Programme and Abstracts

SPERA 08

South Pacific Environmental Radioactivity Association Conference
23 – 27 November 2008

University of Canterbury, Christchurch, New Zealand

SOUTH PACIFIC ENVIRONMENTAL RADIOACTIVITY ASSOCIATION
SPERA

Contents

Social Programme

Conference Registration and Welcome Reception

Sunday 23 November, University of Canterbury Staff Club, 87 Ilam Road
6.00 – 8.00pm

This is an opportunity to meet up with colleagues in an informal, relaxed atmosphere. Your first drink is complimentary - collect your ticket from the Registration Desk. Nibbles are provided.

Poster Function

Monday 24 November, Coppertop
4.00 – 5.00pm

Please hang up your poster by lunch time on Monday. Posters can remain in place for the duration of the conference.

SPERA 2008 gratefully acknowledges the support of Nu Scientific Pty Ltd in sponsoring this function.
Drinks and nibbles provided.

Conference Dinner

Wednesday 26 November, International Antarctic Centre
7.00pm

The gorgeous Siberian Huskies will welcome you to this internationally renowned celebration of Antarctica. Visit the Little Blue Penguins, explore the gallery full of informative displays or chill out at minus 18 degrees Celsius in the Snow and Ice Room. This is a truly memorable experience, capped off by an evening of superb food and beverages.

Coach pickup: 6.45pm at University Halls, 9 Maidstone Road
Coach departs: International Antarctic Centre at 10.30pm

General Information

Conference Venue

Coppertop Room
Level 2
Commerce Building
University of Canterbury
Ilam Campus
Christchurch

Catering

Your conference registration includes morning and afternoon teas, lunches, the Welcome Function, Poster Function and Conference Dinner. Delegates who have advised special dietary requirements will be separately catered for.

Internet Access

User codes are available from the conference registration desk on Sunday 23 November for $10.00 each. Wireless access is available from the Coppertop, alternatively, computers are available at a number of locations on campus including the basement of the Commerce Building and in the Central Library.

Name Tags

Admission to all sessions including morning and afternoon teas and lunches is by conference name tag. Delegates are requested to wear their name tags at all times.

Parking

Parking is shown on the map at the back of this book. All carparks on campus are chargeable and payment should be made at the appropriate meter, There is a limited number of free parking spaces outside of the campus.

Photocopying and Fax Facilities

Photocopying and fax facilities are available at the Copy Centre, situated on Level 2 of the Central Library (James Hight Building). Copy Centre hours are 8.30am to 5.00pm weekdays.

Smoking Policy

Smoking is not permitted inside any building on campus. Smoking is restricted to outside open areas only. Your cooperation in keeping this a smoke-free conference is appreciated.

Central Library

During the summer the Central Library hours are 9.00am to 9.00pm Monday to Friday.

Banking and Currency

ATM machines are located inside the ground floor entrance of the Commerce Building, outside the University Bookshop, in the foyer of the Central Library, outside the entrance to the Registry Building and at the car park entrance to the Students' Association UCSA building. The nearest branches of major banks are as follows:

Bank of New Zealand (BNZ), Upper Riccarton branch, cnr Riccarton and Waimairi Roads
National Bank, Upper Riccarton branch, 322 Riccarton Road
Westpac, Upper Riccarton branch, 3 Waimairi Road

Normal banking hours are Monday to Friday 9.00am to 4.30pm. Banks are closed on weekends and public holidays. The **ASB** is open 7 days in the Westfield Shopping Centre, Riccarton Road.

Post Office

Postal services are available from the Convenience Store in the Student's Association UCSA building. The nearest NZ Post Shop is corner of Maidstone and Waimairi Roads.

Public Transport

Buses (route 24) depart for the city on weekdays approximately every 30 minutes (on the hour and half hour) from the bus stop opposite the School of Engineering on Creyke Road and approximately every 15 minutes (routes 3 and 21) from the bus stop outside the Student Association Building on Ilam Road (approximately every 30 minutes after 7.00pm). Please check the time of the last bus at night. BusInfo phone: 366 8855.

Taxis

First Direct	Phone 377 55 55 (Eco Cabs)
Blue Star	Phone 379-9799
Corporate Cabs	Phone 379-5888

University Bookshop

Week day hours 8.30am-5.30pm.

Emergency Medical Services

Riccarton Clinic, 6 Yaldhurst Road, Church Corner, Upper Riccarton. Phone 03 343 3661. Open 8.00am to 10.00pm Monday to Friday.

After Hours Surgery, corner Bealey Avenue and Colombo Street. Phone 03 365 7777. Open 24 hours, seven days a week.

Pharmacies

Students' Association Building, ground floor. Open Monday to Friday 8.30am to 5.30pm. Phone 364 2215.

Riccarton Radius Pharmacy, 4 Yaldhurst Rd, Church Corner. Phone 03 341 4855, open Monday to Friday 08.30am-8.30pm.

Conference Programme

MONDAY 24 NOVEMBER

SESSION 1 : Environmental Studies 1		
9.00am	Opening	
9.20	Katsumi Hirose	Anthropogenic Radionuclides In The Central South Pacific: Results Of The SHOTS Project
10.00	*Coffee Break*	
10.20	Cath Hughes	Movement Of A Tritium Plume In Shallow Groundwater At A Legacy Low Level Radioactive Waste Disposal Site In Eastern Australia Over Four Decades
10.40	Stephen Long	The Radioactive Content Of Some Australian Drinking Waters
11.00	Jane McLeish	Study Of Groundwater Discharge Into River Systems Using Radon-222 As A Tracer
SESSION 2 : Radon		
11.20	Tracy Wright	Improvements To ARPANSA's Radon Measurement Facilities And A Comparison Between Radon Measurement Instrumentation
11.40	Marcia Pires de Campos	Radon Levels In An Experimental House Constructed With Phosphogypsum Plates
12.00	Rick Tinker	Development Of A Energy Discriminate CR-39 Nuclear Track Etch Dosimeter For Radon-220 Measurements
12.20pm	*Lunch*	
SESSION 3 : TENORM		
1.40	Lucio Leonardo	Assessment Of Atmospheric Pollution In The Vicinity Of A Casseterite Process Industry Using Lichen Canoparmelia Texana
2.20	Andrew Esparon	Determination Of An Analogue Site For Ranger Uranium Mine To Extrapolate Pre-Mining Gamma Dose Rates
2.40	Alison Frostick	Spatiotemporal Assessment Of Sediments From Magela Creek,Northern Australia To Evaluate The Impacts Of Uranium Mining
3.00	*Coffee Break*	
3.20	Mirna.Seleghim	Radioecological Monitoring Of The Impact Of Effluents From A Nuclear Facility Being Decommissioned In The Antas River Hydrographic Basin In The State Of Minas Gerais, Brazil
3.40	Afkar.Al-Farsi	Presence Of ^{227}Ac And Other Naturally Occurring Radionuclides In Oil And Gas Pipe Scales, Sludge And Sediment In The Sultanate Of Oman
4.00 – 5.00 : POSTER SESSION		
1	Michelle Campos	Spatial And Temporal Variation Of Fluctuations Of ACIDITHIOBACILLUS Ssp. In Effluents Of Uranium Mine, Caldas - MG.
2	Marcia Pires de Campos	External Exposure Due To Phosphogypsum Plates Used As Building Material
3	Petr Kovar	Calibration And Verification Of Noble Gases Monitors In Nuclear Facilities.
4	Alison Frostick	Investigating Potential Natural Analogues For Ranger Uranium Mine
5	Rosli Mahat	Variations In Indoor Radon Concentration In Malaysia
6	Byung-Uck Chang	Evaluation Of The Radioactivity Levels In Several TENORM Industries In South Korea
7	Sandra Damatto	Trace Elements In Sediments From Ponds In Pantanal, Mato Grosso Do Sul, Brasil
8	Paulo Sergio Cardoso da Silva	Determination Of Elementary Basal Levels In Sediments Of Baixada Santista, São Paulo, Brazil
9	Ashraf Khater	Technologically Enhanced Pb-210 And Po-210 In Iron And Steel Industry
10	Ashraf Khater	Effects Of Soil Properties On Natural Radionuclides Concentration In Arid Environment: A Case Study
11	Adir Janete Godoy dos Santos	Natural Radionuclide From Soil In A Landfill Area Investigation
12	Andrew Esparon	Visual Gamma - Gamma Spectrometry Analysis Software

Conference Programme

TUESDAY 25 NOVEMBER

SESSION 4 : Dose Assessments		
9.00am		
9.20	Neil Whitehead	Nuclear Forensics - New Approaches
9.40	Ashraf Khater	Radiological Assessment Of Narghile Smoking: Radioactivity Levels And Dose Assessment
10.00	*Coffee Break*	
10.20	Peter Medley	Derivation Of Regional Concentration Factors For Radium In Bush Passionfruit (Passiflora Foetida) From The Alligator Rivers Region, Northern Territory, Australia
10.40	Jessica Veliscek Carolan	I-131 Discharges To The Marine Environment And Uptake By Algae In Sydney, Australia
11.00	John Twining	Method Development For Tritium Measurements And Initial Evaluation Of Tritium Data For Tree Transpirate From A Legacy Waste Site In Eastern Australia
11.20	Andreas Bollhöfer	A Study Of Radium Bioaccumulation In Freshwater Mussels, Velesunio Angasi, In The Magela Creek Catchment, Northern Territory, Australia
11.40	Andreas Bollhöfer	An Ingestion Dose Assessment For Aboriginal Inhabitants Downstream Of Ranger Uranium Mine In The Northern Territory Of Australia
12.00pm	*Lunch*	
SESSION 5 : Methods and Instrumentation		
1.20	Paul Martin	Matrix reference materials: preparation, characterization and use
2.00	Jennifer Harrison	Rapid Determination Of Uranium, Thorium, Plutonium, Americium And Strontium Activities In Water, Soil And Vegetation.
2.20	Liesel Hardege	Sequential Injection Chromatography In The Development Of Automated Radiochemical Separations
2.40	Sandra Sdraulig	An Improved And Rapid Radiochemical Method For The Determination Of Polonium-210 In Urine
3.00	*Coffee Break*	
3.20	Graeme McDonnell	Advances In Portable Radiation Monitoring And Measuring Instruments
3.40	Gordon McOrist	Density Correction - A Better Method For Difficult Samples
4.00	Jiri Suran	Metrological Assurance Of Radioactive Discharges Monitoring Systems In Czech Npps
4.20	Daniella Fiero	Low-Level Gamma-Spectrometry By Using Compton Suppression – Testing The Performance Of Two Systems At The ANSTO Low Level Radiochemistry Laboratory.

Conference Programme

WEDNESDAY 26 NOVEMBER

SESSION 6 : Environmental Studies 2		
9.20 am	Timothy Payne	Applicability Of Surface Area Normalised Distribution Coefficients (Ka) In Interpreting Measurements Of Radionuclide Sorption
10.00	*Coffee Break*	
10.20	Paulo Sergio Cardoso da Silva	Radiological Study In Caves Of Southwest Brazil
10.40	Sandra Damatto	^{7}Be And ^{210}Pb Concentrations In Air, Rain Water And Soil In São Paulo, Sp -Brazil
11.00	Atun Zawadzki	Comparison Of Be-7 Analysis Using Two Gamma Spectrometry Systems And Software Packages
12.20pm	*Lunch*	
1.20	**Spera Meeting**	
3.00	*Coffee Break*	
3.20 – 4.20	**Spera Meeting**	
7:00	**Conference Dinner**	International Antarctic Centre

THURSDAY 27 NOVEMBER

SESSION 7 : Radioactivity in Soil		
9.20 am	Paulina Schuller	Use Of Fallout Radionuclides To Evaluate The Effectiveness Of Changes In Tillage Systems For Reducing Soil Erosion On Agricultural Land
10.00	*Coffee Break*	
10.20	Jerry C Ritchie	Using Cesium-137 To Study Soil Redistribution In Guam And Hawaii
10.40	Ana Navas	Patterns Of Spatial Distribution Of Natural And Artificial Radionuclides In Soils At Catchment Scale (South Central Pyrenees)
11.00	Hannah Leckie	Negligible Soil Erosion At Balmoral Station, Mackenzie Basin Over The Last 60 Years: An Assessment Based On 137Cs And Kawakawa Tephra
11.20	Wee Teck Hoo	Using Plutonium As A Probe Of Change In Erosion Processes?
12.00pm	*Lunch*	
SESSION 8 : Radioactivity in Sediments		
1.20	Stephen Tims	From The River To The Sea - Using Fallout Plutonium To Investigate Erosion And Sediment Transport
2.00	Gary Hancock	Fallout Plutonium As A Chronometer In Australian Sediments
2.20	Rajeev Lal	Analysis Of Pacific Ocean Floor Sediments By The Method Of Neutron Activation
2.40	Shaoming Pan	^{137}Cs And Plutonium In Sediment From The Yangtze River Estuary, P.R. China
3.00	**Closing Remarks**	
3.20	*Coffee Break*	

Abstracts by Programme Order

Monday 24 November

Session 1: Environmental Studies 1

Anthropogenic radionuclides in the central South Pacific: results of the SHOTS project

K. Hirose[a], M. Aoyama[a], M. Fukazawa[b], Y. Hamajima[c], C.S. Kim[d], K. Komura[c], P.P. Povinec[e], J.A. Sanchez-Cabeza[f], S.A. Yim[d]

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The Japan Agency for Marine-Earth Science and Technology (JAMSTEC) conducted in 2003-2004 Blue Earth Global Expedition (BEAGLE2003), visiting during the 7-months the South Pacific (winter), the South Atlantic (late spring) and the South Indian (summer) Oceans. This cruise provided rare opportunity to collect a lot of water samples for anthropogenic radioactivity measurements in Southern Hemisphere oceanic waters. We provide here a first view of transect of current ^{137}Cs concentrations along 30° S in the South Pacific. The present concentrations of ^{137}Cs and plutonium isotopes in the South Pacific surface waters were the same order of magnitude as that in North Pacific surface waters, although atmospheric input of anthropogenic radionuclides in the South Pacific was less than one-third of the North Pacific. ^{137}Cs water column inventories in the western central South Pacific, calculated from the ^{137}Cs vertical profiles, were about 1000 Bq m^{-2}, which is markedly higher than that observed in the east-central Australia waters. We propose from this finding a hypothesis that significant amounts of North Pacific ^{137}Cs have been transported to the central South Pacific (Tasman Sea) at the time scale of several decades. The south Pacific central gyre may be therefore a major reservoir of global-scale ocean contaminants

Movement of a tritium plume in shallow groundwater at a legacy low-level radioactive waste disposal site in eastern Australia over four decades

Hughes, C.E.[1], Cendon, D.I.[1], Collins, R.N.[1,2], Hankin, S.I.[1], Harrison, J.J.[1], Hoffmann,E.L.[1], Loosz, T.[1], Payne, T.E.[1], Pham, A.N.[2], Twining, J.R.[1], Vine, M.[1], Waite, T.D.[2]

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Between 1960 and 1968 radioactive wastes with low levels of activity were buried by the Australian Atomic Energy Commission in a series of shallow trenches in bushland near the Lucas Heights facility, on the outskirts of Sydney. Groundwater monitoring carried out since the mid 1970's has found that no radioactivity, with the exception of tritium, has been detected outside the immediate vicinity of the trenches. However, over this period of more than 40 years, a plume of tritiated water has migrated from the trenched area and extends at least 100 m from the source. The peak tritium activity detected in the mid 1970's was 390 kBq/L directly adjacent to the trenches. Modern tritium activity in the groundwater is less than the drinking water standard of 7.6 kBq/L and poses no radiological risk to the community or local environment. The tritium dataset will be presented and analysed to determine the effects of rainfall and drought periods on tritium levels and plume transport.

Radioactivity content of some Australian drinking waters

Stephen Long

ARPANSA

This report presents the results of a preliminary survey of the radioactive content of Australian Drinking water. The samples that were analysed for this report were collected on an opportunistic basis and, therefore, do not form a representative data set on which to base general conclusions. The methods developed by the Environmental Radioactivity Section of ARPANSA were used to determine the gross-alpha and gross-beta activity of the samples and the activity concentrations of potassium-40, radium-226, radium-228, lead-210, uranium-238, uranium-235 and uranium-234. The results of these analyses are presented, together with dose estimates due to the activity concentrations of the individual radionuclides. It was found that the radioactive contents of the waters were highly variable. While ground waters are more likely to contain higher levels of radioactivity, this study found no clear correlation between the type of water source and dose.

Study of Groundwater Discharge into River Systems using Radon-222 as a Tracer.

Jane McLeish,

ARPANSA

In the central and western areas on Victoria, groundwater/surface water studies are essential for the development of sustainable water management strategies. Radon-222 can be used as a tracer when determining the location and quantity of groundwater discharge into river systems.

The oceanography department at Florida State University has undertaken many studies using radon as a tracer for groundwater movement into large estuaries or coastal ocean regions. They have a system that can be taken on boats or pontoons in which the pump is submerged from the side of the vessel. To adapt this system to much smaller river systems or creeks, a pump housing design has been developed in-house at ARPANSA. Given that radon disperses rapidly near the air/water interface, the pump must be submerged as deeply as possible in the creek. This proved to be a logistical issue requiring the solution of many problems including; limiting the disturbance of deep water layers, filtering capabilities and battery power to the pump.

Abstracts

Monday 24 November

Session 2: Radon

Improvements to ARPANSA's radon measurement facilities and a comparison between radon measurement instrumentation

Tracy Wright, Rick Tinker and Stephen Solomon

Environmental & Radiation Health Branch, Australian Radiation Protection and Nuclear Safety Agency (ARPANSA), Yallambie, Victoria 3085, Australia

Radon (^{222}Rn) is a naturally occurring radioactive gas that is present everywhere. Its concentrations can vary depending on factors such as weather conditions, soil moisture, diurnal and seasonal variations, concentration and distribution of uranium in surrounding ground or building materials and ventilation. In high concentrations it is known to increase the risk of lung cancer. Thus, it is critical to be able to measure radon levels accurately to estimate doses received by members of the public and workers who are occupationally exposed.

ARPANSA maintains a radon field measurement capability and a radon chamber facility to provide calibrations to stakeholders in the Government, research and industry to ensure consistency and accuracy of radon measurements. This calibration facility is currently being upgraded and field capabilities are being improved to allow for more accurate measurements with greater flexibility. This will be achieved by:

- reducing the electrical noise in the calibration facility to reduce the error associated with the reported exposure;
- performing a comparison of new and existing radon measurement instrumentation to ensure consistent measurements between monitors and extent our field measurement capabilities; and
- a visit to an international radon primary standard laboratory to identify possible areas of improvement for the ARPANSA systems and facilities.

This presentation will focus on the results of the monitor comparison.

RADON LEVELS IN AN EXPERIMENTAL HOUSE CONSTRUCTED WITH PHOSPHOGYPSUM PLATES

M.P. Campos, E.W. Martins and B.P. Mazzilli

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Phosphogypsum is a by-product of the wet-acid process for producing phosphoric acid from phosphate rock. For every ton of phosphoric acid made, from the reaction of phosphate rock with acid, commonly sulphuric acid, about four or five tons of phosphogypsum are produced. Brazilian annual production of phosphogypsum reaches 5.4 million tons. The recycling of the phosphogypsum waste is very important from the social-economic point of view and also regarding environmental preservation. Phosphogypsum waste has been used as a base in building roads and as building material, and in agriculture, as well. The radionuclides of the thorium and uranium series, particularly radium-226 and its daughters, are found in phosphogypsum and can become airborne. Radon-222, a decay product of radium-226, is an inert gas and may become airborne by diffusing into the air. Radon and its short-lived decay products in the atmosphere are the most important contributors to human exposure from natural sources. One of the most important sources of indoor radon is the underlying soil but the building materials may be also an important source. The aim of this study is to determine the radon levels in an experimental house constructed with phosphogypsum plates. Radon measurements were carried out through the passive method with solid state nuclear track detectors (CR-39) over a period of 12 months, changing the detectors every three months, in order to determine the long-term average levels of the indoor radon concentrations with varying seasons. The detectors were placed at the two rooms and the bath room. The radon concentrations varied from 50.4 to 105 $Bq \cdot m^{-3}$ in the rooms and 87.8 to 353 $Bq \cdot m^{-3}$ in the bathroom. These results are below 400 $Bq \cdot m^{-3}$, the International Commission on Radiation Protection recommended action level.

Development of a Energy Discriminate CR-39 Nuclear Track Etch Dosimeter for Radon-220 Measurements

J. M. C. Brown[a,b], R. A. Tinker[b] and S. Solomon[b]

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International studies of indoor radon have shown that the dose contribution due to the inhalation of radon-220 and its short-lived decay products can equal or even exceed that of radon-222 and its progeny.

To assess indoor radon levels, radon-222, radon-220 and their short-lived progeny are commonly measured using dual chambered passive diffusion detectors with solid state nuclear track detectors like CR-39®, Makrofol® or Lenax®. This technique applies a subtraction method that is susceptible to a high level of experimental uncertainty for radon-220 determination.

An energy discriminate CR-39 nuclear track etch dosimeter for radon-220 measurements has been developed that will offer better sensitivity and a lower uncertainty of measurement. It utilises a thin film of Mylar® C to attenuate alpha particle energies less than 8 MeV. This allows only the damage tracks created by 8.79 MeV alpha particles emitted from polonium-212 (thorium-232 decay chain) to be registered in the CR-39 plaque. The dosimeter was developed through a combination of experimental investigations and theoretical simulations in the Monte Carlo ion transport modelling program Stopping and Range of Ions in Materials (SRIM-2008).

Keywords: Nuclear Track Etch, Thoron, Radon, CR-39, passive monitor, area monitoring, dosimetry.SESSION 3

Abstracts

Monday 24 November

Session 3: TENORM

Assessment of atmospheric pollution in the vicinity of a tin and lead industry using lichen *Canoparmelia texana*

[1]Lucio Leonardo, [1]Sandra Regina Damatto, [1]Barbara Paci Mazzilli, [2]Mitiko Saiki, [3]Sonia Maria Barros de Oliveira.

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The tin and lead industry located in Pirapora do Bom Jesus in the state of São Paulo, Brazil, is responsible for the production of about 7500 ton/year of tin and 120 ton/year of lead. The raw material used in this facility is cassiterite, which presents in its composition concentrations of natural radionuclides from the uranium and thorium series up to 42 k Bq kg^{-1} and 60 k Bq kg^{-1} respectively. The high temperatures used in the smelting and refining processes may lead to concentrations of these radionuclides, mainly in the precipitator dust and in slag. In the operational process, intermediate refining and final slag are obtained and are stored in piles in open air. It is estimated that the amount of waste stored is about 54000 tons annually. Although in the raw material the radionuclides from the uranium and thorium series are almost in equilibrium, during the processing this equilibrium is disrupted and radionuclides migrate according to their chemical properties. Concentrations up to 63 k Bq kg^{-1} for ^{238}U, 19 k Bq kg^{-1} for ^{226}Ra, 1.2 k Bq kg^{-1} for ^{210}Pb, 127 k Bq kg^{-1} for ^{232}Th, 45 kBq kg^{-1} for ^{228}Ra and were obtained in the slag. It was observed that REEs can also be found in the slag in concentrations higher than in the feedstock. Since this facility has been in operation for more than 20 years, it is expected an environmental impact due to re-suspension of the residue, atmospheric dispersion and deposition in the soil by rain washout. This paper aims to study the viability of using lichen *Canoparmelia texana* as bioindicators of air pollution by radionuclides and REEs. The lichen and soil samples were analyzed for uranium, thorium and REEs determination by instrumental neutron activation analysis. The radionuclides ^{226}Ra, ^{228}Ra and ^{210}Pb in soil samples were determined by gamma spectrometry; and in the lichens samples by radiochemical separation and gross alpha and beta counting in a gas flow proportional counter. Concentration values obtained for lichen samples varied from 19 Bq kg^{-1} to 471 Bq kg^{-1} for ^{238}U, 21.4 Bq kg^{-1} to 265 Bq kg^{-1} for ^{226}Ra, 401 Bq kg^{-1} to 1083 Bq kg^{-1} for ^{210}Pb, 15,9 Bq kg^{-1} to 574 Bq kg^{-1} for ^{232}Th and from 175 Bq kg^{-1} to 389 Bq kg^{-1} for ^{228}Ra. The results obtained show that the lichen *Canoparmelia texana* concentrate radionuclides and therefore can be used as bioindicator of atmospheric pollution.

DETERMINATION OF AN ANALOGUE SITE FOR RANGER URANIUM MINE TO EXTRAPOLATE PRE-MINING GAMMA DOSE RATES.

A Esparon, K Pfitzner, A Bollhöfer, B Ryan

Environmental Research Institute of the Supervising Scientist (eriss), Supervising Scientist Division, Department of Environment, Water, Heritage and the Arts, Darwin, NT 0801

Pre-mining radiological conditions need to be assessed at Ranger Uranium Mine so that post-mining changes in effective dose rates as a result of mining activities can be quantified. However, it is often difficult to assess the pre-mining conditions, because information is scarce, mostly focussed on delineating the extent of the ore body, and the quality of data can not be assessed. Historical airborne gamma surveys (AGS) coupled with appropriate ground truthing may provide a tool for an area wide assessment of the pre-mining conditions. In 1976 a geophysical survey was conducted in the Alligator Rivers Region covering the Ranger area pre-mining. The datasets are available in the public domain (the *Alligator River Geophysical Survey*). A comparison of the gamma signal intensity with known uranium occurrences in the MODAT database illustrated that Anomaly 2 south of the Ranger mining lease may be a suitable site to determine the Ranger pre-mining radiological conditions.

Anomaly 2 contains two areas where radiation levels are elevated above typical background and are referred to as Anomalies 2A and 2B. In August 2007, fieldwork at Anomalies 2A and 2B was conducted by staff from the Supervising Scientist Division. The readings from the 1976 AGS cover a range from 32 to 994 total counts per second per pixel in the region of interest, each pixel being 70 by 70 meters. For groundtruthing, measurements were performed at 40 random locations within individual pixels. In the course of the field survey, a spatial discrepancy between the AGS data and the true location of Anomalies 2A and 2B was observed and more intensive fieldwork was required in 2008 to delineate the location and intensity of the Anomalies. This paper will present the results of the ground truthing and illustrate the approach that will be taken to extrapolate the pre-mining AGS data from Anomaly 2 to determine pre-mining dose rates in the wider Ranger region.

Spatiotemporal assessment of sediments from Magela Creek, Northern Australia to evaluate the impacts of uranium mining

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Abstract
The Magela Creek catchment in Northern Australia is located partly within the Ranger Mineral Lease (RML) while the majority lies within the World Heritage listed Kakadu National Park, which completely surrounds the mineral lease. Should any impact occur as a result of mining of the Ranger uranium ore deposits Magela Creek would be the first catchment to be affected. Radionuclides, stable lead (Pb) isotope ratios and trace metal concentrations have been measured in sediments from 33 sites within the Magela Creek catchment around the Ranger uranium (U) mine to investigate the possible migration and erosion of mine or ore body derived contaminants in a spatial and temporal context. The study found localised areas adjacent to the mine site, within the mineral lease, where sediments had elevated levels of radionuclides and trace metals. In some samples the Pb isotope ratios are highly radiogenic, indicating the presence of lead derived from the radioactive decay of uranium. Results suggest that black soils adjacent to the mine site attenuate uranium and trace metals and display highly radiogenic Pb isotope ratios. At present, there is no evidence that the radiogenic sediments found adjacent to the mine site have contaminated sediments further downstream within the Magela Creek catchment.

Keywords: stable lead isoptopes, uranium mining, radionuclides, trace metals.

RADIOECOLOGICAL MONITORING OF THE IMPACT OF EFFLUENTS FROM A NUCLEAR FACILITY BEING DECOMMISSIONED IN THE ANTAS RIVER HYDROGRAPHIC BASIN IN THE STATE OF MINAS GERAIS, BRAZIL

L. B. Ronqui [1,2*], M. H. R. Seleghim [3], M. R. L. Nascimento [2], C. V. Roque [2], H. A. Gomes [2]

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The Antas Reservoir (AR) receives the treated effluents which come from acid drainage of uranium ore from the UTM-INB (Ore Treatment Unit – Brazilian Nuclear Industries), located in Caldas, MG. This study is being conducted in order to determine the possible environmental impact caused by discharge of the treated liquid effluent from the UTM into the AR. The chemical and radioecological characterization of the AR was performed in order to obtain a diagnosis of the current state of the problem. UTM-INB was the first Brazilian facility to produce uranium on an industrial scale; it began operations in 1982 and was temporarily closed in 1997. Legal procedures for remediation of the area and the decommissioning of the facility are under way. Brazil has neither available technologies nor practical experience with remediation and decommissioning procedures for uranium mines and mills. Biological (protozooplankton and bacterioplankton) and physicochemical variables (hardness, alkalinity, zinc, iron, sulfate, manganese, fluoride, total phosphorous, aluminum, uranium, thorium, temperature, and pH) and the saprobity index are being evaluated in the present study. Sampling in the AR (Cab, P41, P14S, and P14F points) took place during the dry winter season (July 2006) and rainy summer season (February 2007). Each day, samples were collected four times (6:00 am, 12:00 pm, 6:00 pm, and 12:00 am). The lowest values of biomass and biovolume of protozooplankton and bacterioplankton were observed at point P41; this point receives the treated liquid effluent from the UTM. Chemical parameters indicate failures in the nuclear facility effluent treatment plant, showing that effluents being discharged at point P41 are outside of standard limits established by current legislation. These results agree with biological analyses, since point P41 has the lowest biovolume and biomass values for protozooplankton organisms, indicating possible environmental impacts on the ecosystem due to effluent discharge by this mining company.

Presence of ^{227}Ac and other naturally occurring radionuclides in oil and gas pipe scales, sludge and sediment in the Sultanate of Oman

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The Sultanate of Oman oil and gas exploration and production are mainly on-shore operations. Scale and sludge samples were collected from Bahja NORM store yard and from Bahja, Nimr and Marmul sludge farms. Sediments were collected from Al-Noor produced water evaporation pond. These sites are located in the southern oil fields in the desert area between 550 and 800 kilometres from the capital city of Muscat.

Specific activities of ^{226}Ra, ^{210}Pb, ^{228}Ra, ^{228}Th, ^{227}Ac and ^{40}K were determined for 86 samples using HPGe gamma spectroscopy.

This work reports on the detection of ^{227}Ac for the first time in oil and gas industry of the Middle East region. The presence of ^{227}Ac in petroleum industry was hardly reported in the literature and its detection is likely due to its association with the saline produced water accompanying oil and gas production. Activity concentrations of ^{227}Ac ranged from 3 to 614 Bq kg^{-1}.

It is known that radium isotopes preferentially leach into the formation water oil reservoirs due to their higher solubility in water compared to uranium and thorium. Both ^{226}Ra and ^{228}Ra progeny were detected in all of the studied samples with the latter activity concentrations always lower than the former. K-40 was detected in the majority of the surveyed samples but was below minimum detectable activity for oil pipe scales. The maximum measured activity concentrations of ^{226}Ra, ^{228}Ra, ^{228}Th and ^{40}K were 223 and 34, 45 and 1.5 kBq kg^{-1}, respectively. Rn-222 is released from oil and gas reservoir sands and from precipitated scale and sludge. It migrates in the oil pipe stream associated with produced water and in the gas pipe stream associated with ethane and propane. Pb-210 was detected in both oil and gas pipe scales as a result of ^{222}Rn decay. The activity concentration of ^{210}Pb ranged for oil scales from 3.06 to 8.59 kBq kg^{-1} and for gas scales from 0.96 to 66.41 kBq kg^{-1}.

The presence of ^{227}Ac and the other naturally occurring radionuclides in enhanced levels can cause radiological impact. This work therefore establishes the radiological baseline data which does not yet exist in Oman for this non-nuclear industry source of pollution.

Key words: Radioactivity, Ac-227, NORM, Oil and gas industry, Oman, Scale, Sludge

Monday 24 November

Poster Session

Spatial and Temporal Variation of Fluctuations of *ACIDITHIOBACILLUS ssp.* in Effluents of Uranium Mine, Caldas - MG.

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The Caldas Ore Treatment Unit (UTM), Minas Gerais State – Brazil, was the first Brazilian facility to produce uranium on an industrial scale; its operation started in 1982 and temporarily closed in 1997. Since them the nuclear facility operation has been in compliance with regulatory requirements of the Brazilian Nuclear Energy Commission (CNEN).

Legal procedures for remediation of the area and facility decommissioning are under way. The operator must fulfill requirements established by CNEN and the Brazilian Environment Institute (IBAMA) – the environmental inspection authority – through a Degraded Area Recovery Plan (PRAD) to be presented by the UTM, according to a detailed reference document, specifically prepared for this case (IBAMA, Document Number 099/2004 – DILIQ).

The sulfated minerals present in mining areas may cause serious environmental problems due to chemolithotrophic bacteria action of the gender *Acidithiobacillus*, mainly *A. ferrooxidans* and *A. thiooxidans*. These microorganisms are able to oxidize mineral sulfates, elementary sulfur and the ferrous ion, being capable mobilizing radionuclides as the uranium for the environment. The relative seasonal behavior of some variables, when evaluated indicated that the high values of oxidation-reduction potential, the low values of pH, the detection of the highest percentages of incidence and highest values of *A. ferrooxidans* and *A. thiooxidans*, coutings, observed in the sites CM, D3, 75 and BS are the main places of mine acid drainage occurrence and bioleaching bacteria action in the UTM and should be considered critical sites, face to a possible decommission measure.

Key words: *A. ferrooxidans, A. thiooxidans,* uranium mine, bioleaching, decommissioning.

EXTERNAL EXPOSURE DUE TO PHOSPHOGYPSUM PLATES USED AS BUILDING MATERIAL

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Phosphogypsum is a by-product of processing phosphate ore into fertilizer with sulfuric acid. Brazilian annual production of phosphogypsum reaches 5.4 million tons. The recycling of the phosphogypsum waste is very important from the social-economic point of view and also regarding environmental preservation. Until now it is produced in large amounts and there is no adequate final destination in agreement with the demands of the environmental legislation in force. Nevertheless, one of the possible uses of phosphogypsum is as building material. This by-product can contain naturally occurring radionuclides, particularly ^{40}K and gamma emitters comprised in the uranium and thorium series; hence its use as a building material has radiological implications. In order to assess the feasibility of the use of a building material mainly constituted by phosphogypsum, an experimental house was built with phosphogypsum plates. The aim of this study is to assess the external exposure for residents at a house constructed with phosphogypsum plates. Samples of this material were analyzed by high resolution gamma spectrometry for their ^{226}Ra, ^{232}Th, ^{210}Pb and ^{40}K activity concentration. The radium equivalent activity and external and internal hazard indices were also calculated. The activity concentrations results varied from 15.9 to 392 $Bq \cdot kg^{-1}$ for ^{226}Ra, 26.1 to 253 $Bq \cdot kg^{-1}$ for ^{232}Th, and 27.4 to 852 $Bq \cdot kg^{-1}$ for ^{210}Pb. The results of ^{40}K were lower than 81 $Bq \cdot kg^{-1}$. Radium equivalent activity results varied from 55.8 to 759 $Bq \cdot kg^{-1}$. Both external and internal hazard indices were above the recommended limit from the United Nation Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) for exposure due to conventional building materials.

Calibration and verification of noble gases monitors in nuclear facilities

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In the Czech NPPs spectrometric monitors with germanium detectors are used for monitoring of noble gases. Radionuclides Xe-133, Kr-85 and Ar-41 are primarily measured. Gaseous standards of these radionuclides are prepared in the Czech Metrology Institute - Inspectorate for Ionizing Radiation that calibrates and verifies the monitors too. For efficiency calibration curve creating calibration points are supplied by measurement of I-131 gaseous standard.
The presentation describes methods of gaseous standards preparation and calibration and verification procedures of noble gases monitors are shown.

Investigating potential Natural Analogues for Ranger Uranium Mine

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Abstract
Natural analogues have primarily been described for the study of transport and migration of radionuclides in relation to radioactive waste repositories. This research modifies and expands this scope to include stable lead isotopes and trace metals in relation to the rehabilitation of uranium mine sites. As Australian guidelines recommend that tailings materials from uranium milling be contained for at least 1000 years it is hoped that natural analogues can provide a key insight into the erosional processes which occur on temporal scales which are too great and can only be theoretically modelled.
This project involves the development of a method to evaluate the long term stability of rehabilitated uranium mine sites utilising stable lead isotopes, radionuclides and trace metals to monitor the erosion of contaminants off-site. A natural analogue site, where the same climactic erosion processes and materials from an existing undeveloped ore body are expected to be analogous to those at a rehabilitated mine site over the long-term.
Two natural analogues have been investigated in comparison to the operational Ranger Uranium Mine (RUM): Koongarra, an undeveloped mineral lease, approximately 19km from RUM and Ranger Anomaly 2, which is located within the Ranger mineral lease. The research establishes a case for a preferred analogue site for medium to long-term comparative monitoring.

Keywords: natural analogues, stable lead isoptopes, uranium mining, radionuclides, trace metals.

Variations in Indoor Radon Concentration in Malaysia

R. Mahat

This paper will report on a one year long study on the variation of indoor radon concentration in a residential unit. Diurnal, daily and seasonal variation in the radon concentration were done. The radon cencentration was found to vary throughout the day with a maximum at about 6.00 am and a minimum at about 6.00 pm. The daily average concentration was found to vary from 0.3 to 1.3 pCi/l.

Evaluation of the Radioactivity Levels in Several TENORM Industries in South Korea

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Technologically-enhanced naturally occurring radioactive materials (TENORM) are generating through various industrial processes such as pulverization, purification and chemical treatment of raw material and manufacturing of the consumer products in NORM related industries. To evaluate the radioactivity levels of TENORM in the several industrial areas of South Korea, the investigation was conducted for the target of several materials such as flyash, redmud of bauxite by-product, phosphogypsum, metal refining slags and others. HPGe γ-ray spectrometer was used for the determination of ^{40}K, ^{226}Ra, and ^{232}Th in TENORM samples. Uranium was determined by using SF-ICP-MS for waste water and solution samples. After being used for coal-fired power generation, the radionuclides of feed anthracite and bituminous coal were concentrated into the flyash by about 3 and 10 times, respectively. The radionuclides of bauxite redmud samples were concentrated about 3 times after alumina refining comparing to those of the imported bauxite ore. And the phosphogypsum samples; by-product of phosphate fertilizer production, had high ^{226}Ra concentration and the product, phosphoric acids, had higher uranium concentration than the imported phosphate ores. However, the slag samples from three metal processing industries had relatively low natural radionuclide concentration comparing with those of other TENORM samples. In 2006, a pipeline scale sample that screened from the radiation portal monitor of steel recycling industry had very high ^{226}Ra concentration (~120 Bq g^{-1}), however, the origin of the scale was impossible to be traced. Based on current investigated results, the materials which exceed 1 of the external hazard index (Hex) were found commonly. Occasionally, the annual occupational exposure of these materials could be expected over 1 mSv depending on the treatment method of each material. With the industrial diversification in South Korea it is predicted that the occurrence of TENORM will be gradually increasing in various industrial areas. Recently, the Korean government (MEST; Ministry of Education, Science & Technology) decided to establish the regulatory framework for natural radiation including NORM/TENORM and is making the efforts to legislate the relevant regulations with public consensus, based on the international safety standards.

Keywords: technologically-enhanced natural occurring radioactive materials, bauxite redmud, phosphogypsum, flyash, slags, scale, regulation of NORM/TENORM

TRACE ELEMENTS IN SEDIMENTS FROM PONDS IN PANTANAL, MATO GROSSO DO SUL, BRASIL

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The Pantanal, in the southwest part of Brazil, is one of the world's largest freshwater wetlands. This natural ecosystem has been affected due to urban contamination, irregular use of the land, tourism without control, excessive agricultural defensive utilization, etc. In order to verify possible changes in this environment, a study was established in Pantanal da Nhecolândia, Mato Grosso do Sul, Brazil. In 2006 two sediment cores were collected in two small ponds; one in Nhumirim farm, Salina da Ponta and other in Firmo farm, Salina Pedra do Sol. The elements As, Ba, Br, Ce, Co, Cr, Cs, Eu, Fe, Hf, La, Lu, Na, Nd, Rb, Sb, Sc, Sm, Ta, Tb, Th, U, Yb, Zn and Zr were determined by neutron activation analysis technique – NAA and the element concentrations ranged from mg kg^{-1} to %. For validation methodology the reference materials Buffalo River Sediment (NIST SRM 2704) and Soil-7 (IAEA) were analyzed. The majority of the elements and rare earths analyzed showed concentrations lower when compared with shale and earth crust values. The concentration variations of the elements according to the depth were evaluated too. Factorial analysis, mode R, Cluster analysis and principal component analysis were applied for the data interpretation. Some elements showed concentrations slightly high, probably due to variations on water level in flooding periods.

Determination of Elementary Basal Levels in Sediments of Baixada Santista, São Paulo, Brazil.

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Sediments may accumulate contaminants in concentration relatively high that can persist for long periods over the time. The presence of these pollutants represents a threat for the environment and for the ecological system. A major problem concerning environmental studies that uses sediments for the evaluation of environmental impact is to determine the natural levels of the elements of interest. The concentration of the determined elements can be compared to reference values as shale or mean values of the crust. A more realistic scenario is obtained when the basal concentration is used as the standard for comparison. The objective of this work is to determine the basal levels of the elements As, Ba, Br, Ce, Cs, Co, Cr, Eu, Fe, Hf, K, La, Lu, Na, Nd, Rb, Sb, Sc, Se, Sm, Ta, Tb, Yb and Zn by using neutron activation analysis in sediments of Baixada Santista, South-Easter of São Paulo state. This region comprises a dense urbanization area that holds the biggest Brazilian industrial complex with predominant presence of petrochemical, siderurgy and fertilizer industries. For the determination of the basal levels of the elements ten cores whose depth varied from 50 to 100 cm were collected, sliced each two centimeter, grounded and homogenized. For the multielemental analyses, it was applied instrumental neutron activations analysis. Statistics applied to the results showed that the concentrations observed in core button may be considered as the natural level for the region.

Technologically Enhanced Pb-210 and Po-210 in Iron and Steel industry

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Iron and steel industry was ranked as the largest industrial source of toxic environmental contamination in USA. About 2-4 tones of various solid wastes (slag, sludge, dusts and scales) are generated per tone of steel produced. These wastes contain a notable concentration of heavy elements and radionuclides that could be a source of environmental contamination and occupational exposure.

Composite samples of different iron and steel industry's wastes were collected from four Egyptian factories. Specific activity, in Bq/kg, of Pb-210 and Po-210 was measured using gamma-ray spectrometry based on HPGe detector and alpha particle spectrometry based on PIPS detector after radiochemical alpha source preparation. The specific activities of Pb-210 and Po-210 were in the range of < DL–4238 and 1-5656 Bq/kg, respectively. Occupational dose due to dusts inhalation was calculated. According to the assumed scenario, the occupational exposure is much lower than the reference dose limit. The environmental impact due to wastes storage and/or use should be considered generally and case by case.

Effects of Soil Properties on Natural Radionuclides concentration in Arid Environment: A Case Study

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Soil properties are a key factor in the functioning of soil. Naturally occurring radionuclides (NOR), U-238 series, Th-232 series and K-40, have a wide range of concentrations in soils that depends on their origins, their physical and chemical properties, and on some man-made activities such as agricultural application of phosphate fertilizers and different ores mining. Twenty eight soil samples were collected from, arid environment in the central region of Saudi Arabia, 14 locations in an agricultural farm. Two samples, one from cultivated land and the second from uncultivated land, of the same origin were collected from each location to study the changes of soil properties due to dry-land use and its effects on NOR concentration and distribution. The specific activity, in Bq/kg, of Ra-226 (U-238 series), Ra-228 (Th-232 series) and K-40 were measured using calibrated gamma-ray spectrometer based on hyper pure germanium (HPGe) detector. The soil properties, pH, EC, particle size distribution (clay, silt and sand percentages), $CaCO_3$ %, soluble cations (Ca, Mg, Na and K) and soluble anions (CO_3, HCO_3, Cl and SO_4) were determined for all samples. The radium equivalent activity, in Bq/kg, and absorbed dose rate one meter above the ground, in nGy/y, were calculated. The average specific activity, in Bq/kg dry weight, of Ra-226, Ra-228 and K-40 were 26.9, 35.4 and 592 for all samples, 28.3, 39.15 and 596 for cultivated soil samples, and 25.5, 31.6 and 588 for uncultivated soil samples, respectively. Generally, there are not noticeable changes in soil properties due to agricultural activities and there are not strong correlations between the soil properties and NOR specific activities. That could be due to the sandy nature of the soil and the effects of adsorption-filtration processes on the behavior and the distribution pattern of NOR in arid environment. Therefore, the environmental impacts of different man-made activities on underground resources should be carefully considered due to the possible filtration behavior of different pollutants in dry-land environment.

NATURAL RADIONUCLIDE FROM SOIL IN A LANDFILL AREA INVESTIGATION

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A study was conducted to determine ^{232}Th, ^{238}U, ^{228}Ra, ^{226}Ra and ^{40}K concentrations in deep soils, from a landfill area. A total of 23 soil samples were collected from deeps range of 1.45m to 18.45m on the different lithological units of the study area. The soil samples were dried, sieved through a fine mesh, sealed in 100-ml HDPE flasks and assayed for high-resolution gamma spectroscopy, considering radioactive equilibrium of the samples and instrumental neutron activation analysis. The results presents a concentration range of (38 to 287) $Bq \times kg^{-1}$ of ^{238}U, (35 to 200) $Bq \times kg^{-1}$ of ^{232}Th, (42 to 124) $Bq \times kg^{-1}$ of ^{228}Ra, (16 to 89) $Bq \times kg^{-1}$ of ^{226}Ra and (390 ± 306) $Bq \times kg^{-1}$ for ^{40}K. The arithmetic mean values (AM ± SD) calculated from all samples are: (115 ± 83) $Bq \times kg^{-1}$ for ^{238}U, (101 ± 55) $Bq \times kg^{-1}$ for ^{232}Th, 60 ± 19 $Bq \times kg^{-1}$ for ^{228}Ra, 47 ± 19 $Bq \times kg^{-1}$ for ^{226}Ra and (170 to 1260) $Bq \times kg^{-1}$ for ^{40}K. The data shows that human practices can affect the levels of occurring radionuclide in contemporary soil samples, which will vary greatly according to the geologic origin and composition of the soil and the exposure history in terms of time, industrial practices, anthropogenic additions and exposure to fallout. Clearly, such variability will influence decisively the strategies of management of an interest area. Such applied methodology was successfully appropriated to diagnosis related radioactivity level.

Visual Gamma – Gamma Spectrometry Analysis Software

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Abstract will be available at the conference.

Abstracts

Tuesday 25 November

Session 4: Dose Assessments

Nuclear Forensics – New Approaches

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A combined research group from the above universities is trying new approaches for determining the radiation doses from historic nuclear explosions at Hiroshima, Nagasaki, and Semipalatinsk. It transpires that Be-10 is made by fast neutron reactions on the C-13 in carbon dioxide in air and its presence has been verified by AMS measurements. Work continues on trying to measure the isotope in the remains of carbon-containing substances exposed to the blasts, and in soils from Semipalatinsk. At Hiroshima only, U-236 was created from the U-235 of the bomb, and appears to be detectable in the black rain reported. This should allow a better mapping of the black rain distribution.

RADIOLOGICAL ASSESSMENT OF NARGHILE SMOKING: Radioactivity Levels and Dose Assessment

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Narghile (hookah, shisha, goza, "water-pipe") smoking has become fashionable worldwide. Its tobacco pastes, known as moassel and jurak, are not standardized manufacture and generally contain about 30-50% (sometimes more) tobacco, molasses/juice of sugarcane, various spices and , dried fruit (particularly in jurak) and, in the case of moassel, glycerol and flavoring essences. Tobacco contains minute amounts of radiotoxic elements such as 210Pb, 210Po and uranium, which are inhaled via smoking. Only very few data were published on the concentrations of natural radionuclides in narghile tobacco mixtures. Consequently,the aim of this study was to draw first conclusions on the potential hazards of radioactivity in moassel tobacco in relation to narghile smoking. The results indicate the existence of a wide range in the radioactivity contents where the average (range) activity concentrations of 238U, 234Th 226Ra, 210Pb, 210Po, 232Th and 40K, in Bq/kg dry
weight were 55 (19-93), 11 (3-23), 3 (1.2-8), 14 (3-29), 13 (7-32), 7 (4-10) and 719 (437-1044) Bq/kg dry weight, respectively. The average concentrations of natural radionuclides in moassel tobacco pastes are comparable to their concentration in Greek cigarettes and tobacco leaves, and lower than that of Brazilian tobacco leaves . The distribution pattern of these radionuclides, during tobacco products smoking, between smoke, ash and filter is unknown, except for 210Po during cigarettes smoking and (only one existing study) during moassel smoking. Radiological dose assessment due to intake of natural radionuclides was calculated and the possible radio-toxicity of the measured radionuclides is briefly discussed.

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Derivation of regional concentraton factors for radium in bush passionfruit (*Passiflora foetida*) from the Alligator Rivers Region, Northern Territory, Australia

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Development of radiological dose models for Aboriginal people living in the Alligator Rivers Region (ARR) is required to determine the dose received from all pathways from past and present uranium mining activities. However, current understanding of the contribution of radionuclides via ingestion of terrestrial plants is limited. ^{210}Po, ^{210}Pb and ^{226}Ra have previously been identified as the main contributors to radiological dose via the ingestion pathway for Aboriginal people eating traditional terrestrial bush food items, such as fruits and yams.

The most common approach used to assess radionuclide uptake in these models is by the use of concentration factors (CFs) for each food item and radionuclide. These are commonly expressed as the ratio of the radionuclide activity concentration in the food item to the activity concentration measured in the soil in the plant root zone. The IAEA provides default CF values for some food items but analogies used for local foods (eg – the common potato as an analogy to a local yam) in the ARR have been shown to be inaccurate, in some cases by several orders of magnitude. Thus the need exists to develop specific CFs for the region, or even for individual sites. CFs for radionuclides in terrestrial biota determined by using total soil concentrations have spanned a very wide range, typically 3 orders of magnitude.

Various techniques have been suggested to operationally define the transfer mechanisms of radionuclides from soil to plant in an attempt to lower variability in determined CFs. The majority of these attempt to define the 'bioavailable' fraction within the soil by chemical techniques such as sequential extraction. In our study, a soil sequential extraction procedure was developed to assess partitioning of radium isotopes within soils in the ARR. Samples were selected from a wide range of sites including areas impacted by uranium mine tailings, mine waste waters and sites unimpacted by uranium mining. Correlation of ^{226}Ra/^{228}Ra activity ratios in soil fractions from the plant root zone with those in the edible fruit of the introduced passionfruit species (*Passiflora foetida)* was used to infer the specific sources of radium uptake for the fruit. CFs relative to each of the soil fractions contributing to uptake were developed and though a limited range of samples have been fully characterised to date, results indicate this may provide a more accurate, less variable approach to the determination of concentration factors for plant uptake of ^{226}Ra. The study also contributes to growing research indicating that ^{228}Ra can be more bio-available and may contribute more to radiological ingestion dose than ^{226}Ra.

^{131}I discharges to the marine environment and uptake by algae in Sydney, Australia

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The use of radiopharmaceuticals in nuclear medicine results in radioactive material being discharged to the sewer as human waste. Treated sewage effluent is in turn discharged to the marine environment through coastal and deepwater outfalls. ^{131}I is the dominant medical isotope discharged to the environment as treatment doses can be large (up to 8 GBq) and excretion from patients is rapid. Also, ^{131}I has a half life (8.04 days), which is significantly greater than the effluent residence time in the sewerage system (< 1 day), and a low K_d resulting in a low removal during treatment. ^{131}I levels from <1 to 150 Bq/L have been measured in effluent from Sydney sewage treatment plants. Following discharge of effluent to ocean outfalls, ^{131}I levels in the seawater are likely to be low as a result of dispersion and dilution of the effluent. However, ^{131}I is easily detected in macroalgae growing near coastal outfalls as the algae bio-accumulate iodine. In fact, ^{131}I levels between 1 and 375 Bq/kg have been observed in various macroalgae species near the outfall from Cronulla sewage treatment plant in Sydney, since November 1995. This paper presents data on ^{131}I levels in effluent and uptake by algae growing near shoreline outfalls in the Sydney region. Radiation doses to marine biota from ^{131}I discharged to coastal waters are calculated to be very small and below the ERICA screening level of 10 μGy/hr. Human dose assessment is also discussed.

Method development for tritium measurements and initial evaluation of tritium data for tree transpirate from a legacy waste site in eastern Australia

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Tritium (^{3}H), as tritiated water, was one of the radioactive substances placed into the trenches located within the former waste disposal site known as the Little Forest Burial Ground (LFBG). This site is located in the 1.6 km exclusion zone surrounding the previous ANSTO research reactor, HIFAR, south of Sydney. Tritium will behave conservatively in regard to any seepage from the site of deposition, and therefore should be a good indicator of groundwater movement at the site.

Water is also a vital requirement of plants on the site. Hence, it was proposed that analysis of the tritium content of shrubs and trees may be a useful means to assess and access the biologically available ^{3}H. In addition, it should provide an indication of potential exposure for environmental dose assessment, not only for ^{3}H but also for the other radionuclides potentially migrating with the water from the trenches. To test these ideas, sampling of tree transpirate at LFBG has been initiated.

In order to utilise measurements of ^{3}H in transpirate as a monitoring tool, some method development has been required. Relatively small sample volumes have required atypical preparation methods and sample quenching has been an issue. There is also a need to consider background concentrations, given that the HIFAR reactor at the Lucas Heights Research Reactor has emitted ^{3}H to the local environment for several decades. Results of sampling and analysis since July 2007 will be presented and each of these issues will discussed in this initial report.

A study of radium bioaccumulation in freshwater mussels, *Velesunio angasi*, in the Magela Creek catchment, Northern Territory, Australia

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^{226}Ra in freshwater mussels, *Velesunio angasi*, has been identified as the main contributor to radiological dose via the ingestion pathway for Aboriginal people living downstream of the Ranger mine in the Magela Creek catchment. This is because freshwater mussels are an integral part of the diet, the concentration factor for radium in mussels is high, and the dose conversion factor for ^{226}Ra is large. As part of ***eriss***' routine monitoring program, uptake of selected metals and radionuclides, in particular ^{226}Ra, in freshwater mussels from Mudginberri Billabong (downstream of the Ranger mine in the Magela Creek catchment) and Sandy Billabong (control site in the adjacent Nourlangie Creek catchment) is measured annually. In addition to the human health aspect, the measurements provide an ecosystem protection role because any significant increases measured through time, or compared to an appropriate reference site, have the potential for early warning of a developing issue with bioavailability of mine-derived solutes.

Results from the routine monitoring have shown that ^{226}Ra loads in mussels from Mudginberri Billabong are much higher, age-for-age, than in mussels from Sandy Billabong. To determine whether this is an effect of the operational Ranger uranium mine or due to natural differences in the geochemical signatures between the two catchments, and to determine whether there is a more appropriate control site in the Magela Creek catchment, mussels were collected at five locations along the Magela Creek channel in 2007. Radionuclide activity concentrations and other analytes including uranium and stable lead isotope ratios, were measured in mussel soft tissue, sediment and water. ^{226}Ra loads in mussels vary by one order of magnitude along the creek channel with the highest loads, remarkably, measured in mussels from the outlet of a billabong in reaches of the catchment well upstream of mining influence. This variation may be caused by differences in water and/or sediment composition and differences in mussel growth at the various locations. ^{228}Ra/^{226}Ra activity ratios in the <63 μm fraction of the sediment decline slightly along the catchment gradient, with the decline being amplified in mussel flesh, indicating a small but steadily increasing influence of a uraniferous source in the catchment, rather than a point source. This result is corroborated by stable lead isotope measurements. Our study suggests that the impact of mine- or orebody-related contaminants on radionuclide or metal concentrations measured in mussels collected from Mudginberri Billabong is negligible. It emphasizes that concentration measurements alone in bioaccumulators such as freshwater mussels may lead to Type I errors in the detection of mine impacts and that careful consideration must be given to factors such as organism metabolism and catchment geochemical signatures when choosing a control for a potentially impacted site.

An ingestion dose assessment for Aboriginal inhabitants downstream of Ranger Uranium Mine in the Northern Territory of Australia

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The Alligator Rivers Region (ARR) in northern Australia is one of the world's major uranium provinces. At present, it contains one operating uranium mine (Ranger) plus several former and proposed mines. The township of Jabiru, approximately 8 kilometres west of Ranger has a population of ~1200 with the majority of residents being workers servicing the mine. There is a small Aboriginal community living on the edge of the town, Manaburduma, which has a population of around 25 inhabitants. Another permanent Aboriginal settlement, Mudginberri, is located 12 km NNW of Ranger, downstream and adjacent to Mudginberri Billabong on the Magela Creek. As of May 2008 there are approximately 30 residents of this community living in permanent housing.

From current mining and milling operations at Ranger, the principal conduits identified for radiological exposure are the atmospheric and aquatic pathways. Martin et al (1998) have estimated the radiation dose received from the consumption of aquatic foodstuffs, using a simulated release of Ranger Rentention Pond 2 waters to Magela Creek, is dominated by the intake of ^{226}Ra in freshwater mussels. This is due to their high radionuclide concentration factors and their position in the local Aboriginal diet.

As the rehabilitation of Ranger Mine begins, land use expectations at and around the site by local Aboriginal people may move towards harvesting of terrestrial food sources. This being, the ingestion pathway has been identified as a major potential contributor to the post mining related radiological dose to humans of the area. During the development of the dose assessment models it has become apparent that these models need to be site specific and need to include local dietary habits, land use and the land use expectations of the region.

The aim of this paper is to bring together the radiological data collected from earlier studies which focussed more on the aquatic pathway, conducted by the Supervising Scientist Division over the last 25 years and combine this information with the data that has been gathered more recently, particularly the terrestrial plant and animal data. This information is then used to create an up-to-date ingestion pathway model using locally derived values, replacing the IAEA default values previously used, for the group most at risk, the Aboriginal inhabitants living downstream of the Ranger mine.

Tuesday 25 November

Session 5: Methods and Instrumentation

Matrix reference materials: preparation, characterization and use

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Reference materials are basic components of the analytical process. The term "reference material" (abbreviated RM) is a generic one covering a wide range of materials used for a variety of purposes, including for calibration of a measurement system, testing and validation of an analytical procedure, and quality control. The important points are that the material must be fit for its intended use in the measurement process, and that it is used properly.
This presentation will cover some essential aspects of preparation, characterization and use of matrix reference materials, with a focus on IAEA reference materials characterized for radionuclides. Topics covered will include basic definitions, different approaches to characterization of materials, RM certificates, appropriate uses for RMs, and storage and RM stability.
Reference materials are commonly used as an essential part of proficiency test (PT) exercises, including proficiency tests organised by IAEA laboratories. Some aspects of proficiency tests will be covered in this presentation, including various approaches to data evaluation and what laboratories can learn from their participation.

Rapid determination of uranium, thorium, plutonium, americium and strontium activities in water, soil and vegetation.

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A rapid technique for the isolation of U, Th, Pu, Am and Sr isotopes from environmental matrices has been established using resin cartridges and a vacuum box which are commercially available from Eichrom Technologies (Darien, IL, USA).

Separation and isolation of the various elemental fractions from a single sub-sample is possible, thereby eliminating the need for multiple analyses. The time taken for concentration, separation, purification and source preparation is 10 hours for 12 samples, making this technique an excellent option when fast turn-around is required.

The technique involves sample dissolution, concentration via calcium phosphate co-precipitation, resin separation and purification using TEVA™, TRU™ and Sr-Spec™ resin cartridges and alpha spectrometry for U, Th, Pu and Am and Cerenkov counting for Sr.

The technique was tested with various standard reference materials. Chemical yields are in the range of 80 – 95 % for all elemental fractions, except for Sr which is typically 60%. Sample sizes of up to 10 litres for water, 5 grams for soil and 10 grams for ashed vegetation were able to be processed using this technique. Major matrix interferences that were encountered include potassium and strontium.

Sequential injection chromatography in the development of automated radiochemical separations

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Automated analytical techniques are well developed and used in the analysis of trace components where they are generally applied to small samples utilizing relatively simple chemical procedures. The measurement of radionuclides at levels typically encountered in the environment requires the processing of large samples using multi-step chemical separation which has held back the development of automated radiochemical techniques.

Sequential Injection Chromatography (SIC) systems provide flexible liquid handling and sample pre-treatment for the automation of complex chemical separations. This technique can be applied to radiochemical separations utilising selective filters and selective ion resins that are available for the separation of naturally occurring and anthropogenic radionuclides.

This work outlines the development of efficient and simple chemical separation methods using chromatographic resins and the development of an automated separation system based on SIC techniques which will enable the simultaneous radiochemical separation of radionuclides important to environmental studies.

Keywords: sequential injection chromatography, flow injection analysis, automation of radiochemical separations

An improved and rapid radiochemical method for the determination of polonium-210 in urine

E. Manickam, S.Sdraulig, R. O'Brien

Measurements of radionuclides in urine are widely used for assessing the effect of intakes of radionuclides. The events in London in early 2006 highlighted the need for rapid and reliable methods which can be applied to emergency situations. Ideally such a method would also be applicable to the routine assessment of radionuclides in urine. This presentation discusses the development and validation of such a method for measuring ^{210}Po in urine. In this method a known amount of ^{208}Po is added to the sample as a radiochemical tracer, and the polonium isotopes are separated from the bulk urine sample using a manganese dioxide coprecipitation technique. The polonium is then deposited on a silver disc followed by measurement using high resolution alpha spectrometry. The method is validated by assessing the selectivity, accuracy, recovery of the method and the quantification of uncertainty.

"Advances in portable radiation monitoring and measuring instruments."

Graeme McDonnell
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Canberra Industries has released a new range of radiation monitoring instruments with **novel** features that expand the range of counting applications.
Our top of the range Falcon 5000 is a portable high resolution radionuclide identification instrument for security, emergency and assessment applications, either in the field or the lab. Down through our current range to the latest addition, the Colibri Survey Meter.
The latest technology Colibri TTC: CSP™ Survey Meter has Mapping and Networking Applications using Wi-Fi, blue tooth and networking plus GPS and RFID. It can monitor or log up to 8 detectors and can be coupled to the existing CSP smart probes using the CSP-COM. The CSP-COM module is ideal for remote monitoring applications, monitoring radiation in hot zones without human intervention or to centralise data acquisition. It can also simplify instrument installation by eliminating cables.
Falcon 5000, Colibri, CSP-COM

Density correction – a better method for difficult samples

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When most powdered samples are analysed using gamma-ray spectrometry, the ability to accurately determine the concentration of low energy nuclides such as Pb-210 (46.5 keV), Th-234 (63.3 keV), and Th-230 (67.7 keV) requires some degree of density correction. A general method has been previously discussed using a Ra-226 point source to determine attenuation through the sample.

However relatively dense samples and those containing certain elements require a more complex correction process to obtain correct concentration data. In these cases it is not possible to accurately measure the Pb-210 peak in the point source through these samples. The point source method was extended using major element data and incorporated into an Excel spreadsheet. Results obtained from a number of different samples and matrices were compared with nuclide data obtained using a density correction algorithm incorporated in existing proprietary software. These will be discussed.

Metrological Assurance of Radioactive Discharges Monitoring Systems in Czech NPPs

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Complex monitoring systems for measurement of particulate, gaseous and liquid radioactive discharges are used in Czech NPPs. Some subsystems are spectrometric because of radionuclide specific radiation protection limits effective in European Union. The paper describes methods and special tools (standard sources and others) used for metrological assurance performed by Czech Metrology Institute beyond the bounds of metrology law.

Low-level Gamma-Spectrometry by using Compton suppression – testing the performance of two systems at the ANSTO Low Level Radiochemistry Laboratory.

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The successful use of gamma-spectrometry to measure very low level radioactivity relies on several factors, including the actual system and shielding, as well as environmental factors. A low-level laboratory needs to be in a geographic location with low back ground radiation, built with low background materials. The laboratory should ideally be built underground to minimize the interference from cosmic radiation. Compton suppressed systems have been designed to reduce background caused by Compton scattering.
The background can be reduced by the use of Compton Suppression. This is achieved by introducing a second detection system. This second detection system, consisting of a large single crystal NaI annulus, detects the escaping energy from partial absorbed photons in the primary detector, the High purity Germanium detector.
As set of standards tests to check the performance of the Compton suppression systems has been devised by the Monaco Laboratory (J-F Commanducci, 2003). These tests have been carried out on both ANSTO systems and show a considerable improvement in Compton to peak ratios in the testing and an overall decrease in background due to the stripping of incomplete photon absorption in the primary detector.
The two systems allow small environmental samples to be analysed for isotopes such as Pb-210, Cs-137 and Be-7, without comprimising the detection limit too much.

J-F Commanducci, 2003: Construction du Laboratoire Souterrain et des Spectrometres a coincindences "faible bruit" destines a la surveillance de L'Environment Marin. IAEA-MEL Document. PP 69.

Wednesday 26 November

Session 6: Environmental Studies 2

APPLICABILITY OF SURFACE AREA NORMALISED DISTRIBUTION COEFFICIENTS (K_a) IN INTERPRETING MEASUREMENTS OF RADIONUCLIDE SORPTION

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The mobility of radionuclides in the environment is a key issue in assessing the future performance of nuclear waste repositories and modelling the movement of radionuclides in contaminated sites. There have been numerous experimental studies of the adsorption of radionuclides, however, it remains difficult to model the uptake of radionuclides by soils and other complex multi-component geologic materials. Although it would be desirable to utilise mechanistic sorption models (such as surface complexation models) in environmental radionuclide transport modelling, these require a large amount of experimental data and involve considerable mathematical complexity. Therefore, they are not yet available for predictive modelling of complex systems. As a result, predictions of the mobility of radionuclides in the environment generally rely on descriptive measured parameters, such as the solid-liquid distribution coefficient (K_d value) for which various compilations of data values are available (e.g. Sheppard and Thibault, 1990). In order to better understand the mobility of radionuclides in the environment, it has been proposed to utilise a surface area normalised distribution coefficient (K_a value) in which the K_d values are normalised by the measured sample surface area (Pabalan et al., 1998). The concept is developed in this paper by analysing radionuclide sorption measurements from several data sets, including experimental data for well characterised geological materials that were obtained from candidate low-level nuclear repository sites in Australia. In addition, several data-sets summarised in the extensive RES^{3}T database (Brendler et al., 2003) are also utilised in determining whether the K_a would be an applicable tool to constrain the ranges of sorption values expected for natural materials in the environment. Finally, we discuss the conditions under which the K_a value provides useful insights into radionuclide mobility and possible limitations in its applicability.

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Pabalan, R.T., Turner, D.R., Bertetti, F.P., Prikryl, J.D., 1998. Uranium^{VI} sorption onto selected mineral surfaces. In: Jenne, E.A. (Ed.), Adsorption of Metals by Geomedia. Academic Press, San Diego, pp 99-130.

Sheppard, M.I., Thibault, D.H., 1990. Default solid/liquid partition coefficients, K_ds, for four major soil types: a compendium. Health Physics, 59, 471-482.

Radiological Study in Caves of Southwest Brazil

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The *Parque Estadual Turístico do Alto Ribeira* (PETAR) is located in the Southwestern part of São Paulo State, in Ribeira Valley. In this region is found the major number of cave occurrence in Brazil and also shelters the most visited caves of the country. Caves, usually located in a karstic zone, are characterised by the presence of carbonaceous rocks frequently fractured and collapsed. Carbonates (dolomites and calcitic rocks) usually have low U and Th, however, surrounding rocks can be found containing in structural positions U and Th. Radon generated in these rocks may migrate in the subsoil penetrating this carbonate due to its greater permeability causing high radon concentration. It is known that radon emission depends on conditions of the local micrometerology, geological factors and the concentration of U and Th Decay series. In the sense to understand the radon concentrations in these caves, the objective of this paper is to determine the ^{238}U, ^{232}Th, ^{226}Ra, ^{228}Ra and ^{210}Pb in rock, soil and sediment samples by alpha spectrometry and total alpha and beta measurement. The concentrations of radon and thoron in the air's cave were determined in air by solid state track detector. As a complementary study neutron activation analysis also were performed in soil, rock and sediment samples.

Six of the most visited caves, named Santana, Água Suja, Morro Preto, Couto, Alambari and Laje Branca were studied. High radon concentrations was found in Santana Cave, the same with higher concentrations of U and Th.

^{7}Be AND ^{210}Pb CONCENTRATIONS IN AIR, RAIN WATER AND SOIL IN SÃO PAULO, SP – BRAZIL

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The short-lived cosmogenic isotope ^{7}Be ($T_{1/2}$ = 53.3 d) and the natural daughter product of ^{222}Ra, ^{210}Pb ($T_{1/2}$ = 22.3 y) have been widely used as tracer soil erosion, transport processes in watershed and chronometers in the environment. These isotopes have also been utilized to determine the aerosol residence time as well as removal rates of aerosols. The concentrations of these radionuclides were determined in samples of air at a ground level, rain water and soil during the period from 2003 to 2007 at Instituto de Pesquisas Energéticas e Nucleares - IPEN's campus located in the city of São Paulo, São Paulo, Brazil. The sampling site is approximately 10 km west from downtown São Paulo (23°32'S - 46°37'W at 760 m above sea level). Climate in the area is temperate tropical with dry period in winter and rainy in summer with the annual rainfall ranged from 443 mm to 1083 mm. The annual average temperature is 19.1°C, showing minimum and maximum of 15.3°C and 24.9°C, respectively. The radionuclides were measured by non-destructive γ-ray spectrometry in all samples with exception only in rain water samples where ^{210}Pb was measured by beta gross counting in a gas flow proportional detector, after radiochemistry procedure. For γ-ray spectrometry a coaxial Be-layer HPGe detector with 22% relative efficiency, 2.09 keV resolution at 1.33 MeV and associated electronic devices were used, with live counting time of 150,000 s. The spectra were acquired by multichannel analyzer Ethernim and, for the analysis, WinnerGamma software was used. The obtained results for both radionuclides in all sort of samples show that they present a similar behavior with zones of analogous latitude, but in Northern hemisphere, in spite of São Paulo city being situated in low latitudes of Southern hemisphere. The concentrations displayed clearly seasonal variations with higher values in spring and summer time and with the amount of precipitation.

Comparison of Be-7 analysis using two gamma spectrometry systems and software packages

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Naturally occurring radioisotope, Be-7, can be used to study short term deposition and resuspension cycle of surficial bed sediments. The activity of Be-7 can be determined by gamma spectrometry. Due to Be-7 short half life, samples must be analysed within a few days of collection on several gamma spectrometry systems. To test the precision of Be-7 data from two gamma spectrometry systems and software packages, multiple analysis of a sediment sample was performed over 6 months. A statistical procedure was used to investigate the precision of the analytical data as the activity of Be-7 decreases over time. The sample was prepared from a sediment sample spiked with Be-7 activity, collected from fresh rain water, and counted on High Purity Germanium (HPGe) gamma spectrometry systems from EG&G Ortec and Canberra. Software packages Gamma Vision and Genie-PC were employed to determine peak areas and activity calculations. Calculations were also performed manually by visual determination of the Be-7 peak region of interest and simple gamma spectrometry calculation procedure.

Abstracts

Thursday 27 November

Session 7: Radioactivity in Soil

Use of fallout radionuclides to evaluate the effectiveness of changes in tillage systems for reducing soil erosion on agricultural land

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Intensification of agricultural production in south-central Chile since the 1970s has increased soil erosion and associated soil degradation. These problems have prompted a shift from conventional tillage (CT) to no-till without burning of crop residues (NT) system. The erosion rates found on Ultisols of the Coastal Mountains of south-central Chile, are described as being amongst the highest for any agricultural land in Chile due to CT operations. The implementation of NT system has been shown to cause important improvements in the quality of these soils. However, there remained a need to assemble information on the magnitude of the decrease in soil loss associated with the shift from CT to NT systems, in order to provide a more rigorous confirmation of the likely impact, and therefore effectiveness, of such changes in land tillage system.

A standard and a simplified method for using measurements of the ^{137}Cs depth distribution to estimate mean rates of soil loss/accumulation at a sampling point under CT and after the shift to a NT system have been developed. Additionally, to assess the changes from no-till system without burning (NT) to a no-till system with burning of crop residues after harvesting (NTWB), ^{7}Be was successfully used for quantifying the erosion that occurred within the same study area, as a result of burning and a period of extreme rainfall (400 mm in 27 days occurring in May 2005).

The results obtained for a study field located in the Coastal Mountains of the Araucanía Region, characterized by Araucano series Ultisols (Typic Hapludult), a temperate climate and a mean annual precipitation of 1100 mm $year^{-1}$ showed that 16 y after the shift from CT to NT, including crop residue management, the longer-term net erosion rate had been reduced by about 87% (from 11 t ha^{-1} $year^{-1}$ to 1.4 t ha^{-1} $year^{-1}$) and the proportion of the study area subject to erosion from 100% to 57%, and therefore that soil and nutrient loss had been significantly reduced.

The net erosion associated with the NTWB system and the extreme rainfall event that affected the study area was estimated to be 12 t ha^{-1}. This indicated that a large proportion of the soil and ash were mobilised by erosion and transported beyond the study area during the period of heavy rainfall. Comparing this results with the medium to long-term net erosion rate (1.4 t ha^{-1} $year^{-1}$) associated with a prolonged period of NT without burning of crop residues, suggests that burning of crop residues in the autumn is an undesirable practice, which can promote excessive soil loss during the following rainy season, especially if high magnitude erosive events occur.

The new procedures, which permit the changes in erosion rates associated with a shift in tillage practices within the same field to be estimated, must be seen as representing a novel application of fallout radionuclide measurements in soil erosion investigations. Measurements of ^{137}Cs and ^{7}Be have been successfully used to estimate soil redistribution and its spatial distribution associated with three contrasting tillage systems: CT, NT and NTWB at the same area of a field.

The work reported was financed by FONDECYT 1060119, 7070075 and 7080041, IAEA CHI-12321, DID S 2006-12.

Using Cesium-137 to study soil redistribution in Guam and Hawaii

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Understanding soil redistribution and sediment sources on the landscape are keys for the development of management strategies for reducing soil erosion and the delivery sediments to floodplains, streams and water bodies. Fallout Cs-137 has been used extensively to measure soil redistribution, to determine floodplain deposition patterns and rates, and as a tracer or fingerprint to identify sediment sources within a watershed. The objective of this study was to use Cs-137 to study soil redistribution patterns on the landscape and to determine the source of sediments in a watershed in Guam and Hawaii. Soil samples were collected from the various geomorphic surfaces and floodplain deposits in the Hanalei River Watershed in Kaua'i, Hawaii and in Sasa Watershed Guam and analyzed for Cesium-137 concentration. Recently deposited sediments on floodplains in both regions showed deposition in the last 50 years. In the Hanalei Bay watershed, Cs-137 concentration varied with upland soils > colluvial slopes > floodplain deposits > stream banks > Bay sediments. Preliminary results using a simple mixing model to determine sediment sources indicate that stream banks and mass wasting are probably the most significant sources of sediments deposited on the floodplains and in the Hanalei Bay.

Proposed abstract for 10th South Pacific Environmental Radioactivity Conference in Christchurch, New Zealand November 24-27, 2008.

Patterns of spatial distribution of natural and artificial radionuclides in soils at catchment scale (South Central Pyrenees)

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Natural and artificial gamma-emitting radionuclides (^{238}U, ^{226}Ra, ^{232}Th, ^{210}Pb, ^{40}K and ^{137}Cs) were determined in soils across a small catchment in the Central Spanish Pyrenees. The study was conducted in a mountain area which is representative of the Tertiary Flysch landscapes in the South Pyrenean region. A total of seventy-seven bulk soil cores were collected at the intersections of the 200 x 200 m grid established in the the Arnás River catchment. Mean radioisotope activities (Bq kg^{-1}) range from 20 to 60 for ^{238}U; 21 to 35 for ^{226}Ra; 24 to 50 for ^{232}Th, 27 to 140 for ^{210}Pb, 446 to 799 for ^{40}K and 4 to 65 for ^{137}Cs. The largest variability was found for ^{40}K, ^{210}Pb and ^{137}Cs, whereas the less variable were ^{226}Ra and ^{232}Th. The relationships between some basic soil properties and the radionuclide activities indicate that only fallout ^{210}Pb and ^{137}Cs that are fixed to the fine fraction of the soil are directly related to organic matter contents, cation exchange capacity and water retention.

The radionuclides showed different spatial patterns that were mapped with GIS and according to the geospatial interpolation there were significant differences in their distributions. The radionuclide spatial patterns were closely related to physiographic features such as gradient, length, orientation and vegetation cover of the slopes. In the catchment the river bank side less vegetated and with steepest slopes had the lowest radionuclide activities, suggesting that physical processes such as erosion is a main factor of transport of the radionuclides in association with soil particles. The results provide insights into the main factors that have affected the spatial distribution of the radionuclides in the catchment. This research may contribute to improve the knowledge of the behaviour of radionuclides in the environment and to derive information on the factors that affect their mobility in the ecosystems.

Negligible soil erosion at Balmoral Station, Mackenzie Basin over the last 60 years: an assessment based on 137Cs and Kawakawa tephra

Leckie, H. D. and Almond, P. C.

Many authors have reported significant soil erosion resulting from grazing of sheep,rabbit plagues, and invasion of the exotic weed *Hieracium* in the sub humid environmentof Mackenzie Basin. However, inferences have generally been based on subjectiveassessments influenced by vegetation depletion and proportions of bare ground.This study quantifies erosion of orthic Brown Soils formed in loess on Balmoral Station,Mackenzie Basin, over the medium term (ca. 60 years) and the long term (ca. 27,000years). We compare (1) the soil profile inventory of 137Cs, and (2) the soil profiledistribution of Kawakawa tephra grains between an uneroded reference site of redtussock (*Chionochloa rubrà*) and degraded sites of depleted short tussock and herbfieldvegetation to estimate medium term and long term erosion, respectively. Topsoilthickness, percent bare ground and vegetation type were also assessed for each sample.The vertical distribution of 137Cs at the reference plot showed the exponential decreasewith soil depth characteristic of stable sites. 137Cs inventories at degraded sites werereater than the reference plot. The 137Cs inventories and relationships with topsoilthickness and ground cover indicate the degradation of the present landscape was notcaused by erosion in the last 60 years. The lack of correlation between vegetation coverdensity and 137Cs inventory also suggests a lag between vegetation dynamics and erosionresponses. There is no evidence to suggest that establishment and rapid invasion of*Hieracium*, and major periodic rabbit plagues, have accelerated soil erosion over the past60 years.Kawakawa Tephra deposited within the loess at the study site occurred as disseminatedmicroscopic grains of glass. The total inventory and depth to the glass concentrationmaximum were greatest at the reference plot, and both measures declined progressivelywith increasing level of visually assessed degradation in the degraded plots. The primaryKawakawa tephra emplacement horizon was identified at 7085cm at the reference plot.Maximum erosion rate averaged over the last 27,000 years was 0.002 cm/yr.
We present circumstantial evidence to suggest that soil erosion at Balmoral Station,Mackenzie Basin, has principally occurred since the arrival of Maori 800 BP, andpotentially as recently as arrival of Europeans 150 years ago, but not in the last 60 years.This interpretation implies significantly greater potential erosion rates of up to 0.33cm/yr. Despite the lack of measurable erosion in the last 60 years the potential for erosionrates as high as 0.33 cm/yr suggests the soil resource is extremely vulnerable to completeloss.

Using plutonium as a probe of change in erosion processes?

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Abstract

The Cotter River catchment in the Australian Capital Territory has been the main water supply for Canberra since the city was established. Pine plantations occupy significant parts of the lower catchment and in 2003 a substantial bush fire led to conditions conducive to enhanced erosion across much of the plantation area. Strong rains shortly after the bushfire led to elevated sediment levels in the waterway which had a significant detrimental impact on the quality of the water in the dam. A study to assess the potential of using fallout plutonium, which originated from atmospheric nuclear weapons tests, as a tool to investigate fire-related changes in the erosion processes at work in the Cotter catchment has been initiated. Accelerator mass spectrometry is being used to measure plutonium in soil and sediment samples collected from a number of sites across the catchment. The results and findings to date will be presented.

Keywords: Plutonium, Accelerator Mass Spectrometry, soil & sediment transport

Thursday 27 November

Session 8: Radioactivity in Sediments

From the River to the Sea - Using fallout plutonium to investigate erosion and sediment transport.

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Abstract
Atmospheric nuclear weapons tests in the 1950's and 1960's resulted in small but well defined quantities of the ^{239}Pu and ^{240}Pu being distributed around the globe. These isotopes bind strongly to sediment particles, and provide a tracer which can be used to investigate the mobilization of topsoil from hillslopes and its transport through the river catchment. We have been exploring the potential of using plutonium to trace sediment from the Herbert River, Queensland, Australia, as it moves through the river network into the estuarine and near-shore zone, and potentially into the Great Barrier Reef Lagoon. To achieve this we have exploited the ultra-high sensitivity of Accelerator Mass Spectrometry (AMS) using the 14UD accelerator at the Australian National University. AMS measurements are required because of the very low plutonium concentrations present in the sediment material and ocean water samples, and they readily permit determination of the $^{240}Pu/^{239}Pu$ ratio. The results are compared with those obtained using the more traditional topsoil tracer, fallout ^{137}Cs, and highlight the value of plutonium as a tracer of terrestrial sediment in the near-shore zone.

Keywords: Plutonium, Accelerator Mass Spectrometry, Sediment transport

Fallout plutonium as a chronometer in Australian sediments

G.J. Hancock, S. Tims, K Fifield and S. Everett.

The construction of high resolution chronologies of sediment profiles corresponding to the last 50-100 years usually entails the measurement of excess ^{210}Pb and ^{137}Cs. The anthropogenic "bomb" fallout nuclide, ^{137}Cs, can provide an important "first appearance" horizon of known age (the mid-1950's), giving much-needed corroboration to the often ambiguous interpretations associated with ^{210}Pb geochronology. However, while ^{137}Cs provides a strong signal in sediment in the northern hemisphere, total fallout of ^{137}Cs in the southern hemisphere was much lower and the low activities of ^{137}Cs seen in Australian sediments often makes its horizon of first appearance somewhat arguable. Moreover, the 1964 fallout peak usually seen in the northern hemisphere is usually difficult to discern south of the equator.

This presentation will show examples of the use of 'bomb" fallout Pu as a chronometer in Australian sediment profiles. Not only is Pu easier to detect than ^{137}Cs, but it provides additional dated horizons resulting from isotopic changes in fallout Pu during the 1950's and 1960's. In particular, the ^{238}Pu/(total Pu) ratio shows a significant shift in the mid-1960's and is an ideal marker for South Pacific sediment chronologies. Compared to ^{137}Cs, Pu is preferable for the dating of estuarine and near-marine sediments due to the more efficient removal of Pu from the water column and the potentially non-conservative behaviour of ^{137}Cs in saline water.

Analysis of Pacific Ocean floor sediments by the method of neutron activation

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Abstract

During the cruise of the Japanese Research ship Koyo Maru in 1999, 12 grab sediments were taken from the Pacific Ocean floor in the region between the Suva peninsula and the Kadavu island, Fiji. The sediments were collected from distances of 5 – 50 km from the main land and at ocean depths in the range of 500 – 2000 m.

Elemental abundances in the sediments were investigated using the method of neutron activation analysis (NAA). The sediment samples were irradiated in 2003 at the ANTSO nuclear reactor at Lucas Heights, NSW, Australia, and flown back to USP and analyzed using a high-resolution gamma-ray spectrometer (HPGe). A total of 23 elements (Fe, As, Br, Sc, Cr, Co, Rb, Sr, Zr, Zn, Sb, Cs, Hf, Ta, Th, La, Ce, Nd, Na, Sm, Eu, Tb, Yb) were determined by this method.

A comparison of the elemental abundances of these sediments with those of the Suva lagoon and other locations nearer to the mainland shows that these ocean sediments are derived from sediments washed out to the sea from mainland.

Keywords: sediments, South Pacific, neutron activation analysis (NAA), HPGe spectrometer

^{137}Cs and plutonium in sediment from the Yangtze River estuary, P.R. China

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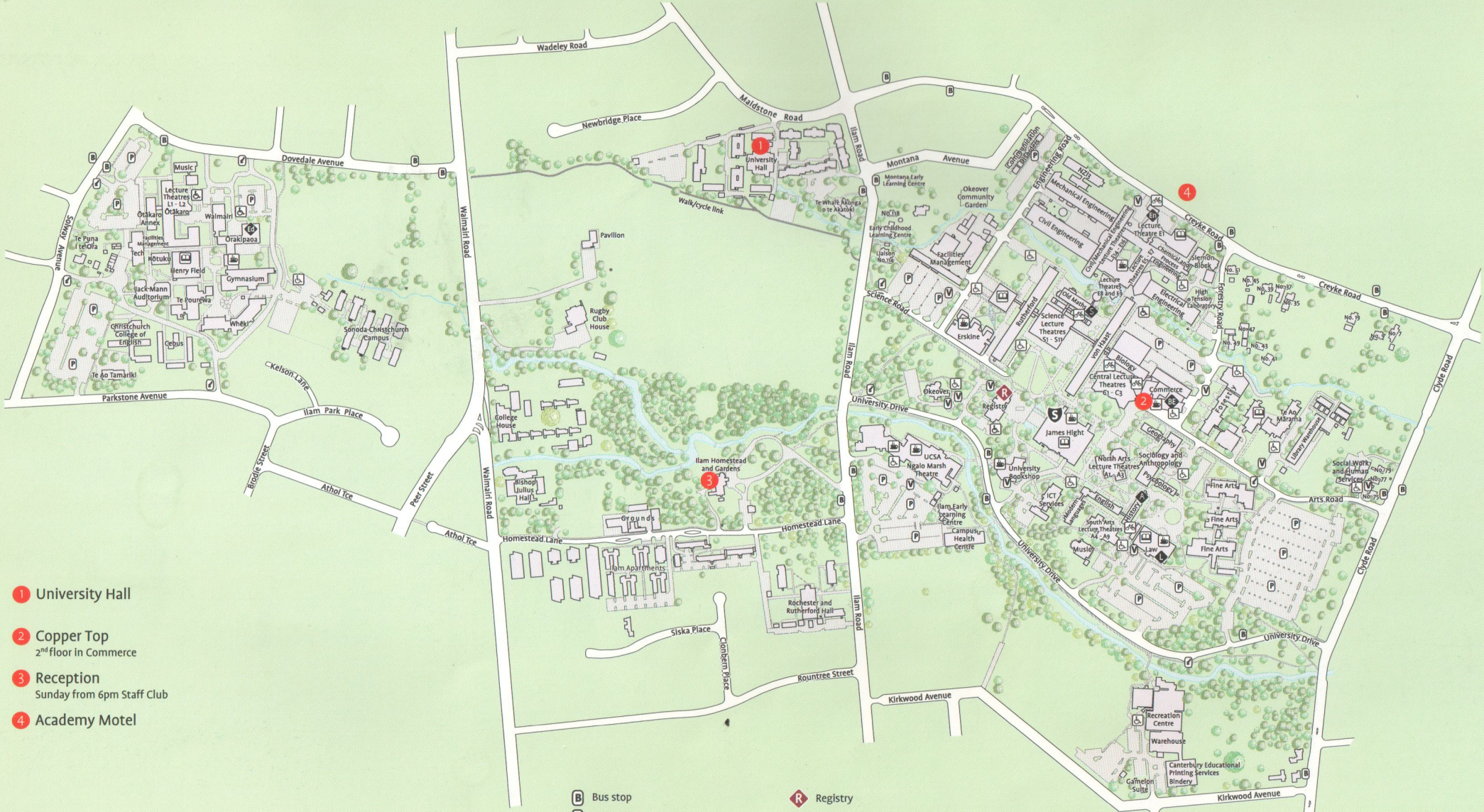
A sediment core from the sub-aqueous delta of the Yangtze River estuary has been analysed for ^{137}Cs and $^{239, 240}$Pu content. Caesium-137 levels were measured using γ-spectrometry at the Nanjing laboratories and plutonium isotope concentrations determined from Accelerator Mass Spectrometry (AMS) measurements made at the Australian National University. The concentrations of ^{137}Cs, ^{240}Pu and ^{239}Pu vary from 2.04 to 16.21 mBq/g, 0.059 to 0.312 mBq/g and 0.074 to 0.404 mBq/g, respectively. The level of agreement in the shape of the plutonium and caesium depth profiles is very good. The average ^{240}Pu/^{239}Pu atom ratio is 0.238 □ 0.038 in the sediment core, slightly higher than the average global fallout value. The changes in the ^{240}Pu and ^{239}Pu concentrations and the ^{240}Pu/^{239}Pu ratios with sediment depth indicate the possibility of using Pu as a geochronological tool for coastal sediment studies. This study confirms that the ability of AMS to yield ^{240}Pu/^{239}Pu atom ratios is a useful tool and can provide valuable information on sedimentary processes in the coastal environment.

Key Words: Sediment; Yangtze River; ^{137}Cs; Plutonium; ^{240}Pu/^{239}Pu atom ratios

Campus map



1 University Hall

2 Copper Top
2nd floor in Commerce

3 Reception
Sunday from 6pm Staff Club

4 Academy Motel

- B Bus stop
- P Car parking
- V Visitor car parking
- Disabled car parking
- Library
- Cafe
- Secure cycle stand
- S Security

- R Registry
- A College of Arts office
- BE College of Business and Economics office
- Ed College of Education office
- En College of Engineering office
- L School of Law office
- S College of Science office

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