An In-field Deployable CsI Detector to Determine $^{226,228}$Ra in NORM Oil Scale

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NETL/EPDI Services

- Laboratories for testing radioactive cleanup
- Laboratories for corrosion studies
- Excellent undergraduate and graduate students in interdisciplinary cross-cutting areas
- Commitment to industry/university collaborations

- Radiation Decontamination Site Survey for NORM
- Cathodic Protection Rust, Scale Corrosion Removal
- Chemical Formulation and Product Development
- Anode Assembly Installation
- Salt Water Disposal Chemical Treatment
- Production Well Chemical Treatment
- Scrap Decontamination and Disposal
- Education for field workers
One of the First Papers on NORM in Oil and Gas

Transactions of the International Electrical Congress, St. Louis, 1904

ON THE RADIOACTIVITY OF MINERAL OILS AND NATURAL GASES.

BY PROF. J. C. McLennan, Toronto University.

https://archive.org/stream/transactionsint06conggoog#page/n406/mode/2up/search/McLennan
Disequilibrium In Decay Schemes
Overview of Goals

- Homogenize (250 µm) 200 grams of a radioactive scale sample from oil production in the field.

- Acquisition of a NIST traceable standard was acquired from Ekerdt and Ziegler Analytics (EZA): 931,500 ± 51,233 Bq/kg (25,176 ± 1385 pCi/g) for $^{226}$Ra, 18,890 ± 1077 Bq/kg (510 ± 29 pCi/g) for $^{228}$Ra

- Prepare a reference material from this sample analyzing the sample in triplicate using EZA standard and high resolution hyper-pure germanium detector.

Thin Be Window
Overview of Goals

- Use this prepared reference material as a “standard” and have the analytical data installed in the software.
- This includes weight of sample, counting time, peak areas and radioactive concentrations in pCi/g (Bq/kg)
- Supply Petrie© dishes and weigh out 20 grams scale sample.
- Software then automatically process giving the final results for $^{226}\text{Ra}$ and $^{228}\text{Ra}$ as well as a combined $^{226,228}\text{Ra}$ and detection limits
- Reduce the background radiation collected by CsI detector
  - Shielding needed – what type- what kind- SS, Pb, Cd, Cu
  - Attenuation calculations
  - Improve detection limits
Scale Sample (20 g)
## Characterization of CsI

<table>
<thead>
<tr>
<th>Energy [keV]</th>
<th>HPGe FWHM [keV]</th>
<th>CsI FWHM [keV]</th>
<th>NaI FWHM [keV]</th>
<th>CsI vs NaI Efficiency [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>186</td>
<td>1.00</td>
<td>16</td>
<td>31</td>
<td>44</td>
</tr>
<tr>
<td>1173</td>
<td>1.54</td>
<td>56</td>
<td>119</td>
<td>100</td>
</tr>
</tbody>
</table>
**226Ra and 228Ra Determination**

**226Ra**
- 186.4 keV photon spectral interference free from 185.4 keV photon from $^{235}\text{U}$
- No need to wait for secular equilibrium with $^{222}\text{Rn}$ daughter products
- Resolution good enough not to have any other overlapping peaks

**228Ra**
- 911 keV photon ($^{228}\text{Ac}$) indistinguishable from other $^{228}\text{Ra}$ (965 keV 969 keV) and $^{214}\text{Bi}$ (934 keV) photopeaks

![Graph showing energy vs. counts]
### 228Ra Determination

<table>
<thead>
<tr>
<th>Isotope</th>
<th>Energy [keV]</th>
<th>Net Counts</th>
<th>Uncertainty</th>
</tr>
</thead>
<tbody>
<tr>
<td>228Ra</td>
<td>911</td>
<td>8320</td>
<td>112</td>
</tr>
<tr>
<td>214Bi</td>
<td>934</td>
<td>2935</td>
<td>80</td>
</tr>
<tr>
<td>228Ra</td>
<td>965</td>
<td>1454</td>
<td>63</td>
</tr>
<tr>
<td>228Ra</td>
<td>969</td>
<td>4516</td>
<td>84</td>
</tr>
</tbody>
</table>

The ratio of the 934 keV peak to the total = 0.170