Origin and Age of the Researcher Ridge Seamount Chain (Central Atlantic)

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Abstract

Researcher Ridge (RR) is a 400km long, WNW-ESE oriented chain of volcanic seamounts, located on ˜20 to 40 Ma old oceanic crust on the western flank of the Mid-Atlantic Ridge (MAR) at ˜15°N. RR remained nearly unstudied, and thus its age and origin are currently unclear. At roughly the same latitude, the MAR axis is bathymetrically elevated and produces geochemically enriched lavas (the well-known 14°N MAR anomaly). This study presents 40Ar/39Ar age data, major and trace elements, and Sr-Nd-Pb-Hf isotopic compositions of volcanic rocks dredged from several seamounts of the RR and along the MAR between 13-14°N. The results reveal that RR lavas have geochemically enriched ocean island basalt (OIB) compositions ([La/Sm]N=1.7-5.0, [Ce/Yb]N=1.58-11.3) with isotopic signatures (143Nd/144Nd = 0.51294-0.51316, 206Pb/204Pb = 19.14-19.93, 176Hf/177Hf = 0.28307-0.28312) trending to or overlapping the ubiquitous FOZO (Focal Zone, e.g., Hart et al., 1992, Science 256) mantle composition. Major and trace element characteristics denote that RR lavas formed by small degrees of melting from a deep source in the garnet stability field and experienced high pressure fractionation beneath a lithospheric lid. Although the sparseness of samples suitable for 40Ar/39Ar dating prevents establishing a clear age progression for the seamount chain, one well constrained basalt groundmass age of 28.75 ± 0.14 Ma (2σ) for one seamount near the western end of RR indicates that this volcano formed ˜11 Ma later than the underlying lithosphere. Taken together, RR is interpreted as a hotspot track, albeit formed by a relatively weak melting anomaly. Compared to RR, the lavas from the 14° N MAR anomaly have slightly less enriched compositions, exhibiting enriched (E)-MORB compositions ([La/Sm]N=1.81-2.29). Their isotopic ratios largely overlap with the RR compositions, thus suggesting a genetic relationship. We therefore propose that the enigmatic 14°N MAR anomaly is caused by deflection of upwelling RR plume material towards the approaching (westward migrating) MAR, causing the production of E-MORBs with nearly similar isotopic compositions to the RR lavas. Once the plume was captured by the spreading ridge, off-axis hotspot track volcanism ceased, resulting in a 300 km wide gap of seamount formation between the eastern end of RR and the MAR.

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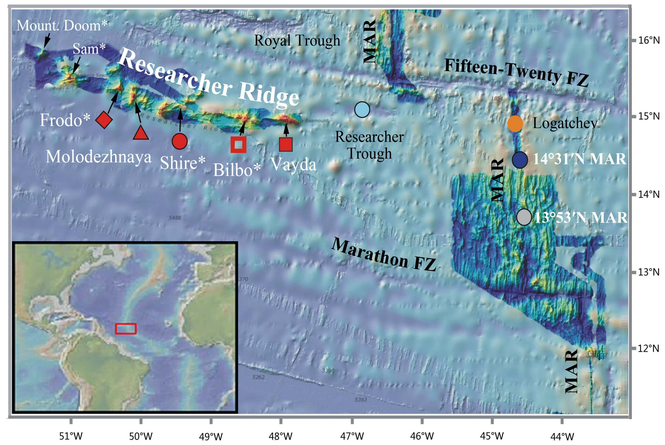
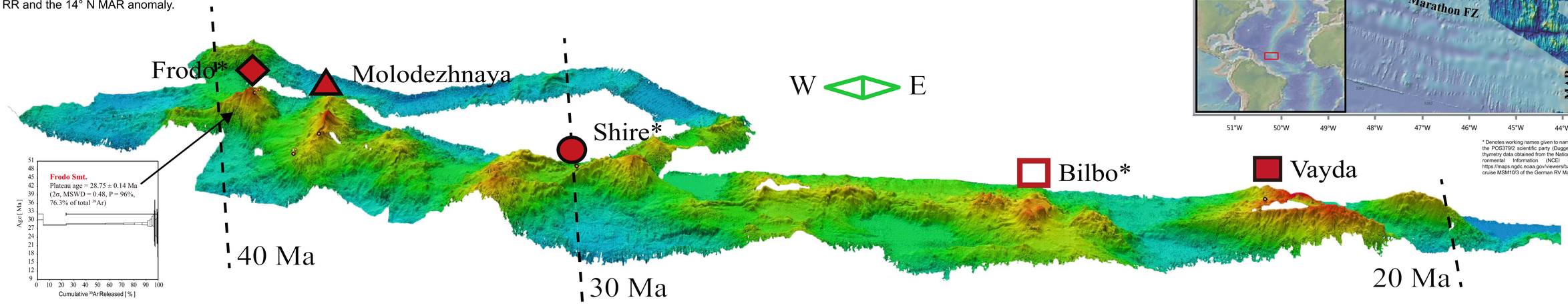
Abstract: Researcher Ridge (RR) is a 400km long, WNW-ESE oriented chain of volcanic structures, located on ~20 to 40 Ma old oceanic crust on the western flank of the Mid-Atlantic-Ridge (MAR). RR has been little studied, and its age and origin are currently unclear. At roughly the same latitude, the MAR axis is bathymetrically elevated and geochemically enriched (hereafter referred to as the 14° N MAR anomaly). This study presents $^{40}Ar/^{39}Ar$ age data, major and trace elements, and Sr-Nd-Hf-Pb (double spike) isotopic compositions of volcanic rocks dredged from several seamounts along the RR. In addition, new geochemical data of MORBs from two 13-14° N dredge sites on the MAR are also presented.

The results reveal that RR lavas have geochemically enriched ocean island basalt (OIB) compositions trending towards the FOZO (Focal Zone, Hart et al., 1992) or HIMU (high μ= time-integrated $^{238}U/^{204}Pb$) mantle end member compositions. Based on the new age and geochemical data, RR is interpreted as a classical hotspot track. The lavas from the 14° N MAR anomaly have an enriched E-MORB type composition. Their isotopic compositions plot at the enriched end of the local MORB array and partly overlap the RR lava compositions, suggesting a genetic relationship. We propose that the 14° N MAR anomaly is caused by deflection of upwelling RR plume material towards the westward migrating MAR, causing the production of E-MORBs with nearly similar isotopic compositions to the RR lavas. Once the plume was captured by the spreading ridge, off-axis hotspot track volcanism ceased, resulting in a gap of seamounts between the eastern end of the RR and the 14° N MAR anomaly.

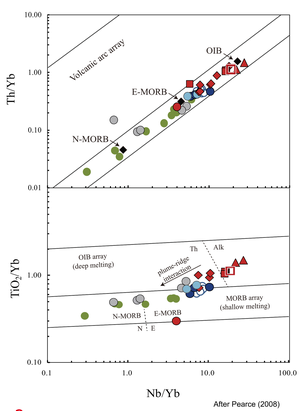
1. Strike of Researcher Ridge (RR) intersects the MAR at 14°-15°N, a well-known segment with elevated bathymetry and geochemically enriched lava composition.



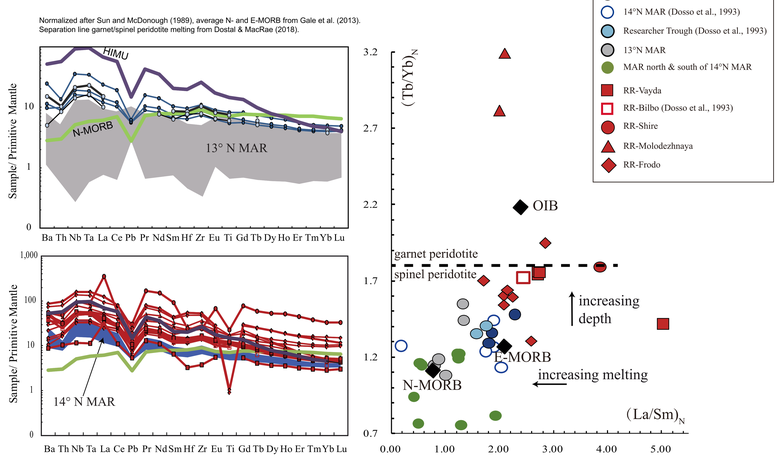


* Denotes working names given to nameless seamounts by the POS379/2 scientific party (Duggen et al., 2009). Bathymetry data obtained from the National Centers for Environmental Information (NCEI (formerly NGDC): https://maps.ngdc.noaa.gov/viewers/bathymetry/) and from cruise MSM10/3 of the German RV Maria S. Merian.

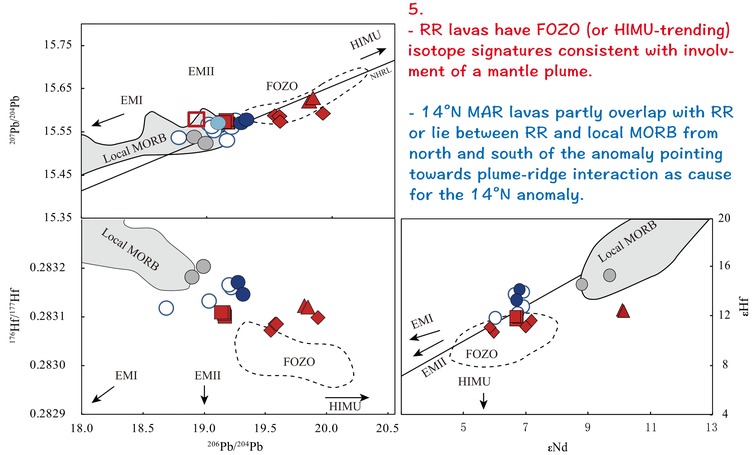
2. Researcher Ridge's (RR) Frodo Seamount formed ~11 Ma later than its underlying ~40 Ma oceanic crust.



3.
- RR lavas are alkalibasaltic/transit. OIBs,
- 14°N anomaly MAR lavas are tholeiitic E-MORBs
- MAR lavas north and south of 14°N are tholeiitic N-MORBs

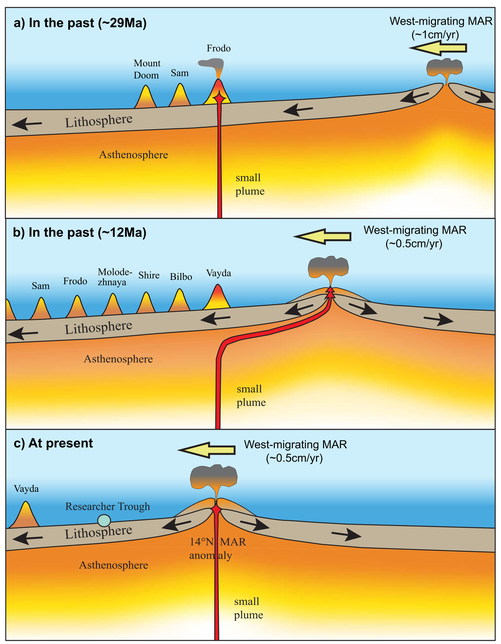


4. The RR lavas formed by smaller degrees of melting at higher pressures compared to 14° anomaly MAR E-MORB (and N-MORB to the north and south).



5.
- RR lavas have FOZO (or HIMU-trending) isotope signatures consistent with involvment of a mantle plume.
- 14°N MAR lavas partly overlap with RR or lie between RR and local MORB from north and south of the anomaly pointing towards plume-ridge interaction as cause for the 14°N anomaly.

6. Preferred model:



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