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La Isla de Gorgona, Colombia: A petrological enigma?

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Abstract

A wide range of intrusive (wehrlite, dunite, gabbro and olivine gabbro) and extrusive (komatiites picrites and basalts) igneous rocks are found on the small pacific island of Gorgona. The island is best known for its ~90 Ma spinifex-textured komatiites: the only true Phanerozoic komatiites yet discovered. Early work led to suggestions that the rocks of the island formed at a mid-ocean ridge, however more recent research supports an origin as part of a hot mantle plume-derived oceanic plateau. One of the main lines of evidence for this origin stems from the inferred high mantle source temperatures required to form the high-MgO (>15 wt.%) komatiites and picrites. Another remarkable feature of the island, considering its small size (8 × 2.5 km), is the degree of chemical and radiogenic isotopic heterogeneity shown by the rocks. This heterogeneity requires a mantle source region with at least three isotopically distinctive source regions (two depleted and one enriched). Although these mantle source regions appear to be derived in significant part from recycled oceanic crust and lithosphere, enrichments in ^{187}Os, ^{186}Os and ^{3}He in Gorgona lavas and intrusive rocks, suggest some degree of transfer of material from the outer core to the plume source region at D″.

Modelling reveals that the komatiites probably formed by dynamic melting at an average pressure of 3–4 GPa leaving residual harzburgite. Trace element depletion in Gorgona ultramafic rocks appears to be the result of earlier, deeper melting which produced high-MgO trace element-enriched magmas. The discovery of a trace-element enriched picrite on the island has confirmed this model.

Gorgona accreted onto the palaeocontinental margin of northwestern South America in the Eocene and palaeomagnetic work reveals that it was formed at ~26 °S. It has been proposed that Gorgona is a part of the Caribbean–Colombian Oceanic Plateau (CCOP), however, the CCOP accreted in the Late Cretaceous and was derived from a more equatorial palaeolatitude. This evidence, and differing geochemical signatures, strongly suggests that Gorgona and probably other coastal oceanic plateau sequences in Colombia and Ecuador, belong to a completely different oceanic plateau to the CCOP.

Keywords: Komatiite; Gorgona; Colombia; Cretaceous; Oceanic plateau

1. Introduction

The discovery of ~90 Ma spinifex-textured komatiites (*sensu* Kerr and Arndt, 2001) on the small

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Pacific, Colombian island of Gorgona (Fig. 1) has ensured that over the past 25 years the island has acquired almost 'cult status' among petrologists. Thus, although Gorgona is relatively small (8×2.5 km) a significant amount of geochemical data has been published on the rocks of the island. Interestingly, for such a small island, these data reveal a remarkably heterogeneous mantle source region, with both relatively depleted and enriched components. The importance of Gorgona komatiites, was given further impetus by the realisation of Storey et al. (1991) that the high temperatures required for the generation of high MgO magmas, with the potential to crystallise as komatiites, probably necessitated the involvement of a high temperature mantle plume source region. Storey et al. (1991) proposed that Gorgona was a part of a large Pacific-derived oceanic plateau, which is exposed in and around the Caribbean and in accreted terranes in northwestern South America.

The purpose of this paper is to review the current available data and petrogenetic models for the komatiites, picrites, basalts and gabbros of Gorgona Island and to assess the islands' contribution to our understanding of oceanic plateau formation. Finally, the issue of whether Gorgona is actually a part of the same oceanic plateau as that comprising the bulk of the Caribbean plate and the accreted terranes in the Western Cordillera of Colombia and Ecuador, will be discussed.

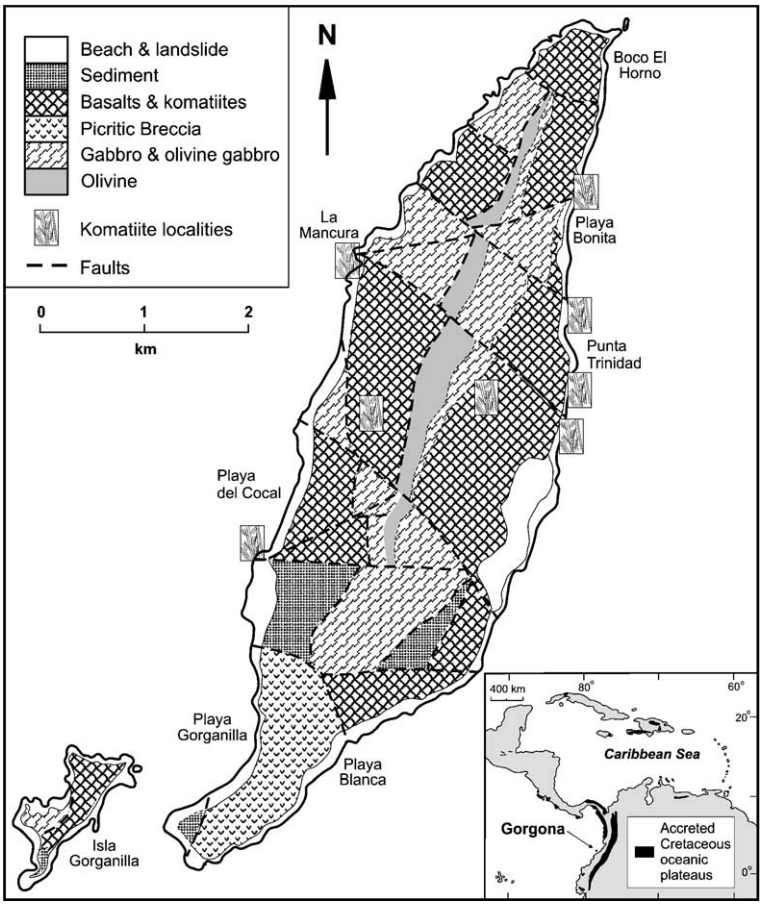

Fig. 1. Geological sketch map of Gorgona Island, showing the main lithological units along with the location of komatiites (after Echeverría, 1980 and Révillon et al., 2000). The inset map shows other accreted Cretaceous oceanic plateau sequences in the Caribbean–Colombian region (after Kerr et al., 2004b).