On a Variographic Experiment
WMC Resources Ltd - Phosphate Hill Beneficiation Plant - Queensland, Australia

Business Context
At Phosphate Hill, grade estimates of the ore fed through the beneficiation plant are based on samples taken by an automatic sampler off the conveyor belt at regular time intervals.

A variographic experiment was carried out to determine the number of increments that produce a grade estimate over a twelve-hour period to a 95%-confidence precision target. Two options for combining individual increments into a composite were also assessed (Fig 1). $P_2O_5$ and $Fe_2O_3$ were among the elements of interest.

This paper broadly outlines the methodology used to perform the study.

The variographic experiment
It consisted in characterising the feed-grade variability on the conveyor belt by taking 60kg-increments every 30 minutes over 2 days, assaying them individually and preparing variograms. Twin increments, spaced 3 minutes apart, were taken over 20 hours to ascertain the nugget variance (Fig 2). Duplicates were collected to assist with the precision of the sample preparation protocol and assay accuracy was monitored with matrix-matched standards.

Optimisation study
The study was carried out in three stages:

1. Variogram analysis and modelling (Table 1, Fig 3)

<table>
<thead>
<tr>
<th>Element</th>
<th>Relative nugget variance</th>
<th>1st range (min)</th>
<th>2nd range (min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$P_2O_5$</td>
<td>40%</td>
<td>150</td>
<td>850</td>
</tr>
<tr>
<td>$Fe_2O_3$</td>
<td>61%</td>
<td>50</td>
<td>320</td>
</tr>
</tbody>
</table>

2. Analysis of the nugget variance, which included the assessment of the mass-precision relationship of each sampling stage of the sample preparation protocol.

3. Assessment of several sampling schemes. The following parameters were varied: the number of increments, the increment-size reduction leading to the composite, the masses of the subsequent sampling stages and the number of analytical determinations. Figure 4 illustrates how some of the results were presented.

Benefits
This study was useful in highlighting the sampling specificities of $P_2O_5$, $Fe_2O_3$ and other elements. The contribution of the nugget variance to the overall precision was found to be greater than that of the long-range variogram components.

The understanding of the contribution of the sampling variance to the nugget variance proved essential to determine appropriate sampling strategies.

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