

PERMIT APPLICATION

New research programme for the fossil bearing site of Gondolin, Cradle of Humankind, South Africa.

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The Gondolin fossiliferous site

The Plio-Pleistocene fossil cave system of Gondolin lies in the north-eastern portion of Cradle of Humankind World Heritage Site of the North West Province, South Africa, on Portion 224 and the Remaining Extent of Portion 112 of the farm Broederstroom 481 JQ (25°49.837'S, 27°51.857'E) (Fig. 1). The cave system was formed in the Precambrian dolomites of the Eccles Formation and preserves a number of depositional units (Herries et al. 2006). The fossil deposits at Gondolin were first exposed by lime-miners in the early 20th century. The lime-mining activity left extensive ex situ breccia dumps and two in-situ remnant deposits (Menter et al., 1999; Herries et al., 2006; Adams et al., 2007; Grine et al 2012; Herries & Adams 2013). The Gondolin deposits have been dated through paleomagnetic and fauna correlation to 1.95-1.78 Ma and are argued to have been deposited when the region consisted of open-to-wooded highland grassland ecosystems (Herries et al., 2006).

Site Significance

The paleo-cave site of Gondolin is rich in fossil fauna, which upon excavation and analysis will bolster our understanding of site formation processes, palaeoecology, palaeoenvironment, and provide insights to opportunities and challenges faced by our early ancestors.

History of research activities at Gondolin

The first excavations at Gondolin were conducted by E.S. Vrba and D. Panagos on fossiliferous breccia blocks from in situ deposits on the north-eastern cave wall (Fig. 2 :GD2) in 1979 (Watson, 1993). Analysis of faunal recovered during this excavation yielded a large and diverse range of Plio-Pleistocene faunas, with at least 27 taxa (Watson,1993).

In 1997, excavations were conducted on ex situ breccia dump (Gondolin Dump A or GDAG) (Fig. 2) with two major aims: “(1) to intensively sample all the sediment types contained in one of the more extensive mining dumps and (2) to survey and map the site in order to achieve a basic understanding of the original cave’s geological and lithostratigraphic features” (Menter et al., 1999: 299-300). This excavation yielded a *Paranthropus cf. robustus* and a possible *Homo*, in addition to non-hominin primate specimens (Menter et al., 1999). The *Paranthropus* left permanent mandibular second molar recovered was shown to fall outside of the range of known *Paranthropine* molar size and Menter et al (1999) suggested that the fossil’s affinity may be resolved through the recovery of additional hominid fossils from Gondolin.

In 2003, new excavations were conducted into the, in situ sediments near the GD 1 datum point in “an attempt to clarify the relationship of the hominin-bearing GD A trench breccias to the in situ sequence of infillings still preserved at the site. (Adams et al., 2007: 2527). This excavation yielded 4843 individual fossil specimens comprising 1349 identifiable craniodental and 39 identifiable postcranial specimens (Adams et al., 2007; Adams 2010; 2012). The researchers also suggested that the recovered fossils from GD 1 were initially accumulated outside of the cave and later hydrologically incorporated within the cave system via a vertical cave entrance (Adams et al., 2007).

Rationale for new research programme at Gondolin

While the 1979 and the 2003 excavations focussed on in situ breccias, the 1997 excavation was centered on the more extensive ex situ breccia dump that was thought to comprise breccia blocks and miner’s rubble from a number of stratigraphic units of the cave. However, all three excavations were conducted over short periods of time not exceeding a month, thus generating limited fossils and restricting inferences and interpretations. The proposed research programme is long-term and aimed at recovering additional fossils from the ex-situ breccias and an attempt to establish links of ex-situ breccias blocks to in-situ localities using XRF analysis.

Traditionally, extracting of fossil specimens from breccias blocks involved using air drills or chemical preparations. A novel method of scanning breccias blocks was tested and proved resourceful (Val et al 2011). To extended preparation and identification possibilities beyond the conventional methods for extracting fossilised bones from calcified clastic sediments, using air drills or chemical preparations, breccias blocks will be scanned at high resolution (approximately 10 mm) using an X-Tek 225 HMX microfocuss CT scanner (Nikon Metrology NV, Leuven, Belgium) at the Evolutionary Studies Institute, University of the Witwatersrand. The resulting serial .tif stack will be imported into Avizo® 6.211 using the Label Fields module to partition bone or enamel from the surrounding matrix, and then render a surface from the labels to produce a 3D rendering. Image data acquisition using microtomography coupled with 3D reconstruction and extraction of specimens, will facilitate exploration of the inside of breccia blocks without the need for manual preparation, thus saving time and finances (Val et al 2011).

Aims of Proposed Fieldwork

The overall aim of the research programme is to further understand the content and context of the fossil faunal remains from the Gondolin paleo-cave.

Specific aims and objectives of the research projects include:

- To generate a data base of taxa present within the fossil bearing cave. Initially, efforts will be concentrated in sorting the miners' dumps into visibly fossiliferous and visibly non-fossiliferous blocks. Loose soil and miners' debris will be sieved for possible isolated fossils.
- To provide definitive descriptions of fossils from the site, that forms the basis for long-term understanding of specific taxa and faunal interaction.
- To deduce the possible scenario through which fauna was accumulated in the cave through taphonomic analysis.
- To reconstruct the environment that prevailed at the time of the deposition of the faunal assemblage.
- To generate data that will further help address questions regarding site formation processes.
- To forge strong research linkages with other researchers in order to generate a deeper understanding of the prehistory of the region and hominid evolution in general.

Expected Outputs

- Information generated through special analysis will help determine if faunal accumulation occurred during different phases within the stratigraphic units.
- Deeper understanding of taxonomic, taphonomic, environmental as well as site formation processes.
- Generation of new database of knowledge, which is essential to understanding the evolution, adaptation and spread of early human ancestors.
- Collaboration with other researchers in seeking a holistic understanding of geology, palaeobiology, palaeoenvironment and palaeoecology.
- Refereed papers and other forms of scientific output.

Site access, excavation and maintenance

Though details of site management may change as research progress, the following site excavation related issues will be followed:

1. On site

- Site access, times and schedules will be arranged with the Landowner.
- The Permit Holders agree to limit excavations and field collections to daylight hours.
- The Permit Holders agree to limit the number of individuals to personnel directly related to excavations.
- An access road to the site exists and will be monitored for erosion on a regular basis.
- The Permit Holders will be responsible for the management of excavations and mapping.
- The Permit Holders and their excavation team will limit their field collections and mapping to the in situ deposits and the areas immediately surrounding the dump sites.
- Every effort will be made by the excavation team to minimise noise levels by restricting fieldwork and the operation of any and all machinery to daylight hours.

2. Maintenance of mining dumps and sieve areas

- Site waste will be restricted to dump substrate sediments and breccias.

- Site waste will be moved to an appropriate demarcated location minimizing possible environmental detriment.
- Sieving of sediments will be restricted to an appropriately demarcated area, in consultation with the Landowner, hence minimizing any detrimental effects to local flora and fauna.
- A suitable low impact route to and from the excavation and sieving area will be identified.
- Sieving area will follow the contours of the landscape and will not extend outside the demarcated excavation area.
- The sieving area will be contained (e.g. by natural plants and rocks) to minimize runoff.

3. Facilities

- All garbage and waste generated during the course of excavations and mapping, or any site visits will be removed after the duration of each visit and properly disposed off-site.
- Chemicals and flammables will have a safe storage, and to minimise spillage of petrol from generators and petrol cans, the items will be removed from the Landowner's property after each visit.
- The landowner has consented to construction of a long-drop toilet. The Cradle of Humankind Management Authority (COH MA) will be approached to establish the ideal location and to assist in the construction.

4. Health and safety

- All members of the excavation team and research visitors will be informed of the potential dangers of working at the site, especially with regards to:
 - ❖ Geological instability from natural terrain and the excavated areas.
 - ❖ Dust inhalation from sieving
 - ❖ Venomous animals found in the area (i.e. snakes and scorpions).
- All members of the team will be issued with a hard hat when working in the roofed sections of the cave.
- Members working with drilling equipment will be issued with appropriate eye, face and ear protection.
- A comprehensive first-aid kit will be on site during every site visit.

5. Fauna and flora

- The Permit Holders will ensure that there is minimal interference with the local fauna and flora.

6. Fire

Fire and smoking are prohibited on site.

7. Water

If necessary, the Permit Holders will provide own water for sieving decalcified breccias as well as for drinking. If a water container is used, it will remain on the Landowner's property for the duration of a field season and with the Landowner's permission.

8. Site protection

- The Permit Holders will endeavour to contain any impact of excavations.
- All loose deposits will be stabilised upon completion of excavation.
- After each excavation season, the deposits will be assessed and appropriate measures of protecting the site taken.
- Because of surface exposure of in situ specimens in calcified breccias, backfilling will only take place in areas that cause minimal damage to those specimens. Specimens left exposed after the excavation period will be protected with the aid of paraloid. The Permit Holders will use appropriate geotextiles and sandbags to backfill deposits.
- All temporary structures, materials and waste will be removed upon completion of the project.

9. Subterranean

The cave surveyed is structurally intact with no immediate structural damage and thus deemed safe.

10. Training

- Researchers involved at various levels of the project may use the site as an instructive tool for educating excavators and students on surveying, mapping and fossil identification.
- Researchers will maintain a high level of proficiency using up-to-date methods in regards to various forms of teaching.

11. Fossil removal

The removal of fossil specimens for research from the site will follow guidelines established by SAHRA, and will employ modern methods of excavation and specimen analysis, with an emphasis on minimizing the impact on local fauna, flora and environments, while at the same time maximising communication and a spirit of cooperation between the Permit Holders, SAHRA and the Landowner.

12. Curatorship

Fossil assemblage from the cave, field notes, excavation records, maps and photographs will be archived at the Evolutionary Studies Institute (ESI), University of the Witwatersrand.

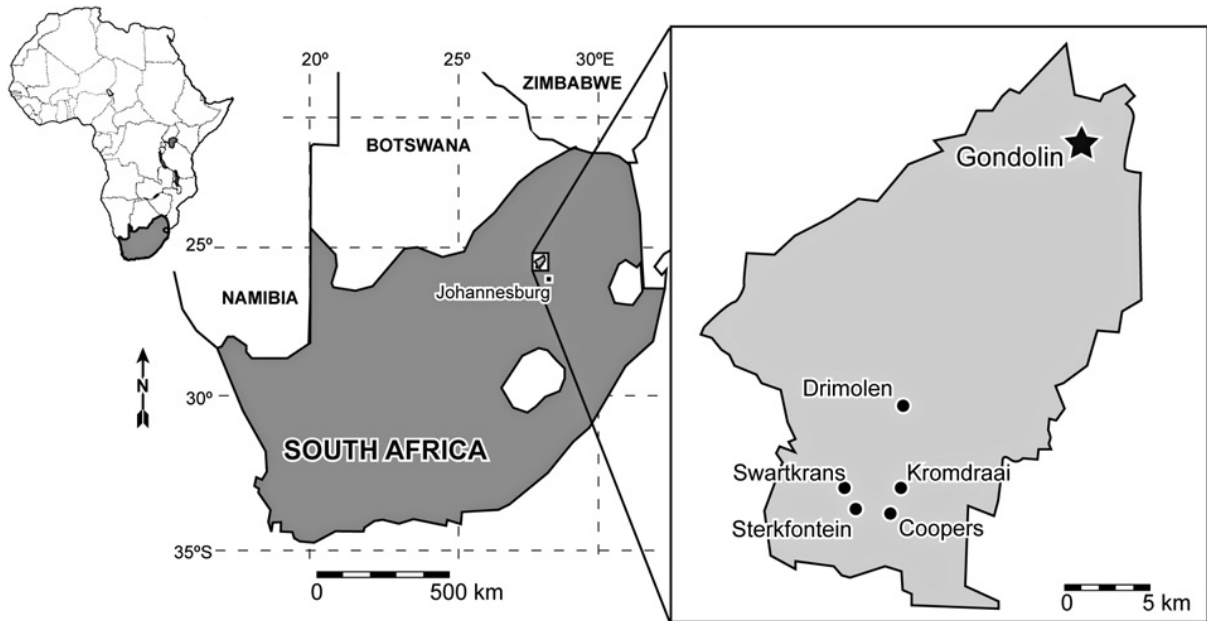


Figure 1: Location of Gondolin paleo cave in the Cradle of Humankind, South Africa (After Grine et al 2012).

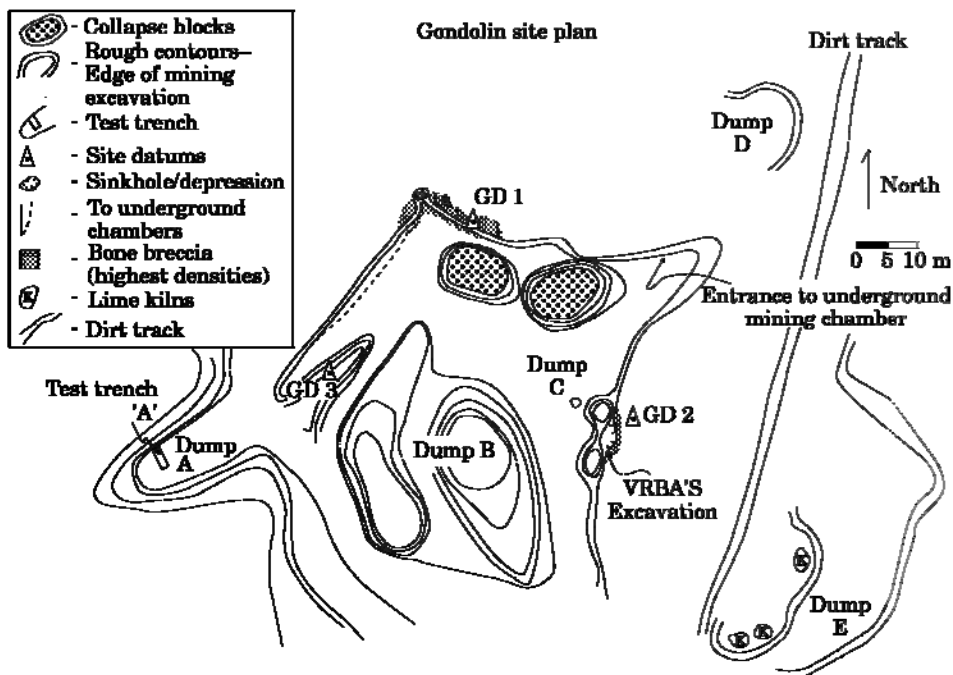


Figure 2: Gondolin Site Plan (Menter et al 1999).

References:

Adams, J. 2010. Taphonomy of the Gondolin GD 2 in situ deposits and its bearing on interpretations of South African Plio-Pleistocene karstic fossil assemblages. *Journal of Taphonomy* **8**: 81–116.

Adams, J. 2012. Stable carbon isotope analysis of fauna from the Gondolin GD 2 fossil assemblage, South Africa. *Annals of the Ditsong National Museum of Natural History* **2**: 1-5.

Adams, J. , Herries, A. , Conroy, G. C. and Kuykendall, K. 2007. Taphonomy of a South African cave: geological and hydrological influences on the GD 1 fossil assemblage at Gondolin, a Plio-Pleistocene paleocave system in the Northwest Province, South Africa. *Quaternary Science Reviews* **26**: 2526–2543.

Grine, F.E., Jacobs, R.L., Reed, K.E., Plavcan, J.M. 2012. The enigmatic molar from Gondolin, South Africa: implications for Paranthropus paleobiology. *Journal of Human Evolution* **63**: 597-609.

Herries, A., and Adams, J. 2013. Clarifying the context, dating and age range of the Gondolin hominins and Paranthropus in South Africa. *Journal of Human Evolution* **65**: 676-681.

HERRIES, A., Adams, J., Kuykendall, K. and Shaw, J. 2006. Speleology and magnetobiostratigraphic chronology of the Gondolin hominin palaeocave, South Africa. *Journal of Human Evolution* **51**: 617–631.

Menter, C.G., Kuykendall, K.L., Keyser, A.W., Conroy, G.C. 1999. First record of hominid teeth from the Plio-Pleistocene site of Gondolin, South Africa. *Journal of Human Evolution* **37**: 299-307.

Val, A., Carlson, K. J., Steininger, C., Kibii, J.M., Churms, C, Kuhn, B. F. and Berger, L. R. 2012. 3D techniques and fossil identification: An elephant shrew hemi-mandible from the Malapa site. *South African Journal of Science* **107**(11/12), Art. #583

WATSON, V. 1993. Glimpses from Gondolin: a faunal analysis of a fossil site near Broederstroom, Transvaal, South Africa. *Palaeontologia africana* **30**: 35–42.