Slanic Project
Romanian underground laboratory

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Romania is rich in natural deposits of salts, mainly encountered in the sub-Carpathian region which have been exploited since ancient times housing many active and in conservation salt mines, the last ones representing ideal locations for low background radiation laboratories.

The radiological mapping of three salt mines was initially performed using a high resolution gamma spectrometer and an Eberline FH40G dosimeter indicated that Unirea salt mine from Slanic Prahova town as the best location.
The Unirea salt mine environment:

temperature: 12.0 -13.0 °C
humidity: 65-70 %
excavated volume: 2.9 million m$^3$
floor area: 70000 m$^2$
average high: 52-57 m

Salt lens dimensions:
Length: 5km
Width: 3km
Thickness: 0.5km
The construction of low-background radiation laboratory started in January 2006 and ended in April 2006.

A high resolution gamma-ray spectrometer equipped with a GeHP detector 22.8 rel. eff. was put into the laboratory in October 2006.

A TLD reader and a portable high resolution gamma-ray spectrometer equipped with a GeHP detector 35.4 rel. eff. for whole body counter were introduced in the underground lab. in November this year.
microBq laboratory realization stages:

I. – conception, design, constructor selection, material selection;
II. – material conditioning, transportation and construction;
III. – leveling the mine floor under laboratory using granulated salt,
IV. – measurement systems purchasing
UNDERGROUND LABORATORY

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The goal is the setting up of an underground laboratory for:
• high resolution gamma ray spectrometry
• whole body counter
• radiation metrology
Total counts versus time
TLDs placed in Sanatoriu area

\[ y = 0.1036x + 5.3611 \]
\[ R^2 = 0.9855 \]

dose rate: 0.2 – 2.0 nSv/h

dose rate: 82 – 94 nSv/h
Fig. 5, Counts vs. time,
sanatoriu area - Slanic Unirea salt mine
measurement performed with a doseratemeter Eberline FH40-10

\[ y = 0.0202x + 3.8147 \]
\[ R^2 = 0.9974 \]
Background spectra collected with a CANBERRA GeHP detector with 22.8% rel. efficiency

Counts/(d*kev*kg) vs. Energy (kev)

- Indoor
- Underground unshielded
- Underground shielded, 5 cm Pb

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Background spectra collected with an ORTEC GeHP detector with 33\% rel. efficiency

**Counts/(d*keV*kg) vs. Energy (keV)**

- **In field**
- **Indoor shielded**
- **Underground shielded, 5 cm Pb**
- **Underground unshielded**
Gamma ray peaks in the background spectrum, collecting time=267500 s, ORTEC detector, 33% rel. eff., underground unshielded

<table>
<thead>
<tr>
<th>Isotope</th>
<th>Energy (k cps)</th>
<th>Isotope</th>
<th>Energy (k cps)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pb-210</td>
<td>46,52 0,0025</td>
<td>Pa-228</td>
<td>911,23 0,0024</td>
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<tr>
<td>Pb-212</td>
<td>77,11 0,0201</td>
<td>Bi-214</td>
<td>934,05 0,0009</td>
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<td>U-228</td>
<td>92,29 0,0132</td>
<td>Ac-228</td>
<td>968,90 0,0020</td>
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<td>Ra-226</td>
<td>185,99 0,0072</td>
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<tr>
<td>Ac-228</td>
<td>328,00 0,0004</td>
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<td>1407,98 0,0011</td>
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<td>338,32 0,0011</td>
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<td>1661,28 0,0003</td>
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<td>806,17 0,0004</td>
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<td>2447,71 0,0004</td>
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</table>
Neutron activation analyses of salt from UNIREA salt mine

<table>
<thead>
<tr>
<th>Element</th>
<th>Neutron activation analyses</th>
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</thead>
<tbody>
<tr>
<td>Uranium</td>
<td>&lt;1ppm</td>
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<tr>
<td>Kalium</td>
<td>ND</td>
</tr>
<tr>
<td>Thorium</td>
<td>ND</td>
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</tbody>
</table>
Whole body counter
The WBC background

person#1

person#2

ILI
Ongoing project

Determination of beta emitters from agro-ecosystems in underground laboratory

From Sept 2007 to August 2010

Goals:

Liquid scintillation beta spectrometry in underground laboratory for measuring of Tritium, C14, Pb210, Be7, Cs137 etc. in samples

Radioanalytical procedures for separation of Tritium, C14, Pb210, Be7
Projects to be submitted in February 2008:

- Radiation metrology in ultralow radiation background
- Muon detection in underground
- Gamma emitting radionuclides in human body
Gamma emitting radionuclides in human body

- calibration procedure
- human body phantom construction
- validation of WBC results
WILLI – UG (Under Ground)

Simulations performed with MUSIC (MUon Simulation Code)

- Propagation of muons through solid rocks – NaCl 2.2 g/cm²
- Energy cut-off: approx: 200 GeV
- Rate:
  Surface: 1 muon / m²s
  UG: 0.3 muon / m²min
- Possibility to investigate the hadronic interaction models at very high energy

![Graph showing muon flux at sea level and underground.](attachment:muon_flux.png)
LAGUNA project

- IFIN-HH could give support to external users by offering:
  - measurement time,
  - scientific projects of external users to be developed in Slanic salt mine
  - testing the behavior of different systems and equipment in low radiation background
WP1 – Management, coordination for Slanic Salt Mine

WP2 – Underground infrastructure and engineering

Prefesability for Slanic Salt Mine:

- Local conditions:
  - potential for large cavity
  - access to surface

- Geological studies

- Promising features:
  - large volume cavern
  - radio purity of the rock
  - constant temperature
  - rock stability

- Potential problems:
  - salt aerosols
  - limitation of object size to be carried by elevator
WP6 – Science impact and outreach

- evaluation of sources of background, cosmogenics and natural radioactivity
- simulations of muon and neutrino flux
- simulations of the detector response
- education

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Other research plans:
Neutrino detection using radio antennas

**Advantages** of radio detection

- Low attenuation
  - clear signals from large detection volumes
- High duty cycle + full-sky coverage
  - good statistics in less time
- Naturally shielded

Previous studies performed by P. Gorham et al., Nucl. Inst. Meths. A 490 (200:

We plan to perform attenuation length measurements in Slanic salt mine

⇒ estimation of propagation losses

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THANK YOU FOR YOUR ATTENTION!