

# Training workshop on *in situ* Characterization of Contaminated Sites

Training Course on  
Environmental  
Monitoring and Mapping

Pecs, Hungary, May 6-10, 2019  
Pecs, Hungary

# TEAM 6

- MEXICO (Geyser and Eduardo)
- BRAZIL (Elder)
- CHILE (Luis)
- CROATIA (Ivana)
- NORTH MACEDONIA (Dejan)
- Serbia (Jovana)



# TEAM 6



# Exercise 1 : Detector calibration $^{152}\text{Eu}$ Source



- Acquiring spectra at:
  - 0 °
  - 10 °
  - 20 °
  - 30 °
  - 40 °
  - 50 °
  - 60 °
  - 70 °
  - 80 °
  - 90 °
- Calculate Intrinsic efficiencies
- Create a file for InSiCal Software tool

# In situ gamma calibration worksheet for calculation of relative angular response factors

= user input

= calculated

## Input quantities

	Measured	Live time	121.7817 keV		244.6974 keV		344.2785 keV		778.9045 keV		1112.076 keV		1408.013 keV	
angle	distance (cm)	(s)	area	rel. unc.										
0	98	600	19001	0,84%	3106	2,31%	8336	1,14%	1805	2,65%	1434	2,86%	1801	2,38%
10	97	300	9982	1,13%	1710	2,96%	4263	1,59%	936	3,57%	671	4,36%	898	3,42%
20	97	300	10962	1,08%	1749	2,90%	4293	1,62%	929	3,64%	666	4,35%	883	3,40%
30	98	300	11678	1,03%	1823	2,85%	4568	1,54%	993	3,54%	685	4,16%	961	3,24%
40	98	300	12193	1,02%	1744	2,88%	4655	1,53%	982	3,61%	768	3,89%	919	3,35%
50	99	300	12899	0,98%	1922	2,70%	4812	1,51%	1003	3,57%	796	3,74%	941	3,31%
60	98,5	300	12897	0,96%	1931	2,77%	4813	1,50%	1072	3,40%	799	3,78%	952	3,30%
70	98	300	12859	0,98%	1962	2,67%	4816	1,51%	1089	3,31%	813	3,87%	935	3,33%
80	97,5	300	12291	1,00%	1993	2,63%	4941	1,48%	1005	3,52%	744	4,14%	944	3,28%
90	98	300	12076	0,99%	1933	2,71%	4914	1,50%	1105	3,33%	802	3,83%	995	3,26%

## Output quantities (relative angular responses and typical relative uncertainty for InSiCal calibration file)

	Approx.tot.	relative	121.7817 keV		244.6974 keV		344.2785 keV		778.9045 keV		1112.076 keV		1408.013 keV	
angle	distance (cm)	distance unc.	k_m	rel unc.										
0	100	0	1	0	1	0	1	0	1	0	1	0	1	0
10	99	3,28%	1,030	3,57%	1,079	4,99%	1,002	3,82%	1,016	5,53%	0,917	6,16%	0,977	5,30%
20	99	3,28%	1,131	3,56%	1,104	4,95%	1,009	3,83%	1,009	5,57%	0,910	6,15%	0,961	5,29%
30	100	3,27%	1,229	3,53%	1,174	4,91%	1,096	3,79%	1,100	5,50%	0,955	6,01%	1,067	5,18%
40	100	3,27%	1,283	3,52%	1,123	4,93%	1,117	3,78%	1,088	5,54%	1,071	5,83%	1,021	5,25%
50	101	3,25%	1,385	3,50%	1,262	4,82%	1,178	3,76%	1,134	5,51%	1,132	5,72%	1,066	5,21%
60	100,5	3,26%	1,371	3,50%	1,256	4,86%	1,166	3,76%	1,200	5,40%	1,126	5,75%	1,068	5,21%
70	100	3,27%	1,354	3,51%	1,263	4,81%	1,155	3,77%	1,207	5,35%	1,134	5,82%	1,038	5,24%
80	99,5	3,27%	1,281	3,53%	1,271	4,79%	1,174	3,77%	1,102	5,49%	1,027	6,00%	1,038	5,21%
90	100	3,27%	1,271	3,51%	1,245	4,83%	1,179	3,77%	1,224	5,36%	1,119	5,79%	1,105	5,19%
Typical relative uncertainty =				0,036	0,049		0,038	0,055		0,060	0,053			

# Exercise 2 : Mosaic Source

- Acquire a  $^{152}\text{Eu}$  spectra for 30 minutes
- Perform a peak analysis
- Calculate the activity of peaks in kBq/m<sup>3</sup>
- Calculate the correction factors for finite plane measurements



**Activity : 2,157 kBq/m<sup>2</sup>**

## Reporting table

Acquisition live time: 1800 s Reference activity: 2860,22 kBq/sheet

Peak energy (keV)	Peak intensity	Peak area	Peak cps	Calculated activity (kBq/m <sup>2</sup> )
121.8	0.2841 (13)	1370	0,761	1,738
244.7	0.0755 (4)	323	0,179	2,050
344.3	0.2659 (12)	824	0,458	2,015
778.9	0.1297 (6)	203	0,133	2,115
1112.1	0.1341 (6)	165	0,092	2,260
1408.0	0.2085 (8)	239	0,133	2,307
Mean =				2,157

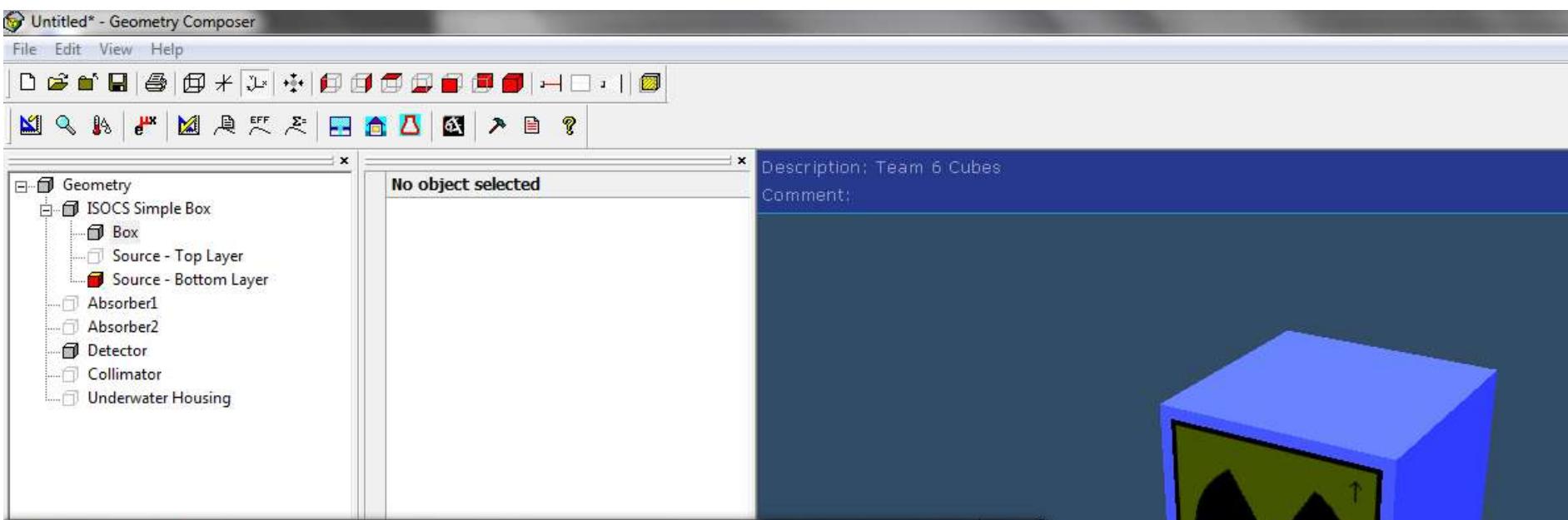
2,081

Numerical  
WM

# Exercise 3 : Object Measures of Standards Blocks



- Cubes with Well know levels of U, Th and K
- Acquire a 15 minutes spectra for each cube
- Simulate measurement geometry using ISOCS
- Calculate efficiency values for the Cube geometry
- Full analysis of Spectrum at Genie Software
- Efficiency Correction
- Nuclides Activity concentrations



Edit dimensions - Simple Box

Description:	Team 6 Cubes								
Comment:									
Units:	<input type="radio"/> mm <input checked="" type="radio"/> cm <input type="radio"/> m <input type="radio"/> in <input type="radio"/> ft								
No.	Description	d.1	d.2	d.3	d.4	d.5	Material	Density	Rel. Conc.
1	Box	0.6	100	100	100		iron	7.86	
2	Source - Top Layer	0					(none)	0	0.00
3	Source - Bottom	100					concrete	2.1	1.00
4	Absorber 1	0					(none)	0	
5	Absorber 2	0					(none)	0	
6	Source-Detector	50	5	5	5	5			

Description: Team 6 Cubes

Comment:

OK Cancel Apply Help View Drawing...

Ready

<b>Block #1 U2</b>		<b>Block #3 Th</b>	
Nuclide	Activity Concentration (Bq/kg)	Nuclide	Activity Concentration (Bq/kg)
$^{238}\text{U}$	10108±565	$^{232}\text{Th}$	8330±219
$^{235}\text{U}$	1340±135	$^{226}\text{Ra}$	699±68
$^{226}\text{Ra}$	10359±201	$^{40}\text{K}$	1196±248
$^{40}\text{K}$	877±123		

# Exercise 4 : Yellow Cake precipitation Reactor



- **Identify the isotopes**
- **Determinate Active inventory**
- **Assess the radioactive equilibrium**

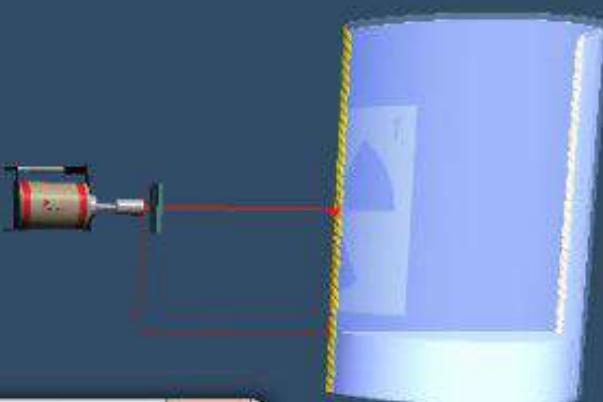
File Edit View Help



- > Geometry
- > ISOCS Pipe
  - Pipe
  - Source1
  - Source2
- > Absorber1
- > Absorber2
- > Detector
- > Collimator
- > Underwater Housing

Description:

Comment:



## Edit dimensions - Pipe

Description:

Tank 5 Team 6

Comment:

Units: mm cm m in ft

No.	Description	d.1	d.2	d.3	d.4	d.5	Material	Density	Rel.
1	Pipe	2	126	150	30		iron	7.86	
2	Source 1	2	147	30			u-per	12.5	1.00
3	Source 2	120	0	30	0	0	water	1	0.00
4	Absorber 1	2					rubber	1.05	
5	Absorber 2	0					(none)	0	
6	Source - Detector	100	0	60	0	60			

OK

Cancel

Apply

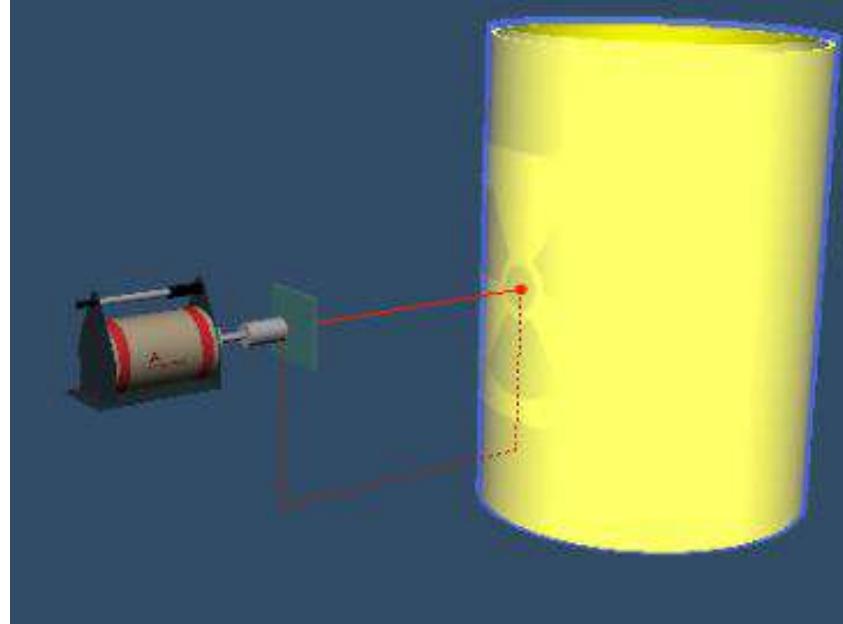
Help

View Drawing...

## TANK 5

$\text{U-235} = 0,22 \pm 0,009 \text{ MBq/kg}$

$\text{U-238} = 5,77 \pm 0,164 \text{ MBq/kg}$



Natural uranium contains 0.7% of the U-235 isotope.

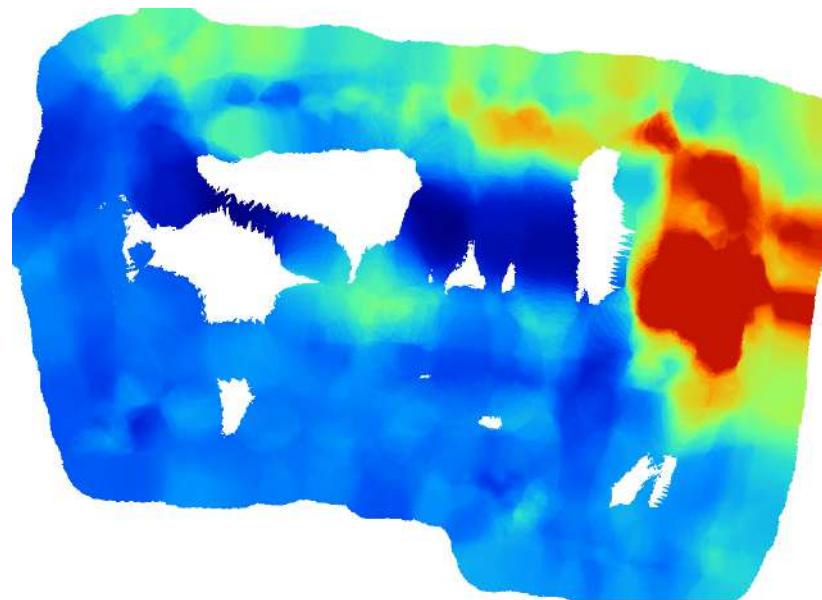
No equilibrium between  $^{226}\text{Ra}$  and  $^{238}\text{U}$

## Exercise 5 :

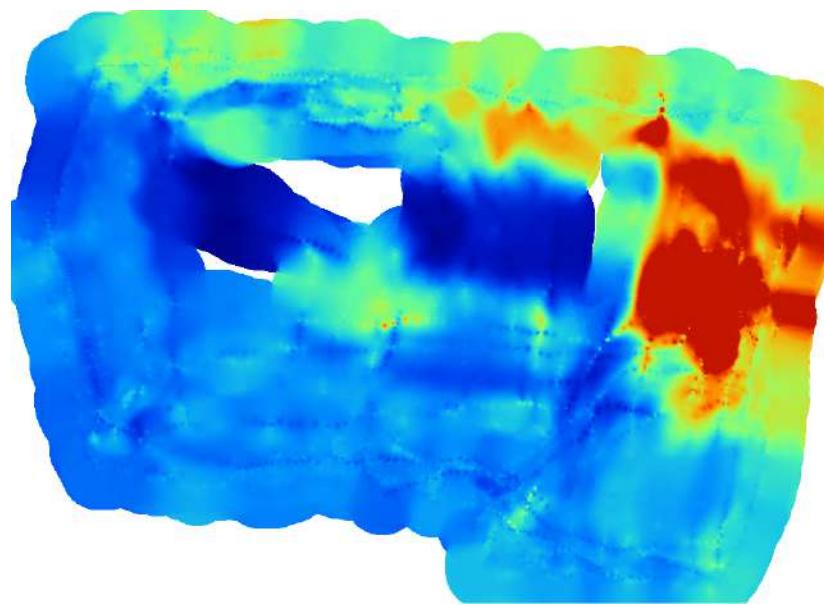
### Identification of Surface Anomaly in uranium tailing site



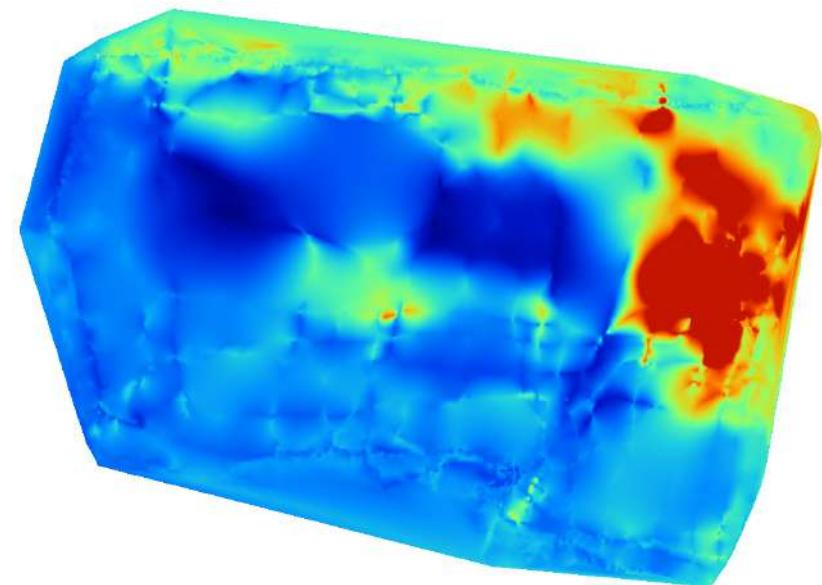
- Determine the Coordinates
- Identify the radionuclides
- Specify Gamma dose rate



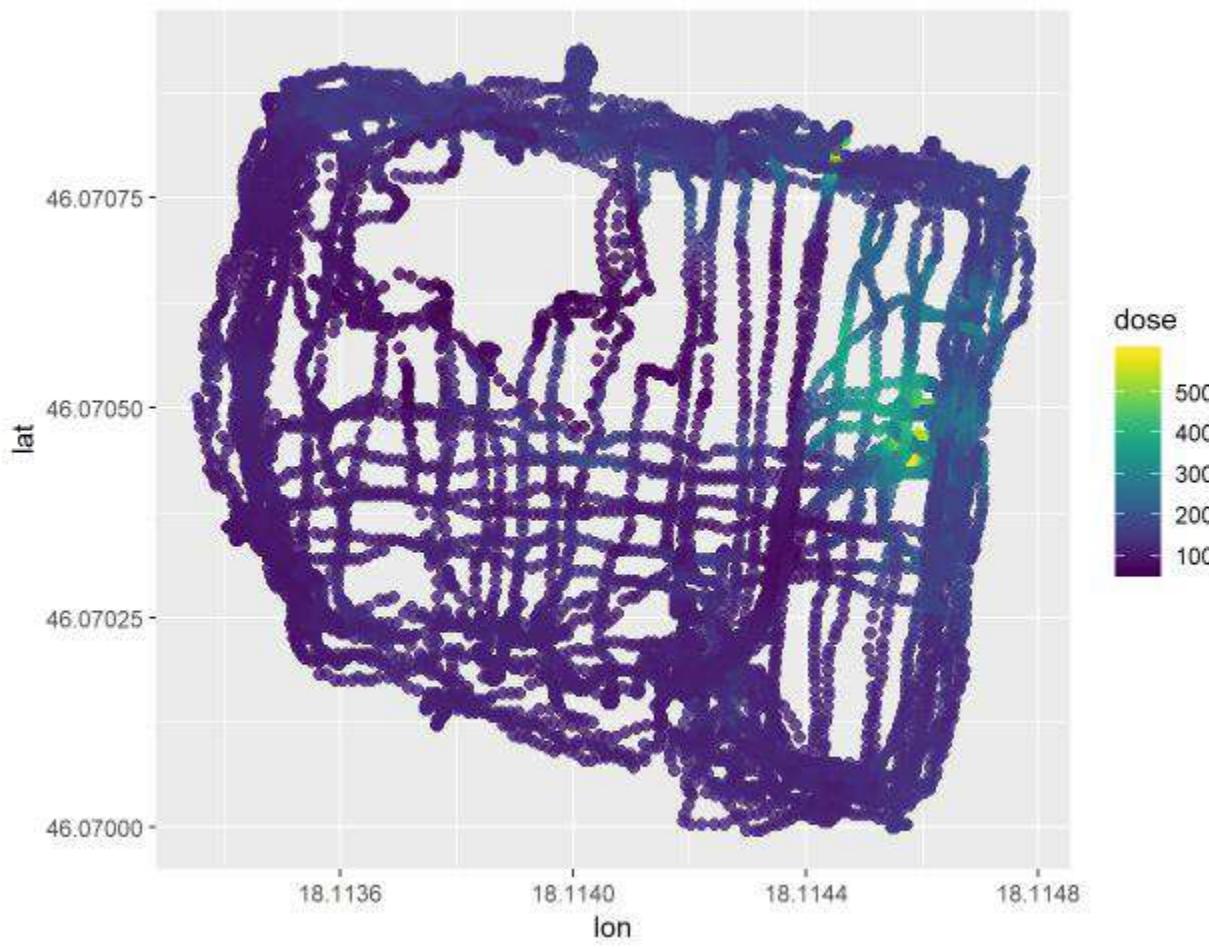
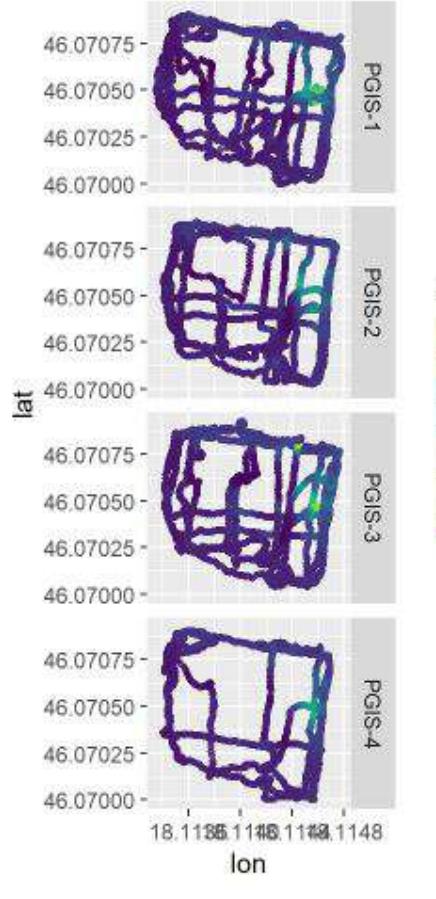
OrdinaryKriging\_PGIS



IDW\_PGIS



NaturalNeighbour\_PGIS



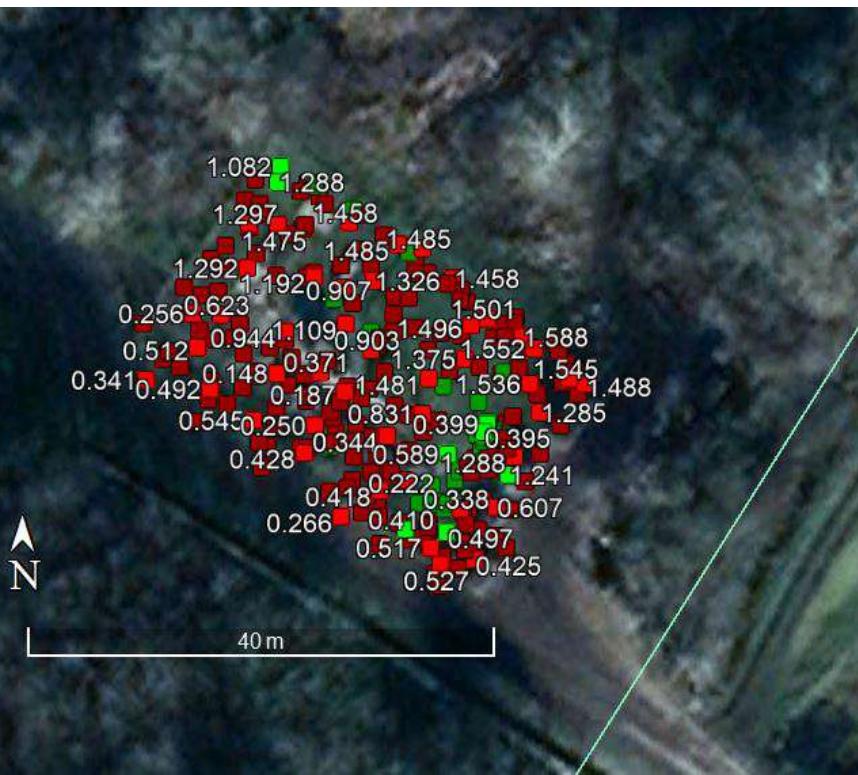
# Exercise 6 : Yellow Cake Storage Area



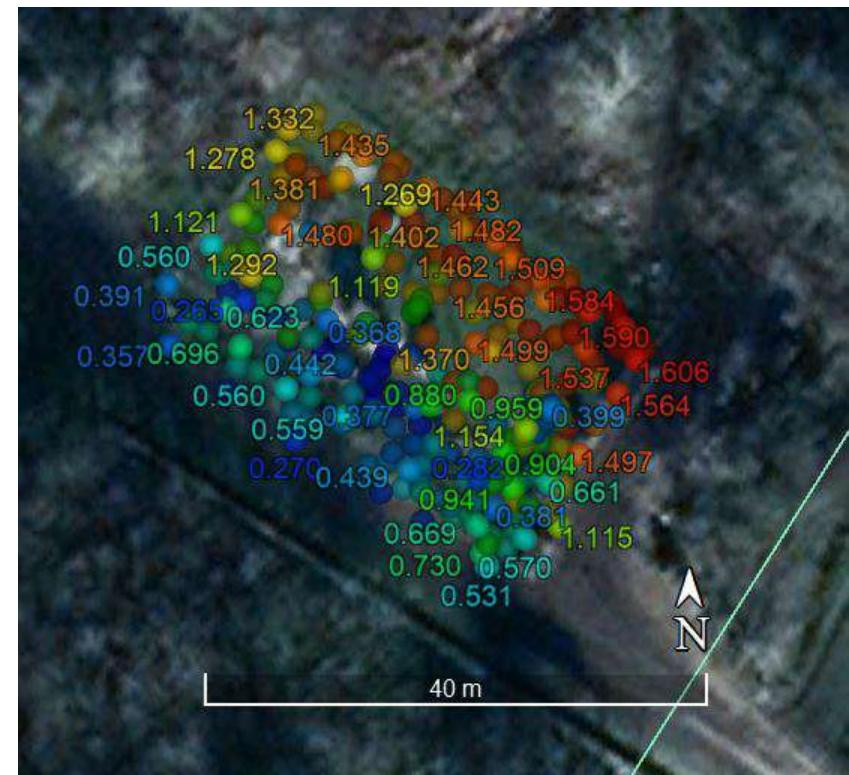
		Point 24	Point 22	Point 20	Point 18		
		Point 23	Point 21	Point 19	Point 17		
Point 26	Point 25	Yellow Cake storage				Point 15	Point 16
Point 28	Point 27	Yellow Cake storage				Point13	Point 14
Point 30	Point 29	Yellow Cake storage				Point11	Point 12
Point 32	Point 31	Yellow Cake storage				Point9	Point 10
		Point 1	Point3	Point5	Point7		
		Point 2	Point4	Point 6	Point 8		

# Exercise 7 : Norm Contaminated Site

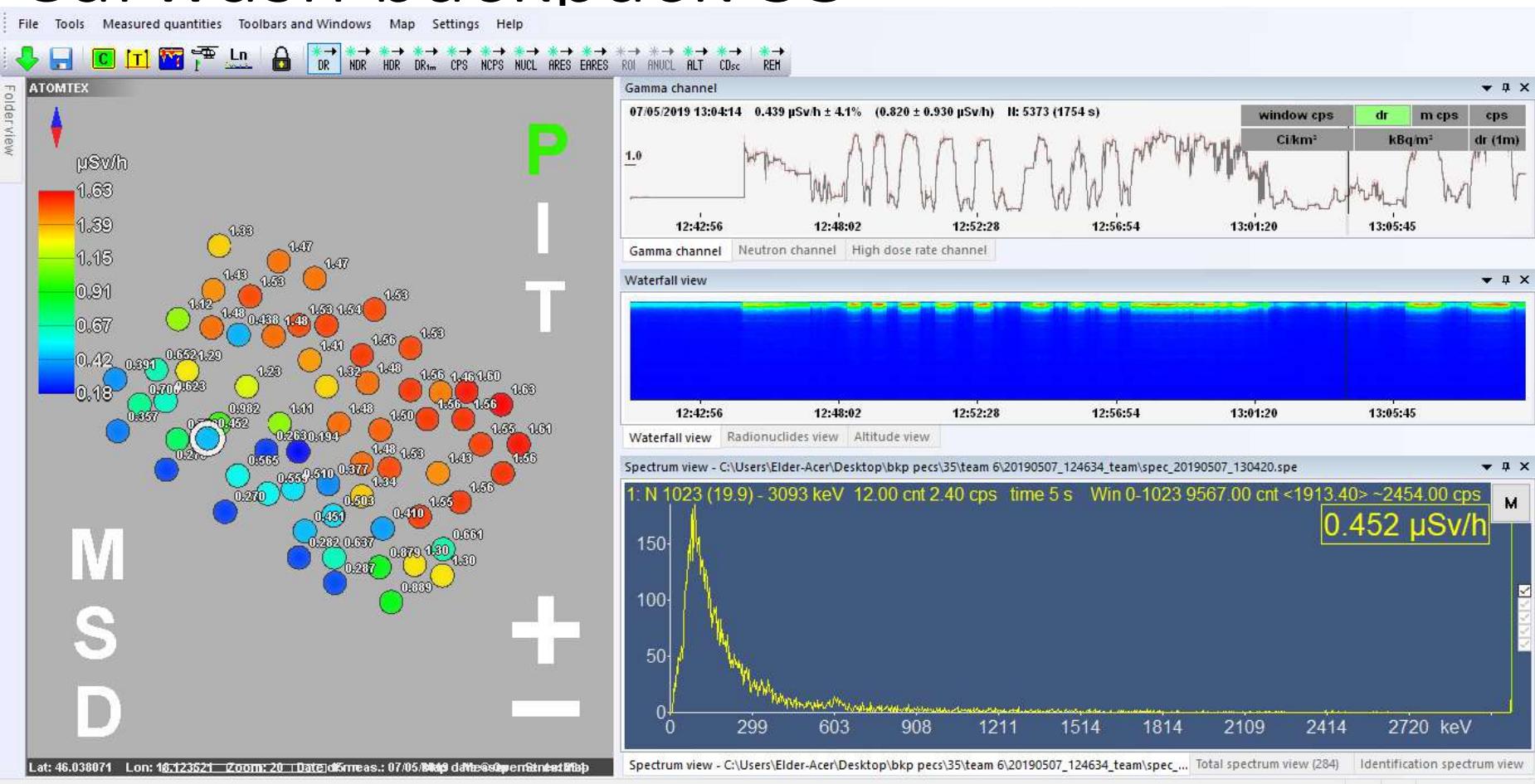
No processed data



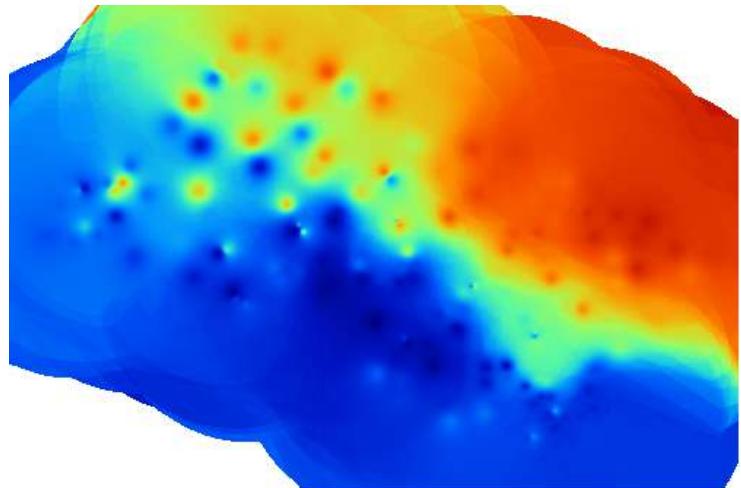
Processed by GARM



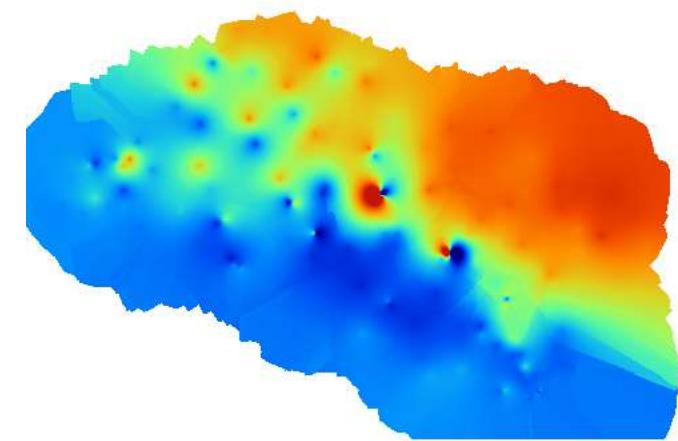
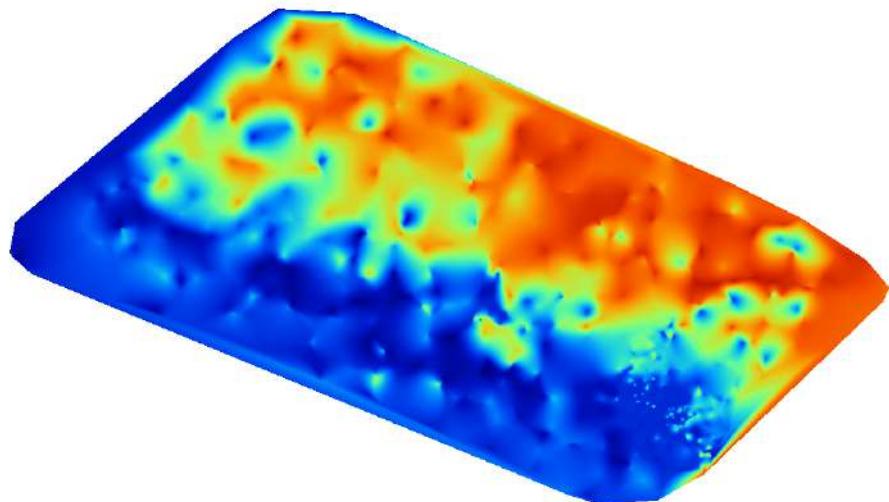
# Carwash backpack 35



IDW\_Backpack



NaturalNeighbour\_Backpack

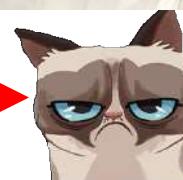


OrdinaryKriging\_Backpack



**THANK YOU FOR YOUR  
ATTENTION**

**PLEASE CLAP AND DO NOT ASK  
TOUGH QUESTIONS**



Duuuhhh,  
forget the claps!  
**BE HAPPY!!!**

**TEAM 6**