



**Proposal No. : 10362**

**Proposer : Frikkie DeBeer**

**Affiliation : Necsa (South African Nuclear Energy Corporation)**

**Short Name : PGNAA on South African Fossil rocks**

### Subject

Title	PGNAA to determine composition of South African Fossil rocks
Scientific area	Archaeology/Museum/Arts
Grand Challenges	Earth & Environment & Cultural Heritage
Instrument	PGAA
Continuation of experiment No.	10360
Resubmission of proposal nr.	

Rapid Access only available for instruments KWS-2, PGAA and SPODI.

Each accepted Rapid Access proposal will receive up to a maximum of 12 hours of beamtime.

Rapid Access Proposal?	Yes
Internal beam time	No
Did you submit this proposal also to another facility?	Yes
Measuring time [days]	1
Abstract (max 200 words)	The application of radiation, especially PGNAA in the analyses of fossil bearing rock has never been performed. The samples and the results of the PGNAA scans, each from a different excavation site in South Africa with different matrix composition, will be used as input to define the acceptance criteria and safety procedures for fossil rock samples to be tested at SANRAD - NRAd facility in South Africa. It is foreseen that the current upgrade initiative of the SANRAD facility and results obtained, will play a major role in the success of the CRADLE FOSSIL PREPARATION LABORATORY, currently being established at Necsa. In the careful planning stage of preparation to either to use a chemical or mechanical process to release the fossil physically from the rock, the composition of the breccia/ bone materials is very important. This application deals with 4 breccia types to obtain information of the different composition and effectively their activation capability/status after neutron radiography.

### Proposalteam

Co-Proposers name, affiliation	Stephany Potze, DITSONG Natural Museum , Pretoria, South Africa
Local contact	

### Sample

Substance	Soil, Bone, Rocks
Elemental formula	Soil (Si, O, Mg, Fe, Ca, and others) Bone (Hydroxyappitite)
Sample type	amorphous
sample size [mm] weight [mg]	10cm < Sample <20cm
Number of samples	4
Availability of samples	2015-03-23
Space group	
unit cell parameters	

**Sample environment**

No sample environment needed	No
Cryostat	
High temperature furnace	
Pressure cell	
Magnetic field	
other sample environment	
Temperature range	
Temperature stability	
Pressure range	
Magnetic field	

**Security aspects**

Toxic	No
explosive	No
radioactive	No
Sample gets activated	No
activity after experiment [Bq / isotope] <a href="https://www.frm2.tum.de/intranet/activation/" target="_blank">(calculate activation)</a>	
Other risks	Ensure safety of samples (Cultural heritage)

**Miscellaneous**

Sample preparation laboratory (neutron guide hall)	No
Typ of work, materials, equipment in use	
Special technical support	No
Details(e.g. own equipment, special configurations, mechanics, control, software)	

## SUBMISSION OF A PROPOSAL

### Experiment Title

PGNAA to determine composition of South African Fossil rocks

### Proposer

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Affiliation	Necsa, South Africa
Co-Proposers	Burkhard Schillinger, Stephany Potze

## Scientific background and detailed description of the proposed experiment

### Introduction and state of science

The SANRAD neutron radiography facility at Necsa is under a process of upgrade and is not available for usage until Dec 2015. However, to support the proposed Cradle Fossil Preparation Laboratory (PREPLAB), which is a chemical and mechanical laboratory and in the process to be established at Necsa, through X-ray and neutron tomography, quantification of the fossil bearing breccia materials is necessary. The PREPLab is in the process to be approved in principle and a number of samples, originating from the various excavation sites within the Cradle of HumanKind are to be analysed for their natural radioactivity. It is important to know the composition of "geological" samples and what kind of materials is being brought onto the Necsa premises and into the PREPLAB and how they will be activated in the neutron beam to determine, for the various fossil sites, a general "cool down" period before the samples can be man-handled again. The data to be collected are also needed for incorporation into the safety case and the SHEQ (safety-Health-Environment-Quality) program to be followed at the Cradle Fossil Lab.

Via neutron radiography, the penetration capability of neutrons through the various breccia materials will be determined as well as to find small fossil bone materials in samples in a non-destructive manner. Each sample in this study represents a different region in the Cradle and many samples originate from these sites will be prepared in the PREPLAB. Additionally, mono-energetic neutrons will add to the knowledge of what energy is effective to obtain high contrast neutron radiographs between bone materials and breccia. This experiments will be the first of this nature to be conducted on South African fossil materials. This project will strengthen the application of neutron radiography in the palaeoscience community.

### Previous results

A fossil bearing rock was scanned at ANTARES and a mandible of a baboon was revealed perfectly. Good penetration through the breccia matrix materials was achieved and good contracts obtained of the bone materials after reconstruction and enhanced visualisation..

### Aim of proposed work

#### a) Radiation Monitoring:

Determine the natural radioactivity of each of the 4 samples

**b) Neutron Tomography (White beam):**

Neutron radiography with the highest resolution aiming to:

- a. Obtain good penetration
- b. Detect any bone structures in the samples and
- c. Virtually extract them from the breccia materials

**c) PGNAA:**

Determine the elemental composition of each of the samples from the individual excavation sites.

**d) Radiation Monitoring:**

Determine the natural  $\frac{1}{2}$  life of the samples through radiation monitoring at several time intervals.

**Proposed experiments**

Samples: Photos of 2 of the typical samples (Smallest and largest):



Experiment-1: (Radiation Protection)

Background radiation scan of all samples for natural radioactivity. (

Experiment-2: (PGNAA) – another proposal

PGNAA on each sample for elemental composition

Experiment-3: (Neutron Tomography)

Neutron tomography (White beam) on all 4 samples with highest spatial resolution and dynamic range to obtain high contrast between bones and breccia materials

Experiment-4: (Radiation Protection)

Immediate gamma scans after the tomography measurement to obtain, from the measurement results, the specific activities and isotopes in order to calculate half-lives.

Experiment-5: (Neutron Radiography – mono-energy neutron beam))

Identify the best candidate of the 4 samples after Neutron tomography (sample with largest fossil bone composition) and use mono-energy neutron beam (via velocity selector) to obtain radiographs with higher contrast between the bone and breccia. If it is successful and time permits, a limited angle neutron tomogram on the sample can be attempted. (First time ever in history to be performed on South African fossil material)

**Your publication record (give references to papers published in the last two years arising from experiments at MLZ instruments)**

None