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Mantle plume or slab window?: Physical and geochemical constraints on the origin of the Caribbean oceanic plateau

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ABSTRACT

The Caribbean oceanic plateau formed in the Pacific realm when it erupted onto the Farallon plate from the Galapagos hotspot at ~90 Ma. The plateau was subsequently transported to the northeast and collided with the Great Arc of the Caribbean thus initiating subduction polarity reversal and the consequent tectonic emplacement of the Caribbean plate between the North and South American continents. The plateau represents a large outpouring of mafic volcanism, which has been interpreted as having formed by melting of a hot mantle plume. Conversely, some have suggested that a slab window could be involved in forming the plateau. However, the source regions of oceanic plateaus are distinct from N-MORB (the likely source composition for slab window mafic rocks). Furthermore, melt modelling using primitive (high MgO) Caribbean oceanic plateau lavas from Curaçao, shows that the primary magmas of the plateau contained ~20 wt.% MgO and were derived from 30 to 32% partial melting of a fertile peridotite source region which had a potential temperature (T_p) of 1564–1614 °C. Thus, the Caribbean oceanic plateau lavas are derived from decompression melting of a hot upwelling mantle plume with excess heat relative to ambient upper mantle. Extensional decompression partial melting of sub-slab asthenosphere in a slab window with an ambient mantle T_p cannot produce enough melt to form a plateau. The formation of the Caribbean oceanic plateau by melting of ambient upper mantle in a slab window setting, is therefore, highly improbable.

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1. Introduction

Knowledge of the tectonomagmatic history of the Caribbean plate (Fig. 1) is important in helping us to understand the palaeogeography of the inter-American region from the Jurassic. Of particular importance is the development, and subsequent closure, of the palaeogateway between North and South America and the associated impacts on the global climate (e.g. Droxler et al., 1998; Schneider and Schmittner, 2006).

Most of the Caribbean plate consists of a 8–20-km-thick Late Cretaceous oceanic plateau (~6×10^5 km^2) that formed in the Pacific (e.g. Edgar et al., 1971; Mauffret and Leroy, 1997; Kerr et al., 2003) and is possibly derived from the initial plume head phase of the Galapagos hotspot (e.g. Hoernle et al., 2002; Geldmacher et al., 2003; Thompson et al., 2003). Although somewhat controversial (e.g. Pindell et al., 2006), many consider the Caribbean oceanic plateau to have erupted onto the Farallon plate and subsequently transported to the northeast to collide with a large intra-oceanic arc [the Great Arc of the Caribbean, Burke (1988)] in the late Cretaceous (Fig. 2a) (e.g. Duncan and Hargraves, 1984; Burke, 1988; White et al., 1999; Thompson et al., 2003; Kerr et al., 2003; Mann et al., 2007). The Great Arc was located at the western side of the oceanic gap (the

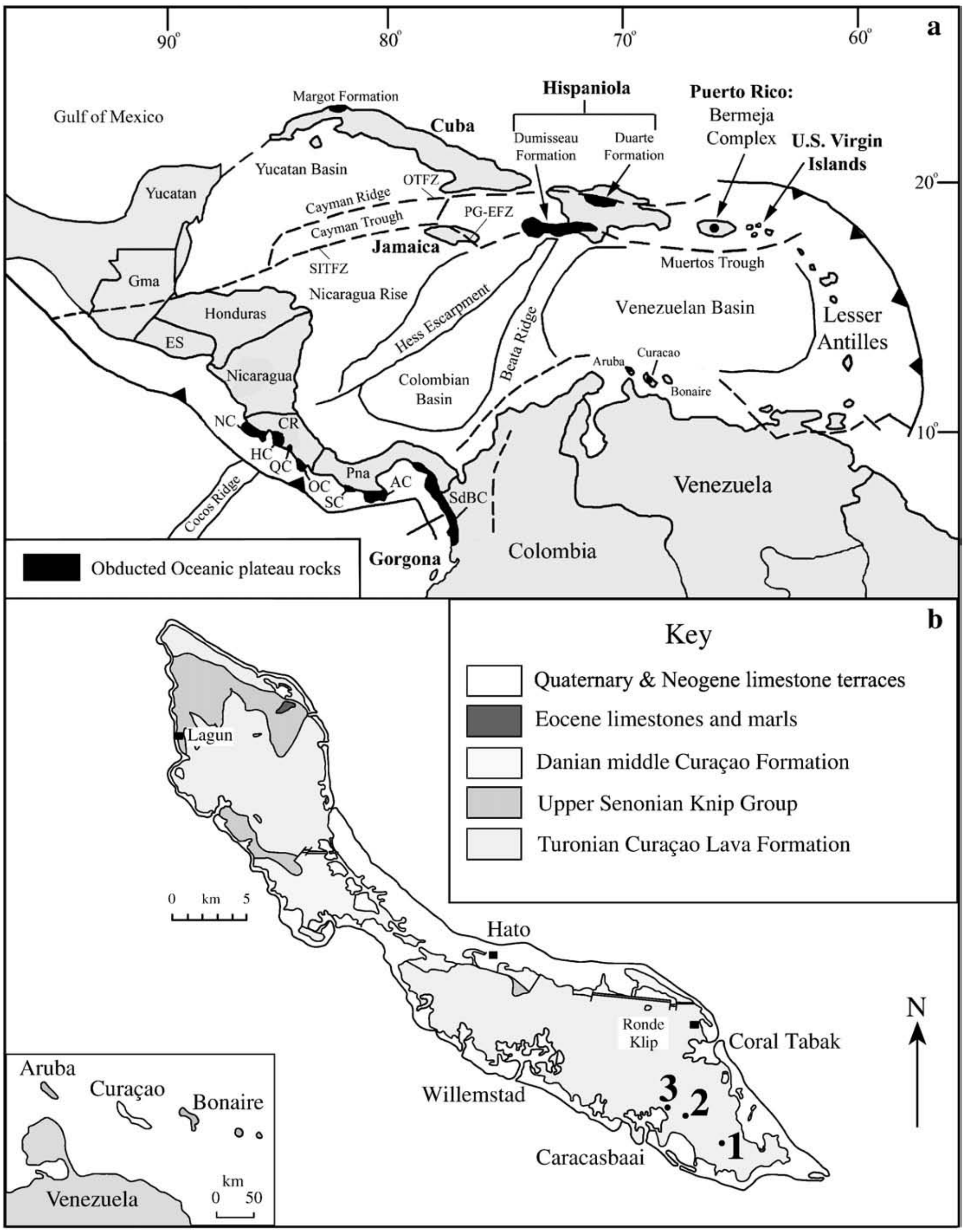

Fig. 1. (a) Map of the Caribbean and Central American region showing the location of the obducted portions of the Caribbean oceanic plateau. Guatemala (Gma), El Salvador (ES), Costa Rica (CR), Panama (Pna), Swan Islands Transform Fault Zone (SITFZ), Oriente Transform Fault Zone (OTFZ), Plantain Garden-Enriquillo Fault Zone (PG-EFZ), Nicoya Complex (NC), Herradura Complex (HC), Quepos Complex (QC), Osa Complex (OC), Sona Complex (SC), Azuero Complex (AC), Serrania de Baudo Complex (SdBC) (from Hastie et al., 2008) and (b) General geology map of Curaçao, Dutch Antilles showing the location of the Curaçao Lava Formation (modified from Kerr et al., 1996c). Locality numbers refer to locations in Table 1.