Significance of Exposed Grain Surface Area in Coarse Flotation of Low-Grade Gold Ore with the HydroFloat™ Technology

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Ref: Lynch et al. (1981)
HydroFloat™ Technology

Fluidized “Teeter Bed” Flotation

Aeration

Fluidization

Initial

Air

Water
HydroFloat™ Technology

Fluidized “Teeter Bed” Flotation

Aeration
Fluidization
Initial
Air
Water
HydroFloat™ Technology

- Applications
  - Phosphate
  - Potash
  - Diamonds
  - Vermiculite
  - Graphite
  - Coal
  - Feldspar
  - Silica Sand
  - Iron Ore
  - Heavy Mineral
  - Sulfides
Data suggests that sulfide particles as large as 1.5 mm can be floated using the HydroFloat technology.

For locked particles, how much surface expression is needed?
Important Features for Characterization

- Fraction of Particle Surface Area Consisting of Exposed Grains
- Maximum Surface Area of Exposed Grains
High-Resolution XMT

X-Ray Microtomography System

Projection

3D View

Slice View
Exposed Grains Surface Area
Exposed Surface Area Analysis of a Multiphase Particle
Exposed Grains Surface Area
## Exposed Grains Surface Area

<table>
<thead>
<tr>
<th>Exposed Grain No.</th>
<th>Surface Area ($\mu$m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>93632</td>
</tr>
<tr>
<td>2</td>
<td>72745</td>
</tr>
<tr>
<td>3</td>
<td>55082</td>
</tr>
<tr>
<td>4</td>
<td>54785</td>
</tr>
<tr>
<td>5</td>
<td>48920</td>
</tr>
<tr>
<td>6</td>
<td>37280</td>
</tr>
<tr>
<td>7</td>
<td>35225</td>
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<td>8</td>
<td>31457</td>
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<td>9</td>
<td>29543</td>
</tr>
<tr>
<td>10</td>
<td>24199</td>
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<tr>
<td>116</td>
<td>142</td>
</tr>
<tr>
<td>Total</td>
<td>742440 (18.8%)</td>
</tr>
</tbody>
</table>
Separation Tests

- Bench-scale tests conducted to compare conventional and HydroFloat flotation systems.

- Sample
  - Gold-bearing sulfide ore

- Sample Preparation
  - > 1 mm removed by screening
  - <0.15 mm removed by classification

- Test Conditions
  - 30 gm/t Aerophine collector (Cytec 3416)
  - 7 ppm glycol-based frother
## Separation Tests

### Flotation Feed Particle Size Distribution

<table>
<thead>
<tr>
<th>Mesh Size</th>
<th>Size (μm)</th>
<th>Wt. (%)</th>
<th>Cum. Wt. (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pass</td>
<td>Pass</td>
<td>Retain</td>
<td>Pass</td>
</tr>
<tr>
<td>16</td>
<td>20</td>
<td>1000</td>
<td>850</td>
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<td>35</td>
<td>70</td>
<td>500</td>
<td>212</td>
</tr>
<tr>
<td>70</td>
<td>--</td>
<td>212</td>
<td>0</td>
</tr>
</tbody>
</table>
Separation Tests

Recovery

![Graph showing sulfur recovery for different size classes (microns) comparing HydroFloat and Conventional methods.](image-url)
Separation Tests

Grade

![Graph showing separation tests results for different size classes. The graph compares HydroFloat and Conventional methods.](image-url)
HRXMT Results

- Analyses performed on 0.85x0.50 mm size class of both concentrate and tailings products.
- Tailings appear to be relatively free of sulfide minerals.

2D (left) image and volume-rendered view (right) of 850x500 μm particles of HydroFloat™ concentrate and tailing (gangue = green, valuable mineral = brown)
HRXMT Results

Three-dimensional View of Individual Particles

HydroFloat Concentrate

HydroFloat Tailing

850x500 μm Particles of HydroFloat™ Concentrate and Tailings
(gangue surface = green, exposed valuable mineral surface = red)
HRXMT Results

Three-dimensional View of Exposed Surface

HydroFloat Concentrate

HydroFloat Tailing

850x500 μm Particles of HydroFloat™ Concentrate and Tailings
(gangue surface = green, exposed valuable mineral surface = red)
HRXMT Results

Distribution of Exposed Grain Surface Area

Frequency, %

Exposed Grain Surface Area, %

- HydroFloat Concentrate (35 particles)
- HydroFloat Tailing (35 particles)
HRXMT Results

3D View of Individual Particles (850x500 micron)
- HydroFloat Concentrate (0.58%)
- HydroFloat Tailing (1.03%)

3D View of Exposed Grain Surface
- HydroFloat Concentrate (0.58%)
- HydroFloat Tailing (1.03%)

5 grains
266 grains
Distributions of Maximum Exposed Grain Surface Area

- Tailing
- Concentrate

HRXMT Results
HRXMT Results

Cumulative Distribution of Exposed Grain Surface Area
850x500 μm Particles of Concentrate (Left) and Tailings (Right)
HRXMT used to compare exposed grain surface area needed to recover 0.85x0.50 mm particles using HydroFloat and conventional flotation systems.

HydroFloat concentrate contained many more coarse locked particles than did the conventional concentrate.

Data showed no particles with exposed grain surface area of 1.5% or higher reported to HydroFloat tailings, while conventional tails contained particles with as much as 6% exposed grain surface area.
Results explained based on

1) Particle distribution of exposed grain surface area
2) Distribution of maximum exposed grain surface area

Data suggest that the HydroFloat may provide a viable option for increasing grinding mill capacity as a result of lower extent of liberation required for particle recovery.