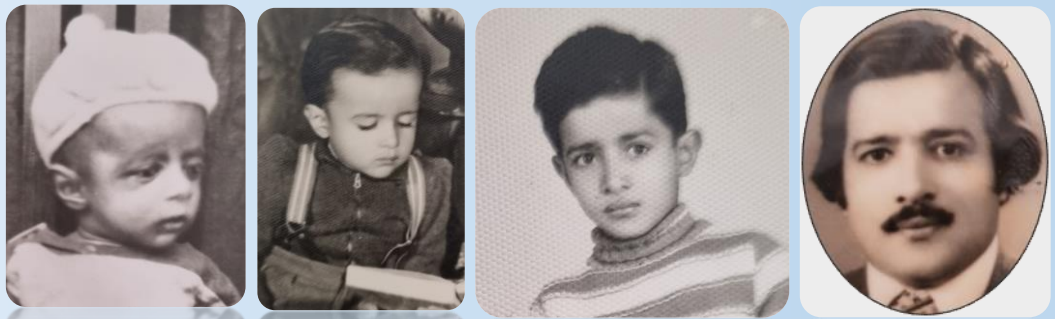
Safe Radiation
Workplace and Environmental Radiation Safety

Riaz Akber

r.akber@saferadiation.com

See you at LinkedIn



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SPERA
ARPS

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Mum
Siblings
Partner
Progeny
GC's

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RADIATION DETECTION FOR RADIATION PROTECTION

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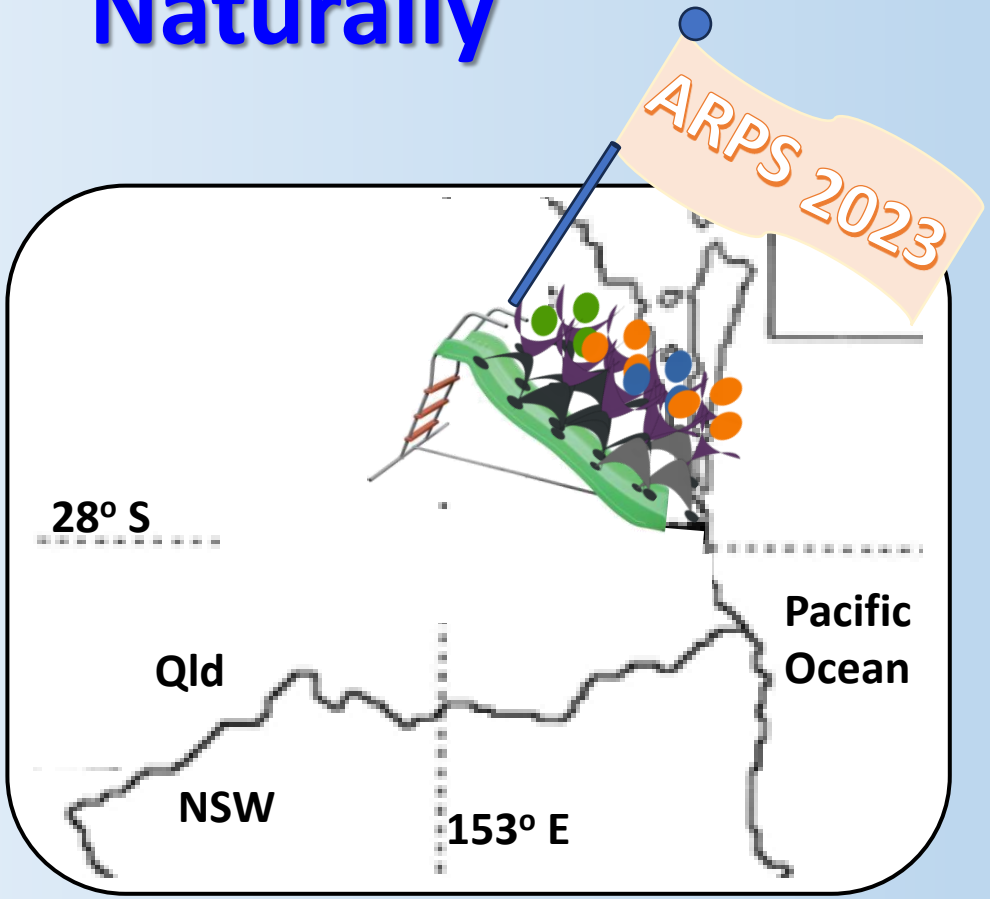
RADIATION DETECTION FOR RADIATION PROTECTION FOR

ARCHEOLOGICAL & GEOLOGICAL DATDING
SOIL SCIENCES
FORENSIC INVESTIGATIONS
GEOMECHANICS & MINERAL EXPLORATION
NUCLEAR STRUCURE and PARTICLE PHYSICS STUDIES
BIOCHEMICAL INTERACTION LABELLING
MEDICAL SCIENCE APPLICATIONS
STUDYING ENVIRONMENTAL SYSTEMS
UNDERSTANDING COSMOLOGICAL PHENOMENA
SAMPLE SCREENING & NON-DESTRUCTIVE TESTING

RADIATION DETECTION FOR RADIATION PROTECTION

Radioactivity Naturally



RADIATION DETECTION FOR RADIATION PROTECTION

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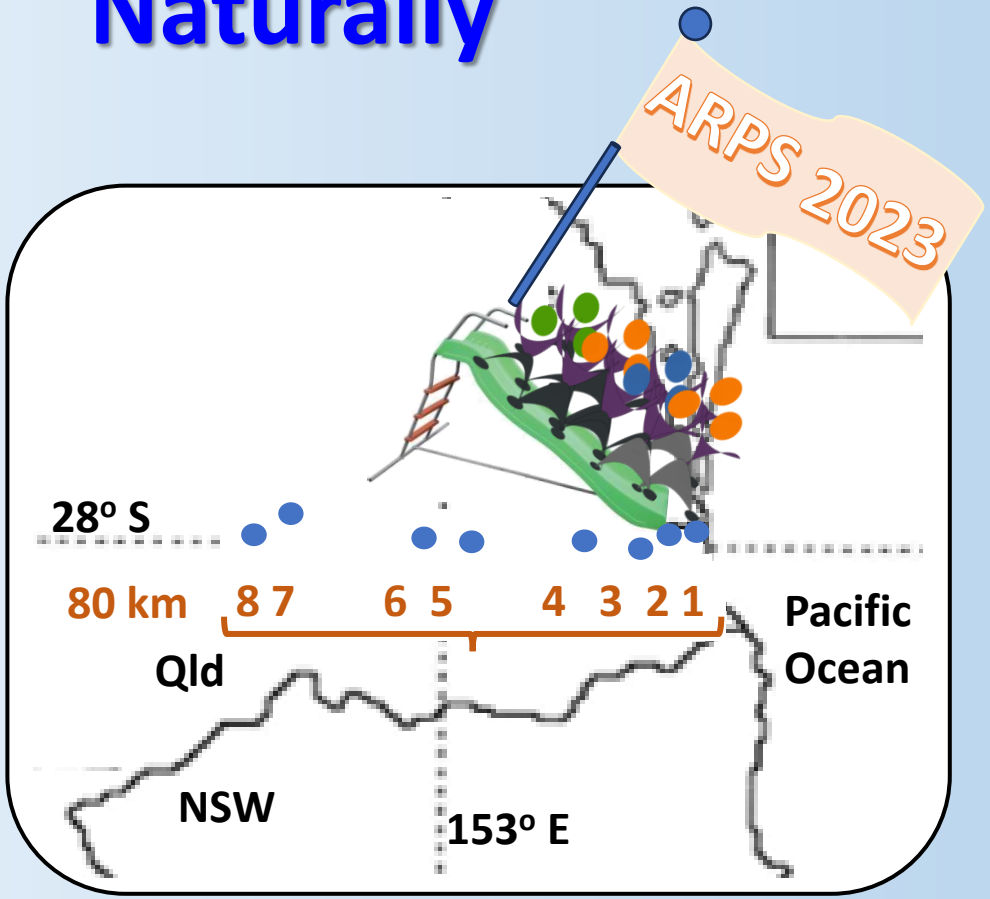

Doering, Akber, Heijnis (2006)
Journal of Environmental Radioactivity Vol 87 pp 135 - 147

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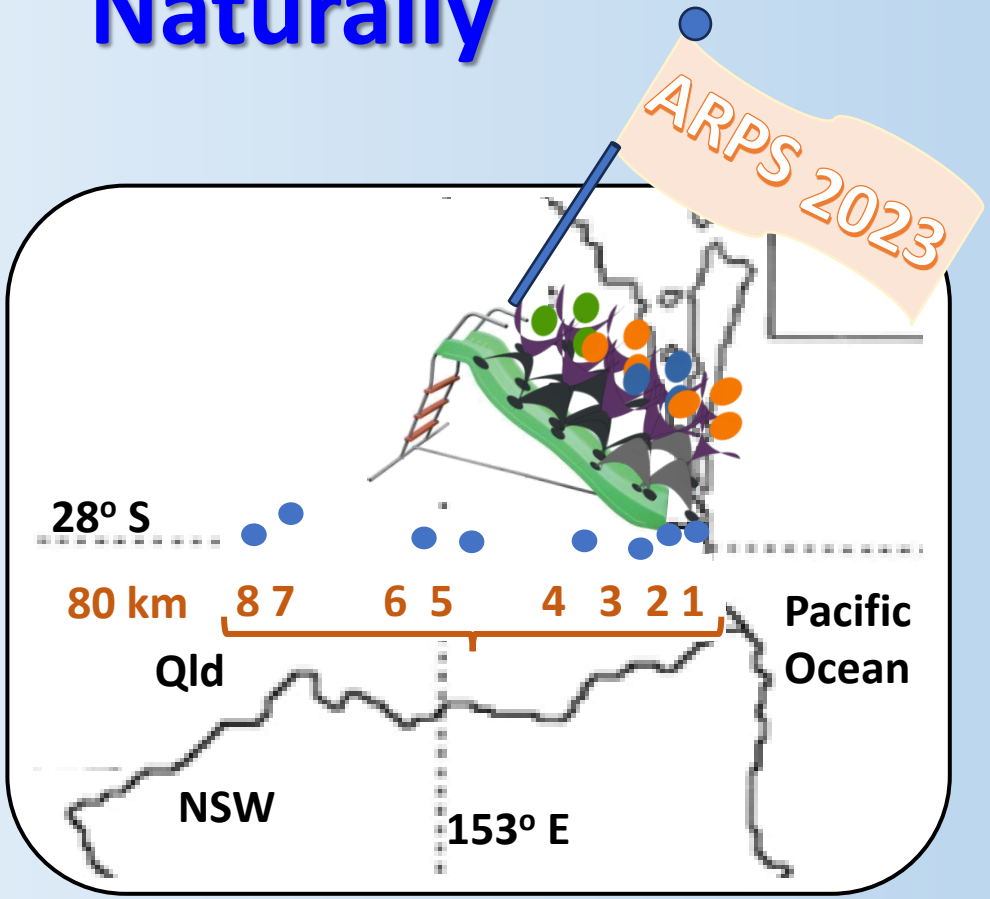

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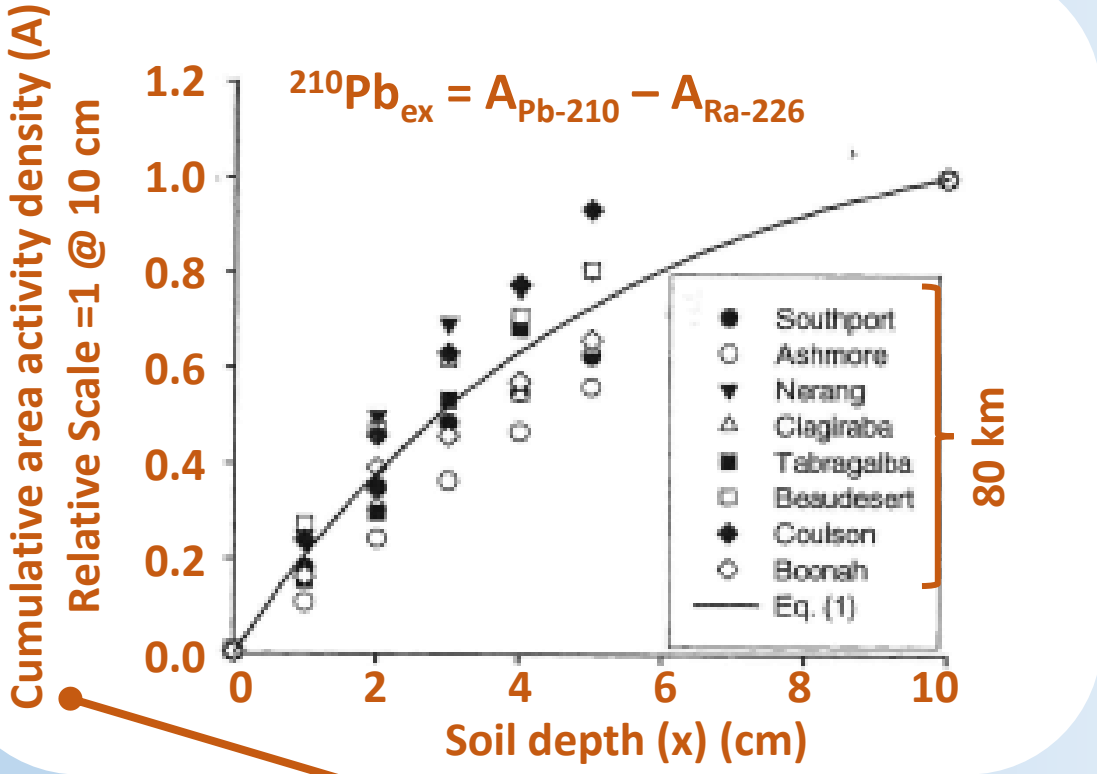


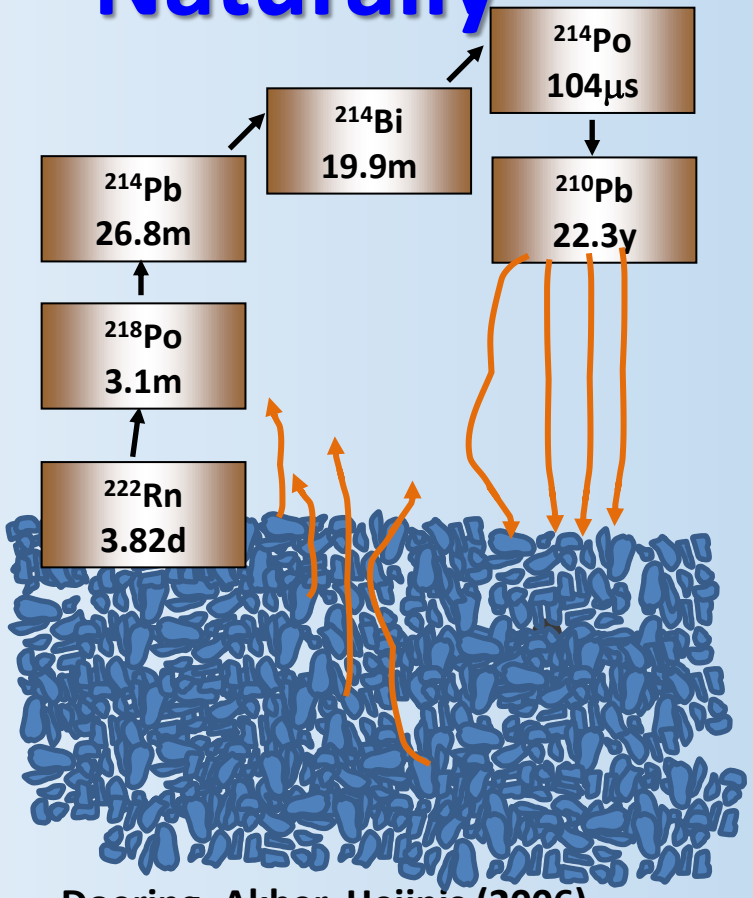
$A/A_{soil} = \{1 - e^{-x\,(\ln 2/P)}\}$

Penetration half depth, P (cm)

$^{210}Pb_{ex}$	(22.2 y)	3.6 ± 0.2
^{7}Be	(0.146 y)	0.3 ± 0.1

RADIATION DETECTION FOR RADIATION PROTECTION

Radioactivity Naturally



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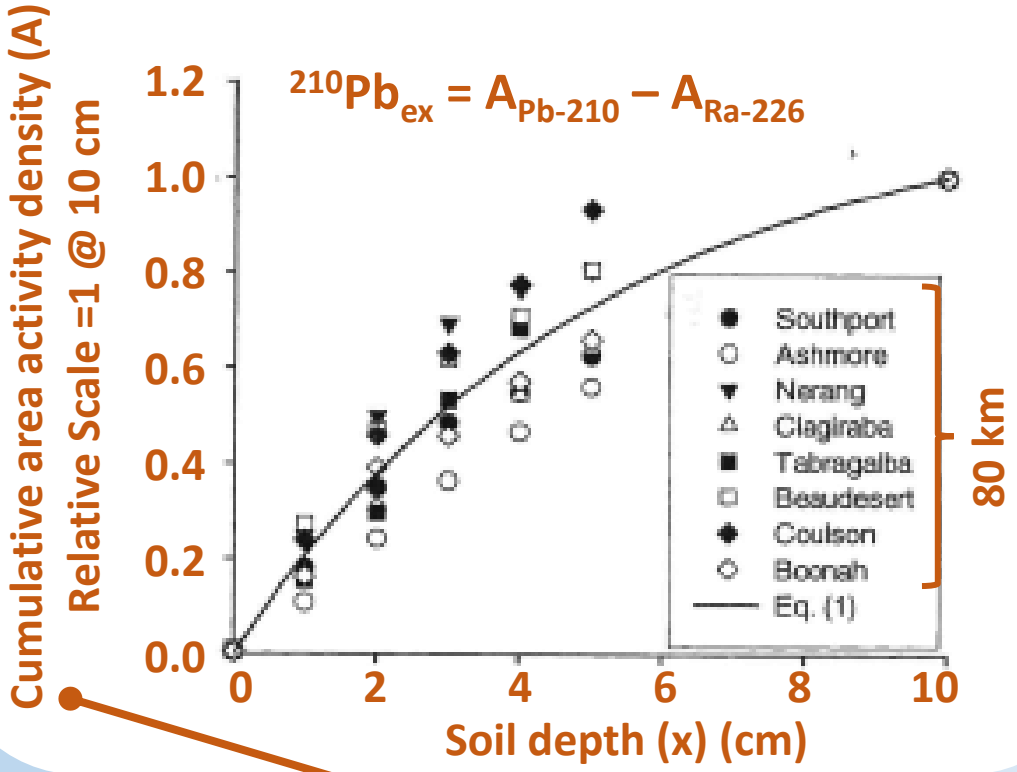

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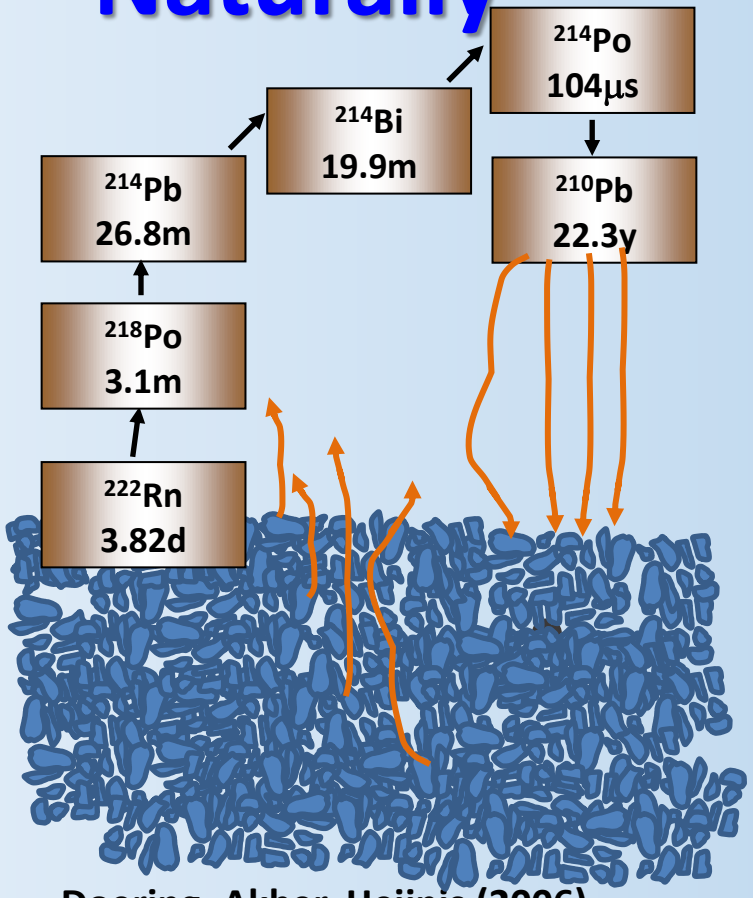

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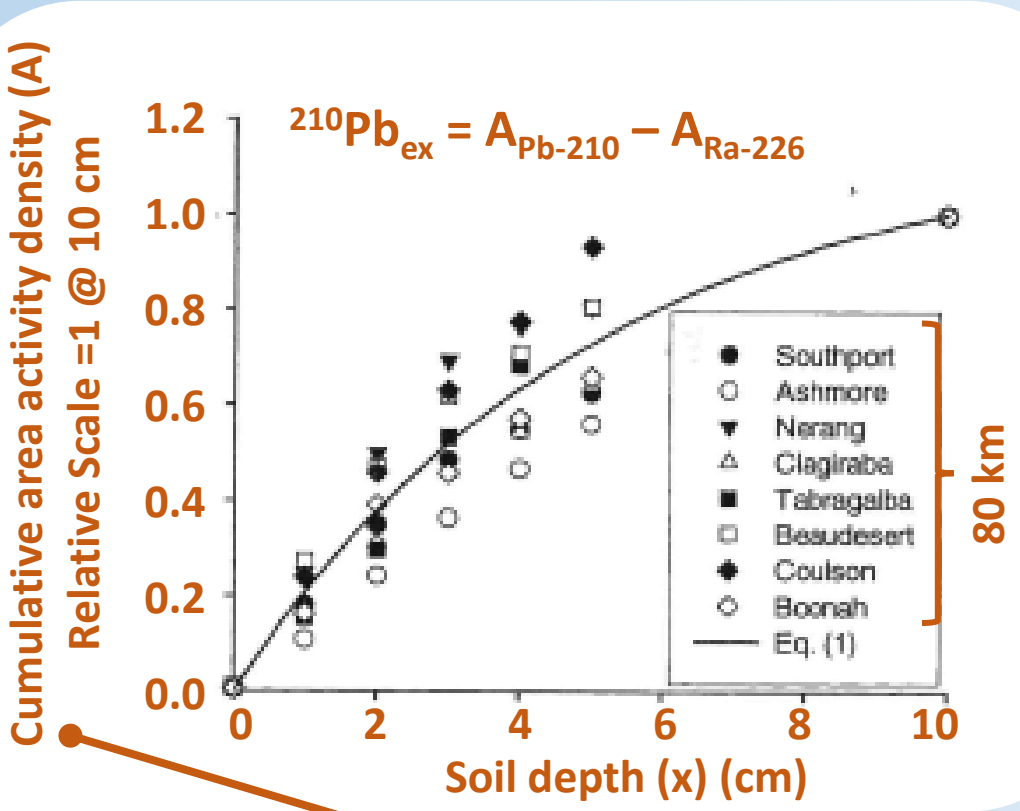

^{222}Rn activity flux density (mBq.m^{-2}s^{-1})

(i)	Long term average estimated from $^{210}Pb_{ex}$	5.1 ± 0.9
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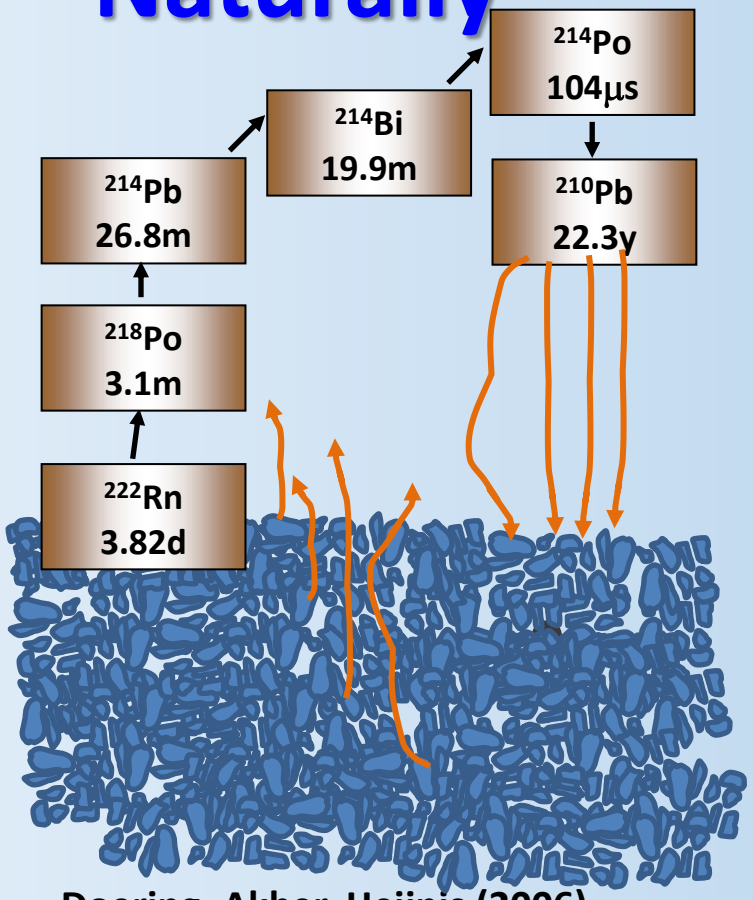
RADIATION DETECTION FOR RADIATION PROTECTION

Radioactivity Naturally



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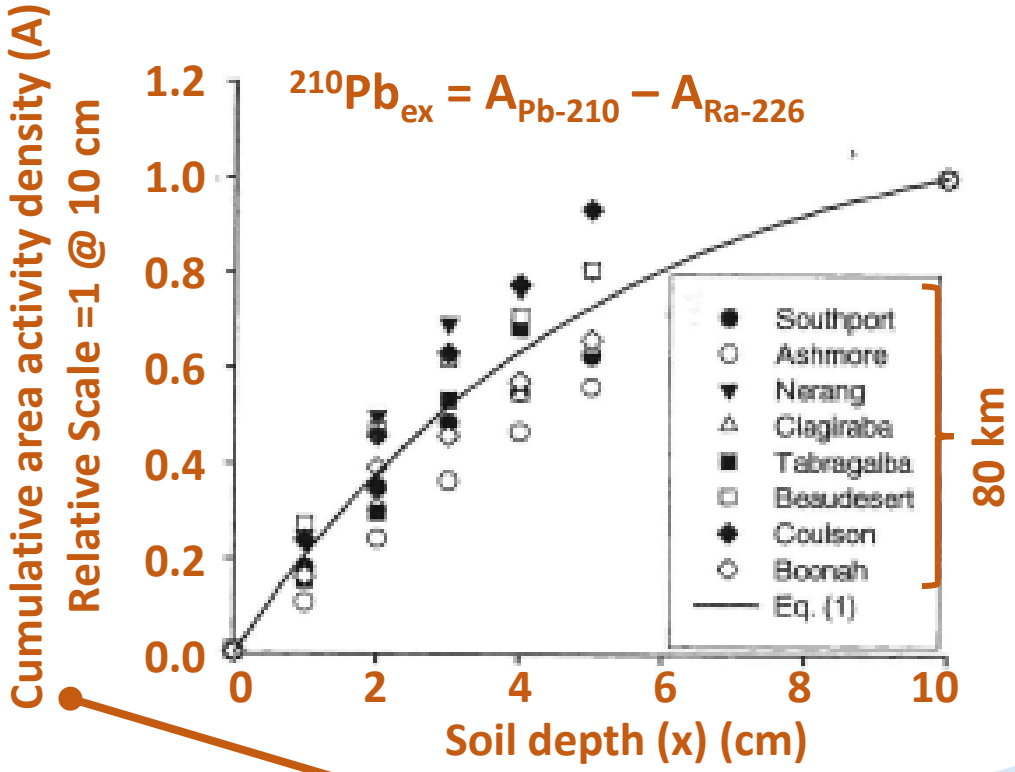
Can we use $^{210}Pb_{ex}$ as a proxy to map long term ^{222}Rn exhalation rates?!



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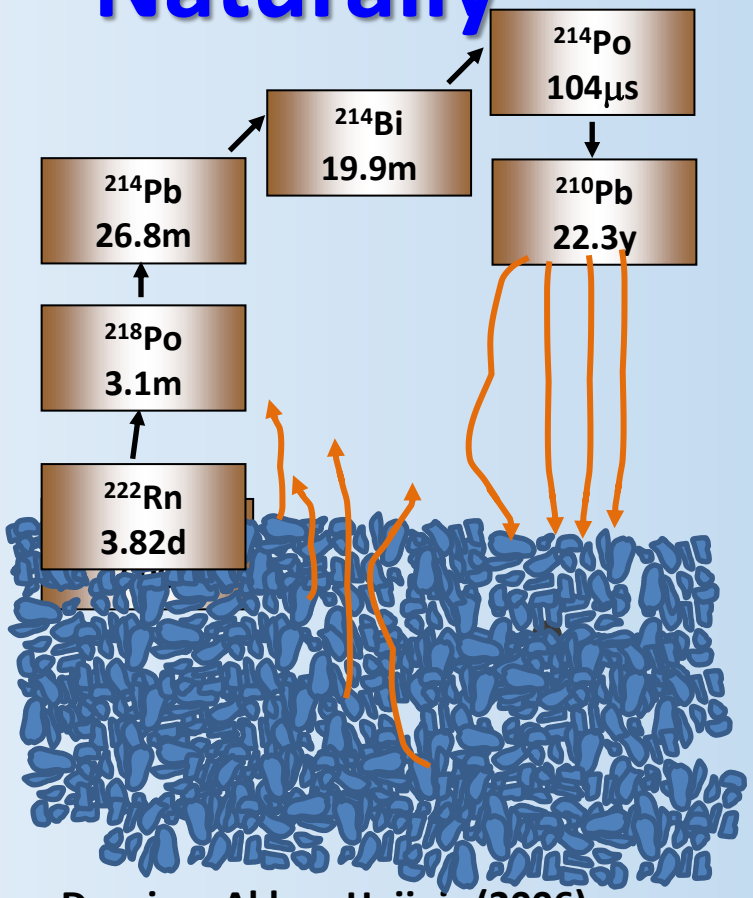

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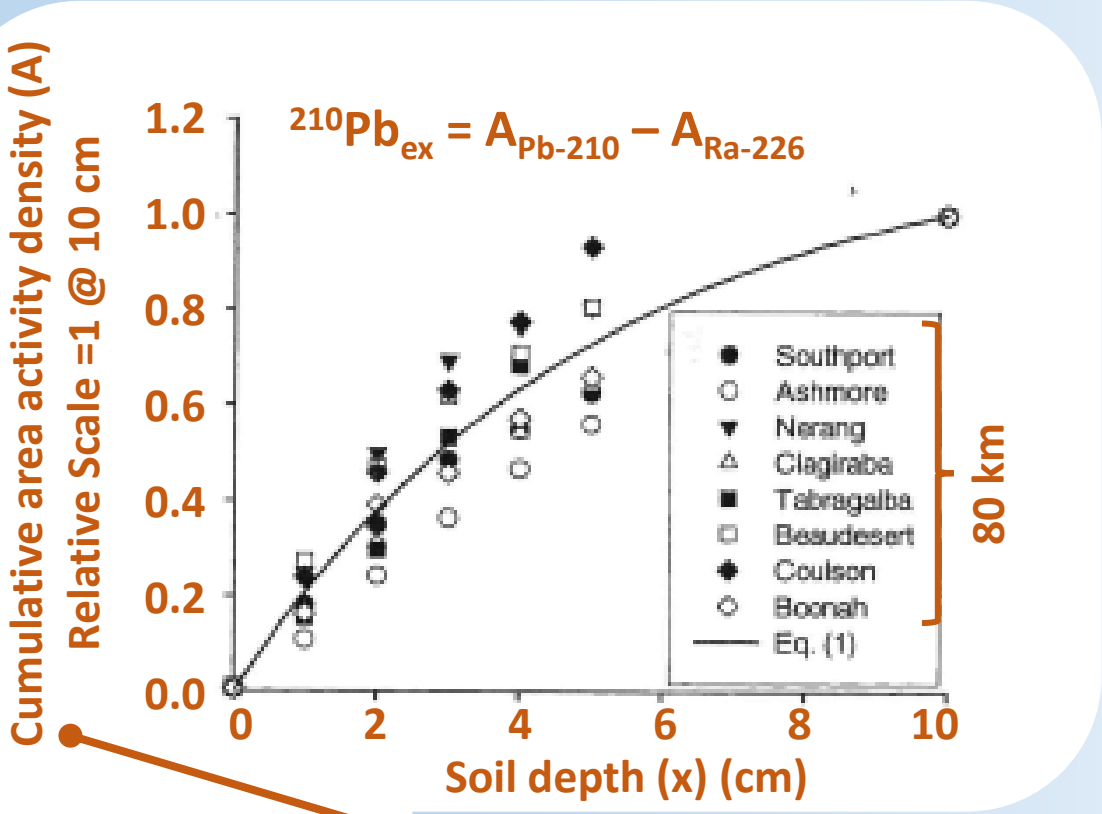
Can we use $^{210}Pb_{ex}$ as a proxy to map long term ^{222}Rn exhalation rates?!

If ^{222}Rn activity flux estimated from $^{210}Pb_{ex}$ is greater or less than the directly measured value then, does it indicate a net gain or loss of the aerosol from that area?!



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When the gamma dose rate is $Gy.h^{-1}$

Can we measure?!

RADIATION DETECTION FOR RADIATION PROTECTION

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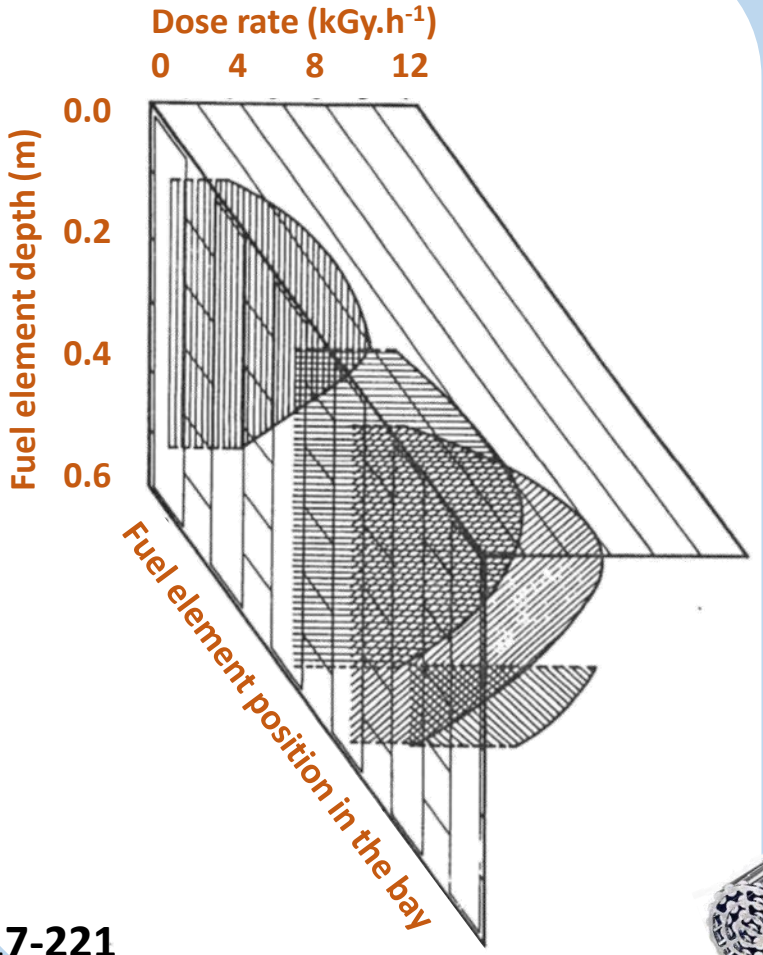
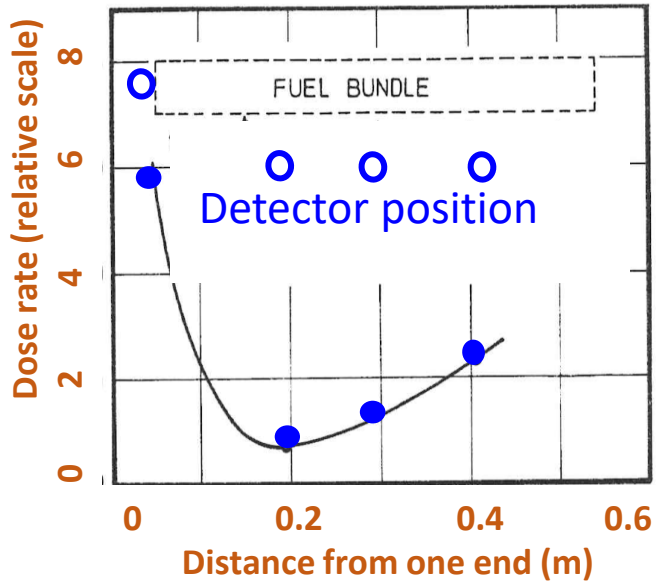
Can we measure?!

Akber *et. al.* (1980)
Nuclear Instruments and Methods Vol 173, pp 217-221

IAEA – Project support 1162/RI/RB
https://inis.iaea.org/collection/NCLCollectionStore/_Public/11/532/11532149.pdf

When the gamma dose rate is Gy.h^{-1}





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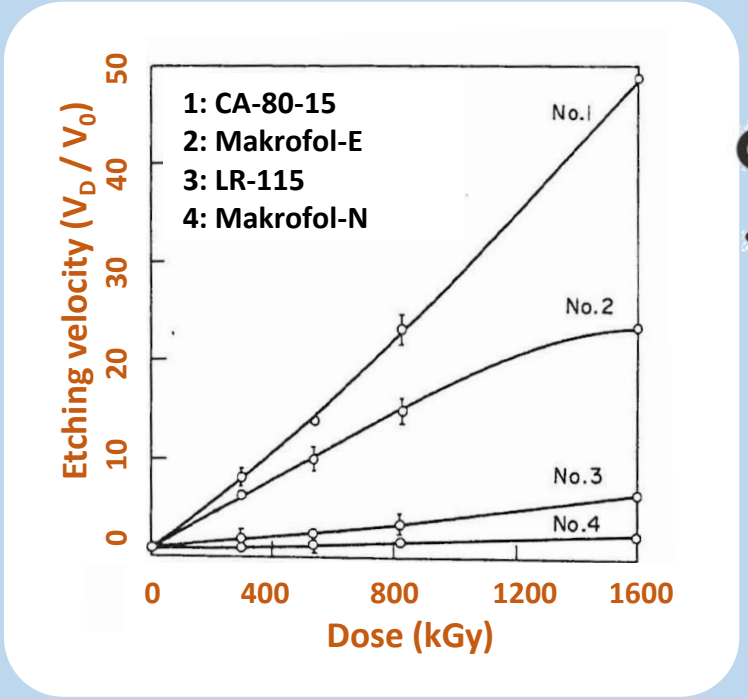

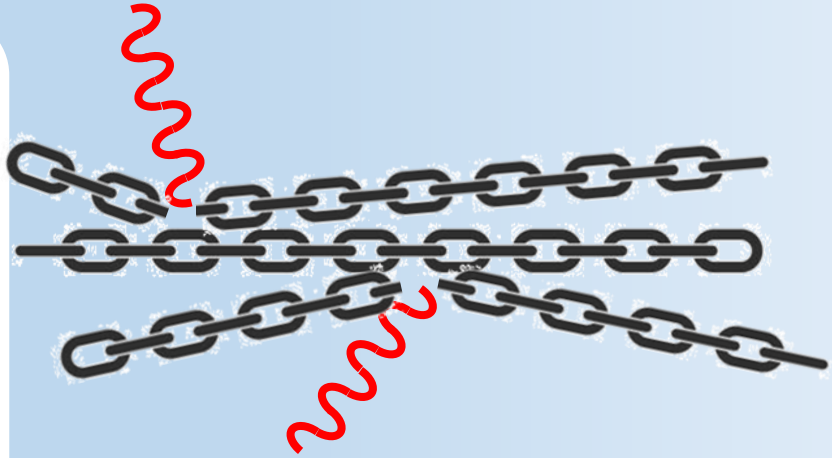

Average molecular weight
Optical density
Effectiveness of etching
Nuclear track dimensions

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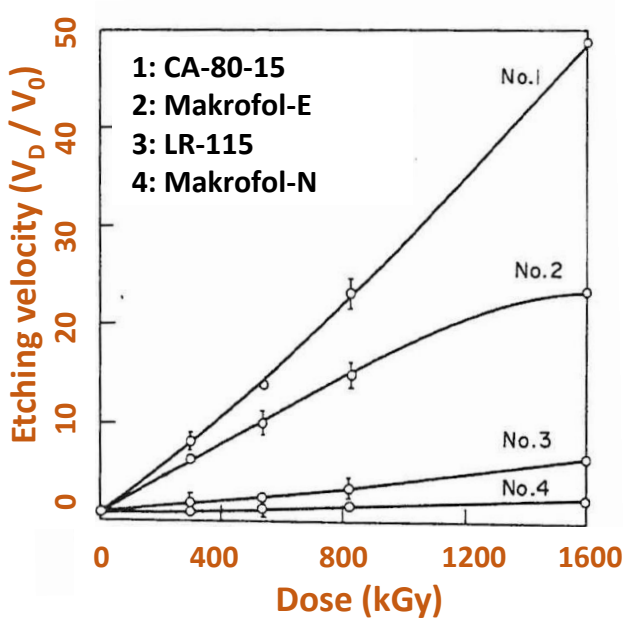

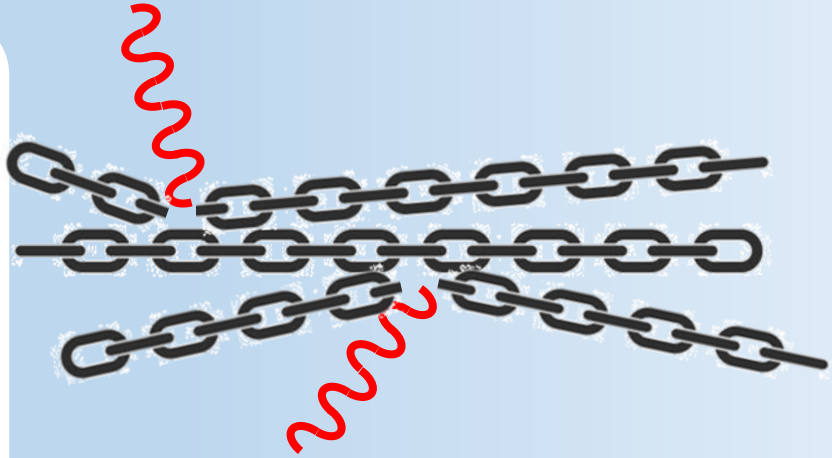

Average molecular weight
Optical density
Effectiveness of etching
Nuclear track dimensions

Various kinds of plastics are now common in domestic and industrial use. Should we know the effect of ionising radiation on their characteristics as a baseline and preparedness knowledge?

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IAEA – Project support 1162/RI/RB
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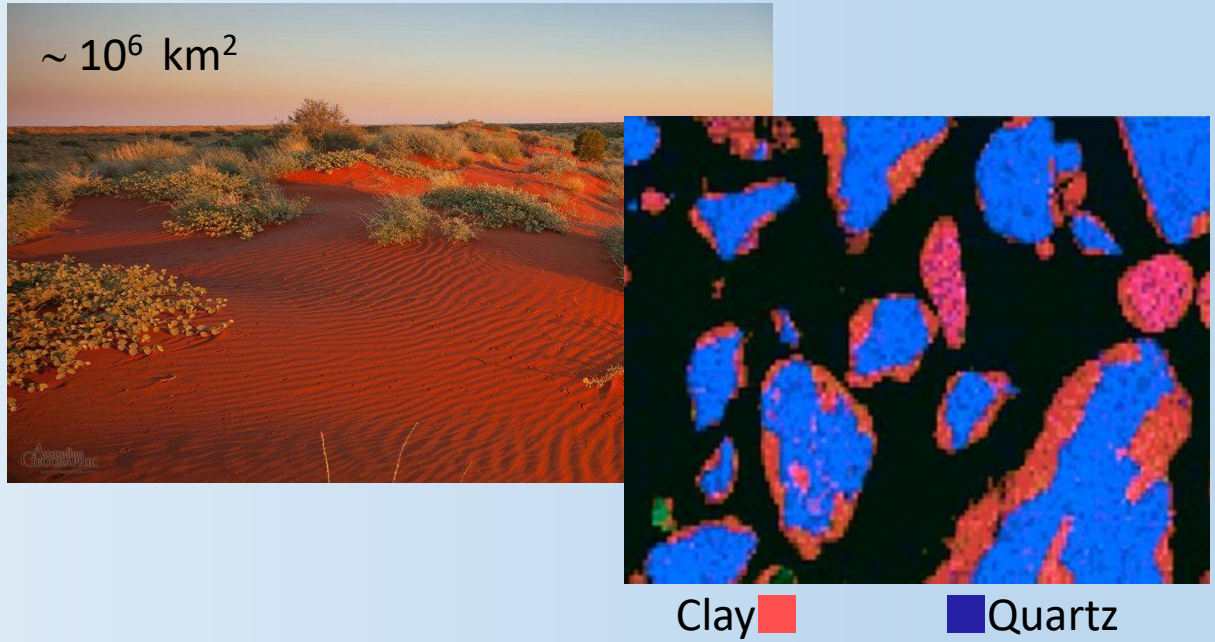
The Red Centre

… is not red at its centre

The Red Centre

… is not red at its centre



Cassels, Akber (2016)
Radiation Protection in Australasia Vol 33 pp 2 - 16

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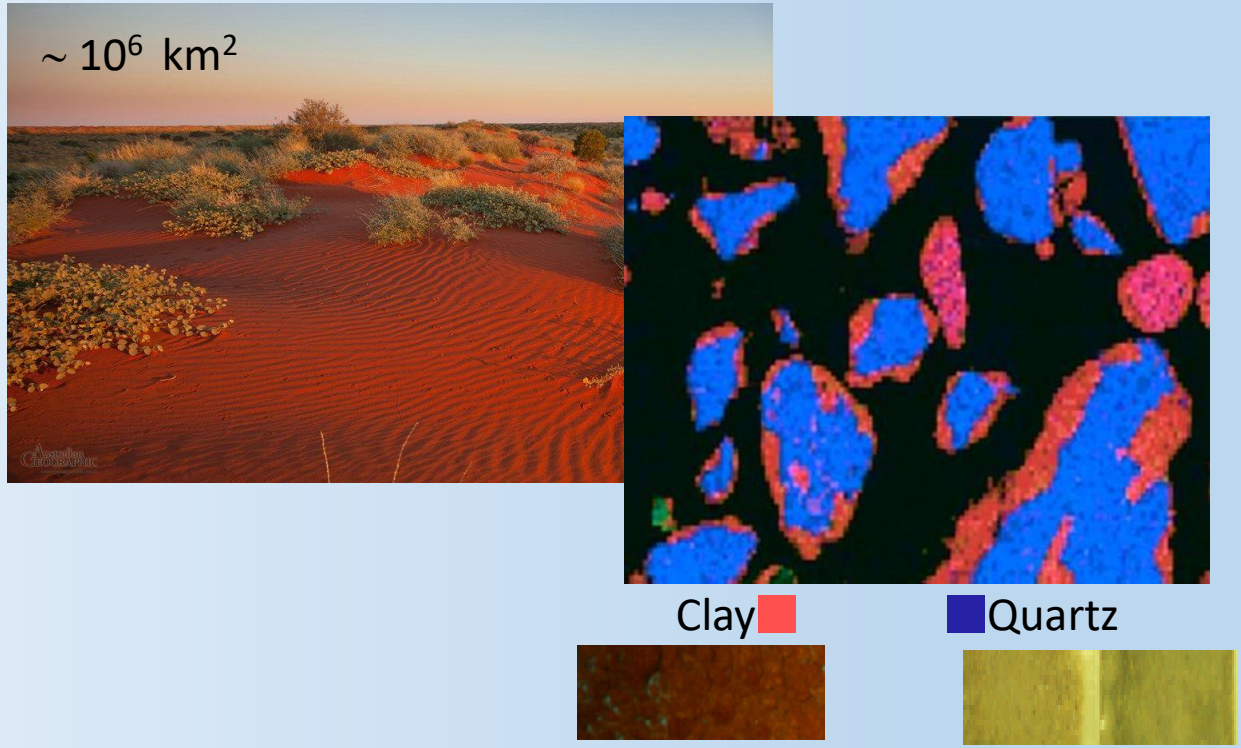

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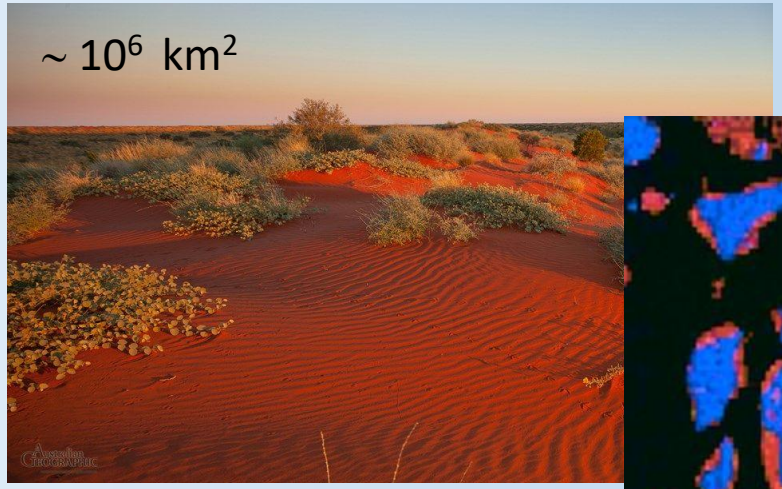
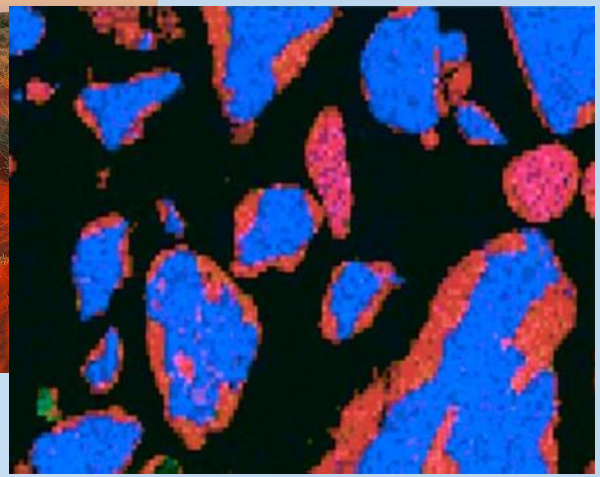
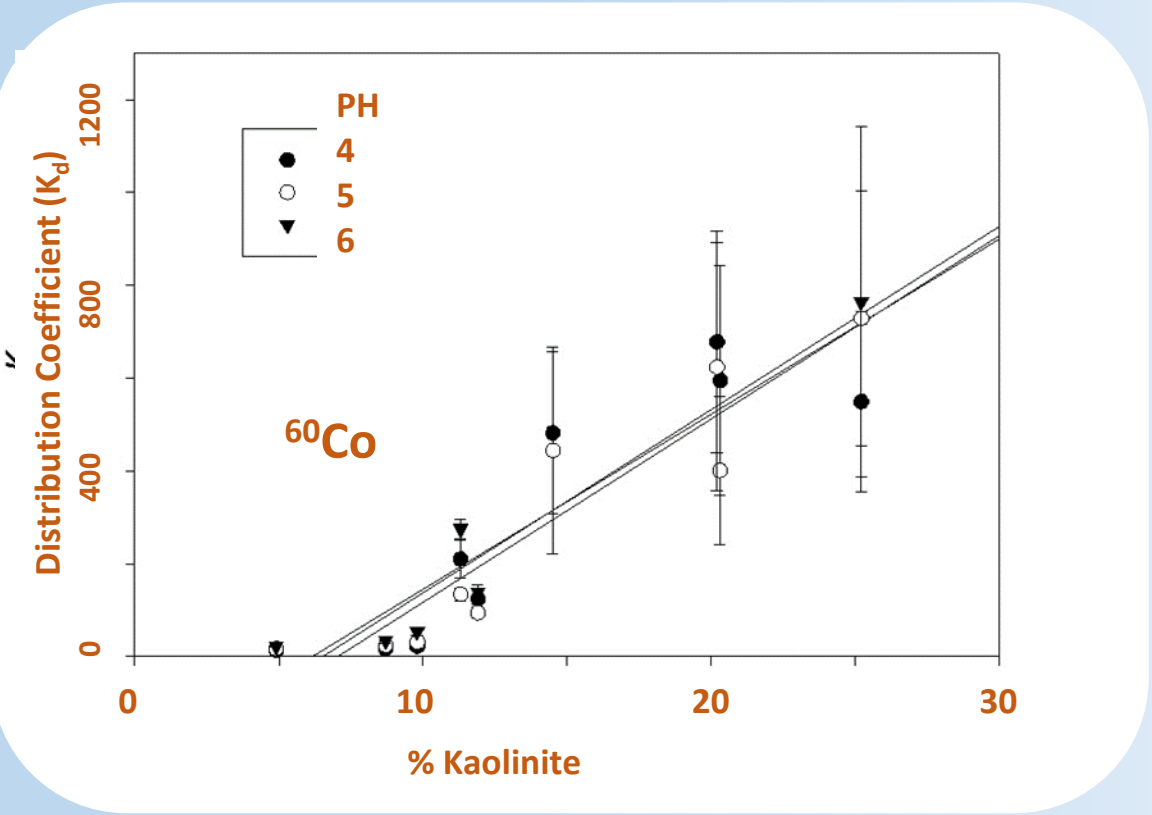




Clay Quartz



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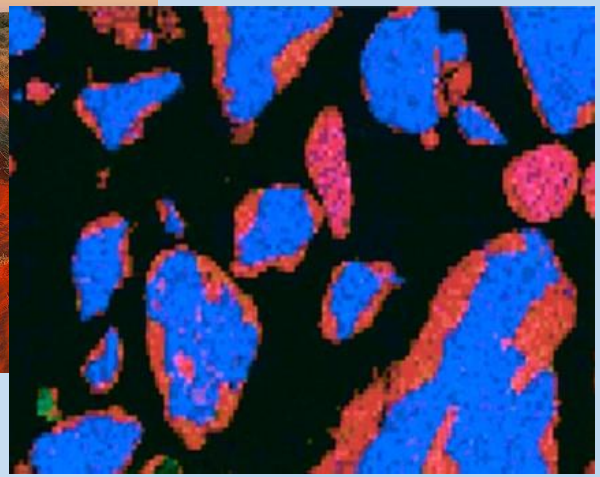

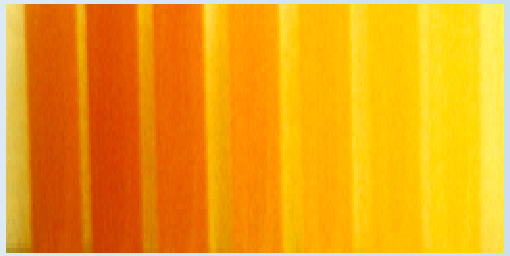

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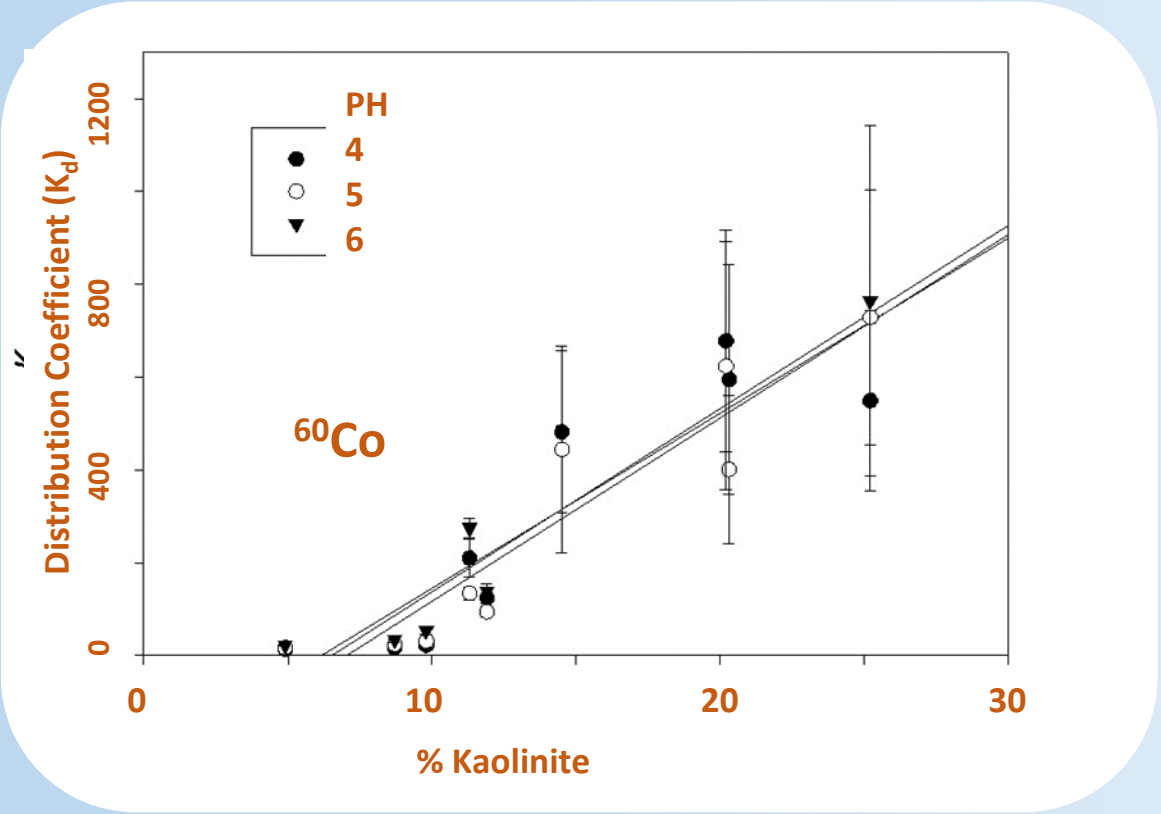

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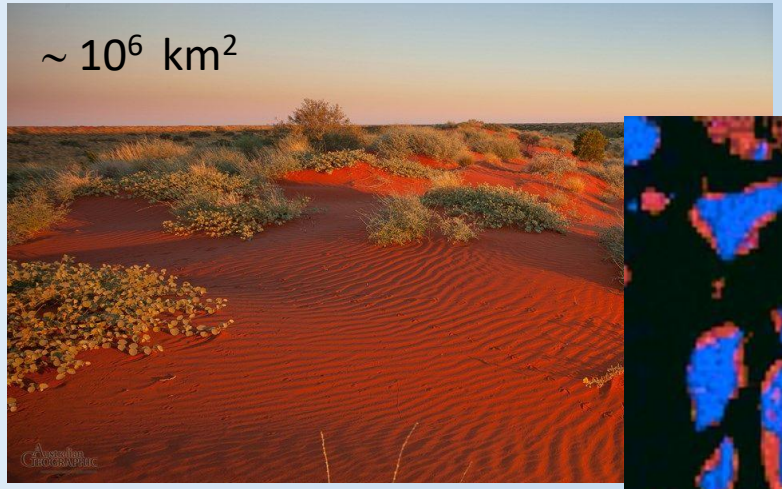
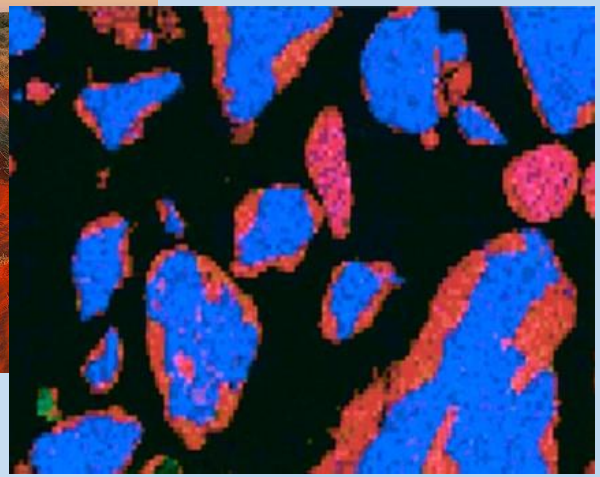
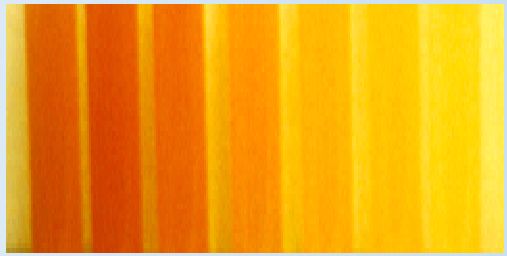
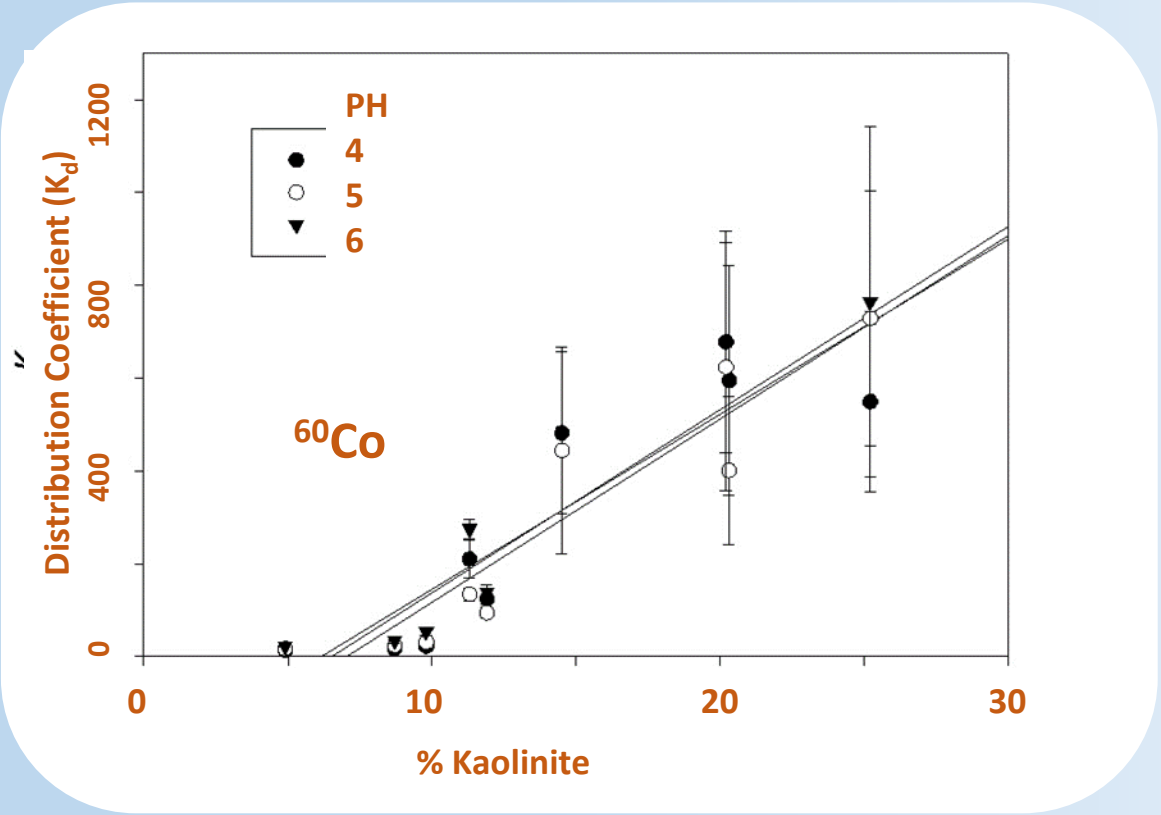






Clay

Quartz



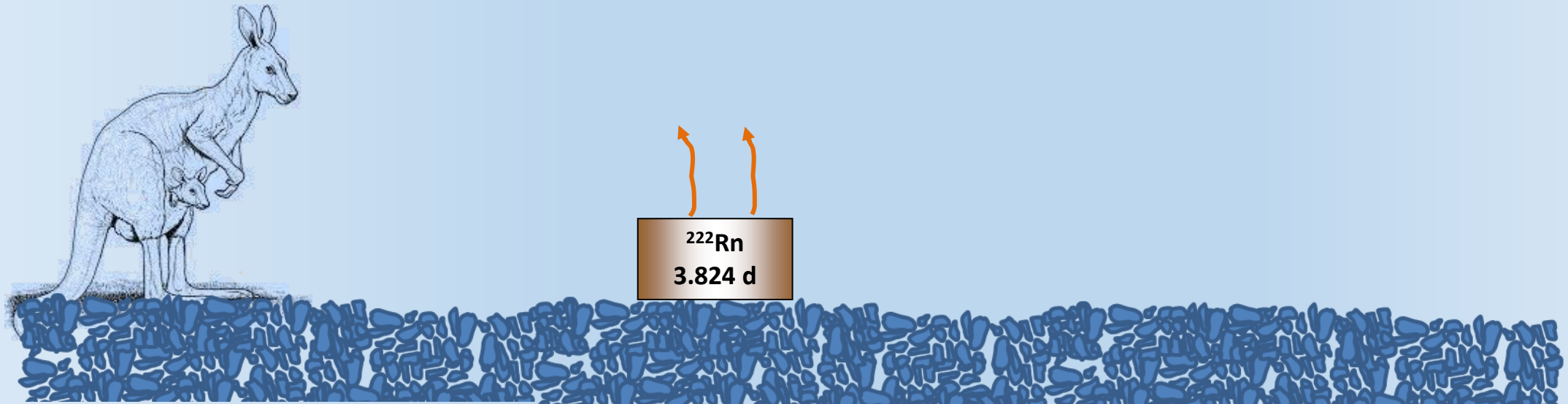
Cassels, Akber (2016)
Radiation Protection in Australasia Vol 33 pp 2 - 16

Do we sufficiently know the radiological contaminant transport mechanisms and fate of fine suspended particles, possibly colloids in the central Australian environment?!

RADIATION DETECTION FOR RADIATION PROTECTION

$^{226}Ra \rightarrow {}^{222}Rn$

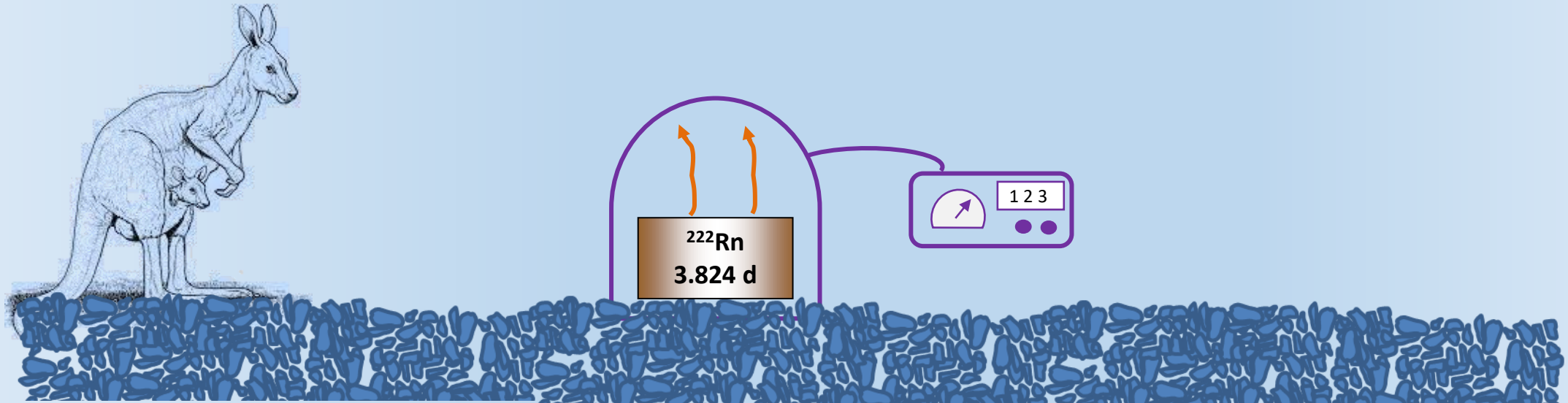
$^{226}Ra \rightarrow {}^{222}Rn$



RADIATION DETECTION FOR RADIATION PROTECTION

$^{226}Ra \rightarrow {}^{222}Rn$

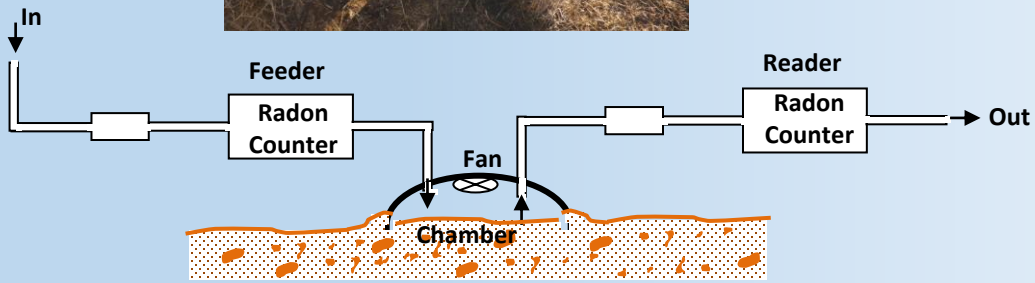
E ($Bq.m^{-2}.s^{-1}$)
^{222}Rn
exhalation rate
activity flux density



RADIATION DETECTION FOR RADIATION PROTECTION

$^{226}Ra \rightarrow {}^{222}Rn$

$E_h = E_\infty \tanh(h/L)$

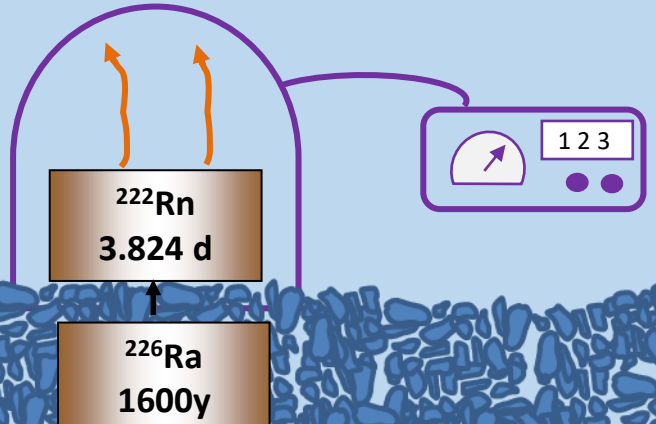


E (Bq.m^{-2}.s^{-1})
^{222}Rn
exhalation rate
activity flux density

$C_{Ra\text{-}226}$ (Bq.kg^{-1})
^{226}Ra
activity concentration in soil

$E \propto C_{Ra\text{-}226}$

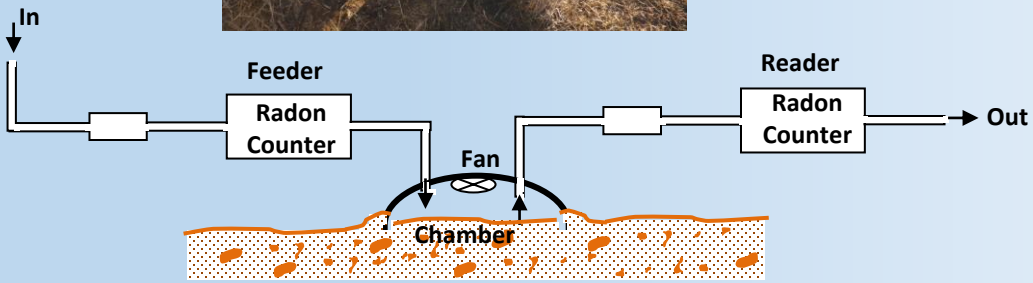
$R_{E\text{-}R} = E / C_{Ra\text{-}226}$



RADIATION DETECTION FOR RADIATION PROTECTION

$^{226}Ra \rightarrow {}^{222}Rn$

$E_h = E_\infty \tanh(h/L)$



E ($Bq.m^{-2}.s^{-1}$)
^{222}Rn
exhalation rate
activity flux density

$C_{Ra\text{-}226}$ ($Bq.kg^{-1}$)
^{226}Ra
activity concentration in soil

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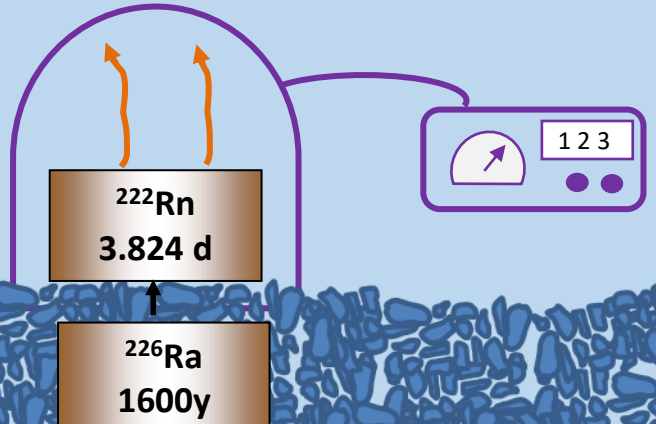
Lawrence, Akber, Bollhöfer, Martin (2009)
Journal of Environmental Radioactivity Vol 100 pp 1 - 8



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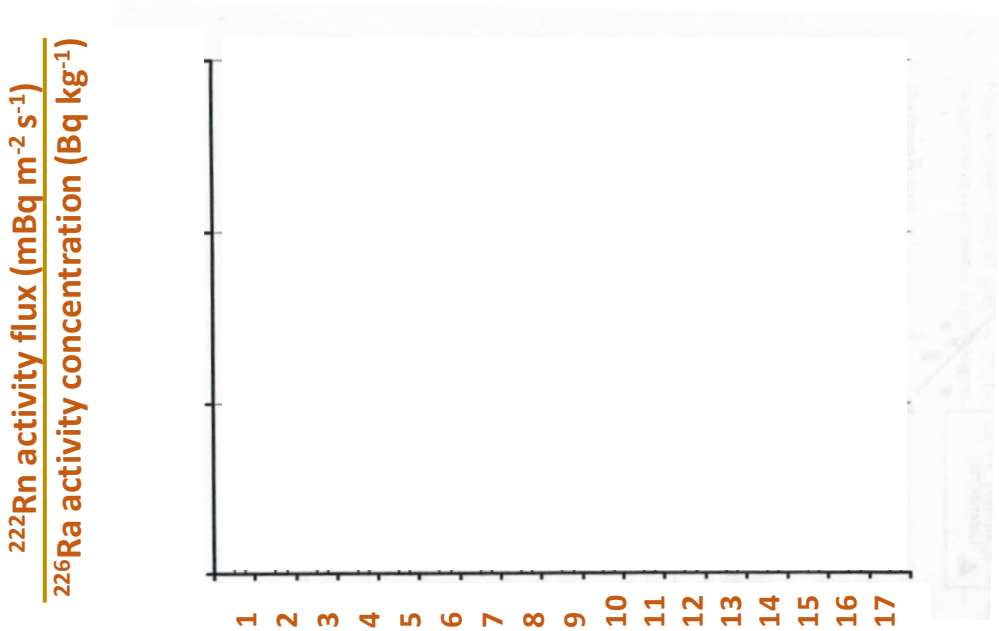

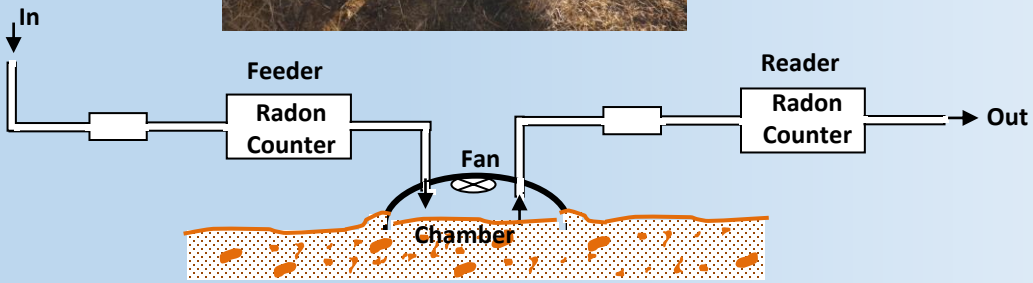

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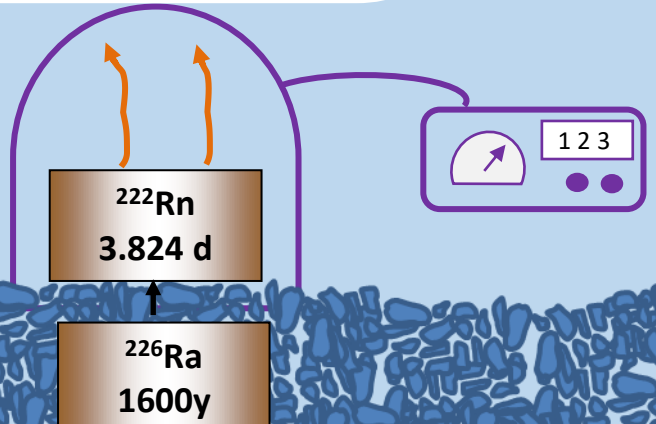

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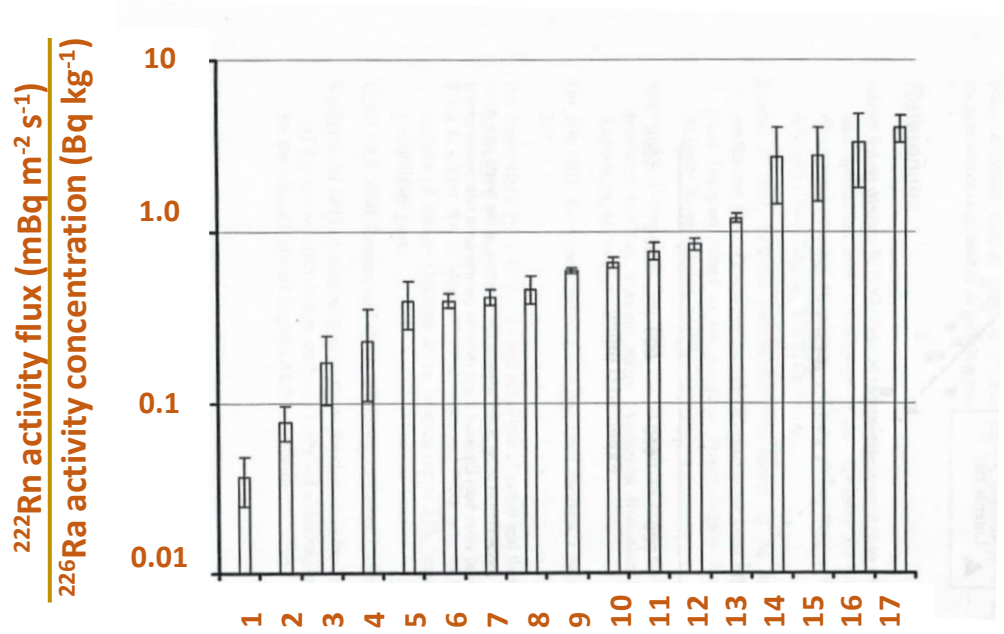

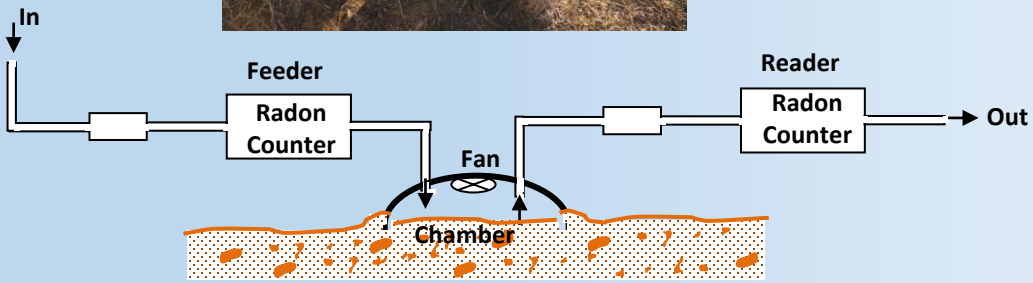

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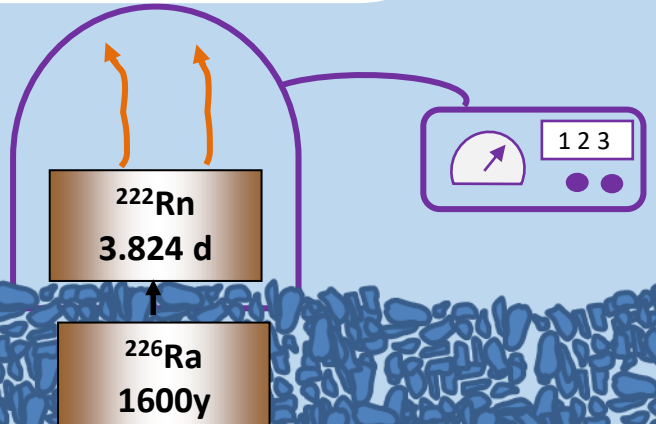

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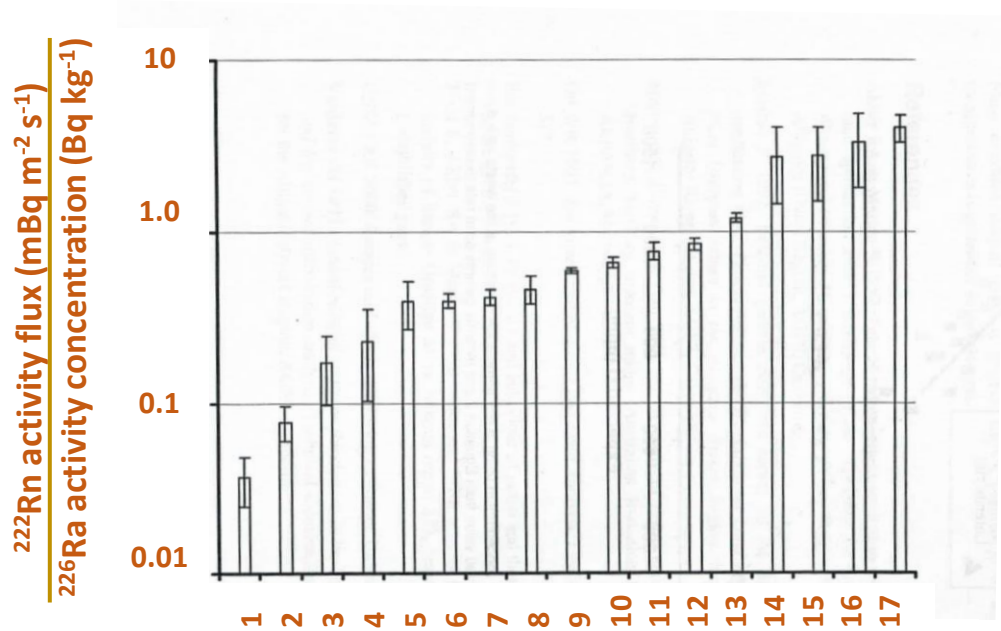

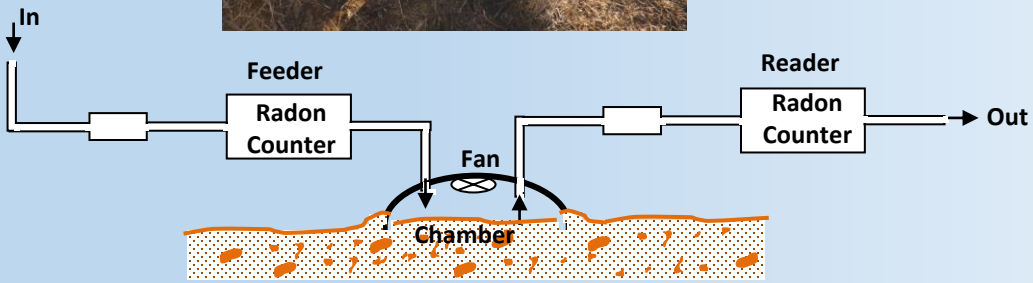

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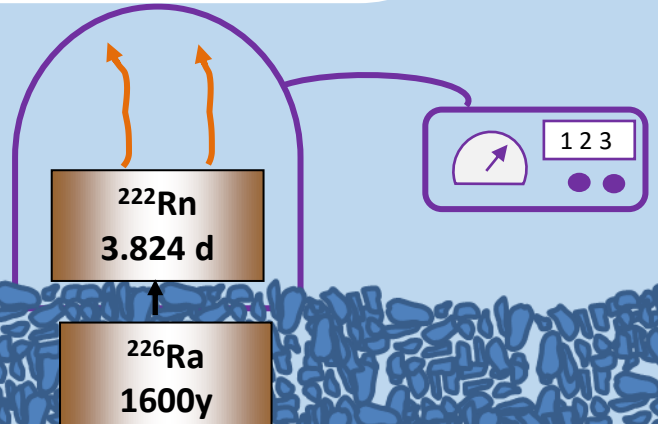

Factors other than ^{226}Ra activity concentration dominantly control ^{222}Rn exhalation rates from the soil. Default values used in the models should be validated for the local conditions

RADIATION DETECTION FOR RADIATION PROTECTION

Survey Meters

The first responders to radiation

RADIATION DETECTION FOR RADIATION PROTECTION

Survey Meters

The first responders to radiation

Aqeel Akber, Matt Wiggins (2019)
Journal of Radiation Protection and Research Vol 44 pp 97-102

Response traceability

to a National Standard of Air Kerma

↓

Codes of Practice

- Moisture density gauges (RPS-5)

- Fixed radiation gauges (RPS-13)

- Industrial radiography (RPS-C-4)

Regulatory requirement

Radiation protection plans

RADIATION DETECTION FOR RADIATION PROTECTION

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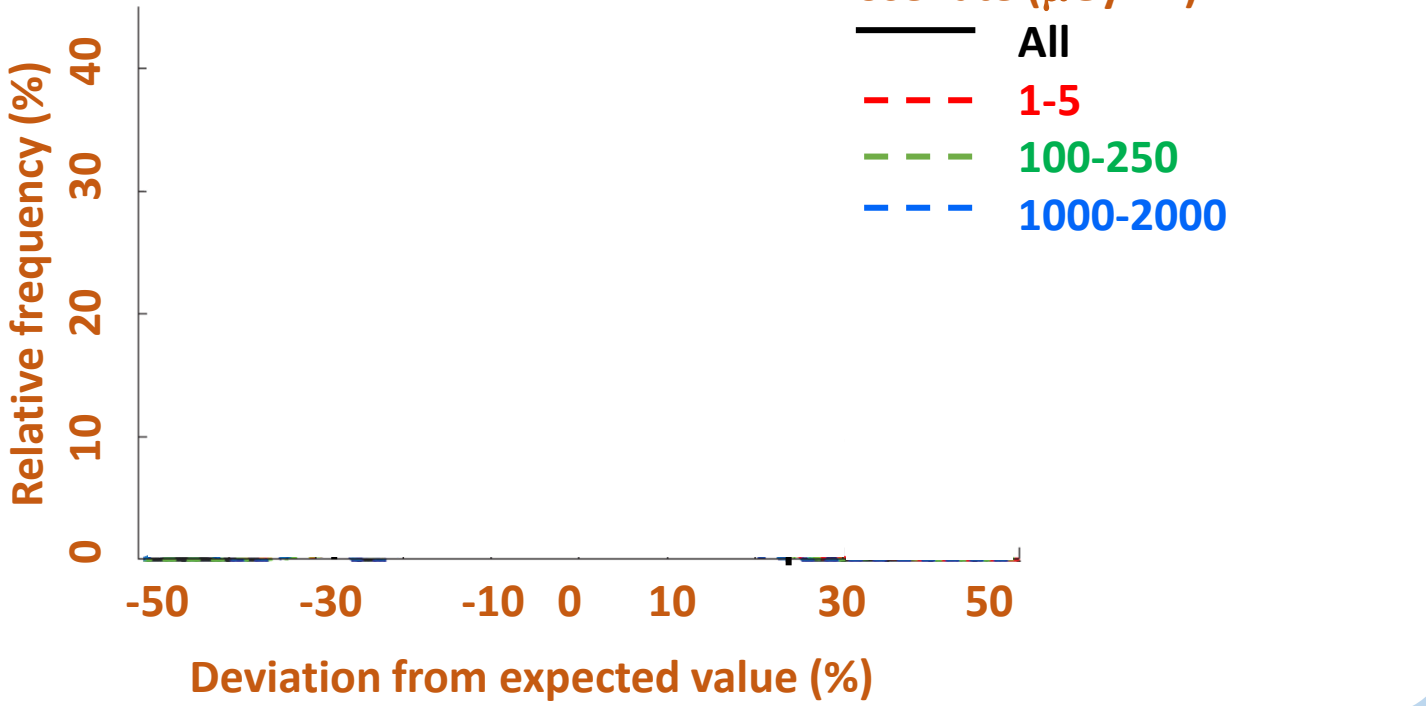
Survey meters: 1,158
Individual readings: 40,305



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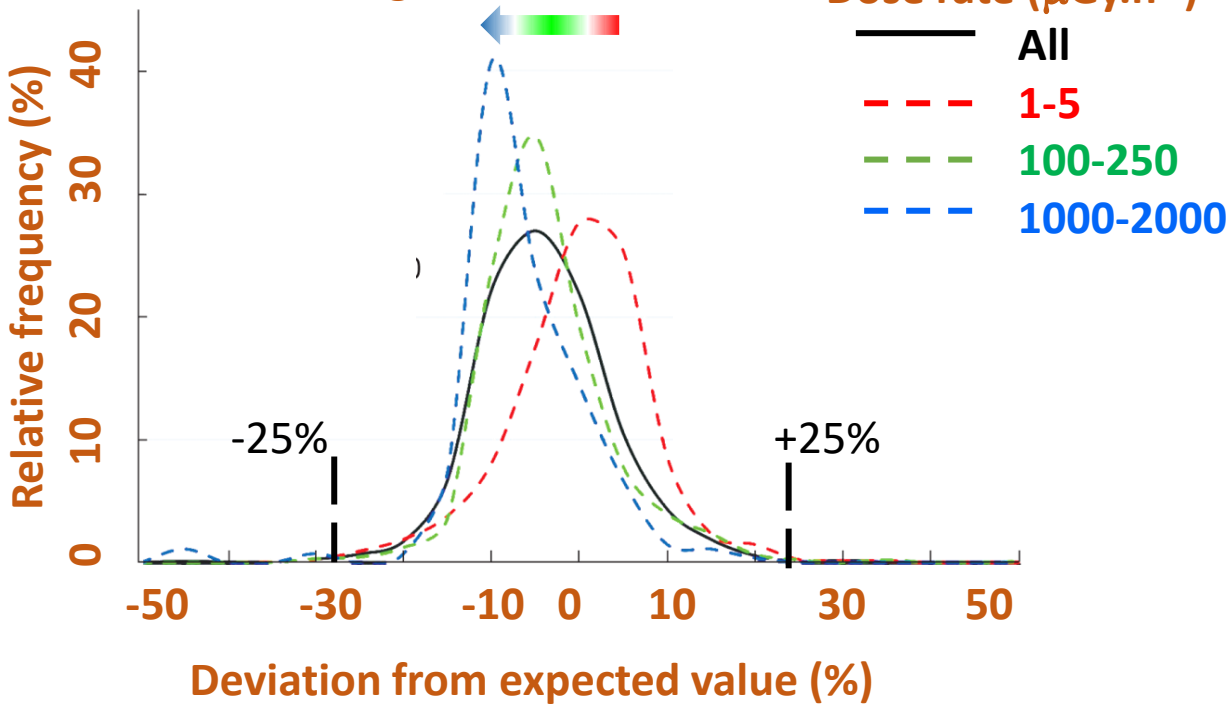

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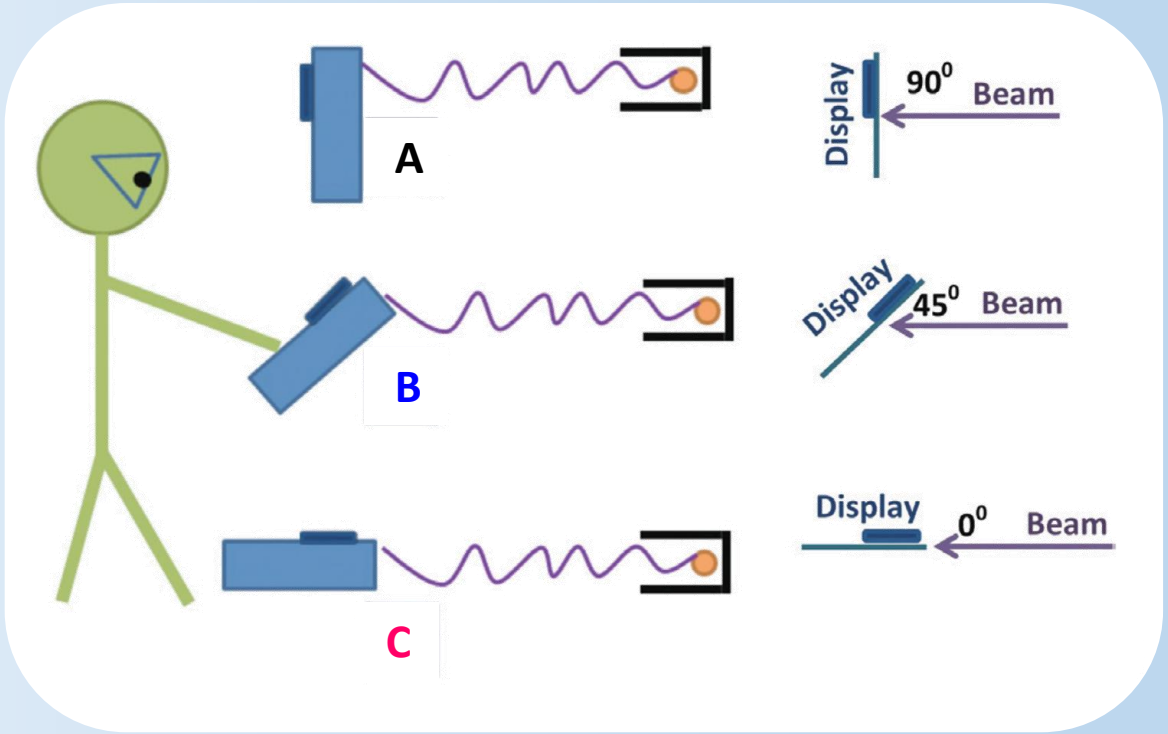

Ergonomics

For dose rate measurements, a survey meter may be tilted in different directions.

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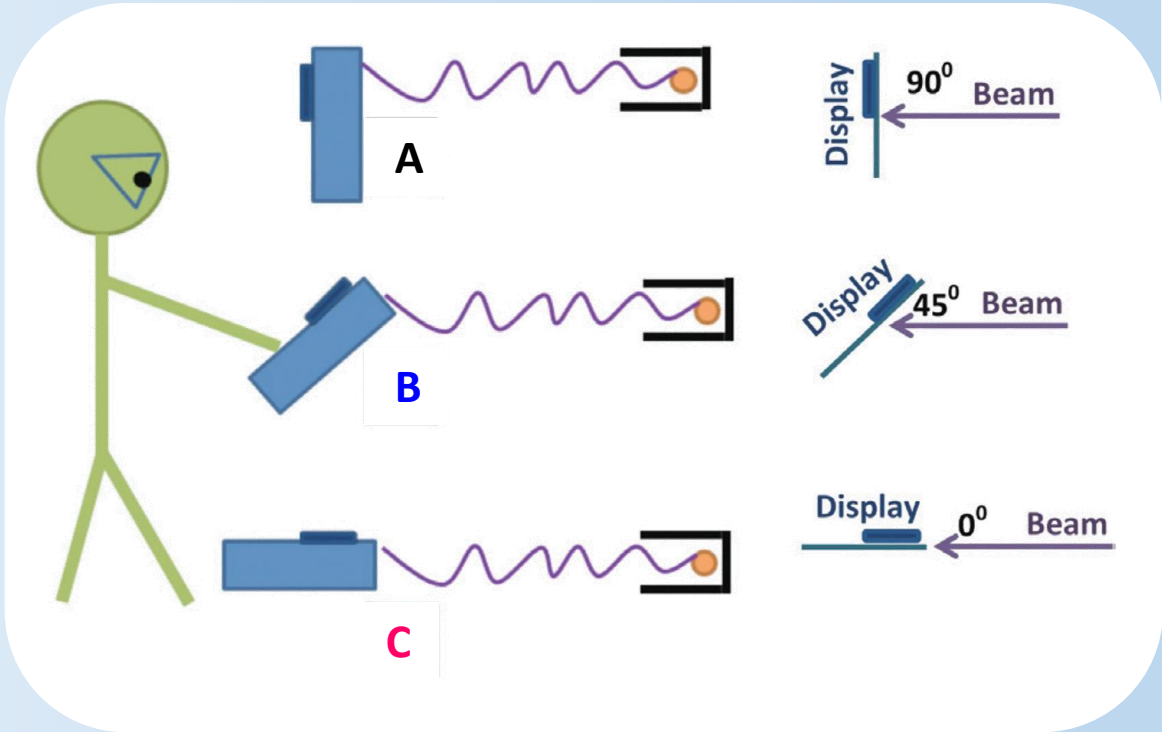

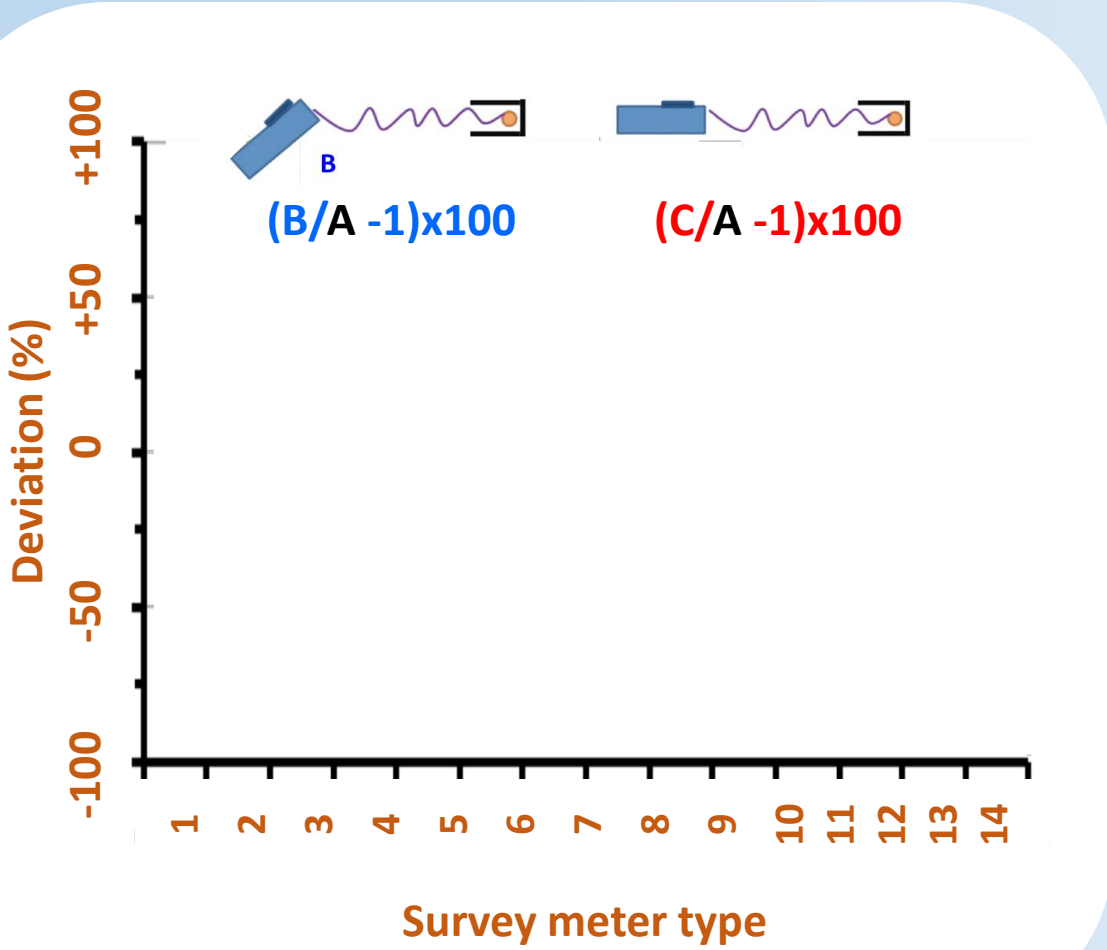

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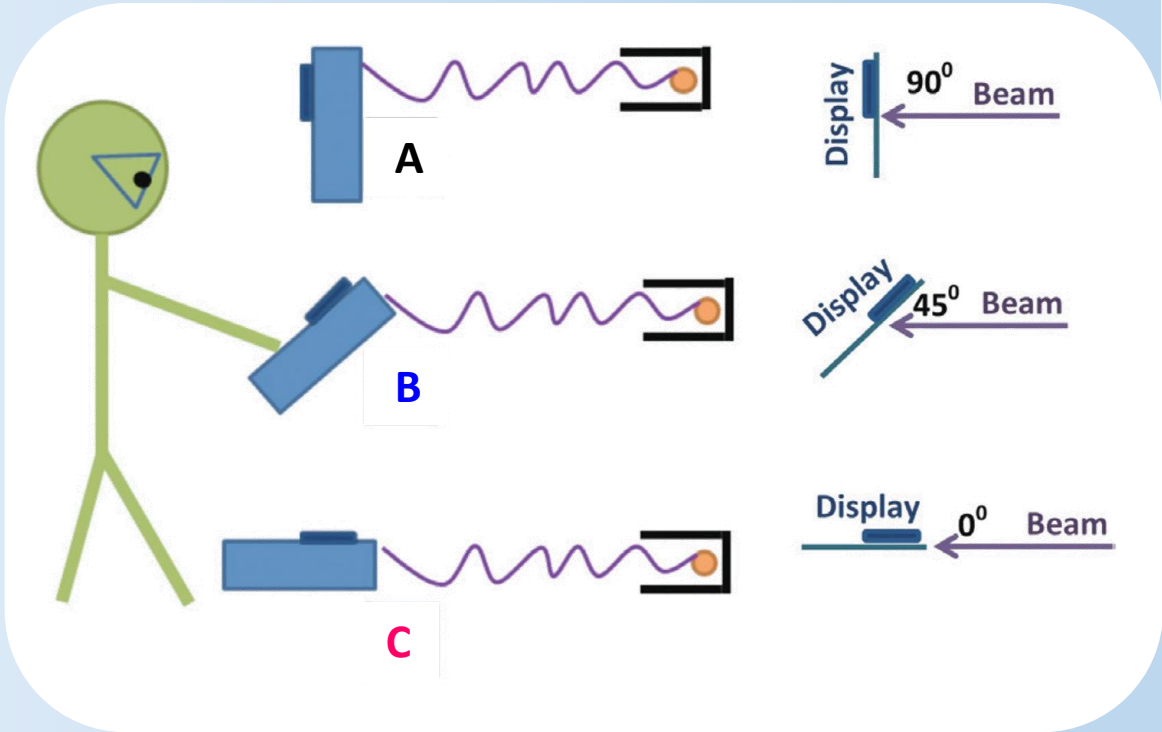

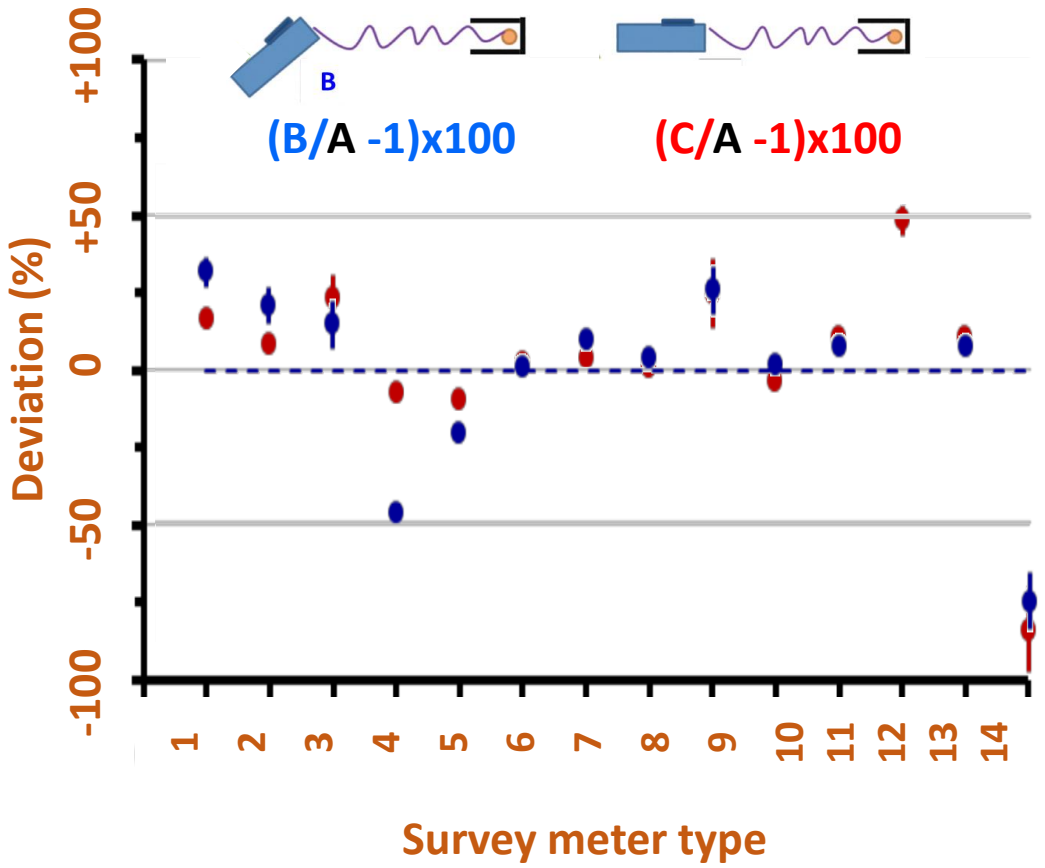

Ergonomics

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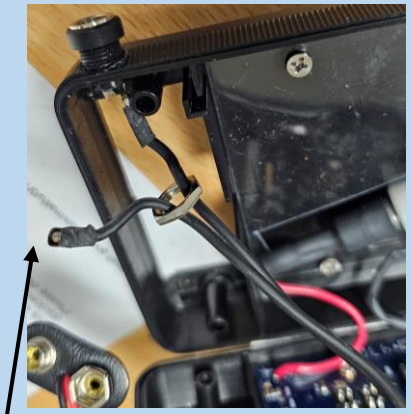
RADIATION DETECTION FOR RADIATION PROTECTION

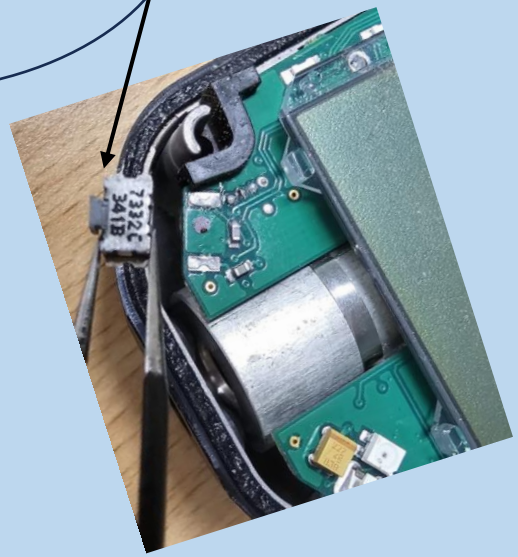
Survey Meters

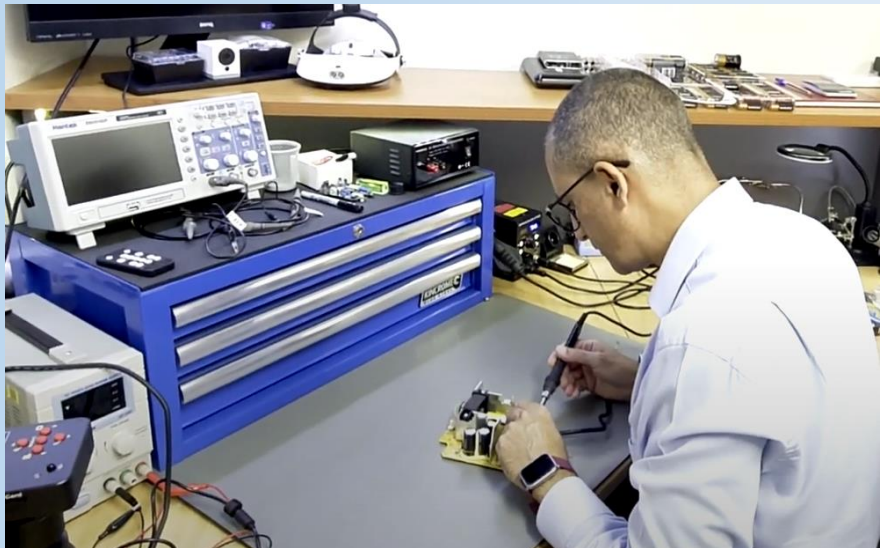
The first responders to radiation

Smashed screens
Broken detector tubes
Broken solders
Dislodged components



Repairs – Lessons Learnt





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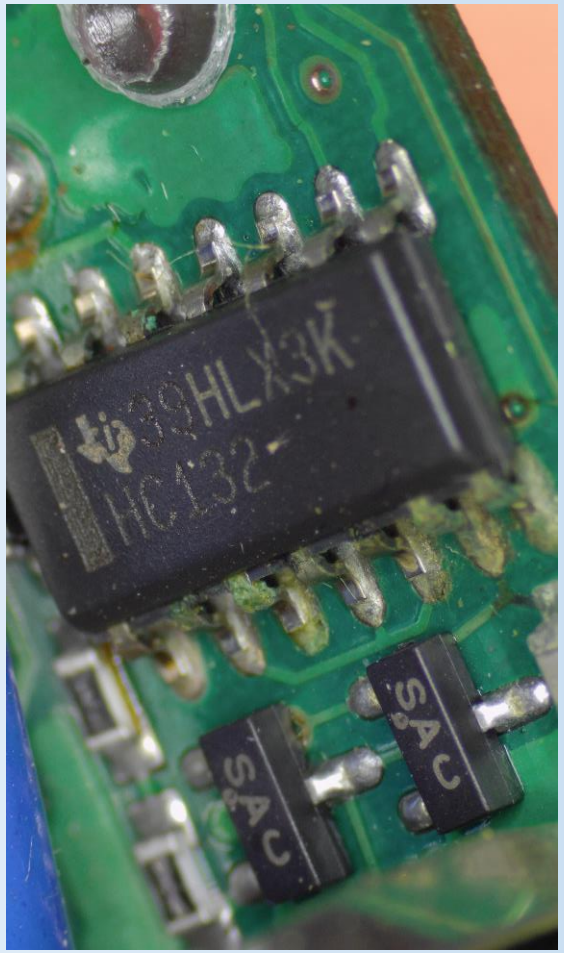
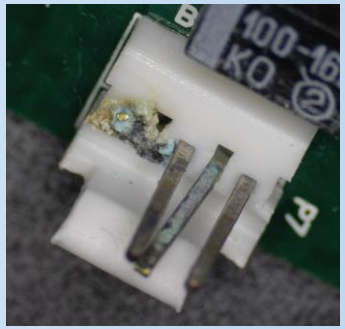
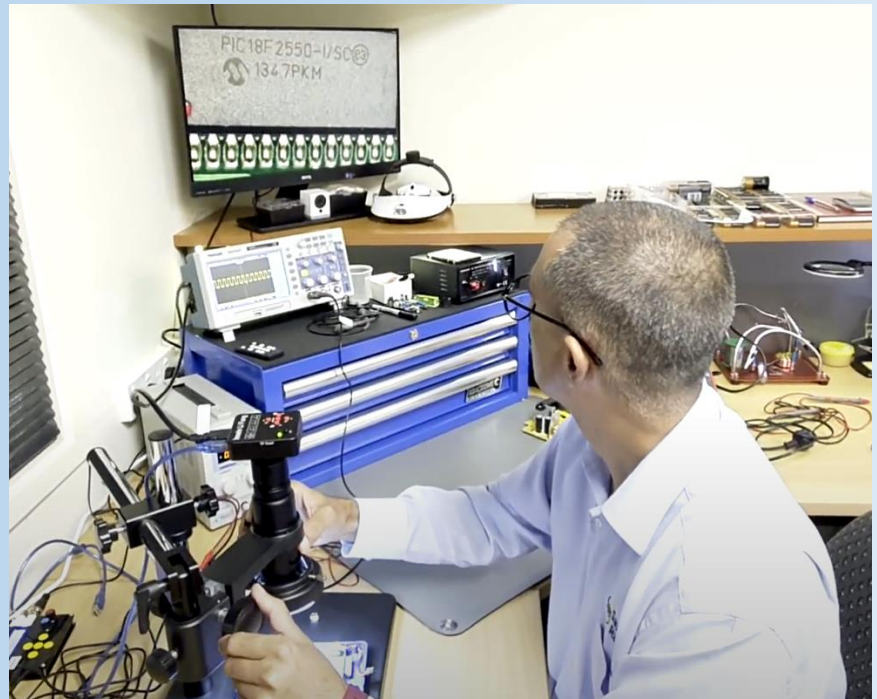




Corroded
Circuit boards
IC components

?

Repairs – Lessons Learnt



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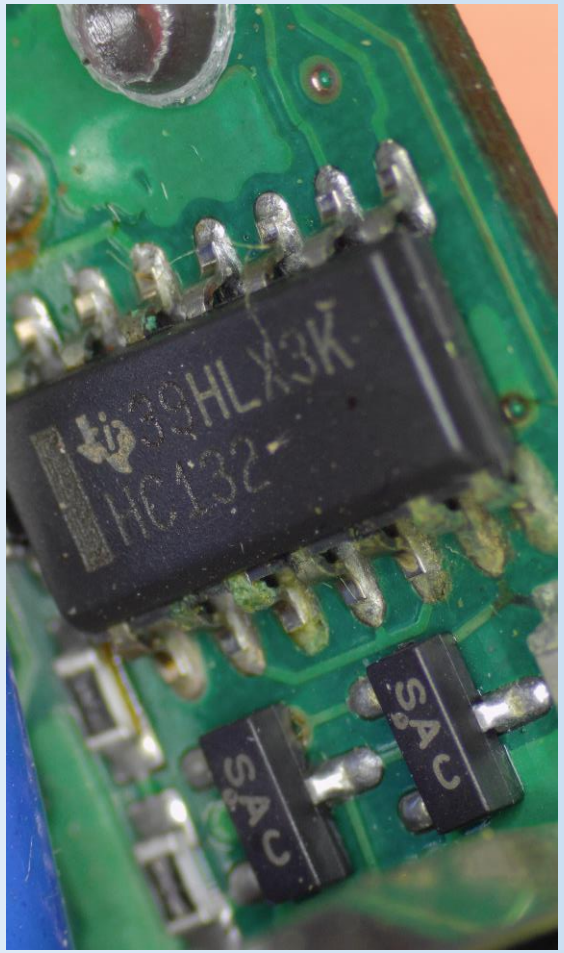

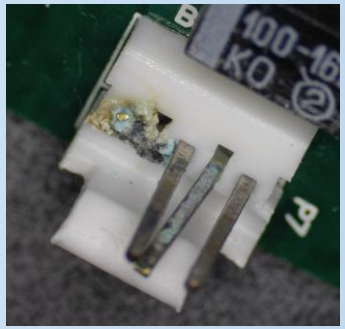

Corroded
Circuit boards
IC components

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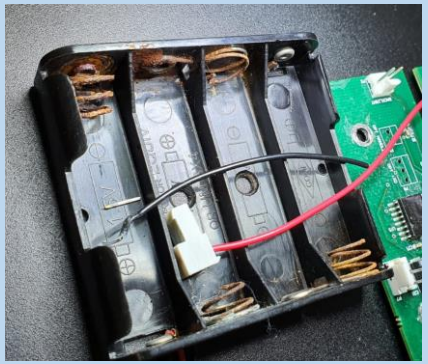
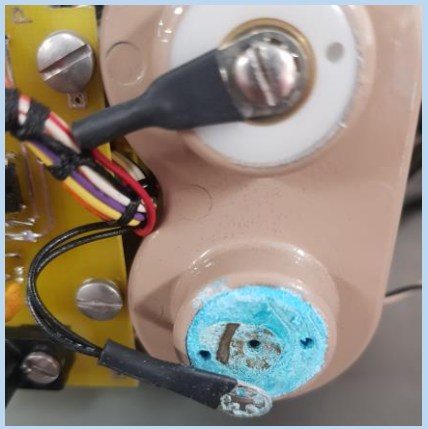
Leaking
batteries





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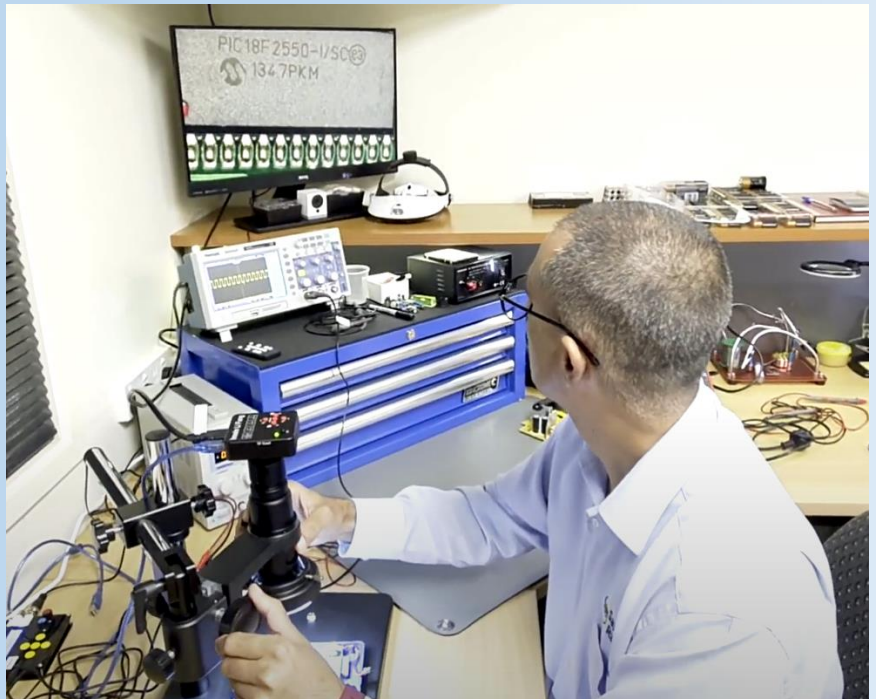

RADIATION DETECTION FOR RADIATION PROTECTION

Survey Meters

Aqeel Akber, Matt Wiggins (2019)
Journal of Radiation Protection and Research Vol 44 pp 97-102

A review based on ~ 1000 gamma survey meters in Australia suggests:

- **Majority are operational within ± 25% of expected dose rate**
- **1.5% were inadequate (assorted reasons)**
- **Keep the survey meters serviced, repaired, change batteries**

RADIATION DETECTION FOR RADIATION PROTECTION

Radon progeny

Wandering unattached in wet and dry tropics

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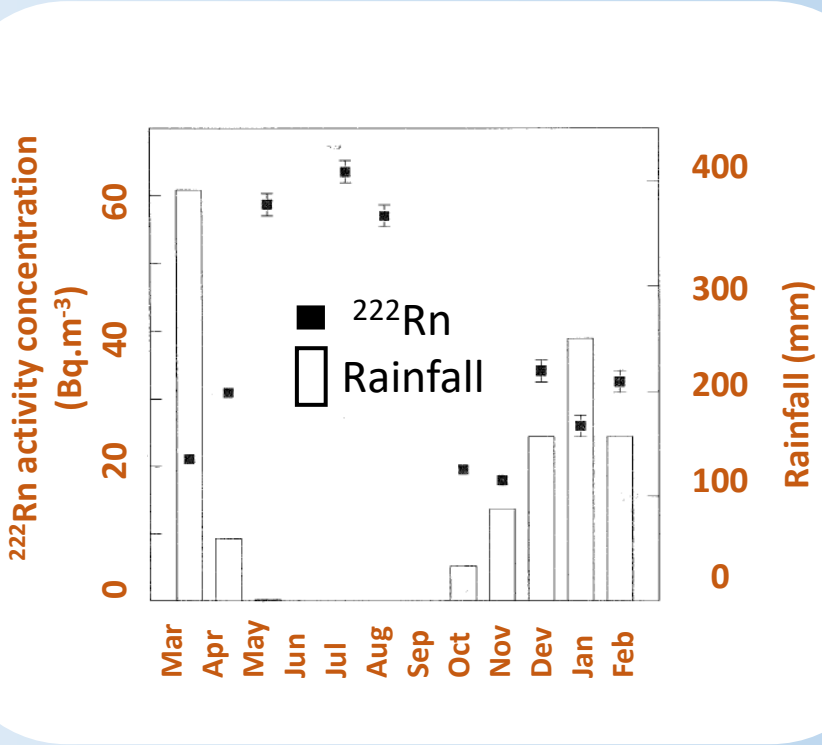
Wandering unattached in wet and dry tropics



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Akber and Pfitzner
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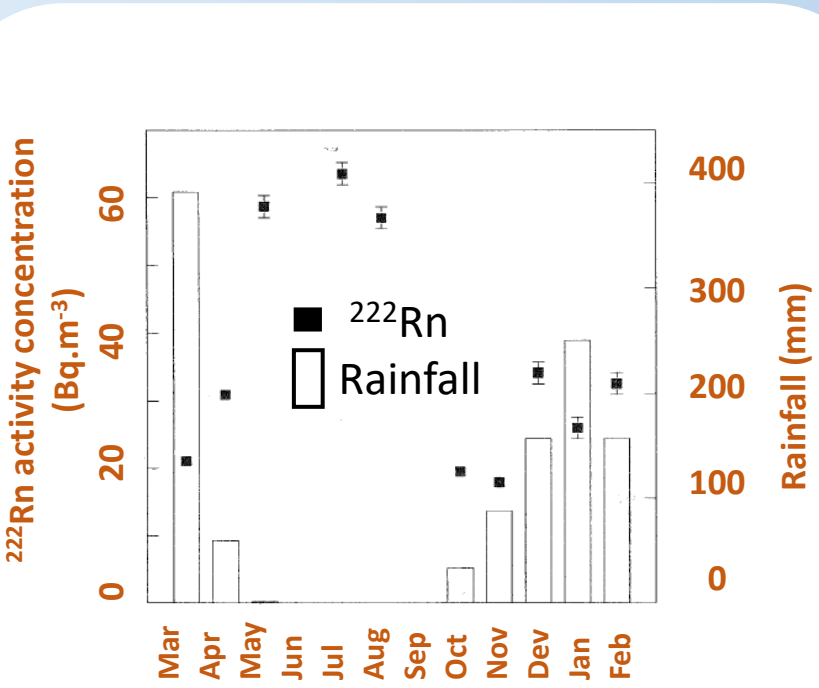

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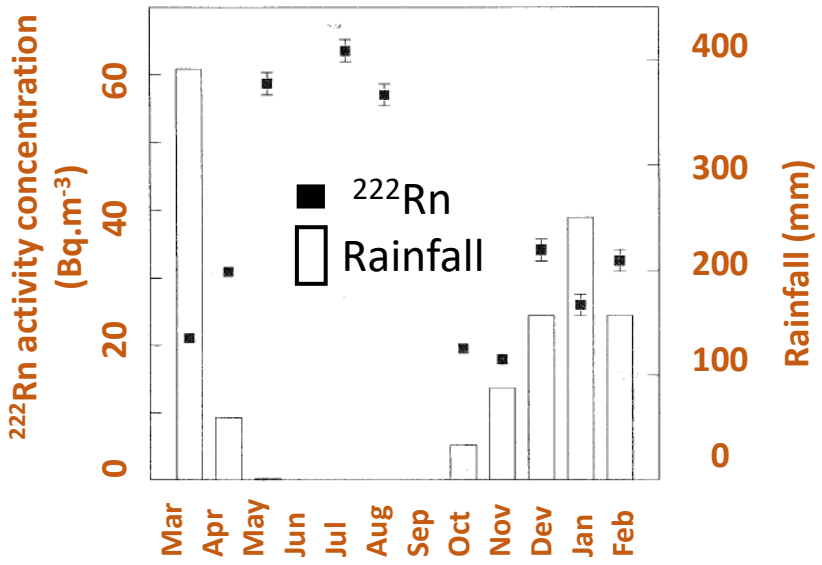

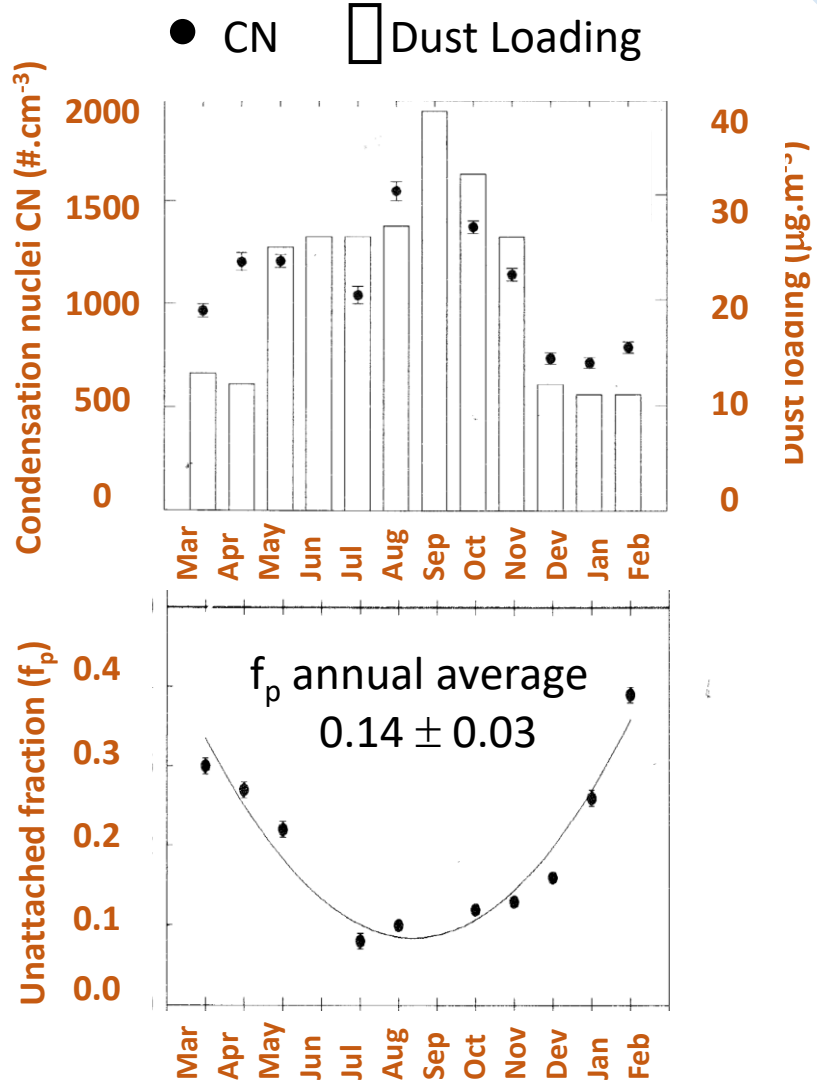

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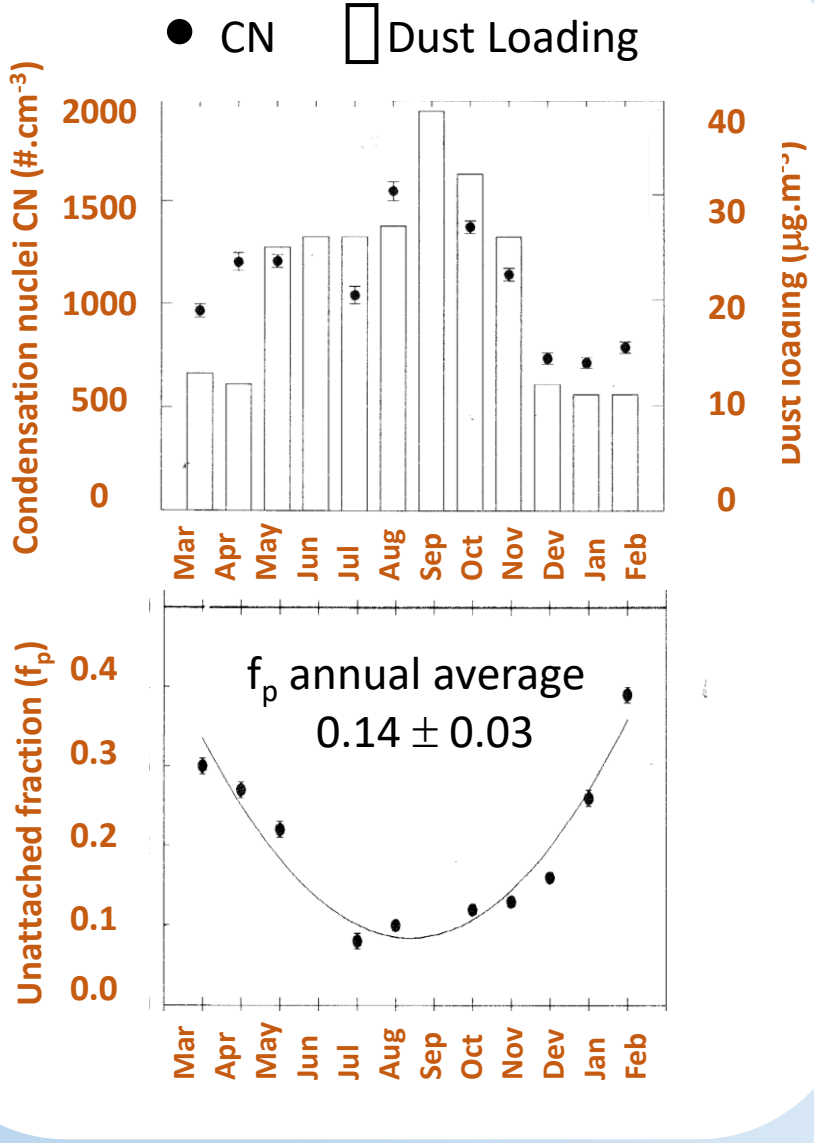
Perhaps most extensive reported dataset of unattached radon fraction measurements in wet and dry tropics.

Perhaps we need a bibliography and review of reported radon progeny concentrations in Australia. Who would do it?!



RADIATION DETECTION FOR RADIATION PROTECTION

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Despite spending a life on a task …

RADIATION DETECTION FOR RADIATION PROTECTION

Despite spending a life on a task …

… there is plenty left to do.

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See you at LinkedIn

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Safe Radiation
Workplace and
Environmental Radiation Safety

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