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Control of sedimentation by active tectonics, glaciation and contourite-depositing currents in Endurance Basin, South Georgia

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ABSTRACT

Endurance Basin is an elongate broadly WNW–ESE trending basin located on the northern margin of the Scotia Sea, adjacent to the southern margin of the South Georgia micro-continent. Bathymetric and TOPAS sub-bottom profile data acquired in 2010 by the British research ship RRS James Clark Ross map this basin and its sedimentology for the first time. Endurance Basin contains a number of sub-basins and a substantial glaciogenic fan. The northern margin of Endurance Basin is formed by a series of steep slopes and intervening troughs. These are interpreted as a left-stepping en echelon array of oblique, strike–slip faults whilst the sub-basins are separated by compressional dip–slip faults. It appears that South Georgia is moving NW with respect to the basin. We interpret five seismic facies from TOPAS data, which are associated with distinct sedimentologies. The most striking units in the basin fill are: substantial contourite drifts located in the NW of the basin and on its southern margin; and two distinct mass transport deposits that pond in the centre of the basin. Combined with the known regional oceanographic setting, the contourites provide evidence of broadly eastward flowing bottom currents, entering the basin from at least two locations. Although landslide scars are present on the steep northern basin margin, the imaged mass transport deposits are interpreted to have been sourced from the glaciogenic fan, located in the SE of the basin, and from a contourite unit located on the basin's southern margin. Sediments from these events are transported at least 40 km. The contourite drift sequence is at least 100 m thick in the west of the basin and may contain a palaeoenvironmental archive of Antarctic Circumpolar Current (ACC) flow and the climate of South Georgia extending to the Pliocene. Such an archive would allow the reconstruction of ACC flow through the Pleistocene glaciations and provide a means of linking ocean circulation and climate records in the sub-Antarctic Polar Front region.

1. Introduction

The continental slopes of the Antarctic continent and sub-Antarctic micro-continents preserve records of sediment transport and deposition related to ocean currents and slope instabilities during glacial–interglacial cycles (Dowdeswell et al., 2006; Noormets et al., 2009; Gales et al., 2012, 2013; Casas et al., 2013). South Georgia is the largest of the micro-continental blocks in the Scotia Sea (Fig. 1A). Because of its position in the northern Scotia Sea, and history of glaciations, deposits in the basin and on the continental slopes provide a unique opportunity to investigate the interactions between glaciosedimentary and oceanographic processes associated with the Antarctic Circumpolar Current (ACC) during glacial–interglacial cycles.

Situated between the Polar Front (PF) and the Southern Antarctic Circumpolar Current Front (SACCF) (Meredith et al., 2003), the proximal basins south of South Georgia represent an ideal and underutilised location to investigate the palaeoflow of the ACC (Fig. 1B). This current transports >100 Sv eastwards and the deep water components exported from the Southern Ocean ventilate the majority of the world's oceans; it is, therefore, a key component of the global thermohaline system (Orsi et al., 1995, 1999; Gebbie and Huybers, 2011). Improved knowledge of its variation will help in the understanding of the relative contribution of ocean circulation and greenhouse gases as climate influences (Barker and Thomas, 2004).

Although there is some debate surrounding the timing of the onset of the ACC, it is agreed that this is directly related to the deepening of the Drake Passage and the creation of a continuous circumpolar seaway. This has been widely proposed to have occurred around the time of the Oligocene–Eocene boundary at circa 30 Ma (Barker and Burrell, 1977; Barker and Thomas, 2004; Lodolo et al., 2006; Livermore et al., 2007).

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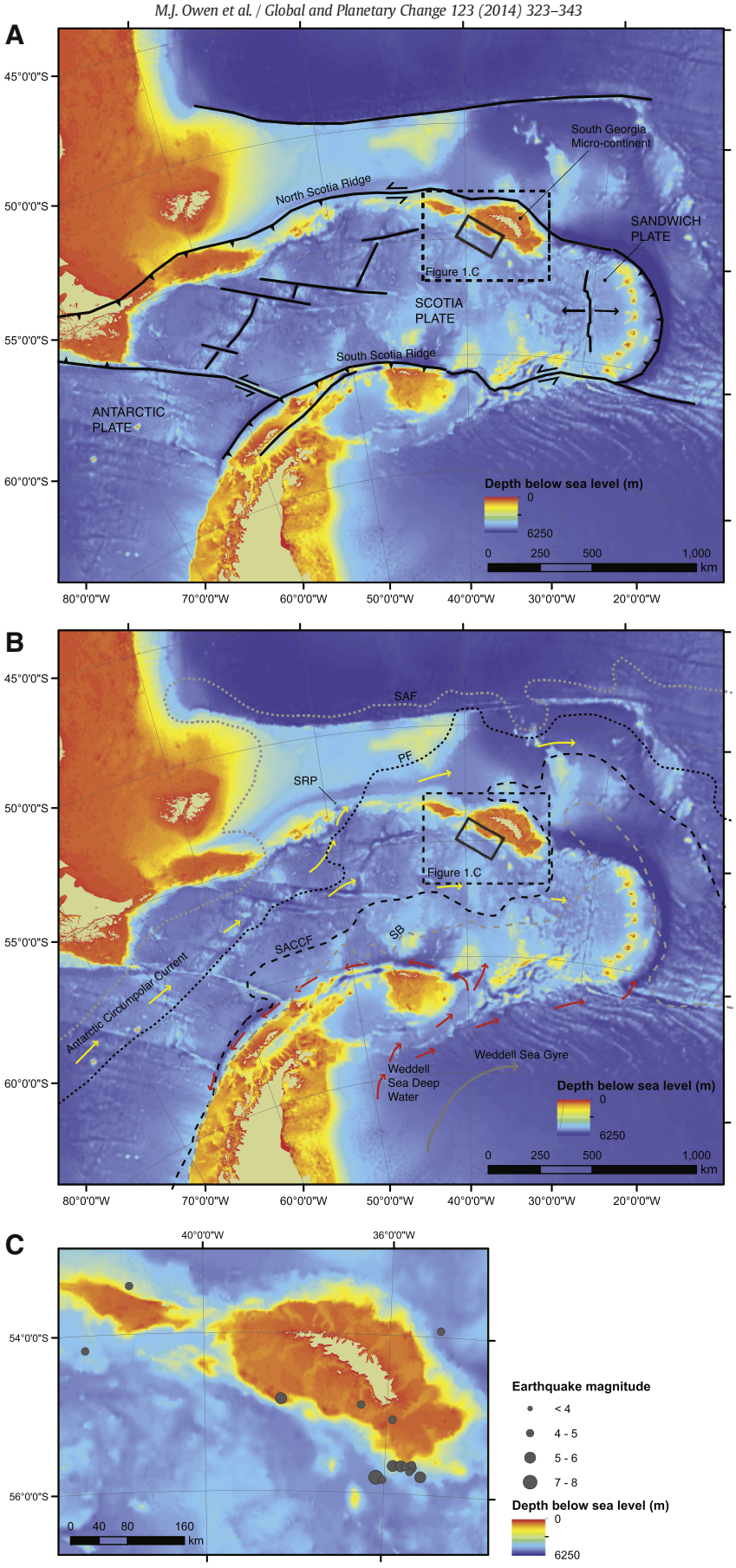

Fig. 1. Regional map of Scotia Sea. A. Tectonic setting, thick black lines indicate key tectonic plate boundaries, solid inset box shows location of Fig. 2. B. Present-day oceanographic setting, current circulation from Maldonado et al. (2003) and frontal locations from Meredith et al. (2003). SAF — Sub-Antarctic Front; PF — Polar Front; SACCF — Southern Antarctic Circumpolar Current Front; SB — Southern boundary of Antarctic Circumpolar Current; SRP — Shag Rocks Passage. C. South Georgia microcontinent and seismicity from USGS (2014).