

Research & Commercial Activities in Jamaica

By

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The Mona Campus of the U.W.I.
in its setting of the foothills of the Blue Mountains.



ICENS General Information



Image of Mona Campus UWI



ICENS Building

- Originally the Centre for Nuclear Sciences (CNS), opened in 1984
- Officially renamed the International Centre for Environmental and Nuclear Sciences after joining COMSATS
- As of 1st April, 1997, the Government along with the University, has been providing core funding for the Centre.
- The scientific agenda emphasises integrated research programmes based on environmental geochemistry, international collaboration, and encourages the transfer of knowledge between academia, government, and the production and service sectors.

History of Reactor Commissioning



International Atomic Energy Agency
INFORMATION CIRCULAR

INF

IAEA- INF/CIRC/315
April 1984

GENERAL Distr.

Original: ENGLISH and
FRENCH

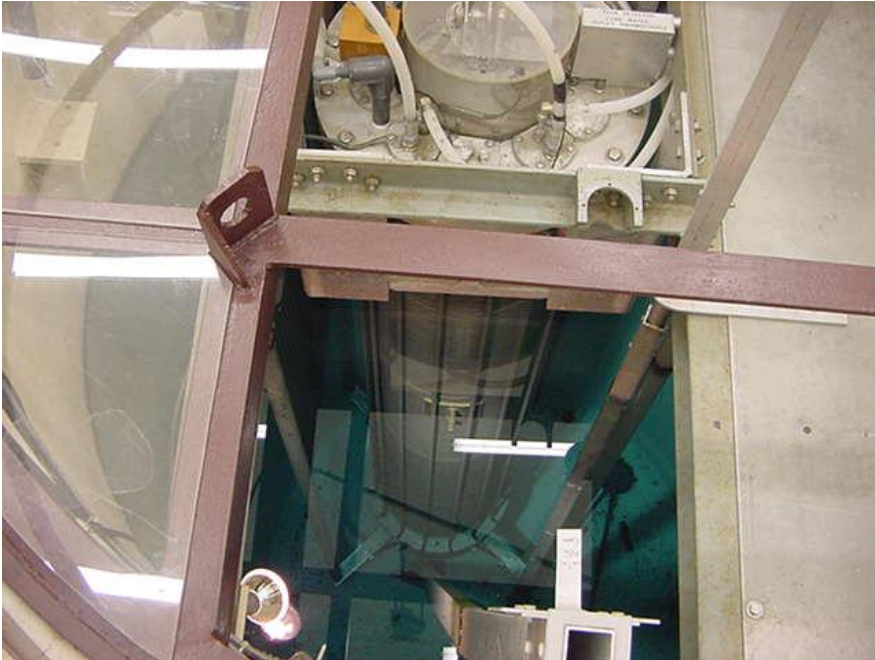
THE TEXT OF THE AGREEMENT OF 25 JANUARY 1984 CONCERNING
THE AGENCY'S ASSISTANCE TO JAMAICA FOR THE
TRANSFER OF ENRICHED URANIUM FROM CANADA
FOR A RESEARCH REACTOR

1. The text[1] of the Project and Supply Agreement signed on
25 January 1984 between the Agency and the Governments of Canada, Jamaica
and the United States of America for the transfer of enriched uranium



- Reactor commissioned under European Development Fund (EDF) and Lome Programme
- SLOWPOKE -2 Vendor: Atomic Energy of Canada Ltd. – Paid for with EEC funds
- Project and Supply Agreement signed between the Agency and Governments of Canada, the United States and Jamaica for the HEU Core, 1984.

The SLOWPOKE-2 Reactor



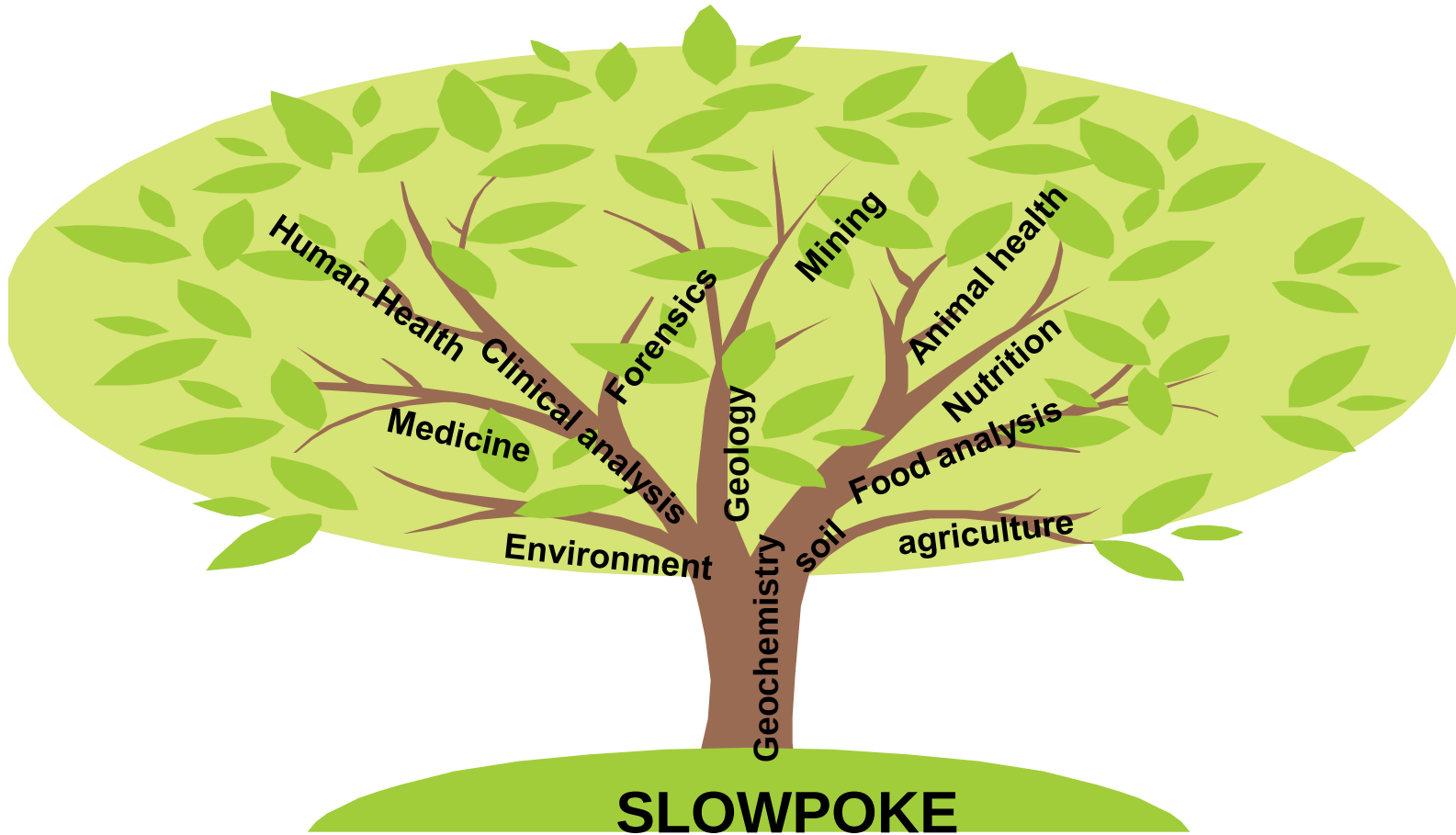
- Commissioned on March 13th, 1984.
- Only nuclear reactor in the English-speaking Caribbean.
- Principal utilization: Instrumental Neutron Activation Analysis.

Safe **LOW POWER K(c)**ritical Experiment

Highly Enriched Uranium Core Specifications

Type	Tank in pool
Licensed	20 kW
Excess	4.0 mk
Fuel	Extruded
Moderator	Light water
Cooling	Conduction/convection
Core width	22 cm
Core Height	22.1 cm
Enrichment	93% U ²³⁵
Critical mass	816.664 g
Fuel life	3.395 x 10 ⁵ kWh

"Peaceful uses of the Atom "



Complementary Nuclear Analytical Techniques

- **ED-XRF:** Energy dispersive X-ray Fluorescence is a convenient analytical technique, offering multi-element analyses, particularly for elements not convenient for Neutron Activation Analysis such as **copper, lead, magnesium, nickel, phosphorus, and potassium**
- **T-XRF:** Total reflection X-ray fluorescence is also a multi-element technique. It is energy dispersive X-ray fluorescence where the angle of the incident x-rays is less than the critical angle. **Used primarily for biological samples when ultra trace levels are required**
- **Portable XRF analyzer:** Primarily for **exploratory lead in soils** but may be used for other elements such as **copper, lead, magnesium, nickel, phosphorus and potassium.**



Spectroanalytical Techniques



Thermo Scientific iCE 3500 AA
Spectrometer with integrated graphite
furnace



ICP Atomic Emission
Spectrometer



Flow Injection
Analyser

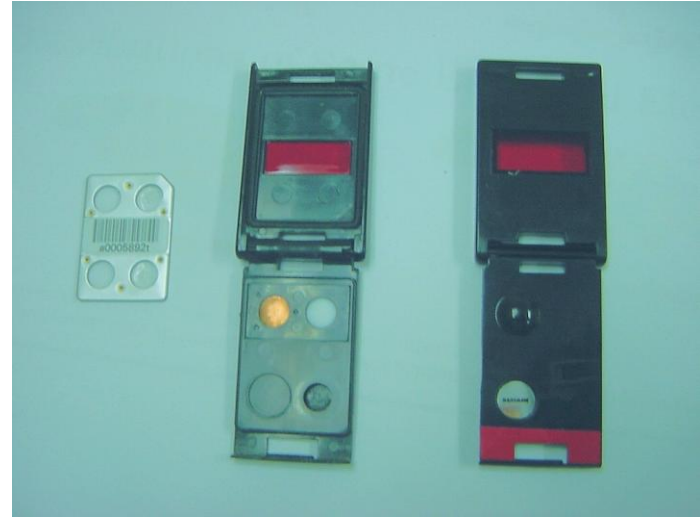
Primarily used for elemental analysis in liquids and biological solid samples (Ca, Cd, Co, Cr, Cu, Fe, K, Mg, Mn, Mo, Na, Ni, P, Pb, Sr, Zn).

Radiation Protection, Monitoring & Measurement



- Principal radiation dosimeter instrument at ICENS is an Automated HARSHAW Model 6600 reader with an in built ^{90}Sr irradiator for the purposes of calibration.
- Quality assurance is ensured by frequent test readings using the internal irradiator; participation in inter-laboratory comparison studies.
- Routine monitoring – TLD cards, uniquely bar coded for each staff member are worn on the job for a month and then processed.
- Cards are read after each exposure period and personal data file of each staff member is computer archived.
- 1300+ Badges for over 100 Clients in the region

Radiation Measurement & Monitoring



^{137}Cs source annually checked for leakage
(over 60 units in the country)

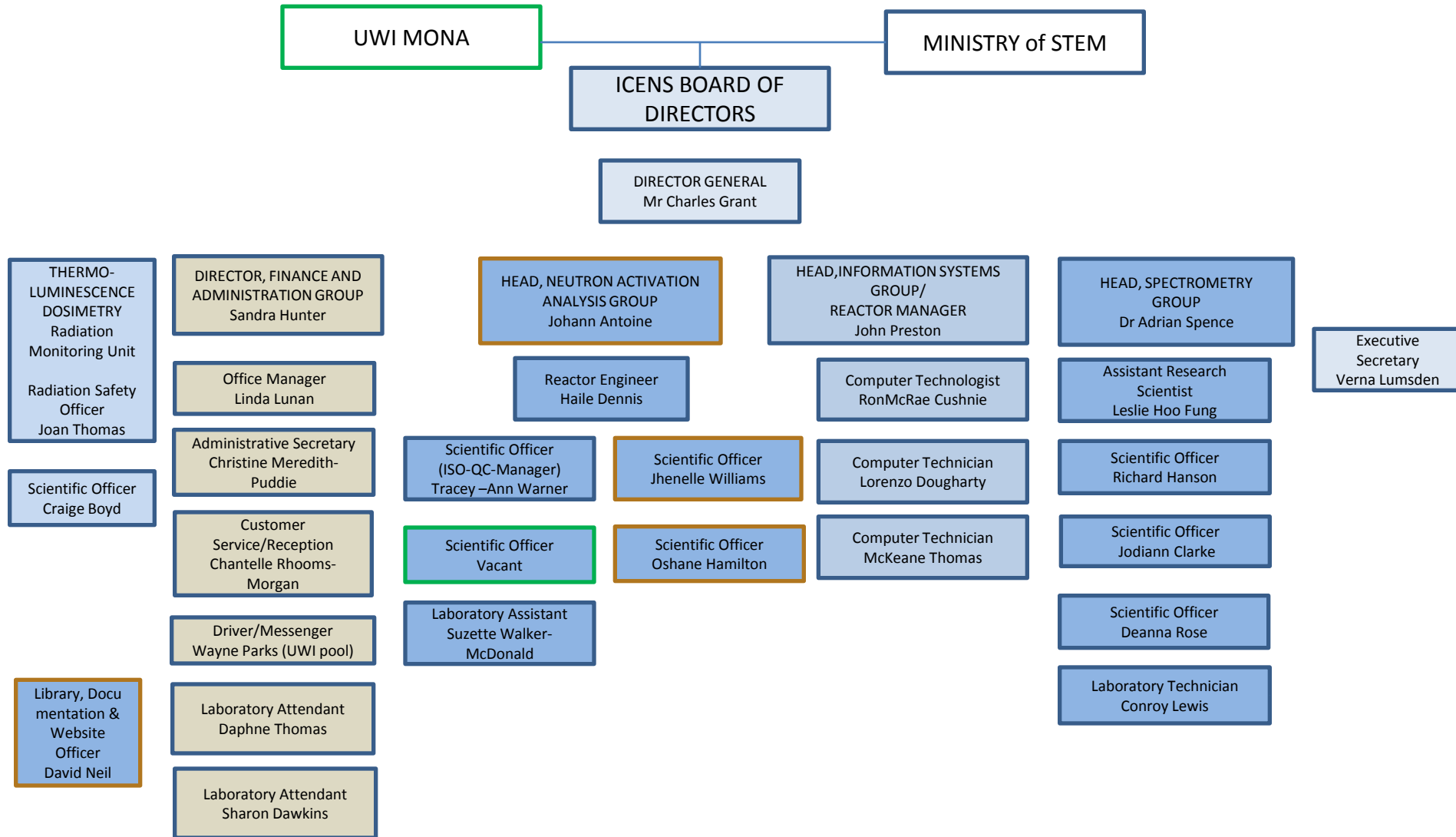
Scrap Metal Orphan Source Detection



ICENS Priority Research Areas & Applications

- Environmental Geochemistry
- Agriculture
- Heavy Metal Pollution in Jamaica
- Mineral composition of food
- Trace elements in animal/human tissue
- Biogeochemical Cycles
- Health
- Forensics

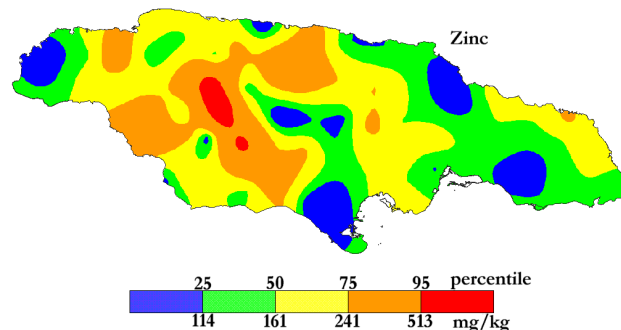
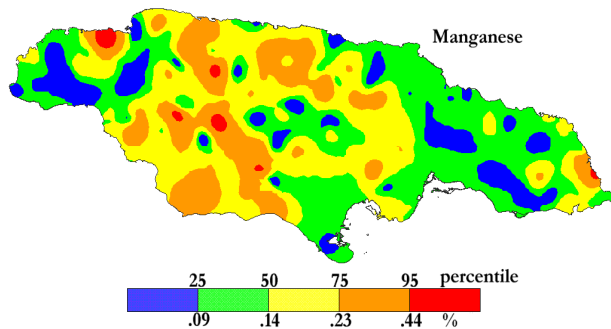
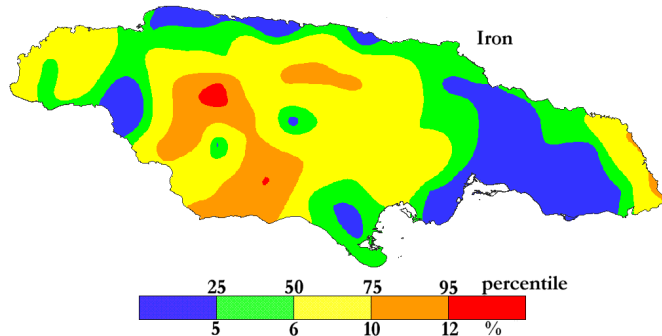
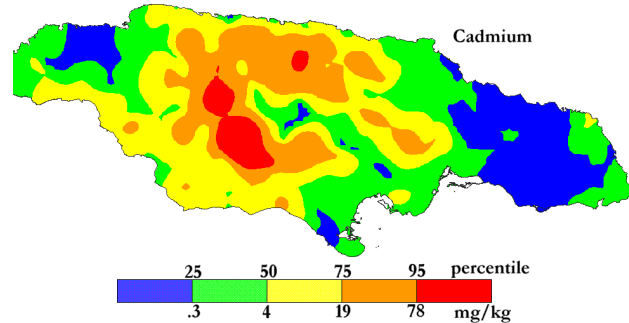
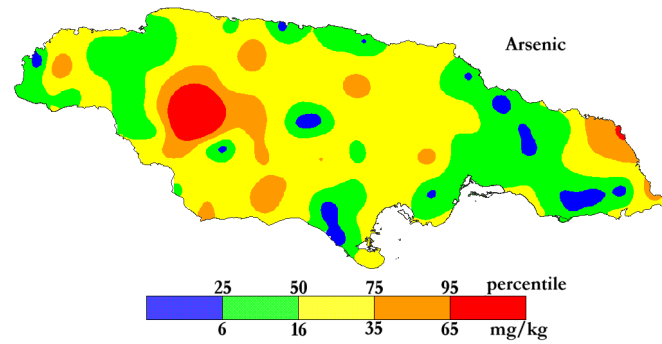
Present Organizational Structure



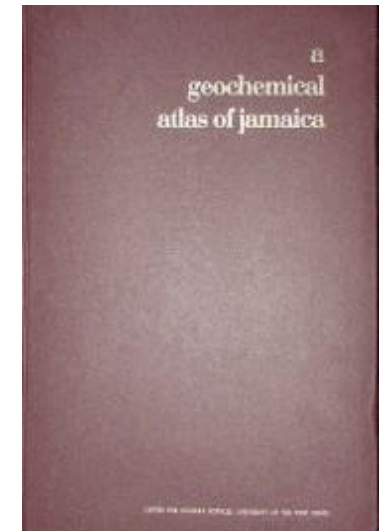
Recent Awards, Achievements & Acknowledgements

- The ICENS Nuclear Analytical Laboratory reached the topmost level of performance, recognised as ‘consolidated state of the practice’ in the latest round of the IAEA-sponsored Wageningen Evaluating Programs for Analytical Laboratories (WEPAL) proficiency testing programme.
- The strategic plan of the ICENS Reactor Laboratory topped the list of 31 strategic plans for effective utilization of research reactors (RRs) evaluated in a 2013 review by a group of international experts. The plans were submitted by different laboratory managers around the world.
- Scientists were awarded the David H. Byron award for the Best Poster Presentation at the FAO/IAEA International Symposium on Food Safety and Quality in November 2014 for their presentation, **“Geographic Determination of the Growing Origins of Jamaican and International Coffee using Multi-Element Analysis”**

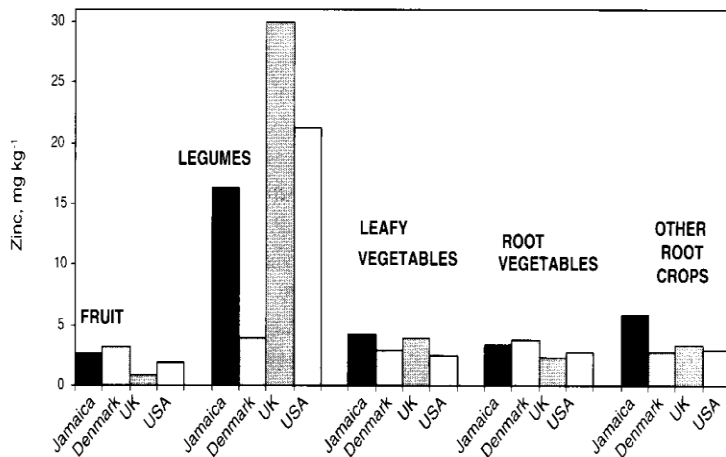
Geochemical Mapping of Jamaica



Baseline data on essential and potentially hazardous elements in the Jamaican environment, reported in our Geochemical Atlas of Jamaica



Pioneering research on mercury, selenium and other elements in Lionfish *Pterois volitans*

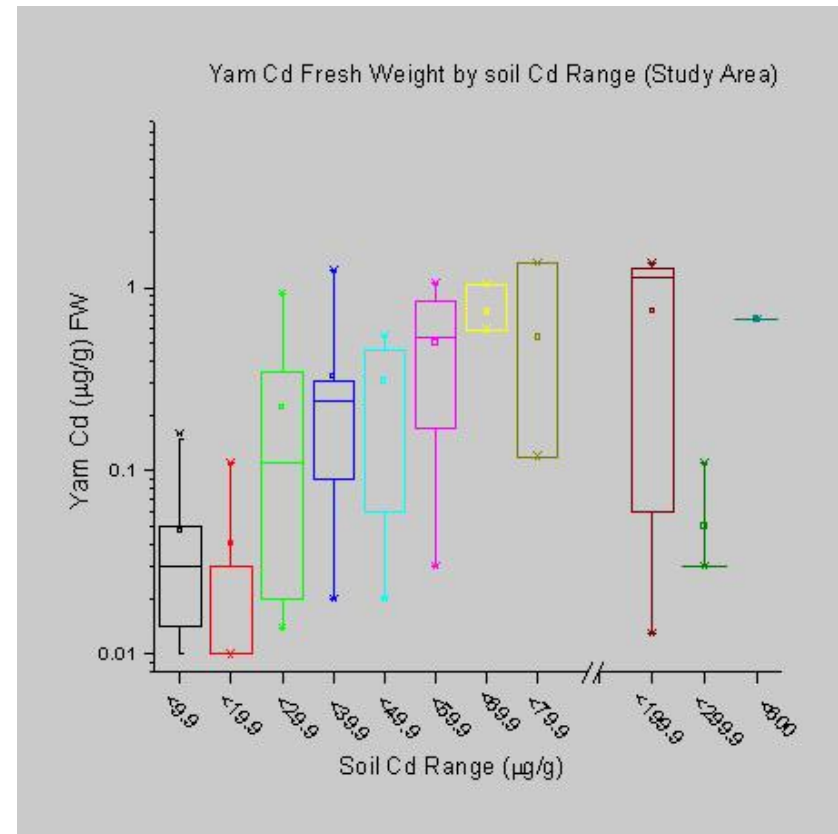
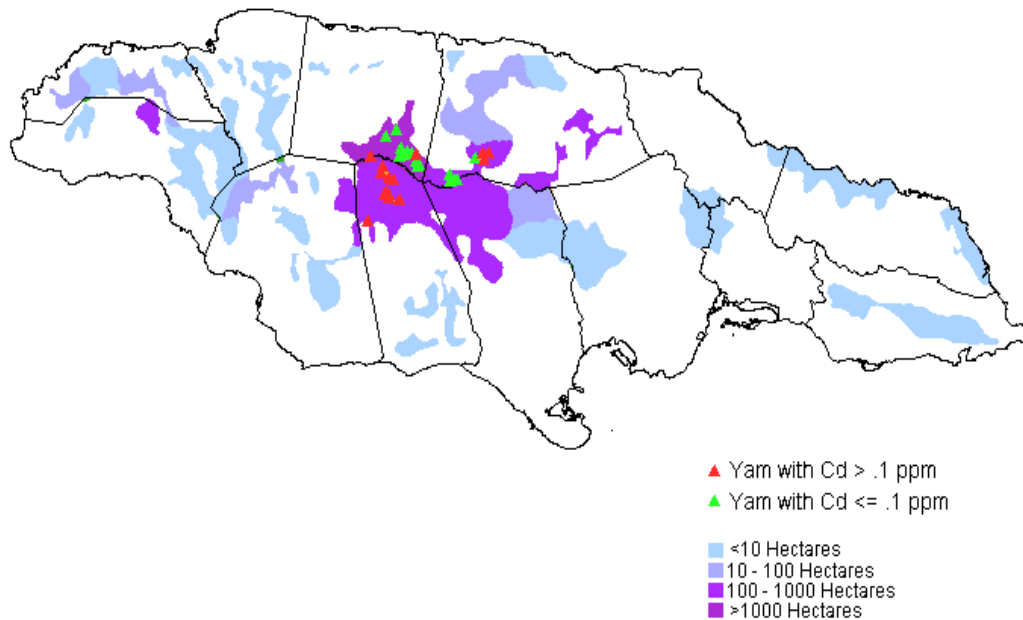
[illegible]

Element	Range	Median
Al	6.10 - 43.01	8.86
As	0.05 - 0.49	0.18
Br	0.25 - 113	0.75
Ca	24.6 - 425.4	76.61
Co	0.07 - 0.14	0.10
Cr	0.03 - 0.49	0.09
Cu	1.29 - 4.69	2.62
Fe	3.10 - 153.4	13.05
K	539 - 3667	1366
Mg	176 - 1449	468.43
Mn	5.41 - 45.60	14.34
Na	1.65 - 48.14	7.09
P	335 - 4339	1669.5
S	912 - 1671	1204.5
Se	0.03 - 0.32	0.12
Zn	14.2 - 25.6	18.46

Dietary Intake of Minerals and Trace Elements in Rice

Agricultural Soils & Food Crops

Cd in Yam for main production areas



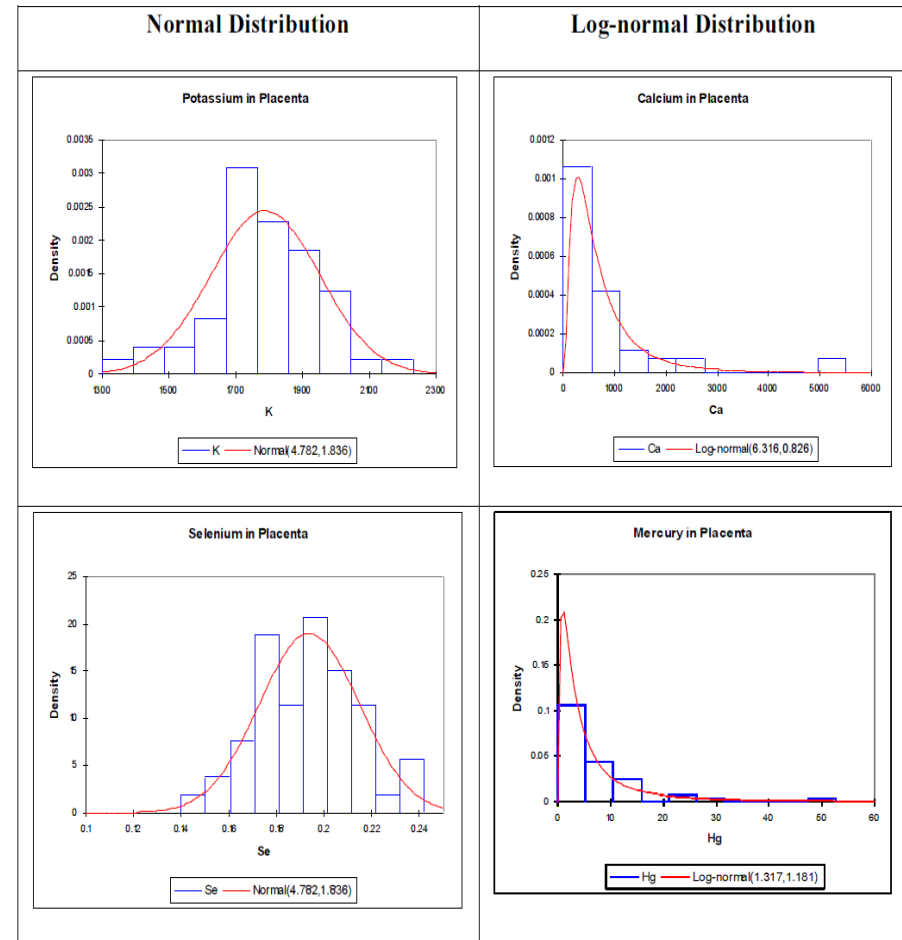
Blood Pb Analysis Using Anodic Stripping Voltammetry (ASV)



Blood lead monitoring of Pb-contaminated communities, commercial work for hospitals, staff of battery companies, police officers and other occupationally exposed members of the population

Studies in Human Placenta

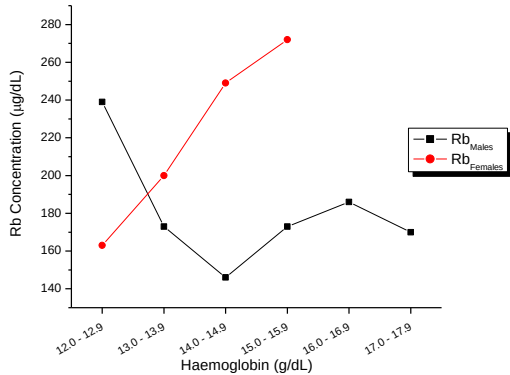
- Placental Samples were analysed by neutron activation analysis for elements including bromine, calcium, chlorine, iron, mercury, potassium, rubidium, selenium, sodium and zinc.
- Apgar 2 scores were correlated with some elements.
- Consumption patterns were documented to determine mercury exposure.



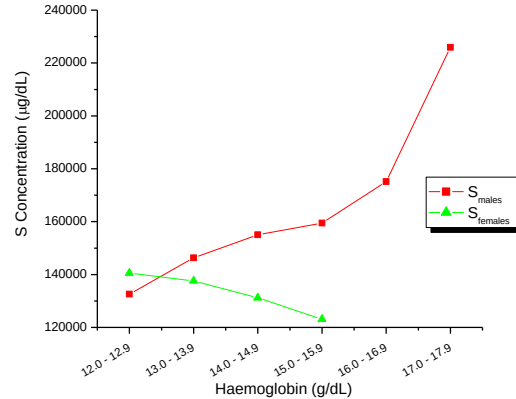
Trace elements in Blood & Gender

Investigation into the concentration of trace elements in whole blood samples of 100 male and female blood donors in Jamaica and to determine the relationship, if any, between these elements and age and gender.

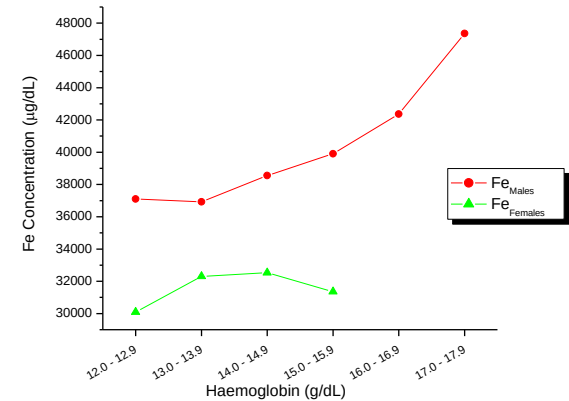
Variation in Rb with Haemoglobin for Males and Females



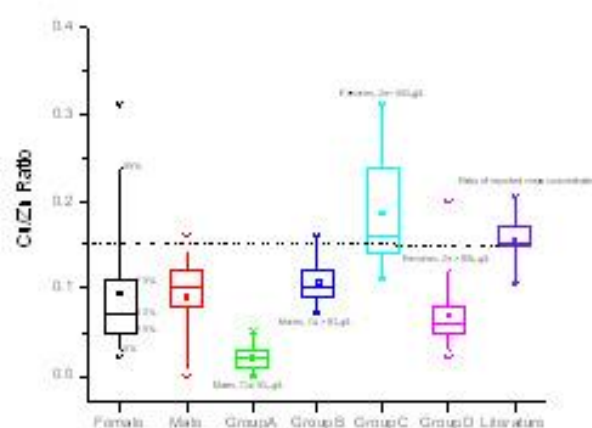
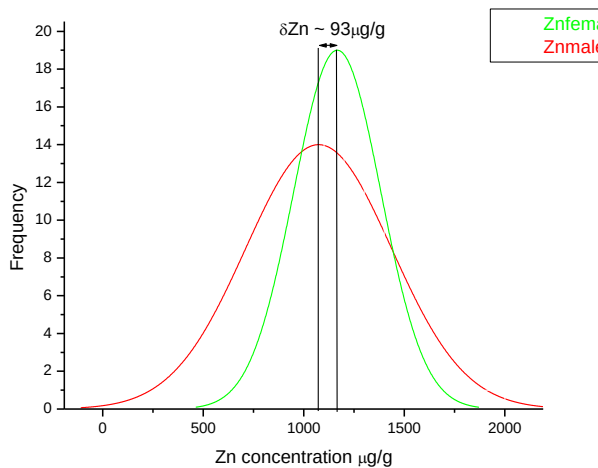
Variation in S with Haemoglobin for Males and Females



Variation in Fe with Haemoglobin for Males and Females



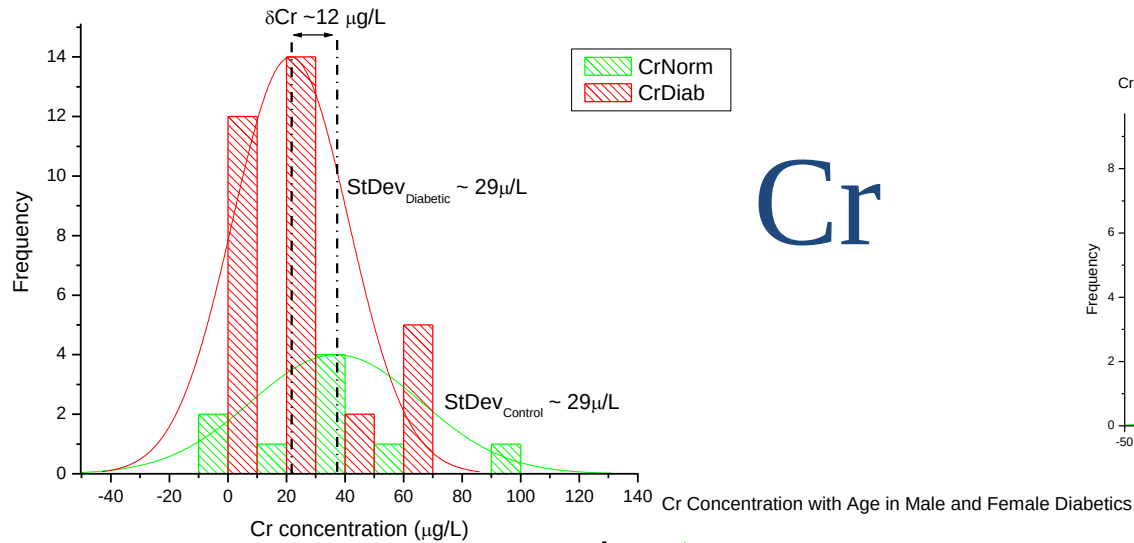
Zn Distribution in males and females



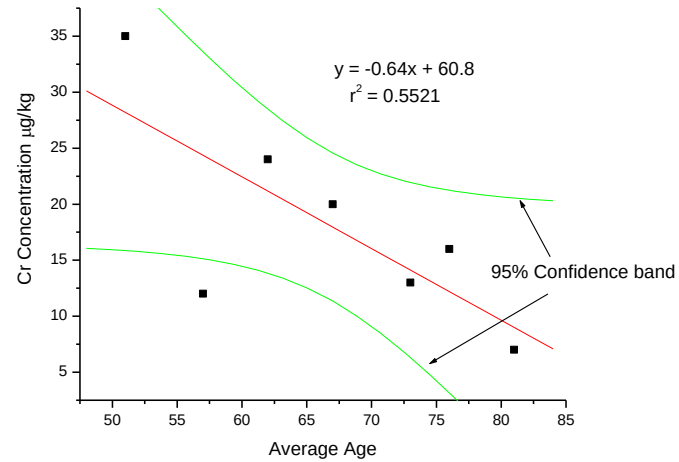
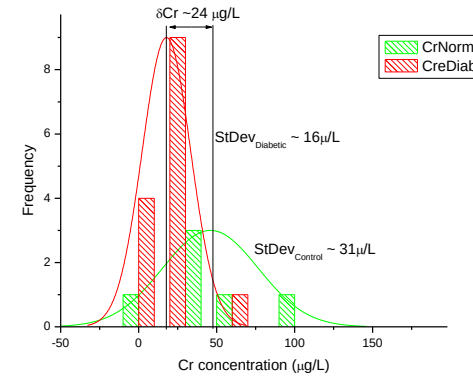
Many studies have been conducted to determine relationships between this ratio and illnesses such as cancers and coronary heart diseases.

Diabetic Studies

Cr Distribution in Control and Diabetic Populations

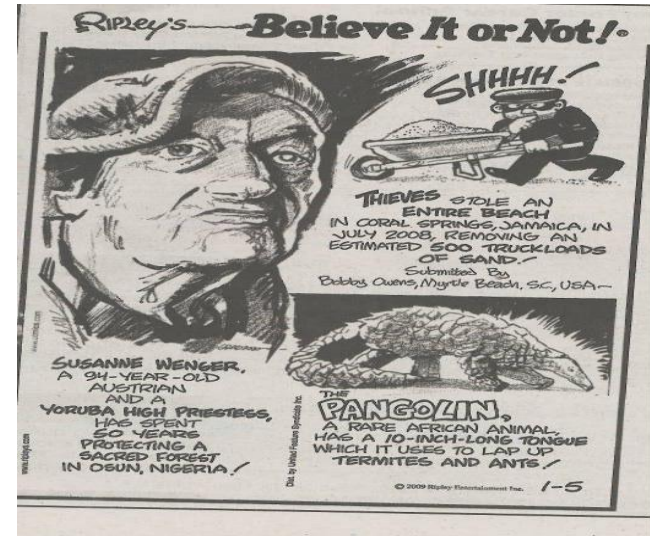


Cr Distribution in Male Control and Diabetic Populations

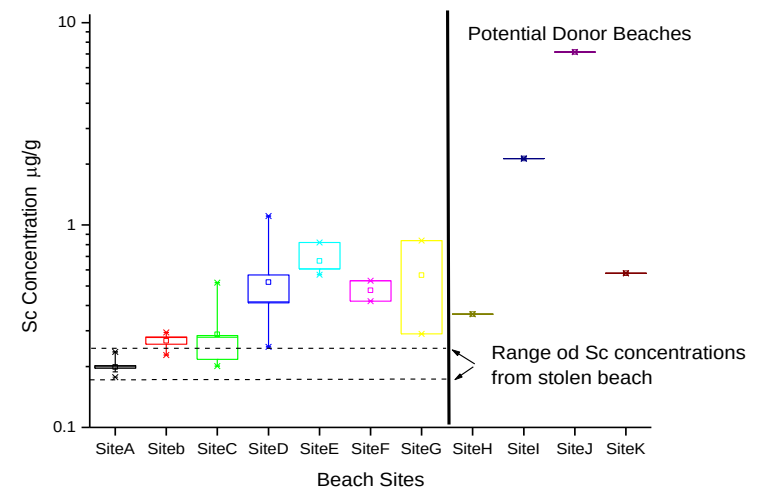
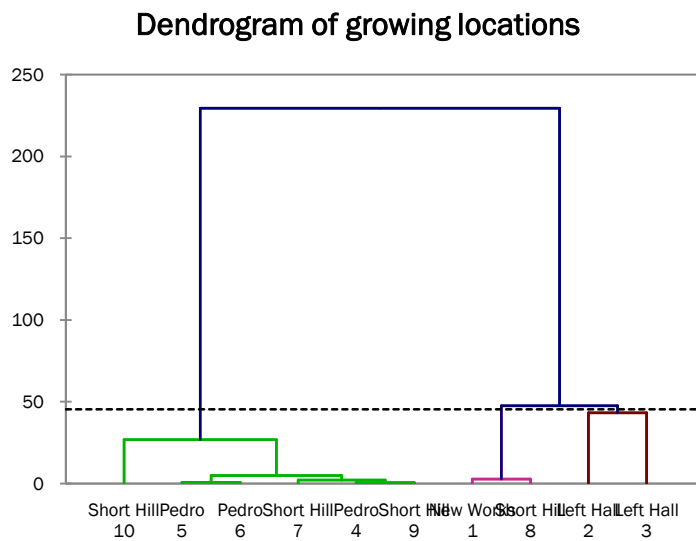


Forensics

- Using trace element analysis to identify stolen beach samples
- Trace element analysis to source the provenance of Jamaican Cannabis



Sc concentrations at Various Beach Sites



Customer Base

- **Reactor**
 - Programs
 - Commercial
- **LN2**
 - University
 - Vet services (frozen semen)
 - Dermatologist
 - Bauxite industry
- **Radiation Monitoring TLD**
 - Hospitals
 - Dentist
 - Industrial radiographers
 - Vet services
 - Port Authority
 - Researchers
 - Cement company
 - Bauxite company
- **Radioactivity measurements**
 - Industrial radiographers
 - Therapeutic mineral baths
 - Property developers
- **Blood lead**
 - Hospitals
 - Police
 - Battery companies
 - Exporters

7. Future?

- Increased local collaboration (Analysis)
 - University of the West Indies Departments
 - Local Industry: Mining, manufacturing, exports (Codex)
 - Will require ISO certification
- Maintain relevance with Jamaican Government
 - Agriculture and land use
 - Medical applications
 - Radiation Protection Activities
 - Radiation Measurements
 - Energy issues
 - Publicity: Radio, Television, Newspapers
- External Funded Projects
 - IAEA, IDRC, IDB,....

Thank you for your kind attention!!