

# A Comprehensive Geochronology Study of the Rio Grande Rise: Evidence for Prolonged On and Off-ridge Volcanism

Peter Davidson<sup>1</sup>, Anthony Koppers<sup>1</sup>, Cornelia Class<sup>2</sup>, and William Sager<sup>3</sup>

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## Abstract

Expedition NBP1808 on the R/V Nathan B. Palmer completed 32 dredges between October and December, 2018 from locations across the Rio Grande Rise (RGR)—a largely unstudied oceanic plateau on the South American plate—and several seamounts located between RGR and the Mid-Atlantic Ridge (MAR). Eighteen samples from 10 dredge locations on RGR were dated to better understand the geochronological history of this large igneous province and to provide clues to its relationship with the Walvis Ridge and Tristan-Gough hotspot(s) on the conjugate African plate.  $^{40}\text{Ar}/^{39}\text{Ar}$  results from plagioclase separates (and one biotite) show a prolonged emplacement history throughout RGR ranging from ~84 to 48 Ma. Ages in general decrease towards the MAR in accord with plate motions showing that RGR as a whole was emplaced over at least several Ma and not as a single pulse like some other oceanic plateaus. Using the recently published tectonic reconstruction of Sager et al., most volcanism in the NW and NE sectors on RGR was emplaced off-axis while that in the SE sector was erupted on-axis. This suggests that the plume source for RGR changed from more intraplate to more ridge-centered as the system evolved through time. There is evidence of a possible reversed age progression in the NE RGR which could provide evidence for micro-plate activity that has been suggested in this region, though more ages are needed to confirm this trend. Geochemistry studies are ongoing and will be used in the future to better understand the eruptive processes. Additional age analyses are also ongoing and will focus on the other dredge locations throughout RGR as well as the seamounts to complete the geochronological picture of the emplacement of RGR.

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## Intro/Scientific Problem

- Did the Rio Grande Rise form at the Paleo Mid-Atlantic Ridge with the Walvis Ridge as reconstructions suggest?
- Is the Rio Grande Rise/Walvis Ridge a Large Igneous Province and emplaced rapidly by a mantle plume head? Or does it have a more prolonged emplacement history?
- Previous to this study, only two locations from the entire Rio Grande Rise (RGR) had been sampled and yielded ages. Cruise NBP1808 was the first extensive dredging campaign to the RGR.

## <sup>40</sup>Ar/<sup>39</sup>Ar Results

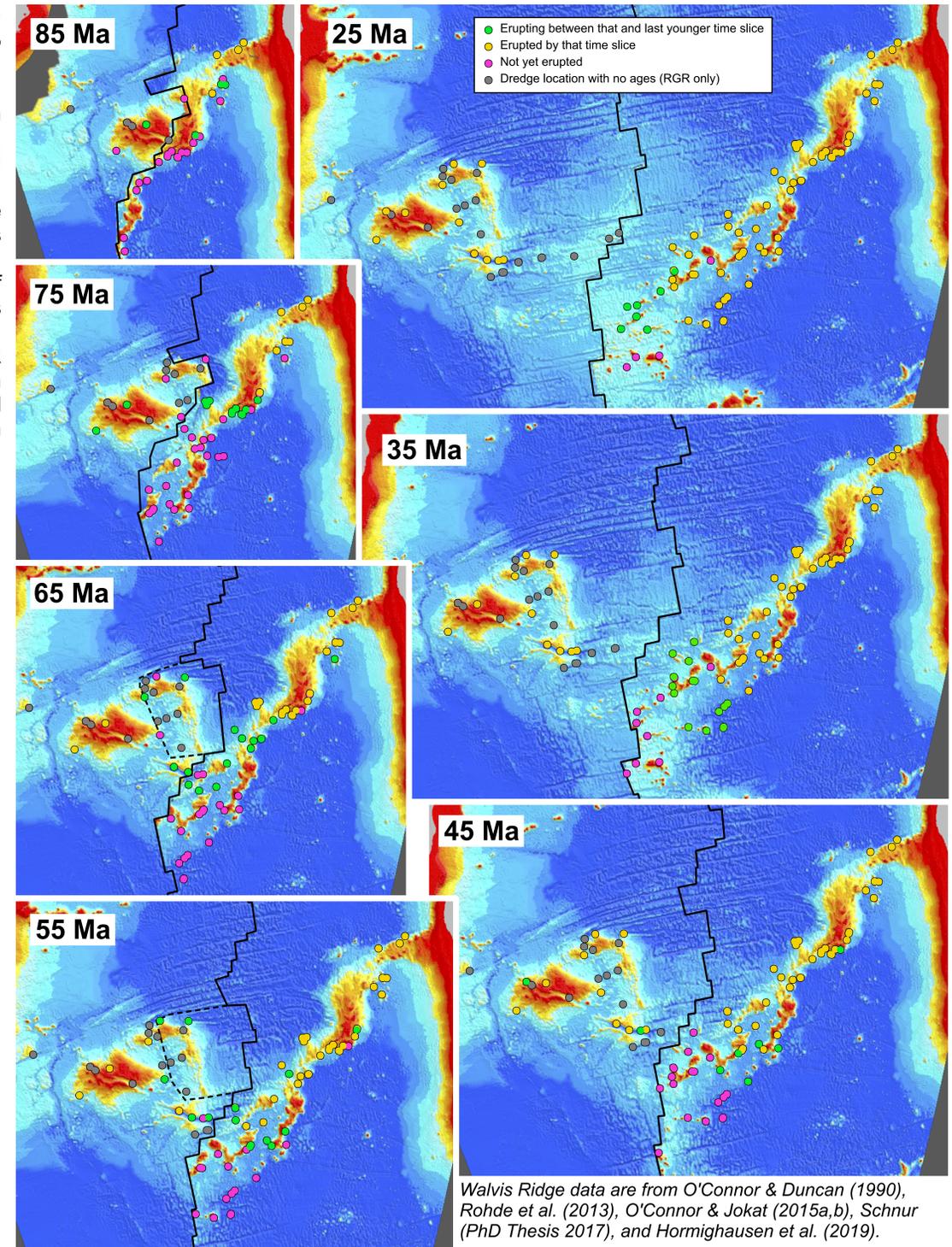
- Red diamonds are the locations of the 32 dredge sites that recovered material from the Rio Grande Rise and several seamounts East of the RGR.
- <sup>40</sup>Ar/<sup>39</sup>Ar ages from this study are shown in the white boxes in [Ma] with 2 sigma errors. Most sites with multiple ages agree within several Mya
- Colored dots are the magnetic picks of Pérez-Díaz & Eagels (2014).

## Conclusions

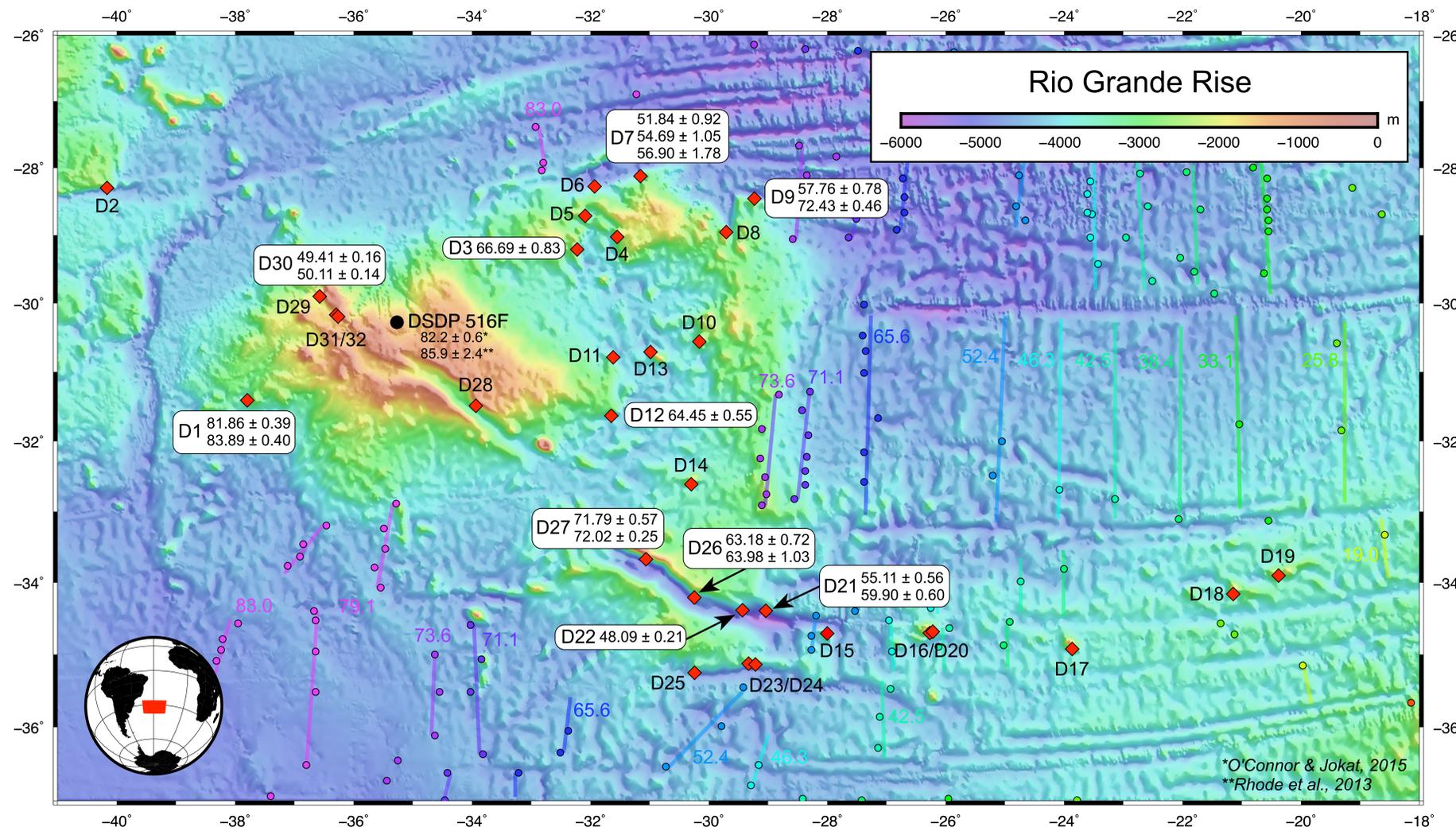
- The Rio Grande Rise was emplaced over a prolonged period of time, unlike many other Oceanic Plateaus such as Ontong Java Nui and Kerguelen that are classified as Large Igneous Provinces.
- The apparently off-axis volcanism in the North-eastern Rio Grande Rise could have been on-axis as a result of microplate activity during the time of its emplacement.
- Geochemistry including isotopic studies are ongoing from Conny Class at LDEO.

## Reconstructions

- South Atlantic plate reconstructions between 85 and 25 Ma made in GPlates using plate rotations from Seton et al. (2012) and the locations of dated samples (see legend).
- The northwestern Rio Grande Rise erupted with the main phase of the Old Walvis Ridge at a spreading center, though more ages from both of these locations are needed to confirm the exact timing of this initial phase.
- On-axis volcanism formed the southeastern Rio Grande Rise between ~ 65 and 55 Ma while significant off-axis volcanism occurred in the northeastern RGR.
- Northeastern off-axis volcanism could be the remnants of microplate activity shown with possible spreading centers as dashed black lines.
- Older undated seamounts near the South-eastern RGR likely emplaced between ~ 50 and 35 Ma in association with the isotopically distinct Tristan rack though several younger seamounts appear to have been emplaced much further north at the time of their emplacement.



Walvis Ridge data are from O'Connor & Duncan (1990), Rohde et al. (2013), O'Connor & Jokat (2015a,b), Schnur (PhD Thesis 2017), and Hormighausen et al. (2019).



## Acknowledgments

This project was supported by NSF award OCE-1558681. Thanks to the Captain and crew of the R/V Nathaniel B. Palmer for a safe and smooth cruise and a special thanks to the ship techs onboard for their instrumental help with dredge recovery.

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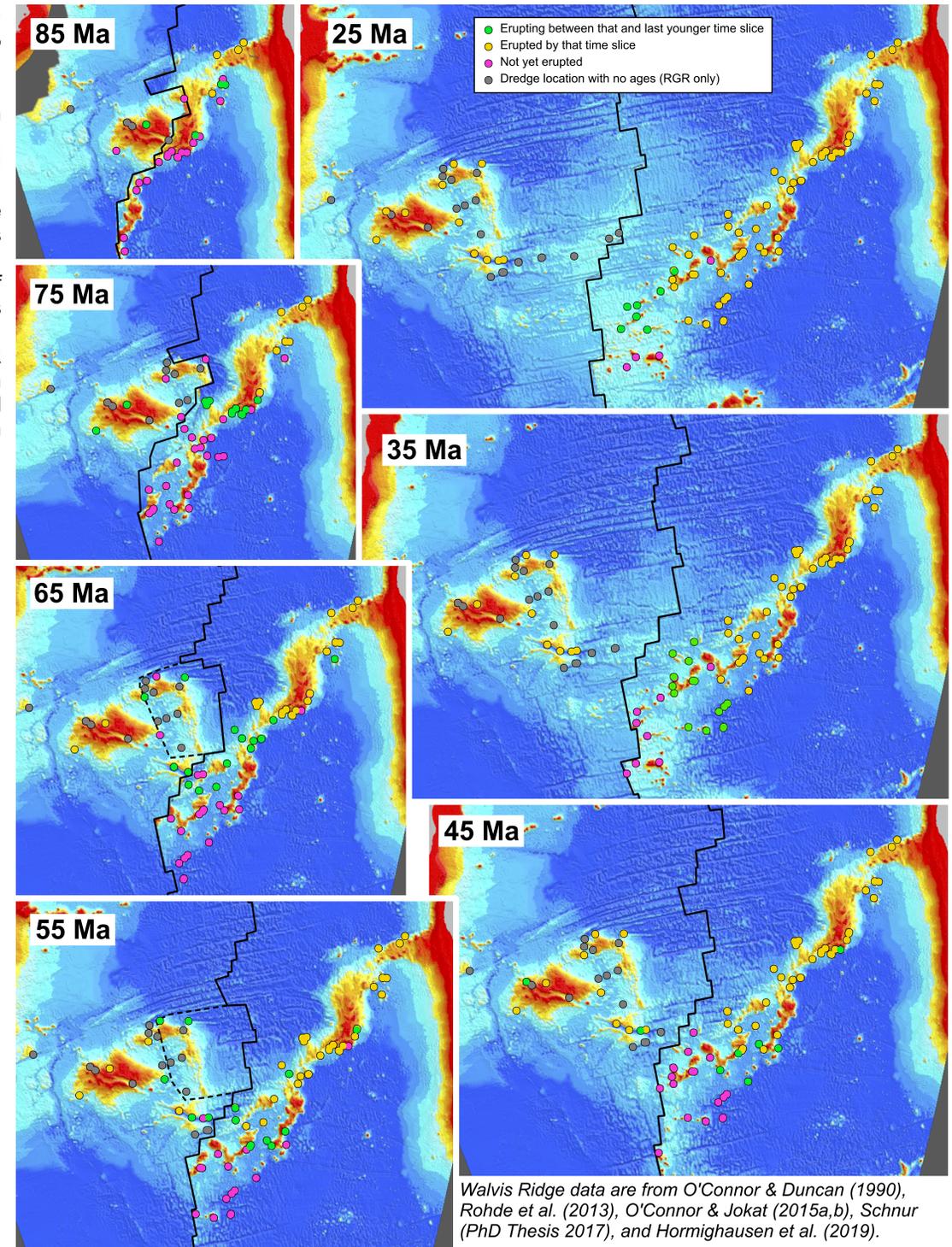
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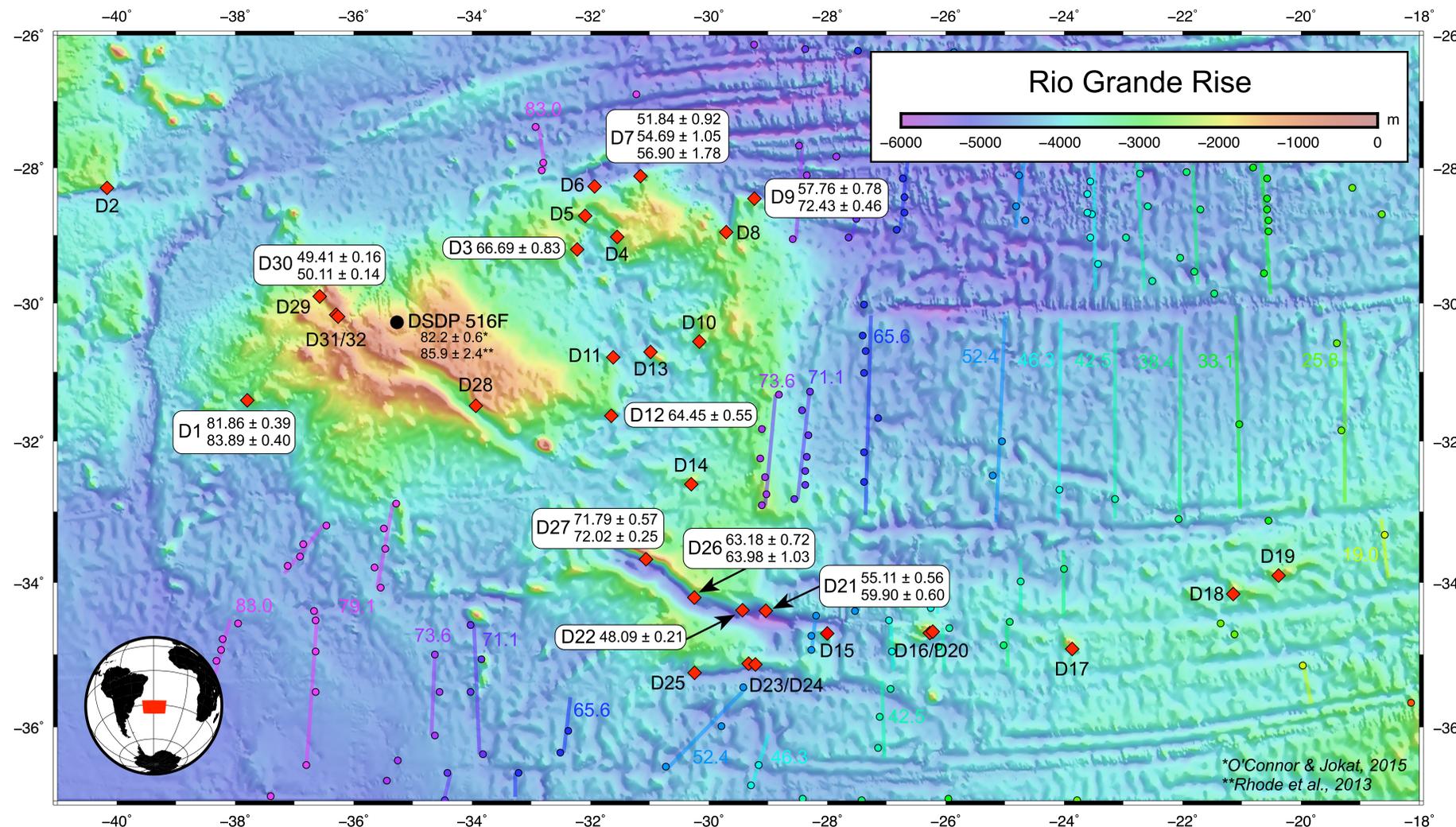
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