Carnamah Radiometric Test Range.

Do we assign concentration values?

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Discussion

Since 1997 there have been seventy eight documented ground runs down the Carnamah Test Range. The first eight were done in a rather haphazard manner and have been ignored for this discussion. Of the remaining runs, twelve have been assessed as 'damp/wet' and fifty three as 'dry' runs. The remainder have either been done with a different spectrometer or had a questionable calibration file applied to the raw data. These latter runs are the subject of this discussion.

The percentage drop in mean concentrations under dry - damp conditions is in the order of ≤ 8%, however some of the percentage errors produced by using different spectrometers or questionable calibration files, are ≥ 20% (see 'Carnamah Progessive.xlsx' - Edited means,poles only). As any errors in attributing concentration values to the test range are reflected in the concentrations calculated from later surveys, it would make sense to standardise the range concentration values to assure some degree of repeatability between aircraft systems and the eConcentration images they produce.

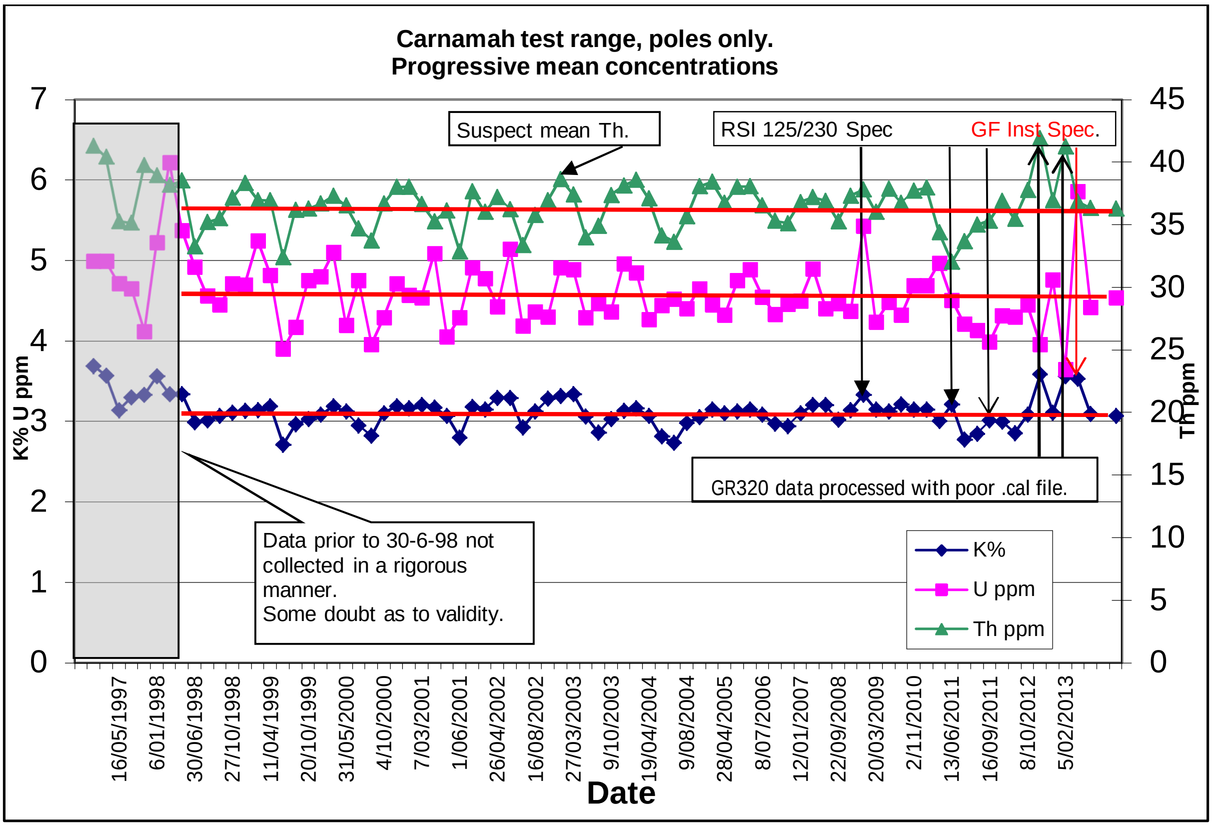
The Range History

The mean concentrations for each run down the test range are shown graphically in the chart below. The majority of the runs from 30-6-98 were taken with a GR320 that had been carefully calibrated against the two metre CSIRO pads at North Ryde and these readings form the basis of this report. The data prior to 30-6-98 has been excluded from further calculations, likewise those later readings from 2008 onwards that were taken with spectrometers with unknown calibration credentials and the readings do not fit the historical pattern, or in one case, do not match readings taken simultaneously with a GR320. These readings are highlighted by the arrows and notes.

It can be seen that there is at least one value that does not fit the historical pattern in five of the rejected runs. In the case of the two runs processed using a questionable GR320 calibration file, all three means are anomalous.

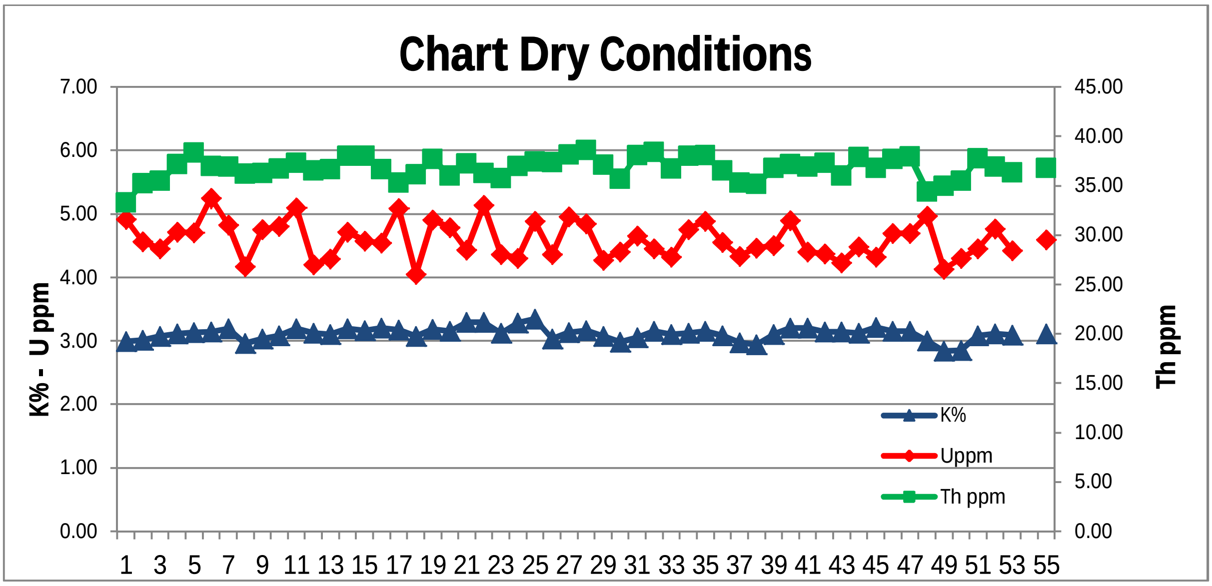
The values at the far right of the chart and highlighted by the red lines are the means of all the valid runs both wet and dry. These are K% = 3.07, Uppm = 4.54, and Thppm = 36.27
NOTE: This Uranium mean has <u>not</u> been radon corrected.

The Carnamah Test Range ground data has been collected over a period of some 15 years (1998-2013) and shows little sign of drifting with time. However, it might be prudent to have some competent, independent organisation (the Geophysics Dept. at a University for instance) resample the range every five years or so at the monumented sample points; using a suitable spectrometer, properly calibrated on the two metre CSIRO pads.



eConcentration history in ‘dry’ conditions

The chart of the mean concentrations taken when the soil conditions were reported as ‘dry’ is shown below. Note: Radon has <u>not</u> been removed from the Uranium means.



The data points on the far right of the chart are the mean of the dry runs and are as follows:

Potassium = 3.11% Uranium = 4.59 ppm Thorium = 36.75 ppm

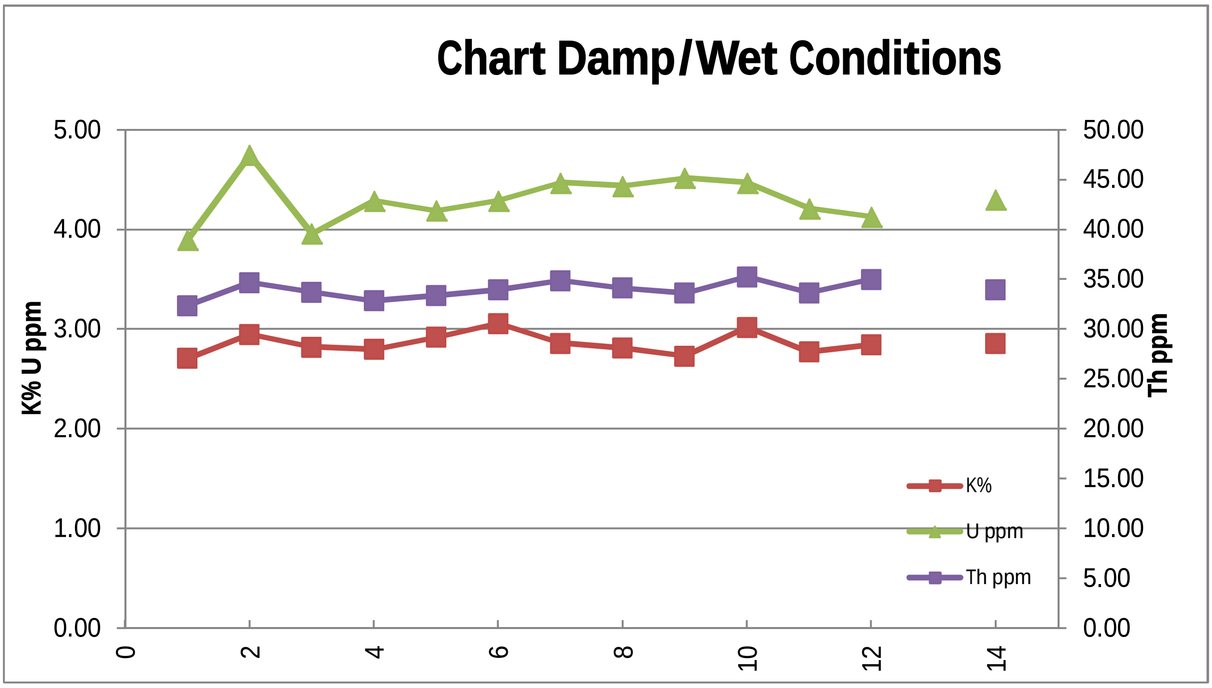
‘Dry’ radon free Uranium value

The ‘dry’ (radon free) value for the uranium mean, was the run taken on the 26/5/2001. The Uranium concentration mean for the range this day was 4.05 ppm (typical wet value), the Potassium and Thorium concentrations were at typical dry values (3.07% and 36.12 ppm respectively).

The range soil condition on this day was dry, however there was a rain front moving from the WSW that had brought rain over Perth the previous night and most of the next day. This rain had progressed as far North as Moora by the afternoon. The surface wind at the range had been from the SSW all day, blowing from the rain area. The Uranium concentration from the Coorow lake background was 0.01 ppm. When the data was processed and the height attenuation coefficients were extracted, they fell on the theoretical values without having to remove the Salt Lake Radon correction data.

eConcentration history in ‘wet’ conditions

The chart of the mean concentrations taken when the soil conditions were reported as ‘damp/wet’ is shown below. (Wet conditions are when the top 50-75+ mm of soil is noticeably waterlogged. Dampness in the top 10 mm only, does not have much effect on the range readings). Note: Radon has not been removed from the Uranium means.



The data points on the far right of the chart are the mean of the damp/wet runs and are as follows:

Potassium = 2.86% Uranium = 4.30 ppm Thorium = 33.97 ppm

The Radon Problem

No attempt was made to remove radon from the 'DRY' Uranium means, as many of the Coorow Lake background readings were often –ve or not reported, and a later study of two sets of background readings (where there was both 'before and after' backgrounds taken and they were not -ve) revealed an alarming Radon drift during the approximately 3 ½ hours between readings.

Readings taken in the freshwater lake at Coorow before and after surveying the range.

12/4/1999

Time in days.		U ppm
.43851	10:31:27	0.04694
.58209	13:58:12	0.56519
=.14358*24=3hrs 26.7mins		<u>0.51825 ppm</u>

15/7/2004

Time in days.		U ppm
.38811	09:18:52	1.21864
.53954	12:56:56	0.37845
=.15143*24=3hrs 38 mins		<u>0.84019 ppm</u>

It can be seen that variations in the Radon during the time taken to survey the range are common and can be quite large. This could make accurate Uranium/Total Count range readings virtually impossible to obtain under normal (radon polluted) conditions.

This might also explain why the Uranium Stacked Profiles in the 'Carnamah Progressive' spreadsheet do not correlate as well as the Potassium and Thorium Profiles (see charts below). The variability of the Uranium profiles also suggests that there is no uniform offset due to Radon at any given time, and that the radon is both spatially and temporally variable.

To arrive at a Uranium mean for Damp/Wet conditions the Coorow backgrounds (when available) were removed.

Damp/wet conditions reported on range.

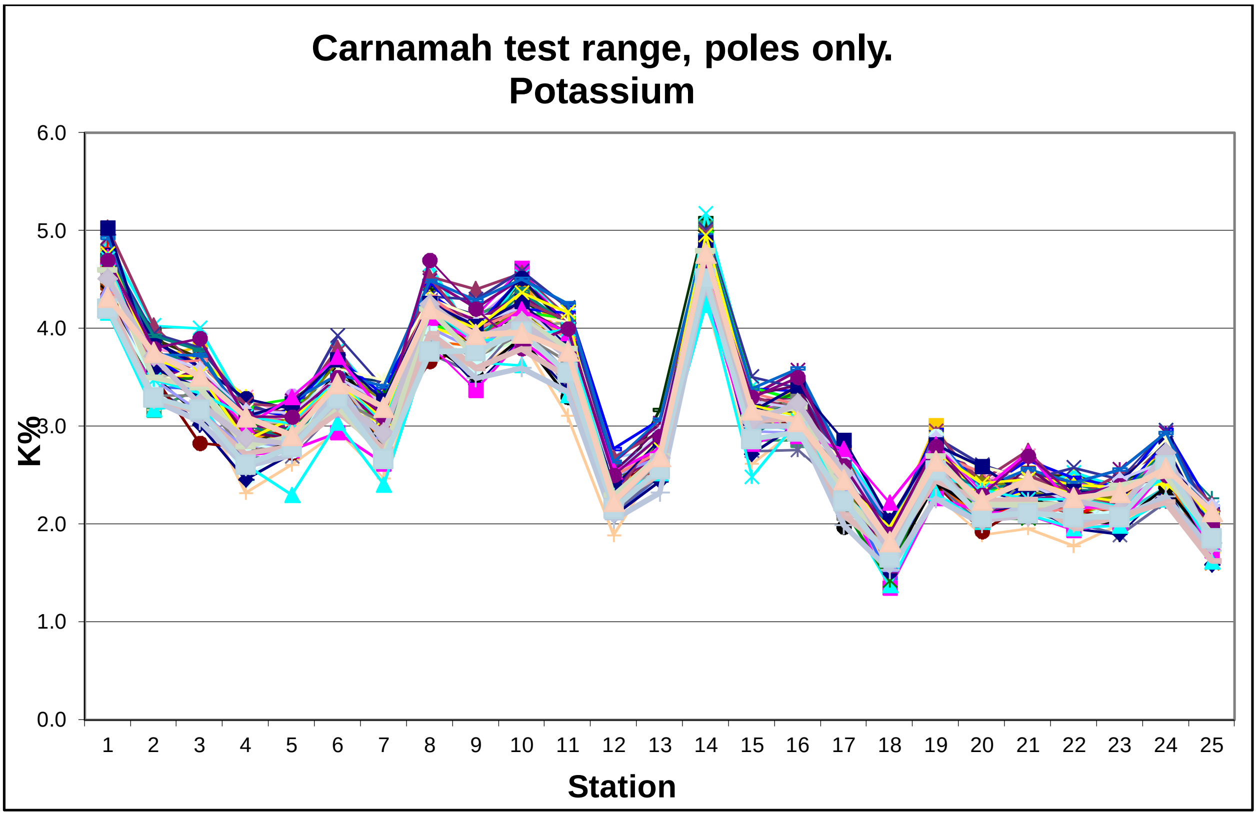
		K%	U ppm	Th ppm	Radon from Corow	U - Radon
23/06/1999	1	2.71	3.90	32.39		
2/07/2000	2	2.95	4.75	34.69		
17/07/2000	3	2.82	3.96	33.73		
1/06/2001	4	2.80	4.29	32.85		
11/06/2002	5	2.92	4.19	33.37		
23/05/2003	6	3.06	4.29	33.96		
6/08/2003	7	2.86	4.47	34.89	0.83	3.64
26/05/2004	8	2.81	4.44	34.14	0.77	3.67
15/07/2004	9	2.73	4.52	33.65	0.80	3.72
22/09/2008	10	3.02	4.47	35.27		
12/08/2011	11	2.77	4.22	33.67	0.37	3.85
6/09/2011	12	2.84	4.13	35.00	0.34	3.79
	13					
Mean	14	2.86	4.30	33.97	0.62	3.73

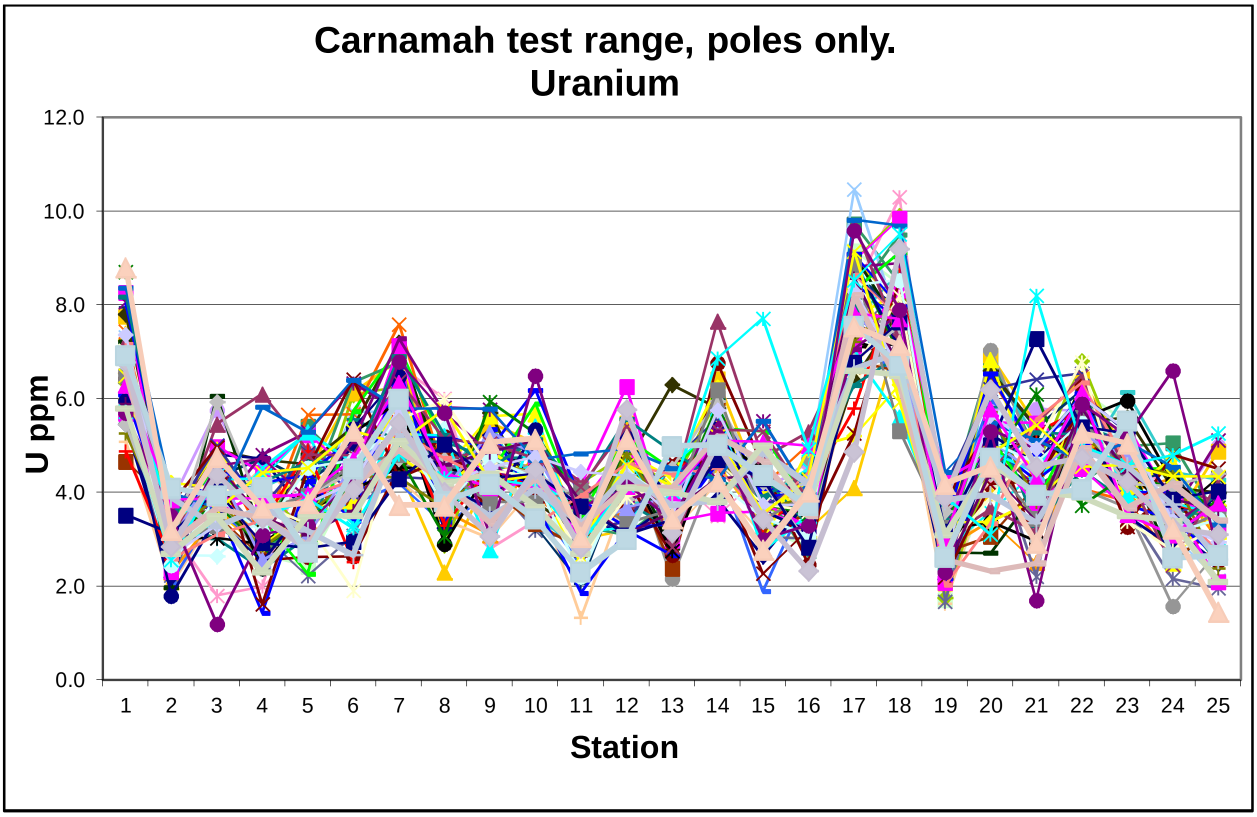
As it can be seen, there were no Radon backgrounds reported for the first six wet runs, There was no background for reading ten. The background reading for 15/7/2004 is interpolated. The mean for the five damp/wet runs that have radon background removal is 3.73 ppm and this seems to fit the dry/wet pattern reasonably well.

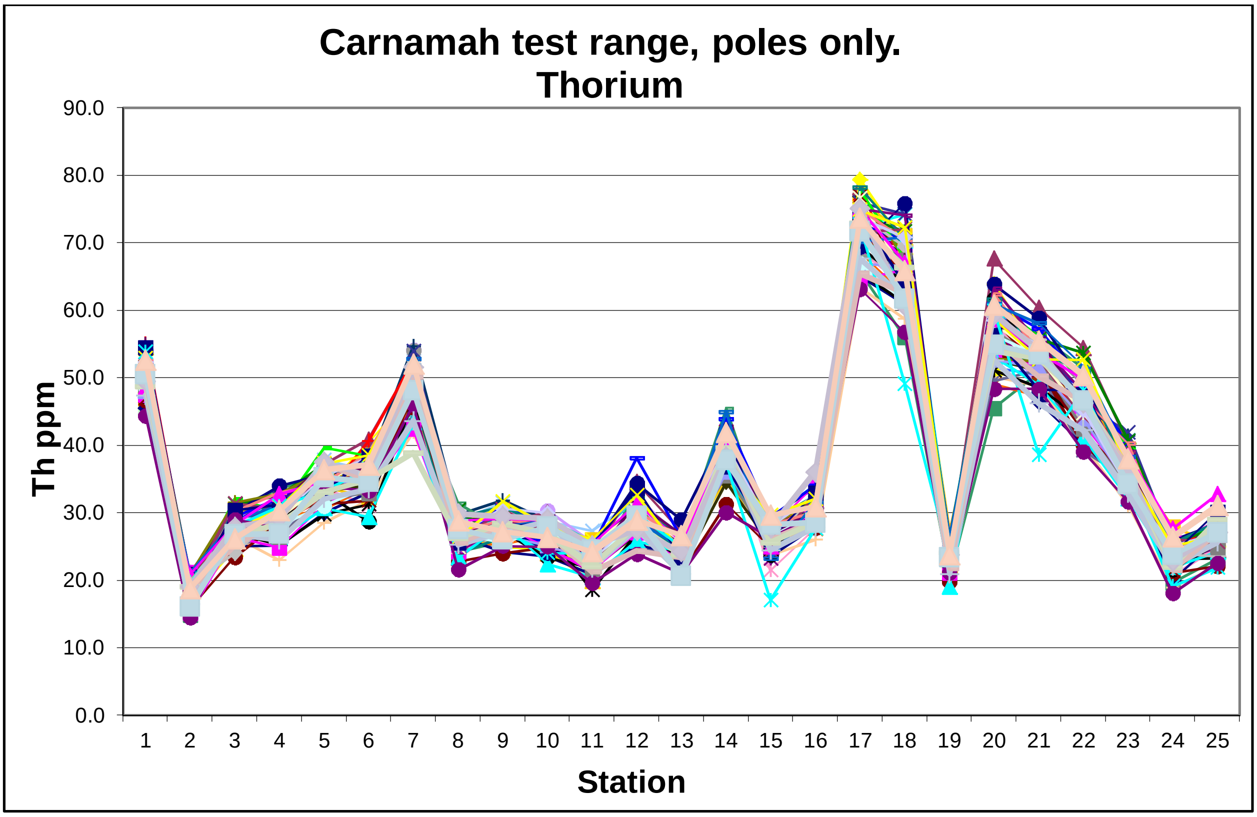
Damp/Wet Means			Dry Means		
K%	U ppm	Th ppm	K%	U ppm	Th ppm
2.86	3.73	33.97	3.11	4.05	36.76

Percentage drop in wet conditions

8.04	7.90	7.59


Carnamah test range, poles only.
Potassium
6.0
5.0
4.0
3.0
2.0
1.0
0.0
K%
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
Station


Carnamah test range, poles only.
Uranium
12.0
10.0
8.0
6.0
4.0
2.0
0.0
U ppm
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
Station



Height attenuation coefficients.

If any Radon contribution is not accounted for, solving for the height attenuation coefficients using range data may be severely compromised. However, solving for the attenuation coefficients is a good quality control for the data set. The closer the numbers come to the theoretical, the better the data set. Much discussion has resulted in the following sets of theoretical (Monte Carlo simulated) height attenuation coefficients which are a good approximation for the 40 -150 m altitudes. (Dr. Jens Hovgaard of RSI and Pavel Jurza of SGC - personal communication).

IAEA Window	Jens	Pavel
K	-0.0094	-0.0097
U	-0.0084	-0.0087
Th	-0.0074	-0.0075
T/C	-0.0074	-0.0075

Conclusion

During the last few years (from 2008 onwards) the Carnamah Test range has been surveyed using handheld spectrometers with varying capabilities and calibration backgrounds. Some results have shown large variation from the historical range 'mean' values. Any errors in the eConcentrations attributable to the range are reflected in subsequent survey results. To minimise discontinuities between the results of adjacent airborne surveys, it could be argued that the range should be treated in a similar manner as the Test Pads.

To achieve accurate results when calculating the counts/eConcentration coefficients after flying the Carnamah Test Range, the aircraft spectra/window data must be corrected to remove any contribution introduced by the presence of airborne Radon. There are several methods that could be employed to achieve this - perhaps the simplest is subtracting the Uranium and Total Count means derived from ‘local over water altitude stacks’ (in the case of the Carnamah range, the local Salt Lake test line altitude stack) from the corresponding range data. Both data sets should be Stripped and Cosmic and Aircraft Background corrected as well as being height corrected to the same STP altitude using the <u>theoretical attenuation coefficients</u> (to remove any offsets introduced by poor flying). The processing stream should be identical to that used in subsequent survey processing to avoid any errors introduced by differing background calculations.

To derive the best calibration results from the Test Range

Best option:

1. Fly the range when it is ‘DRY’, ie. No dampness discernible in the topsoil. This can be verified by checking the BOM website historical rainfall data for Carnamah (no rain greater than a few mm for the previous week) and landing at the Carnamah airstrip and kicking the dirt. Use the ‘Dry’ historical means rather than surveying the ground.

Next best option:

2. If the range <u>must</u> be flown when the BOM website indicates recent rain and the pilot detects saturation in the topsoil at the airport, then use the ‘Damp/Wet means for subsequent calculations.

Either of these options will produce more consistent aircraft Counts/eConc calibration coefficients than using an assortment of handheld spectrometers with uncertain calibration histories to survey the range.

References

Carnamah Report.pdf - 22/5/2013

Carnamah Progressive.xlsx – 12/6/2013

Dr. Jens Hovgaard of RSI and Pavel Jurza of SGC - personal communication.