Determination of the Uranium level in CRPP water with MnO2 coated acrylic Beads

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June 19, 1993 SNO-STR-93-036

MnO_2 column 007 (acrylic body with teflon O-ring seals and NM25 fitting on one end) was loaded (March 14) with 200 grams of MnO_2 beads. These beads were a fresh Seakem batch that had been dry sieved (0.010 to 0.029 inches) at CRPP (M. Shatkay, Feb).

The beads were pumped with the WET lab pumping station. It was noted that even after two days of pumping using a liquid-nitrogen cooled coil that the pressure in the column did not go below 425 microns (compared to 12 microns if the chamber was empty). A similar experience by E. Bonvin with a spiked column had indicated that there was a significant amount of water still left in what apparently looked like "dry" beads. After a day sitting unpumped, the beads would move (due to the water vapor coming out of them) for several minutes if the pumping was turned on.

Dry hot nitrogen gas was passed through the column for about 5 hours to remove the water vapor. After this drying the column weight was measured to be 2647.6 $\pm$ 0.1 grams and the column pumped down to a base pressure of 100 microns (April 7). Another day of pumping gave a base pressure of 65 microns (April 11).

An extraction on the fresh MnO_2 beads was done after a seal time of 4 days. The column was sealed for another 5 days and a second extraction done. The counts observed for these two background runs were :

1. April 15 44 counts in 87579 sec
2. April 20 46 counts in 84874 sec, 256 counts in 617657 sec

The column weight before it was sent to CRPP was 2645.7 $\pm$ 0.1 grams (so it lost almost two grams of water vapor during the background extractions). From May 14 to May 17 a total of 12.45 tonnes of water (from a batch of new water that had been put into the CRPP 10 tonne tanks) was run through the column. The column was dried with hot nitrogen gas for four hours. The final weight was 2640.7 $\pm$ 0.1 grams. This loss of 5 grams is puzzling. Several explanations have been suggested: loss of MnO2 off the beads (M. Shatkay says each bead has 5% weight of MnO2 and their leaching studies show <0.01 ppm going into the water) or loss of fines during extraction/drying procedure.

The column was returned to Queen's and allowed to emanate for 8.8 days. A radon extraction was performed May 26. There were 365 counts recorded after 516895 seconds (6 days) of counting. The column was sealed 7 days and a second radon extraction was done. There were 231 counts in 356870 sec of counting.

Analysis of the data assumed the following efficiencies:

Eff. the beads have for taking out ^{226}Ra from the water	100%
Emanation out of beads	100%
Transfer from MnO2 column to trap	75%
Transfer from radon trap to Lucas cell	75%
ZnS scintillation cell efficiency	63%

(We plan in the future to check the emanation out of beads and the efficiency for transfer from the MnO_2 column to the radon trap with a spiked (0.1 Bequerel) ^{226}Ra on MnO_2 bead source.)

The first extraction gives an emanation rate of 48.7 $\pm$ 7.5 radon per day from the MnO_2 beads. This gives an equivalent uranium weight of

$(48.7 \pm 7.5) \times (4.5 \times 10^9 \text{ y} \times 365 \times 238) / (\ln 2 \times 6.02 \times 10^{23})$

in 12.45 tonnes of H_2O or $(3.6 \pm 0.6) \times 10^{-15}$ gU/g (where the error is based only on statistics).

The second radon extraction gives an equivalent uranium level of $(2.8 \pm 0.6) \times 10^{-15}$ gU/g.

The third radon extraction gives an equivalent uranium level of $(4.6 \pm 0.6) \times 10^{-15}$ gU/g.

The overall weighted average gives $(3.7 \pm 0.5) \times 10^{-15}$ gU/g for the 12.45 tonnes of water.

We are in the process of calibrating our extraction efficiency with 0.1 Bq MnO_2. The above results should be treated as preliminary until this calibration is completed.