

Self-Assessment Report 2013- 2017

Centres of Excellence Review March 2018

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LIST OF ABBREVIATIONS

'CoE-Pal', 'the Centre' or 'CoE in Palaeosciences' - DST-NRF Centre of Excellence in Palaeosciences

- CoE Centres of Excellence
- CoH Cradle of Humankind
- Ditsong Ditsong National Museum of Natural History
- DST Department of Science and Technology
- ESI Evolutionary Studies Institute
- ESRF European Synchrotron Radiation Facility
- GAES Geography, Archaeology and Environmental Studies
- Iziko Iziko Museums of South Africa
- KFEC Kitching Fossil Exploration Centre
- NSCF Natural Science Collections Facility
- NRDS National Research and Development Strategy
- NRF National Research Foundation

'Partners' – Includes the University of the Witwatersrand, University of Cape Town, Albany Museum, National Museum Bloemfontein, Ditsong Museum, and Iziko Museum

'Palaeosciences' – Here it the word refers to all disciplines of palaeontology and archaeology up to the Middle Stone Age

- SAASTA South African Agency for Science and Technology Advancement
- SAASTEC Southern African Association of Science and Technology Centres
- SAHRA South African Heritage Resource Agency
- SLA Service Level Agreement
- SARIR DST South African Research Infrastructure Roadmap
- SAMA South African Museums Association
- SapienCE Norway Centre of Excellence in Modern Human Behaviour
- UCT University of Cape Town
- Wits University of the Witwatersrand

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1 INTRODUCTION

The Centre of Excellence in Palaeosciences (CoE-Pal), established in May 2013, is a global hub for the study of the origins of species, using cutting-edge research techniques to understand South Africa's unique and time extensive fossil and archaeological record. The Centre adopts a multiand inter-disciplinary approach to research incorporating the disciplines of palaeontology, palaeo-anthropology, palaeobotany, molecular biology, genetics, geosciences, archaeology, geography, biology, ecology, and climatology to interpret our unique South African Fossil Heritage. Substantial effort is invested in establishing an environment in which the creativity of researchers, postdoctoral fellows, and postgraduate students are strongly encouraged in achieving the research aims and directions of the CoE for Palaeosciences. This is achieved by providing the necessary infrastructure and funding, as well as having a research culture which encourages dialogue and collaboration. Workshops are organised to inform members of the research undertaken by the Centre and to assist staff and students in writing "winning" funding proposals.

The CoE-Pal operates across six partner institutions: University of the Witwatersrand (Host); University of Cape Town (UCT); Iziko Museums, Cape Town; National Museum, Bloemfontein, Albany Museum, Grahamstown; and Ditsong Museum, Pretoria. Our Centre is the only CoE to have natural history museums as partners. The Centre continues to expand its already extensive and international network of collaborators. These collaborations not only provide an additional stream of funding, but they also enable access to equipment and expertise not available in the country to South African students and researchers. They thus enhance the quality and scope of research projects the Centre undertakes, and also provide a superior training experience to the students. This collaboration extends to the European Synchrotron Radiation Facility at Grenoble in France where the CoE-Pal has a very active and productive collaboration. In addition to seed funding supplied by the Centre, members continue to leverage additional funding from several different sources, including industry, to enable completion of their research projects.

To address the research aspirations of the South African Strategy for the Palaeosciences of the Department of Science and Technology (DST), and to cover a large percentage of the palaeoscience record reflected in the South African stratigraphic record is a considerable challenge for the Centre within its budget constraints. To achieve its mandate, the Centre undertakes a diverse range of research projects including the origin of life and multicellularity, invertebrate palaeobiology, palynology, and palaeobotany of various ages, taxonomy and palaeobiogeography of fishes, amphibians, parareptiles, therapsids and dinosaurs, origins of mammals and hominins. Additional projects include, but not limited to, hominin morphology and behaviour, the earliest tools of hominins, the emergence of behavioural complexity, faunal analysis, and taphonomy. Additionally, palaeontology is applied in groundbreaking broader multidisciplinary studies to understand climate and biodiversity change, stratigraphy and basin development studies. The CoE-Pal is proud of the productivity and quality of our members reflected in a large number of researchers who have National Research Foundation (NRF) ratings (Table 1); these include 5 A; 7 B, 9 C and 1 P rated researchers.

The DST South African Strategy for the Palaeosciences recognises the scarcity of well-trained human capacity as the most severe threat facing the discipline of palaeosciences. To address this issue, over the past five years, the Centre has funded and trained palaeoscience expertise at various levels, including school learners, technicians, collections curators, palaeo-tourism guides as well as undergraduate students, postgraduate students, and postdoctoral fellows. Details of these ambitious programmes and its achievements are presented in Section 5.

Title	Surname	First name	NRF Rating	Role in CoE-Pal	Institution
Prof	Ackermann	Rebecca	B2	Principal Investigator	UCT
Dr	Avery	Margaret	В	Principal Investigator	Iziko Museum
Dr	Badenhorst	Shaw	С	Principal Investigator	Wits
Prof	Bamford	Marion	B2	Principal Investigator	Wits
Dr	Benoit	Julien	applied 2018	Principal Investigator	Wits
Prof	Berger	Lee	B1	Principal Investigator	Wits
Dr	Bordy	Emese	C2	Principal Investigator	UCT
Dr	Botha-Brink	Jennifer	B3	Principal Investigator	National Museum
Dr	Brink	James	С	Principal Investigator	National Museum
Prof	Chinsamy-Turan	Anusuya	A2	Principal Investigator	UCT
Prof	Choiniere	Jonah	Р	Principal Investigator	Wits
Prof	Clarke	Ronald	not rated	Principal Investigator	Wits
Dr	de la Penya	Paloma	applied 2018	Principal Investigator	Wits
Dr	Durand	Pierre	C1	Principal Investigator	Wits
Dr	Elliot	Marina	not rated	Principal Investigator	Wits
Dr	Fitchett	Jennifer	applied 2018	Principal Investigator	Wits
Dr	Gess	Robert	Not rated	Principal Investigator	Albany Museum
Dr	Govender	Romala	not rated	Principal Investigator	Iziko Museum
Prof	Grab	Stefan	В3	Principal Investigator	Wits
Prof	Henshilwood	Christopher	A2	Principal Investigator	Wits
Mr	Jakata	Kudakwashe	not rated	Scan Manager	Wits
Dr	Jinnah	Zubair	not rated	Principal Investigator	Wits
Mr	Jirah	Sifelani	not rated	Collection Manager	Wits
Dr	Matthews	Thalassa	C2	Principal Investigator	Iziko Museum
Dr	МсКау	lan	not rated	Principal Investigator	Wits
Dr	Prevec	Rose	not rated	Principal Investigator	Albany Museum
Dr	Reynard	Tamaryn	not rated	Principal Investigator	Wits
Dr	Reynard	Jerome	not rated	Principal Investigator	Wits
Dr	Rossouw	Lloyd	not rated	Principal Investigator	National Museum
Prof	Rubidge	Bruce	A2	Director	Wits
Prof	Sealy	Judith	B1	Principal Investigator	UCT
Dr	Sithaldeen	Riashna	not rated	Principal Investigator	UCT

Table 1. Researcher associated with the CoE-Pal.

Prof	Smith	Roger	A2	Principal Investigator	UCT
Dr	Steininger	Christine	not rated	Manager	Wits
Dr	Stratford	Dominic	C2	Principal Investigator	Wits
Dr	Stynder	Deano	C1	Principal Investigator	UCT
Dr	Tawane	Mirriam	not rated	Principal Investigator	Ditsong Museum
Dr	Taylor	Wendy	not rated	Principal Investigator	UCT
Prof	Wadley	Lyn	A1	Principal Investigator	Wits
Dr	Wilkins	Jayne	not rated	Principal Investigator	UCT
Prof	Wurz	Sarah	C2	Principal Investigator	Wits
Dr	Zipfel	Bernhard	C2	Principal Investigator	Wits

Knowledge brokerage and service rendering are an essential aspect of the CoE-Pal output. Almost all CoE-Pal researchers and students participate in science communication or public awareness as this is a requirement of all our members. The Centre supports the salary of a Palaeoscience Outreach Officer, who in turn raises additional funding to employ an assistant and to run outreach activities, with the result that the Centre is very active in public awareness and educational outreach. As social media is a robust platform for science communication the Centre hires, on a contractual basis, a Science Communication Officer who has experience in the field of palaeosciences.

Apart from supervising more than 30 MSc and PhD students, members of the CoE-Pal also teach in undergraduate and honours programmes in the archaeology, geosciences, and biological science curricula of Rhodes University, University of Cape Town, and the University of the Witwatersrand. In collaboration with partners, and the NRF African Origins Platform, the CoE-Pal assists in the maintenance and expansion of important palaeontological and archaeological museum collections and world-class palaeoscience research facilities. It is essential to keep updating these to ensure that the CoE-Pal Partner Institutions continue to be at the cutting-edge in the use and application of state of the art technology for palaeoscience research.

The Centre recognises the uniqueness and importance of the southern African fossil heritage and its significance to South Africa and the rest of the world. To this end, the Centre is committed to the objectives outlined in the *DST South African Strategy for the Palaeosciences*. To ensure that momentum which has been built up by the actions of the Centre to fulfil this mandate, we are strategising for the successful movement of the CoE in Palaeoscience to a National Institute or Facility for Palaeosciences at the end of the next five-year cycle in 2022.

2 STRATEGIC CONTEXT

The National Research and Development Strategy (NRDS) has identified some knowledge fields in which South Africa should aim at achieving international research excellence because of our geographical position and natural or cultural heritage. The Palaeosciences (collectively including Palaeontology, Palaeo-anthropology, Palaeobotany, Middle Stone Age Archaeology and related disciplines) are areas in which South Africa has a geographical advantage, owing to the quantity and diversity of finds within our national borders.

The *DST South African Strategy for the Palaeosciences* document addresses five goals which recognise the need for a holistic approach to the development of palaeosciences:

- 1. Transform the minds of South Africans to instil a sense of pride and provide the intellectual content to their African heritage
- 2. Support the country's universities to produce a critical mass of palaeoscience researchers with a range of research, technical, curatorial, public engagement and managerial skills
- 3. Enhance the capacity of museums to curate, conduct and support research in palaeosciences
- 4. Ensure that South Africa's palaeoscience heritage is well managed and used for the benefit of current and future generations
- 5. Make South Africa the destination of choice for palaeo-tourism

The establishment of a DST-NRF funded Centre of Excellence in Palaeosciences has been one and by far the most productive way to realise the goals of this strategy.

Alignment with National strategies: The South African National Research and Development Strategy (2002) prioritises areas of research that are potentially world-class and could contribute towards 'leading-edge global knowledge'. The DST's Ten-Year Innovation Plan (2008) agrees with this analysis and identifies palaeontology as being one of South Africa's Key Science Missions, in which it is possible to "exploit South Africa's 'living laboratories' of local resources and geographic advantage".

Alignment with Institutional strategies: Wits University, as host of the CoE-Pal, has a distinguished eight-decade history of research in the palaeosciences and generates a remarkable quality of work acknowledged widely by peers and other users as being of critical value. Palaeosciences are integral to the focus areas identified in the *University Research Strategy*.

3 ORGANISATIONAL CONTEXT

The distinctive character of the Centre includes its value system of visibly committed academics and students and a socially engaged and independent-minded institution. These values are in the Wits policies and procedures, ethical governance outlined in the *King III Report*, and the *Singapore Statement on Research Integrity*. To effectively manage and govern, we follow the guidance embedded in the *Handbook to assist with the Operation of a DST-NRF Centre of Excellence* (2015), the *Framework for the Establishment of DST-NRF Centres of Excellence* (version 3.0, 2015).

3.1 Management

The Director of the CoE-Pal, Professor Bruce Rubidge, is an NRF A2-rated scientist with high international standing. He leads multiple projects within the Karoo sedimentary Basin and has given keynote talks all over the world. He has supervised 36 postgraduate students, produced 160 peer-review papers some in top journals such as Nature and Science, and several books.

The management of the Centre provides a functional framework within which we operate. It is concerned with organising people, financial resources and procedures so that research, education, and outreach can prosper (Table 2). It proposes strategic direction and action while retaining the flexibility to accommodate unforeseen circumstances as they arise.

Table 2. CoE-Pal Management Team.

CoE-Pal Management	Name
Director	Prof Bruce Rubidge
Manager	Dr Christine Steininger
Financial Officer: Grants	Ms Tandi Scott-Turner
Education Outreach Officer	Dr Ian McKay
Science Communication Officer	Ms Kimberleigh Tommy

3.2 Executive Committee

CoE-Pal Executive Committee members are selected and based at partner institutions. Membership of the Committee is representative of the Themes of Research Focus (Section 5.1), and they advise the Director on the running of the Centre and are responsible for allocation of finances for human capital development and research activities (Table 3).

Table 3. CoE-Pal Executive Committee.

Executive Committee Position 2013-2017	Name	Based at	NRF Rating
Director	Prof Bruce Rubidge	Wits	A2
Theme Leader: Evolutionary Process	Dr Jennifer Botha-Brink	National Museum	В3
¹ Theme Leader: Cultural & Behavioural Evolution	Prof Christopher Henshilwood	Wits	A2
Theme Leader: Palaeo-environments & Palaeoclimates	Prof Marion Bamford	Wits	В2
Theme Leader: Applications & Innovations	Prof Judith Sealy	UCT	B1
² Theme Leader: Palaeosciences & its Publics	Prof Roger Smith	lziko Museum	A2
³ Member	Prof Lee Berger	Wits	B1
Project Manager	Dr Christine Steininger	Wits	not rated

New members for 2018-2020:

¹Prof Sarah Wurz replaces Prof Christopher Henshilwood

²Dr Thalassa Matthews replaces Prof Roger Smith ³Dr Mirriam Tawane replaces Prof Lee Berger

3.3 Steering Committee

The activities of the Centre are guided and directed by the Steering Committee who give strategic direction and are responsible for high-level control of the CoE-Pal (Table 4).

Table 4. CoE-Pal Steering Committee.

Steering Committee 2013-2017	Positions	Based at
Prof Zeblon Vilakazi	Chairperson	Wits
Prof Bruce Rubidge	Director	Wits
Dr Makobestsa Khati	Executive Director: CoEs & SARCHI	NRF
Dr Gilbert Siko	Director: Science Platforms	DST
Prof Marion Bamford	ESI Director	Wits
Dr Johann Neveling	Member	Council of Geosciences
Mr Rick Nuttall	Partner Representative	National Museum, Bloemfontein

¹ New member added to the committee 2018-2020: Professor Christopher Henshilwood, Executive Director of a Centre of Excellence in Modern Humans (SapienCE) and holds an NRF SARCHI.

3.4 Institutional commitment

While the University of the Witwatersrand hosts the Centre, the Centre is dependent on its partner institutions for productivity about the goals of research programmes, human development, and outreach initiatives.

The CoE in Palaeosciences is closely allied with the Evolutionary Studies Institute (ESI) at Wits, the largest palaeoscience research entity in South Africa. The ESI has world-class palaeontological research facilities and is thus an ideal hub for the CoE in Palaeosciences. Wits have invested millions of Rands in building up, maintaining, curating and developing sophisticated practices of fossil curatorship of one of the world's most extensive and anthropologically most significant fossil and artefact collections that focuses on the evolution of life on Earth and the evolution of humankind in the southern hemisphere. The collections are used extensively for teaching, public outreach, and research programmes, and are particularly noted for their early therapsid 'mammal-like' reptiles and dinosaurs from the Karoo, the largest palaeobotany herbarium in the southern hemisphere, and an extensive assemblage of fossils (including hominins) and artefacts from the Cradle of Humankind (CoH) and other palaeoanthropological and archaeological sites. These collections are used on an ongoing basis for research by both local and international scholars. In addition Wits is the owner of two major fossil hominid-bearing sites (Swartkrans and Sterkfontein), holds artefact collections from most sites in the Cradle of Humankind, was closely linked with the development of the latter's World Heritage status, and is a full partner with the Gauteng Provincial Government in the management of the Cradle.

The Centre, while being housed in the building of the ESI at the University of the Witwatersrand, operates across South and even southern Africa, and is active in promoting the palaeoscience programmes of our partner institutions. The ESI has sophisticated research facilities that support the palaeosciences and houses palaeontological and palaeoanthropological collections, staff offices, laboratories and working spaces, a preparation laboratory, casting rooms, a palaeontology museum with an active outreach programme, exceptional scanning, image

processing and GIS facilities and extensive interactive databases. The Micro CT scanner and Virtual Image Processing Laboratory at Wits, which is supported by CoE-Pal, provides the country with a significant advantage in a wide range of palaeosciences related disciplines and other ancillary studies.

The enduring commitment of the Centre to intellectual excellence and public engagement is embraced through the following values: independent enquiry and trust, intellectual excellence and integrity, debate and critical engagement, and academic freedom. The success of all phases of the development of the CoE-Pal depends on relationships between the partner institutions, collaborating with individuals and institutions in South Africa and internationally.

The structure of the Centre is intended to accomplish the following conditions:

- Establish a single organisational identity with latitude for independent, focused research, curation and outreach projects.
- Provide flexibility to allow growth and shifts in disciplinary emphasis.
- Retain the strengths, structures and reputations of the existing projects.
- Provide rigorous financial controls and governance.
- Offer the framework for multi-disciplinary and interdisciplinary interaction.
- Minimise bureaucracy while maintaining clear lines of responsibility and accountability.

4 **RESOURCE ALLOCATION**

The CoE-Pal and its members have received substantial funding through its duration, ranging from DST-NRF Centres of Excellence Grant to various grants and donations awarded to the Centre's members (Table 5). The Centre provides seed funding to its members to enable them to undertake research, but they are expected to use this funding to leverage additional research funding.

A significant portion of the DST-NRF Centres of Excellence grant to the CoE-Pal goes towards bursaries to postgraduate students from Honours to Doctoral, Postdoctoral Fellowships, and Operational Support grants (research, conferences/workshops, programmes, and outreach). As agreed upon, the award provides funds for core staff: Director, Manager, Financial Officer, Collection Manager, Scan Manager, Education Outreach Officer, a temporary science communication officer and six technical support staff. The CoE-Pal Host institution, the University of the Witwatersrand, provides their 10% contribution to the CoE-Pal towards the salaries of academic staff for the Evolutionary Studies Institute. This contribution is accepted to be the host university's contribution and is not reflected here.

Funding source	Total
DST-NRF Centres of Excellence	R 45 256 313
Millennium Trust	R 680 000
Palaeontologial Scientific Trust	R 1 976 624
NRF rated scientist	R 500 000
DST-NRF African Origin Platform	R 4 375 000

Table 5. Total CoE-Pal funding generated 2013-2017.

Wits Incentive Funding	R 255 800
TOTAL (R)	R 63 043 737

4.1 Millennium Trust

In 2017, the Centre received three years of funding from the Millennium Trust to support the *Origin* of Land Ecosystems – The South African Story Project (Table 6). The project supports the salary of Dr Robert Gess who is employed by the Albany Museum and is making groundbreaking discoveries of plant, early fish and basal tetrapod fauna from the Devonian aged Witteberg Group. Several of his findings have been, and continue to publish in the prestigious journals of Nature and Science. The rest of the funds are used to develop and hire technical staff to curate the extensive and expanding the Devonian collection.

Table 6. Millennium Trust funding to CoE-Pal, 2017-2019.

Description	2017	2018	2019	Total
TOTAL (R)	680 000	714 000	749 000	2 143 000

4.2 SapienCE

The CoE-Pal developed a close collaboration with the Professor Christopher Henshilwood, Director of Norwegian Centre of Excellence in Modern Human Behaviour (SapienCE) at the University of Bergen and Professor at the ESI. Over the next ten years, SapienCE will provide the CoE-Pal R16 977 847 towards personnel, research, and excavations conducted at Blombos Cave, Klipdrift Cave and Klasies River Cave (Table 7). These series of caves have yielded significant Middle Stone Age archaeological finds that have pushed back the dates of novel human innovations such as art, ornamentation, production of tools, and hunting strategies.

Table 7. SapienCE (Norway) funding allocated to the CoE-Pal, 2018 – 2027.

Description	2018	2019	2020	2021	2022	
Personnel	275 864	285 170	293 726	302 537	311 613	
Operating expenses	784 136	780 830	799 274	832 463	856 387	
Total (NOK)	1 060 000	1 066 000	1 093 000	1 135 000	1 168 000	
TOTAL (R)	1 802 000	1 812 200	1 858 100	1 929 500	1 985 600	
	2023	2024	2025	2026	2027	Total
	320 961	330 590	340 508	350 723	391 246	3 202 938
	875 039	905 410	950 492	-	-	6 784 031
	1 196 000	1 236 000	1 291 000	350 723	391 246	9 986 969
TOTAL (R)	2 033 200	2 101 200	2 194 700	596 229	665 118	16 977 847

5 PERFORMANCE PER KEY PERFORMANCE AREAS

5.1 Research/knowledge production

The diverse projects undertaken by the CoE-Pal include research involving the earliest tools of hominins, the emergence of behavioural complexity and material culture, faunal analysis, bone taphonomy, taxonomy and and palaeobiogeography of therapsids dinosaurs. Palaeobotanical work includes the description of fossil pollen of varying ages, Palaeozoic and Mesozoic woods, and palaeobotany of fossil hominin sites in East Africa. The above are traditional areas of South African palaeoscience research strength, but to broaden its scope, the Centre has also funded additional areas in which South Africa has essential fossil resources, e.g. Late-Precambrian origins of metazoan life, Ordovician-Carboniferous invertebrate and fish diversification. Palaeontology is also used in broader multidisciplinary studies to understand climate and biodiversity change, stratigraphy and basin development studies.



Due to the diverse nature of research in Palaeoscience, this Key Performance Area is managed under the following themes:

- 1. *Evolutionary Processes:* This theme includes increasing knowledge of southern African palaeobiodiversity; study the timing of evolutionary events in major clades and significant climatic events; characterise the global geographic distribution of fossil taxa; investigate the nature of functional morphology and critical innovations in morphological evolution.
- 2. *Cultural and Behavioural Evolution: Material Culture and Behaviour:* This theme aims to explain key long-term transitions in hominid behaviour and how they led to modern human behaviour.
- 3. *Palaeo-environments and Palaeoclimates:* Earth systems change dynamically, and when stretched beyond certain thresholds lead to changes (and potentially collapses) in ecosystems and biodiversity. This theme will uncover variability in the resilience of past ecosystems to fluxes through space and time.
- 4. Applications and Innovations: This theme focuses on applying technologies to maximise the use of heritage objects through expanded efforts to discover, conserve, augment, and study them. Of vital importance is pursuing new, innovative means of information extraction and analysis.
- 5. Palaeosciences and its Publics: To redefine the ways in which we communicate the palaeosciences and reassociate the palaeosciences with a sense of value and prestige in the minds of South African public, there is a need to acknowledge, understand and be



attentive to the different sectors of society and their attitudes towards and understanding of the deep past. South Africa's unique combination of a rich palaeontological,

palaeoanthropological, and archaeological heritage, together with research excellence and experience in the field, positions this country to take the lead in international research in palaeosciences. The enabling research environment created by the CoE-Pal builds on opportunities provided by the temporally diverse southern African record and will develop new research linkages and collaborations, enabling us to attain far higher levels of research accomplishment.

The above themes pertain to areas where the palaeoscience record of South Africa gives us a geographic advantage, particularly about the Cape and Karoo Supergroups, the Tertiary and Quaternary fossil record including the cultural and behavioural evolution of *Australopithecus* and *Homo* and the development of Oldowan, Acheulean, and Middle Stone Age industries. Also of significance is research into establishing effective mechanisms of knowledge brokerage and information dissemination about the palaeosciences, particularly in a South African context. In addition to these "traditional" areas of research of the South African palaeorecord, the Centre has encouraged exploration into the origins of life and multicellularity (including investigation of the Precambrian Nama and Vanrynsdorp Groups) and has inspired a strong focus on the Devonian biodiversity of the Cape Supergroup.

This review provides only an outline of the research undertaken by members of the CoE in Palaeosciences, details are provided in the annual reports, and in Appendix 1 - Key Performance Area Targets and Achievements. It is gratifying to see the significant increase in research productivity in peer-reviewed research outputs from 14 book chapters, 65 papers in 2013 to 19 book chapters, 140 articles in 2016 as the Centre has become established (Figure 1). Many of the papers published are in high impact journals for palaeosciences (impact factor \geq 3). Also, many of our grantees attend both local and international conferences, giving them the opportunity to showcase their research to the broader palaeocommunity and to interact and build collaborations (Figure 2).





5.1.1 Conferences, Workshops, and Courses the CoE-Pal as supported

The Centre has supported some local and international conferences held in South Africa. Also, we support workshops that develop skills in areas that South Africa has an advantage in by utilising techniques as stable light isotope mass spectrometry and microfocus scanning in research.

Conferences:

- 2016, Biannual Meeting of the Palaeontological Society of Southern Africa (PSSA)
- 2016, 35th International Geological Congress (IGC)
- 2017, 2nd International Conference of Continental Ichnology (ICCI)
- 2017, 3rd National Imaging with Radiation Conference (IMGRADS)
- 2018, The First African Conference of Experimental Archaeology (ACE)

Workshops:

- 2017, Stable Light Isotope Mass spectrometry Workshop
- 2017, FEI Avizo training workshop for researchers using computed tomography data

5.2 Education and training

The CoE-Pal, via our partner universities and museum institutions, continue the aim of the Centre to achieve an unrivalled position in South Africa in the research training of postgraduate students in its focus. Many different approaches have and are being used to build capacity and competence to meet the needs of Academia, Museums, Tourism Industry, Environmental Impact Assessment, Government, as well as the students themselves.

Education and training form a central component of the CoE in Palaeosciences. Our funding supports postgraduate students from Honours to Doctoral level through bursaries. Also, we support Postdoctoral Fellows and research. The last five years have seen an increase in the number of female

and black postgraduate students (Figure 3). We are confident that through our transformation strategies (discussed below and in Section 6) that we are transforming the landscape of palaeoscience to be more diverse and inclusive.



5.2.1 Student and scholar training

Recognising the urgent need to be transformative in palaeosciences in South Africa, we support postgraduate students and develop programmes that improve equity and diversity in our science community. Our goal is to attract postgraduate students who represent South Africa's diversity. However many undergraduate students do not choose careers in palaeosciences because they did not view palaeosciences as a path to a permanent position because of the paucity of positions in South Africa and the lack of representation in those positions. To address this, the CoE in Palaeosciences supports the Undergraduate Accelerator Programme developed by one of our grantees, Prof Jonah Choiniere with the support of his postdoctoral fellows and postgraduate students. The programme identifies high performing undergraduate black females in their 2nd year of study. The students join a supplementary academic programme for six hours per week for 14 weeks, where they learn transferable skills such as GIS data collection and analysis, palaeosciences legislation, three-dimensional data collection and analysis (e.g., CT-scanning), and palaeontological fieldwork methods. The students collect and analyse data as part of a larger palaeontological study which will lead to publication in peer-reviewed journals. During their last field trip, the students made a scientifically significant discovery of dinosaur eggs in the Elliot Formation near Clarens in the Free State Province. Currently, this programme has been initiated only at the Evolutionary Studies

Institute at the University of the Witwatersrand. In the future, the Centre hopes to inspire other universities and museums to develop more programmes of this nature.



The CoE-Pal, through our Education Outreach Officer, engages with the Department of National Education to develop curriculum-based palaeosciences and evolution courses for school learners at both junior and senior school level, as well as for tourism guides. These courses are presented

annually at numerous venues in South Africa. Our Education Officer has worked hard to engage with the education departments of our partner museums to increase the reach of the programmes on offer, which in turn enhances national pride in the remarkable palaeoscience record of South Africa.

The CoE-Pal is proud of the grantees we support for their academic excellence and for the number of public awareness programmes and science communication initiatives they have implemented (see section 5.3).



5.2.2 Museums

In the last five years, the Centre has been increasing awareness of and troubled by the relatively low research output of our museum partners and the lack of interest of museum management in understanding the significance of research to their collections and for the development of relevant exhibits which will attract public attention. To this end, the Centre initiated a three-year postdoctoral fellowship with an additional research grant to exceptional researchers to help to boost research productivity within our South African Natural History Museums.

5.2.3 Mentors

Many of our grantees are researchers in diverse fields within palaeosciences. Not only are they intellectual leaders in their respective research fields, but also provide an encouraging and supportive environment with strong mentorship. We have developed three mentorship programmes

designed to assist postgraduate students and emerging researchers in achieving their career goals:

- 1. Career Mentorship advice on careers with palaeosciences degrees
- 2. Peer to Peer Mentorship students supporting each other
- Mentorship to Publication development doctoral to produce manuscripts through to publication with a mentor assisting throughout the process. Through this programme, we strongly encourage supervisors to publish with their students.

Enhanced education and training continue to achieve in a variety of ways:

- 1. Seminar series are presented by visiting scientists and students under the auspices of the CoE-Pal. This worthwhile exercise will be expanded.
- 2. CoE-Pal Members present courses at undergraduate level and supervise postgraduate research.
- 3. The CoE-Pal provides support to grantees to attend both local and international conferences, allowing them the opportunity of presenting their work and interacting with leaders in their

respective fields. A goal of the CoE-Pal is that all students should be able to attend at least one international conference during their studies.

- 4. To further develop skill sets needed in an academic field, we developed a grant writing workshop and a present how-to seminar at a conference or to a potential donor.
- 5. As appropriate, postgraduate students have been supported to conduct research in overseas laboratories with international collaborators for short periods of time. This has very beneficial outcomes, not only for the work undertaken but also good contacts for the students.
- 6. The CoE-Pal has and will continue to, play a significant role in developing a new cohort of leaders in the field. Special effort is made to address historical imbalances. The Centre,

through various initiatives, makes substantial efforts to attract and retain black South African postgraduate students, as well as female postgraduate students (see Figure 3).

 Research in palaeoscience can be expensive depending on the amount of field or lab work required. Our Centre encourages students and researchers to leverage their CoE-Pal funding to look for other potential funders. On a weekly



basis, our Centre sends notices from other potential funders to members of the CoE-Pal.

5.2.4 Technical staff and tourism guides

A significant outcome of the programme is human capital development at different levels (semiskilled to professional), and the creation of expertise and careers in newly developed areas of the knowledge economy such as palaeo-tourism, virtual imagery, data management, and GIS. Fossil preparation and casting offer job opportunities to skilled technicians. Through our Partners, fossil preparators and casters are given in-house training in these critical skills, which is equated to the highest international standards. All of our Partners employ technicians to assist with excavations, preparation and lab work. Through our Education Outreach Officer, the Centre has been actively involved in the ongoing training of tour guides for the CoH and Nieu Bethesda heritage sites.

A feature of the CoE-Pal is the excellent degree of collaboration between members of the Centre from different South African institutions (museums and universities) as well as the strong international presence and collaborations with researchers from around the world. Many of the discoveries made and research conducted were with the assistance of skilled technical support. However, we realised that skill sets across Africa were not the same. In 2015 the Centre, in collaboration with the National Museums of Kenya, successfully ran a *Pan African Palaeosciences Knowledge Exchange Workshop* in Kenya. The talks and demonstrations were given by the technical staff from South Africa, Kenya, Tanzania and Uganda. Workshops included Micro CT scanning, curation management of fossils and large data sets, preparation techniques of fossils, casting of fossil specimens for research and the classroom, new equipment used in the field (drones, EDMs, photo imaging), and outreach initiatives. Due to the positive discussions during the workshop, the CoE-Pal and the National Museums of Kenya will be hosting the 2nd Pan African Exchange Workshop in September 2018 at the University of the Witwatersrand. This year we are opening the workshop to more Southern African countries that have palaeontological collections. Also, because we know

that many countries have tourism associated with their discoveries, we will be including a workshop on tourism.

5.2.4.1 Unsung Heroes

In July 2018 at the biennial conference of the Palaeontological Society of South Africa (PSSA), the Centre, in association with all our partners, will be highlighting the contributions made by the technical staff member that has made significant contributions to the field of palaeosciences. Each university and museum will select a technical staff member as their Unsung Hero.

5.3 Information brokerage

5.3.1 Research

The CoE-Pal makes a special effort to communicate the results of its research to the broader public. This is achieved in numerous ways: scientific publication in prestigious journals; use of media outlets including the popular press, television, and social media and the internet to make our research accessible to the general public; running of regular focused workshops and forums for specialists and the general public; use of outreach programmes to ensure that South African students appreciate the country's biological and palaeontological heritage; and developing openaccess databases that contain the collective palaeo-bioinformatic results of our work. The widespread popular appeal of visual representations of heritage objects (e.g., 3D renderings of fossils) means that the media is a crucial element of information brokerage. The information gained is disseminated for public awareness through the CoE-Pal website, other social media outlets, science communication, workshops and by participation in scientific conferences.

The CoE-Pal engages in knowledge brokerage in some ways:

- 1. The CoE-Pal environment is conducive to knowledge generation and transfer by interactions. This is promoted by meetings, conferences, workshops, colloquia and working together on collaborative projects.
- 2. CoE-Pal publications, including research papers in international and local journals, books and conference proceedings all form essential vehicles for knowledge brokerage.
- 3. The CoE-Pal encourages palaeoscience consulting and participation of our members in Heritage Impact Assessments.
- 4. Courses are presented to undergraduate and postgraduate students at South African Institutes and Universities.
- 5. Members visit international institutions for research and attend conferences, and in the process, promote the work done by the CoE-Pal.
- 6. Members of the Centre produce popular articles, media and social media outputs relating to new research findings.
- 7. Members in the CoE-Pal play significant roles in the organisation of both local and international conferences and workshops, as well as giving presentations (both oral and posters) with the CoE-Pal logo prominently displayed, and acknowledgements given to our sponsors.
- 8. A CoE-Pal website has been set up and is currently undergoing revamp for our 5th Anniversary celebration. The website and our other social media platforms have and will continue to highlight the research undertaken by our members. All our grant applications are on the site for members and new members to access.

5.3.2 Science Engagement

Community outreach and science engagement is an important function of CoE-Pal, and our programme has expanded every year. In 2017 our palaeoscience outreach programme reached more than 400 000 learners, teachers and members of the public (Figure 4). The emphasis of the programme is on making contact with members of the public, school learners and teachers because it is felt that although more and more South Africans are becoming connected to the internet, most still need to be physically exposed to palaeontology before they are likely to go and look for it online. We have expanded our digital footprint using web pages (www.ancient-earth.co.za), Facebook (https://www.facebook.com/coepal/), Twitter (@CoE_Palaeo), Instagram (@CoE-Palaeo) and YouTube. Also, we have a *PalNews Letter* that we support bi-annually. Apart from the outreach programme run by Dr Ian McKay most of the CoE-Pal partners and members including students are

committed to this important function, and each has contributed in various creative and productive ways (Figure 5). In media announcements during 2017, the CoE-Pal had an Advertising Value Equivalency (AVE) of R3.7 million. The programme also continues to support the management of the Kitching Fossil Exploration Centre in Nieu-Bethesda as well as to train its guides and has input into the various tourist and outreachrelated activities of the Cradle of Humankind and the West Coast Fossil Park. Our members also assist with and maintain the programmes of the Cradle of Humankind exhibition centres.





Our outreach programme continues to be developed. Interest in the field at school level is nurtured using curriculum-based targeted education outreach programmes run by our partners. This is achieved by:

- 1. Invitations to school pupils and their teachers to visit the Origins Centre at Wits University and participate in our outreach programme.
- 2. Open Days at universities are strongly supported by the CoE-Pal.



- 3. Visits to South African schools and universities highlight research being conducted by our researchers and students. This may ignite interest in pursuing a degree in palaeosciences.
- 4. Development of sustainable palaeo-tourism and heritage ventures is supported and encouraged.

5.3.2.1 Highlights

- Four palaeosciences researchers were identified as South Africa's most visible researchers in a publication by Marina Joubert and Lars Guenther: Professors Bruce Rubidge, Anusuya Chinsamy-Turan, Lee Berger and Francis Thackeray.
- Professor Anusuya Chinsamy-Turan was named on the Legends of South African Science in the Academy of Science of South Africa. Ms Aviwe Matiwane was named emerging postgraduate student.
- At SciFest, our education outreach team won two awards: Best Exhibition (First Place) and Best Workshop Curriculum.
- Over the past year of promoting the importance of science communication, a number of CoE-Pal postgraduate students have participated successfully in national competitions, this includes: Dr Kerryn Warren (Doctoral Grantee) winner of the 3-Minute Thesis competition (SAASTA) and 2017 Runner-up of audio section of the SAASTA Young Communicators Competition 2017; Ms Aviwe



Matiwane (Doctoral Grantee) a finalist in FameLab 2017; Ms Kimberley Chapelle (Doctoral Grantee) winner of the best presentation at the Sixth Symposium on Dinosaur Eggs and Babies 2017; Mr. Silindokuhle Mavuso (Masters Grantee) the winner of the Wits Science Slam 2017; and Ms Kimberleigh Tommy (Masters Grantee) named one of *Science Today* Top 20 Postgraduate Writers for 2017.

- Our Centre, in collaboration with CoE in Strong Materials and CoE in Mathematical and Statistical Sciences hosted a FameLab competition for our postgraduate students. Ms Matiwane, through her achievements, presented her experience at the Centres of Excellence Directors Forum in August 2017. She gave an emotional and inspirational speech about being in the science she loves. Also, she was also invited to Minister Naledi Pandor's Women in Science Day.
- The CoE-Pal sponsored Christa Kuljian book, Darwin's Hunch: Science, Race and the Search for Human Origins. The book discusses the history and current status of research for human origins, and the influence of changing social and political contexts on research and scientists.

The CoE-Pal is very active in the following areas of science engagement:

- 1. In collaboration with the Wits University Media Department, the CoE-Pal makes use of every opportunity to provide the press with information on discoveries and developments to inform and excite the public of South Africa on this important part of our heritage.
- 2. All members of the Centre (scientists and students) are expected to be involved in science engagement activities, and these are reported in their annual progress reports. The types of

activities range from lectures at schools, museums, public venues, talks to civic organisations and academic organisations.

- 3. Because research activities of the Centre involve fieldwork, many scientist and students engage with schools and the public in the rural areas where they work. Some spend a great deal of time educating farmers and farm hands-on how to search for fossils and what to do if they discover fossils. This has paid huge dividends in the past, and many exciting discoveries have been made by interested members of the public, who then inform the scientists.
- 4. The CoE-Pal organises outreach activities aimed mainly at school learners at various venues.
 - Rand Show
 - Grahamstown Foundation (Grahamstown Science Festival)
 - Sci-Bono Science Centre
 - School of Animal, Plant, and Environmental Sciences, Wits University (Yebo Gogga Exhibition)
 - Unizul Science Centre- Zulu Fest Richards Bay
 - SAASTA (South African Agency for Science and Technology Advancement)- National Science Week
 - Gauteng Department of Education
 - Marang Centre, Faculty of Education, University of the Witwatersrand
 - Origins Centre, National Health Laboratory, Genetics Days
 - Origins Centre, Kitching Gallery, combined tours with ESI
 - Centres of Excellence Directors Forum
- 5. Kitching Fossil Exploration Centre (KFEC). This rural palaeo-tourism venture, which offers employment to four members of the local community, is getting ever closer to its goal of financial sustainability. The success of the KFEC may be ascribed to external funding raised on an annual basis, the strong long-term partnership with the Owl House Foundation, and enthusiastic management team which includes the University of the Witwatersrand, the

Albany Museum, and private individuals. The KFEC building, made available through the efforts of a private benefactor, Mr Ross Foxton, is well maintained. This is a model of the type of self-sustaining palaeo-tourism ventures which should be set up in rural parts of the country to enhance palaeo-tourism in the nation.



- 6. Through the efforts of Professor Lee Berger and Dr Bonita de Klerk, the Marapo Stones and Bones casting programme was launched at Sterkfontein and employed more than eight people from the Cradle of Humankind area. Apart from the economic benefits of this innovative programme is also an essential point of outreach for palaeoanthropological education.
- 7. Professor L. Berger's projects host two websites, including the SciMania.org site which reaches school children around the world on topics related to human origins. The *Australopithecus sediba* page has more than 840 friends, and he has more than 1970 followers on Twitter.
- 8. Professor Francis Thackeray and Tandi Scott-Turner, with the assistance of an enthusiastic

organising team, ran a very successful Evolution Day. This event was held in the Wits Great Hall on June 2015 and included a set of lectures on a range of topics relating to evolution. It attracted more than 500 people and served to promote public awareness of South Africa's rich palaeontological and archaeological heritage.

9. In 2018, the Centre hired a temporary Science Communication Officer to revamp the website for our 5th Anniversary and to ignite our social media platforms. As of March 2018, we have over 3000 followers on our Facebook page. Along with some of our Partners, we have initiated a twitter, Instagram, and YouTube page. Also, we are developing content in various indigenous languages to reach more South Africans.

5.4 Networking

Active research collaborations are in place and are expanding as this programme continues. Use of South Africa's large fossil and archaeological collections is enhanced through the development of a shared digital database of CoE-Pal partner institutions which enables long-lasting network and collaboration.

Curatorial efficiency has been increased by the development of a Pan-African curatorial network. We commit to expanding our collaborative horizons to include researchers in education facilities, Southern African Association of Science and Technology Centres (SAASTEC), South African Museums Association (SAMA), South African Agency for Science and Technology Advancement (SAASTA) and South African Heritage Resource Agency (SAHRA).

How networking was achieved:

- 1. Through research collaborations of the members of the CoE-Pal at various institutions in South Africa, beneficial synergies and co-operation are being actively encouraged and planned. It is anticipated that these types of collaborative projects will continue, and new ones initiated.
- 2. A feature of the CoE-Pal is the number of partner institutions, particularly museums that form a valuable formal network of researchers in the palaeosciences. It is the policy of the Centre to involve other Partners as the opportunity arises. The Centre also has an extensive network of collaborations both abroad and locally which is encouraged to expand. Attention is given to supporting researchers on the African continent to engage in collaborative programmes with the CoE-Pal.
 - Efforts in this direction include projects in East Africa such as the Olduvai Landscape and Palaeo-anthropology Project (OLAPP) and the multinational team working at Laetoli, Tanzania.
 - There are currently three separate projects running in Kenya at Koobi Fora, East Turkana Basin, Rusinga and Mfwangano and Lukeino. All the projects include local and international collaborators.

- A new project has been initiated at Mhengere in Mozambique. Other projects include prolific research in Mali, Angola, Zimbabwe, Botswana and Namibia. Links already exist between the CoE-Pal and a range of African museums, universities and institutions, particularly those in Botswana, Egypt, Ethiopia, Kenya, Namibia, Tanzania, Uganda, Zambia, and Zimbabwe.
- The CoE-Pal developed a close collaboration with Professor Christopher Henshilwood, Director of Norwegian Centre of Excellence in Modern Human Behaviour (SapienCE) at the University of Bergen and Professor at the ESI.
- 3. Continued collaborations with palaeoscientists at various institutions around the world are in place [e.g. MIT, University of Washington, SUNY at Stony Brook, Field Museum in Chicago, University of Chicago, Rutgers University, University of Georgia, Colby College, John Hopkins University, University of Milwaukee, University of Minnesota, Oxford University, George Washington University, University of North Carolina, American Museum of Natural History, University of Bergen, Natural History Museum in London, University of Toulouse, CNRS (Paris), Palaeontological Institute in Moscow and Institute of Vertebrate Palaeontology and Palaeo-Anthropology (China)].
- 4. Developing partnerships with Historically Black Universities. In 2018, we formed partnerships with Sol Plaatje University and Sefako Makgatho Health Sciences University to support students registered at those universities.
- 5. Funding permitting, it is intended to increase the number of researchers engaging in shortterm visits to the Centre to enrich our research programmes and broaden the perspectives of our postgraduate students. Researchers are encouraged to use their extra funds as well, be they from the NRF or industry-based. This is in part preparation for the long-term sustainability of the CoE-Pa.
- 6. The attendance of conferences and workshops both locally and abroad and the presentation of papers is encouraged and supported. We are trying to expand this, particularly for postgraduate students, thereby broadening their perspectives and contacts. An increased number of short and long-term visits to institutions abroad will enhance the international research co-operation of the CoE-Pal. Similarly, more researchers based overseas are attracted to collaborate with CoE-Pal members, further improving the opportunity of engaging in high standard research.
- The CoE-Pal website will continue to facilitate the expansion of its interactions locally and abroad. Where possible, other forms of publicity will continue to be employed to enhance the image and prominence of the Centre.
- 8. Wits and other partner institutions already have numerous regional, national, continental and international partnerships and



involvement with established institutions of higher learning with the aim of promoting better diffusion and exploitation of the knowledge produced by tertiary institutions. Our palaeo-anthropologists, palaeontologists, and archaeologists thus actively collaborate with

reputable individuals and groups that add value to this field of knowledge and will continue to negotiate and cement additional partnerships. There is a diversity of skills among those who participate in local and international consortia and who serve on government bodies and management committees. A workshop was run in Nairobi through collaboration with the National Museums of Kenya. The two partners developed a collaborative Pan-African approach to support palaeoanthropological research, training, and public outreach. This workshop brought together technical staff from South Africa, Kenya, Tanzania and Uganda to exchange knowledge on 3D scanning, curation of fossils and large datasets, preparation of fossils, casting techniques, new equipment used in the field (drones, EDMs, photo imaging), and outreach initiatives. We like to continue this workshop in the future. Currently, the CoE-Pal is drawing up a Memorandum of Agreement with interest in formalising collaboration with the National Museums of Kenya and other Africa museums.

5.5 Service Rendering

The Centre has established itself as a source of information to its stakeholders and the broader scientific community using a variety of approaches. Our members know the importance of Academic Service to their institutions and the broader community from editorships to policymakers.

- 1. The Centre and its members have established a tradition of service to science and technology and the community in a variety of ways. It encompasses a vast range of activities, both locally and internationally.
- 2. The Annual Reports provides a detailed account of the current service rendering achievements, and every effort is made to increase these activities.
- 3. The CoE-Pal provides input in many ways: serving as editors, on committees, undertaking reviews, board memberships, and input on policies.

6 TRANSFORMATION

Every effort is made to ensure that the students are representative of the demographics of South Africa. Already in the short existence of the Centre, the number of students from designated groups has dramatically increased. While the CoE-Pal has limited input in staff recruitment in a previously white male-dominated field, significant advances have been made in the employment of research staff from designated groups at all our partner institutions. Vigorous efforts will continue to be made to address race and gender imbalances. This is being done by:

- 1. Collaborating with other funding bodies and industry (e.g. Palaeontological Scientific Trust) to increase bursaries amounts for black female postgraduate students.
- 2. Encourage our academic staff in research positions to lecture undergraduate courses. Many students are shown a path to a career in palaeosciences from some of our dynamic researchers who have taught courses in biology, geology, climatology, botany, geography, and anatomy.
- 3. Assist our academic staff in finding additional sources of funding for students interested in Palaeosciences.
- 4. To provide talks to universities across South Africa.
- 5. Continue with our extensive public engagement and science communication activities.

7 SUSTAINABILITY STRATEGY

In a time of global change, South Africa faces significant challenges in respect of its climate and resources, but there is uncertainty, mainly because it is difficult to predict the future. The Palaeosciences is the only discipline which offers the opportunity to look back in time to study the interaction between past biodiversity and environmental change. The extensive geological and palaeontological record of South Africa offers unique opportunities to understand the effects of at least four of the significant five global mass extinctions.

The South African National Research and Development Strategy (NRDS) and South African Research Infrastructure Roadmap (SARIR) have identified the palaeosciences as a discipline where this country has a geographic advantage because of its natural palaeoscience resources, internationally significant collections, relatively good scientific infrastructure which has made this country an international leader in the field. The establishment of the CoE for Palaeosciences which has built on this infrastructure has dramatically enhanced palaeoscience research productivity, improved research infrastructure, an enhanced human capital development plan that incorporates capacity development at multiple levels including Honours, Masters, Doctoral students, Postdoctoral Fellows, research, support staff and tour guides.

Because of the geographic advantage of the South African natural palaeoscience resources and the tremendous strides in the development of multidisciplinary research and the incorporation of technology made by the CoE in Palaeosciences in its relatively short existence, the palaeoscience is a logical contender for development as a National Facility as the next stage in its development.

8 **RECOMMENDATIONS**

As has been demonstrated in this five-year review document of the CoE in palaeosciences, the Centre has excelled in all its KPAs. It has shown that the geographic advantage offered by the extensive palaeoscience record of South Africa is worthy of a world-class national institute for palaeosciences. It is not possible to write a comprehensive document on the development of life without referring extensively to the South African fossil and archaeological record.

The Centre undertakes a diverse range of research projects including the origin of life and multicellularity, invertebrate palaeobiology, palynology, and palaeobotany of various ages, taxonomy and palaeobiogeography of fishes, amphibians, parareptiles, therapsids and dinosaurs, origins of mammals and hominins. Also, hominin morphology and behaviour, the earliest tools of hominins, the emergence of behavioural complexity, faunal analysis, and bone taphonomy. Additionally, palaeontology is applied in groundbreaking broader multidisciplinary studies to understand climate and biodiversity change, stratigraphy and basin development studies.

Our Centre has an extensive network of collaborators who significantly enhance the quality and scope of research projects the Centre undertakes, and also provides a superior training experience to students. The Centre adopts a multi- and interdisciplinary approach to interpret our unique South African Fossil Heritage. Use of South Africa's large fossil and archaeological collections is enhanced through the development of a shared digital database of CoE-Pal partner institutions which enables long-lasting network/collaboration. Curatorial efficiency has been increased by the development of a Pan-African curatorial network. We commit to expanding our collaborative horizons to include researchers in education facilities, Southern African Association of Science

and Technology Centres (SAASTEC), South African Museums Association (SAMA), South African Agency for Science and Technology Advancement (SAASTA) and South African Heritage Resource Agency (SAHRA).

8.1 Natural History Museums as partners

The future of research at South African Natural History Museums is an important issue which needs to urgently be addressed for the future wellbeing of the Centre of Excellence in Palaeosciences and indeed maintaining the internationally leading profile of South Africa in research relating to the discipline. The Natural History Museums curate the excavated South African palaeoscience record (fossils and artefacts) and were set up to undertake this critical function. In the past, they employed the largest number of palaeoscientists in the country. As a result of the Natural History Museums, which curate palaeoscience collections, were specifically chosen as partners under the CoE-Pal. However, the past five years have witnessed a dramatic decline in palaeoscience research undertaken by the museums, which would have been even more devastating had the CoE-Pal not intervened. Despite this intervention, the administrators of our partner Museums do not seem to have an understanding of the requirements to nurture natural history research in a museum environment.

Research traditionally is undertaken by natural science museums, by utilising and building up their biological reference collections through multidisciplinary research programmes, offer answers to the impact of climate change in any specific country. Apart from research, these collections play a vital role in education. For the public, seeing real objects at proximity has an incredibly powerful effect on people. The power of this authenticity is emphasised in an increasingly virtual world. Up to date, high impact museum exhibits are the products of research undertaken by scientists using the scientific collections curated in the museum. Increasingly around the world, museums are requiring collections curators to have a PhD degree and to conduct research in addition to curation.

A worrying trend in South Africa has been the steady decline in palaeoscience research productivity of all the museums, except the National Museum, over the past 15 years – ever since the establishment of the Flagship museums. This decline in research productivity is linked to the decrease in the number of palaeontologists employed particularly at Iziko and Ditsong Museums. This trend is not only reflected in the palaeontology departments of these museums but all the other natural science departments as well, where there are less senior scientists employed to curate the collections, and this task is being left to technical staff who lack the necessary qualifications and experience. Sadly the number of palaeontological technical staff employed and paid by these museums has also declined, and the position for palaeosciences would be dire if the NRF had not established the African Origins Programme, which has made it possible for museums to employ technical staff.

As the research productivity of the CoE-Pal is dependent on the accessibility of the palaeontological and archaeological collections of these museums, and also the resident and relevant scientific expertise linked to each of these collections, it is important that museums employ scientists who are internationally competitive to maintain and expand these collections by actively researching the palaeoscience record of the country.

A decade ago the NRF launched an audit into the state of Natural Science Museum Collections in the country. To rectify the poor state of many of the collections the NRF provided funding for the curation of museum collections over three years, and the Natural Science Collections Facility (NSCF) was launched as part of the Department of Science & Technology's South African Research

Infrastructure Roadmap (SARIR). The NSCF will support securing collections by improving their storage, digitisation of collections and communication and outreach, and provide some opportunities for enhancing research. The NSCF cannot, however, appoint or employ permanent scientists at these institutions, and the research capacity at museums remains a risk to initiatives like the NSCF and the Centres of Excellence.

A major problem of museums in recent years is the non-competitive salaries which are paid to highly qualified museum scientists. As a result, highly productive scientists are not being attracted to apply for positions at museums. This has had a downward spiral effect with active research staff leaving museums and not being replaced by the best possible people. Another problem is the increasingly bloated administrative capacity of museums, especially the flagship museums, with less funding available for the natural science departments. In many cases, DAC Central administration, inappropriate Councilors and Directors of Natural Science Museums of South Africa have no experience in our understanding of natural science research. Thus they do not understand the opportunities and challenges relating to natural science research and are not in a position to develop research projects, identify possible research collaborations, and so miss out on the opportunity to raise additional research funding through local and international research collaborations. The management and encouragement of Natural History Research require constant nurturing and reassurance by Council and Directorate. Currently, natural science museum researchers are spending so much time complying with bureaucratic legislation and policies that very little work is done. A very recent advert for a Director (CEO) for one of the sizeable natural science museums of the country does not list research as a priority, and the skills and knowledge required for the position do not include research experience or even exposure.

The fact that the major natural science museums of the country do not prioritise research as a critical function creates a significant problem for the CoE-Pal, which is dependent on research productivity for its survival. Currently, the Centre expects each of its member scientists to produce about five research publications per year. All museum staff produce much, much less. This is the result of fewer scientists being employed by the museums, and also low salaries fail to attract highly productive scientists. Furthermore, there are no incentives to produce publications in high ranking international journals, and not much support from management to create an environment that is conducive to research.

It is globally accepted that the greatest crisis facing Earth is the biodiversity crisis, as Earth experiences global warming, climatic change and a massive decline in biodiversity, the so-called 6th extinction. The future of humanity on Earth is dependent on the preservation of biodiversity. The biodiversity of South Africa, and indeed all countries, is curated by science museums where all the type and reference specimens are housed. Accordingly, these collections are essential to undertake audits of biodiversity and global climate change.

Now is the time that the precious collections of the Natural Science Museums reflecting the past and current biodiversity of our country, which have been built up over many decades and even centuries, need to be nurtured and researched, yet it appears that research is no longer a priority of the Natural Science Museums. This appalling state must be addressed and rectified urgently. Possibly a way to begin is to re-assess the appropriateness of the Department of Arts and Culture (DAC) as a governance structure for institutions responsible for scientific research. Additionally, there needs to be engagement with museums to find a way of addressing declining capacity and creating a strong research culture.

8.2 Establishment of a National Institute for Palaeosciences

The previous Minister of Science and Technology, realising the global importance and significance of the South African palaeoscience record and the considerable interest in it manifested by the participation of scientific collaborators from every continent of the world (even Antarctica), suggested that a "Smithsonian type institute" be established for the palaeosciences. The DST, in turn, has recommended that National Institutes be established to ensure the longevity of productivity for successful centres of excellence. Following this review, the CoE-Pal will hopefully be given an additional five years of funding by the DST and NRF. The Centre has demonstrated the national and international interest in southern African palaeosciences, its great scientific productivity, and the ability of the discipline of palaeosciences to capture the imagination of the public and to engage young people in considering science as a career.

Although the Director and staff of the CoE-Pal have been able to raise additional funding for the Centre, this is not an easy task for a discipline such as palaeosciences, which will always be dependent on some level of state funding as has been recognised internationally. In its short, existence the CoE-Pal has demonstrated, with relatively little government financial input, the capacity of the discipline to catapult South Africa to be a major player in the forefront of the international scientific arena and thus the establishment of a multidisciplinary National Institute for the palaeosciences is a logical follow-on to enhance the high level of productivity achieved so far.

The question is to decide whether to establish a single building to house the national institute or to run the institute as a virtual centre, with a hub, much like the current CoE-Pal model. This issue will require the input and debate of the South African palaeoscience community together with the DST and NRF, and the final configuration with depend very much on the future management of natural history museums, the curation of their precious and internationally famous palaeoscience collections, and their capacity to participate as full partners in the productivity of the National Institute.

9. CLOSING REMARKS

This review report details the philosophy and achievements of the CoE-Pal from 2013 to 2017. The Centre and its Partners are looking forward to the next five years as we transition into the CoE-Pal Service Level Agreement, Stage 4 (Performing Stage), with the NRF Centres of Excellence (Appendix 2) and as move towards a strategy for developing a National Facility that further promotes South African Palaeosciences to the highest international ranking.

In summary, the South African fossil and archaeological record is of great international importance to the extent that it is not possible to write a comprehensive report on the development of life on earth without referring extensively to the South African fossil record. The CoE-Pal plays a pivotal role in the palaeoscience output of South Africa, and indeed in Africa, in a wide variety of spheres facilitating research; expansion and custodianship of SA fossil collections; palaeoscience training at various levels (tourism guides, technicians, schools, undergraduate students, postgraduate students, postdoctoral fellows, emerging researchers); science communication and developing sites for palaeotourism. By international standards, it is a leading centre for research and training in the palaeosciences, including international collaboration with some of the world's leading palaeoscientists, and has world-class research facilities which are utilised by palaeoscientists and students from many continents.

It is self-evident that the far-sighted vision of the DST and NRF to establish a Centre of Excellence in Palaeosciences has paid off in many different spheres. It has dramatically enhanced the palaeoscience research output of South Africa and resulted in numerous local and international research collaborations. Also, it has greatly increased the cohort of MSc and PhD graduations and is address the skills shortage of South Africa. The extensive outreach programme of the CoE-Pal has led to much greater science awareness by the public and resulted in more young people considering science as a profession. Now that the foundation has been laid, future phases of the CoE in Palaeosciences will achieve even greater success.

Appendix 1: Key Performance Area Targets and Achievements.

SLA	SLA 1 2013	SLA 1 2014 #	SLA 2 2015 #	SLA 3 2016 #	SLA 3 2017 #
Honours Students	na	6	5	0	8
Masters Students	na	5	13	17	14
Doctoral Students	na	10	11	12	10
Total Postgraduate Students Supported (Masters & Doctoral)	na	15	24	29	24
Female Postgraduate Students (Masters & Doctoral)	na	8	14	22	18
Black Postgraduate Students (Masters & Doctoral)	na	4	5	9	11
Total RSA Postgraduate Students (Masters & Doctoral)	na	19	20	24	23
Total SADC Postgraduate Students (Masters & Doctoral)	na	1	1	0	0
Total Other African Postgraduate Students (Masters & Doctoral)	na	1	1	1	0
Total Foreign Postgraduate Students (Masters & Doctoral)	na	0	2	0	2
Honours Graduation	na	6	4	0	8
Masters Graduations	na	1	0	8	9
Doctoral Graduations	na	0	0	9	4
Average Masters Duration (post Honours) (year/months)	na	0	2	24	26
Average PhD Duration (months)	na	0	3	38.4	45
Postdoctoral Fellows	na	20	21	23	14
Female Postdoctoral Fellows	na	12	15	17	7
Black Postdoctoral Fellows	na	5	3	1	0
Core team members received operational support	15	37	33	31	27
Core team members	25	45	52	53	52
Core team members with NRF Rating	11	13	19	18	25
Number of South African collaborators/partners (associates with	26	16	67	62	46
research projects)	20	40	67	02	40
Number of other African collaborators/partners (associates with research projects)	6	12	10	13	11
Number of other International collaborators/partners (associated on					
research projects)	119	118	390	280	396
Total Collaborators	151	176	467	355	453
Peer-review articles	65	59	93	140	109
Chapters in books	14	14	3	20	7
Books	3	1	0	0	1
Peer-review published abstract	0	0	0	0	2
Total peer-review published articles/books with postgraduate students	7	12	19	17	12
Total peer-review articles with female students	1	5	10	11	6
Total peer-review articles with black students	1	8	3	7	3
Journals with Impact Factor ≥ 3	20	11	12	32	24
Conference abstracts	20	23	65	137	103
International conference (presentation & poster)	19	10	21	76	63
Local conference (presentation & poster)	1	13	44	61	40
Number of joint venture postgraduate student training initiatives	1	1	1	1	2

1	1	1	1	2
1	1	1	1	1
7	21	21	19	15
na	na	na	375,620	495,515
33	85	111	195	331
1	1	1	1	1
na	na	1	1	1
	1 1 7 na 33 1 na	1 1 1 1 7 21 na na 33 85 1 1 na na	1 1 1 1 1 1 7 21 21 na na na 33 85 111 1 1 1 na na 1	1 1 1 1 1 1 1 7 21 21 19 na na na 375,620 33 85 111 195 1 1 1 1 na na 11 195 1 1 1 1 na na 1 1

*na = not applicable for that year.

Appendix 2: CoE-Pal Service Level Agreement, Stage 4 (Performing Stage) with the DST-NRF Centres of Excellence.

DST-NRF Centres of Excellence (CoE)

SERVICE LEVEL AGREEMENT Stage 4, Performing

Centre of Excellence in Palaeosciences January 2018 – December 2020

Preamble

This Service Level Agreement is linked to the Memorandum of Agreement between the National Research Foundation and the University of the Witwatersrand.

Stage/Gate

This CoE is currently in Stage 3, the Norming Stage and is moving to Stage 4, the Performing Stage.

Timeframes

- The pending Gate review (Gate 4) shall take place during October of each year.
- Two CoE Steering Committee (virtual or real) meetings should take place per year: Typically during March and October.

Activities related to the Current Stage

- The CoE should have solidified and maintained its intended research themes and projects by the end of this stage.
- The CoE shall provide to the NRF a list of students that are being supported by the Centre by October of each year, using the student nomination platform on the NRF online submission system. Additional students can be appended to this list as and when they arrive.
- The CoE shall make available to the NRF, on a quarterly basis (March, June, September and December), current "nuggets" of information for publication on the CoE website.

Financial responsibilities

- The CoE shall present an audited set of financial statements at the April of each year at the Steering Committee meeting reflecting the financial situation of the CoE during the previous financial year (January to December).
- The CoE shall submit monthly cash-flow statements within 15 days of the end of each calendar month, indicating expenditure and commitments in their first year of funding, thereafter quarterly from the second year onwards.

Reports due in this Stage

- The CoE shall submit an Annual Progress Report documentation by no later than April of each year to be reviewed by the CoE Steering Committee
- The CoE shall submit a Statement of Compliance by no later than April of each year referring to Stage 4.

Standard Output Targets per annum in the Current Stage

The CoE-Pal undertakes to the best of our ability into this funding programme in accordance with the *Ministerial Guidelines for Improving Equity in the Distribution of the DST-NRF Bursaries and Fellowships*.

Student Training Categories	SLA Stage 4 2018-2020
Honours Students	12
Masters Students	11
Doctoral Students	12
Total Postgraduate Students Supported (Masters & Doctoral)	≥ 35
Female Postgraduate Students (Masters & Doctoral)	≥ 40%
Black Postgraduate Students (Masters & Doctoral)	≥ 20%
Total RSA Postgraduate Students	87%
Total SADC Postgraduate Students	5%
Total Other African Postgraduate Students	4%
Total Foreign Postgraduate Students	4%
Masters Graduations	≥12
Doctoral Graduations	≥8
Average Masters Duration (months)	≥ 2 years/24 months
Average Doctoral Duration (months)	≥ 3 years/36 months
Average Duration of submitted PhD degrees (upgraded from Masters)	≥ 5 years/60 months
Postdoctoral Fellows	≥ 15
Female Postdoctoral Students	≥ 40%
Black postdoctoral fellows	≥ 20%
Research Initiative Categories	SLA Stage 4
Core team members undertaking at least one scientific review per annum on behalf of the NRF	100%
Number of peer-reviewed publications	≥ 100
Number of joint venture postgraduate student training initiatives	2
Number of local conference/workshop organised	≥2
Number of international conference/workshop organized	≥2
Number of educational outreach events	≥ 8

Special Output Targets for the Current Stage

- Fine-tuned strategy to increase research and other output from the key performance areas.
- Form Partnerships with Historically Black Universities in South Africa.
- At least one team activity to further encourage team spirit with our Partners.
- The CoE in Palaeosciences shall demonstrate a sound working relationship between the CoE host institution and the satellite institutions.
- Development and implementation of Publication Mentorship Programme to assist Doctoral, Postdoctoral Fellows and Emerging Researchers to publish.
- Introduce Palaeosciences to students from previously disadvantaged backgrounds.
- Develop PhD academics from designated (formerly disadvantaged) groups.
- Provide three new Master's Bursaries for Science Communication, Heritage Management and Education (Palaeosciences in the classroom).
- Build a stronger Public Engagement and Science Communication profile.

Long-Term Outputs

- Increase human capacity at Natural History Museums.
- Develop and implement a strategic plan for increasing our funding base.
- Develop a sustainable strategy for Palaeosciences to move towards a National Institution.

