Research Protocol: Haasgat Fossil Site 09/2013

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Introduction: Original Exploration and Results from Haasgat

Palaeontological deposits in the Haasgat karstic system were first noted in 1987, and led to initial geological description (Keyser and Martini, 1991) and faunal analysis (Keyser, 1991; McKee and Keyser, 1994; Plug and Keyser, 1994) of fossils processed at Council for Geosciences during the late 1980's and early 1990's from the extensive *ex situ* miner's rubble at the site.

Original interpretations of the Haasgat cave system suggest development along a typical low-topographic relief pattern, where progressive erosion and deepening of the valley into the surface dolomites drained the phreatic cave, allowing for internal collapse and expansion of the system (Brain, 1958; Keyser and Martini, 1991). An unknown quantity of *ex situ* breccia collected by researchers was mechanically prepared, yielding a diverse faunal sample that has only been partially described in the literature (Keyser and Martini, 1991; McKee and Keyser, 1994; Plug and Keyser, 1994). Although early publication on the Haasgat faunas (the HGD collection; Keyser and Martini, 1991) noted the occurrence of *Parapapio broomi*, '*Simopithecus* sp.' (i.e. *Theropithecus*), and *Cercopithecoides williamsi*, later analysis (McKee and Keyser, 1994) concluded the entire papionin sample (n=83; MNI= 15 ♂, 10 ♀, 4 unknown sex) can be attributed to *Papio angusticeps*. This species has been recovered from the Kromdraai A, B and the nearby Cooper's deposits of the Blauubank Valley, while *Cercopithecoides williamsi* has been recovered from the Makapansgat Member 3, Bolt's Farm Pit 23, Kromdraai B, and Sterkfontein Member 4 fossil beds (Turner et al., 1999). The occurrence of colobus monkeys and a diverse, rich *P. angusticeps* assemblage (which has been associated with dense woodland environments at Kromdraai) suggested to McKee and Keyser (1994) that the Hoogland palaeoecosystem was a mix of proximate montane forests on rocky slopes, with open woodlands and grasslands nearby.

This interpretation was supported by later description of the non-primate mammalian fauna (Plug and Keyser, 1994), which is numerically dominated by rocky landscape-browsers like the klipspringer (*Oreotragus oreotragus*) and hyrax (*Procavia transvaalensis* and *Procavia antiqua*) among a mix of browsing and grazing ungulates (including *Giraffa camelopardalis* and four genera of alcelaphins). Among the bovids, the presence of the reduncins *Kobus leche* and *Kobus ellipsiprymnus* suggest seasonal to permanently inundated floodplains or a river near the site during fossil deposition (Plug and Keyser, 1994). None of the carnivore or porcupine remains from Haasgat (including the rarely recovered *Chasmoporthetes nitidula*) were officially described in the literature.

Keyser and Martini (1994) suggested that the elevation of the system (near 1500m) and erosional deroofing prior to mining might indicate a terminal Pliocene age for primary fossil deposition. Evaluation of the *P. angusticeps* sample suggested to McKee and Keyser (1994) that faunal accumulation was contemporaneous with Kromdraai A, B (1.8-1.7 million years ago [Ma]; Herries et al., 2009) and Cooper's (1.9-1.6 Ma; ibid.). In contrast, Plug and Keyser (1994) describe a relatively modern ungulate sample and suggested 1.5 – 0.5 Ma as the maximum range of the sampled faunas.

Summary of Recent Research on Haasgat HGD collections and excavations at Haasgat (2010-2013) (SAHRA Permits 80/10/03/010/51, 80/10/08/005/52, and 80/12/05/004/52)

Our interdisciplinary team applied for permits from SAHRA to undertake research at Haasgat, starting in 2010, for three primary reasons: 1) the faunas previously reported from the originally described Council for Geosciences Haasgat HGD assemblage demanded further palaeobiologic assessment, particularly to provide greater context for the uniquely diverse

primate assemblage and clarify the undescribed portions of the sample; 2) the occurrence of extensive *in situ* flowstone and siltstone deposits at Haasgat made the site ideal for geologic and palaeontologic sampling with strong stratigraphic controls, avoiding the compromises imposed by heavily mined deposits and *ex situ*-derived assemblages for analyses of karstic evolution, site taphonomy and regional palaeoecology; and 3) the geographic position and complex topography of Haasgat would provide key geologic, palaeobiologic, and palaeoecologic data on the northern portions of the Cradle of Humankind World Heritage site that has been demonstrated to vary significantly from the Bloubank River Valley sites (e.g. Sterkfontein, Swartkrans, Kromdraai)(Adams and Conroy, 2005; Adams, 2006; Herries et al., 2006; Adams et al., 2007a,b; Berger et al., 2010) and provide data for testing specific hypotheses about the karstic, palaeofaunal and palaeoecological evolution of the region, including hominin and non-hominin primate habitat utilisation on the diverse landscape during the late Pliocene and early Pleistocene.

These specific aspects of the Haasgat locality and pre-existing fossil collections led us to address three primary objectives in our first permitted research phase from 2010-2013. First was to fully assess and update the currently existing Haasgat faunal collection catalogue, currently stored with the Council for Geosciences (Pretoria). Second, to survey and map the modern cave system, coinciding with the first geochemical sampling of the deposits for both establishing a dating framework of the locality and evolution of the karstic system. Third, targeted sampling of the *ex situ* and *in situ* deposits at Haasgat to assess faunal composition in sediments represented in the dumpsite and to attempt to correlate dumpsite specimens with the *in situ* sequence of deposits.

As more fully described in our submitted 2013 final report to SAHRA, we have either completed or largely addressed each of these objectives and published (or currently have in review) a series of peer-reviewed manuscripts to disseminate our research outcomes. Our comprehensive reanalysis of faunal materials from Haasgat (Research Objective #1) has produced the first full documentation of the Council for Geosciences HGD assemblage (Adams, 2012; Kegley et al., in review). While this process encompassed nearly three full field seasons, our analysis expanded and clarified essential components of the assemblage, including the first detailed palaeobiologic analysis of the primate samples (Kegley et al., in review). We have completed the first detailed geological mapping and initial geochemical (palaeomagnetic and U-Pb) sampling of the Haasgat cave system (Research Objective #2)(Herries et al., in press, in preparation). This has provided the first well-justified ages for the depositional sequence and established a framework for undertaking more detailed sampling and micromorphological study of the Haasgat deposits. And finally, we have undertaken controlled processing of fossiliferous *ex situ* and *in situ* calcified sediment blocks and begun to catalogue the first well-documented faunal assemblage from the locality (Research Objective #3); a process that has been greatly expedited by the permissions of the Ditsong Museum and SAHRA to temporarily export fossil specimens for primary identification and cataloging.

Proposed Agenda for Continued Research at Haasgat

With reassessment of the original HGD assemblage, primary mapping and geochemical sampling, and controlled *ex situ* and *in situ* excavation during our first period of research at Haasgat completed, we have three primary research objectives for continued research at the site if our renewal application is granted:

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1) Continued sustainable excavation of *in situ* fossil deposits, specifically from the Tobias' Steps and collapsed roof sediments of Tetley's Hall (Figure 1).

Our surveys of the *in situ* deposits revealed two fossiliferous depositional zones that could be safely sampled by our team at this time. The first is collection of blocks from the floor of Tetley's Hall that dislodged from the ceiling/wall deposits of the main chamber during the original lime mining. While 'loose', the blocks can be associated with the proximate, 'fixed' *in situ* sediment beds adhering to the ceiling/walls of the cavern system. The second are fixed blocks comprising the Tobias' Steps calcified sediment section that rests on basal dolomite collapse in the south-central portion of the cave system. This column of sediments is both fossiliferous and can be readily approached for sequential, spatially-controlled 'top-down' excavation of blocks.

As has been our policy in past excavations, we are committed to the goals of conservation of resources and limiting the environmental impact on the site. We plan on only removing sediment volumes that can be reasonably processed and catalogued within the three year permitted period by the Plio-Pleistocene Section of the Ditsong National Museum of Natural History (the designated repository institution for our Haasgat collections) to minimize the production of a backlog of unprocessed materials off-site.

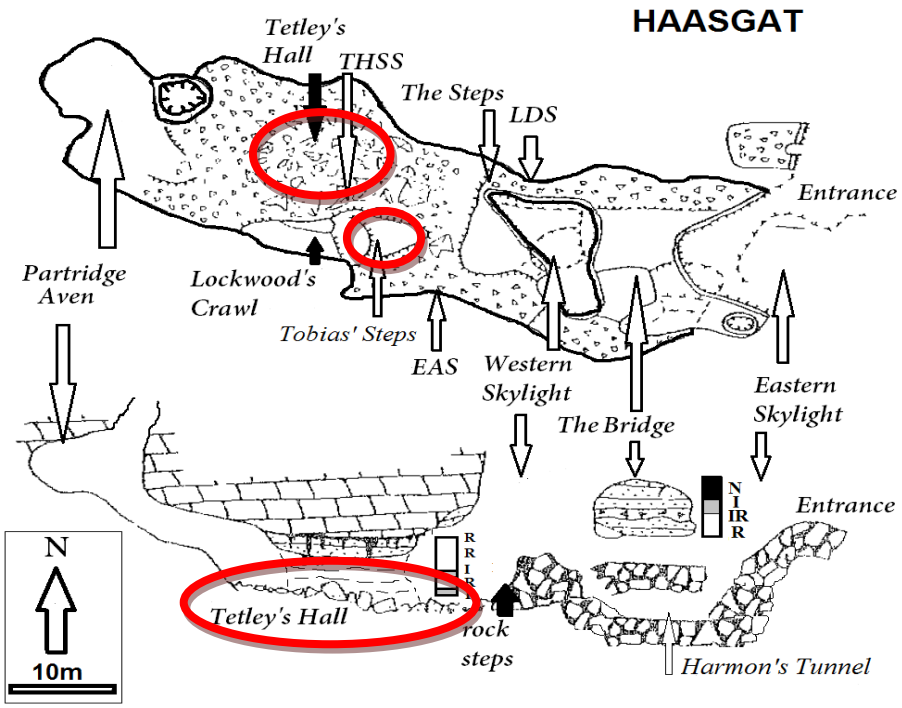

Figure 1. Site plan of Haasgat, with the proposed areas of *in situ* excavation highlighted.

2) Additional palaeomagnetic and U-Pb sampling of the Haasgat cave system sediments.

Our initial, published sampling of the Haasgat sedimentary sequence has provided a baseline framework for both dating the deposits and interpreting the evolution of the Haasgat cave system. Our first results (Herries et al., in press) revealed subtle palaeomagnetic signatures and trace element compositions in the Haasgat sedimentary sequence, and indicate that additional sampling would improve our resolution of the chronology and evolution of the

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fossil-bearing deposits (as well as the general process of speleogenesis in the northern Cradle region). Proposed sampling during this phase of research would include removal of small, oriented cores from the *in situ* sediment and flowstone sequences for palaeomagnetic and microstratigraphic analysis; as well as samples for U-Pb dating of flowstone layers not sampled during our prior field seasons. Where possible, samples for palaeomagnetic analysis would be taken in tandem with the *in situ* excavated blocks, such that the eventually processed fossils have associated geomagnetic data.

3) Initiate long-term site conservation by organising and stabilising the large *ex situ* dumpsite.

The original phase of lime mining produced a massive dumpsite immediately adjacent to the modern cave entrance and extending to the valley floor. Since the original phase of mining, and possibly exacerbated by palaeontologic sampling in the early 1990s, this dumpsite has become destabilised. Removal and organisation of the loose *ex situ* dumpsite materials will aid the future stability of the dumpsite, and provide an opportunity to clarify the extent of sterile and fossil-bearing sediments in the dump.

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Our methods for excavation, processing, curation, and specimen identification will follow standards in place at the Ditsong National Museum and those we have used in research at Haasgat and at other localities (see Adams, 2006 for detailed discussion). Excavated blocks will be transported to the Plio-Pleistocene Section, Ditsong National Museum for processing in the acetic acid processing laboratory. All specimens processed in these proposed excavations will be studied relative to fossil and modern comparative collections at the Ditsong National Museum and the Evolutionary Studies Institute at the University of the Witwatersrand. Where necessary, separate export permits will be applied for to allow Dr. Adams (as primary faunal analyst) time to sort, catalogue, curate, and undertake primary identification of specimens.

Methods for palaeomagnetic sampling and other geoisotope assessments will follow those previously employed at Haasgat and more fully described in Herries (2003), Herries et al. (in press) and Herries et al. (in preparation). The location of geological samples removed will be fully documented by taking survey points with a Nikon reflectorless total station and physically marking sample locations in the cave system.

The majority of the equipment required for survey, mapping, and excavation are already in place from our prior research in the region. Funding for the airfares of international collaborators, costs of geological analysis, and the processing and curation of specimens will be funded either via the Australian Research Council (ARC, funding application for 2014-2016 inclusive, decision pending) or directly by the participating researchers.

A tentative schedule of research activities, pending successful granting of this permit application, is as follows:

Proposed Reseach Schedule

2014: Geologic sampling and *in situ* excavation (June-July) followed by acetic acid processing of calcified sediment blocks at the Ditsong National Museum of Natural History (July-completion);

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2015:	Geologic sampling and *in situ* excavation (June-July) followed by acetic acid processing of calcified sediment blocks at the Ditsong National Museum of Natural History (July-completion); Analysis of 2014 excavated/processed fossil specimens (May-July)
2016:	Geologic sampling and *in situ* excavation (June-July) followed by acetic acid processing of calcified sediment blocks at the Ditsong National Museum of Natural History (July-completion); Analysis of 2014 excavated/processed fossil specimens (May-July); Manuscript preparation and submission; Filing of SAHRA final reporting and possible renewal application

Summary

During the first phase of research we conducted at Haasgat (2010-2013) we focused on addressing outstanding issues from past research at the site, and establishing the geologic and chronologic context necessary for undertaking our own phase of excavation and research at the locality. We feel that this initial interdisciplinary approach towards Haasgat, and our

success at translating our research program into both grant applications and peer-reviewed publications, has begun to highlight the significance of the site for South African palaeontology. However, while we did address each of our initial primary research objectives, the significant time our team invested in reassessing the pre-existing Haasgat Council for Geosciences HGD assemblage and establishing the geochronology of the deposits limited the amount of *in situ* sampling we could accomplish during this first research period.

This application for renewal of the Haasgat permits represents our commitment to sustainable palaeontological exploration of the site. With the further investment, site development and continued scientific inquiry proposed here, Haasgat will continue to provide significant data on the tempo and mode of evolutionary events impacting hominins, primates and other mammals during the terminal Pliocene and early Pleistocene of South Africa.

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