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Canada Centre for
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Centre canadien de la
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et de l'énergie

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January 26, 1999

File Number: 601903

Larry Connell
Manager - Environment
Royal Oak Mines Inc.
5501 Lakeview Drive
Kirkland, Washington,
WA 98033

Dear Mr. Connell,

Re: CANMET/Royal Oak Mines project, "Recovery and Purification of Arsenic Oxide at Giant Mine", being supported by DIAND.

Previously we have contacted Mr. Richard Allan regarding this project, however, we understand that he has left Royal Oak and John Dutrizac (CANMET project leader) suggested you would be the contact now.

Following recent discussions between CANMET and DIAND regarding the availability of extra funds that can be assigned to this ongoing project in the current fiscal year, please find attached an amendment to the existing agreement relating to the additional work requested by DIAND.

The amendment outlines the scope and costs for this additional work, which it is estimated will cost an additional Can\$25,300, thus bringing the total cost of the project to Can\$80,296. We understand that DIAND will be totally responsible for the cost of this additional work.

We are sending the attachment for your information, however, if you require additional details or wish to discuss this amendment further, please do not hesitate to contact John Dutrizac at (613) 995-4823.

Yours sincerely,


Robert T. Blake
Business Development Office
CANMET - Mining and Mineral Sciences Laboratories

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AMENDMENT TO PROJECT 601903

Expanded Scope for Project: Recovery and Purification of Arsenic Oxide - Giant Mine

Background

The on-going studies originally defined in project 601903 indicate a number of problems related to the solubility of Giant Mine arsenic-rich dusts in water or the selective volatilization of arsenic oxide from the dusts. It was felt that additional work in both areas would be required to establish definitively whether either method offers a viable option for up-grading the dusts produced in the roaster circuit.

Accordingly, additional work is proposed for the leaching of the dusts and the vaporization of the arsenic oxide. In the leaching area, it is proposed to examine saturation temperatures $>100^{\circ}\text{C}$ as well as the use of acidic media, followed by neutralization, for the leaching. The vaporization of As_2O_3 seems to be most selective at low temperatures, and accordingly, work is proposed wherein the arsenic oxide would be sublimed at low temperatures and with the use of a vacuum to achieve the required degree of mass transport. These studies will monitor mostly As and Sb, but will also include a few gold analyses to provide a more comprehensive picture of the deportment of this key element.

Scope of Work

1) Solubility Measurements

Low solubilities of As_2O_3 from the various dusts are noted, even at temperatures up to 100°C ; the low solubilities could be due to either very slow dissolution kinetics or low equilibrium solubilities caused by the presence of Sb in solid solution in the As_2O_3 . It is proposed, therefore, to examine the solubility of one of the dusts in water at 125°C , 150°C and 175°C using a 2-L autoclave for the solubility tests. The hot autoclave solution will be cooled under pressure to $95\text{-}100^{\circ}\text{C}$ and the autoclave then will be opened. The resulting slurry will be transferred to a vessel in an oil bath heated at $\sim 100^{\circ}\text{C}$, and the solution will be sampled using the procedure employed for the solubility measurements. The slurry will be cooled to room temperature and the solution again will be analysed to see if significant amounts of As_2O_3 are crystallized.

Efforts will also be made to achieve high As solubilities by using acid media. The intent is to solubilize the arsenic, and then precipitate As_2O_3 by cooling or neutralization. One dust will be used to test the viability of this approach which will include three acid concentrations, three temperatures between 50 and 100°C and two pulp densities designed to yield 100 and 200 g/L As in solution. For these experiments, HCl, H_2SO_4 and HNO_3 will be compared and the kinetics

of As dissolution will be assessed by analysing the amount of As dissolved as a function of time in these experiments. The experiments will be monitored by analysing the solutions for As, Sb and Fe.

2) Dust Vaporization

The initial results on the vaporisation of As_2O_3 from the dusts suggest that the greatest As selectivity over Sb occurs at low temperatures. Unfortunately, the total vapour pressure also decreases rapidly with decreasing temperature, such that the total mass transport of As is reduced. Therefore, the use of low temperatures and vacuum distillation hold some promise. To pursue these concepts, conventional vaporization and sublimation in air will be done using one dust at 250, 300 and 350°C. For each experiment, the sublimate will be collected over four sequential periods to provide an indication of any initial As over Sb selectivity during the vaporization period.

The same dust will also be subjected to vacuum distillation at 150 and 200°C to see if a high purity As_2O_3 product can be produced along with an acceptable mass transport of the oxide. Some of these experiments will explore the possibility of passing the vapours through a column of As metal chips or Fe_2O_3 to try to strip the Sb from the gas phase.

To complement the vaporization studies and to provide a fundamental rationale for the vaporization results, a preliminary mass spectrographic study of the vapours will be carried out to see if the vapours consist of mixtures As_4O_6 and Sb_4O_6 or whether mixed $(\text{As}_{4-x}\text{Sb}_x)\text{O}_6$ molecules are involved. The latter circumstance would mitigate against the separation of As and Sb by selective vaporization.

Schedule

It is estimated that this additional work will be completed within eight (8) weeks of the signing the contract for the expanded studies.

Deliverables

These additional studies will be summarized in a written report which will be issued within two (2) weeks of completion of the work.

Estimated Costs**Summary of Estimated Costs to Implement Additional Scope of Work**

1. Autoclave water solubilities and Acid solubility measurements	\$ 9,000
2. Dust vaporization	\$ 5,000
3. Laboratory analyses - internal and external	\$ 4,000
4. Coordination and report preparation	\$ 4,000
Subtotal	\$22,000
5. Contingencies at 15%	\$ 3,300
Total Estimated Cost	\$25,300

Terms & Conditions

The same terms and conditions will apply to the expanded work described in this amendment to project 601903.

**Schedule & Basis for
Payments**

The additional work covered by the amendment will be completed before March 31, 1999 for up to an estimated cost of \$25,300. Suitable Invoices will be submitted to DIAND by CANMET after the work has been completed.