24-063

New Life for the Veragold Mine—Low Risk Tailings Storage

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ABSTRACT

The Mina Santa Rosa mine in Panama was the victim of a mine closure 24 years ago that left the community in dire straits. The mine showed the potential resources of greater than 1M ounces of gold and 4.5M ounces of silver. Veragold Mining Company decided to reopen the mine and address all the issues that were involved in the startup of an historic mine. This paper provides methods to restore the community trust, provide a transparent process, and develop an environmentally sound flowsheet. Immense scrutiny surrounded the Tailings Storage Facility, and the company developed a plan focused on paste thickening and surface stacking to eliminate the need for a conventional tailings' facility. Paste thickener principles and benefits are also provided.

INTRODUCTION

In early 2000, the town of Cañazas in the Veraguas Province of Panama lived an experience not uncommon to mining communities whenever depressed markets or technical failures result in the premature closure of a mine and the departure of a foreign company. In the aftermath of unkept promises, unmet payrolls, limited economic opportunities, and environmental legacies of an abandoned mine at their doorstep, the prospect of reopening the mine understandably agitated old wounds and rekindled community divisions. After riots ensued, fires were set, and mine infrastructure was destroyed, and with memories of past cyanide spills still lingering, fears of history repeating itself understandably resurfaced. When the new owners acquired the property a decade later, the community was naturally suspicious. Public statements by the Mayor of Cañazas in 2012 acknowledged that although some sectors of the district supported mining development, local authorities were not universally supportive of resuming mining activity in the area. It is against this backdrop that Veragold Mining Company has worked over the last decade to reopen a brownfield project. Through ongoing dialogues with the community, the company has sought to understand the needs, desires, and fears of its stakeholders, and has allowed each interchange of ideas to reshape the Mina Santa Rosa project.

HISTORY

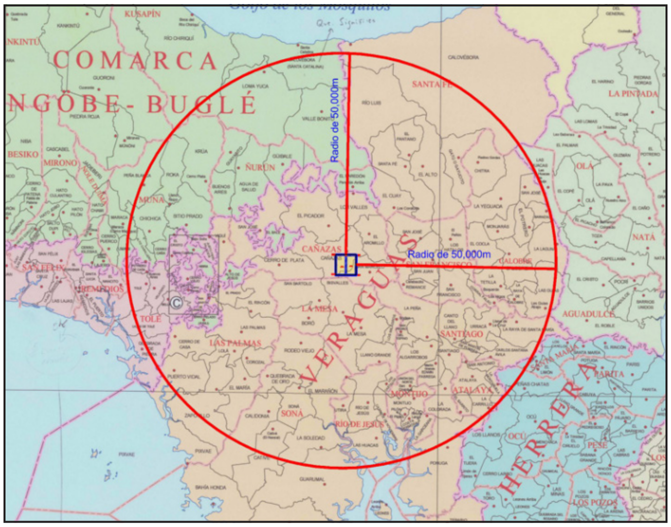
Located adjacent to the town of Canazas, Panama, 300 km from Panama City, resides the Minas Santa Rosa project that operated under the previous owner Greenstone Resources, Ltd. They operated an open pit-heap leach facility from mid-1996 through August 1999 and produced 100,007 oz of gold. Heavy rainfall in 1997 and 1998 caused operational problems and diluted the pregnant leach solution. The Minas Santa Rosa operation was put into care and maintenance by November 1999 and was closed by March 2000 when the average spot gold price fell below $290/oz.

Veragold has been working to reopen Minas Santa Rosa. Unfortunately, the previous owner left in the middle of the night without a word to the employees or the community. Final payrolls were left unpaid and much of the property and records were destroyed during community riots. The only physical drill core left from the previous operation was sliced into coasters found in some of the local taverns.

Almost a decade later, the property was acquired by land developers who were originally looking to provide more housing opportunities in the Interior of Panama. When they learned more about the history of the project and met with the community, they set up card tables at the site and paid the back wages and severances of former employees still living in the area.

Political and Community Committees were formed so Veragold Management could meet regularly with the representatives of the 8 districts surrounding the project. On November 7, 2013, the National Assembly of Panama approved Law N° 92, whereby the mining concession contract for the extraction of gold and other metallic minerals granted by the government of Panama to Veragold Corporation was elevated to a Contract Law. (Law No 92 was published in the Official Gazette No 27410). This allowed Veragold to control all minerals within a 50 km radius of the original concession. The work that Veragold had been doing to date with the local community was paying off. When the vote was held for the Contract Law, nearly 400 members from the local Canazas community showed up and picketed in favor of Veragold Mining.

Currently the project is fully permitted for mining and mineral processing. The Santa Rosa project surface rights and mining concession rights are adequate to support a future gold mining and processing operation at the project area. The selection of processes and operation have been selected.



SITE AND COMMUNITIES CONCERNS

The Mina Santa Rosa mineral inventory consists of the Alto de la Mina (ADLM), Mina Santa Rosa (SR), and Cerro Otero (CO) mineralized zones and the residual gold in the Leach Pad material. The low-grade stockpiles left by the previous operators have not been tested yet. The mineral resources for the three mineralized zones were developed with the In-Pit resources in the three pit areas showed a total of nearly 1M ounces of gold. Since silver is in a 4.5:1 ratio to the gold there are approximately 4.5M ounces of silver. The historic heap leach which still contains considerable gold. Upon drilling the heap leach it was determined that there was an additional 109,000 ounces of gold present that had already been mined and crushed and sitting on the surface awaiting processing.

Because of the close proximity of the mine to the town of Canazas, it is important that Veragold become part of the community and have their needs in mind. When meeting with the community leaders, the major community concerns were the risks associated with cyanide and tailings dams. Even though all permit approvals for a heap leach process were in hand, Veragold initiated a new design iteration to evaluate other alternatives that could possibly address these community fears. In 2013, Veragold tested 10 composite samples from the Leach Pad and drilled 5 PQ size holes to provide samples of the in-situ mineralization for metallurgical testing. Mineralogical work was undertaken on samples of sulfide mineralization by McClelland Laboratories. The main objective of this preliminary test work was to determine the best recovery for gold and silver using gravity concentration, sulfide flotation treatment or cyanide processing.

For both the leach pad and in-situ material flotation showed the best metallurgical results where gold recoveries, in general, were above 90 percent. The testing also validated that heap leaching was not the correct choice for the site. It was decided that flotation would be the major process to recover the gold and silver from both the pit ores and the heap leach material. This gave Veragold a solution that produced the best metallurgical results and one that eliminated most all cyanide consumption. This was beneficial to the community's needs.

Production of a tailing product that could be used in the generation of paste was a more difficult problem. Testing was implemented at both McClelland Labs in cooperation with Pocock Industrial. The flotation process was altered to utilize as coarser feed size in hopes of producing a viable paste without reducing the metallurgical results. After numerous "tweaks" to the process Veragold was finally able to achieve a product sufficient for paste thickening and surface stacking to eliminate the need for a conventional tailings' facility. Thus, we were now able to meet the community needs while not impacting the process parameters, a decision that was well received by the community.

Once feasibility was confirmed by testing of drill core and existing heap leach material, the ore processing flowsheet was revised to (a) use flotation that would eliminate any outdoor use of cyanide and (b) produce paste tailings instead of conventional liquefied tailings. These and other design changes have created new opportunities to generate longer-term benefits from all extracted materials, inclusive of waste rock, paste tailings, and future agricultural output produced sustainably from the regenerated landscape.

Veragold has continued building the bond between them and the neighboring communities with; a farmstead supporting a "Comador" kitchen, a regional computer center, Sewing Academy for vocational training, contributed land and other resources for a regional hospital, to name a few. This community focus has played a critical part in the success of the whole area. Through testing and research, Veragold selected safe mineral beneficiation process and low-risk surface stacking of the plant tailings. A key factor in the surface staking success was the selection of a trusted thickener supplier. ClearStream paste thickener design has been optimized over the past 20 years and the operational training and support contribute greatly to the success of the tailings system.

TAILING STORAGE—SURFACE STACKED

In the 1960's the British National Coal Board (BNC) developed what we recognize today as the first paste thickeners. These units were used to make coal refuse thick enough to be placed on and transported by a conveyor belt. This "new" technology had mixed success but did introduce paste thickening to the world. By the 1970's, Alcan applied and improved upon the BNC paste thickening technology to increase the efficiency of alumina red mud washing in counter current decantation (CCD) circuits.

Building on those early applications, today the use of paste thickening has expanded to many other mining sectors. These include Gold, Nickel, Lead, Zinc, Copper, Iron, Phosphates, Kimberlites, Mineral Sands and others. The use and service of paste thickening has also broadened to include; Tailings disposal/stacking, CCD washing, Underground backfill, Leach feed, Kiln feed, Sub-aqueous deposition and Tailing re-work.

By the late 1990's and early 2000's the installation base and experience of paste thickening had grown. There was wide consensus within the minerals industry that "paste" was simply part of a continuum of concentration and rheological properties. Descriptives terms of this continuum were "slurry," "thickened tailings," "paste," and "cake." Each of these generally described a range of the rheological property of yield stress, or more precisely the ability of a suspension to resist a stress to a point of yielding. One end of the spectrum is a slurry with little or no appreciable resistance to a shear stress, to a "cake" that has significant resistance to a shear stress and even exhibits the beginning of compressive strength. The range of practical yield stress rheology for "thickened tailings" to "paste" is roughly 50 Pa to 300 Pa. Low rheology values are indicative of suspensions that can segregation (particle size classification by sedimentation) and flow with relative ease, while increasing yield stress produces very little segregation and significant flow resistance making these materials more suitable for direct deposition and surface stacking.

The maturity of paste technology and its benefits is demonstrated quite clearly by an important paste thickening project in Brazil. Paragominas bauxite mine (1) is located in the state of Pará, in Northern Brazil. The mine started production in 2006 with a production capacity of approximately 16 Mtpy of run-of-mine, producing about 11.5 Mtpy of bauxite and generating approximately 4.5 Mtpy of tailings. A tailing system was designed that incorporated a paste thickener to improve the rheological properties and concentration of the tailings and enable consistent surface disposal stability. Mill tailings were delivered at 4%wt to 6%wt solids and the paste thickener increased concentration from 33% to 35% solids while developing yield stress rheology. Tailings were deposited in 50cm lifts to facilitate desiccation and improve consolidation.

The site practice included the use of a paste- type thickener that was fed with the concentrator tailings at 4 to 6 wt% solids. The paste-thickener underflow, dewatering to 35 wt% which had Non-Newtonian properties. The underflow was pumped to the storage facility in the next valley where the drying cycle between depositions was 4 to 8 weeks. The dried stack contained 60 wt% solids when the next layer was applied. The 60 wt% stack had dried to be very stable with a moisture content where large cracks had developed.

The Paragominas study included drill core in a relatively uniform pattern with some hole extending to more than 30 meters. The cores revealed that the full depth consistently was 65.4 wt% (±2.4 wt%). The result was a tack with well consolidated material. Paragominas is an excellent example of the importance of paste thickening to produce stable non segregating depositions that can achieve high strength and reliable safety within the entire cross section of the deposit over 13 years of life.

CLEARSTREAM PASTE THICKENER

A paste thickener can be considered the heart of the success of the tailings storage. The consistent non-Newtonian underflow is essential.

The site benefit of stable low-risk tailings storage is dependent on the feed character, the design and operation of the paste-type thickener. The feed has some important character traits, like the particle size distribution that must be met to even consider a paste or thickened tailings. A Rule of thumb states that 20% of the weight must be smaller than 20 microns. The fines particles provide, particularly the sub-micron size, the 'bonding' between the particles that creates the structure that supports the coarse particles in a stable paste. This non-Newtonian suspension is characterized by a significant yield stress which is required to achieve the low-risk storage benefit discussed in this paper.

Success is based on design and operation, there is not one without the other. Even if the material meets all the requirements to form a stable non-Newtonian suspension, if the thickener design is lacking then the desired underflow will not be achieved regardless of the operating conditions. The opposite is true for operation of the thickener.

First, the thickener design, particularly the mechanism, is critical and can be a limiting factor. The thickener objectives of dewatering the feed slurry to the target underflow (wt% for the target yield stress), then discharge the paste/thickened tailings underflow are critical and depend on the design.

Second, the operation of the thickener can easily negate the careful design of the mechanism. The market is scattered with paste-type thickener installations that are under performing due to operation. Though a thickener operation sounds simple; adding flocculate to settle the solids for clear water overflow and discharge the underflow to collect the solids for downstream use, proper control at prescribed settings is needed. Sometimes the instincts of the operator must be changed, contrary to popular opinion, more flocculant is rarely the answer (2). ClearStream provides proven operating control and operating training insuring a productive start and operation of the paste thickener.

CONCLUSION

The Veragold mine has been an example of attention to detail, starting with repairing good relations with the surrounding communities. The metallurgical process selected lowered the risk to the environment and increased recovery. The selection of surface stacking for the tailing storage facility continued with the careful low-risk approach. Understanding that the paste thickener and the operation of the thickener is the heart of the tailings management and selected the ClearStream paste thickener.

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24-064

NIOSH Gas Well Stability Research: Investigation into the Causes of an Anomalous Shale Gas Well Casing Deformation at a Deep Longwall Mine

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ABSTRACT

Following the first longwall excavation at a deep-cover gas well site, the pre-mining modeling prediction of longwall-induced casing deformations in the fully cemented production casing were in excellent agreement with post-mining Caliper survey results. However, after second panel mining, the post-mining Caliper survey revealed a large plastic deformation near the top of the Pittsburgh Seam. The focus of this paper is to identify the possible cause of such an anomalous deformation. Very high longwall-induced casing stress near a thick claystone layer at 23 feet above the Pittsburgh seam horizon was identified as the primary cause. Leaving the production casing uncemented or using softer cementing material between intermediate and production casings is identified as the best practice.

INTRODUCTION

Since 2003, over 1,800 unconventional shale gas wells have been drilled through active and future Pittsburgh seam coal reserves in Pennsylvania, West Virginia, and Ohio. These unconventional gas wells, whether tapped into the Marcellus or Utica formations, contain very high gas pressure and volume. Strata deformations associated with underground longwall coal mining could induce stresses and deformations in the shale gas well casings, which in certain situations could compromise the mechanical integrity of the production, intermediate, and coal protection casings. Damaged well casings could potentially introduce high-pressure, high-volume explosive gas into underground mine workings to jeopardize underground miners' safety and health.

To provide critical scientific data to the stakeholders, which includes the Mine Safety and Health Administration (MSHA), the Pennsylvania Department of Environmental Protection (PADEP), the West Virginia Department of Mine Safety and Training (WVDOMS&T), the Ohio Department of Natural Resources (OHDNR), coal operators, and gas operators, the National Institute for Occupational Safety and Health (NIOSH) initiated a research program in 2016 to evaluate the effects of longwall-induced deformations on shale gas well casing stability under deep as well as shallow covers. The effects of longwall-induced subsurface deformations on shale gas well casing stability under deep cover, under medium cover, and under shallow cover were published previously (Su et al., 2018a and 2018b; Su et al., 2019a and 2019b; Su et al., 2020; Zhang et al., 2020; Su and Zhang, 2021; Su et al., 2021), which indicate that longwall-induced horizontal displacements under shallow cover are one order of magnitude higher than those under deep cover; and longwall-induced vertical stresses under deep cover are one order of magnitude higher than those under shallow cover. Shale