

RICHARD F. DOWN, P.Eng.
CONSULTING SERVICES IN MINERAL PROCESSING

Vangorda Metallurgy

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Richard F. Down
& Associates Inc.
120 Sweeney Drive
Toronto, Ont. M4A 1V5

TELEPHONE 416-737-1727

November 12, 1990

Dr. Godfrey McDonald
Vice-President, Metallurgy
Curragh Resources Inc.
Suite 1900
Box 12
95 Wellington St. West
Toronto
Ontario
M5J 2N7

Re: Vangorda Refractory Caprock Ore.

Dear Dr. McDonald.

I visited Faro November 5 to 10, 1990, to study the problem of milling Vangorda refractory caprock ore. This letter contains my comments. Testwork is still ongoing and hence any conclusions at this time are necessarily tentative. Nevertheless, at this time we do know the cause of the problem and one way of dealing with it. My comments are summarized as follows.

1. The sands fraction of the Vangorda refractory caprock ore contains soluble copper which activates the zinc in the ore and causes flotation of a bulk lead-zinc concentrate. *AGREED*
2. The sands contaminate any other ore with which they may be mixed because the soluble copper also activates the zinc in that other ore. As little as 1% sands may be sufficient to cause contamination. *TRUE*
3. The sands can be removed by screening. *TRUE*
4. The plus screen fraction can be mixed with Faro ore for milling. *TRUE CORRECT*
5. The minus screen fraction is probably untreatable except to produce a bulk lead-zinc concentrate. The marketing of such a concentrate should be investigated. *UNSURE IF TOTALLY NECESSARY @ THIS TIME*
6. Effective screening in wintertime is doubtful. *AGREED NEVERTHELESS WE'LL PROCEED.*
7. The mill can probably treat competent caprock from Vangorda this winter; but more samples should be tested to confirm this. *AGREED*
8. Zinc sulphate improves lead-zinc selectivity when treating Vangorda refractory ore. *AGREED*

9. When milling Vangorda refractory ore (plus screen fraction or competent rock) mixed with Faro ore, the zinc assay of the lead concentrate will be higher than normal.

Agreed

10. The copper assay of the lead concentrate will also be high.

Agreed

The rest of this letter discusses some of these comments in more detail.

Categories of Vangorda Refractory Ore.

The Vangorda refractory caprock ore may be divided into two, or possibly three, categories. The first category is the sands. This material contains a range of sizes from claylike fines, through sands to gravel. The minerals have been oxidized. One sample of baritic sands, DT 14, assayed 1.89% Ox Pb, 0.12% Ox Zn and 2.34% Ox Cu.

*1 - SANDS
2 - COMPETENT
CAPROCK*

The sands contain soluble lead, zinc, iron and copper. It is the soluble copper which has activated the sphalerite and which will activate any other sphalerite with which it comes in contact. This is the worst feature of this material - it contaminates other good ore with which it is mixed. A calculation, assuming that the above 2.34% Ox Cu is soluble, and knowing that 800 g/t of copper sulphate is used in Faro zinc flotation, indicates that as little as 1% of baritic sands may contaminate good ore.

The second category is competent caprock. Oxidation has occurred and the sphalerite has been activated, to some extent at least. However, this material does not seem to contain soluble copper and does not seem to contaminate other ore. It appears that this material can be mixed with Faro ore for milling, with appropriate adjustments to the reagent recipe. Testwork is still being done to confirm this conclusion.

A third possible category is vuggy ore, which is porous and oxidized. This material is probably intermediate between the other two in flotation characteristics.

In practical terms, only two categories appear to need to be recognized, sands or coarse rock. These categories can be easily identified visually in the open pit. Should there be any doubt about the visual identification, oxide copper assays can be used. Material containing less than 0.1% Ox Cu is acceptable ore. Material containing more than 0.4% Ox Cu is contaminated. Further testwork is required to identify material in the range of 0.1% to 0.4% Ox Cu.

Screening.

Screening is the obvious method of separating contaminated sands from acceptable coarse rock. While I believe that screening can be successfully done in the summertime, I am doubtful that sufficiently effective screening will be possible in the wintertime. A test run the night of November 9, screening some 10 to 20 tons of material over the screening plant near the Faro mine stockpiles, looked to be successful. This material came from the stockpile at Faro.

By my observation, the stockpile at Vangorda contains a greater proportion of sands. It also has frozen lumps which would be difficult to screen in winter. I suggest that a screening test should be run on Vangorda stockpile material (but not the coarse rock from the toe of the stockpile) before any decision is made to screen during the winter.

Flotation.

Flotation tests on the plus screen fraction from laboratory screening were run on the last day of my visit. Full assay results are not yet available, and further tests need to be run, but from my observations I believe that it should be possible to mix a proportion of the plus screen fraction of Vangorda refractory ore with Faro ore.

Zinc sulphate, in addition to sodium cyanide, appeared to improve lead-zinc selectivity when treating the plus screen fraction of Vangorda refractory ore - as it had done in some earlier tests. If it is cheaper to do so, it may well prove possible to use a sodium cyanide - zinc oxide mix instead of zinc sulphate. I recommend that you have a test quantity of zinc sulphate on hand when you do your first mill test with Vangorda ore.

When milling Vangorda refractory ore with Faro ore, difficulties with lead-zinc selectivity can be anticipated. The lead concentrate will assay higher in zinc than normal.

Because of the copper content of the Vangorda ore, the lead concentrate will also assay high in copper.

Further Work.

At Faro, the first priority should be testwork to confirm that the plus screen fraction and competent caprock can be mixed with Faro ore for milling.

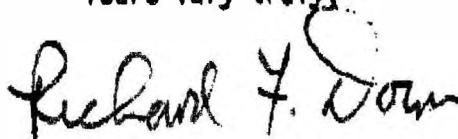
Further testwork on the minus screen fraction (or on total caprock containing the minus screen fraction) can be carried out at Faro, as a second priority, and at Lakefield Research to try to find a way of treating this material. However, I doubt that production of selective lead and zinc concentrates will be possible.

In my opinion, for the time being production planning at the Vangorda open pit should be based on the assumption that screening of the sands from the coarse rock will be necessary.

The possibility of marketing a bulk lead-zinc concentrate should be investigated. When screening of the caprock has been finished, it would be possible to treat the minus screen fraction through the mill by itself in a single campaign to produce such a concentrate.

I would be pleased to discuss the contents of this letter with you at any time. Thank you for this assignment. It was a pleasure to visit Faro again. Please convey my thanks to your staff, especially Eric Beaumont and Gordon Wilson, for their help during my visit.

Yours very truly,

A handwritten signature in cursive script that reads "Richard F. Down". The signature is written in dark ink and is positioned above the typed name.

Richard F. Down.