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High degrees of melt extraction recorded by spinel harzburgite of the Newfoundland margin: The role of inheritance and consequences for the evolution of the southern North Atlantic

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Abstract

Serpentinized spinel peridotites of the Newfoundland margin drilled during ODP Leg 210 at Site 1277 have preserved, relic mineral compositions similar to the most depleted abyssal peridotites worldwide and different from those of the conjugate Iberian margin. The samples are derived from mass flows containing clasts of peridotite and gabbro and from in-situ basement, and are mostly mylonitic cpx-poor spinel harzburgites with Cr-rich spinels ($Cr\#_{0.35-0.66}$). Melting of the Newfoundland mantle occurred in the spinel peridotite field and probably exceeded the cpx-out phase boundary for some samples. Using proposed spinel peridotite melting models and experimentally derived phase diagrams, the Newfoundland harzburgites can be modeled as a residue after extraction of 14 to 20–25% melting. Basalts that are interleaved with mass flow deposits on top of the peridotite basement resemble normal to transitional mid-ocean ridge basalt. This, together with the unusually high Cr# of some spinel harzburgites suggest that the formation of basalts and partial melting of the underlying peridotite are not cogenetic. Among mantle samples some of the Newfoundland harzburgites approach mineral compositions of the Bay of island ophiolite and ophiolites from Japan that represent peridotites formed in an arc-setting. Thus, the peridotites drilled at Site 1277 may represent inherited (Caledonian or older) subarc mantle that was exhumed close to the ocean floor during the rifting evolution of the Atlantic.

Compared to the spinel harzburgites from Newfoundland, the peridotites from the conjugate Iberian margin are, on average, less depleted and provide evidence for local equilibration in the plagioclase stability field. This can either be explained by an inherited, primary, Ca-richer composition of the Iberia peridotite, or, alternatively, by local melt impregnation and stagnation during continental rifting, and thus refertilizing previously depleted (arc-related) peridotite.

Keywords: Mantle melting; Newfoundland margin; ODP Leg 210; Spinel harzburgite

1. Introduction

Non-volcanic (or magma-poor) passive margins have been the subject of ongoing debates for the last 20 yr, since rift-related decompression of the mantle is generally considered to produce substantial amounts of

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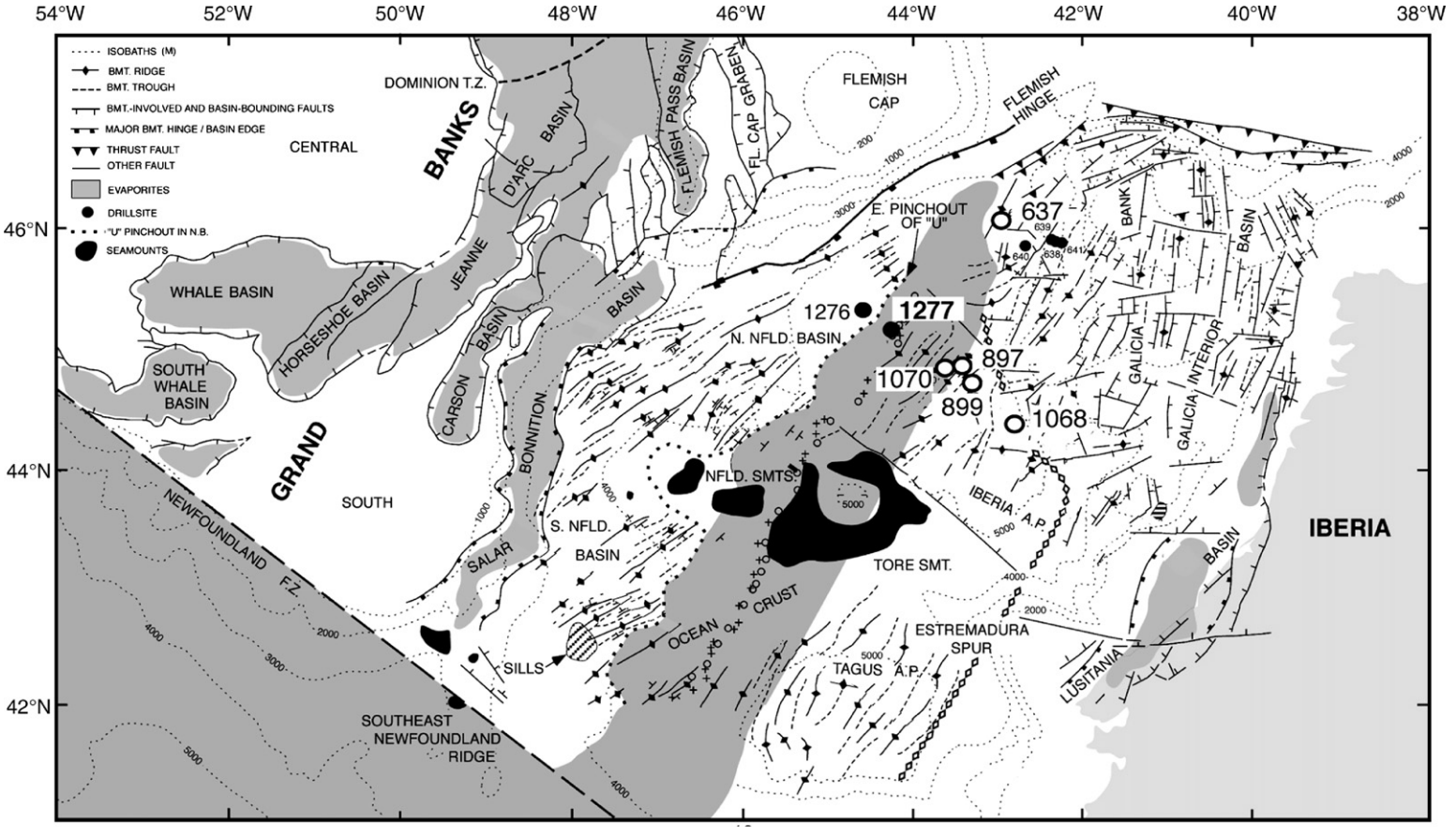

Fig. 1. Reconstruction of the Iberia–Newfoundland rift to anomaly M0 (~121 Ma), based on the reconstruction of [54]. Onset of oceanic crust formation was interpreted to initiate around magnetic anomaly M3 (grey shaded area). Solid circles indicate locations of drill Sites (1276, 1277) during ODP Leg 210. Open circles indicate locations of peridotite highs, which were drilled during previous ODP legs 103, 149 and 173, respectively. Modified from [19].