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Regional and global context of the Late Cenozoic Langebaanweg (LBW) palaeontological site: West Coast of South Africa

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ABSTRACT

The palaeontological site of Langebaanweg (LBW) is internationally renowned for its prolific, diverse and exceptionally well preserved Mio-Pliocene vertebrate faunas. The site is located on the southern West Coast of South Africa which represents a passive intraplate, trailing edge setting. The southern African subcontinent is also removed from glacial influence and has experienced no Cenozoic volcanic activity. Rates of vertical crustal motion are consequently low and Late Cenozoic shoreline datums at LBW chiefly reflect glacio-eustatic sea level history. The primary aim of this study is to clarify the chronology as well as the regional and global context of LBW and to review previous work on these aspects. LBW is ideally situated to document the complex interactions of ocean, atmosphere and land and their respective influence on climate evolution, given its location near the coast and mix of marine, estuarine and terrestrial faunas and depositional settings. This paper also provides a background to the study of the vast existing faunal collections and a guide to undiscovered fossil deposits. Towards these ends, the first detailed geological/topographic maps of the site and surrounds, accompanied by a summary stratigraphic column are provided. Virtual geological modelling using a subsurface database has clarified the spatial and temporal relationships of sedimentary facies, as well as their depositional settings.

The geological and palaeontological record at LBW tracks and documents the major regional and global climatic/oceanographic events of the Late Cenozoic. During the Oligocene drawdown in sea levels, the landscape was etched by river incision. Fluctuating sea levels of the Neogene periodically reversed the trend from erosion to deposition, preserving contemporary faunas and floras in the Oligocene palaeovalleys. Earlier Miocene pollen from fluvial facies indicates a humid sub-tropical climate, reflecting a warm southern Atlantic Ocean. The abrupt late Middle Miocene global cooling (Monterey Excursion) coincided with intensified cold upwelling in the Benguela Current and extensive phosphate authigenesis. A globally documented Early Pliocene highstand possibly related to the shoaling of the Isthmus of Panama reached ~90 m above sea level (asl), implying extensive melting of the cryosphere. Palaeomagnetic data in tandem with global sea level reconstructions suggested an age of ~5.15 ± 0.1 Ma for the faunas and a correlation with the earlier part of this transgression. A subtropical C3 vegetation is indicated by the faunas and floras, but with a significant contribution by sclerophytic *fynbos* pointing to a cooler and more seasonal climate than in the Miocene. A mid-Pliocene highstand to ~50 m asl truncated the Early Pliocene succession at LBW and the globally documented Late Pliocene highstand to ~30 m asl saw the Atlantic shoreline approaching LBW for the last time. With the progressive climatic cooling and instability of the terminal Pliocene, culminating in the growth of the Arctic ice cap, strengthening southerly winds driven by a tighter coiled South Atlantic Anticyclone deposited extensive coastal dune fields over the region.

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Contents

1. Introduction

In terms of diversity, the Late Miocene has been termed the 'climax of the Age of Mammals' (Kurten, 1971) and LBW offers a unique African archive of the latter part of this period. This record includes the first bear found in Africa (*Agriotherium africanum*), a wolverine (*Plesiogulo monspessulanus*), the only African peccary (*Pecarichoerus*) and several species of hyaena. Some forms are present in great abundance, such as the short-necked giraffid *Sivatherium hendeyi* (Fig. 2), of which more than 500 individuals have been counted (Hendey, 1981a,b). Isotopic and dental pathological studies on the teeth of this species have shed light on aspects of dietary and population health and confirmed the prevalence of C3 vegetation in the Mio-Pliocene (Franz-Odendaal, 2002; Franz-Odendaal et al., 2002; Franz-Odendaal and Solounias, 2004; Franz-Odendaal, 2006; Ungar et al., 2006). Importantly though, LBW also documents the initiation of the more specialised and less diverse mammalian faunas, evolving to cope with the climatic instability and extremes of the Quaternary (Hendey, 1981a). The seal *Homiphoca capensis*, which shows adaptations to colder waters exemplifies this transformation. The Mio-Pliocene time frame of LBW also overlaps the emergence of the hominin lineage and some of the earliest forms in eastern Africa come from sites with temporally comparable faunal assemblages (Grine et al., 2006; Adams et al., 2007). The Elandsfontyn site where the early Middle Pleistocene 'Saldanha Man' cranium was discovered (Strauss, 1957) is situated only 30 km south of LBW. The coastal deposits which hosted these remains have counterparts at LBW, associated with which are Early and Middle Stone Age artefacts (Kandel et al., 2006).

Avians are also exceptionally well represented at LBW and Rich (1980) suggested that the site ranks amongst the richest pre-Pleistocene fossil bird localities in the world. Although several works on the avifauna have been published (Simpson, 1971; Olson, 1984, 1994; Rich and Haarhoff, 1985; Olson and Eller, 1989; Stidham, 2006; Manegold, 2009) most of the material remains unstudied. Amongst the lower vertebrates, the anurans are especially prolific and diverse with at least four and probably six families documented (Van Dijk, 2006). Less well known are the Plio-Pleistocene faunas found in the aeolianites unconformably overlying the Tertiary strata, as well as phosphatic fluvial sediments at Baard's Quarry ~2 km east of LBW (Tankard, 1974; Hendey, 1981a). These faunas are less diverse and more fragmentary in nature than their Mio-Pliocene counterparts, but nonetheless contribute significantly to the continuum between Tertiary and Quaternary forms. The LBW fauna also provide an important context for dating and interpreting contemporary sites in other parts of Africa, thereby helping to distinguish between extinction/migration events in space and time. Some mammalian groups such as the felids and micromammals display a high degree of endemism (Hendey, 1981a; Matthews, 2004, 2006), shedding light on the origins of Quaternary and present faunas indigenous to the region.

The Mio-Pliocene palaeontological site of Langebaanweg (LBW) is internationally renowned for its prolific, divers and exceptionally well preserved fauna. This National Heritage Site occupies an old phosphate