Authors Response to Reviewer’s Comments

Comment 1

We have revised Figure 8 adding a, b, c and d labels.

Comment 2

We have updated figure 8b, c & d and associated text to make clearer our measurement and reporting of the TWTT of first proximal SDRs. Our revision explains more clear the uncertainty range shown in figure 8 and how it arises. The revised text is as follows:

“Examination of the seismic reflection sections in the time domain shows that the TWTT for the first appearance of proximal SDRs is also very variable. The observed north to south variation of TWTT of first volcanics is plotted as a function of latitude in Fig. 8b. For the purpose of showing the uncertainty in the measurement, two measurements of the TWTT of first proximal SDRs are plotted for each profile corresponding to lower and higher measured values. The term SDR *sensu stricto* simply means “seaward dipping reflector”, and while the common use of the term is applied to volcanic seaward dipping reflectors, seaward dipping reflectors can also be generated by sedimentary sequences within fault controlled half-grabens. The lower TWTT values shown in Fig. 8b may correspond to either the onset of volcanics or sedimentary accumulations; their exact nature cannot be reliably determined using the available seismic data alone. In contrast the higher TWTT values shown in Fig. 8b represent a much more certain measurement for the onset of volcanics. The TWTT of first volcanic SDRs, using either lower or higher measured values, shows an inverse correlation with the magnitude of volcanic addition shown in Fig. 8a.

The lower and higher measurements of first proximal SDRs are shown in Fig. 8c for the magma-rich margin profile S1 over the Torres High in the north, and in Fig, 8d for the magma-normal margin profile S3 in the south. For profile S1, TWTT measurements lie in the range 1.2 to 2.2 s. These values are similar to those reported by Mutter et al. (1982) and Planke et al. (2000) for the long flow-length SDRs on the Voring segment of the Norwegian margin which formed at or above sea-level and have subsequently thermally subsided. For profile S3, TWTT measurements lie in the range 4.2 to 6.5 s similar to those reported by Planke et al. (2000) and Hinz et al. (1999) for the deep marine erupted SDRs on the Exmouth Plateau the Argentine margins.”

Comment 3

We have expanded the text making it clearer that it has long been known that SDRs do not form exclusively subaerially and that they also form in deep-water. We cite references making this point (Hinz et al 1999, Planke et al. 2000). If there is a common misconception that SDRs only form subaerially, then this additional text should help to correct that. The additional text making this point is as follows:

"SDRs with long flow lengths and large thicknesses, which form by extrusive magmatism in a sub-aerial environment, have been extensively studied (Mutter et al., 1982; Planke et al., 2000; McDermott et al., 2019; Harkin et al., 2019). However volcanic SDRs also form in a deep marine environment as voluminous effusive sheet flows (Planke et al., 2000) as shown in Hinz et al. (1999, figure 14), Planke et al. (2000, figure 9) and Sapin et al. (2021, figure 6). In this paper we use the term SDRs to denote the general observation of volcanic sea-ward dipping reflectors not only applied to those formed in a sub-aerial environment but also to those formed in deep water."

Comment 4

In the application of Warner's 10s rule in figure 9 we have added that we used a basement seismic velocity of 6.5 km/s. The updated text reads:

"Warner (1987) observed that the Moho TWTT on marine deep long-offset seismic data was consistently at about 10 s TWTT for thermally equilibrated lithosphere and was remarkably constant (flat) in time irrespective of the complexity of the geology above including sediment thickness variation. Invoking Warner's 10 s rule for the Moho TWTT for thermally equilibrated lithosphere allows the cross-sections shown in Fig. 9c and Fig. 9d to be converted into the time domain as shown in Fig. 9e and Fig. 9f. To do this basement thickness is converted to interval TWTT (using a basement velocity of 6.5 km/s) and subtracted from 10s to give the TWTT of top basement; this estimate of TWTT of top basement is therefore independent of the interval TWTT of bathymetry and post-rift sediments. In the time domain, first volcanics are predicted to occur at ~ 1.5s TWTT for the magma-rich model, while for the magma-normal magmatic addition model first volcanics occur at ~ 5.5 s. These model predictions are consistent with the observed TWTT of first proximal volcanics between 1.2 to 2.2 s for the Torres High Profile S1 and 4.2 to 6.5 s for the Rio Grande Cone Profile S3 shown in Fig. 8. It should be noted that the model prediction assumes a fully equilibrated lithosphere thermal structure while the Pelotas margin with Early Cretaceous breakup age is not yet fully re-equilibrated."

Comment 5

We have modified the summary of TWTT of first volcanics as explained in our response to comment 2. The 6th bullet point now reads:

- In the time domain, a magma-rich margin, with sub-aerial SDR flows, shows first volcanics between 1.2 to 2.2 s TWTT while a "normal" magmatic margin has first volcanics between 4.2 and 6.5 TWTT.

Comment 6

We have added text at the end of section 5.3 as suggested to expand on the usefulness of using TWTT of fist volcanics to distinguish magma-rich margins from margins with normal magmatic addition. The text reads:

"A common classification of rifted margins is whether a margin is magma-rich, magma-normal or magma-poor. An obvious approach to distinguishing a magma-rich from a magma-normal margin, or a margin's position in between these two end members, might appear to be through measurement of the volume of magmatic addition. However the problem arises, as highlighted by Tugend et al. (2020), that in practice thinned continental crust at a rifted margin cannot reliably be distinguished from volcanic extrusives above it and magmatic intrusives (underplate) below for reasons explained by Karner et al. (2021). As a consequence it is not possible to accurately measure the volume of magmatic addition at a rifted margin. Tugend et al. (2019) and Chenin et al (2024) also show that the relative timing of decompression melting with respect to crustal thinning may be as important as magmatic volume in generating a magma-rich margin. As shown above, the TWTT of first proximal volcanics may represent a practical and efficient method of distinguishing a magma-rich form a magma-normal margin, or for placing a margin in between these two end-members."