Proposal for Continued Research at Swartkrans Cave

(Accompanying the application for research permit renewal)

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The first phase of research conducted by the Swartkrans Paleoanthropological Research Project (SPRP) was focused on the stratigraphically complex, northeastern portion of the cave, where some of the site's oldest and youngest known deposits (respectively, the early Pleistocene units of Member 1 [the Lower Bank and Hanging Remnant] and the Middle Stone Age [MSA] unit of Member 4) are in contact (fig 1). Our work in this area yielded the first uranium-series absolute dates for Swartkrans, which also established the maximum age of the site's important MSA stone tool assemblage at 110,000 years old (Sutton *et al*., 2009). In addition, our fieldwork in the northeastern portion of the site revealed a previously unknown early Pleistocene deposit (the Talus Cone Deposit [TCD], which is yielding *Paranthropus robustus* and other mammal fossils), and also extended the known extent of the important Member 1 Lower Bank deposit (Sutton *et al*., 2009). Our work also added substantially to the hominid fossil sample of the site, including the especially significant recovery a rare *P. robustus* proximal femur (Pickering *et al*., 2012).

We are broadening the goals of our fieldwork for the next three years of the SPRP. The focus will be on three primary areas:

1) We will conclude our excavations in the Member 1 Lower Bank and stabilize, rehabilitate and close the deposit.
2) We will continue our research on the dating and stratigraphic interpretations of the contact region between Member 4 and the early Pleistocene deposits that underlie it in the cave's northeast corner (as discussed above)
3) We will begin new excavations in Member 3 of the Swartkrans formation.

Member 1

The Member 1 Lower Bank (LB) represents the oldest known deposits in the Swartkrans formation and has provided a wealth of information on early Plio-Pleistocene hominins and their behavior. This is evidenced in the recovered stone tools, bone tools and cut marked/percussion damaged fauna reflecting butchery habits. The enlarged stone tool sample has allowed us to conclude the assemblage represents an Oldowan industry. Likewise the expanded fauna sample has provided additional insight into the accumulating agents that contributed to the depositional phase of the LB. SPRP work during the new permit period will include the final phase of excavation in the deposit. Excavation will be conducted in 8 square metres (1-4N 5E and 1-4N 6E)(fig. 2). This will require the removal of approximately 20cm of sediment from row 6 and 10cm from row7. The excavation will be prepped by M. Sutton and B. Jacoby and conducted by the full excavation team with the assistance of international field school students. While our current sample of stone tools and fauna are sufficient to reach the project objectives. We do hope to expand the hominin sample with this excavation. Clarke's recent review of his 1977 identification of an early Homo juvenile cranium from Member 1, SK 27, has resulted in the fossil now being classified as *Homo habilis*. As the Hanging Remnant portion of Member 1 has previously yielded *H. ergaster* fossils this deposit now appears to contain two different hominin species.

The presence of an Oldowan industry and *Homo habilis* fossils make the dating and stratigraphic work on Member 1 of critical importance. While some debate still remains, the overall consensus regarding the LB and the HR of Member 1 is that each represents a distinct infill, with the LB entering the cave first, followed by the HR. Work published on the U Pb dating and our stratigrapic analysis have shown that both of the Member 1 deposits are bracketed by dates of <1.7 and <2.4m years ago. The faunal age of Member 1 has been published as 1.7/1.8m years ago, but this age is influenced by the content of the younger Hanging Remnant. The SPRP has undertaken a program to date the LB. Preliminary results of cosmogenic nuclide burial dating have already provided an age close to 2m years ago for the Lower Bank which fits the maximum U Pb age of the underlying flowstone of 2.4m years ago. Additionally, the SPRP will conduct a detailed stratigraphic study (project will be headed by Bruxelles) to establish the relationship of the Lower Bank and Hanging Remnant deposits.

However, the primary goal of additional excavations in the LB is to level the excavation rows and create the optimum stage for final closure of the deposit. A final plan for closure has been developed by the SPRP. This plan has been discussed with SAHRA and has been accepted as the best option to rehabilitate and preserve this area of the site. Funds have been granted and are available for 2013. Quotes have been accepted from contractors using ReMaCon products. This process will entail building a retaining wall against the exposed west face of the LB deposit. Beginning at the base of the current excavation (~9m below datum) and extending up to the current surface of the overburden. This retaining wall will consist of over 550 interlocking hollow blocks (L11). Sediment/backfill will be placed behind the blocks to maintain the correct angle from bottom to top. The blocks will be filled with sediment and seeded to encourage plant growth to improve aesthetics.

Member 1 Research projects

Stone tool analysis will be conducted by **M. Sutton** and **K. Kuman**. This will involve a typological and technological study of the ~ 1,000 artefacts recovered from the Lower Bank. The primary question involves whether the assemblage represents a late Oldowan Industry or an early appearance of Acheulean technology. Preliminary analysis suggests it is Oldowan.

Fauna analysis will be conducted by **T. Pickering** and **J. Heaton**. This will involve classification of the fossils and a taphonomic study of the assemblage. Objectives include identifying the primary accumulating agents, the level of butchery present, and resource selection process behaviors of the hominins.

Hominin fossils will be analyised by **R. Clarke** and **T. Pickering**. What hominins are present? Does the deposit contain three hominin speices?

Dating of the Lower Bank. Cosmogenic nuclide burial dating is being conducted by **R. Gibbon**. A quartz manuport has already been sampled as well as quartz grains from sediment from the lower levels of the deposit. Gibbon has completed the lab work and is

now finalising the results. These results will then be interpreted by **M. Sutton** and **T. Pickering**.

A stratigraphic analysis of the infills will be conducted by **L. Bruxelles**. This will be used to help resolve the distinction and relationship of the Lower Bank and the Hanging Remnant. This project is planned for the 2014/2015 year of the permit.

A secondary project related to the dating and stratigraphic studies will be a chemical analysis of the HR and LB sediments for trace elements. This project will be conducted by **M. Sutton** and involve XRF and ICP-MS to determine element composition as a proxy for identifying and distinguishing the different infills in the Member 1 formation. This project is planned for the 2014/2015 year of the permit

Member 3

Member 3 of the Swartrkrans Formation, lies in a gully in the western portion of the site (Brain, 1993). Member 3 is especially important for three reasons: (1) Brain (1993) identified burned bones from this deposit, which are argued to have been burned by hominins in controlled fires and some of which also preserve cut marks created by early hominin butchers; (2) the fossils from this unit are among the site's best preserved, with fresh cortical surfaces and lacking tightly adhering breccia, ideal for detailed taphonomic studies; (3) based on a faunal date of ~1.0 Ma (Brain, 1993), it is argued that the *P. robustus* fossils from Member 3 represent the last known appearance of this species anywhere in the world. Research since Brain's (1993) early conclusions about hominin behavior in Member 3 have prompted our decision to test his hypotheses employing newly excavated samples from the depositional unit.

First, archaeologists are critical of most claims of hominin-controlled fire from African sites (including Swartkrans) that are >400,000 years old and that also lack well-developed hearth features (Roebroeks and Villa, 2010). However, important new evidence of ~1.0 million-year-old controlled fire from Wonderwerk Cave (South Africa) (Berna *et al*., 2012) is changing this attitude, and thus the time is right to re-evaluate the Swartkrans burned bone data using new techniques of recovery (Berna *et al*., 2012) and with newly excavated samples. Using an EDM to piece plot each burned bone recovered will allow greater understanding of the formation processes which took place during the depositional phase of Member 3. Recovering new material within the matrix will allow for microstratigraphic analysis of the sediments.

The old debate—current at the time of the discovery of butchered ungulate bones from Swartkrans Member 3 (Brain, 1993)—whether early hominids were primarily hunters or scavengers has been superseded by an overwhelming body of taphonomic and zooarchaeological data from across Pleistocene Africa that concludes the former (reviewed in Pickering and Bunn, 2012). However Member 3 represents one of only a few southern African sites dated to ~1.0m years old. This scarcity of evidence has restricted our understanding of hominin behavior from the early

Pleistocene. Chief among the questions during this period involve the hunting abilities and resource selection preferences of these hominins. A newly excavated sample of fauna from Member 3—the best preserved and most behaviorally informative of all early Pleistocene zooarchaeological faunas from southern Africa (Pickering et al., 2004)—will thus assist us in refining models of early hominin meat-foraging and meat-eating in the subregion.

Additionally, the Member 3 deposit contains a small assemblage of Acheulean stone tools which have not been published as a single collection. An expansion of this assemblage and analysis of the recovered artefacts will allow for a more comprehensive understanding of both raw material selection and tool making capabilities of these early Pleistocene hominins.

Finally, Member 3 is believed to represent the last known appearance of the species P*. robustus.* No other younger site contains fossils of this species. Because of this and the wealth of evidence of hominin behaviour present in Member 3 it is critical to establish a more accurate date of the deposit. The current accepted age of ~1.0m years ago is a fauna based estimate. To address this we will conduct cosmogenic nuclide burial dating on quartz grains from the sediment. Additionally, we hope the renewed excavations will uncover, previously absent, speleothem material which will allow us to conduct uranium-series (U Pb) dating. These new methods will provide a more precise date of this significant deposit; possibly determining a more exact date for the last appearance of *P. robustus* as well as some of the earliest evidence for controlled use of fire by middle Acheulean hominins.

The new excavations in Member 3 involve removal of the lightly consolidated, slightly calcified material clinging to the north wall of the main hole. This includes 3 square metres to a depth of ~2m. This material overhangs the main Member 3 hole and thus must be removed for safety reasons before excavations can take place at the base of the hole. The material lies in the contact zone with Member 2 and may be Member 2 or a mixture of the two deposits. Excavations should reconcile this issue. This material will be excavated by M. Sutton and B. Jacoby. Once this material is removed a metal mesh roof will be installed above the Member 3 hole. This will provide safety for the excavators at the base as well as stabilize the walls of the Member 3 hole. Funds have been raised for this project and a Wits contractor has been appointed for the installation. The roof is expected to be installed in mid 2013. Once completed excavations will begin in the base of the main deposit. The excavation work will be conducted by the project team with the assistance of international field school students (should the roof be installed on schedule). Previous exploratory excavations by the SPRP established a minimum of 2m of deposit at the base of Member 3. As this material is more heavily calcified it is anticipated this work will carry on into 2015.

Member 3 Research projects

Stone tool analysis. Member 3 contains Middle Acheulean tools. The only other assemblage that exists in the CofH is Sterkfontein. The Member 3 assemblage will be analyised to determine technology and then compared to the Sterkfontein material. This analysis will be conducted by **M. Sutton and K. Kuman**.

Fauna analysis will be conducted by **T. Pickering and J. Heaton**. Because of the excellent surface preservation the taphonomic study will include analysis for cut-marked and percussion damaged bone. The focus will be on the resource selection behaviours of the Member 3 hominins.

Burned bone will undergo taphonomic analysis as well. The primary objective will be to determine the percentage of cut-marked burned bone with a goal of establishing a relationship between the two. This area of research might possibly assist in establishing intention regarding the burned bone. This will be conducted by **T. Pickering**.

Microstratigraphic analysis of the Member 3 deposit. This project is still in the planning stages and the team is still being assembled. Possibly headed by **F. Berna**. The goal is to better date the burned bone and link the assemblage with the sediments.

Dating of Member 3. Cosmogenic nuclide burial dating is being conducted by **R. Gibbon**. This method involves sampled quartz grains from sediment from the Member main hole. The hope is that the renewed excavations will result in the recovery of a suitable quartz artefact to provide a second source sample for the cosmogenic dating This requires a sample of suitable size from a depth of at least 5 meters. The lab results will be interpreted by **M. Sutton** and **T. Pickering**.

Member 4

The previous work of the SPRP has established that the Middle Stone Age Member 4 deposit is actually three separate deposits (Sutton *et al*., 2009). A Middle Stone Age stone tool bearing overburden which overlies a large talus cone deposit extending >10m into the cave designated as the Talus Cone Deposit (TCD) and a second previously unknown underground deposit now designated as an east extension of the Member 1 Lower Bank (LB east extension). Both of the underground deposits have yielded *Paranthropus robustus* fossils.

Our future plans for this area of the site involve addressing the stratigraphic questions. 1) the MSA overlies an excavated sterile zone, how does it relate to the underlying TCD? 2) What is the age of the TCD? As the deposit has yielded *P. robustus* fossils then it is assumed to be greater than 1.0m years ago. Thus tighter resolution is needed to place the TCD chronologically within the Swartkrans formation, and 3) if the age correlates with the Member 3 (1.0mya) deposit then do both represent contemporaneous depositional episodes?

Regarding the recovered material, both the TCD and LB east extension have yielded fauna, however the small sample size has precluded a comprehensive analysis, thus we would like to continue to excavate the north face of these two deposits to increase the sample size. One goal is to compare the fauna from the LB east extension with the material from the main Lower Bank to further establish the association of the two deposits. Another goal is to provide an adequate fauna sample from the

TCD to determine hominin behaviour (i.e. cut marks or percussion damage). This could also be compared with the Member 3 material.

We intend to perform Optical Stimulated Luminescence (OSL) dating to the MSA overburden to determine an accurate age of the MSA tool bearing deposit. We intend to also attempt OSL dating on the underground TCD. It is also hoped the contuined excavations of the underground deposits will yield speleothem material that will allow for U Pb dating. As the sediment is slightly calcified along the outer edges of the talus cone it is anticipated the interior of the cone will contain speleothem providing a source for additional and alternative dating of the deposits.

Work in Member 4 will include the continued excavation of 4 square metres (10N 18-21E). This deposit is loosely consolidated, decalcified sediment.

Member 4 Research projects

Middle Stone Age tool analysis. The Swartkrans assemblage represents the only large collection of the MSA stone artefacts in the Cradle area. The assemblage can give us insight into the technological behaviour of the some of the earliest modern human (*Homo sapiens*) to occupy the Cardle of Humankind area. Unlike most MSA assemblages the Swartkrans material has a narrow range of tool types and a lack of points (projectiles), suggesting specific activities were conducted at the site. This first stage of analysis has been completed by **M. Sutton**. Stage two involves analysing the steep-edged scrapers for use wear with a goal of establishing the function of the tools.

Fauna analysis of the recovered material from the TCD and the LB east extension. This includes a taphonomic assessment of the material and a comparison with the Member 3 (for the TCD) and Member 1 Lower Bank (for the LB east extension) assemblages. To be conducted by **T. Pickering and J. Heaton**.

Stratigraphic analysis of the two underground deposits to better understand how they are related and their position within the Swartkrans formation. To be conducted by **L. Bruxelles.**

Dating of all three of the Member 4 deposits. This includes OSL dating of the overburden and TCD. This will be conducted by S. Woodbourne of CSIR**.** Also includes U Pb radiometric dating if speleothem material is located.

References

Berna F, Goldberg P, Horwitz LK, et al. 2012. Microstratigraphic evidence of in situ fire in the Acheulean strata of Wonderwerk Cave, Northern Cape Province, South Africa. *Proceedings of the National Academy of Sciences (USA)*, in press.

Brain, CK. 1993. *Swartkrans: A Cave's Chronicle of Early Man*. Pretoria: Transvaal Museum.

Pickering, TR, Domínguez-Rodrigo, M, Egeland, CP, Brain, CK. 2004. New data and ideas on the foraging behaviour of early hominids at Swartkrans Member 3, South Africa. *South African Journal of Science* **100,** 215-219.

Pickering, TR and Bunn, HT. 2012. Another take on meat-foraging by Pleistocene African hominins: Tracking behavioral evolution beyond baseline inferences of early access to carcasses. In (M. Domínguez-Rodrigo, Ed.) *Stone Tools and Fossil Bones: Debates in the Archaeology of Human Origins*, pp. 152-173. Cambridge: Cambridge University Press.

Pickering, TR, Heaton, JL, Clarke, RJ, Sutton, MB, Brain, CK, Kuman, K. 2012. New hominid fossils from Member 1 of the Swartkrans Formation, South Africa. *Journal of Human Evolution* **62,** 618-628.

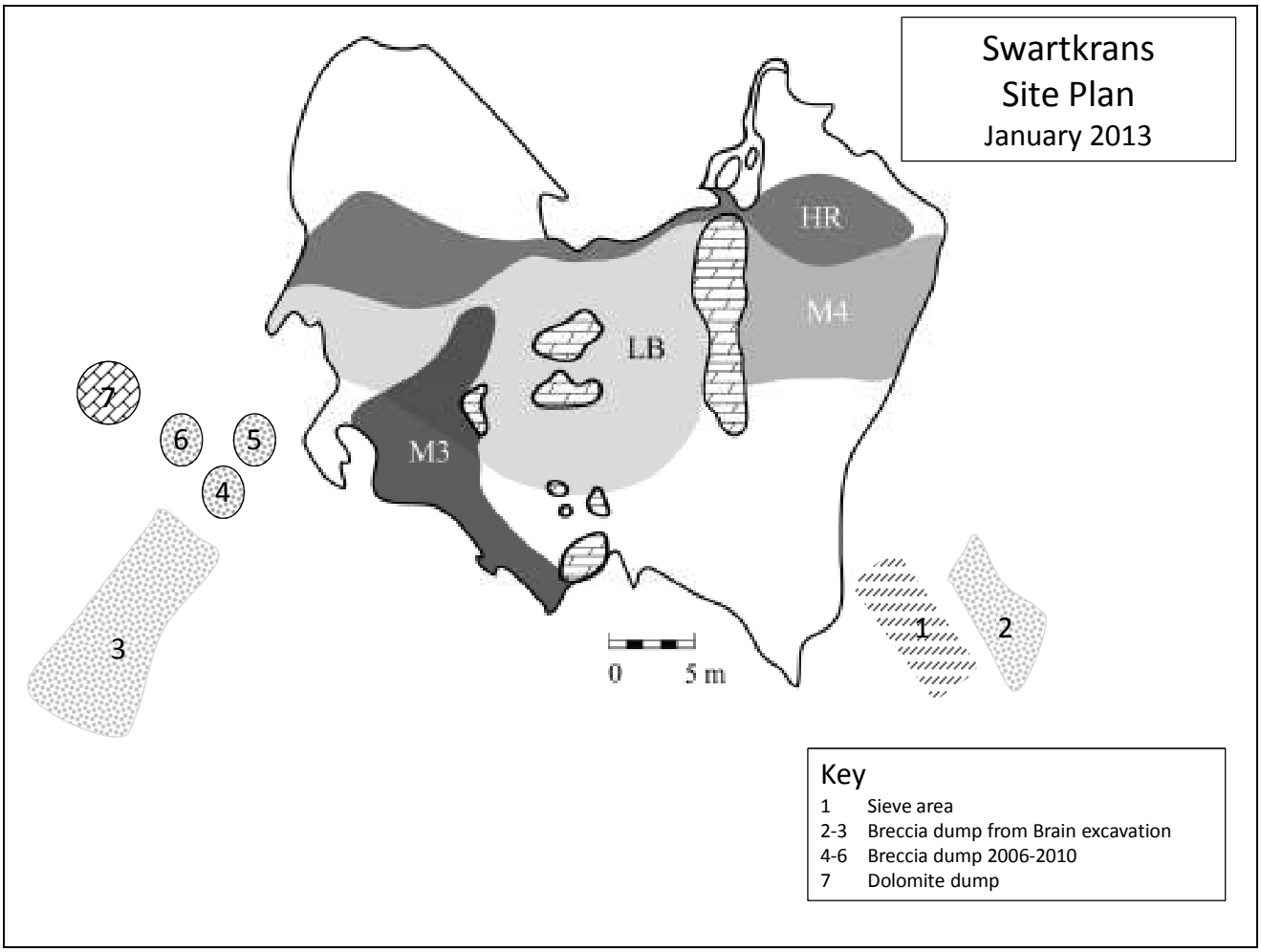
Roebroeks W, Villa P. 2010. On the earliest evidence for habitual use of fire in Europe. *Proceedings of the National Academy of Sciences (USA)* **108,** 5209–5214.

Sutton, MB. 2012. The Archaeology of Swartkrans Cave, Gauteng, South Africa: new excavations of Members 1 and 4. Unpublished PhD dissertation. Johannesburg, University of the Witwatersrand.

Sutton, MB, Pickering, TR, Pickering, R, Brain, CK, Clarke, RJ, Heaton, JL, Kuman, K. 2009. Newly discovered fossil- and artifact-bearing deposits, uranium-series ages and Plio-Pleistocene hominids at Swartkrans Cave, South Africa. *Journal of Human Evolution* **57,** 688-696.

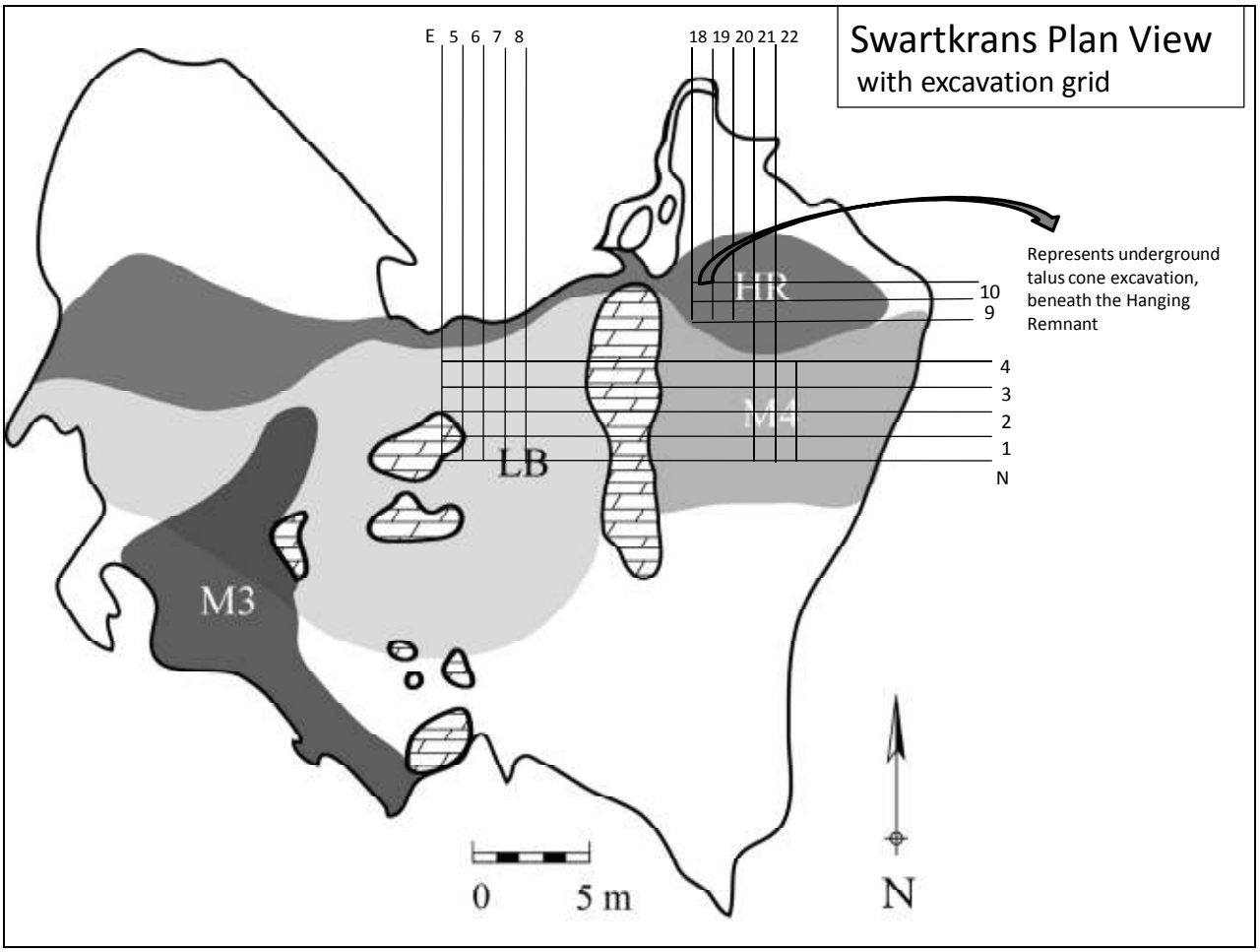
Sutton, MB, Kuman, K, Clarke, RJ, Pickering, TR, Heaton, JL, Brain, CK. 2012 The Oldowan and *Homo habilis* at Swartkrans Cave, South Africa. Paper presented at the *21st Annual Meeting of the Paleoanthropology Society*, held in Memphis, Tennessee, April 17-19, 2012.

Sutton, MB, Kuman, K, Pollarolo, L, Pickering, TR, Heaton, JL, Clarke, RJ, Brain, CK. (manuscript in prep). The Middle Stone Age at Swartkrans Cave: an analysis of the stone tools.

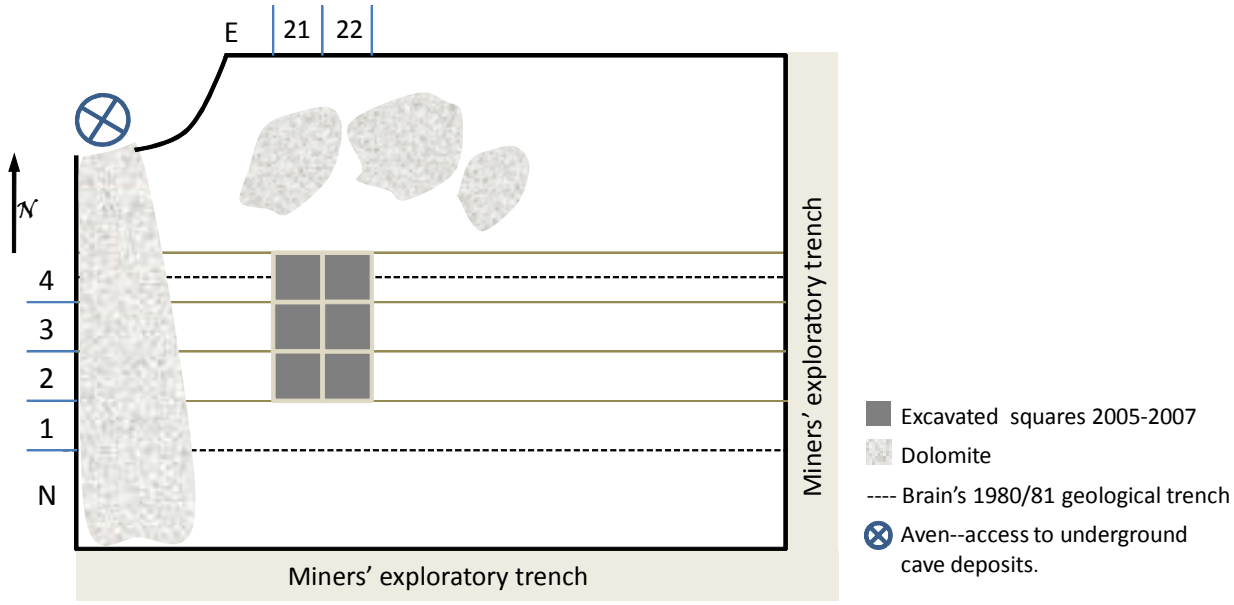


Site plan of Swartkrans Cave with breccia, sieve and dolomite dumps identified. Material from current project work (dumps 4, 5 and 6) are being sorted and will eventually be reduced to one dump containing material with no visible and low potential fossil bearing blocks.

Swartkrans Cave site: 26 01’ 02.08” S 27 43’ 25.05” E. Elevation 1481m

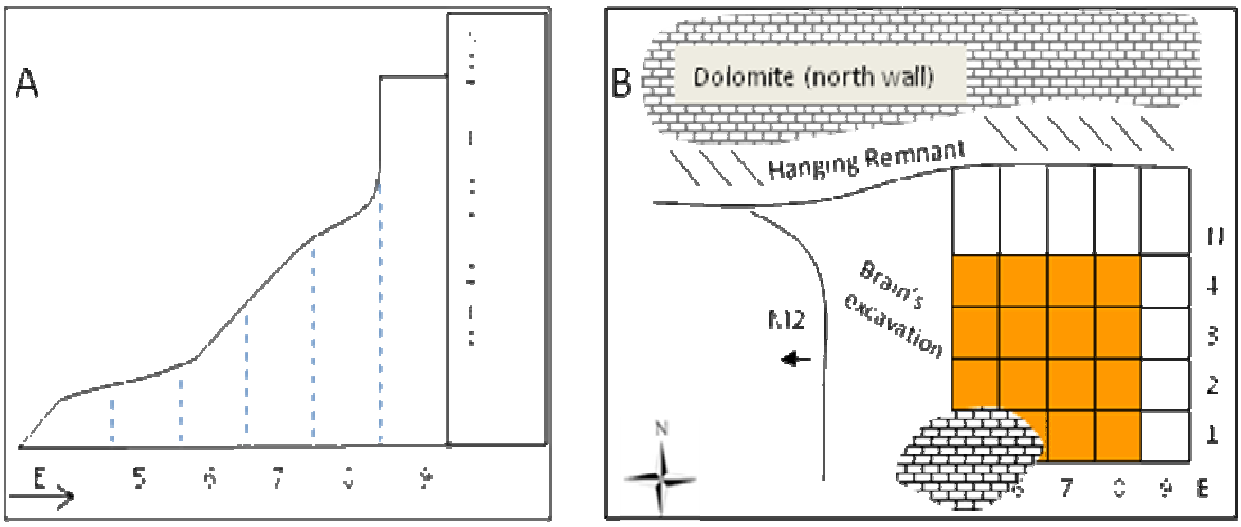


Plan view of excavation areas. The M1 Lower Bank (LB) excavation includes 16 meter squares (1-4N, 5-8E). Squares 7-8N, 1-4E were excavated during the first phase from 2006-2008. Squares 5-6N, 1-4E were excavated during the second phase 2009-2011. M4 surface excavations include 6 squares (2-4N, 21-22E) excavated during the first phase 2006-2008. M4 underground excavations include 6 squares (9N, 18-19E and 10N, 18-21E) excavated during the second phase 2009-2011.



Plan view of the Member 4 surface excavation area in the north east portion of the cave system.

Photos of Member 4 surface excavation area at beginning of excavations (L) and at conclusion of excavations (R).



(A) Profile of Member 1 Lower Bank excavation slope. Of the original excavations by Brain, only row 9E was still clearly stepped down to row 8E. 9E had been excavated ~1.5m below the surface. The remaining East rows had eroded to such an extent that they were no longer stepped. Because of the steepness of the infill the squares were excavated to varying depths. (B) Plan view of Lower Bank excavation area. Sixteen one meter squares have been excavated to either 1.5m to 2m each along the slope of the deposit.

Photos of Member 1 Lower Bank excavation area at beginning of excavations (L) and at conclusion of excavations (R).