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Cretaceous–Cenozoic sedimentary budgets of the Southern Mozambique Basin: Implications for uplift history of the South African Plateau

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ABSTRACT

In this study, data from 41 wells were used to quantify the evolution of the sedimentary budget in the Southern Mozambique passive margin basin, with a high temporal resolution for the Cenozoic period. We found that the drainage areas, which supplied sediments to the Southern Mozambique Basin, were eroded in two episodes. The first, of Mid–Late Cretaceous in age, is concordant with both thermochronological datation and sedimentary fluxes estimated by other studies in the Namibian and South African and Northern Mozambique margins. This erosion episode ended when the African surface, as defined by Burke and Gunnel (2008), had become flat and low-lying over most of the South African Plateau by ~65 Ma. Carbonate sediment deposition became more important in the shallow waters of the Mozambique basin after that time. The second erosion episode began at ~23 Ma and is likely due to an uplift event of the North-eastern part of the South African Plateau. It seems that the Limpopo catchment and the whole area sourcing the studied basin have inherited their present relief from two epeirogenic uplift pulses of Late Cretaceous and Miocene ages.

1. Introduction

The Meso-Cenozoic history of the South African Plateau and its tectono-morphic evolution has been widely studied over recent decades. However, there remains no clear consensus on the timing of the related vertical motions, demonstrated by the existence of various models. These models fall into two broad categories, hypothesising either a continuous single phase of exhumation or multi-pulse exhumation. The timing of the uplift ranges between times prior to the Gondwana dispersion (Gilchrist et al., 1994; Van Der Beek et al., 2002; Pysklywec and Mitrovica, 1999; Doucoure and De Wit, 2003) and the Late Neogene (Partridge and Maud, 1987; Partridge, 1997). Significant stages of exhumation in the South African Plateau have been documented in the Late Cretaceous (King, 1967; De Wit et al., 1988; Brown et al., 1990, 2000; Gallagher and Brown, 1999; Tinker et al., 2008a,b; Kounov et al., 2009) and since the Oligocene (~30 Ma; Burke, 1996; Burke and Gunnell, 2008).

Erosion and subsequent sediment transport are commonly identified as results of the uplift of shields and plateaus (Stephenson, 1984; Bishop and Brown, 1992; Tinker et al., 2008b). Thus, the quantification of terrigeneous sediment in the surrounding marginal basins can be used to constrain the timing of continental relief evolution. Such an empirical approach has been used in the study of several basins located on the edges of the South African Plateau in Southern Africa (McMillan, 2003), including the Orange Delta basin (Guillocheau et al., 2012), the Outeniqua basin (Tinker et al., 2008b) and the Zambezi Delta off central Mozambique (Walford et al., 2005). However, except for Walford et al. (2005), these studies lack precision in the Cenozoic because they adopt a single time interval for the sediments accumulated during that epoch. As for the Limpopo delta and the associated Southern Mozambique Basin, which are the focus of this paper, the only published sediment estimates are based on a single interpreted seismic cross-section (Macgregor, 2010).

Here we aimed to unravel the vertical motion of the catchment area located at the north-eastern margin of the South African Plateau that supplies sediment to the Southern Mozambique Basin. Based on a compilation of 41 exploratory wells, we carried out a volumetric study of the sediments preserved in the Southern Mozambique Basin from the Early Cretaceous onwards. The presented results provide a better estimate of the uplift timing and the topographic building of the north-eastern margin of the South African Plateau relief.

2. Geological settings

The present-day Southern Mozambique Basin was formed during a complex geodynamic evolution of the south-east African

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margin (Fig. 1). Its formation started during the Karoo rift and the Karoo Magmatic events in the Triassic and Early to Middle Jurassic times, respectively. These events led to the Gondwanaland break-up in Late Jurassic–Early Cretaceous times and the subsequent drift of major- and micro-continents from the Early Cretaceous onwards (Martin and Hartnady, 1986; Salman and Abdula, 1995).

Also called the Mozambique Thinned Zone (Cox, 1992), the Southern Mozambique Basin is a thin Meso-proterozoic (or older) crustal fragment embedded within an oceanic crust of the Early Cretaceous age (Ben Avraham et al., 1995). Before the M10 magnetic anomaly marker of ~135 Ma, the prominent Dronning Maud Land of East Antarctica was adjacent to the Lebombo and the Mwenetzi monoclines (Fig. 1b). It subsequently slid southward for more than

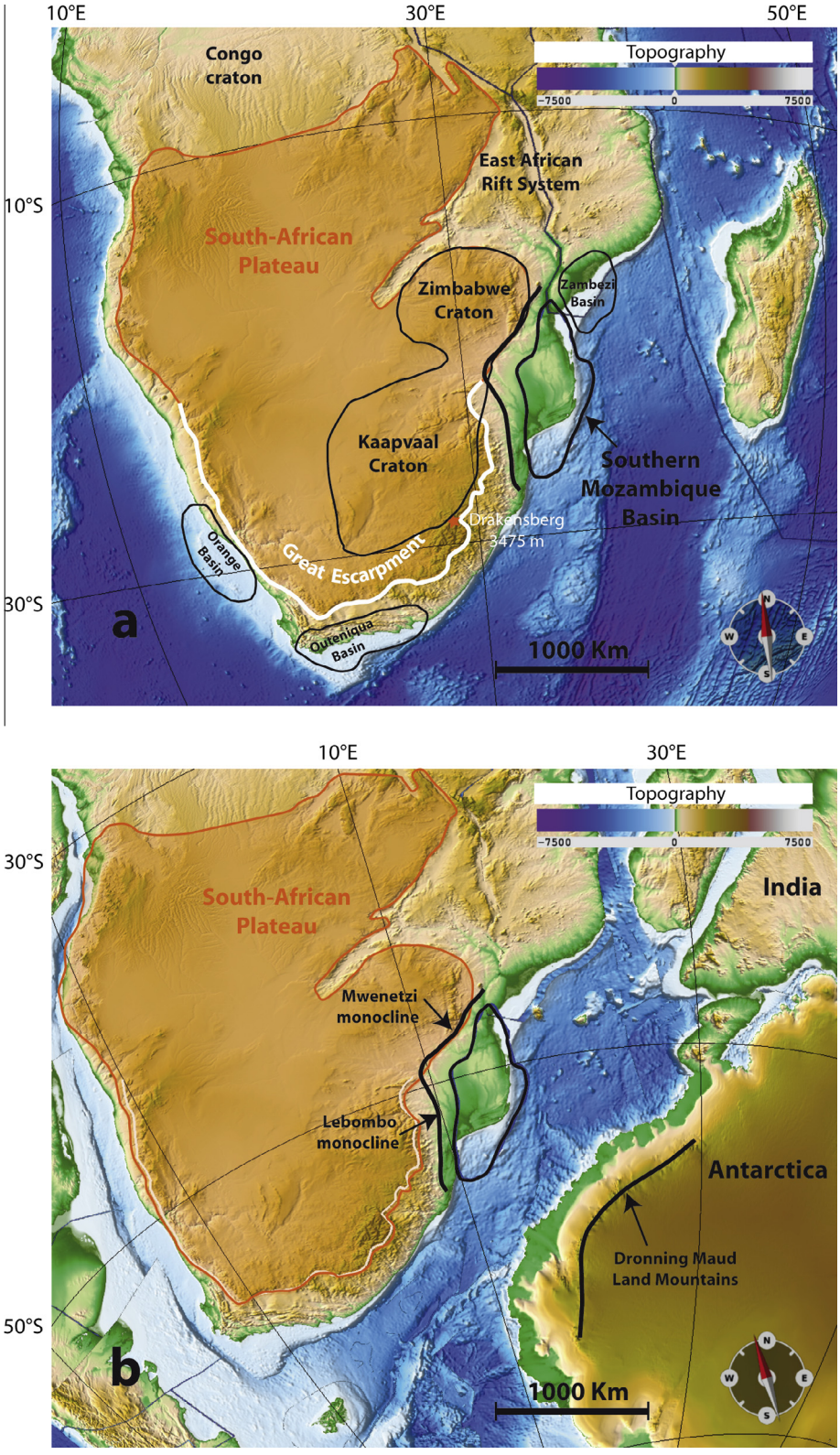

Fig. 1. Digital elevation model of Southern Africa. (a) Present day and (b) reconstructed at 150 Ma using the UTIG model (Lawver et al., 1998).