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Research paper

Architecture of the distal and outer domains of the Mid-Norwegian rifted margin: Insights from the Rån-Gjallar ridges system

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ABSTRACT

Based on a 3D seismic cube and regional 2D long-offset seismic reflection profiles, we propose a reconsideration of the architecture of the Mid-Norwegian outer Vøring margin. A system comprising large-magnitude detachment faults and steeper fault arrays was mapped together with key sedimentary markers to provide constraints on the structural history of the outer Rån-Gjallar ridges system. Additionally, a detailed mapping of the so-called 'T-reflection' permitted a revision of the nature, origin and tectono-magmatic significance of this debated major reflector.

Based on our results, we develop a more general discussion on the final evolutionary stages of rifted margins, including the construction of the outer domain, the birth of an oceanic spreading centre and the definition of breakup.

1. Introduction

1.1. Margin domains

The terminology and methodology used in this contribution is based on Peron-Pinvidic et al. (2007, 2016, 2015), Sutra et al. (2013) and Tugend et al. (2015) (Fig. 1). In summary, we study the architecture of rifted margins via the definition of distinct structural domains: the *proximal*, *necking*, *distal*, *outer* and (embryonic) *oceanic* domains. Each margin domain is associated with specific deformation processes (*stretching*, *thinning*, *hyperextension*, *exhumation*, *magmatic*, *oceanization*) that can overlap, overprint and interact in time and space. At the margin scale, the phases of deformation migrate progressively oceanwards and each is characterized by a specific tectonic, stratigraphic, isostatic, thermal and magmatic evolution. The dip arrangement of structurally and stratigraphically distinct domains is directly related to the different tectono-magmatic processes that successively affect the rift. Lithospheric extension causes major changes in the lithospheric strength profile in the domain of the tectonically and magmatically active system, which, in turn, leads to changes in the dominant deformation mechanism accommodating the extension. This contribution focuses on the distal and outer domains of the Mid-Norwegian Vøring margin (Fig. 2).

1.2. The distal domain

The *distal domain* occurs between the crustal neck and the more magmatic outer domain (Fig. 1). Conceptually, this is the domain where deformation is coupled on the crustal scale, where high-beta extensional processes lead to the removal of ductile layers within the continental crust, allowing faults to cut from the top crust into the mantle and sea water to feed serpentinization processes - where and when pressure and temperature conditions are adequate (Escartín et al., 2001; Mevel, 2003; Skelton et al., 2005). Outboard of the crustal neck, basement geometries consist of series of tilted blocks flanked by upward concave detachment faults, with

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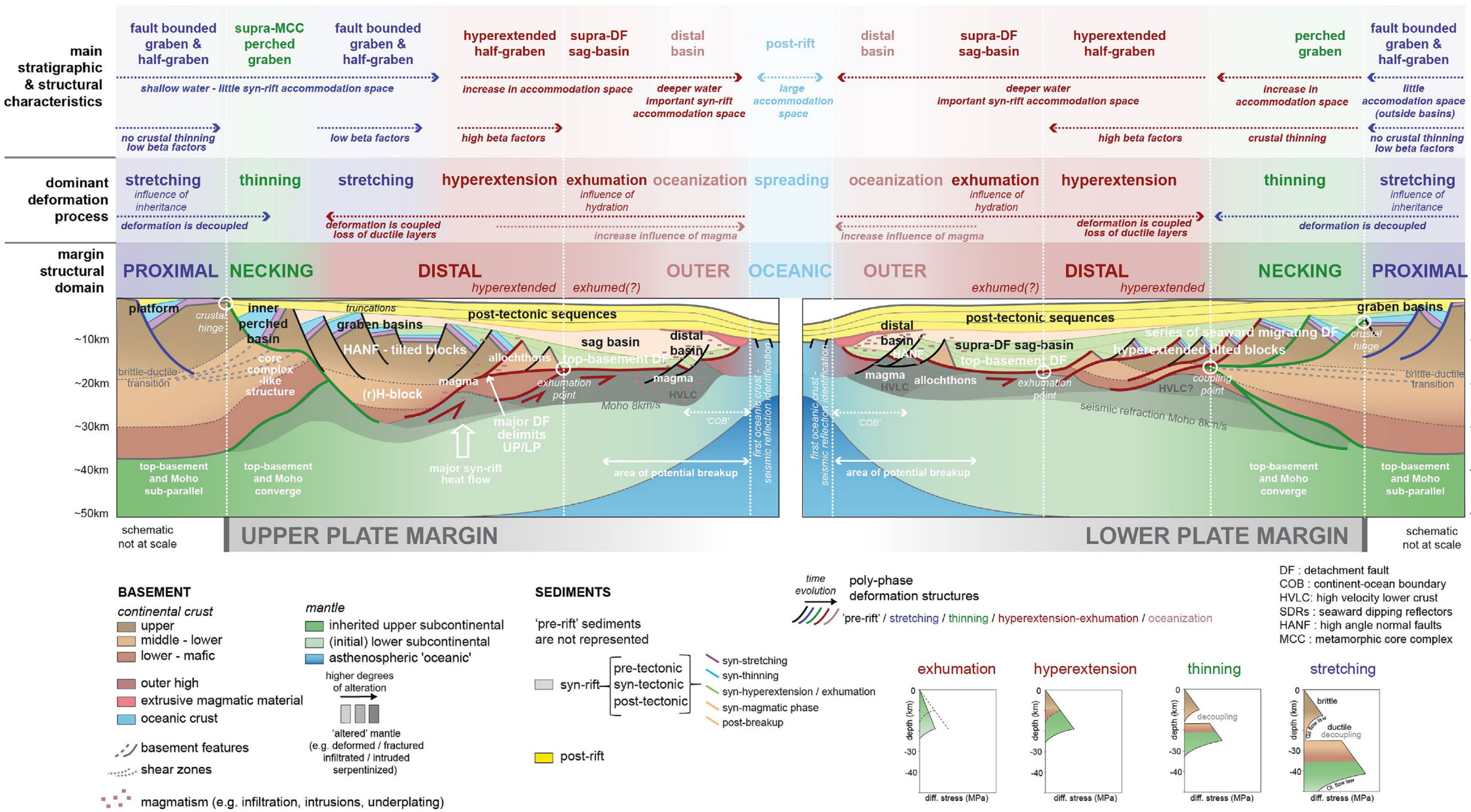

Fig. 1. Schematic cartoon illustrating the terminology used in this contribution. From Peron-Pinvidic et al. (2015). The cartoon summarizes the major structural and stratigraphic characteristics of upper-plate and lower-plate settings. The definitions are (notably) from Peron-Pinvidic et al. (2013), Sutra et al. (2013), Tugend et al. (2015), Manatschal et al. (2014).