

Proposal to supplement an application for a renewal of a SAHRA permit to work at Kromdraai A and B, in the Cradle of Humankind World Heritage Site, South Africa

John Francis Thackeray, Director, Institute for Human Evolution, University of the Witwatersrand (Francis.Thackeray@wits.ac.za) in collaboration with José Braga, Computer-assisted Palaeoanthropology Team, UMR 5288 CNRS-Université Toulouse (Paul Sabatier), 37 Allées Jules Guesde, 31000 Toulouse, France (jose.braga@univ-tlse3.fr)

Introduction.

The early Pleistocene sites of Kromdraai A and B (KA and KB) (26°00'S, 27°45'E) are former limestone caves situated approximately 2 km east of Sterkfontein on the southern side of the Bloubank River Valley, 9 km north-northwest of Krugersdorp, in the province of Gauteng, South Africa. No hominin fossils have been found at KA, which is likely to have been primarily a carnivore lair occupied by *Dinofelis* and other carnivores, but stone artefacts indicate the presence of Early Pleistocene hominins. Hominin fossils from Kromdraai B (KB) are attributed to *Paranthropus robustus* and early *Homo*. The KB animal bones collected from in situ breccias include cercopithecoid monkeys, notably leaf-eating (colobine) taxa whose presence suggest relatively wooded and moist surroundings. At least some of the fossil remains were probably introduced to the cave by carnivores or natural pitfall trapping. We propose to undertake further fieldwork and analysis of material, leading to a book in which we provide a synthesis regarding the geology, the palaeoecology, the dating and the hominin finds at Kromdraai B

Our proposal relates to preparations for a book which will include several chapters, outlined below.

History of excavations at Kromdraai

The type specimen of *Paranthropus robustus* was discovered at Kromdraai B in 1938 and subsequent explorations were undertaken by Robert Broom. Further exploration was undertaken by Bob Brain in the 1950's, by Elisabeth Vrba in the 1970's, and renewed in 1993 by Francis Thackeray. Thackeray and Braga have identified a specimen from Kromdraai B which is identified as early *Homo*.

A list of publications relating to Kromdraai since 1992, under the direction of Francis Thackeray, is given in Table 1.

A three-dimensional template for new excavations at Kromdraai

This study is being undertaken by Jean DUMONCEL (Computer-assisted Palaeoanthropology Team, UMR 5288 CNRS-Université de Toulouse (Paul Sabatier), 37 Allées Jules Guesde, 31000 Toulouse, France, jeandumoncel@gmail.com), Benjamin MORENO, IMA solution (IMA Solutions, morenobenjamin@mac.com) and J. BRAGA. This study will provide a three dimensional (3D) model of the Kromdraai B excavation which records the spatial distribution of fossils, artifacts and aspects of geology. This 3D-model was reconstructed by using a portable 3D measurement system for large volume measurements which uses laser technology. These data help to identify the main formation processes of the site and to reconstruct the complex history of the breccias interbedded with flowstones. This 3D-model also provides a reliable digital template to devise future new excavations at Kromdraai B.

The geomorphological context and karst deposits of Kromdraai B

This study is being undertaken by Laurent BRUXELLES (Inrap, 7 rue de Madrid, 75008 Paris; Laboratoire TRACES, UMR 5608 CNRS-Université de Toulouse (Le Mirail), Maison de la Recherche, 31058 Toulouse Cedex 9, France). The area is characterized by a special geomorphological context: the karst. The development of underground network of caves by dissolution of the dolomite created many voids according to lithological, structural, hydrogeological and geomorphological conditions. Due to the deepening of the valley and the development of topographies (dissolution surfaces), some parts of these caves were cut and entrances were formed. Since this time, colluvia containing bones accumulated in the caves and formed a huge talus. In order to understand the age of the openings and of the talus formation, we must consider the sequence of geomorphological evolution of this area. Caves are able to protect their fillings from outside influences, but are subject to processes of erosion. Underground deposits can also be subjected to reworking. Several kinds of breccia have been recognized. We have to take into account that, between two breccia deposits, new voids could be formed. An accurate cartography and description of different breccia bodies will be undertaken. This approach will facilitate a re-assessment of previous age-estimations, and furnish a better understanding of the stratigraphic position of the flowstones that we are studying (uranium/lead datings, geochemistry, stable isotopes etc.).

Petrography and geochemistry of the Kromdraai B speleothems.

This study is being undertaken by Richard MAIRE (Laboratoire ADES, CNRS/Univ. Bordeaux 3, 12 esplanade des Antilles, 33607 Pessac cedex, France), Guillaume DEVES and Richard ORTEGA (Laboratoire CENBG, CNRS/Univ. Bordeaux 1, Chemin du Solarium, 33175 Gradignan, France).

Speleothems of Kromdraai are mainly represented by flowstones and sometimes by stalagmites both associated with breccia. They are composed of calcite and aragonite. However, because of the age of these concretions, they show important diagenesis. Under the microscope, the CaCO_3 layers are composed of two main types of recrystallization: aragonite-calcite and aragonite-calcite-calcite with the disappearance of laminae. The neocalcite are of two types: sparitic crystals with remnants of aragonite needles and sparitic crystals without aragonite. Into the cement of breccia, silicification is possible as a

consequence of recrystallisation of aragonite into amorphous silica (opal). Microchemical imaging and analysis using micro-XRF (X-ray Fluorescence) on KB-D flowstone shows clearly the distribution of Sr in CaCO_3 and a P rich-layer formed by phosphorite coming from altered bones. Among all the analysed samples, only two samples (KB-E and KB-F) are not recrystallized with a microlaminated calcite slightly contaminated by ferruginous soils (red colour). The diagenesis and detritic contamination can alter the results of U/Pb datings.

Uranium-lead dating of primary aragonite and secondary calcite in Kromdraai B speleothems.

This study is being undertaken by Vincent BALTER (CNRS UMR 5276 "Laboratoire de Géologie de Lyon 69364 Lyon Cedex 07, France, Vincent.Balter@ens-lyon.fr),

Many uranium-lead dates of speleothems from various hominid sites in the Cradle of Humankind yield ages of around 2 million years. So far, for analytical reasons, the technique involves the measurement of uranium-rich carbonate calcium layers. However, the uranium-rich layers are often composed of secondary calcite which has been incorporated during the recrystallization phase of a new source of uranium. This "open system" behavior can rejuvenate the apparent age of the speleothem layer. For the speleothems of Kromdraai B, a prescreening of the mineral nature of the calcium carbonate layers has been conducted using thin sections prior to isotopic analysis. Following this approach, the uranium-lead results for several associations of an "open system" calcite and a "closed system" aragonite sampled from the same speleothem is presented.

Micromammal fossils from Kromdraai B.

This study is being undertaken by Jennifer LEICHLITER (Department of Anthropology, University of Colorado, Boulder, Jennifer.Leichliter@colorado.edu), Oliver C. C. PAINE, and Matt SPONHEIMER.

Fossilized faunal remains have long been used to infer paleoenvironmental conditions at hominin-bearing localities, but mammalian microfauna have been underutilized despite their abundance in the fossil record. Preliminary assessments of newly excavated microfaunal remains from Kromdraai B reveal taxonomic similarities to other nearby fossil hominin-bearing sites including Sterkfontein, Swartkrans, and Gladysvale. Though these sites span over 2 million years, two genera of micromammals, *Mystromys* and *Otomys*, dominate all assemblages. These genera have been described in the modern ecological literature as predominantly riverine grassland species, thus implicating the presence of localized riparian habitats in the Sterkfontein Valley. This hypothesis is supported by both the geology of the valley, through which the Blaaubank River runs, as well as reconstructions using different variables. It has also been proposed that the site was more humid than members of Sterkfontein and Makapansgat of a similar age. Interestingly, microfaunal reconstructions conducted by Avery (2001) for the Sterkfontein Valley are at odds with many macrofaunal analyses and suggest lower mean annual precipitation and higher temperatures than other reconstructions for the area. Analyses of subtle differences in species diversity and relative abundance in the microfaunal assemblage at Kromdraai B provide an opportunity to cast these paleoenvironmental questions in a new light and refine an understanding of prevailing environmental conditions in the Sterkfontein Valley throughout the Plio-Pleistocene.

Catalogue

An illustrated revised catalogue of the hominid remains from Kromdraai B, with an emphasis on the type specimen of *Paranthropus robustus* (TM 1517) will be prepared by J BRAGA, Didier DESCOUENS (Computer-assisted Palaeoanthropology Team, UMR 5288 CNRS-Université de Toulouse (Paul Sabatier), 37 Allées Jules Guesde, 31000 Toulouse, France, archaeodontosaurus@live.fr), J.F. THACKERAY.

A minimum number of nine individuals are identified from 28 specimens. Four of these individuals are recognized as juveniles, one as a subadult and four as young adults. Here we provide the first illustrated and detailed catalogue of the hominin remains discovered at Kromdraai B, including the most recent ones. Particular attention is given to the type specimen of *Paranthropus robustus* (TM 1517) on account of the rarity of partial skeletons attributed to this species, so far.

The phylogenetic affinities of the hominins remains from Kromdraai B, with an emphasis on newly discovered specimens.

The hominin specimens from Kromdraai B will be discussed by J BRAGA and JF THACKERAY

A few hominin remains are of known provenience in the calcified breccias of the KB excavations. Moreover, most of the KB hominins, as compared to the Swartkrans *P. robustus* samples, combine *Paranthropus robustus* traits and a number of primitive, *A. africanus*-like features. This paper has two principal goals. The first goal is to discuss the possible associations between these remains, especially the juvenile remains. The second goal is to test whether the combination of traits observed on the Kromdraai hominins may indicate an ancestor-descendant relationship between the Kromdraai B and Swartkrans samples.

Table 1. Publications on Kromdraai by Thackeray et al since 1992.

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