

9/04/02

*Makapansgat Area  
Palaeoecology & Palaeoanthropology (MAPP)  
Research Project*

*Progress Report for 2001 Research  
Proposal for ongoing research in 2002*

Prepared for the Makapansgat Research Advisory Committee (MRAC),  
Bernard Price Institute (Palaeontology),  
University of the Witwatersrand

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### *Introduction and MAPP Overview.*

The objectives and ongoing research activities of the Makapansgat Area Palaeoecology & Palaeoanthropology (MAPP) Project have been outlined in previous reports for the Makapansgat Research Advisory Committee (MRAC). Research activities and output have been summarised in Progress Reports for the National Research Foundation (NRF) and the Leakey Foundation, who have provided the majority of funding support for this project, as well as in previous reports for this committee. Copies of any such reports are available on request.

The primary aim of *MAPP* research is to recover palaeontological, palaeoecological and geological/stratigraphic data on a regional and temporal scale, for the purpose of palaeoecological reconstruction relevant to early hominid evolution. Although we aim to employ 'in situ' excavation for fossil recovery at sites in our research area, we are equally concerned with recovery of contextual data to provide information about palaeoecology (e.g., palynology, isotopic sampling), local/site and regional geology, lithostratigraphic reconstruction, and geochronological dating. The MAPP strategy involves excavation and sampling at sites with extensive stratigraphic sequences such as the Makapansgat Limeworks and Buffalo Cave, but our aims are to include additional sites preserving geological and palaeontological evidence for different and shorter temporal windows, and different palaeoecological conditions. Thus, our long-term strategy aims to include yet-unknown fossiliferous localities in the Malmani Dolomites Subgroup, regardless of whether they produce hominid fossils, in order to refine evolutionary reconstructions of palaeoecology – including reconstructions of habitats in which hominids did *not* appear to exist.

At present *MAPP* research focuses on two sites in the Makapansgat Valley: the world-renowned Makapansgat Limeworks hominid locality, and nearby Buffalo Cave. Members 3 and 4 at the Limeworks have produced hominid fossils attributed to *Australopithecus africanus* and dated within the range 2.9 – 3.3 my. According to the palaeomagnetic survey work conducted by our team, the oldest recognised strata at the Limeworks (associated stratigraphically with, but representing a separate depositional event from deposits recognised as Member 2) date to 4.29 Ma.

In our recent work we have recovered two new hominid mandibular fragments from the breccia dumps at the Limeworks, both attributed to *A. africanus* from Member 3. A poster presentation comparing these specimens to mandibular material from Sterkfontein and East African localities was made at the XVIth International Symposium on Morphological Sciences in Sun City in 2001. Further work incorporating a biomechanical comparison is currently underway, including a BSc Honours student project in the School of Anatomical Sciences. Formal publication will follow completion of this project at the end of 2002.

Buffalo Cave has yet to produce hominid fossils, but does preserve a rich and diverse fauna representing the time period estimated at present to be 600 – 900 k ya on the basis of faunal correlation. Based on our recent palaeomagnetic sampling research, the basal speleothem at Buffalo Cave appears to be no older than 1.77 m years, and the fossiliferous deposits date between 0.78 – 0.99 Ma. This fossiliferous deposit is extremely rich, and we are currently preparing an extensive collection of breccia blocks recovered in 2001. The results of this time-consuming task will eventually direct our future research endeavours at this site.

For the past four seasons, the MAPP project has operated through international and local research collaborations, and also through the *Palaeoanthropology Field School at Makapansgat* (PFSM) programme in the School of Anatomical Sciences. This international field school in palaeoanthropological and palaeoecological field research is co-directed by KL Kuykendall (Witwatersrand) and KE Reed (Arizona State University), and is offered for credit in the Science Faculty at Wits, or as transfer credit to overseas institutions. The PFSM runs annually in July and August, involving approximately 15 students and 5 postgraduate teaching assistants in its 6-week programme.

MAPP research activities over the past several years have been supported from several sources: the National Research Foundation (South Africa) to KL Kuykendall (Director of MAPP); the LSB Leakey Foundation (USA) to GC Conroy (Washington University), Kuykendall, and JK McKee (Ohio State Univ); a Washington University Faculty Grant to Conroy; a Faculty Seed Grant at Ohio State University in support of fossil preparation at Wits to McKee; an ASU Faculty Grant to KE Reed (co-director of PFSM) for travel costs, and analysis of faunal, pollen and neutron activation samples; and various grants in the UK to AG Latham (Liverpool) for palaeomagnetic and uranium series dating. In addition, the PFSM budget generates all required funds for its own field activities, and provides support for South African students and teaching assistants who participate in the field school.

Postgraduate students from the School of Anatomical Sciences, and from UCT have assisted in the teaching and running of the PFSM, in addition to those coming from Arizona State University. Several Wits Human Biology III, Honours and MSc student projects have been related to MAPP research objectives in recent years (see previous reports). In particular, Kuykendall is currently supervising Mr ADT Kegley for his MSc research, titled 'Nonmetric molar trends in South African Australopithecines', and Mr D Edwards in a MSc project tentatively titled 'Aspects of cave development in South Africa with respect to hominid research'. In addition, AG Latham (Liverpool) has been supervising Mr A Herries for both his MSc and PhD research, which has produced all of the recent palaeomagnetic survey and dating interpretations. From last year, Latham has also initiated work with Mr P Hopley on stable carbon and oxygen isotopes from both speleothem and fossil (tooth) specimens from the Limeworks and Buffalo Cave. We have established a collaborative arrangement with J Lee Thorpe at UCT in this regard. In addition, last year (2001) Latham initiated a second Ph.D project with Ms. Joanne Walker (Liverpool) involving sampling for Uranium-Lead dating. This work will also continue this year, requiring limited sampling at the Limeworks and Buffalo Cave.

#### *Collaborators and contact details.*

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### *Ongoing Research – Progress Report.*

*Research objectives in 2002 (Excerpted from 2000/2001 report):*

#### *Makapansgat Limeworks.*

Please refer to the map of the Makapansgat Limeworks – Map 1.

#### *General*

- a) Ongoing sampling programme for pollen, NAA, palaeomagnetic analysis, Uranium series dating, and oxygen and carbon isotopes.

*In 2001 we did not collect additional pollen and NAA samples since our in situ excavation activities were limited (see below). However, the palaeomagnetic, U-Pb, and isotopic samples were collected and shipped to Liverpool for processing and analysis. Analysis of these samples is nearing completion, and the major results are mentioned where relevant below and in the Overview.*

- b) Processing breccia from the breccia camps, including cleaning, identification and cataloguing. These specimens will primarily be utilised in future student projects through the field school and the Human Biology III programmes.

*These activities are ongoing, but are essentially part of the teaching aspect of the field school, and for occasional Human Biology projects. We did not actually accession any new specimens in 2001, though we did continue the sorting exercise. Until our results for NAA/trace element analysis are more successful, all such materials remain unprovenanced and are of limited value given our research objectives. I have now made arrangements with Prof M Viljoen from Wits Geology to begin several projects relating to geochemical and petrological analysis of the*

*sediments at the Limeworks and Buffalo Cave sites, and these are discussed later as part of the 2002 proposal.*

c) Acid and airscribe laboratory preparation of breccias at Wits Anatomical Sciences.

*I was able to hire one laboratory assistant in approximately March 2001, who is now only working part time. Funds for this post were provided by Dr JK McKee (Ohio State University), and the focus has primarily been on preparation of Taung breccias remaining from his excavations there prior to 1993. However, these efforts have allowed us to develop an effective (though still slow) method combining acid preparation and manual/air scribe techniques for breccia preparation. This experience will be of great benefit to us once we are able to hire additional laboratory assistants (see funding section below).*

*Since approximately February 2002, the School of Anatomical Sciences has provided me with a technical assistant for two hours per day (Mr E Mofokeng). He has been working primarily on the extremely fossiliferous Buffalo Cave breccias, and is still in the training phase for this new task.*

*Anticipated funding for 2002 is earmarked for training of new preparators this task; see 2002 objectives.*

*Activities in Member 2 (See area marked 'M2' on Map 1).*

a) Removal of loose breccia blocks from the Member 2 exposure (see Map 1) using hammer and chisel technique.

*Most of the excavation activities during the 2001 season were involved with the mapping, removal and reduction of these loose blocks, and also with excavation (in 10 cm levels) and sieving of sediments infilling the solution depressions and tubes from the cleared surface. As requested by the committee, overburden sediments were sieved for potential recovery of fossils and lithic artefacts. Although a minimal amount of fossil bone was recovered from the loose surface breccia blocks, we did not recover a single bone or lithic specimen from the infill sediments in three weeks of excavation/sieving. Most of the infill was clearly mining rubble (including small-to-medium sized chunks of dolomite and flowstone) and recent erosional sediment. It was largely a teaching exercise for the students, but has informed us that there is little need to continue with such detailed procedures.*

*The bone specimens recovered have been recorded in the field logbooks and are stored at the field warehouse. Few are complete enough to warrant further processing or analysis at this time.*

b) Utilising the local labour force, the remaining overburden in the area of the Member 2 exposure will be cleared by following the dolomite walls and the intermediate flowstone layer. This will assist in further elucidating the configuration of the ancient cave chamber and sedimentary deposits contained therein.

*Workers cleared the overburden to the northwest but the dolomitic walls continue under the nearby mining waste dumps. We do not plan to relocate these dumps, and so the workers continued clearing additional overburden to the north. This was quite productive in that it exposed further cave infill sediments below the intermediate flowstone and the basal flowstone*

*lining the dolomite walls of the cave chamber. These two flowstone deposits have yielded palaeomagnetic dates between approximately 3.5 and 4.29 Ma. Thus, the deposit uncovered is of considerable interest due to its age. The surface was brushed clean, and approximately 6 fossil bone specimens were located in exposure – some of which are potentially identifiable following recovery and preparation. None warranted immediate attention, and all remain in situ.*

*There is a small area of overburden remaining to be cleared in 2002, and then the map of the exposure must be completed. Excavation will continue in this area in 2002.*

- c) Rough screening the overburden dirt piles from the clearing completed in previous years, in order to attempt recovery of fossil or lithic material that might have eroded from the deposit.

*No specimens were recovered after one week of screening, and I could not justify keeping the workers on this task any longer.*

### *Member 3*

- a) Sampling of Member 3 fossil breccia remnants in the ledge at the top of the Classic Section, and in the ceiling of the Main Quarry above the Classic Section.

*After examination of the ramsackle scaffolding available at the Limeworks Warehouse, this objective was postponed. We will need to consider alternative arrangements for obtaining safe scaffolding before pursuing fossil extraction from this location, determined by funds available in 2002.*

### *Member 4*

No detailed plans at present.

*No activities pursued.*

### Buffalo Cave

Please refer to the map of Buffalo Cave provided – Map 2.

- a) Extraction of fossils exposed in the *in situ* sediments that correspond to samples taken for palaeomagnetic analysis.
- b) Drilling of large (metres in size) displaced blocks in Locality J, the huge mound of collapse in the centre of the site. Most of these blocks are extremely fossiliferous, and it is time to begin collecting.
- c) In conjunction with the drilling, we will begin digging a trench along the exposed face of the Ledge deposit. This face is covered by a 'living' tufa deposit, but constitutes an extensive continuous deposit from Locality C (where the old excavation was conducted) to the deeper underground chamber. This will assist with understanding the cave geomorphology and palaeomagnetic sampling, and expose *in situ* sediments that may be fossiliferous.

*Buffalo Cave has been wet, with running or dripping water, for at least the past two years. The water happens to drip exactly where we planned to dig the trench in item 'c' above. The rocks on the ledge are also often wet, and the dripping splatters into the area designated Locality J (item 'a'). Thus, the planned activities at Buffalo Cave were not possible due to safety and logistical considerations.*

*Two alternate activities at Buffalo Cave were conducted during the 2001 season:*

- 1) Continued clearing in the area marked 'Area cleared 1998' was extended upslope further to the north – in the direction of in situ deposits from the cave infill strata. 'Rock sausages' were also constructed to control for erosion after clearing on the slope was complete.*
- 2) Removal of a large block of bone-bearing breccia near the top of the sequence, on the northern face of the exposed deposit (in the deposits above the subsurface 'Locality C'). This block was removed for both safety considerations (it was designated as a danger by the mining engineering inspector in 1999), and also because it was near the top of the sequence from which palaeomagnetic samples had been taken in 2000. Thus, it would potentially give us a faunal sample to compare to the palaeomagnetic dates for confirmation. This block was partially reduced as it was removed, and all transportable blocks were removed to the Limeworks Warehouse; a sub-sample of these was transported to Wits and remains to be prepared during 2002/3. Three large blocks that could not be transported remain on site at Buffalo Cave. NB. It is worth noting that I have observed in subsequent trips to Buffalo Cave that additional blocks have fallen from this exposure; additional safety precautions are necessary. No further sampling or excavation at Buffalo Cave is planned for 2002 so that we can make arrangements to stabilise the deposit if necessary.*

#### *Specimens collected and curation undertaken.*

Updated comments/progress to be tabled at meeting. I have had contact with Dr M Raath, as requested at the meeting in 2001. He expressed no concern or urgency that the available Makapansgat faunal sample is curated at the BPI facilities if there was a need to utilise them for description, research or teaching. However, it will be necessary to re-label some of the specimens prior to their return (not all have been numbered in any event), as Dr Raath was implementing a new numbering system for the BPI collections. We have not yet employed this system for labelling these specimens.

These specimens have been very useful in assisting the students of the Field School in learning fossil fauna from fragmentary identified remains. We would like to retain the assemblage for this purpose in future teaching situations.

#### *Research output.*

##### Presented Papers and Abstracts:

1. Herries, AIR, and AG Latham (2002). Dating the depositional sequence and Australopithecine "Grey Breccia" of Makapansgat Limeworks using magnetostratigraphy. Symposium: Australopithecines to AMHS: Current Palaeoanthropological Research in South Africa. Seventy-first annual meeting of

the American Association of Physical Anthropologists, Buffalo, NY. (will be abstracted in AJPA).

2. K.L. Kuykendall and A.D.T. Kegley (2001). Metric and non-metric variation in two new hominid mandibles from the Makapansgat Limeworks (*poster*). XVI<sup>th</sup> International Symposium on Morphological Sciences. Sun City, South Africa.
3. Kegley, ADT and KL Kuykendall (2001). Dental asymmetry in South African australopithecines: a preliminary analysis of odontometric and morphological components. Annual meetings of the Palaeoanthropology Society, Denver, USA. Abstracted in *Journal of Human Evolution*, March 2002.
4. Herries, AIR, 2002. *The application of mineral magnetism to the study of the hominid caves of South Africa..* Magnetic Interactions UK. John Moores University.
5. Herries, AIR, 2001. *The application of mineral magnetism to the study of the hominid caves of South Africa..* British Cave Research Association (BCRA), 2001 Cave Science Symposium, Oxford University.
6. Herries, A.I.R (2001) The relationship of palaeokarst to the modern cave forming processes in the Transvaal, South Africa. *Cave and Karst Science* (abstract).

#### Publications:

1. Herries, AIR., AG Latham, and KL Kuykendall (2001). The use of 'SRT' in sampling the Makapansgat Limeworks hominid palaeocave, South Africa. *Antiquity* 75:251-252.

#### Ongoing projects/ publications in progress:

- 1) Latham and Herries are both writing up additional results from their palaeomagnetic results, and the following provisional list is an indication of the topics and the journals we plan to submit them to:
  - Herries, Reed, Kuykendall and Latham (in prep) Speleology and Dating of the Buffalo Cave Fossil Locality, Makapansgat, South Africa.
  - Herries, Latham and Kuykendall (in prep) The Age of the Makapansgat Limeworks Australopithecine Palaeocave as determined by Magnetostratigraphy. *J. Human Evolution*.
  - Latham, Herries and Kuykendall (in prep) The depositional sequence of the Makapansgat Limeworks Australopithecine Palaeocave. *Palaeontologia Africana*.
  - Herries and Kuykendall (in prep) Speleological and palaeomagnetic studies at the Gondolin Hominin Palaeocave. *S.A.S.*
  - Herries, Latham, Kuykendall and Merz (in prep) New Caves in the Zwartkrans Valley, N. Province, South Africa. *Cave and Karst Science*.

In addition, Herries will complete his PhD by the end of 2002. Additional publications will come from Hopley, who has already presented preliminary results from the sampling in 2001 at conference (details unavailable). Walker will also be generating results of the U-Pb sampling from samples collected in 2001 and 2002.



- 2) Reed has been working on the Buffalo Cave faunal analysis, but has been waiting for the palaeomagnetic results for the dating. These are now available (sent to us in March 2002), and this paper can now proceed. However, Reed feels that the fauna recovered from the Limeworks dump breccias are of very limited value because they are unprovenanced, and because there are no novel species compared to previous work. Our ongoing research aims to recover a new provenanced assemblage from the Limeworks.
- 3) The two hominid mandible fragments from the Limeworks are very interesting because they add to the available Makapansgat assemblage, and further support potential morphological distinctions between Makapansgat and Sterkfontein specimens attributed to *A. africanus*. As far as the mandibles are relevant, it appears that a general morphological pattern of 'deep mandibles and small teeth' is typical of the Makapansgat hominids at roughly 3 Ma, while a morphological pattern described as 'shallow mandibles and large teeth' applies to most of the available Sterkfontein assemblage. However, the poster presented last year is perhaps too preliminary for publication, and I am withholding this until completion of an Honours project during 2002. This project aims to examine the biomechanical properties of these two patterns of mandibular morphology to determine whether different biomechanical, functional or (implied) taxonomic interpretations can be supported for the two assemblages.
- 4) In 2000, Mr Wilbert Sibanda completed a light microscopic study of tooth and wear marks on the Makapansgat fauna that have been recovered since 1998 during the Field School. I have been hoping to attract a student to continue this study using more acceptable SEM and digital imaging techniques, but so far have not been successful. I am hoping that a student from the new MSc by coursework programme will pick up this project in 2003.

#### *Proposed research for 2002.*

##### Makapansgat Limeworks

- a) the sampling programme for Uranium-lead dating (Walker), Carbon and Oxygen isotopes (Hopley) will continue as needed. The sampling for palaeomagnetic dating (Herries & Latham) is essentially complete, but it may be necessary to re-sample certain deposits in the case that any samples did not produce results.
- b) Sampling for pollens, geochemical trace elements (NAA) etc. will continue in conjunction with excavation as in previous seasons.
- c) Laboratory preparation at Wits will continue. In addition, pending administration of funds from the National Science Foundation grant (USA; McKee, Conroy, Latham, Kuykendall) we would like to initiate a training programme at Makapansgat so that preparation at the site would be feasible on at least a part time basis. We hope to be able to employ 2-3 preparators who would work in the Warehouse using the equipment we have already purchased (petrol air compressor, air scribes).
- d) Member 2 excavation will proceed in the area where we initiated drilling last year (see 'M2' notation on Map 1) in deposits dating roughly between 3-4 Ma based on palaeomagnetic results. Breccia blocks will be reduced as they are removed unless bone is recovered. Bone bearing blocks will either be stored for later preparation on

site after training (as in item 'c') or transported to Wits for preparation. Overburden will be cleared as needed to facilitate excavation.

- e) Pending sufficient funding for scaffolding, etc. it would be important to carry out the sampling of the remnant Member 3 breccias as planned in 2001. As mentioned earlier in this report, this task was not carried due to the unsafe state of the available scaffolding.

#### Buffalo Cave

- a) The main focus of work called for at Buffalo Cave is to continue with preparation of fossils already removed. There are ample breccia blocks both at the Warehouse and in storage at Wits to keep us busy with this task.
- b) Sampling for Uranium-Lead dating and C/O isotopes will be conducted as needed by Walker and Hopley.

#### Makapan Valley Geoscientific Study

- a) Prof Morris Viljoen has become involved in an MSc project proposed by Mr Dave Edwards project, and he has agreed to serve as co-supervisor (subject to Faculty approval). In light of this agreement, Prof Viljoen has submitted the attached 'Proposal for a Geoscientific study of the Makapansgat area', which we consider to provide the 'big picture' in which Mr Edwards MSc will be seen. There are two primary objectives to this proposal: i) to conduct a regional mapping project that would produce a detailed stratigraphic column of the dolomitic units in the valley. This will be accompanied by a sampling programme to undertake petrological and trace element geochemical studies for these geological units. This work would include taking structural measurements for geological faults, folds and joints and correlating the ground features with aerial photographs. Overall, maps will be produced that document the relationship of cave sites to the stratigraphic, structural and geomorphic features in the region. Mr Edwards will be involved in this mapping project, though his specific objectives are more limited (see item 'b' below). ii) detailed mapping of the cave stratigraphy, utilising the exposed sidewalls and vertical faces left by mining activities. This will involve photographic documentation (producing extensive photo-mosaics of all such exposures) to interpret and portray cave stratigraphy. A sampling programme will also be undertaken for mineralogical, and trace element geochemistry of all sedimentological units. This has the potential to document distinctive geochemical signatures for different stratigraphic units (and is the objective we had previously pursued in taking neutron activation analysis samples in earlier seasons).
- b) Mr Dave Edwards (MSc student in the School of Anatomical Sciences) has submitted a proposal to me for a geological mapping project in the Makapansgat Valley. I have attached a copy of a proposal he submitted through the School in application for a bursary (letter addressed to Prof JN Maina); this proposal summarises the objectives of his work. In summary, the work will focus on defining the geological and geomorphic features associated with the bone-breccia bearing deposits in the Makapansgat Valley. His work will utilise existing topographic maps & aerial photos, as well as extensive ground-truthing, in order to document the (local) regional structure of the dolomites and the modern topographic features in the areas where ancient cave deposits are known. In this

way, it may be possible to use such geological and geomorphological evidence to identify additional areas where palaeontological sites might occur, both in the Valley (unlikely) and in neighbouring areas.

#### *Funding for 2002.*

1. The Field School activities have resulted in a respectable funding source in support of future Field School and research. This year I have been able to allocate R25,000.00 in support of field and laboratory research. This will cover the basic running costs at a level of research activity equivalent to previous years. Additional funds will be provided by the 2002 Field School in July – August.
2. In November 2001, the NSF informed JK McKee that the joint proposal we submitted for Makapansgat research (McKee, Conroy, Latham, Kuykendall) had been assessed and allocated to the 'Must Fund' category, but that their total funding allocation had not yet been determined. Thus, we are anticipating that we will receive an award in \$US from the NSF, but have not yet been informed of the final outcome.
3. I am submitting an application to PAST in support of running costs for field survey and mapping activities, and in support of salaries for laboratory assistance for breccia preparation.

#### *Envisaged time and utilisation of facilities.*

- The major periods of fieldwork will be in the first week of July to the second week of August 2002 (approximately 6 weeks) in conjunction with the Field School, and during December 2002 – January 2003 during the end-year teaching break.
- Shorter trips will be undertaken as necessary in preparation, or as follow-up to, these periods. These will normally be weekend trips.
- Following approval, Mr Edwards will proceed with his mapping project, and we anticipate that he will work on a schedule involving periods of 2-3 weeks of fieldwork. He will most likely book the Research House if it is available.
- We will plan to use the Field School season for training of preparators, and will hopefully be able to rely on a trustworthy 'site manager' to see the work carried out in my absence. I plan to make periodic trips to Makapan on a monthly basis if this arrangement becomes possible.

(Attachment 1: Proposal from Prof M Viljoen)

## **PROPOSAL FOR A GEOSCIENTIFIC STUDY OF THE MAKAPANGSAT AREA**

Although a large amount of work has been done in the Makapansgat Valley on the cave breccias and their contained fossil bones, relatively little work has been undertaken or published on the geology of the caves and their surroundings.

*A two-fold geological study is proposed:-*

### **1. GEOLOGICAL AND GEOMORPHICAL SETTING AND CONTROL OF CAVES.**

A geological mapping project of the region is proposed. Particular attention will be focused on the establishment of a detailed stratigraphic column for the dolomite stratigraphy starting at the underlying Black Reef quartzite. A number of profiles will be measured with the aim of establishing the nature of the stratigraphic unit or units, which host the caves. Use will be made of enlarged aerial photographs to map well-defined geological packages or units. At the same time structural measurements of the orientation of faults, joints and folds will be undertaken and major structural features identifiable on aerial photographs will be mapped. An attempt will also be made to establish the erosion history of the area during and after the initial formation of the caves. Maps depicting the caves in relation to stratigraphic, structural and geomorphic features will be produced.

It is also planned to collect a suite of representative samples from the measured profiles for petrological studies as well as for major and trace element geochemical studies. It is hoped to define distinctive geochemical signatures for the major stratigraphic units. It is also hoped to acquire airborne geophysical data as an aid to the geological mapping of the area.

## **2. CAVE STRATIGRAPHY AND STRUCTURES.**

A number of apparently unrecorded local unconformities have recently been recognised in the cave deposits. It is planned to map the cave stratigraphy by way of the detailed mapping of cave sidewalls and various vertical faces. It is planned to photograph these faces in advance so as to create a series of continuous mosaics that can be used as a photographic base for detailed interpretation and portrayal of the cave stratigraphy and structure. The localities at which important palaeo-anthropological discoveries were made will be shown on the profiles.

A sampling programme will be undertaken for mineralogical as well as major and trace element geochemistry on representative samples. It is hoped that a distinctive geochemical signature for various members of the cave stratigraphy will emerge. This could be of great value in correlating between cave sites.

An initial study will be made of the literature to establish the nature and extent of various studies already undertaken. This should also ensure that no duplication of existing work takes place.

It is hoped that the study will add considerably to our knowledge of the Makapansgat caves, their geological setting and controls, as well as the stratigraphy.

PROF. MORRIS VILJOEN  
PROFESSOR OF MINING GEOLOGY  
DEPARTMENT OF GEOSCIENCES  
CO-ORDINATOR OF MAKAPANSGAT GEOSCIENTIFIC STUDY

(Attachment 2: Proposal from Mr Dave Edwards)

To: **Professor J.N. Maina,**  
**School of Anatomical Science,**  
**University of the Witwatersrand.**

15<sup>th</sup> March 2002

*Re: J.J.J. Smieszek Bursary 2002*

I would like to be considered for the above bursary.

I am registered full-time for a M.Sc. in Palaeoanthropology by dissertation through the Witwatersrand School of Anatomical Sciences supervised by Dr Kevin Kuykendall.

My research will focus on applying detailed geologic and geomorphologic studies principally at the Makapansgat Heritage Site, but also at the Sterkfontein Heritage Site, to establish criteria that will assist in delineating additional areas of potential palaeoanthropologic importance within the large area of dolomites that encircles the Bushveld Igneous Complex. The dolomite area referred to above is extremely large and covers approximately 1 500 square kilometres extending from the Botswana: South Africa border in the west, to Lydenburg to the east and open-ended in the sense that there is as yet insufficient geologic or geomorphic evidence to narrow down this search.

At present, our knowledge of the geologic and geomorphic controls that apply at both Heritage sites is limited. However, there are several indications that strong geologic and geomorphic controls may exist in both these localities. This research would therefore be of primary importance in establishing the "ground rules" for the discovery of further important sites.

My investigations have so far shown that, while the detail varies, the broader geological features at both the Makapansgat and Sterkfontein Sites are similar. Both sites occur near the base of an ancient dolomite sequence and are underlain by a quartzite that is relatively impervious to water. This quartzite outcrops east of Sterkfontein at the gold Kromdraai Mine. At the entrance to the mine, the contact with the dolomites is visible and consists of a soft, water-indurated, manganese-rich, clay seam. The dip of this contact and the regional geological structure indicate this quartzite almost certainly underlies the hominid-bearing cave deposits at Sterkfontein. The depth of this contact below the surface at Sterkfontein is unknown, however as dolomites allow water to pass down to unusually great depths due to the development of a network of vertical and horizontal joints it is possible that this quartzite forms or formed the base of the water table and was an important control factor in the formation of the caves.

The geology at Makapansgat seems to be very similar. Early detailed mapping up the Makapansgat valley by Lester King – a skilled geologist and geomorphologist – indicate that the same quartzites as those at Kromdraai are exposed in some of the lower levels of the stream section and are overlain by similar dolomites to those that outcrop at Sterkfontein, thereby reinforcing the possibility that this geological

juncture may be an important factor in cave initiation and development. Hence, the elevation of caves west of the main Makapansgat valley and the elevations of the Limeworks, Historic cave and the Cave of Hearths may be related to this quartzite:dolomite contact.

The regional structure of these dolomites and the topographic rise to the east suggests that they may form a large elevated aquifer so that the distribution of springs around the perimeter of this raised aquifer may indicate the location of the quartzite:dolomite contact. If so, other caves in other locations around this aquifer may have a similar history.

In addition, despite their large lateral separation, there is also a strong positional correlation between these two sites on the basis of regional geomorphology. Both are peripheral to zones of relative subsidence associated with the denser rocks of the Bushveld Igneous Complex. In both cases, their positions are such that net result of a series of broad scale uplifts that commenced after the break-up of Gondwanaland were more-or-less neutralised by the Bushveld down-sag. This net reduction in uplift would explain why these sites have been preserved at or near surface while others beyond this "neutral to slightly positive" margin will have been eroded away.

Of particular interest is the possibility that geomorphologic studies within the Makapansgat region where the topography is extremely rugged, may reveal the sequence and size of the vertical movements there. A river section from west to east up the main drainage system to the Makapansgat valley constructed using contour detail from the 1: 50 000 topographic map of the area suggests that the valley may be preserved as an elevated terrace between two uplift events, which may have occurred some time before the early phase of hominid evolution and continued in fits and bursts since then.

If detailed geologic and geomorphic mapping confirms this to be the case, then it may also be possible to use both geologic and geomorphic evidence to outline areas of palaeoanthropologic promise and concentrate searches within these areas.

If successful, this is likely would greatly reduce the potential search area and provide a cost effective way for palaeontologists to focus attention on these areas as well as assess whether these potential sites are at risk from erosion and human activities.

The topography at Sterkfontein is much more subdued than at Makapansgat and may quite likely have been subjected to a different series of vertical movements and erosion. However, there is a possibility that a concentrated geologic and geomorphic study at Makapansgat will add to our understanding of events there.

A progress report from Dr Kevin Kuykendall is attached.

No funds have yet been obtained for this research.

Yours sincerely,

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