HISTORY

Pleistocene fossil elephant tracks in the Addo Elephant National Park, South Africa

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Abstract

Fossilized elephant tracks, along with other vertebrate tracks, have been identified at several sites in the coastal Woody Cape section within the Addo Elephant National Park, in South Africa's Eastern Cape Province. The tracks occur in aeolianites (cemented dunes). The track-bearing unit has been dated to 126 ± 8 ka, at approximately the boundary between the Middle Pleistocene and Late Pleistocene. In all probability, the trackmaker was the African savannah elephant (*Loxodonta africana*). Viewed in conjunction with the thirty-five elephant track sites that have been identified on South Africa's Cape south coast, a widespread Pleistocene elephant presence can be inferred, which is not obvious from the body fossil record. Collaboration with Park management is aimed at developing an interpretive exhibit, which can be complemented by the physical recovery and exhibition of suitable fossilized elephant tracks or the creation of replicas using photogrammetry data.

Résumé

Des empreintes fossilisées d'éléphant ainsi que des traces d'autres vertébrés, ont été identifiées sur plusieurs sites de la zone côtière de Woody Cape, dans le parc national des éléphants d'Addo (province du Cap oriental en Afrique du Sud). Les marques, visibles sur des aeolianites (dunes cimentées), se situent dans une zone qui a été datée à -126 000 ans (± 8 000 ans), soit approximativement au passage du Pléistocène moyen au Pléistocène supérieur. Selon toutes probabilités, le propriétaire des empreintes était un éléphant de savane (*Loxodonta africana*). Si l'on examine ces marques conjointement à celles identifiées dans les trente-cinq autres sites présentant des traces d'éléphants sur la côte méridionale sud africaine, on peut en déduire que ces animaux étaient présents dans l'ère du Pléistocène, bien qu'on ne puisse l'étayer sur la base d'ossements retrouvés dans cette région. Une exposition didactique, en collaboration avec les gérants du parc, est attendue et pourra être enrichie des pièces fossiles originales ou de répliques créées à l'aide de données photogrammétriques.

Introduction

Through the Cape South Coast Ichnology Project, more than 350 vertebrate Pleistocene track sites have been identified along 350 km of South African coastline (Helm 2023). 'Ichnology' refers to the study of tracks and traces. Three published works have documented aspects of elephant tracks: they were shown to be potential precursors of potholes (Helm et al. 2021), the first elephant trunk drag impressions in the global record were described (Helm et al. 2022), and a possible trace fossil signature of seismic communication between elephants was reported (Helm et al. 2024). Thirty-five elephant track sites were identified, indicating the presence of regional elephants from Marine Isotope Stage MIS 11 (~400 ka) through MIS 5 (~130–80 ka) to MIS 3 (~35 ka) (Helm et al. 2022). One site, in the Robberg Nature Reserve, exhibited some of the largest Cenozoic tracks ever identified (Helm et al. 2019).

This prevalence of elephant track sites can be contrasted with the paucity of elephants in the regional body fossil record. Only two unpublished Pleistocene records from the Cape south coast are known, both from Cape Vacca: elephant bones were found in a palaeosol in the 1980s and reportedly dated to ~120 ka (Fred Orban, pers. comm., 2020), and possible elephant tusk fragments were identified in 2015 (Frikkie Orban, pers. comm., 2020). Similarly, the only localities in Eastern Cape Province from which Pleistocene elephant bones have been reported are the Klasies River 'Main Site', (Klein 1976; Avery 2019) and near Oyster Bay (Carrión et al. 2000), in both cases in Middle Stone Age layers. Evidence for a more recent widespread elephant presence in southern Africa (Carruthers et al. 2008) includes archaeological sites (Plug and Badenhorst 2001), the rock art record (e.g. Paterson 2007), and place names (Möller 2017).

This discrepancy has been attributed to the 'schlepp effect', whereby the likelihood of a carcass not being transported is related to the size of the animal, with consequent under-representation of larger animals in the body fossil record (Perkins and Daly 1968), as many southern African Pleistocene skeletal records are from archaeological sites. Similar explanations have been advanced by Parkington and Poggenpoel (1971) and Thackeray (1979), who suggested that large animals were butchered and prepared before returning to camp. Likewise, Badenhorst et al. (2021) commented on the paucity of rhinoceros remains from the Middle Stone Age (MSA), suggesting that large carcass size inhibited portability.

In contrast, the track record does not display this bias, and the tracks of large, heavy animals are identifiable with relative ease. In suitable palaeo-settings the ichnological record can thus be a more reliable guide to the presence of Pleistocene large animals in southern Africa. While the proboscidean fossil record is complex, extending back to the Paleocene (Shoshani 1998), the most plausible candidate for the Cape coastal Middle to Late Pleistocene tracks is the African savannah elephant (*Loxodonta africana*). The latest reported occurrence of earlier representatives of the *Loxodonta* genus, such as *L. atlantica*, is ~400 ka (Klein et al. 2007; Carruthers et al. 2008).

Over time we have expanded our documentation of Pleistocene vertebrate track sites, both temporally (into the Pliocene) and spatially, to South Africa's west coast and south-east coast. The latter involved exploration of the coastal portion of the Addo Elephant National Park (AENP) in the Eastern Cape Province (Fig. 1). The AENP was proclaimed in 1931 (with an initial size of just over 2,000 ha) to protect the remaining Addo elephants (Grobler and Hall-Martin 1982; Reardon 2021). The size of the Park has expanded to the current 360,000 ha, which includes the coastal Woody Cape (this section was added in 2002), making it the third largest national park in South Africa (Reardon 2021). The purpose of this field note is to describe the Pleistocene elephant tracks that have been identified in the AENP, and to discuss the potential for education and interpretation.

Geological context

The 10-km stretch of coastal cliffs (Fig. 2) in the remote Woody Cape section of the AENP comprises Pleistocene aeolianites (cemented dunes) of the Nahoon Formation of the Algoa Group (Le Roux 1989), which rise over 40 m above sea level in a stacked geological sequence draped by Holocene sands. The elephant tracks occur in the basal aeolianite unit, except for the easternmost site, as discussed below, where the tracks were found in an ex situ loose slab adjacent to the basal unit. This unit has been dated to 126 ± 8 ka, using optically stimulated luminescence (Van Tonder 2024),

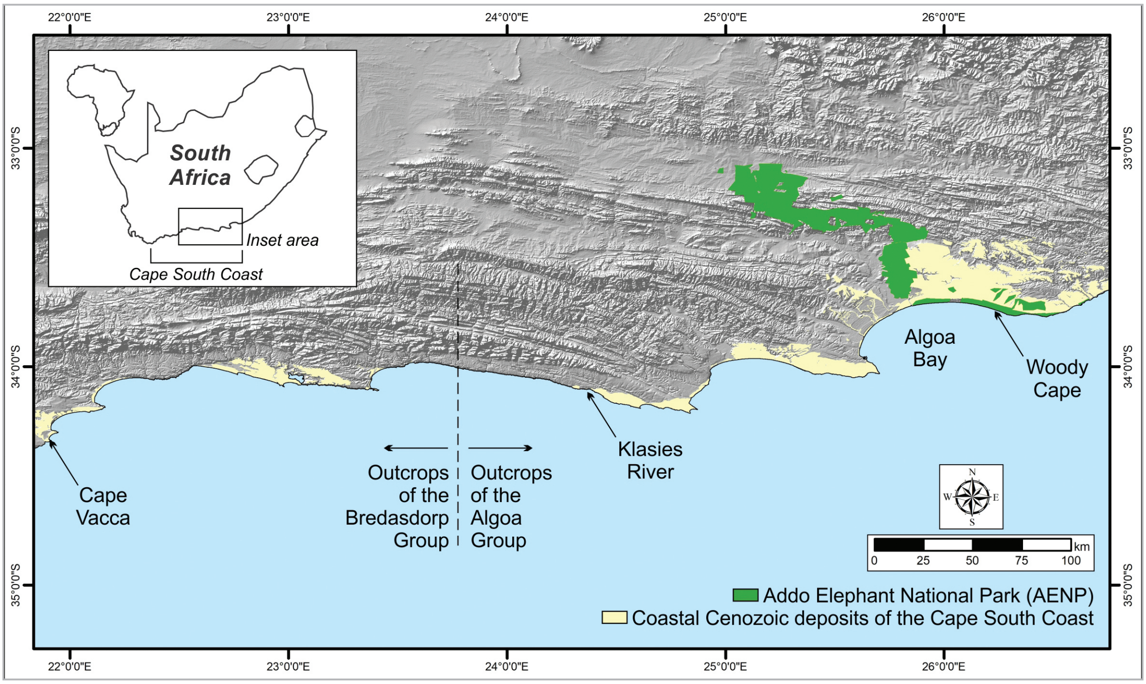

Figure 1. Map of South Africa's Cape coast, showing sites mentioned in the text.

Figure 2. The Woody Cape coastline, in the approximate area from which the sample for Optimal Stimulated Luminescence (OSL) dating was taken.

placing it approximately at the boundary between the Middle Pleistocene and the Late Pleistocene, and within MIS 5e (the last interglacial), a period with a climate and sea-level comparable to the present. The tracks would have been registered on unconsolidated dune and interdune surfaces.

The aeolianite bedding planes, including the track-bearing layers, are fairly level and laterally persistent. In places aeolianites are calcified, suggesting ancient palaeo-aquifers. Higher up in the cliffs, palaeosols predominate and contain fossilized land snails (*Achatina zebra*). Landward of the cliff tops lies the Alexandria dune field with a surface area of over 15,000 ha.

Storm surges and spring tides batter the cliffs, causing sections to collapse, exposing new track sites and destroying others. A dynamic equilibrium thus exists, and track sites are ephemeral unless they can be recovered and accessioned in suitable facilities.

Elephant tracks may be preserved in epi-relief on the original surface on which they were registered, in hypo-relief (natural casts) in the layer that filled in the tracks, or in profile. When tracks are evident in profile, distorted bedding and deformation are apparent in the underlying layers. In all cases, elephant tracks can be identified by their size. Even when viewed only in profile, a track diameter of more than 35 cm effectively excludes other large candidates such as the rhinoceros and hippopotamus, whereas tracks in the 25–35 cm range could have been registered by these animals or by juvenile elephants (Liebenberg 2000; Stuart and Stuart 2019; Van den Heever et al. 2017; Gutteridge and Liebenberg 2021).

The geology, archaeology and ichnology of the Woody Cape area form chapters in an ongoing MSc thesis by one of the authors (Van Tonder in prep.).

Methods

Track measurements included length, width and depth. Results were recorded in centimetres. The dip and strike readings were recorded on in situ surfaces. Standard field techniques were applied to understand the context of the track sites.

Photographs were taken of tracks, and photogrammetric analysis (Matthews et al. 2016) was performed. 3D models were generated with Agisoft Metashape Professional (v. 1.0.4) using an Olympus Tough model TG-6 camera (focal length 4.5 mm; resolution 4,000 x 3,000; pixel size 1.56 x 1.56 um). The final images were rendered using CloudCompare (v.2.10-beta).

Global Positioning System readings were obtained for track sites using a handheld device. Locality data were reposited with the African Centre for Coastal Palaeoscience at Nelson Mandela University, Gqeberha, to be made available to researchers upon request.

Figure 3. The westernmost elephant track; scale bar is in cm.

Results

Elephant tracks

The elephant track sites in the Woody Cape section within AENP are described here from west to east. The westernmost site contains a large, oval track 42 cm in length and 36 cm in width, (Fig. 3, see below). It is located on the ceiling of a small overhang, in an area of well-consolidated deposits that cleave readily to yield palaeosurfaces.

Two km east of here lies a 1–km stretch of coastal cliffs in which distorted bedding and elephant tracks in profile are identifiable in at least four sites (Figs. 4a-d). A typical track width of 37 cm was noted, whereas the largest track measured 50 cm in diameter and 25 cm in depth. At one of these sites, tracks were evident over an east-west distance of 10 m and in four distinct layers, separated (from top to bottom) by 20 cm, 20 cm and 22 cm. The profusion of tracks suggests trampling of surfaces by elephants, and their presence in multiple layers indicates repeated use of an area over time.

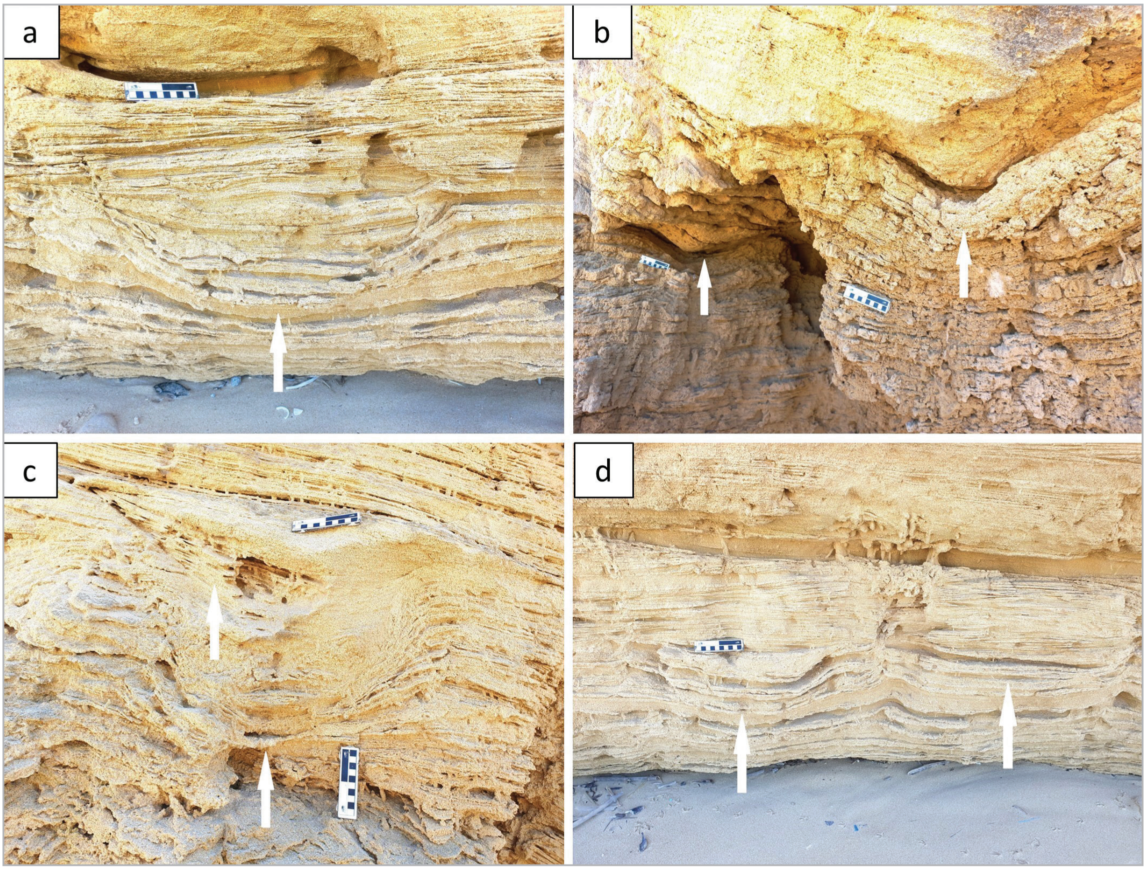

Figure. 4(a-d). Arrows indicate elephant tracks in profile; scale bars = 10 cm.

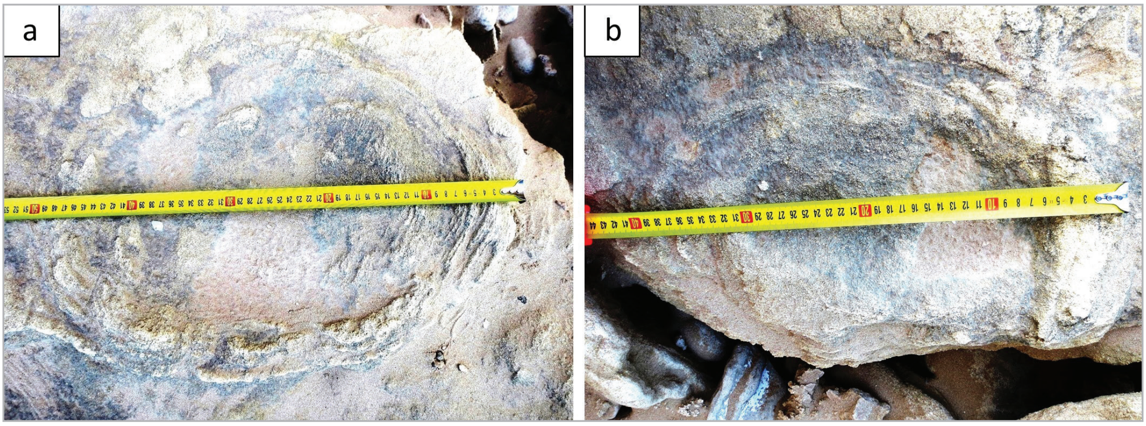

Figure. 5(a, b). Elephant tracks at the easternmost site; scale bars are in cm.

The easternmost site is situated six km further to the east. Here a loose slab contained two oval elephant tracks, respectively 50 cm and 45 cm in length (Figs. 5 (a,b) and 6). Both tracks exhibited a concentric ring-and-groove pattern, mostly in the outer portions of the tracks, which could be related either to elephant seismic communication or to the intersection of fine laminae with the tracks (Helm et al. 2024). Unfortunately, a landslide has buried the track-containing slab, which is currently not visible.

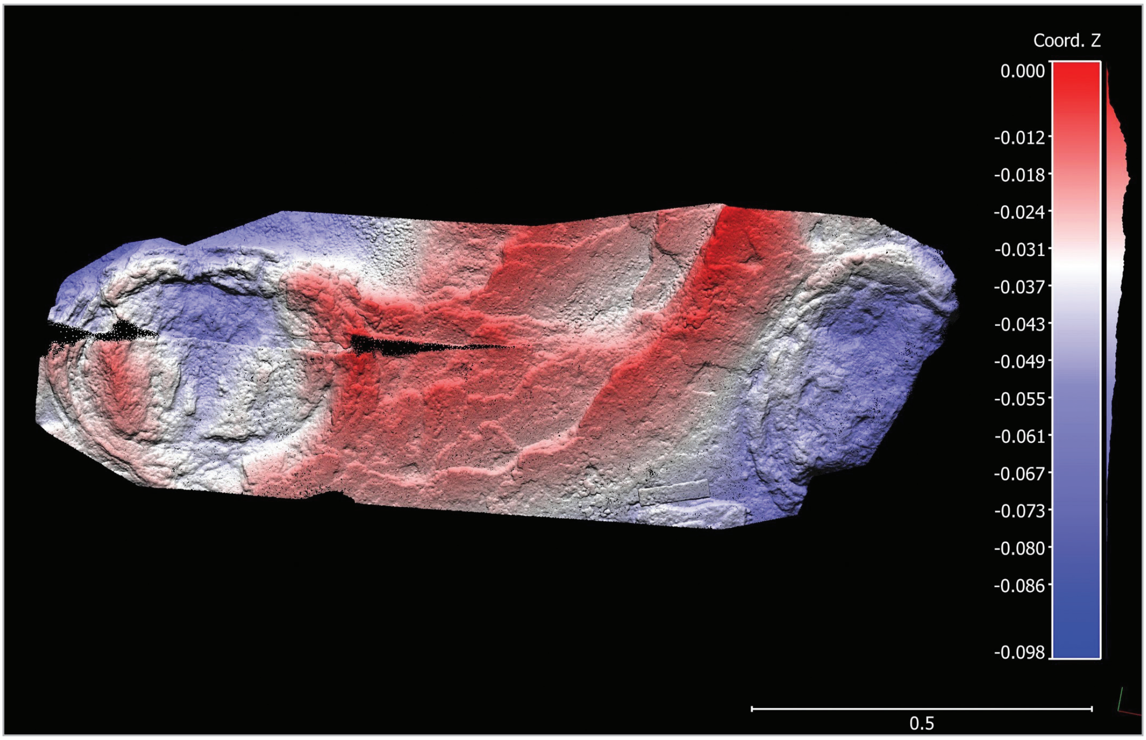

Figure 6. 3D photogrammetry model of the tracks shown in Figure 5; horizontal and vertical scales are in metres.

Other tracks

In addition to elephant tracks, traces of a sand-swimming golden mole were reported, resembling those made by the *Eremitalpa* genus, currently confined to the west coast of Namibia and South Africa. These formed the holotype for the ichnotaxon *Natatorichnus sulcatus* (Lockley et al. 2021). A trackway consistent with that of a juvenile shod hominin has also been described—this would be among the oldest known cases of humans fashioning footwear (Helm et al. 2023). Unfortunately, the loose slabs containing both the *N. sulcatus* traces and the shod-hominin trackway were destroyed in a 2023 storm surge. However, our photogrammetry data non-invasively preserve a record and can be used to make accurate replicas.

Bovid tracks of various sizes have been identified, ranging from buffalo tracks (*Syncerus antiquus* or *Syncerus caffer*) to probable duiker sp. (subfamily Cephalophinae) or grysbok (*Raphicerus melanotis*) tracks. Finally, in another 'global first', the wall of a fossilized aardvark (*Orycteropus afer*) burrow contained claw scratch marks.

Discussion

Seen in isolation, the presence of only one site in the Eastern Cape containing Pleistocene skeletal material might suggest a limited regional elephant presence. However, the complementary ichnological evidence of elephant tracks within the AENP boundary indicates that such a conclusion would be unjustified. The fossil elephant tracks that have been discovered would almost certainly have been registered by the African savannah elephant, the species that inhabits the AENP today. Expanses of sand and dunes would have formed an ideal medium for long distance seismic communication.

Considering the AENP elephant tracks in conjunction with the 35 elephant tracksites that have been identified on the Cape south coast (Helm et al. 2022), a widespread elephant presence can be inferred in both the Middle Pleistocene and Late Pleistocene, something which has hitherto not been obvious from the body fossil record in the Western Cape and Eastern Cape. Perhaps the most important consideration from the AENP perspective is that this Park, which has done so much to protect and preserve elephant survival and heritage, contains Pleistocene fossilized elephant tracks within its boundaries, as described herein. We anticipate that visitors to the AENP might find this interesting and that it might add an extra dimension to their experience. The Main Camp has an excellent interpretive centre, opened in 2011, which includes an exhibit on dinosaurs found in the vicinity (but outside the AENP boundary) and regional geology. A wall exhibit with photographs, informing visitors of the ancient presence of African savannah elephants, could have many benefits.

Although elephant tracks have been identified in epi-relief, profile and hypo-relief, currently there are none that are suitable for recovery and exhibition. However, future discoveries can be anticipated during return visits to the Woody Cape coastline, or the eastern track-bearing slab might become re-exposed. Use of a helicopter or all-terrain vehicle to recover tracks and place them on exhibit might be of considerable visitor and media interest. An alternative is using a 3D printer to produce a 1:1 replica of the elephant track depicted in Fig. 6, using photogrammetric data. Our research team has established a good collaborative relationship with AENP management and staff, with plans in place to jointly develop such an exhibit.

Conclusions

The presence of fossilized elephant tracks in the AENP, dated to ~126 ka and probably made by the African savannah elephant, indicates an ancient elephant presence in the Park. More evidence is likely to accrue through future exploration. The recovery of tracks, or replication through photogrammetry, represent ways of preserving this evidence. The interpretive centre in the Addo Main Camp can function as a suitable venue for interpretation and education on this aspect of AENP palaeo-heritage.

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