Reply to Lydian and GRE Statements Critical of Blue Minerals Consultancy ARD Assessment

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This brief reply addresses the main points of rebuttal of our geochemical assessment made by Mr Larry Breckenridge (GRE Consultants; contracted to Lydian for AMD assessment and management planning) as detailed in:

- https://www.lydianarmenia.am/en/news/view/larry-breckenridge-on-ard.html Acid rock drainage at Amulsar will be controlled and will not negatively impact water quality
- https://www.lydianarmenia.am/en/news/view/international-expert-gave-comprehensive-clarifications.html International Expert Gave Comprehensive Clarifications to Questions of Public Concern on the Amulsar Project

We agree with Mr Breckenridge that mining continues to be essential to economic, manufacturing, wealth and social progress in all countries. BMC have run and are continuing to run projects on improvements to mining and minerals processing as well as mine waste management and AMD control. ***There is no Blue Minerals Consultancy (BMC) agenda to oppose mining in Armenia as suggested by Mr Breckenridge.***

We agree with Mr Breckenridge that acid rock drainage (ARD) can be controlled at many (but not all) sites with proper assessment, planning and full implementation of control measures ***following best practice in the GARD Guide from the International Network for Acid Prevention[2]***. The reality is that this is often not done in new mine approval and start-up in order to meet financial requirements for income to the company (to service debt) and government revenue in royalty flow.

In context, a recent survey of 25 mine sites sampled in the USA that did develop acid drainage, 89% predicted that they would not; 76% polluted groundwater or surface water severely enough to exceed water quality standards.[3] At these sites, the resulting water release in all forms did not meet the planned and EPA-approved quality standards after start-up due to compromised planning and execution in production.

This is the likely outcome for the Lydian Amulsar site planning because the assessment of AMD in the mine has been inadequate and has not followed the GARD Guide or international best practice as claimed.

Specifically, the inadequacies in the GRE and Lydian assessment and planning are: using too few samples relative to the volume of rock mined; not using samples that represent the full range of acid-generating or contaminant leaching behaviours; prematurely ending kinetic tests before they reached steady-state, maximum contaminant concentrations or steady-state pH values; using inappropriate short-term leach tests; and not testing mitigation measures claimed to prevent or mitigate the formation and transport of acid mine waters.

International Best Practice

There are many instances in which the GRE and Lydian assessment and management of ARD have not followed accepted international best practice. We illustrate this with a few examples only. The following quotes from the GARD Guide are compared to Lydian's practice.

"Since some tests, such as leach tests or oxidation rate measurements, require a long time frame to provide the necessary data, it is important to initiate this work well ahead of key project milestones." [4.3.2 Source Material Geochemical Characterization]

This was not done. The mine is proceeding to operation without this essential rate data.

"Geochemical characterization programs typically follow a phased approach, beginning with laboratory testing followed by field testing. The design of most testing programs is dynamic, with each successive phase building on the results of previous phase or phases. A brief summary of the testing approach is provided below, with significantly more detail presented in Chapter 5. Statistical analysis of test results is advisable to confirm that a representative data set has been obtained. For example, histograms may be used to ensure that the entire distribution has been captured in sample selection (Runnells et al., 1997) and samples with "extreme" characteristics have not been overlooked. The number of samples will increase as the heterogeneity (e.g., particle size and composition) of a material type increases. [4.3.2.3 Testing Program Overview]

Pre-Feasibility	Static testing of **several hundred representative samples of high and low grade ore, waste rock and tailings**, the number dependent on the complexity of the deposit geology and its host rocks. [BMC highlights]	Where required, **the number of samples must be sufficient to populate a "resource" block model of the ore and host rocks that will be affected by mining with a reliable distribution of NAPP[1] data (e.g., acid producing potential (APP), sulphur and acid neutralizing capacity (ANC) (or NPR data) on ore, waste rock and wall rock.** [BMC highlights]

[Extracted from Table 4-5]

Although drilling and sampling will focus on ore zones in the exploration and pre-feasibility stages, samples of host and country rock should be increasingly represented as the project develops, so that adequate data are available to produce block models and production schedules by geochemical waste types, where required. [4.3.2.1 Sample Selection]

The laboratory phase of a geochemical characterization program will typically include the following analyses:

Static Tests
- chemical composition (whole rock and elemental analysis)
- mineralogical analysis
- acid base accounting (ABA)
- net acid generation (NAG)
- water extraction (batch extraction) tests − with solution assay

Kinetic Tests
- humidity cell leach testing
- column leach testing" [4.3.2.3 Testing Program Overview]

No resource block model of the ore and host rocks correlated to ARD testing has been produced to plan mining and disposal for ARD management. The size of the deposit and the complexity of the interzonal regions between Upper Volcanics and Lower Volcanics would require at least 400 samples for this purpose; approximately 200 were collected.

The geochemical testing was not conducted on representative samples, and too few samples were subjected to testing. Only eleven Lower Volcanic rock samples (not correlated to ABA and sulfide S) and seven Upper Volcanic samples were analyzed for mineralogy. Only eight long-term kinetic tests (inappropriate humidity cell tests) were conducted. No kinetic leach columns were run in the assessment. Lydian proposes to start kinetic leach drums well after the pre-feasibility stage at which it should have been started. Results from this testing will be too late to alter the main elements of the ARD management plan.

No exploration or assessment of surrounding country rock has been made despite the need for neutralising minerals to control the barren rock storage facility (BRSF) ARD.

Testing during mining is essential to identify ARD material in disposal; this cannot be done adequately by visual identification of rock type as suggested by Lydian. It is not possible in mining the Amulsar deposit to fully separate barren rock from the "oxide ore" as suggested by both Mr Breckenridge and the Lydian chairman. There will be some sulfides intermixed at the wide boundaries between these categories so that all of the ore will not be "oxide" due to the formation and structure of the deposit described in their own documentation.

Assessment of the net acid generation rate (not just ABA accounting) is required since this will determine requirements for initial and on-going treatment. This rate of release of ARD is not measured or discussed.

No neutralisation of the sulfide reaction in the BRSF is proposed. The cover design for the BRSF also does not follow INAP best practice in the Cover Design manual[4]. No neutralising mineral addition to the cover is proposed. The Cover Design manual makes clear that is not possible to eliminate water coming in contact with the sulfides in the BRSF or the mined pits as suggested by Mr Breckenridge.

The Potential Impact of Failure to Control Acid Mine Drainage (from BMC reports)

There are potential impacts predicted *in their own Lydian modelling* based on current inadequate assessment and planning. Changes in groundwater levels (e.g. up to 60 m lower), redirection and reduction in springs and streams within and around the mine site are predicted in their modelling. Significant impact to water quality at springs located around the pits is also predicted with respect to beryllium, cobalt, nickel and nitrate as a result of leakage from the pits. There is a significant impact predicted to groundwater quality adjacent to the Vorotan River as a result of leakage from the pits.

There is serious conflict in their assessment of likely impact on Jermuk's water supply suggesting that groundwater found beneath the footprint of the project does not supply Jermuk's renowned mineral spring waters but also that "Jermuk's water is sourced from four groups of springs, one of which, the Madikenc group, is within the Project area." These conflicting statements and conclusions in the same Geoteam Summary report are not found in the full reports on groundwater and surface water. They are important results with major implications for the Jermuk Spring. The isotope testing evidence should be available for review. A previous study has indicated that "deep mineral and underground waters are still connected"[5]. The potential impact of compromised quality of the Jermuk waters is both economic in loss of local income and potentially toxicity risks to biota and human health. This requires initial (before mining) and regular monitoring during operation and after closure which is not proposed by the Company or the Government.

"There is a potentially significant predicted impact to groundwater input to the Spandaryan-Kechut Tunnel. However, groundwater inflow is not intended to be the main source of water in the tunnel that provides supply to the Kechut Reservoir, so this reduction in quality should not be considered as a material impact to water resources in the area. Therefore, **no additional mitigation is presented to limit or avoid this impact.**" [Section 6.9.7 Mitigation Measures, ESIA, 2016, BMC highlights]

The more general impact of improperly-controlled ARD on streams, agriculture, fish, other biota and, in some cases, human health is well known.

References

1 http://www.bluemineralsconsultancy.com.au/contact.php
2 http://www.gardguide.com/images/5/5f/TheGlobalAcidRockDrainageGuide.pdf
http://www.gardguide.com/index.php?title=Main_Page
3 A. Septoff, 2006. Predicting Water Quality at Hardrock Mines. www.ceaa.gc.ca/050/documents/42000/42000E.pdf
4 Global Cover System Design – Technical Guidance Document (November 2017);
http://www.inap.com.au/research/#globalCoverSystem
5 Geomorphology of Armenian SSR, 1986, pp. 134−145