

Estimación de Recursos y Reservas: Problemas Frecuentes

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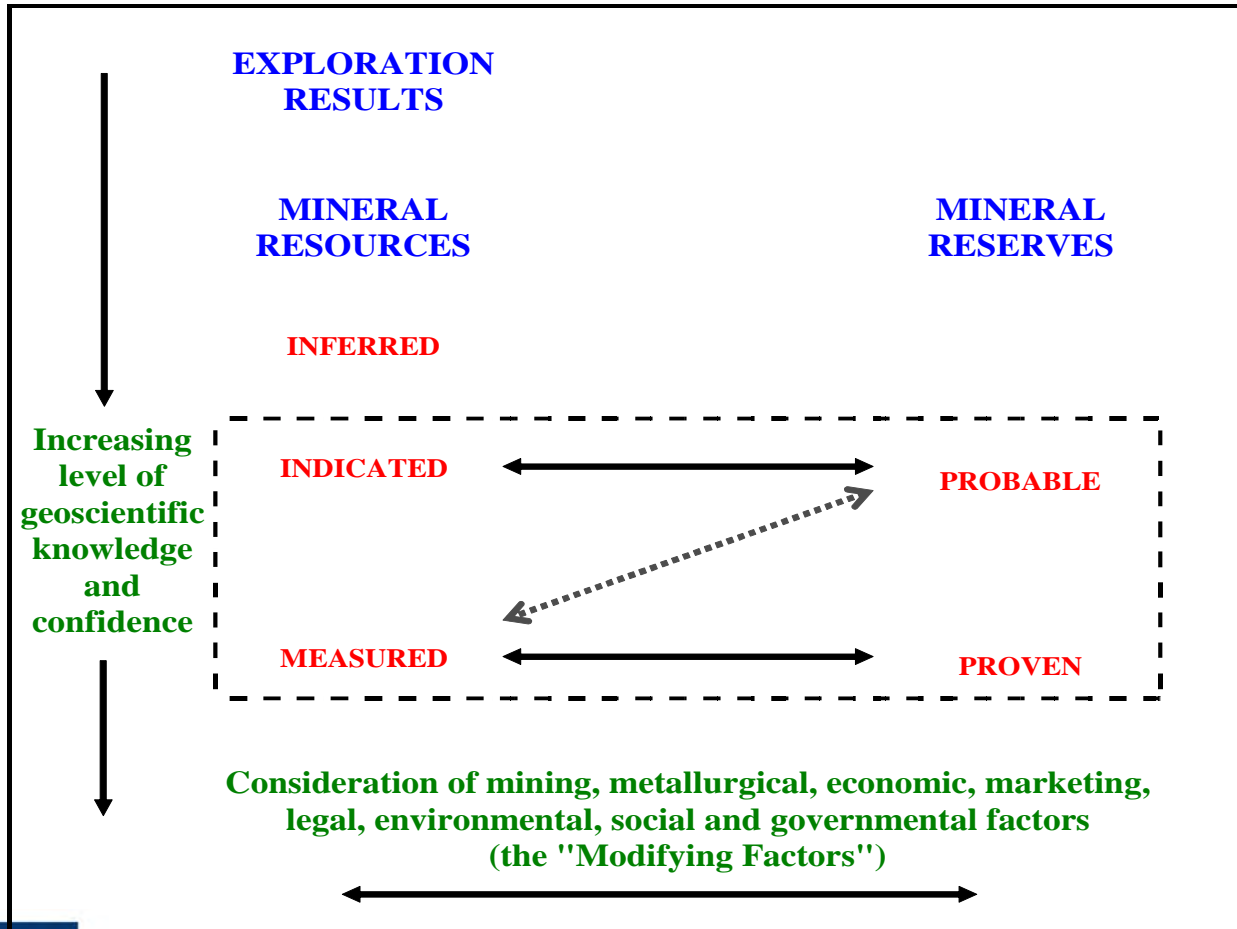
SNOWDEN

21 Junio 2010

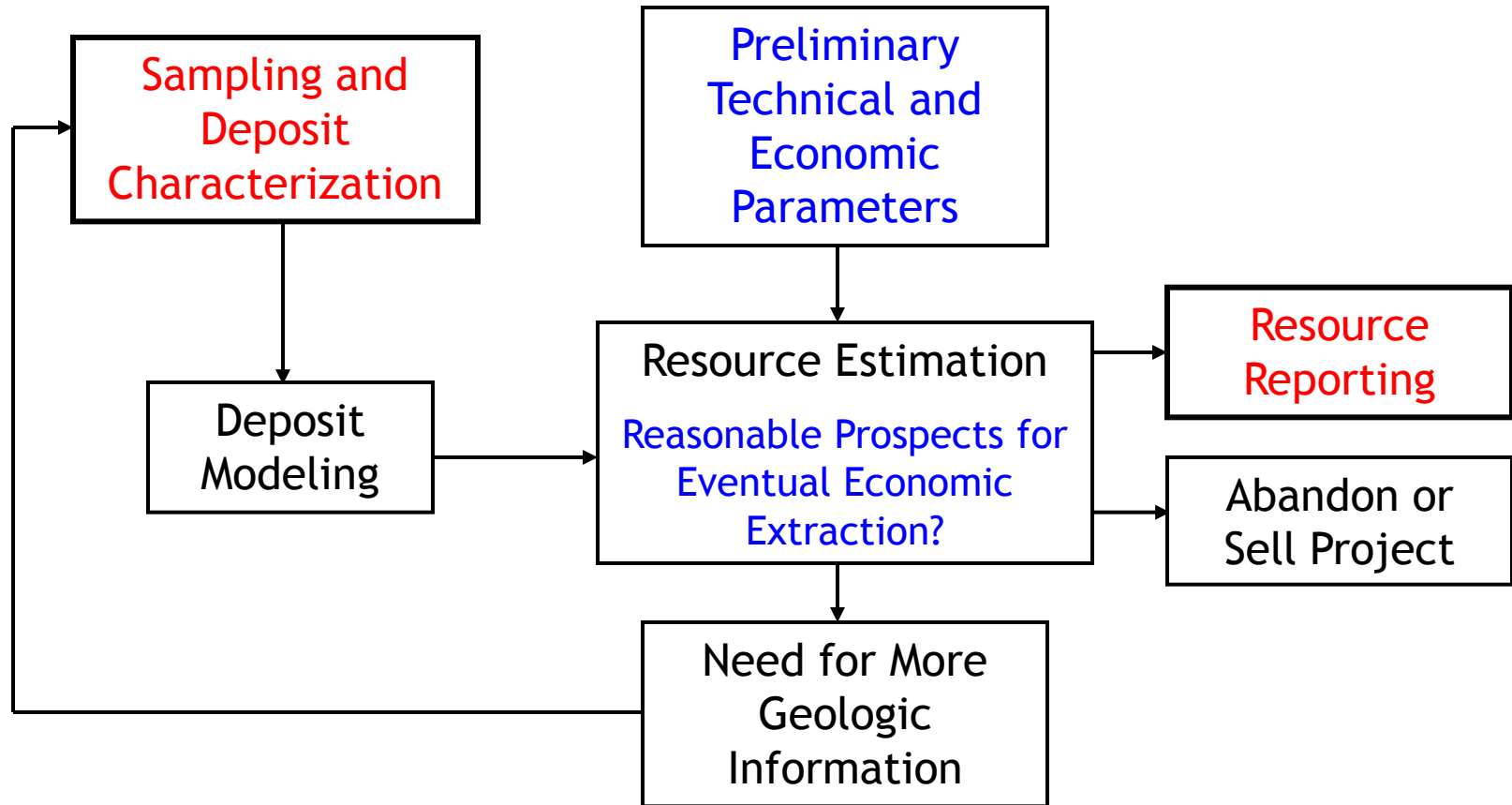
General Outline

- **Estimation Process**
- **Drilling, Sampling, and Sample Preparation**
- **Mining, Metallurgical and Economic Factors**
- **The Human Factor and Quality Control**
- **More Challenges for Competent Person**

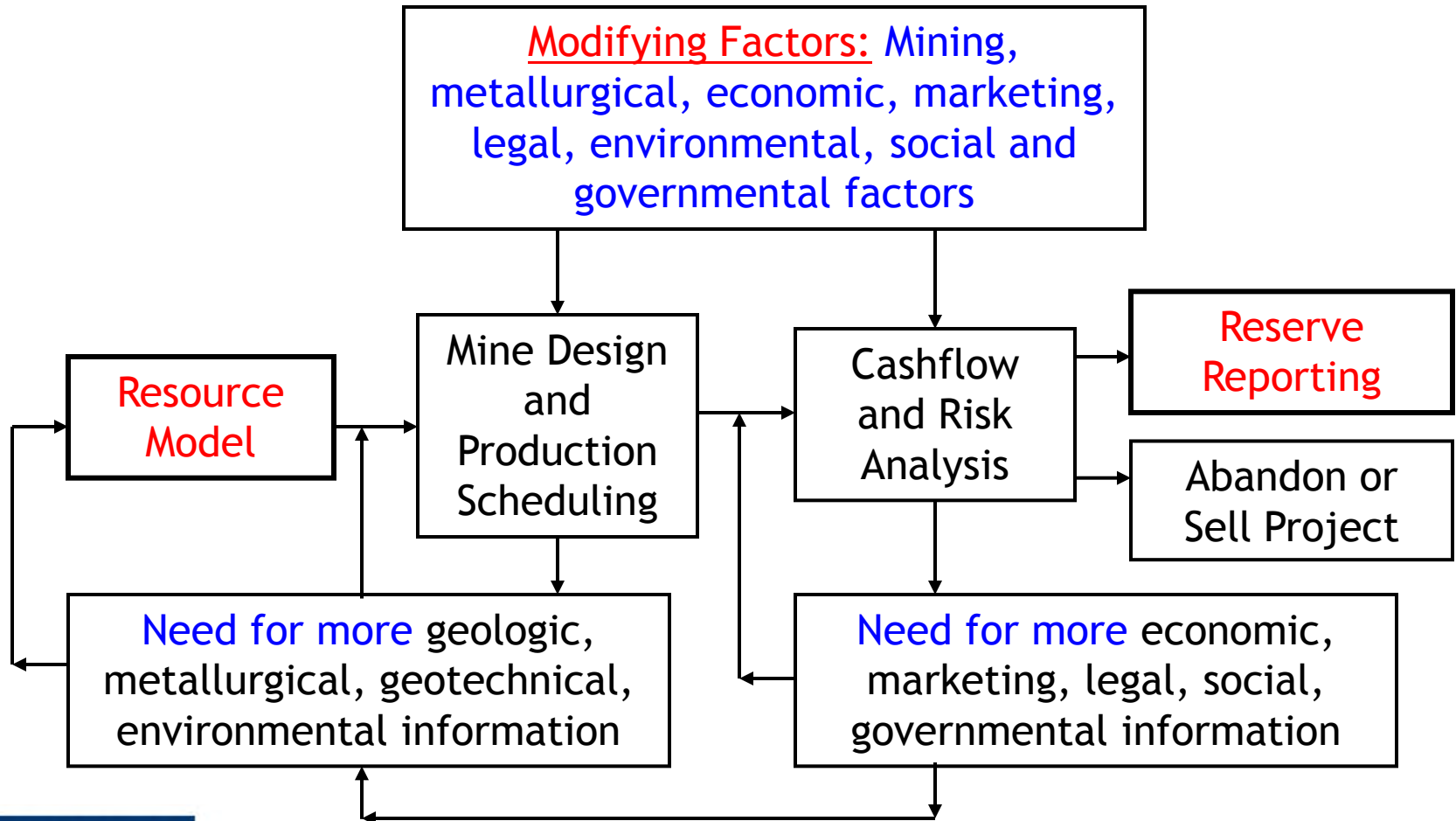
Relationship between Exploration Results, Mineral Resources and Mineral Reserves



Estimation Process: Resources



Estimation Process: Reserves



SAMPLING METHODS



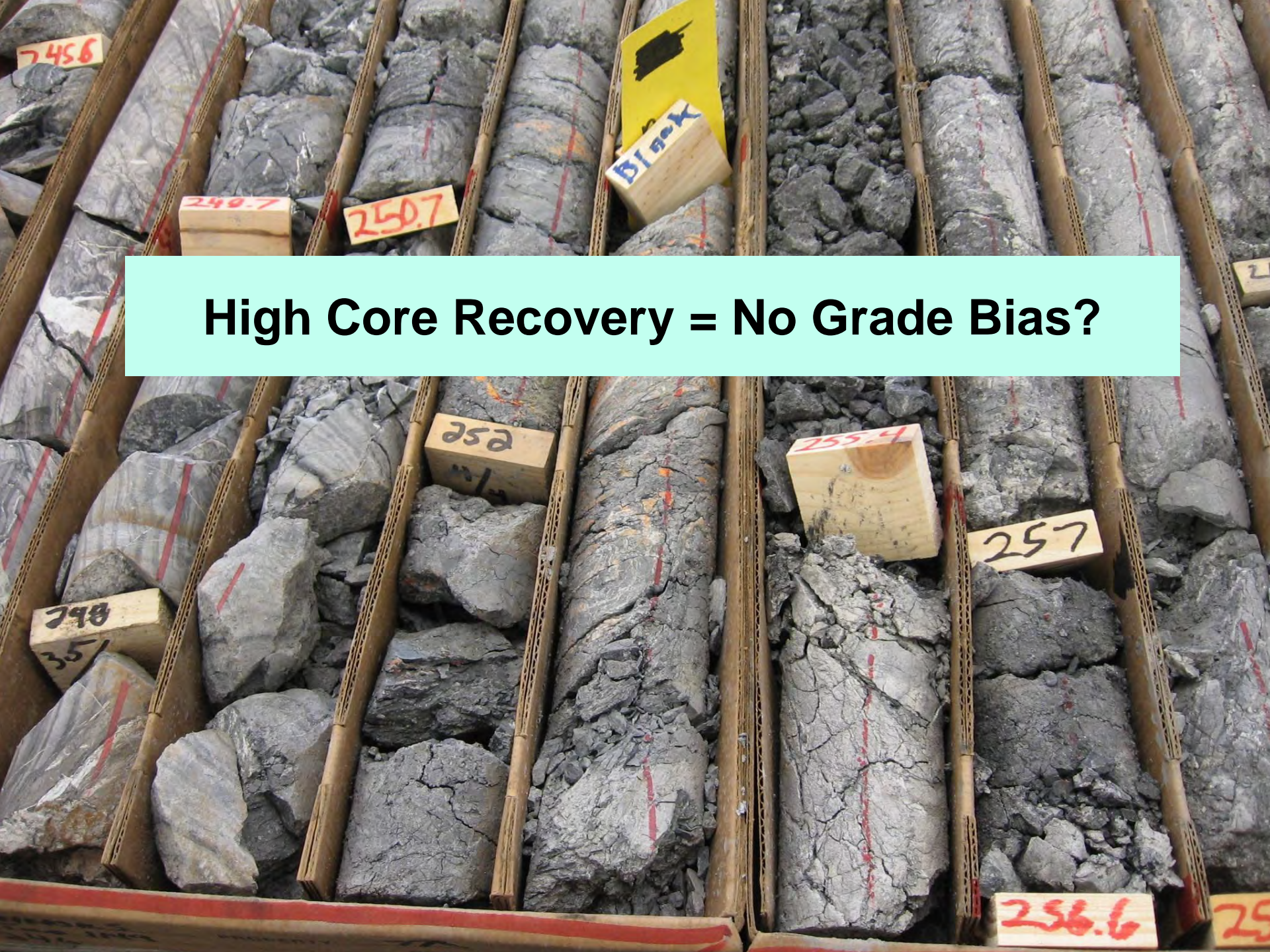
Exploration and Data Collection

Drill Hole Sampling

- Core Holes
- Normal (Direct) Circulation
- Reverse Circulation

CORE HOLES





High Core Recovery = No Grade Bias?

Problems with Core Sampling

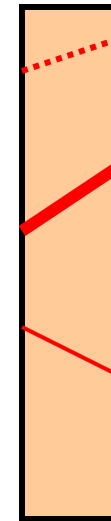
- Poor Recovery
- Selective Recovery
- Loss of Fines during:
 - Core Washing
 - Core Cutting
 - Core Splitting
 - Crushing and Pulverizing

Is a core sample representative of what is in the ground?

- What percentage recovery is acceptable?
- Is 98% acceptable?

- Recovered: 98% at 0.30% Cu
- Lost: 2% at 3% Cu
- Should be: 100% at 0.35% Cu (+18%)

- Recovered: 98% at 0.30% Cu
- Lost: 2% at 0% Cu
- Should be: 100% at 0.29% Cu (-2%)

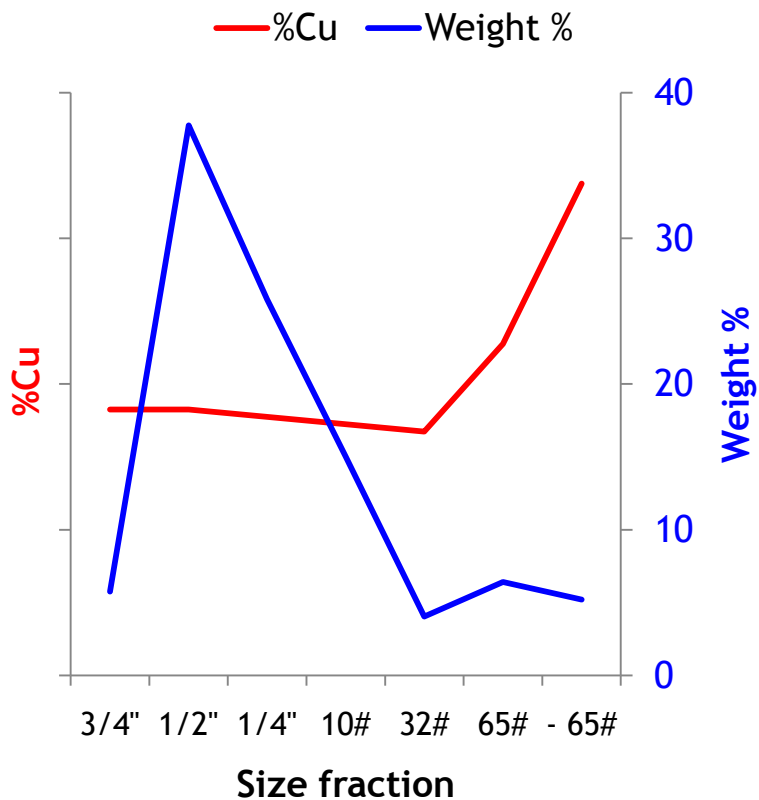


Loss of Fines During Core Splitting Where does it Happen? (Guillotine; Saw)

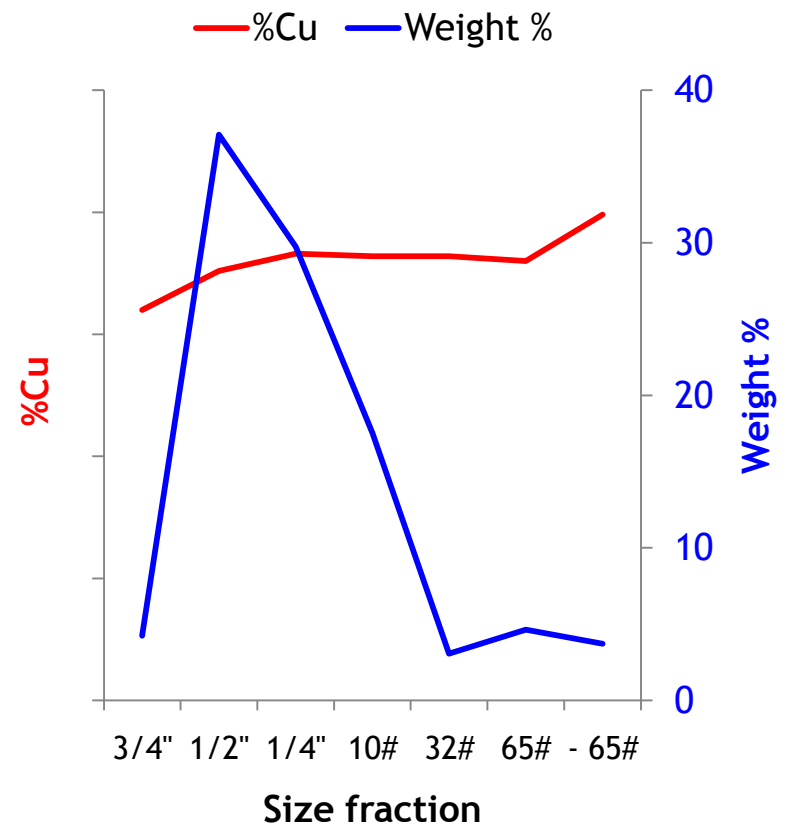


Size Distribution in Porphyry Copper Deposit

Rock Type 1

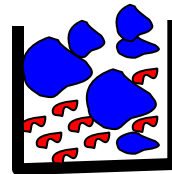


Rock Type 2

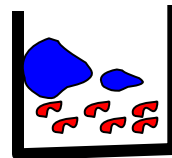


Core Splitting Problem

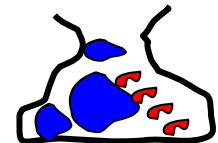
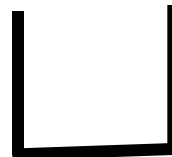
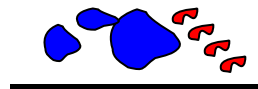
- Broken core in box



- Splitting method 1



- Splitting method 2



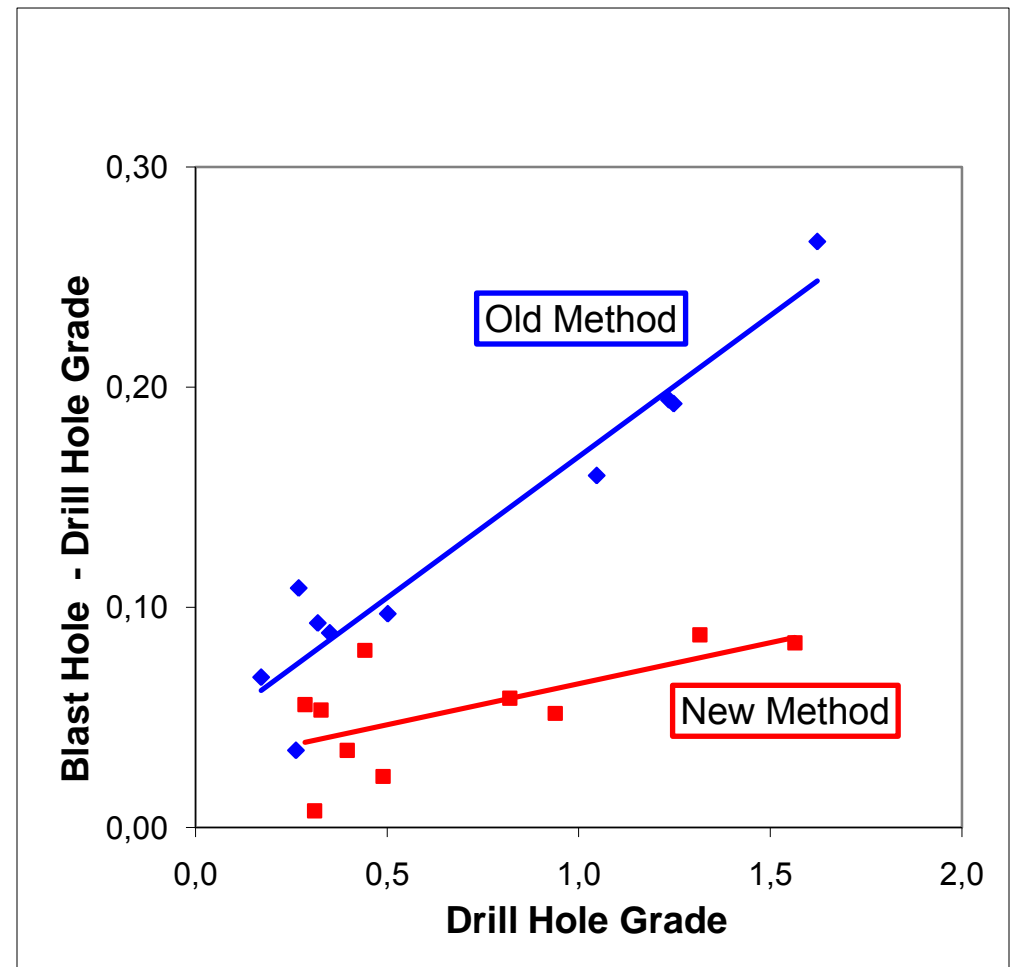
Comparison of Blast Hole and Drill Hole Grades

•Old Method:

- Take broken material from top of core box
- Fines are left inside box
- Blast holes are much higher grade than core samples

•New Method:

- Split core evenly
- Blast holes are slightly higher grade than core samples

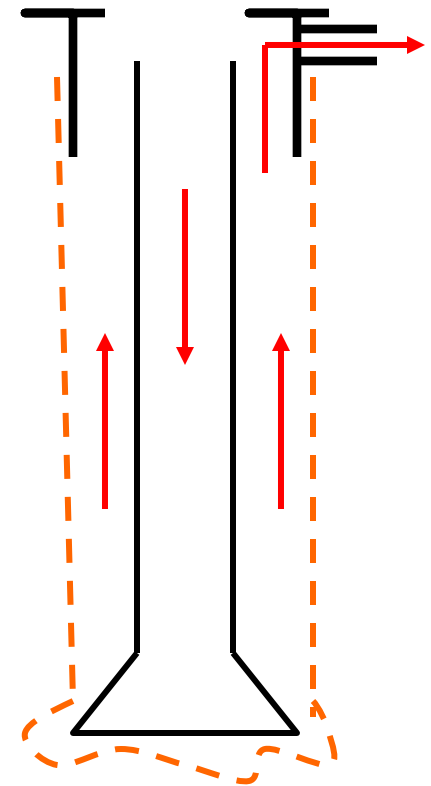


Normal and Reverse Circulation



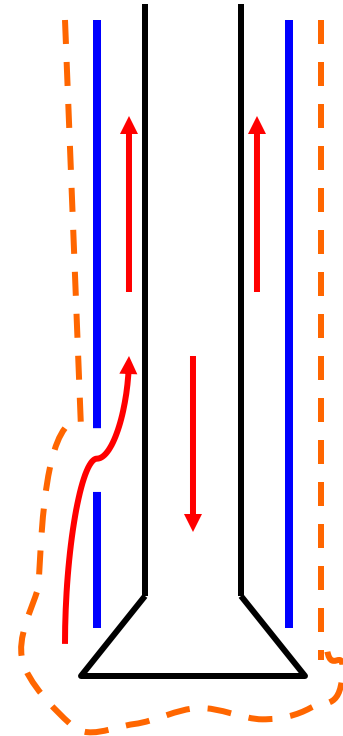
Problems with Normal Circulation Rotary Drilling

- Is Normal (Direct) Circulation Rotary Drilling as “Bad” as Claimed? **YES!**
- **Water** is the Enemy, whether Injected or from Underground
- Can it Ever be Used?
 - Yes, to Determine Whether there is Mineralization
 - But Not to Characterize Mineralization (Depth, Thickness, Grade)



Problems with Reverse Circulation Drilling

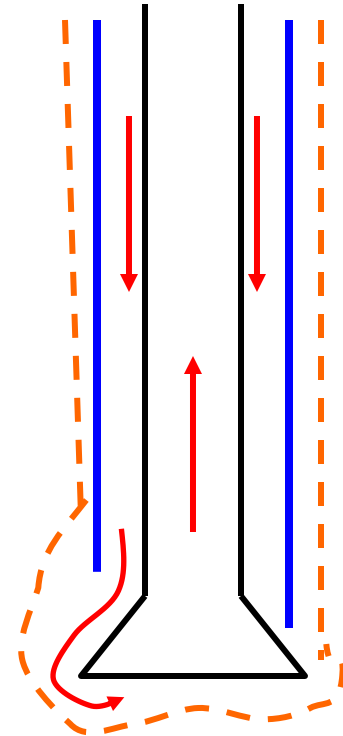
- Is Reverse Circulation Really Much Better than Normal Circulation?
 - Usually Yes
 - Bypass Contamination
 - Face Sampling Bits
 - Water is the Enemy, whether Injected or from the Ground



Problems with Reverse Circulation Drilling

- Face Sampling Bits
- Water is the Enemy

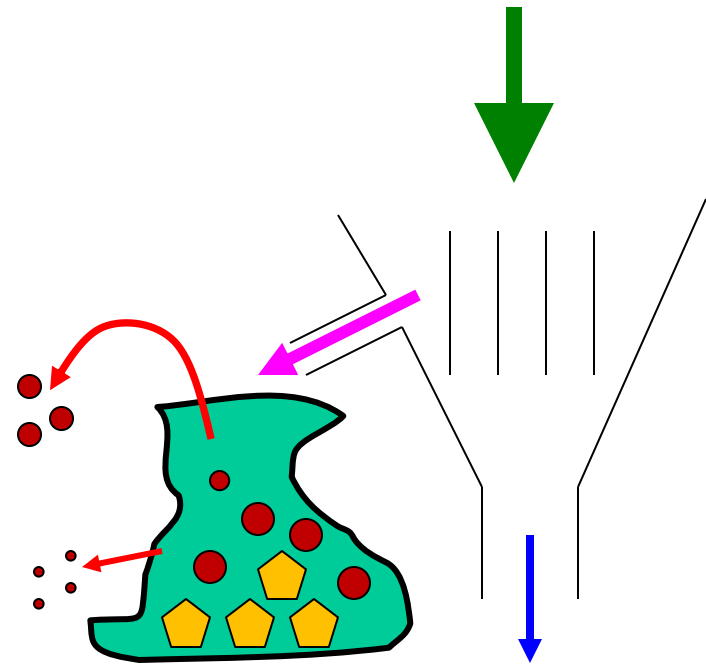
Water inflow can result in sample contamination



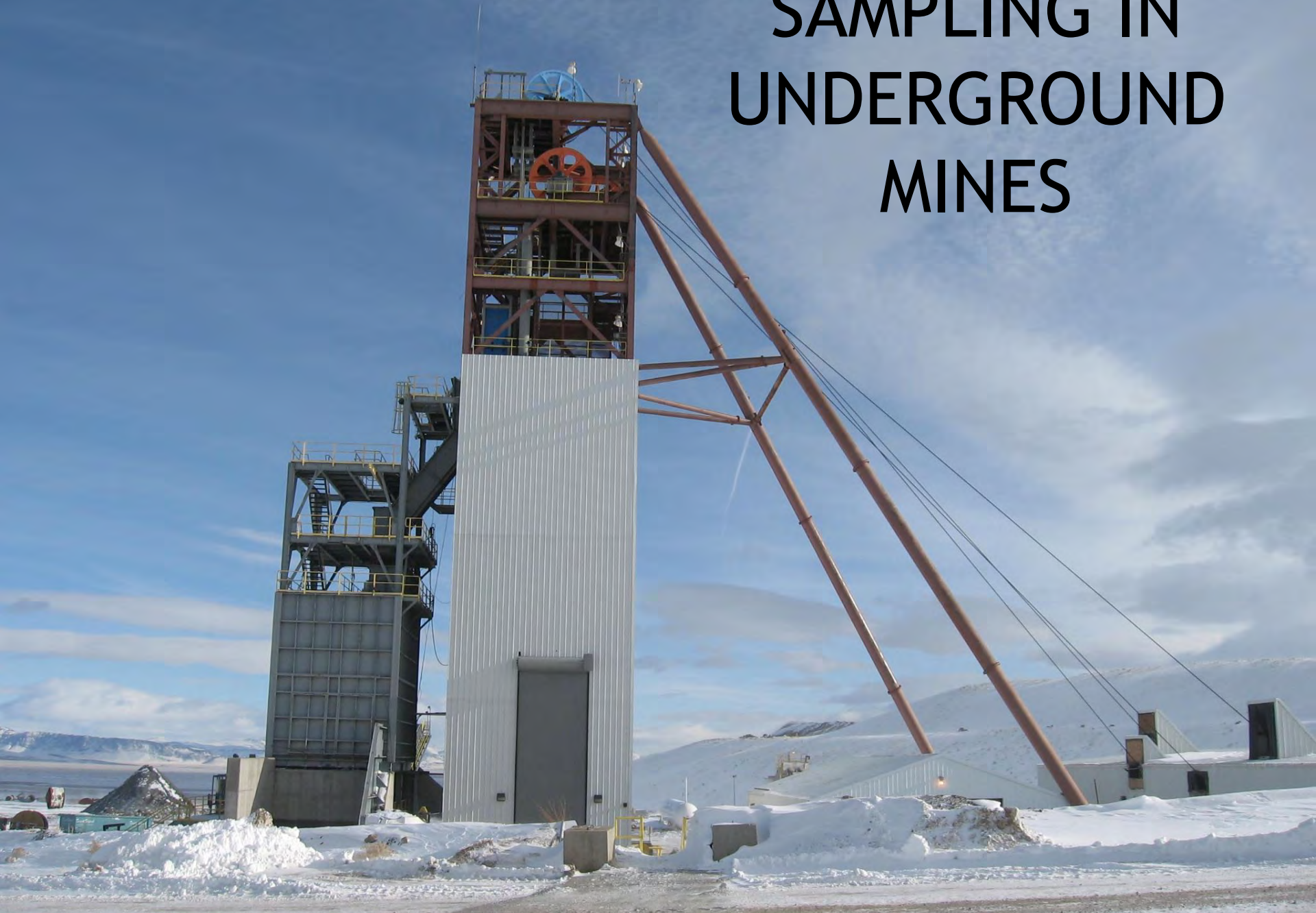
Problems with Reverse Circulation Drilling

•Sample Splitting

- Too Much Water
- Bag Overflowing
- Loss of Fines
- Use of Micropores
- Speed or Quality?



SAMPLING IN UNDERGROUND MINES



Some Underground Sampling Methods

- Core Samples: Location, Orientation, Deflection
- Blast Hole Samples: Water, Sample Collection
- Chip Samples
- Channel Samples
- Muck Samples

How do I Sample This?



Chip Sampling



Channel Sampling



Sampling of Broken Muck





Stockpile Sampling:
Is this a Good Sample?

Compare Size of Scoop with Size of Material Sampled



Sampling of Individual Loads

Sample (10 kg)

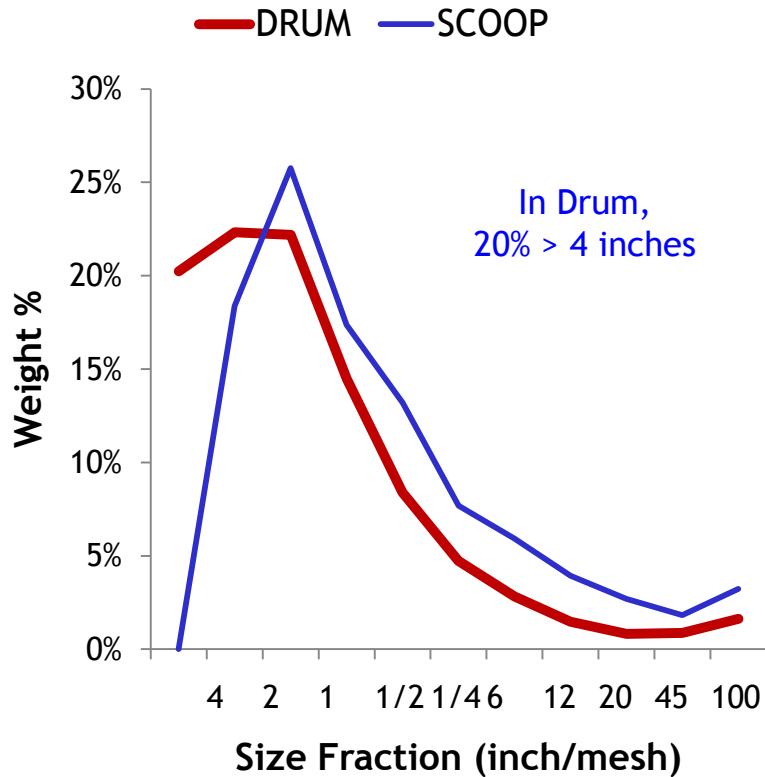


Loader (1 tonne)

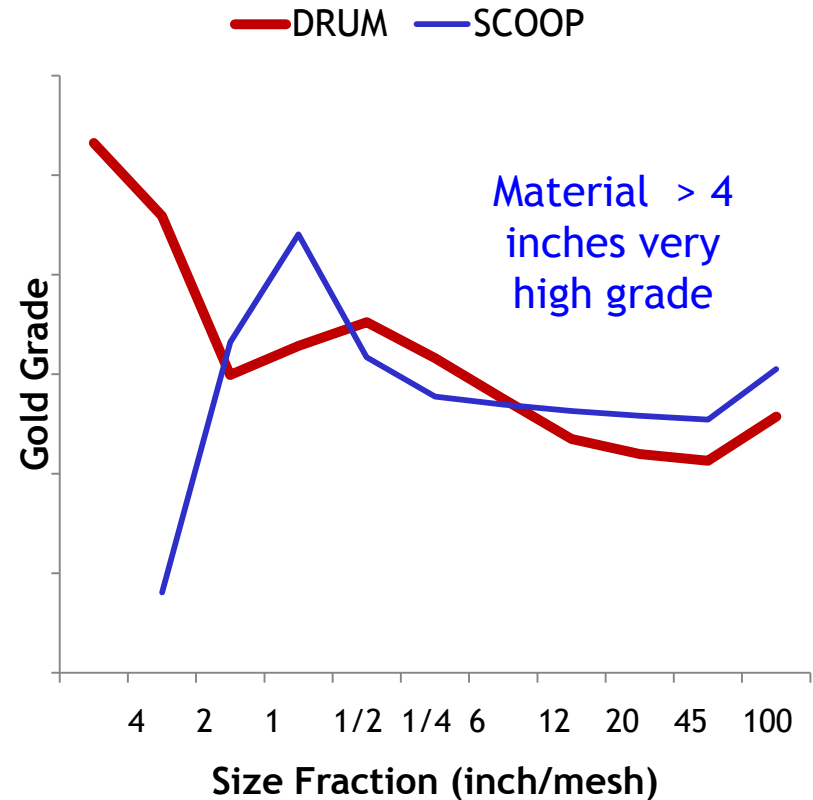


Comparison of Bucket and Drum Samples

Size Distributions



Grade Distributions



ESTIMATION OF MINERAL RESOURCES



Deposit Modeling and Estimation of Mineral Resources

- **A Deposit Model is not a Resource**
 - A Resource must show **Reasonable Prospects for Eventual Economic Extraction**
 - Technical, Economic and Other Assumptions must be Made, Albeit at a Preliminary Level.

DEPOSIT MODEL AND MINING METHOD



- Deposit Model and Mining Method -

- Different Models for Different Mining Methods

- Open Pit or Underground
- Bulk Mining or Selective Mining
- High or Low Cutoff Grades

DEPOSIT MODEL AND METALLURGICAL PROCESS



- Deposit Model and Processing Method -

- Different Models for Different Processing Methods
 - Copper Oxide, Sulfide, Transition
 - Gold Cyanide Amenability
 - Mill Throughput, Power Consumption, Acid Consumption
 - Recovery

What is a **Representative** Geometallurgical Sample

- From Laboratory Test to Semi-Industrial Test to Full Scale Operation
 - Many Small Samples
 - Few Large Samples
 - According to Geology
 - High Grade, Low Grade, Near Surface, At Depth



Resource and Reserve Estimation Economic Considerations

Estimation of Mineral Reserves Economic Analysis

- Which **Commodity Price** Should be Used?
 - Who Decides and Who Signs the Competent Person's Report?
 - Beware of External Pressures
 - Use a High Price to Report Higher Reserves
 - Use a Low Price for Tax or Other Reasons



THE HUMAN FACTOR
ESTIMATION IS BY PEOPLE FOR PEOPLE

Resource Estimation

Quality Control

- **Maintain Effective Communications** with:
 - Those Generating the Data (Geologist, Driller, Laboratory, Surveyor, etc.)
 - Those who will Use the Model (Mining Engineer, Metallurgist, Project Engineer, Environmentalist, Management)

Resource Estimation

Quality Control

- Have **Regular Meetings throughout the Entire Modeling Process** with Detailed Review at Beginning and End
- Ask for and Compare **Geologic Interpretations from Different Geologists**
- Use **More than One Modeling Method**. Compare Results. Explain Differences
- Consider **Outside Reviews**.



**Crocodiles Lurking in the Murky Waters
- Warnings to Competent Person -**

Challenges for the Competent Person

•Corporate Objectives:


- Raise Funds for Continuous Project Development
- Grow the Company by Bringing a New Mine to Production
- Sell the Deposit

Challenges for the Competent Person

- **Competent Person Objectives:**

- To Do the Best Technical and Ethical Job he/she Knows How to Do
- To Answer Management's Questions
- The Answer May Differ from Management's Expectations

- **Maximizing Personal Bonus** (or the Boss's Bonus) must **NOT** be a Competent Person's Objective.



**FINAL OBJECTIVE:
A TECHNICALLY AND
ECONOMICALLY SUCCESSFUL
MINING OPERATION**

**THE
END**