Proposal No. : 10360
Proposer : Frikkie DeBeer
Affiliation : Necsa (South African Nuclear Energy Corporation)
Short Name : South African Fossils Neutron tomography and Activation

Subject

Title	Study South African Fossil bearing breccia materials through Neutron Radiography and –Activation
Scientifique area	Archaeology/Museum/Arts
Grand Challenges	Earth & Environment & Cultural Heritage
Instrument	Antares
Continuation of experiment No.	
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?	No
Internal beam time	No
Did you submit this proposal also to another facility?	No
Measuring time [days]	3
Abstract (max 200 words)	Neutron Tomography on fossil bearing breccia materials is a relative new application field. The SANRAD facility at Necsa in South Africa in currently under upgrade and a need exists to show for various breccia/fossil bearing rock types the neutron penetration capability and bone/breccia contrast capability. The NRAD tomography results of the 4 samples to be scanned, 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. It is foreseen that the SANRAD facility, to reveal non-destructively the fossil bone material, 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, a “neutron picture” of bone materials and their location within the rock is very important. This application deals with 4 breccia types to obtain their activation capability/status after neutron radiography and results to obtain fossil bone information from the tomograms

Proposalteam

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

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	Velocity selector
Temperature range	
Temperature stability	
Pressure range	
Magnetic field	

Security aspects

Toxic	No
explosive	No
radioactive	No
Sample gets activated	Yes
activity after experiment [Bq / isotope] (calculate activation)	Part of the experiment
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	Yes
Details(e.g. own equipment, special configurations, mechanics, control, software)	Support on the energy selective radiography when velocity selector is being used.

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SUBMISSION OF A PROPOSAL

Experiment Title

Study South African Fossil bearing breccia materials through Neutron Radiography and –Activation

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

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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 ½ 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 resolusion 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