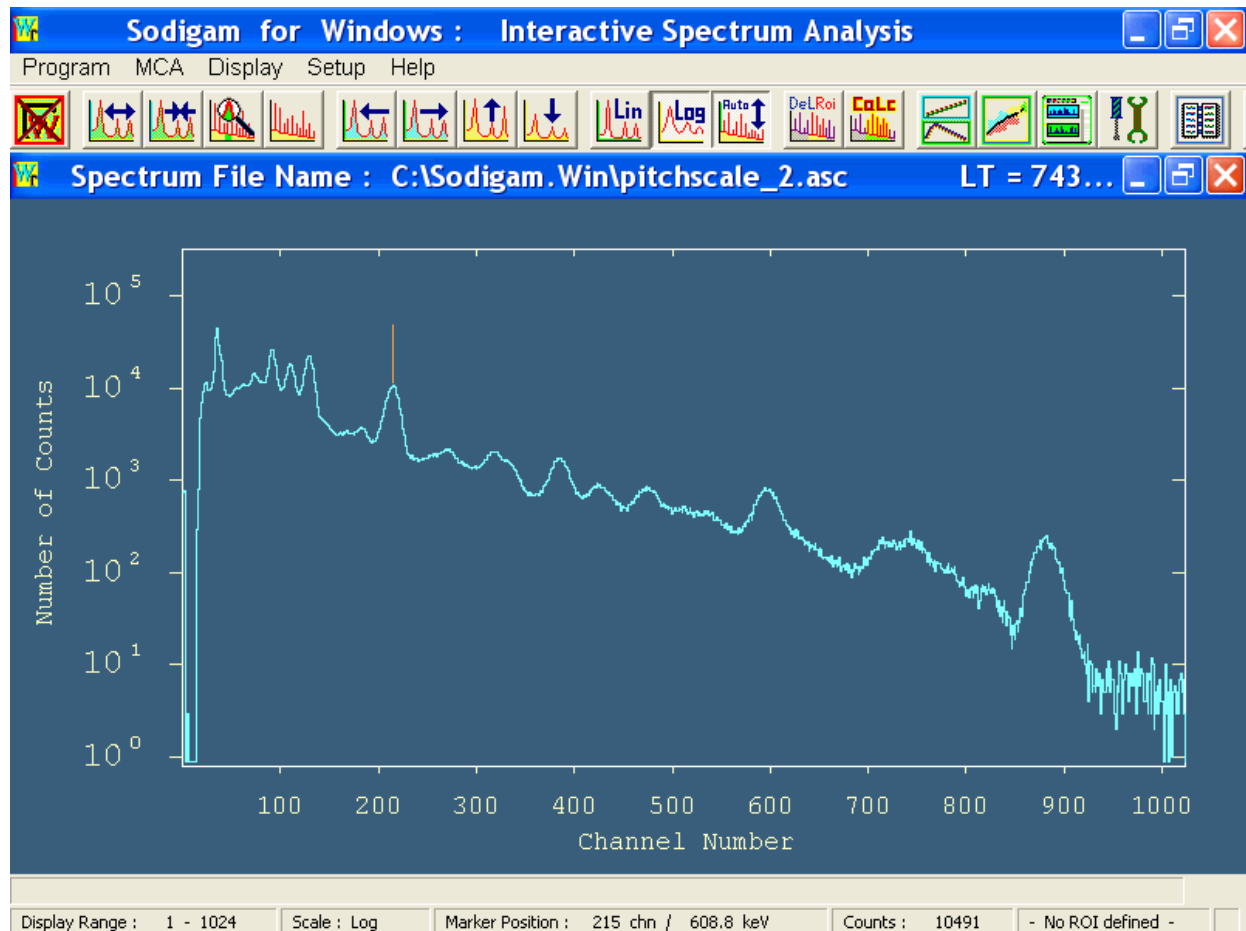


Thorium and Uranium Prospection with NaI(Tl)

Prospecting measurements using a portable gamma-ray spectrometer with NaI(Tl) or BrillanCe detectors provide a fast and safe method for in-situ determination of thorium and/or uranium contents in rock or other materials. The quantitative spectrum analysis with SODIGAM yields reliable data on the Th and U contents.

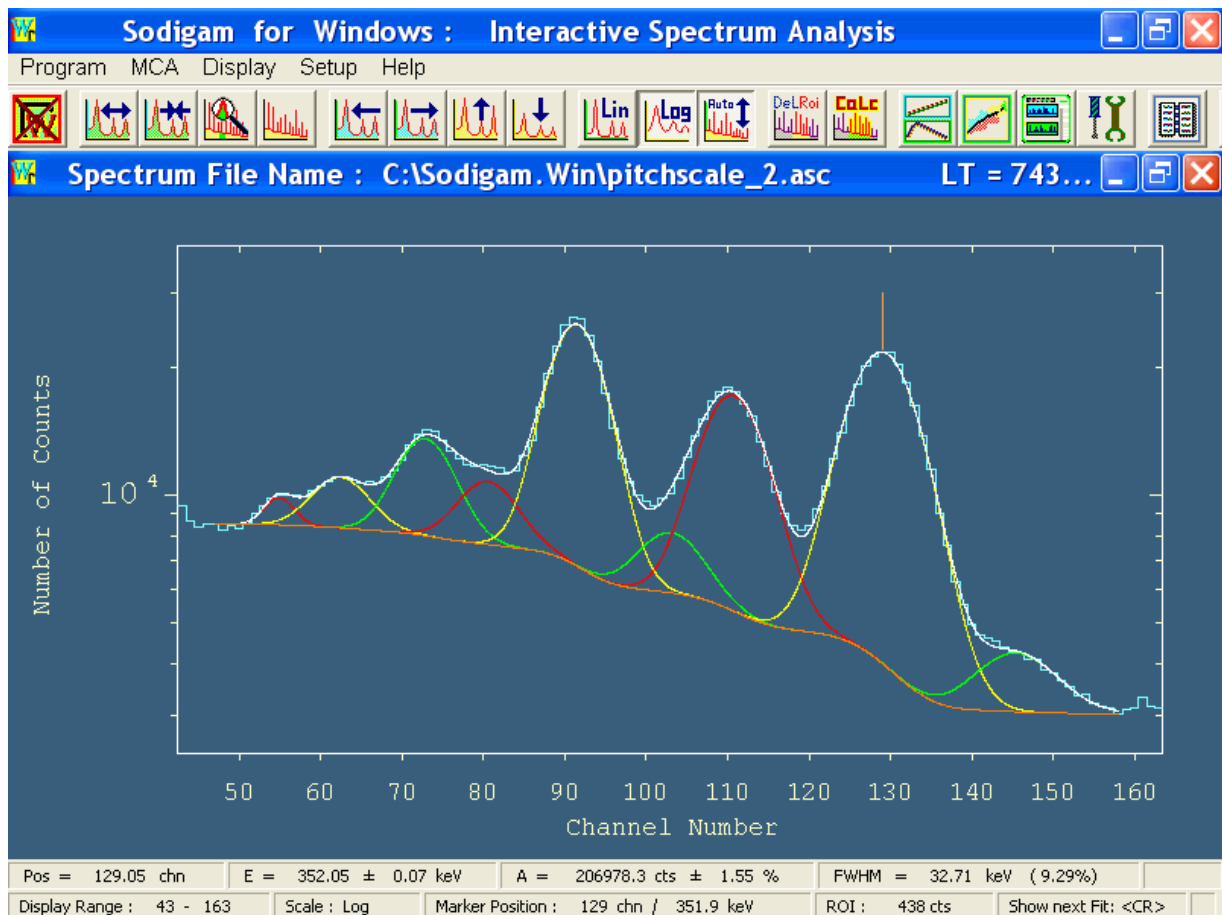
The spectrum below was measured from a rock sample containing low concentrations of uranium and thorium in an activity ratio of approximately 4 : 1.



NaI(Tl) spectrum of a U/Th sample (744 seconds measuring time)

Many of the overlapping peaks in the spectrum are well suitable for quantitative determination of uranium and thorium. The spectrum was measured in a well-defined, calibrated beaker geometry and analysed with the SODIGAM program.

The deconvolution analysis of a multiplet is shown in the following figure.



SODIGAM fit of the multiplet around 238.6 keV (channel 91.6)

The peak around 238.6 keV (channel 91) is from ^{212}Pb , a daughter of ^{232}Th and the peak around 295.2 keV (channel 110) is from ^{214}Pb , a daughter of ^{238}U .

For optimised analysis, a fast energy calibration is made from peaks in the spectrum and several regions of the spectrum are automatically analysed using batch-files.

In the following SODIGAM printout table the peak assignment to nuclides and quantitative activity calculation is shown for peaks that were analysed in this prospecting task.

Peak Assignments:

Library : E:\winTMCA32_scintiSPEC\Sodigam.Win\Library\scale.lib
 Spectrum : E:\winTMCA32_scintiSPEC\Sodigam.win\Spectra\Noname.spc
 Sample = 1000.0000 grams , measured for 743 seconds ± = 0.0 keV

Th-232	/1.41E+10Y/	Energy	E-Lit.	Ig/%	Bq/kg	Q	Interf.
		2614.2	2614.6	35.80	1531.9 ±	102.0	
		582.9	583.1	30.90	1154.2 ±	93.1	
		916.5	911.1	29.00	1548.0 ±	103.7	
		965.8	967.0	22.50	1761.6 ±	126.9	
Average activity from clear lines (4)					1456.1 ±	126.7	
Ra-226	/ 1600.0 Y/	Energy	E-Lit.	Ig/%	Bq/kg	Q	Interf.
		184.5	186.0	3.59	11750.7 ±	667.1	
Average activity from clear lines (1)					11750.7 ±	667.1	
Rn-222	/ 1600.0 Y/	Energy	E-Lit.	Ig/%	Bq/kg	Q	Interf.
		609.4	609.3	46.10	4818.7 ±	250.3	
		352.5	351.9	37.10	6618.9 ±	297.8	Th-232
		294.8	295.2	19.20	7858.2 ±	362.8	
		1757.4	1764.5	15.90	6182.4 ±	394.5	
		1121.8	1120.3	15.00	6173.4 ±	363.4	
		1240.1	1238.1	5.92	9132.9 ±	635.0	
		2204.2	2204.1	4.99	7351.0 ±	553.9	
		777.2	768.4	4.88	5886.1 ±	449.6	Th-232
		2433.5	2447.7	1.56	6407.6 ±	919.9	
Average activity from all lines (9)					6274.5 ±	435.8	

The peak at 186 keV is assigned to ²²⁶Ra, however, its area actually contains shares from ²²⁶Ra (57.56%) and ²³⁵U (42.44%). Percentage shares were calculated with the assumption of natural uranium that has not undergone enrichment processes.

The correspondingly corrected activity of the ²²⁶Ra-share is ARa-226 = 6763.3 ± 384.0 Bq/kg. The activity of ²²²Rn and progeny is somewhat lower than the ²²⁶Ra activity because part of the noble gas ²²²Rn is released in the decay of ²²⁶Ra by alpha-recoil and due to its long half-life it can emanate from the sample.

²³⁸U and ²³²Th contents in a sample is quantitatively determined with SODIGAM even after short measuring times, with high precision and small uncertainties.