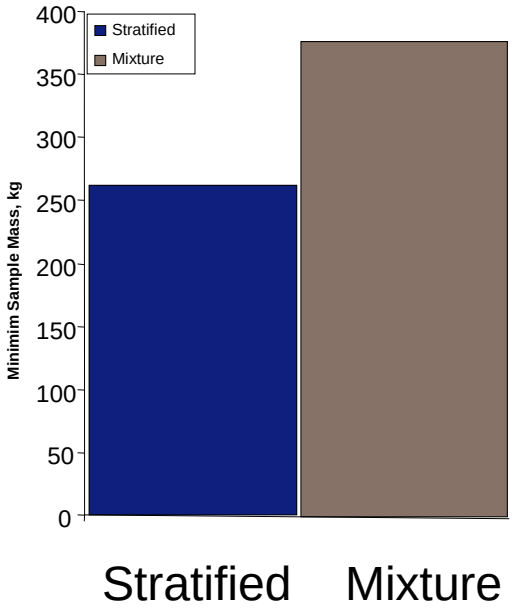
Stratified Sampling of Drill Core

xstrata
process support

Norman O. Lotter

Summary

- Raglan Drill-Core used as a Case Study
- Gy's 50-Piece Sampling Experiment Successfully Adapted to Drill-Core
- For an 8% Fundamental Variance we need the following minimum sample masses:
  - Stratified Sampling by GeoMet Unit 261.73 kg
  - Ore Mixture 377.33 kg



Overview

- Problem Statement
  - Compound Distributions
- Methodology
  - GeoMet Units
  - Gy's 50-piece experiment
  - Modifications to suit drill core
- Key Findings
- Conclusions

Problem Statement
Compound Distributions are Difficult to Sample

Wanted: Reliable Test Data

- Start with Representative Samples from Stratified Sampling
  - More efficiently obtained from drill-core from individual Geomet units
- Perform Tests at High-Confidence
  - Reduces errors through averaging effects

Samples - or Specimens? What's the Difference?

- Sample
  - Unbiased
  - Sufficiently small variance
- Specimen
  - Any particle taken from the whole in a biased manner

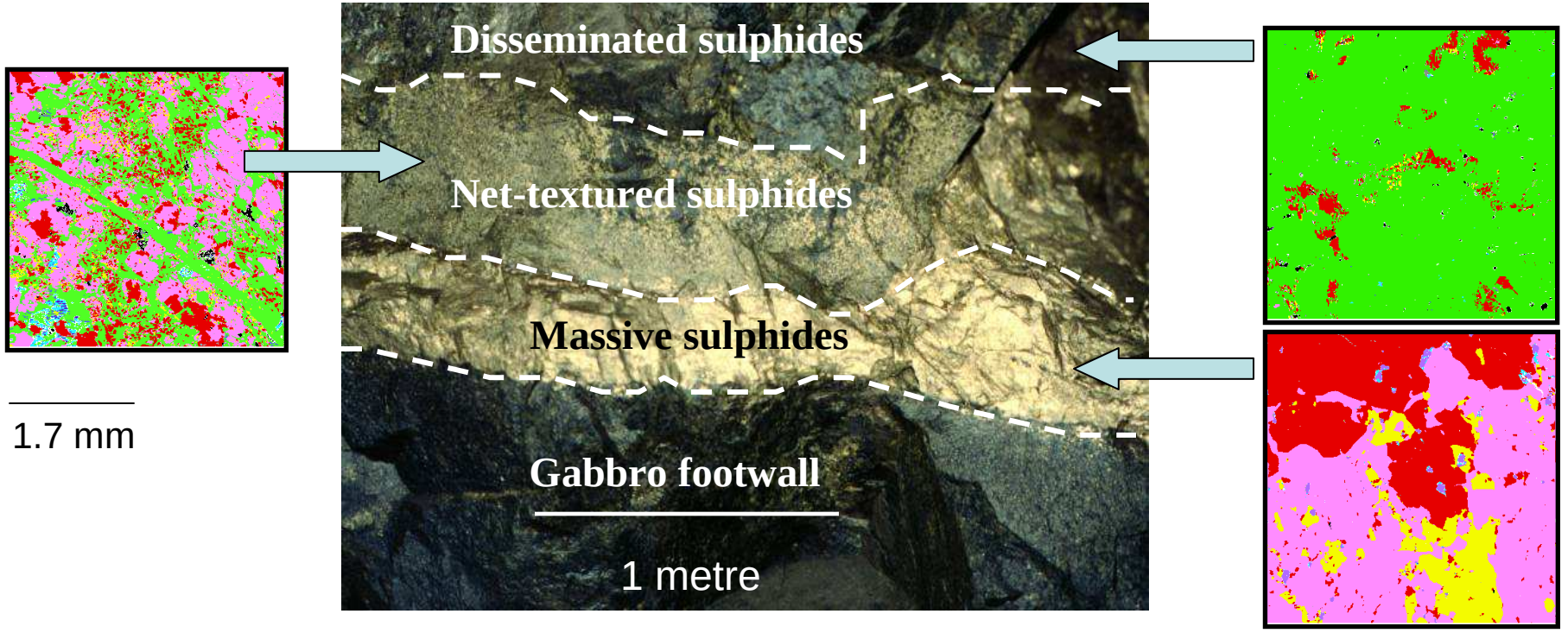
Geomet Units

- A Geomet unit is …
  - Defined by a Professional Geoscientist
    - in the first sampling and characterisation activities of the project
  - An ore type or group of ore types
    - that possess a unique set of textural and compositional properties from which it can be predicted that they will have similar metallurgical performance
- What Geomet units offer…
  - A sampling strategy that uses Stratified Sampling
  - Encounters less variance than in the ore mixture

Stratified Sampling

- Stratified Sampling is….
  - It follows and builds on
    - the primary definitive sampling and characterisation work
  - Sampling a compound distribution
    - at the individual subdistribution level, then making up a compound distribution from that information
  - Will provide sample material for the flotation testwork

Raglan GeoMet Units



These three units form a compound distribution.

What happens if:

1. We sample them individually?
2. We sample them as a mixture?

Gy's 50-Piece Experiment

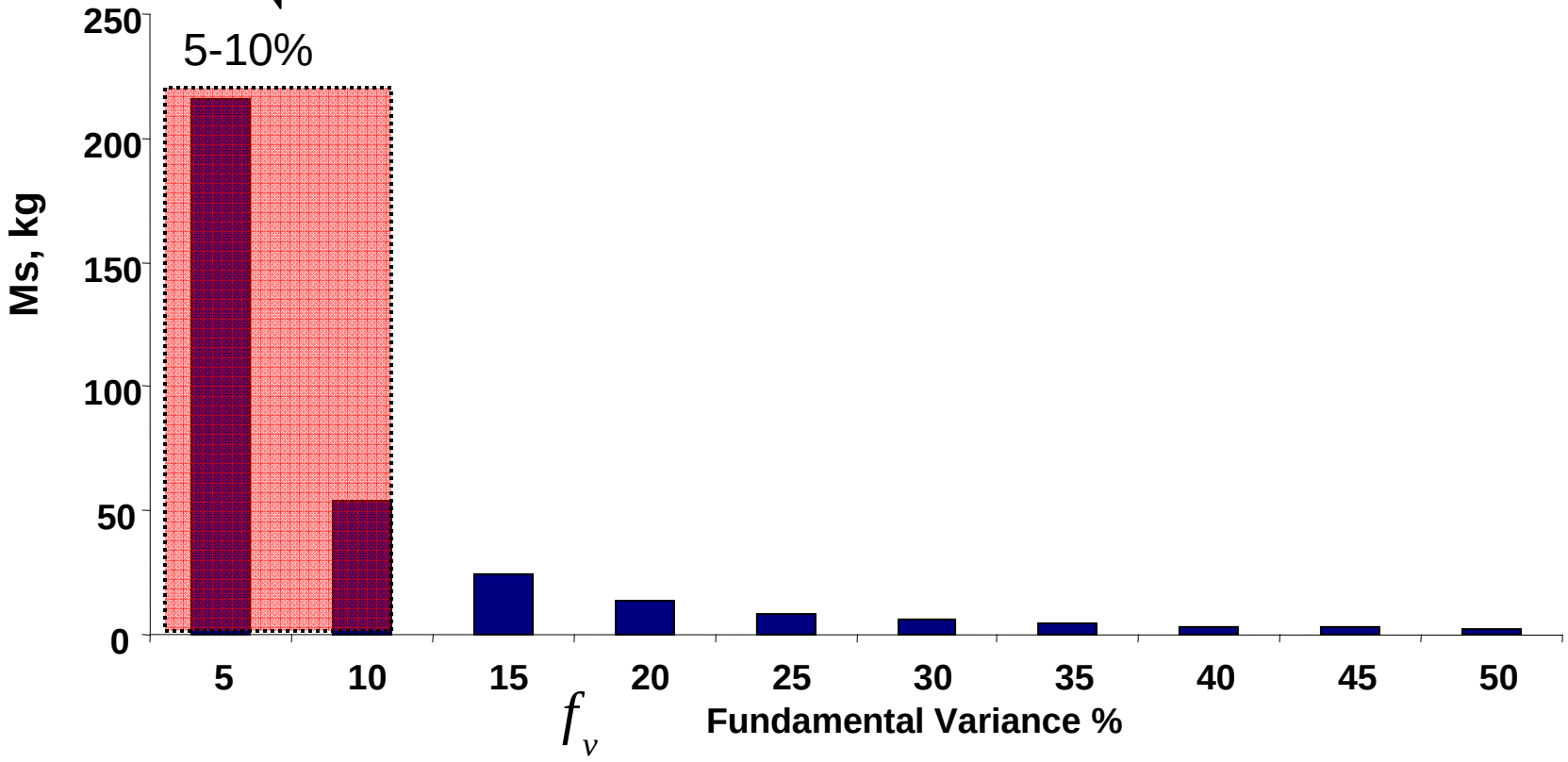
- This experiment is designed to obtain
  - the sampling coefficient K from empirically measured variables from each of 50 pieces
    - mass
    - density
    - volume
    - grade
- The larger is K, the larger Ms will be for the same fundamental variance
  - Units: Ms in grammes, f_v as a square decimal fraction, e.g. $(0.08)^2$ for 8% fundamental variance

$$M_s = K / f_v$$

Gy's 50-Piece Experiment

Sufficiently Small Variance

$$M_s = K / f_v$$



Gy's 50-Piece Experiment

Ms = K/ f_v

Is the simplified product from the measurements for

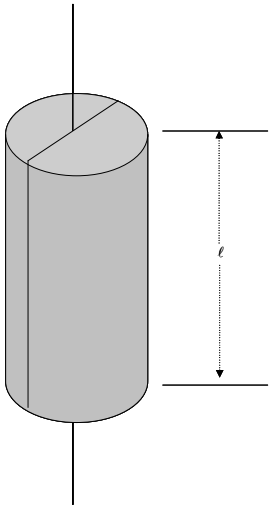
$$f_v = \left(\left(\frac{1}{M_s}\right).\left(\frac{g.\bar{v}}{M\,\bar{a}^2}\right)\left(\sum_{1=1}^{n}\left(a_i-\bar{a}\right)^2 (M_i)^2/(v_i)\right)\right)$$

d_i^3

$$g = \left[\frac{1}{M\,\overline{d^3}}\right].\sum_{i=1}^{n} M_i$$

Modification to Suit Drill Core

$$V = \pi . r^2 . \ell$$



V	=	Volume, ml
π	=	3.142
r	=	drill core radius, cm
ℓ	=	drill core length, cm

We can estimate the volume of each piece of drill core and adjust for core splitting losses (10% at Raglan)

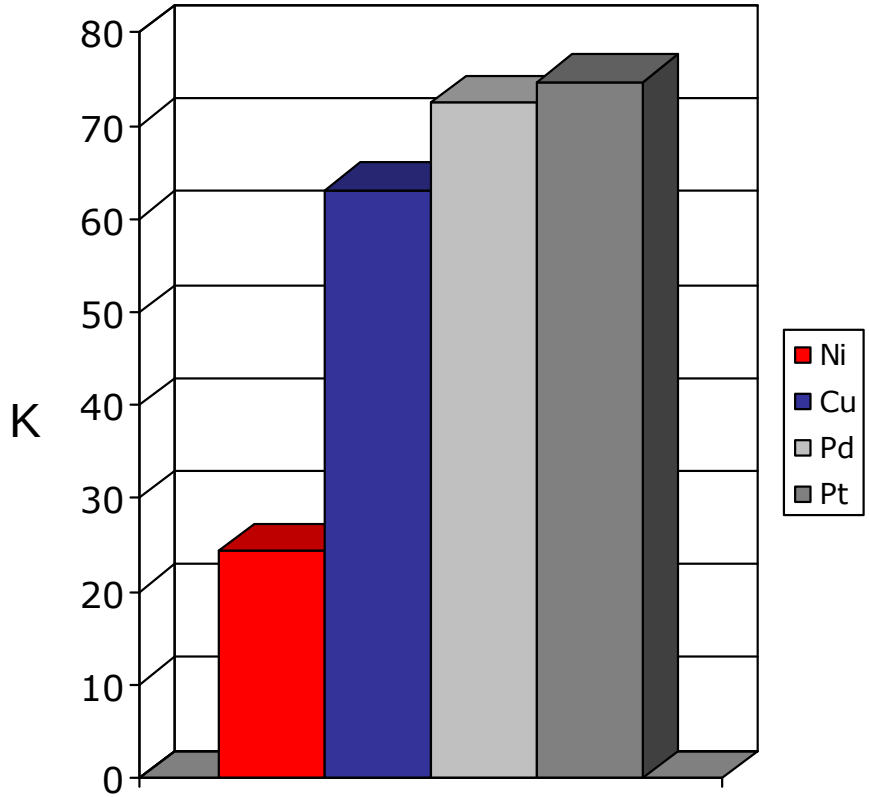
Thus a piece of half-core becomes a ‘piece’ in Gy’s 50-piece experiment

Key Findings

- The sampling constants are different within each Geomet unit for each individual paymetal
- For the same orebody, we need larger samples when sampling the ore as a mixture than when we sample the ore by individual Geomet unit

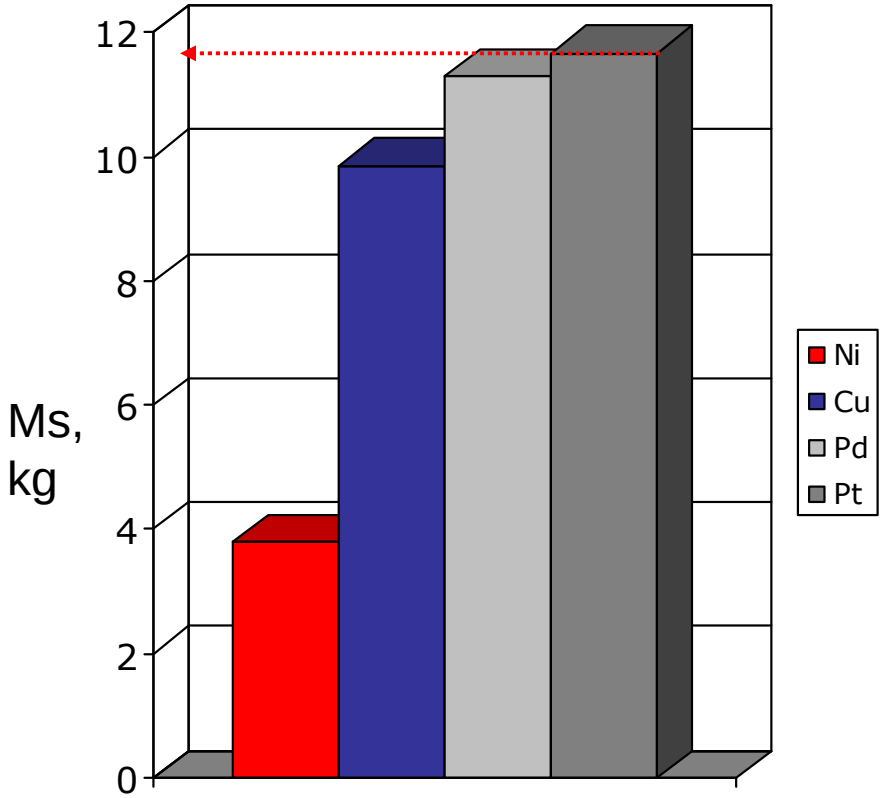
Sampling the Geomet Units Individually

- Disseminated Sulphides
- Sampling Constant K
  - Ni 24.31
  - Cu 63.12
  - Pd 72.43
  - Pt 74.72



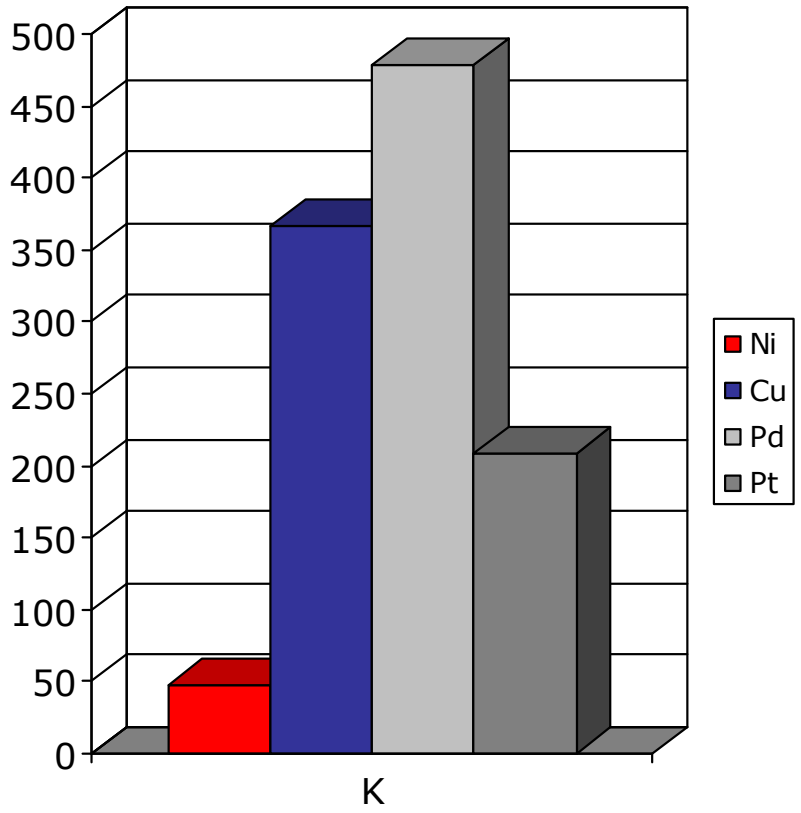
Sampling the Geomet Units Individually

- Disseminated Sulphides
- Minimum Sample Mass (kg) for 8% f_v
  - Ni 3.80
  - Cu 9.86
  - Pd 11.30
  - Pt 11.67



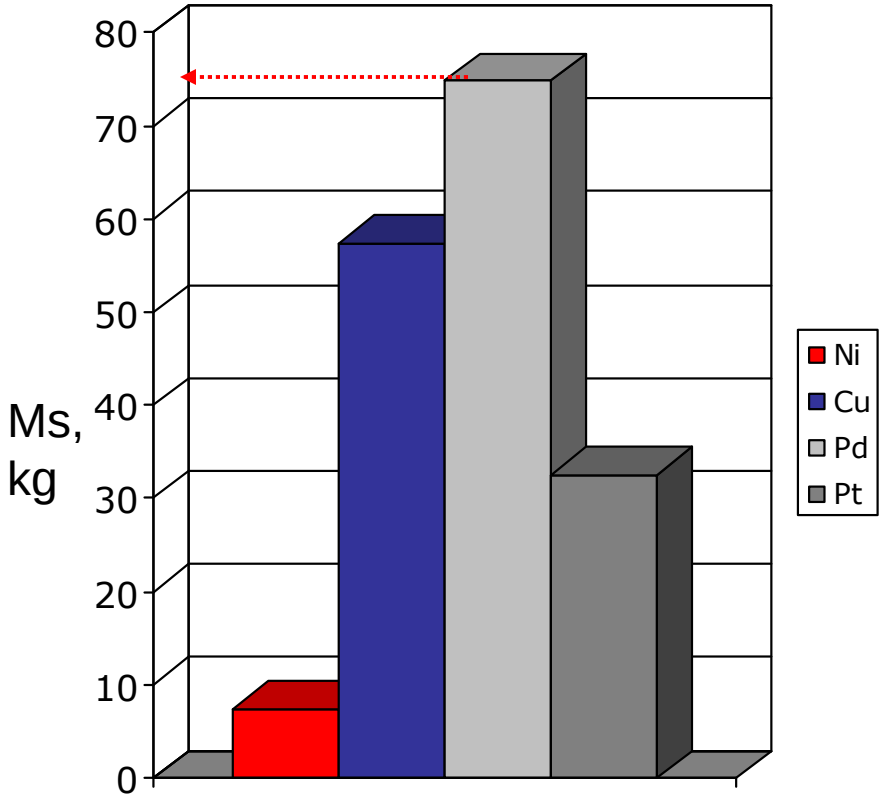
Sampling the Geomet Units Individually

- Net-Textured Sulphides
- Sampling Constant K
  - Ni 47.15
  - Cu 367.30
  - Pd 479.33
  - Pt 208.41



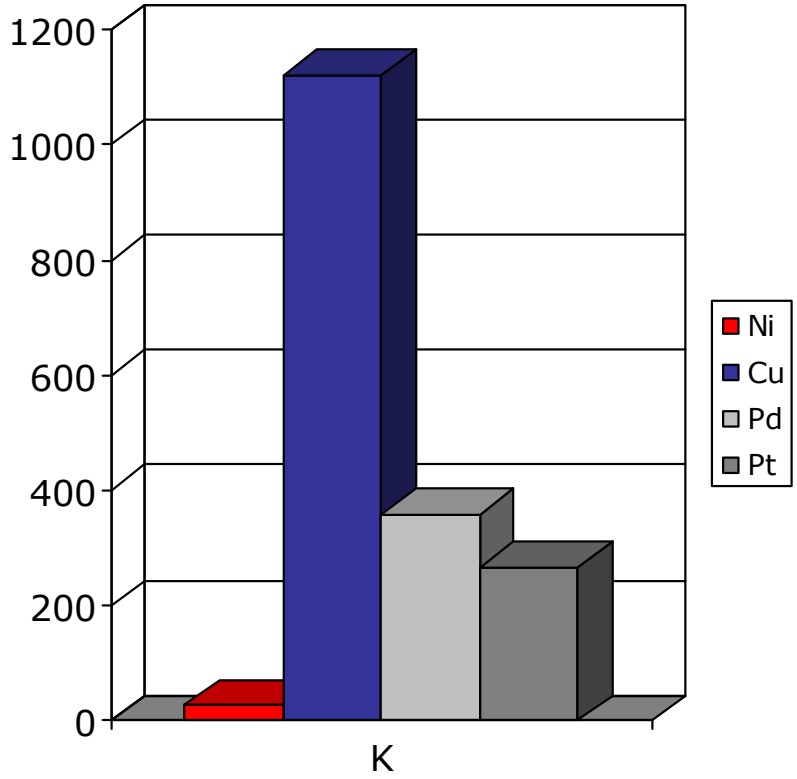
Sampling the Geomet Units Individually

- Net-Textured Sulphides
- Minimum Sample Mass (kg) for 8% f_v
  - Ni 7.37
  - Cu 57.39
  - Pd 74.90
  - Pt 32.56



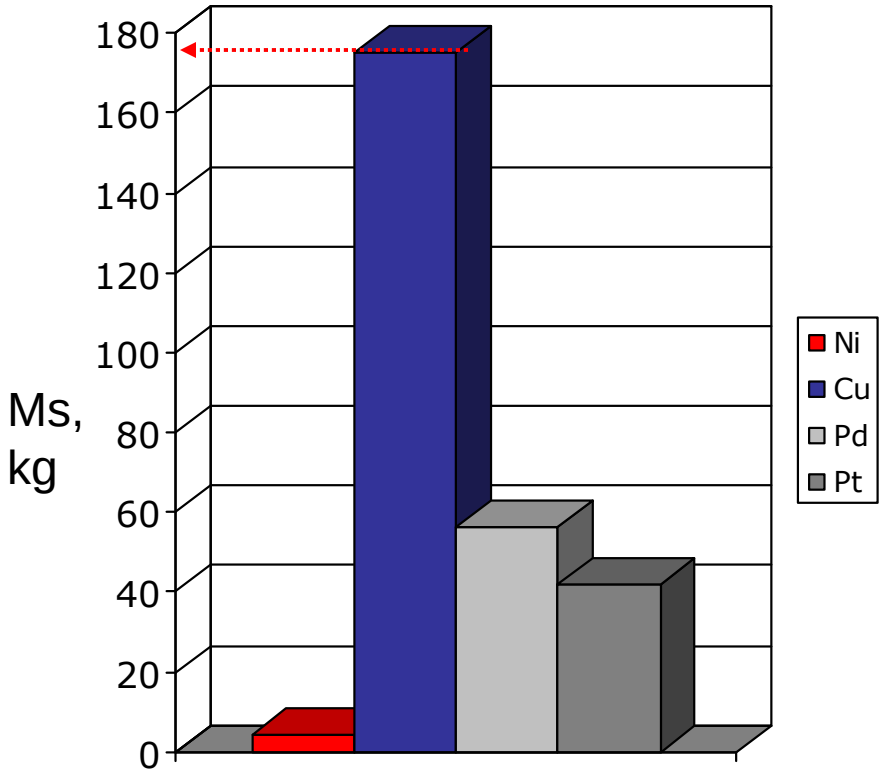
Sampling the Geomet Units Individually

- Massive Sulphides
- Sampling Constant K
  - Ni 28.10
  - Cu 1121.05
  - Pd 358.42
  - Pt 266.43



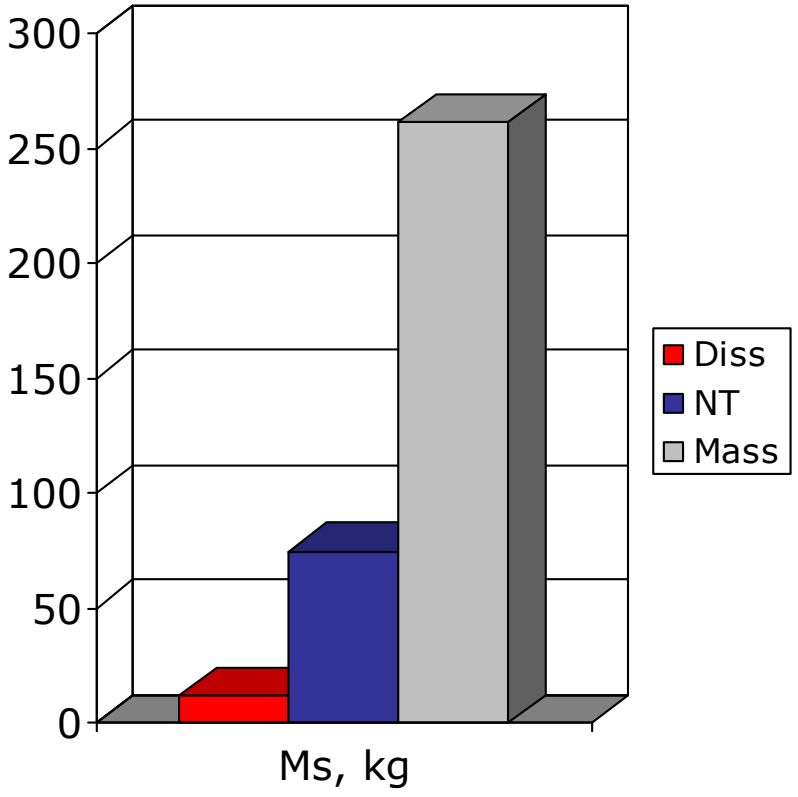
Sampling the Geomet Units Individually

- Massive Sulphides
- Minimum Sample Mass (kg) for 8% f_v
  - Ni 4.39
  - Cu 175.16
  - Pd 56.03
  - Pt 41.62



Sampling the Geomet Units Individually

- Result of Stratified Sampling
- Ms for Each Geomet Unit:
  - Disseminated Sulphides 11.67 kg
  - Net-Textured Sulphides 74.90 kg
  - Massive Sulphides 175.16 kg
  - Total 261.73 kg
- Relative Mass in Mining Plan:
  - Disseminated Sulphides 10%
  - Net-Textured Sulphides 80%
  - Massive Sulphides 10%
  - Total Composite 100%



Sampling the Geomet Units Individually

- Preparation of ROM Composite from Geomet Units

$$\frac{M_1}{M_2} = \frac{d_1^{\,3}}{d_2^{\,3}}$$

Half-core is approx. 19mm (BQ core)

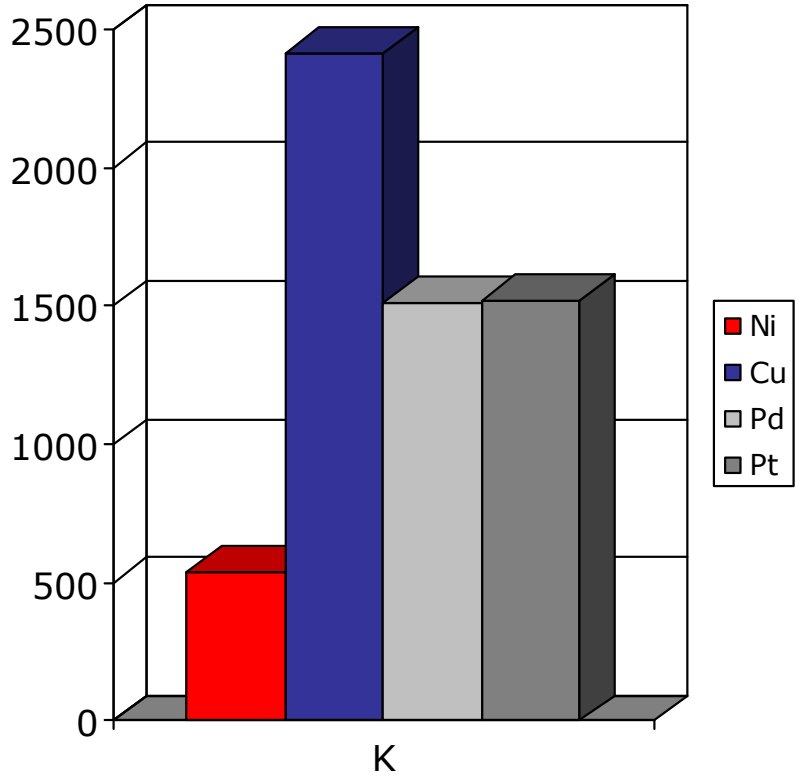
If we crush the primary sample to a known (smaller) product topsize, we are allowed to take a subsample according to this relationship (safety line)

Sampling the Geomet Units Individually

- Preparation of ROM Composite from Geomet Units
- Normal lab practice crushes to 1.7 mm topsize (10 mesh)
  - Allows extraction of a smaller subsample than the primary Ms
  - Can now prepare composite:
    - The crushing significantly reduces Ms
    - Allows investigator to exceed Ms to suit flotation programme needs

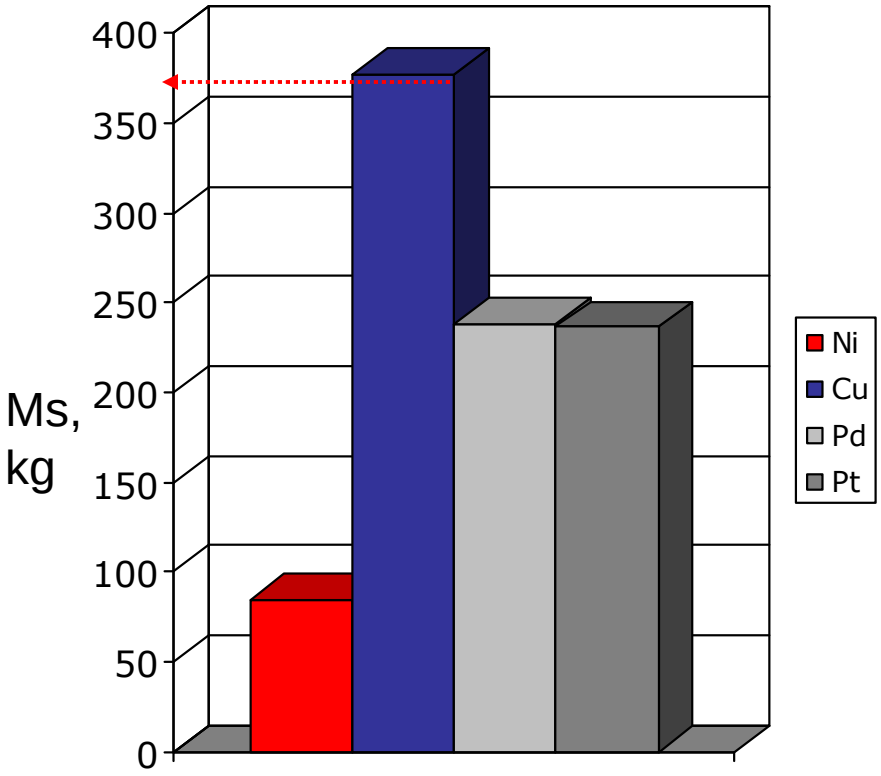
Sampling the Drill-Core as a Mixture

- Ore Mixture
- Sampling Constant K
  - Ni 539.41
  - Cu 2414.90
  - Pd 1512.08
  - Pt 1521.87



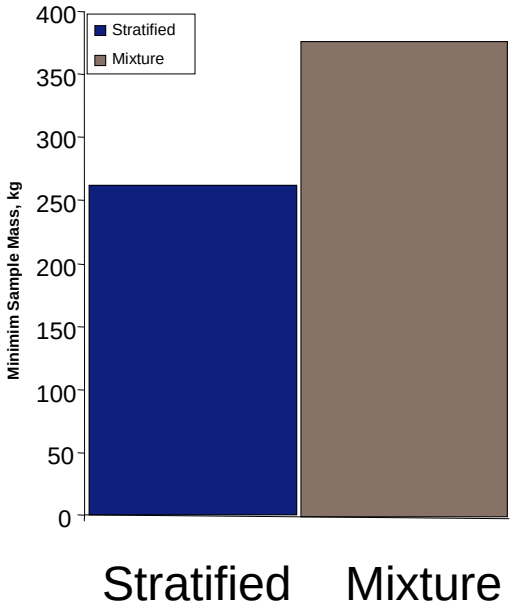
Sampling the Drill-Core as a Mixture

- Ore Mixture
- Minimum Sample Mass (kg) for 8% f_v
  - Ni 84.28
  - Cu 377.33
  - Pd 237.79
  - Pt 236.26



Comparison

- For an 8% fundamental variance we need:
  - 261.73 kg drill-core by stratified sampling
  - 377.33 kg by ore mixture



Conclusions

- Gy's 50 piece experiment offers a practical platform for drill core
  - It is advisable to perform the 50 piece experiment prior to the sampling
- The Ms models for the individual Geomet units are smaller than for the compound distribution
  - A weighted composite of the ore mixture can be efficiently prepared from the individual Geomet units
  - The sampling constants for each paymetal differ between Geomet units

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