**Abancay Mining Training program**

**Lesson plan outline**

1. Intro
   1. Meet and greet
   2. Preview key learning objectives:
      1. Process control
      2. Liberation
      3. Analysis
      4. Concentration
2. Morning seminars based around videos
   1. expanded video segments link learning objectives to:
      1. Bolivia v. Colombia process control and concentration
      2. Philippines liberation analysis
      3. Burkina size control, concentration, payback period
3. Afternoon plant building activities
   1. Break miners into 4 expert groups and train them in detail on:
      1. Crush and classification
      2. Milling and screening
      3. Primary concentration
      4. Secondary concentration
   2. Reorder into new groups of 4, each team builds a plant on chart paper
      1. One expert type in each group.
      2. Choose equipment from among the equipment information sheets given in expert groups.
      3. Match capacities, very simple worksheet guided calculations of concentration rates, operating costs, payback rate.
4. Wrap up: Groups present their plant designs to each other.

**Learning objectives**

1. Process control
   1. Optimization finds the best balance between costs and benefits
   2. The optimal grain size is the size to which the ore must be ground in order to liberate the gold.
   3. Analysis is essential to optimize plant design, and for tracking the efficiency and effectiveness of processes.
   4. Ore must be milled so that 80% of the ore passes the optimal grain size mesh.
   5. It is important to crush to uniform size
   6. Size control ensures optimal liberation
   7. Uniform feed rate ensures optimal efficiency
   8. The capacities of each piece of equipment must be matched to the feed rate of the equipment downstream
   9. Classification
      1. Both crushing and milling steps require screening/classifying afterward to separate the oversize particles so that they can be added back into the equipment feed, thereby reducing them to the proper size.
      2. Coarse size classification (piedras) uses screens and fines (barro y arena) are separated using hydrocyclones.
2. Liberation
   1. Ore must be ground only long enough to liberate the gold
   2. Grinding too long creates particles that are too fine and hammered flat.
   3. Fine gold is harder to concentrate.
      1. Very fine (<100 mesh) and flattened particles can be mobilized by turbulence much more easily, which makes them much harder to concentrate with sluices, jigs, and tables.
   4. Continuous mills take in crushed ore and discharge milled ore constantly during operation.
   5. Continuous mills mill must be the long enough that the ore is milled to the correct size by the time it has moved through the mill (longer for harder ore).
   6. Insufficient liberation can result from:
      1. Poor mill feed size control; pieces of ore larger thank 2cm
      2. Insufficiently long mills(in the case of continuous mills) or grinding too little time (in the case of batch mills).
      3. Worn out grinding media (balls) or lining
      4. Incorrect mill speed.
   7. The speed of the mill is must be 70% of the critical speed, which can be calculated using the diameter of the mill, and is the speed at which the grinding medium no longer cascades inside the mill.
   8. Fine gold is liberated with a secondary milling circuit once the coarse gold has been removed.
3. Analysis
   1. Monitor efficiency by comparing head grades to tailings grades.
      1. Use a professional laboratory to analyze samples on a regular basis.
   2. A distribution, or histogram, of sieve fractions should be bell shaped and smooth, meaning that few particles are too fine or too coarse.
   3. Sieving milled slurry or tailings into fractions can show you if you are grinding to the correct size.
   4. The liberation test uses regular periodic milling and concentration to determine the optimal grain size.
4. Concentration
   1. The concentration ratio is the original ore mass divided by the mass of concentrate produced.
   2. All concentration methods lose some gold. The higher the concentration ratio, the greater the losses will be.
   3. Using a chain of concentration tools enables capture of gold lost in earlier steps and upgrade the concentrate enough for direct smelting.
   4. Concentrates of sulfides or fine gold can be sold based on analysis of the gold content.
   5. Concentration equipment:
      1. Sluices concentrate most gold in the first metre, before the flow velocity and turbulence are too high.
      2. Z or L sluices are more efficient because they reduce flow speed, thus increasing the efficiency of concentration after the bend.
      3. Sluices must have a slope of about 10%; or a few degrees steeper for coarser gold.
      4. Special gold concentrating sluice carpets greatly increase efficiency.
      5. Jigs and sluices have higher capacity and are better primary concentration tools.
      6. Tables have a lower capacity and are better for secondary concentration.
      7. Floatation is the best way to concentrate the finest gold and sulfides.
      8. Floatation traps fine gold and sulfide in oily bubbles that are skimmed off to form the concentrate.
      9. Centrifuges primarily use centrifugal force, so they can capture the finer gold that turbulent forces mobilize into the tailings when using sluices, jigs, and tables.
5. Economics
   1. Improved gold recovery and reduced operating costs can quickly pay for processing plant upgrades within 1-3 years.
   2. Cleaner processing is more profitable, but requires planning, technical training/consulting, and investment.

Lesson notes:

The histograms which show the Bolivia tails v. optimal case… the gold in the analysis was determined by shaker table and centrifuge of two fractions; above and below 100(?) mesh. The actual gold content within each individual size fraction of the histogram is estimated.