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Crust-mantle interactions during continental break-up: insights from an early Eocene dacitic unit within the Norwegian margin collected during IODP Expedition 396

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A transect of five boreholes was drilled during IODP Expedition 396 on the Mimir High adjacent to the Vøring transform margin to constrain the paleoenvironmental conditions during the Paleocene-Eocene Thermal Maximum (PETM), a phase of rapid global warming linked to the Northeast Atlantic continental breakup [1]. In two of these five holes (U1570A, U1570D), a discrete (< 10 m thick) glassy and highly vesicular graphite-garnet-cordierite dacitic unit was recovered in post-PETM sediments. We performed detailed petrographic and textural descriptions combined with in situ major and trace element analyses on the glass and porphyroblasts in order to reconstruct the origin and emplacement of this unit. The samples show subhedral crystals, flow textures, and a high degree of fragmentation and is likely the result of partial melting of the upper continental crust. The glass is rhyolitic (~77 wt% SiO_2). The porphyroblasts (garnet, cordierite, plagioclase, quartz) present in the unit are consistent with a crustal origin. Almandine garnets show xenocrystic compositions [2,3], similar to those found in metapelite enclaves from the Neogene Volcanic Province (NVP, Spain) [4]. Temperatures and pressures predicted by the MAGEMin [5] thermodynamic calculation package are 650-800°C and 2-4kbar. These results overlap with the temperature obtained from the Ti-in-quartz thermometer (700-900°C) [6]. We propose that the formation of this unit is similar to the formation of El Hoyazo (NVP), a volcano interpreted as a fossil atoll formed on a thin lithosphere [4]. However, textural observations from our samples suggest its protolith had a shorter residence time in the magmatic chamber and was intruded in a shallow, subaqueous environment. The El Hoyazo volcano then serves as an analog for the origin of the dacite where in situ partial melting of the crust would be facilitated by mafic underplating, a consequence of the Northeast Atlantic opening, and highlights the importance of crust-mantle interactions during large igneous province emplacement and continental break-up.

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