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Problematic plate reconstruction

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As previously proposed^{1,2}, Bronner et al.³ suggest that opening of the Newfoundland-Iberia (NI) rift involved mantle exhumation until 112 Myr, subsequent seafloor spreading, and crustal thickening at the J anomaly by magma propagating from the Southeast Newfoundland Ridge (SENR) area. However, they suggest that ~112 Myr magmatism formed the J anomaly and associated basement ridges (J Anomaly Ridge: JAR, Madeira Tore Rise: MTR) north of the Newfoundland-Gibraltar Fracture Zone (NGFZ). This contrasts with prior interpretations that these features formed at ~125 Myr (anomaly ~M0, Fig. 1a) simultaneously with the JAR-MTR complex along the Mid-Atlantic Ridge (MAR) to the south^{1,2,4,5}, probably with later magmatic overprinting⁶.

The magnetic model central to the Bronner et al.³ paper is plausible, although no more so than models based on M-series geomagnetic reversals^{2,7,8,9}. However, the scenario of Bronner et al.³ is problematic in terms of plate reconstructions. They propose that an offset between MAR and NI rift axes at the NGFZ (M0 offset ~70 km; bold dashed lines, Fig. 1b) inhibited magma transport from the SENR northward to ODP Sites 1070 and 1277 for ~10 Myr after M0; this would necessitate rapid propagation by 112 Myr and thus a near-isochronal J anomaly. During this period the conjugate JAR and MTR south of the NGFZ separated widely (Fig. 1b). However, by Chron 34 (Fig. 1d) the MTR north of the NGFZ was co-linear with the MTR to the south and has remained so to the present⁷. Thus the Bronner et al.³ scenario would require that: 1) a >100 km left-lateral NGFZ offset at 112 Myr (Fig. 1b) reversed to 100 km right-lateral by 84 Myr (Fig. 1d), 2) the spreading rate just north of NGFZ was at least ~1.5 times faster than to the south for some period following 112 Myr but dramatically slowed to the Africa-North America (AF-NA) rate by 84 Myr, and 3) Iberia (IB)-NA plate separation serendipitously aligned formerly offset MTR segments north and south of NGFZ. The presumed NGFZ offset reversal and extension-rate discrepancy occur within the Cretaceous Quiet Zone and thus are unconstrained, but they seem highly unlikely. More importantly, the required alignment of the northern and southern MTR is too coincidental to be believed.

Alternately, if northward propagation of magma from the SENR was prolonged, rather than delayed, for 10 Myr, a significantly diachronous J anomaly would result (Fig. 1c). This too is problematic. There is no excess magmatism observed in the wake of a supposed propagator, nor was there any mirrored, southward propagation south of NGFZ, so any SENR melt anomaly that drove propagation ceased to exist well before 112 Myr. Therefore, prolonged propagation would require the unreasonable assumption that an isolated melt anomaly was moving northeast through the NI-rift mantle, creating a seafloor track nearly opposite in direction to that expected from absolute plate motion¹⁰. We conclude from the plate-kinematic constraints that a 112 Myr age of the J-anomaly complex in the NI rift is not viable and that its predicted consequences are not pertinent to the rift evolution.

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Figure

Figure 1 : Plate reconstructions. a) Conventional anomaly M0 reconstruction of AF-NA⁷ and IB-NA⁸, with JAR-MTR basement ridges shaded and seafloor isochrons identified. b) 112 Myr reconstruction with a nearly isochronal J anomaly in the NI rift; AF-NA positions interpolated between M0 and C34 reconstructions⁷. Bold dashed lines indicate earlier, M0 extension axes on NA plate (chron M0 south of NGFZ; assumed extension half rate ~7 mm/yr north of NGFZ²). c) 112 Myr reconstruction assuming JAR-MTR ridges formed by prolonged propagation (arrow, ~125-112 Myr) of an isolated melt anomaly northward from SENR. d) Chron 34 plate reconstruction⁷. FC, Flemish Cap; GB, Galicia Bank.

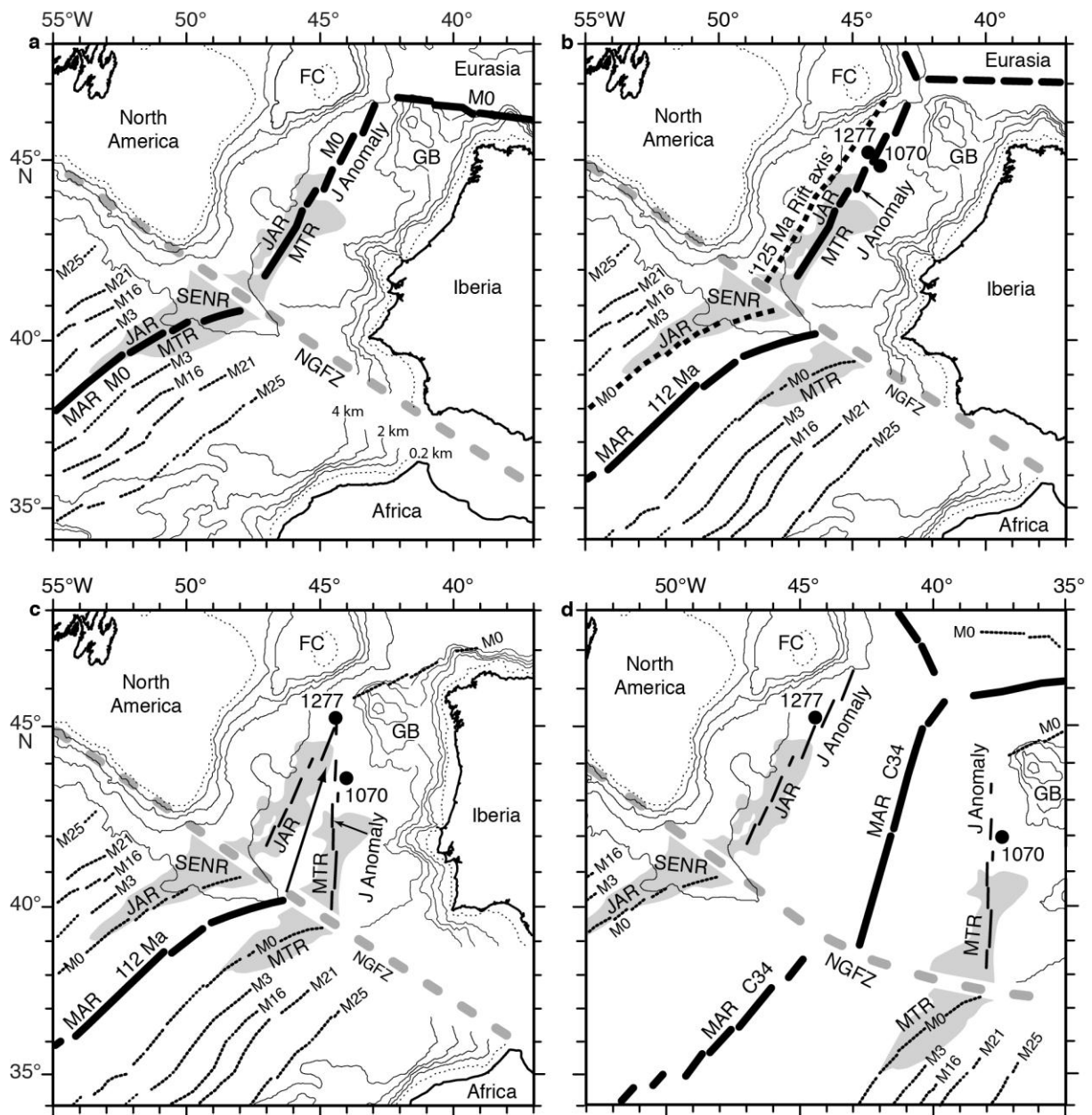


Figure 1. Plate reconstructions.