

Preliminary Economic Assessment

Sylvinite Mining in the Danakhil Potash Deposit, Afar State/Ethiopia

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1 Executive Summary

Allana Potash Corporation (ALLANA) owns mineral concessions in the Danakil Depression, Afar State/Ethiopia (also known as Danakil Potash Deposit) where historical data show the local occurrence of potash salts.

ERCOSPLAN Ingenieurgesellschaft Geotechnik und Bergbau mbH (ERCOSPLAN) prepared a NI 43-101 compliant resource estimate for this property (ERCOSPLAN; 2011, /10/) and was requested to provide a Preliminary Economic Assessment study (PEA) to define best mining and processing options to exploit the deposit. The target of the PEA is the estimation of the capital expenditures (CAPEX) and the operational expenditures (OPEX) with an accuracy of $\pm 35\%$ and based on these figures, the assessment of the economical feasibility of the project. The scope of project has been restricted to Muriate of Potash (MOP) stand-alone production from the Sylvinite Member. Therefore, the PEA has to consider the following outline:

mining options, as

- solution mining of sylvinite;
- open pit mining of sylvinite in the shallow part of the deposit

for all these mining options the potential processing options to a standard MOP product were investigated

- MOP only from flotation of open pit mined material (Option 1)
- MOP only from solar evaporation and technical evaporation of a solution mined brine (Option 2)
- MOP only from solar evaporation of a solution mined brine and flotation of the crystal products (Option 3).

Further boundary conditions are:

The total production capacity for PEA purpose should be 1,000,000 t/a final product(s).

All product is a standard product only (no compaction).

The products will be shipped to the customers from a port in Djibouti.

The ALLANA exploration properties are located in the East of Northern Ethiopia in the northern part of the Danakil Depression (Afar State), near the Eritrean border and cover approximately 158 km².

The Danakil depression is a tectonic graben at 100 m below sea level, with the graben shoulders going up to 2000 m above sea level in the Ethiopian highlands. The ALLANA properties lay in the graben and consist of salt flats with some alluvial fan deposits on top in the western part.

In summer daytime temperatures in the Danakil Depression reach up to 50°C and even in winter the daytime temperatures are consistently in the high 30's and precipitation is rare. Because of the extreme conditions and the presence of salt at the surface there are no permanent settlements within the properties.

The geological history of the Danakil Depression is connected to rifting processes of the Afar-Region and therefore affected by volcanic activity and extensional tec-

Introduction

Location and Property Description

Geological Setting and Mineralization

tonic faulting. Opening of the graben structure started in the early Tertiary and is still ongoing. The onset of deposition of evaporite rocks within the graben is not well constrained but assumed to be late Tertiary or even early Quaternary. The potash occurs near the top of the older evaporite sequence, within the Houston Formation. The **Sylvinite Member**, consisting of rock salt with appreciable amounts of Sylvite in lenses and subordinate amounts of Anhydrite and clay in lenses, with an average KCl content in the order of 30% and a thickness varying between 1 m and 9 m, is the upper potash bearing part of the Houston Formation.

The potash mineralisation is classified in terms of Measured, Indicated and Inferred Resources as defined by NI 43-101 in CIM (2005, /9/). This reflects the level of confidence in the extent and grade of the identified potash mineralisation. The authors have interpreted the drill hole data for the Sylvinite Member in such way that these are considered secondary evaporite deposits that formed through infiltration of Potassium rich fluids in the lower part of the Marker Beds. This scenario implies that a stratigraphic correlation between drill holes for this Member is very well possible, but that due to differences in the hydrological regime during development local variations in grade and thickness are to be expected. Therefore it is the opinion of the authors that for the Sylvinite Member:

- Measured Resources occur in a radius of 250 m of an investigated drill hole.
- Indicated Resources occur in a radius of 750 m of an investigated drill hole, minus any measured resources in this area.
- Inferred Resources occur in a radius of 1500 m of an investigated drill hole, minus any measured and indicated resources in this area.

A fault structure cross cuts the property, separating a western part with the deposit at depths between 100 m and 300 m, from an eastern part with the deposit at depths in the range of 750 m. Confidence intervals were not constructed over this fault zone. Based on these considerations confidence polygons were constructed around each drill hole for the different resource categories.

For the Sylvinite Member following Resources have been identified:

	Measured Resources	Indicated Resources	Inferred Resources
10 ⁶ t of Mineralised Material	16.0	81.8	108.2
Average KCl Grade (%)	29.1	30.2	31.3

Because some important information for the project were not yet available following assumptions have been made:

- a reliable supply capable of delivery of 2000 m³/h of water can be found near the production site,
- the formation overlying the deposit is tight,
- dust setting in the solar ponds is superficial only and can be removed by the flotation process,
- NaCl and KCl crystallizing from the ponds do not form intergrowths or form coarse grained intergrowths that can be separated by minor crushing.

Mineral Resource Estimates

Basic Assumptions

Estimation of Capital and Opera- tional Expendi- tures

With these basic assumptions all three options are technically feasible and a preliminary design for the mining and processing operation for an annual production of 1 million tonnes of standard MOP has been made as basis for an economical evaluation of the three options. Based on the preliminary design the initial capital expenditures (iCAPEX), the sustaining capital expenditures (sCAPEX) and the operational expenditures (OPEX) have been estimated at a level of $\pm 35\%$. Basis for the cost estimate were West European prices from comparable projects in 2009/2010. For the estimate the project has been divided in three units

- Production site, with mining, processing and auxiliary facilities,
- Transportation of the product from the production site to the port in Djibouti,
- Port site, where the product is stored and loaded on ships for transport to the customers.

The last two units are comparable for all three options. It has been estimated that the transportation of 1 million tonnes of standard MOP per year by 50 tonnes trucks will have :

iCAPEX of 38.5 million US\$, (31.6 million direct costs, 1.9 million indirect costs and 5.0 million contingency),

sCAPEX after year 3 annually of 1.4 million US\$,

OPEX of 8.85 million US\$ (direct cost for transportation).

For the port facility with 50,000 tonnes storage capacity and 2000 t/h loading capacity it has been estimated that

iCAPEX are 92.8 million US\$ (63.5 million direct costs, 17.2 million indirect costs and 12.1 million contingency),

sCAPEX are after year 5 annually 0.5 million, increasing to 0.9 million after year 10,

OPEX are of 2.88 million US\$ (direct cost for port operation).

For the preferred mining and processing Option 3 the costs have been estimated at

iCAPEX of 664.4 million US\$, (437.6 million direct costs, 116.1 million indirect costs and 110.7 million contingency),

sCAPEX from year onwards of annually of 43.7 million US\$, increasing to 46.1 million after year 5 and 46.4 million after year 10,

OPEX of 70.24 million US\$ (direct cost for transportation), with additionally 5.7 million US\$ indirect expenditures and 2.87 million US\$ contingency.

For Option 3 a discounted cash flow model has been developed assuming

- 30 years project life,
- 4% royalties,
- 30% tax after 7 years tax holiday,
- potash price of 500 US\$/tonne free on board (FOB) Djibouti

The results are that the net present value (NPV) @ 12% discount rate is 1.85 billion US\$, and that the internal rate of return (IRR) is 36.8%.

Discounted Cash Flow Model

Conclusions and Recommendations

The economic evaluation of the three investigated options have shown that the best option for the development of the project in the boundary conditions from the introduction is solution mining of the Sylvinite Member and solar evaporation of the resulting brine, followed by flotation of the NaCl and KCl crop. This is similar to the technique used by Intrepid Potash in their Moab solution mining operation. It is recommended to start and continue the following studies, which ALLANA already initiated to confirm and verify these assumptions:

- Hydrogeological investigations to identify a potential water source,
- Dissolution test work on sample material from the deposit Pilot Solution Mining operation to verify the estimated brine composition and obtain information about the dissolution behaviour of the deposit material,
- Rock mechanical test work and modelling to optimize the present cavern and pillar configuration and eventually increase recovery,
- Pilot solution mining operation to verify the tightness of the Marker Beds overlying the deposit and to obtain experience with the in situ dissolution behaviour of the deposit,
- Large scale evaporation test with original brine to study (i) the behaviour of dust in the crystal product and (ii) crystal size and interaction between NaCl and KCl crystals,
- Flotation test work on material obtained from the ponds to optimize the flotation circuit.

In a further stage of the project the use of carnallite and kainite for the production of MOP and Sulphate of Potash (SOP) products should be further investigated. If it is possible to mine the mineralisation in these members with a comparable solution mining method as the Sylvinite Member, the economics of the project might get even better.

Furthermore it is recommended to prepare an updated resource report in the first quarter 2012, based on the drilling campaign over summer, fall and winter 2011.