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Initial stages of oceanic spreading in the Bransfield Rift from magnetic and gravity data analysis

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A B S T R A C T

Bransfield Basin, a 500-km-long and 100-km-wide extensional structure with a well-marked NE–SW orientation, is considered a back-arc basin developed since the Pliocene and associated with subduction of the former Phoenix Plate below the South Shetland Islands Block. Extension also occurs in this area as a consequence of the end of the sinistral fault zone that deforms the South Scotia Ridge. On the basis of potential field data from marine cruises, we provide new magnetic and Bouguer gravity maps of the area at sea level. We have characterized the central magnetic anomaly by using Euler deconvolution method, spectral analysis and forward modeling obtaining a thin (1.5 km) and shallow (4 km b.s.l.) layer, and a low total magnetization (2.6 A/m). The forward modeling was constrained on basis of previous seismic refraction studies. Our models show two situations. The first presents a uniform density values along the entire crust in the basin. This would be compatible with rifting in a more advanced stage, or even an oceanic crust in its earliest stages, while the second would support the existence of a stretched, thinned and altered crust through the injection of volcanic material. In the light of these models, analysis of the new potential field maps presented in this work and information from previous studies we consider that the Central Bransfield Basin is in a rifting in its latest stages or presents an incipient oceanic crust formed by recent oceanic spreading.

1. Introduction

The process that leads to the formation of an ocean can be studied in different areas in the world. North of Africa and Arabia shows three rifts systems which represent different stages of a evolutionary sequence: (a) a continental rift system in East Africa, (b) at the Red Sea where the transition from a continental rift to oceanic rift is taking place right now, and (c) the Gulf of Aden which has already evolved to oceanic rift (Bonatti, 1987; Cochran and Martinez, 1988). This evolutionary process could seem simple.

Taylor et al. (1995) study the western Woodlark Basin/Papuan Peninsula region of New Guinea. They showed the manner in which seafloor spreading is initiated at continental margins, and what conditions are necessary to cause them, are more complex than it might first appear. Some assumptions should be reconsidered: (a) that continental rifting ceases when sea-floor spreading begins, or (b) that oceanic fracture zones develop from transfer or transform faults within continental rifts.

Marginal basins are extensional structures developed along active continental margins in different tectonic contexts. They may be formed during continental rifting as occur in Afar Depression related to the development of the triple junction between Nubian, Arabian and Somalian plates (Beyene and Abdelsalam, 2005). However, they are generally related to oceanic subduction, forming arc and back-arc systems (Taylor, 1995 and references herein). Back-arc basins are especially well developed around the Pacific and Indian oceans (New Zealand, Japan, New Hebrides, and Kuril) and also in the Scotia Sea area. Arc and back-arc systems parallel to continental margins allows to the development of narrow and elongated basins that determined the development of marginal areas of restricted oceanic circulation. These regions have related active magmatism with differentiated geochemical features (Taylor, 1995).

The Antarctic Peninsula and the South Scotia Ridge provide two examples of inactive and active back-arc basins parallel to continental margins: The Jane Bank and Jane Basin (Bohoyo et al., 2002) and the South Shetland Islands and Bransfield Strait (Gamboa and Maldonado,

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1990; Gonzalez-Casado et al., 2000). The Jane Basin is an oceanic basin formed between the Weddell Sea margin of the South Orkney microcontinent and the Jane Arc. The seismic profiles and magnetic anomalies demonstrate that it was formed during the Miocene and is inactive at Present. However, the Bransfield Basin is a more recent structure and continues to be under debate its active opening and its crustal nature (Galindo-Zaldívar et al., 2004; Gamboa and Maldonado, 1990; Gonzalez-Casado et al., 2000; Lawver et al., 1996, among others).

The aim of this contribution is to constrain the deep structure of the Bransfield Basin, discussing its oceanic or non-oceanic character, from the study of a new compilation of available gravity and magnetic data.

2. Geological setting

The study area lies between the Antarctic Peninsula and the South Shetland Islands (SSI) (Fig. 1). This area (Bransfield Strait) is considered a back-arc basin related to the subduction of the former Phoenix Plate below the SSI block (Barker et al., 1991; Dalziel, 1984; Gamboa and Maldonado, 1990). Moreover it is affected by the southwestward extensional end of the transtensional and transcurrent fault system that deforms the continental blocks of the South Scotia Ridge (Galindo-Zaldívar et al., 2004, 2006). The Bransfield Strait is a 500-km-long and 100-km-wide extensional structure with a well-marked NE–SW orientation that has been developing since the

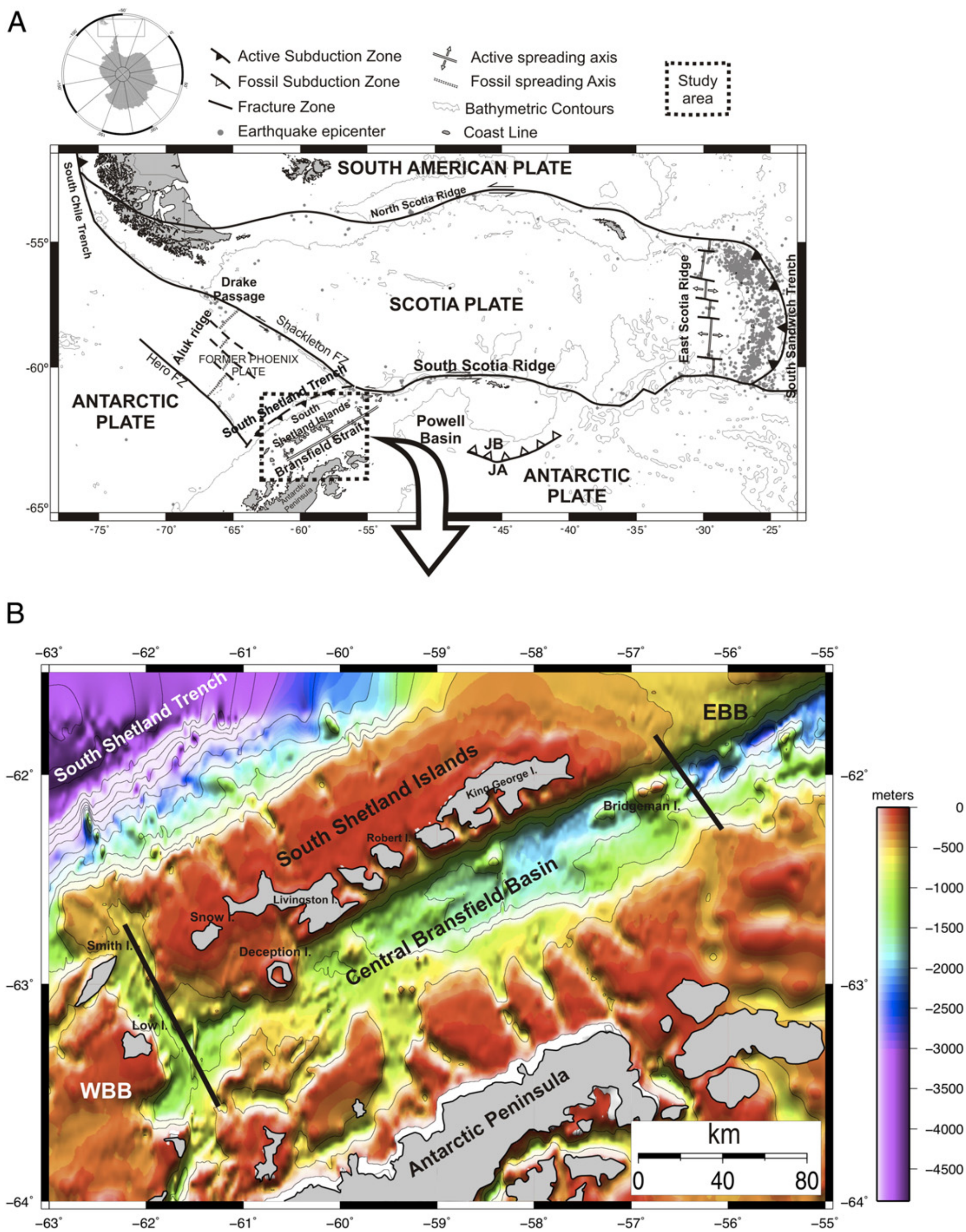

Fig. 1. a) Regional geotectonic framework of the region and location of the study area. Main geological features are included. b) Regional satellite bathymetry of the work area (Sandwell and Smith, 1997). JB : Jane Basin. JA: Jane Arc. EBB: Eastern Bransfield Basin. WBB: Western Bransfield Basin. Boundaries between basins are represented by black solid lines.