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New early Pleistocene hominin teeth from the Swartkrans Formation, South Africa

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ABSTRACT

We describe 14 hominin teeth and tooth fragments excavated recently from Swartkrans Cave (South Africa). The fossils derive from Members 1 (Lower Bank) and 3, from the Member 2/3 interface and from two deposits not yet assigned to member (the "Talus Cone Deposit" and the "Underground North Excavation" [UNE]) of the Swartkrans Formation, and include the first hominin fossil from the UNE, the two smallest *Paranthropus robustus* deciduous maxillary second molars in the entire hominin fossil record, and one of the smallest *P. robustus* permanent maxillary second molars from Swartkrans. The small permanent molar is accompanied by another tooth from a different individual but from the same stratigraphic level of the Swartkrans Formation; this second tooth is among, if not, the largest *P. robustus* permanent maxillary first molars known from anywhere—lending credence to assertions that degrees of body size sexual dimorphism previously ascribed to this species may be underestimated. It is more equivocal whether this evidence also supports hypotheses proposing that *P. robustus* assemblages from Swartkrans (as well as those from other South African cave sites) formed through the taphonomically biasing actions of large carnivores.

1. Introduction

Swartkrans Cave (Gauteng, South Africa) continues to yield an important early Pleistocene record of hominin evolution that includes fossils of *Paranthropus* (*Australopithecus*) *robustus* and early *Homo* (e.g., Broom, 1949; Broom and Robinson, 1949, 1950, 1952; Clarke et al., 1970; Clarke and Howell, 1972; Clarke, 1977; Brain, 1981; Brain et al., 1988; Grine, 1989, 1993; Susman, 1989, 1993; Sutton et al., 2009; Pickering et al., 2012), as well as abundant archaeological traces (i.e., stone tools, butchered animal bones, purported bone tools and bones that might have been burned in hominin-controlled fires) created by one or both of these taxa (e.g., Brain, 1981, 1993a; Brain et al., 1988; Backwell and d'Errico, 2003; Pickering et al., 2004, 2005, 2007, 2008) (Fig. 1). Excavations conducted by the Swartkrans Paleoanthropological Research Project (SPRP) since 2005 have generated large samples of non-hominin vertebrate fossils and artifacts. These extensive paleoanthropological samples, derived from several areas of the site and from various members of the Swartkrans Formation, are still under analysis, but here we provide descriptions of all previously unreported hominin teeth and tooth fragments (14 in total) recovered by the SPRP, augmenting the 400+ hominin specimens already recovered and described from Swartkrans.

2. Geochronological and paleoanthropological contexts of the newly described fossils

Swartkrans Cave is located ~40 km northwest of Johannesburg in the 466 km^2 UNESCO World Heritage Site that, with its multiple fossiliferous caves, is designated as the "Cradle of Humankind" (Fig. 1). Swartkrans developed as a phreatic maze cave within the impure dolomitic limestone of the Chuniespoort Group (Palmer,

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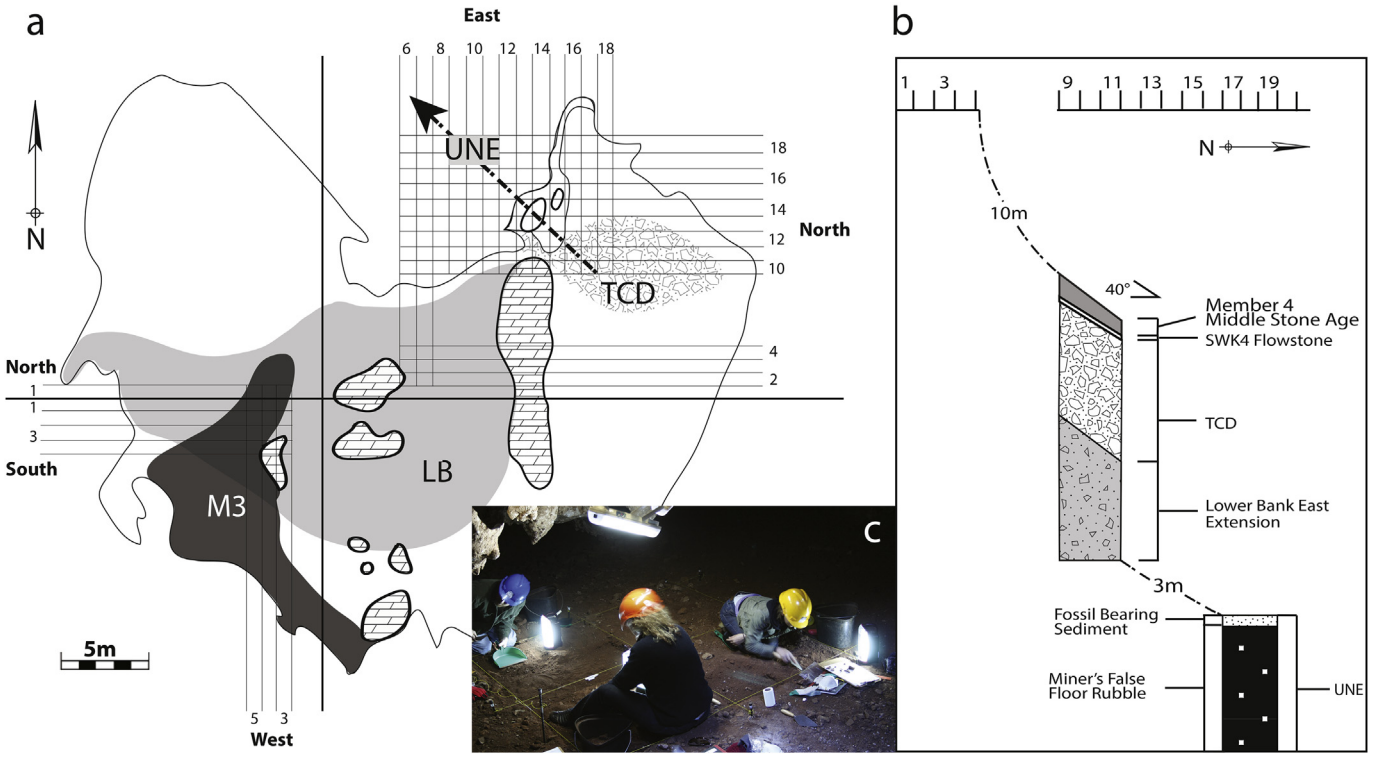

Figure 1. (a) Plan view of Swartkrans Cave illustrating most of the depositional units discussed in this paper (adapted from Brain, 1993b). Select 1 × 1 m excavation grid squares are indicated by intersecting N-S/E-W lines; site datum is at 0N-S 0E-W, represented by the intersection of the bold lines in the middle of the plan. Depositional bodies exposed aboveground include the Lower Bank (LB) of Member 1 and Member 3 (M3); in order to clarify positions of the LB and M3 deposits, Member 2 is removed in this plan but its interface with M3 includes excavation grid squares 1N 4W and 1S 3W. Relevant underground deposits include the "Talus Cone Deposit" (TCD) and the "Underground North Excavation" (UNE), which are represented in the linked stratigraphic columns (b) that show their relationships to previously described (Sutton et al., 2009) underground deposits of the Swartkrans Formation. The indicated SKW-4 flowstone was dated via U–Th to 110,000 ± 1980 years old (Sutton et al., 2009). An informal view of an early stage of archaeological work in the UNE (north is roughly in the direction of the excavator in the right of the image) is shown in (c).

1991; Brain, 1993b). It is likely that the cave first opened to the ground surface sometime in the early Pleistocene, when it then began to admit materials of the Swartkrans Formation (Butzer, 1976; Brain, 1976, 1993b).

Starting with Member 1, the five sequential members of the Swartkrans Formation are separated by erosional discontinuities. The three subunits of Member 1 are the Lower Bank (LB), the Lower Bank East Extension (LBEE) and the Hanging Remnant (HR) (Brain, 1993b; Sutton et al., 2009; Pickering et al., 2012). The LB and LBEE of Member 1 are indistinguishable depositionally and sedimentologically. They form a single infill, and are only classified separately because the eastern portion of this depositional body was recognized by Sutton et al. (2009) long after the Swartkrans Formation was re-codified by Brain (1993b). The soils of the LB/LBEE were admitted into Swartkrans via a shaft (or shafts) that opened to the ground surface above. Eventually this surface-derived material—characterized by sandy silt, with occasional clasts of subangular dolomite, chert and quartz (4–120 mm in size), as well as numerous artifacts and fossils—filled most of the underground opening, banking against the north wall of the cavern. The entryway (or entryways) for the LB/LBEE sediments was/were eventually choked by sediment and new shafts then opened along the north wall of the cave, admitting a subsequent cycle of materials. This younger, heavily calcified deposit—originally referred to as the "pink breccia" (Robinson, 1952; Brain and Robinson, 1953; Brain, 1958) but now designated as the HR—consists of surface-derived soils and sandy sediment, characterized by stony inclusions that include blocks of dolomite and chert roof-spall (Brain, 1958). Fossils are abundant in the HR, but the breccia has yielded no stone tools and only two purported bone tools. The HR sediments eventually completely filled their points of entry. Uranium-lead (U–Pb)-dated flowstones, which bound the lower and upper reaches of Member 1 (in toto), provide a bracketed age of 2.249 ± 0.077–1.706 ± 0.069 million years old (Ma) (reported uncertainties at two-sigma) (Pickering et al., 2011) for the member; this range is in broad agreement with previous estimates of the member's age based on faunal data (e.g., Vrba, 1985; Churcher and Watson, 1993; Brain, 1993b) and with more recent ones based on cosmogenic nuclide burial dating (i.e., average age = 1.99 ± 0.19 Ma, ± 1 s.e.) (Gibbon et al., 2014).

A gap, several meters in width, eventually eroded between the base of the HR and the top of the LB. New openings to the ground surface then admitted the Member 2 sediments (Brain, 1993b). Except for a thin remaining skin of water-lain, stratified sediments that adhere to the northwest wall of the cave, most of Member 2 was removed long ago by scientific excavations at Swartkrans. Generally, the Member 2 "brown breccia" (Brain, 1958) is easily distinguished by its lack of stony inclusions any larger than gravel (a few pieces of dolomite roof-spall excepted); fallen blocks of calcified "pink breccia" from the HR are sometimes observed in the Member 2 matrix. Member 2 has also yielded abundant fossils, stone tools and purported bone artifacts. Pickering et al.'s (2011) U–Pb-derived 1.706 ± 0.069 Ma date of a flowstone that separates the HR and the overlying sediments of Member 2 along the cave's northwest wall provides a maximum age for the latter unit. No other reliable radiometric ages are currently available for Member 2, but faunal data suggest an age of ~1.5 Ma for the infill (e.g., Vrba, 1985; Churcher and Watson, 1993; Brain, 1993b).