Use of Radio-Tracers in Evaluation of Sluice-box Efficiency
Outline

• Part 1
  – Introduction to Radio-Tracers
  – Summary of Clarkson’s Work
  – Some Results Obtained
  – Some Limitations

• Part 2
  – Summary Of Research on Alternative Techniques (to be presented sometime later)
What are Radio-Tracers?

- Selected gold particles ($^{197}$Au) irradiated, within nuclear reactor, to $^{198}$Au
  - One neutron gained
  - Gamma/Beta radiation released
    - Identifiable with scintillometer
    - Short half life
    - Decays back to gold (loss of neutron)
# The Au Radioactive Isotopes

<table>
<thead>
<tr>
<th>Isotope</th>
<th>Mass</th>
<th>Half-life</th>
<th>Mode of decay</th>
</tr>
</thead>
<tbody>
<tr>
<td>$^{194}\text{Au}$</td>
<td>193.96534</td>
<td>1.64 d</td>
<td>EC to $^{194}\text{Pt}$</td>
</tr>
<tr>
<td>$^{195}\text{Au}$</td>
<td>194.965017</td>
<td>186.12 d</td>
<td>EC to $^{195}\text{Pt}$</td>
</tr>
<tr>
<td>$^{196}\text{Au}$</td>
<td>196.966551</td>
<td>6.18 d</td>
<td>EC to $^{196}\text{Pt}$; $\beta^-$ to $^{196}\text{Hg}$</td>
</tr>
<tr>
<td>$^{198}\text{Au}$</td>
<td>197.968225</td>
<td>2.694 d</td>
<td>$\beta^-$ to $^{198}\text{Hg}$</td>
</tr>
<tr>
<td>$^{199}\text{Au}$</td>
<td>198.968748</td>
<td>3.14 d</td>
<td>$\beta^-$ to $^{199}\text{Hg}$</td>
</tr>
</tbody>
</table>

After Mark Winter, University of Sheffield, 2000

[GENCAPD MINING Image]
Naturally Occurring Gold Isotopes

• There are 35

  – Taken from “Table of the Nuclides”, by Jonghwa Chang, Korean Atomic Energy Research Institute, 2000
Use of Radiotracers

- Enables backward particle tracking
  - (About 75) irradiated particles are introduced into operating sluicebox; tracer in three size ranges of 600, 300 and 150 microns
  - Each size fraction introduced separately, distribution mapped before introduction of the next size fraction
- Sluicebox operated for predetermined period
- Sluicebox stopped, distribution of radioactive particles mapped (location tracers are recovered within box)
- Gold recovered by standard methods, amalgam digested with HNO₃, tracers separated and counted
Results

• Confirms that most (90%) of gold is recovered in first 1/3 of sluice length (Fricker, 1984)
• Average increase in radiotracer recovery of 28%
  – Conclusion that (Mahdia) sluiceboxes were too wide for flow rates (flow velocities too low)
  – Achieved by narrowing sluiceboxes (Mahdia), fitting angle iron and expanded metal riffles and Nomad matting
Native Gold Vs. Radiotracer

Grain Size Analysis

Percent Finer Than
Black Sands Gold Mahdia Gold Radiotracers

Grain Size (microns)

Percent Finer Than

Black Sands Gold Mahdia Gold Radiotracers
Limitations

• Influence of Gold Grain Shape
  • Corey Shape Factor
    – NA gold irradiated and imported; morphology different from local gold, therefore conclusions on recovery of in-situ (native) gold may be misleading
  • Alternative: irradiate gold from location (costly)

• Technique Proprietary
  • Non transferable
  • No long term benefit to Guyanese (will always need Clarkson)
Any Alternatives?

• Equipment With Superior Recovery
  • Knelson Concentrator
    – Recovers 89-95% of gravity recoverable gold
    – Evaluate head grade and tail grade, of representative fraction
    – Assess change in (gravity recoverable gold) recovery
    – More representative than assessment of recovery based on 75 particles of 3 sizes