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Effects of Fertile Mantle Compositional Variation and Spreading Rate Variation on the Working of Global Ocean Ridges

Yaoling Niu, University of Durham, Durham, United Kingdom and Michael J O'Hara, Aberystwyth University, Institute of Geography and Earth Sciences, Aberystwyth, United Kingdom

Abstract Text:

Mantle temperature variation, plate spreading rate variation and mantle compositional variation have been considered to be the three fundamental variables that govern the working of global ocean ridges [1]. An analysis demonstrates that mantle compositional variation exerts the primary control on ocean ridge processes; it determines (1) variation in both composition and mode of mantle mineralogy, (2) variation of mantle density, (3) variation of ridge axial depth, (4) source-inherited MORB compositional variation, (4) density-controlled variation in the amplitude of mantle upwelling, (5) apparent variation in the extent of melting, and (6) the correlated variation of MORB chemistry with ridge axial depth [2]. The above interpretations are reinforced by the updated MORB database [3]. The new database also confirms spreading rate control on the extent of melting as shown previously [4]. Mantle temperature variation could play a part, but its overstated role [3,5] results from a basic error (1) in treating ridge axial depth variation as evidence of mantle temperature variation by ignoring the intrinsic control of mantle composition, (2) in treating “mantle plume” influenced ridges (e.g., Iceland) as normal ridges of plate spreading origin, and (3) in treating low Vs at greater depths (> 300 km vs. < 200 km beneath ridges) beneath these “mantle plume” influenced ridges as evidence for hot ridge mantle. In order to understand the working of global ocean ridges, we must avoid plume-influenced ridges (e.g., in the vicinity of Iceland) and remove/average out data from such ridges. As a result, the correlations (e.g., between ridge axial depth, mantle low Vs anomaly, and some geochemical parameters) required for the interpretation of mantle temperature control all disappear. There is thus no evidence for large mantle temperature variation away from ridges influenced by “mantle plumes”. References: [1] Niu et al., 2001, Earth Planet Sci. Lett., 186, 383-399; [2] Niu & O’Hara, 2008, J. Petrol., 49, 633-664; [3] Gale et al., 2014, J. Petrol, 55, 1051-1082; [4] Niu & Hékinian, 1997, Nature, 385, 326-329; [5] Dalton et al., 2014, Science, 334, 80-83; [6]Niu & Hékinian, 2004, In Oceanic Hotspots, Springer-Verlag, 285-307.

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Submitter's E-mail Address: yaoling.niu@foxmail.com
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First Presenting Author

Presenting Author

Yaoling Niu

Primary Email: yaoling.niu@foxmail.com
Phone: 01913342311

Affiliation(s):

University of Durham
Durham (United Kingdom)

Second Author

Michael J O'Hara

Primary Email: mio@aber.ac.uk
Phone: 01291641476

Affiliation(s):

Aberystwyth University
Institute of Geography and Earth Sciences
Aberystwyth (United Kingdom)

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