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Plate-plume interaction driving microcontinent formation in the South Atlantic: The Rio Grande and Valdivia microcontinents

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The Rio Grande Rise and Valdivia Bank are significant bathymetric and geological features in the South Atlantic Ocean, situated on the South American and African plates, respectively. Most models agree that the interaction with the Tristan-Gough mantle plume and mid-ocean ridge has influenced the formation of these plateaus. However, the role of rifting and continental breakup driving their formation remains controversial. In this study, we integrate geological, geophysical, and geochemical data to determine the nature of the crust within the Rio Grande Rise and Valdivia Bank and develop a plate tectonic model to contextualise their formation within the breakup of Southwest Gondwana and the time-dependent interaction with the Tristan-Gough mantle plume in the Late Cretaceous.Our approach includes analysing the tectonic provenance of dredged continental rock samples from the Rio Grande Rise, DSDP borehole data for sedimentation history, seismic imaging for magmatic rift structures, and Ce/Pb and Nb/U ratios for continental crust contamination.Gravity anomaly data provided insights into crustal thickness and structural fabric across the region.A regional cross-section linking the magmatic rifted margin of the Pelotas Basin and the Rio Grande Rise provided insights into the geological processes, and their relative timing, that influenced the region.Our study classifies the Rio Grande Rise and Valdivia Bank as microcontinents characterised as magmatic transitional crust with complex tectonic histories shaped by mantle plume activity during the breakup of Southwest Gondwana.We present a plate motion model that captures the evolution of a microplate and related seafloor spreading. It incorporates the temporal evolution of the Rio Grande and Valdivia microcontinents, including their final separation around 72 million years ago.Geochemical analysis confirmed continental crust contamination, supporting previous interpretations of Proterozoic continental rock samples dredged in the Rio Grande Rise.Seismic interpretation pointed to similar magmatic rift structures involving rifted continental crust in these geological features and their conjugate rifted margins, highlighting their common tectonic history. Initial off-axis spreading ridges and the inheritance of major continental tectonic fabric conditioned the creation of microcontinent and rift-related structureswithin a magmatic setting.Relative rotations (100 – 72 Ma), recognised by internal structures and curved fracture zones, support the existence of a microplate in the South Atlantic. Under the influence of the mantle plume, spreading ridges to the east and west of the microplate were aborted, and a new ridge linking the Central and Southern South Atlantic mid-ocean ridge became established by this time. Our kinematic plate model challenges existing ideas by linking these features to a combination of continental and plume-related processes and demonstrating

their formation through magma-rich continental rifting rather than simple oceanic plateau formation. This study contributes to the understanding of microcontinent dynamics in plume-influenced rift settings, offering a new perspective on the geodynamic history of the South Atlantic. It provides a foundation for future research to explore the physiographic evolution of these structures, their roles in ocean circulation and climate, and how they influence sedimentation processes in the adjacent rifted margins.