clearer.

Response to Editor's Comments of 4 June 2024

Dear Cassel et al.,

Thank you for revising your manuscript and thoroughly replying to the reviewers' comments.

After reading the revised manuscript and your rebuttal, I think that there are two points that were raised by the reviewers that still require your attention:

1- The use of time (i.e., TWT) to describe primary observations from the seismic lines:

in your rebuttal you justify the use of time instead of depth by the lack of accurate/reliable seismic velocities, which would make any depth conversion highly uncertain.

However, your own modelling work (i.e., 2D flexural back-stripping) relies on depth converted sections.

This make me wonder how reliable are the modelling results that you have obtained?

- i.e., post-rift accommodation and its relationship with breakup volcanic addition.

Response

We apply flexural backstripping and decompaction to post-rift sediments only; we do not apply it to the extrusives volcanics below post-rift-sediments. As a consequence we avoid errors arising from the depth-conversion of extrusive volcanics. Errors in the depth conversion of post-rift sediment thickness will exist and affect the magnitude of water-loaded accommodation space determined by flexural backstripping and decompaction. However these errors are consistent between profiles and relatively minor so that the relative differences in accommodation space between profiles and our overall observation and interpretation are not changed.

2- One of your main conclusions is the depth in time at which first volcanics occur

- i.e., ~2s TWTT for magma-rich margin, and 6-7s TWT for "normal" magmatic margin.

This is confusing for two reasons:

(i) as one of the reviewers rightly highlighted, current models of SDR emplacement assume that they are subaerial flows, as you mention your conclusions. If these depths are not emplacement depth then what are they exactly?

Response

Magmatic extrusives commonly take the form of seaward dipping reflectors (SDRs), resulting from the lateral migration and accretion of both subaerial and submarine lava flows during rifting, breakup and initial sea-floor spreading (Harkin et al., MPG 2020). The reviewer statement (i) above is incorrect ; it implies that the current model of SDR emplacement assumes that all SDRs are formed as sub-aerial flows. It is only correct to say that some SDRs, usually with long lateral flow lengths, are emplaced as subaerial flows. However this does not apply to all SDRs. Many occurrences of extrusive

magmatism at rifted margins (perhaps the majority) with sea-ward dipping attributes (i.e. SDRs) have deposition with relatively short flow lengths and are emplaced in relatively deep water.

(ii) What are the geological/physical processes/factors that control this depth of first volcanics?

Response

The water depth of first volcanics is controlled by the isostatic consequences of the relative timing of crustal/lithospheric thinning and the onset of melt production by decompression melting (see Chenin et al 2023). Factors advancing the initiation of melt production with respect to crustal/lithospheric thinning are elevated lithosphere and asthenosphere temperature and/or inherited lithosphere chemical enrichment. Factors delaying the initiation of melt production with respect to crustal/lithospheric thinning is inherited lithosphere chemical depletion.

I think that these aspects need to be addressed in the manuscript to remove some of the remaining ambiguities regarding your work and your results.

Mohamed Gouiza