A higher level of mine-to-mill optimization

SRK Consulting's Adrian Dance says there is a place for preconcentration testing for heterogenous ore deposits

By Ailbhe Goodbody

Courtesy of SRK Consulting (Canada)

With over 30 years in his field, Adrian Dance has established himself as an authority on comminution circuit operation. He has both industrial and consulting experience, working at operations in Australia, Canada and Peru.

He practices a proven methodology called "mine-to-mill optimization" that looks at improving the quality of the feed in the mine so that the process plant can perform at higher levels and save costs. The main focus of that mine-to-mill work has been on examining how to make fragmentation better so that the process plant can do 20 to 30 per cent more throughput.

The next challenge is to improve the feed quality even more, in terms of its composition, value and grade. In Dance's opinion, mineral processing operations should look at the material on a size-by-size basis at every stage and ask if it is really worth processing. Rejecting the lower grade, poorer quality material before sending it to the processing plant can enhance the viability or operating performance of a project as well as save costs and reduce environmental impacts.

Dance is part of a team at SRK Consulting (Canada) that has developed sensor testing procedures and has acquired a laboratory-scale batch X-ray transmission (XRT) sensing unit to carry them out. These tests can be used in conjunction with crushing and screening to assess the potential for preconcentration, which can then be applied to scoping or prefeasibility studies.

CIM: Why is preconcentration important for heterogenous ore deposits?

Dance: It is evident to everybody in the mining industry that ore bodies are becoming increasingly lower in grade. What we're not doing, as an industry, is investigating whether or not deposits have greater or less heterogeneity, which is a characteristic that actually can be exploited. I like the term "grade engineering" that came out of the CRC (Cooperative Research Centre) ORE research project some years ago in Australia. The idea is that, essentially, we don't have to live by the grade that we find in our deposits, but we can engineer the grades to be more suitable by being more selective in what ends up going into our plants and tailings ponds.

SRK Consulting has seen the need for an industry standard testing and evaluation procedure for preconcentration amenability—to see if the material is amenable to preconcentration when it is coarse, dry and conveyable.

The reason for standardization is that if everybody follows it, they can compare and benchmark to see how their results are related to operations that have been successful at applying preconcentration. Particularly when it comes to novel technology, the first question typically asked by clients, operations or owners of properties is, "Where has it been successfully done before? We want a conventional proven solution."

Our industry responds very well to benchmarking against similar properties worldwide. If you can say, for example, "Your copper porphyry operation is very similar to another copper porphyry operation, which has gone ahead and successfully done particle sorting or screening," then it can be replicated. There is a level of achievement and competence that people need to move ahead in this risky environment that we call the mining industry.

But to be able to find this industry standard, we needed to find a laboratory protocol that could be easily inserted into the existing metallurgical testwork program.

CIM: How did the partnership between SRK Consulting and Base Metallurgical Laboratories develop?

Dance: We found a company willing to sell us a laboratory unit that works in batch. I reached out for a joint venture partner and ended up speaking to Base Metallurgical Laboratories about it. I have had a long-standing relationship with the senior people there, having worked with them over many years in their previous positions, and now as owners of their own independent laboratory.

The XRT lab unit is a joint ownership between the two companies, and it resides at Base Metallurgical Laboratories' facility in Kamloops, B.C., where it is operated by its qualified technicians.

The unit was purchased in March, it arrived in Kamloops in late August and was operating by late September. The first

commercially paid particles went through the machine in the first week of October.

The unit is the first of its kind—a laboratory-scale batch XRT sensing unit. It was designed to run a test that can be done on the same size and style of samples we use for metallurgical testing, namely, half core samples. The test protocol itself is an assessment test; it is not meant to reproduce what existing sorting manufacturers do in using their equipment or their techniques. Instead, it is a characterization test designed to assess whether it looks very likely or not likely that material can be separated early on, in the stage before it is ground and before water and power is applied.

The unit works on batches—you put in a tray of rocks, it scans the individual rocks and gives you a response on each one. For testing purposes, to keep the cost down, we group the rocks into categories and then assay the groups.

CIM: How does this approach compare to typical ore characterization testing?

Dance: At the moment, to my knowledge, the only ore characterization testing out there for preconcentration is what we call performance tests, which are done by equipment manufacturers. They request a large sample mass in order to run their almost full-scale units for a reasonable period of time; the material size is what they consider to be suitable. All of that is done on their terms to allow them to demonstrate how their expertise can be applied by a combination of sensors, and how their technology differs from other companies' technologies.

That is not suitable for companies with limited sample masses that really only need to understand whether their ore body has potential. They are not interested in finding out if a manufacturer's piece of equipment works well, they're more interested in finding out when and how often their material will respond to such technology.

Our characterization test is more focused on the projects and the owners of the project, and follows a standard metallurgical approach—taking small sample masses, doing repeat standard tests and then scaling up from there. In my opinion, the current characterization work provided by manufacturers is really a pilot plant scale, which needs to be done, but after early-stage preliminary amenability type tests have been done.

CIM: How will the XRT sensor testing fit into SRK Consulting's preconcentration services?

Dance: SRK Consulting focuses on being an independent, reliable expert in different fields. To continue with that independence, we are including this in the routine services that we provide. We have no skin in the game, as we don't want to sell equipment; we want the best for the project, and if that best means preconcentration, we should include it in our list of opportunities.

As a service, we include testing as a second stage. In our methodology, the first stage is an initial heterogeneity analysis toolkit—many companies like to get a relatively inexpensive consulting opinion on the potential of their ore deposits, with some economics. My colleague Bob McCarthy, a principal mining engineer in Vancouver, looks at the deposit heterogeneity and the potential for ore and waste, depending on the scale of the operation. He runs some preliminary economics, which he calls "size the prize," to recommend where the project could benefit from preconcentration—perhaps pulling up marginal grade material into the mine plan or rejecting waste, depending on the operation.

Courtesy of SRK Consulting (Canada)

The XRT sensor lab unit, which is jointly owned by SRK Consulting and Base Metallurgical Laboratories.

Then we proceed to laboratory-scale testing, to see if the material is amenable to preconcentration. It is normally done only after an assessment of the deposit and to identify the samples that should be tested to show that diluted waste can be rejected or that lost ore can be recovered from the mine. This recursive test sorts out the grain from the chaff and says, "Your project is not going to work, even measuring it in our way. Don't send it to the manufacturer."

We do the preliminary testing on a number of samples, and that's the main focus—by doing this at a small mass size, we want to test as many samples as possible to get the statistics in our favour. Because it seems likely that preconcentration variability will be significantly higher than what we've seen in other types of testing, it makes sense to test small-scale samples many different times. At the size we're testing, which is 15 to 30 millimetres, we expect a fair bit of noise in the results. It's not going to be a consistent response because of the sample mass, so we need to test more samples. If 10 or 20 samples gave us the same result, that gives us the confidence [in the results].

Previously, to support that, we had no choice but to send samples to the manufacturers to have them sensor test it. We see the XRT sensor unit as a step forward in cost, speed and independence by being able to provide that service ourselves. Certainly in terms of time, it is remarkably quick, because we have heard stories that manufacturers are so inundated with requests that they are three or four months backed up for testing.

CIM: What are the latest developments of the XRT sensor unit?

Dance: We have had remarkably good results recently on some gold samples. We're about to test out some tungsten samples as well as some base metal samples, including lead-zinc.

As part of our initiatives to make the testing cheaper and faster, we have been applying a combination of hardness and XRT sensor sorting. We are using SimSAGe's HIT [hardness index test] to measure the relative hardness of the different sorted groups, investigating the idea that a concentrated sample mass using preconcentration may potentially be softer or require lower amounts of specific energy (or kilowatt hours per tonne). We are combining more of the comminution testing with the sensor testing, using the unit to understand how hardness changes as the sorted product changes.

Another aspect, which we think is unique for this test, is that by combining the comminution and sorting testing in one, we can estimate the amount of material that would be too fine for particle sorting, and also how it may or may not upgrade. This is something that is missing in the industry, because at the moment the only material that is getting tested is the material large enough for sorting, and there is little characterization done on the material that is too fine to bypass, which is quite important when you have softer friable materials such as oxide deposits going to heap leaching.

Another excellent application of this machine is to assess semi-autogenous grinding (SAG) mill or autogenous grinding (AG) mill pebbles, because that is a perfect stream to reject material of no value or limited grade and increase plant capacity. I have a particular concern about AG/SAG mill pebbles—we send material into the mill, put seven to 10 kilowatt hours per tonne of energy into it, it comes out the other side, and then we send it back round and put it back in the mill again. Why are we doing this? It is an incredible opportunity to assess pebbles with our machine.

CIM: What are SRK Consulting's plans for the next phase of the unit's development?

Dance: Our plans include rolling the unit out as the final stage of our fully independent analysis method. Currently it is fitted with only XRT, but the plans are to expand upon that when we get more funding. The unit has the capability to add X-ray fluorescence (XRF) in the future.

We have had a lot of response from clients and operations saying they really like the idea of a completely independent evaluation that follows a standardized industry test protocol that could be done at very early stages of the project to assess whether or not preconcentration has some economic potential.

I am not suggesting in any way that every operation would benefit from preconcentration. In fact, it is likely that a minority of cases will really benefit. But I think it is the industry's obligation to consider heterogeneity in their deposits and consider exploiting them through preconcentration to reduce their carbon footprint, their energy and water consumption and their tailings storage requirements. CIM