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1. Abstract

Sedgman Novopro has finalized the FEED for the Dallol Potash Project for Ethiopotash B.V., planned to produce fertilizer grade Sulfate of Potash (SOP) located in the Danakil Depression of northeastern Ethiopia. This project shall be the first ever solution mining project based on a kainite deposit, with an extensive piloting program of cavern operation, evaporation pond operation and processing tests completed in the development of this project.

The local deposit geology shows a unique rock composition of the mining horizon called the Houston formation; mainly consisting of rock salt, sylvite, carnallite, bischofite, kieserite and kainite. The kainite member is the main target of mining as it provides the bulk of potash.

The project development went through prefeasibility study, feasibility study and front-end engineering stages (FEED) since 2010. The main project development phases including pilot cavern and pond operations and processing tests and in 2025 the latest FEED studies were carried out by Sedgman Novopro with the assistance of Ethiopotash, and Agapito Associates. The processing technology used is covered by the patent owned by Sedgman Novopro (No. US 10815130B2). Piloting included the construction and operation of 3 pilot caverns from 2014 to 2016. The cavern operation was accompanied by a simultaneous solar evaporation pond program with pilot salt production at Dallol, followed by process testing of these salts to form saleable sulfate of potash (SOP) product.

The commercial mine plans for a Phase 1 capacity with 300,000 mtpa (330,700 stpa) SOP production, operating about 20 caverns in parallel to feed the evaporation ponds. Phase 2 of the project which follows soon after startup of Phase 1 doubles the capacity to 600,000 mtpa (661,400 stpa) SOP production.

It is expected that the combined brine from multiple caverns at different stages of development will be at a relatively constant composition, feeding the solar evaporation ponds. Therefore, it is possible to design the ponds for precipitating the target mineral composition, which is sent to the adjacent processing plant by the steps of conversion of all potash bearing salts to schoenite and further conversion of schoenite to SOP product.

The evaporation ponds will be started up with $MgCl_2$ enriched brine recovered from a separate wellfield mining of the bischofite horizon, which occurs locally in layers up to 80 m (260 ft) thickness. $MgCl_2$ is required for the pond operation to enable purification of the raw salts and its solution mining and supply is performed to accelerate startup of the ponds. The project is currently engaged in financing activities which when completed will allow project implementation with timeline expected to take 3 years from start to finish.

Key words: Kainite, Ethiopia, Potash Solution Mining, Cavern Operation, Brine Processing, Sulphate of Potash

1 INTRODUCTION

Ethiopotash B.V. is developing the Dallol Potash Project in Ethiopia's Danakil Depression. The project has progressed to the Front-End Engineering and Design (FEED) stage, completed in collaboration with Sedgman Novopro and other consultants.

Sulphate of Potash (SOP) is typically produced through various methods, including the conversion of potassium chloride (KCl) using sulfuric acid, the decomposition of potassium-bearing double salts, or the combination of KCl with magnesium sulfate-rich ores. These raw materials are primarily extracted from sylvinite, carnallite, and magnesium sulfate deposits. The deposit contains three main potash-bearing minerals:

- Sylvite, chemical formula KCl
- Carnallite, chemical formula KCl.MgCl2.6H2O
- Kainite, chemical formula KCl.MgSO4.3H2O

Kainite is particularly well-suited for SOP production, as it naturally contains both potassium and sulfate components. The overall process of the project is based on solution mining of potash and solar pond evaporation, followed by conversion and SOP crystallization.

While sylvinite and carnallite deposits are found across all continents, kainite is relatively rare. Theoretically, kainite forms as a secondary mineral within potassium- and sulfate-rich deposits. It may also develop during incomplete evaporation sequences, where residual brine alters existing salts into kainite (Garrett, 1996).

To validate the solution mining approach and demonstrate its economic feasibility, pilot caverns were established at three locations. These test caverns were operated successfully. This marks the first successful extraction of kainite using solution mining. Other minerals in the deposit carnallite, kieserite, and sylvinite were also recovered, though kainite represents the bulk of the extractable potash resource.

Phase 1 aims to produce 300,000 mtpa (330,700 stpa) of sulphate of potash (SOP), with Phase 2 doubling output to 600,000 mtpa (661,400 stpa). Solution mining and evaporation ponds are used to extract and process SOP from the evaporite deposit. All unit operations were tested for process development.

Extensive hydrogeological studies have been undertaken to confirm the availability of water for the project, both as a solvent for solution mining and as process water.

The following sections will outline the investigations carried out during the project's development, including studies on solution mining pilot trials, and process development, recovery methods and testing.

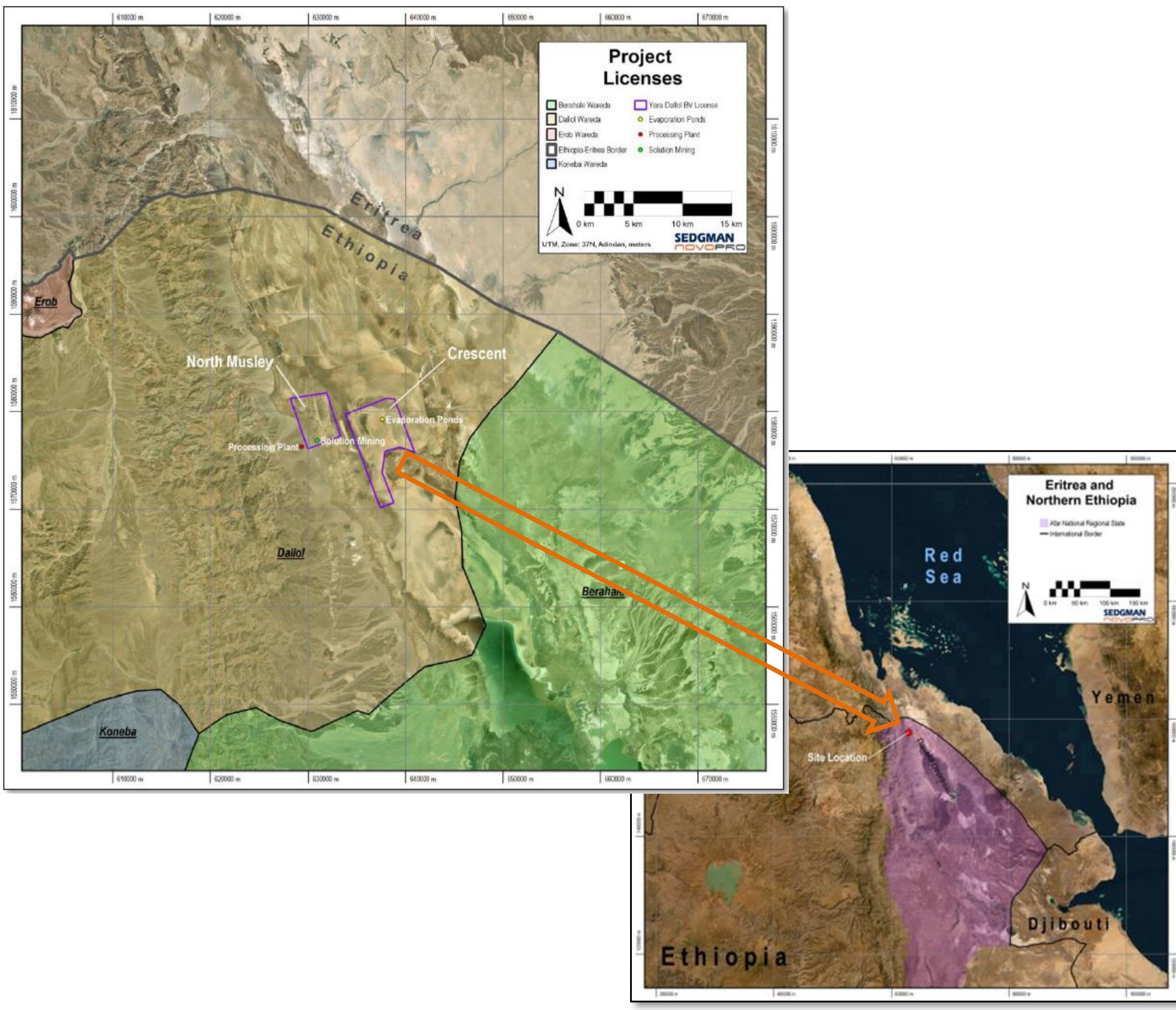
2 Project Location, Regional & Deposit Geology, Exploration

2.1 Location

The project is located in Dallol Woreda, within the Afar Regional State of northeastern Ethiopia, close to the Eritrean border. The concession covers areas in the Crescent and North Musley zones on the western edge of the Danakil Depression as depicted in Figure 2-1. Among these, the western part of North Musley has been selected as the initial site for solution mining.

Situated around 125 m (410 ft) below sea level, the Danakil Depression is known for having the highest average temperatures globally, ranging to over 50°C (122°F). Its exceptionally high evaporation rate, about 12 mm (1/2 “) per day, makes the location ideal for evaporation-based processes, significantly reducing costs associated with pond construction and operation.

Figure 2-1: Project Location in Northeast Ethiopia (Sedgman Novopro, 2025)



2.2 Regional Geology

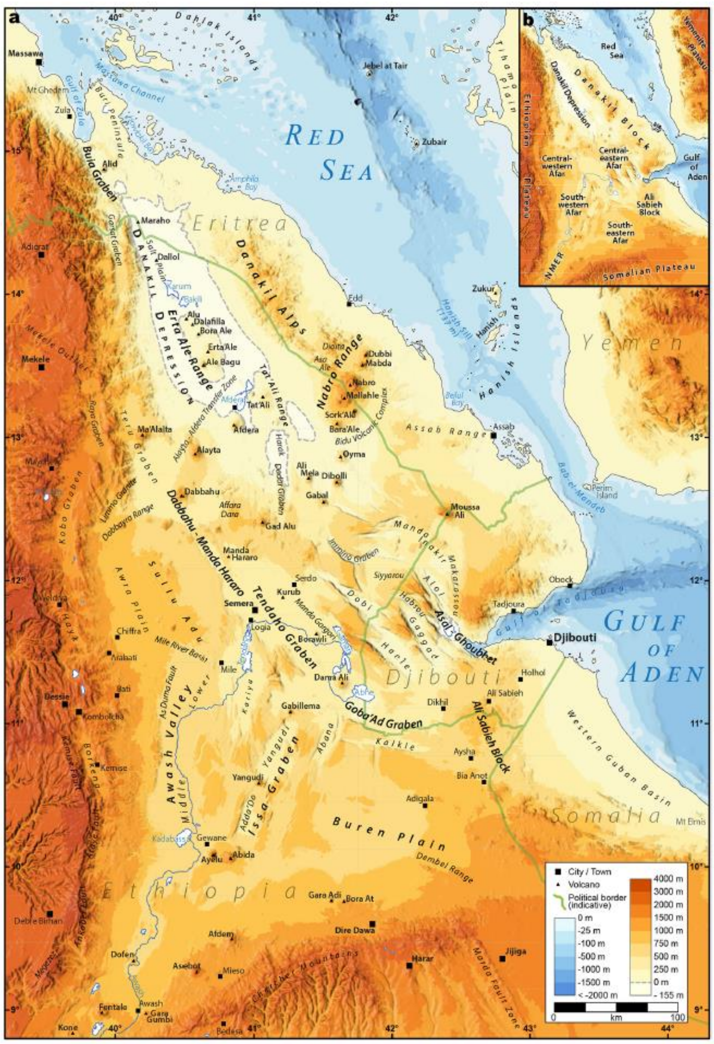
The Musley Block is located on the western side of the Danakil Depression, about 30 km (19 miles) south of the Eritrean border. It is shaped by three main tectonic structures:

- The Red Sea Graben (NW-trending)
- The Ethiopian Graben (NE-trending)
- The Gulf of Aden structure (ENE-trending)

The depression, also known as the Afar Triangle, is a low-lying region spanning about 105,000 km² (40,500 mile²) across Ethiopia, Djibouti, and Eritrea. Figure 2-2 shows the position between the Ethiopian plateau (west), the Somalian plateau (south), and the Danakil Block (east), with elevations ranging from -154 m (500 ft) (Lake Asal) to about 1000 m (3,300 ft), while surrounding plateaus rise above 3000 m (9,850 ft). This area marks a geological triple junction, where the Nubian, Arabian, and Somalian tectonic plates meet. Plate movements here vary, with the Arabian plate moving faster than the others. These tectonic dynamics led to the opening of the Red Sea and the Gulf of Aden and contributed to the rifting of the East African Rift System.

The region also experienced massive volcanic activity, notably the Ethiopian flood basalts, mainly erupted around 30 million years ago. These are linked to deep mantle processes, possibly from a superplume beneath Africa.

Figure 2-2: Topographic map of the Afar Depression (Valentin Rime, 2023)



The forces driving the rifting in this region are still debated. Mantle plumes, gravitational forces, and earlier slab-pull (from subducting ocean plates) all played roles. However, plume activity likely weakened the lithosphere enough to localize the Afro-Arabian Rift (Valentin Rime, 2023).

The Danakil Depression strikes northwest-southeast from Lake Badda in the northwest to Lake Acori in the southeast (Brinckmann, 1971). A stratigraphic section through the Depression is presented in Figure 2-3. The individual units are discussed in more detail in the following. The basement complex consists of older metamorphic rocks (gneisses) and younger phyllites and schists (Upper Precambrian to Lower Paleozoic), overlain by Triassic to Cretaceous sandstones and limestones.

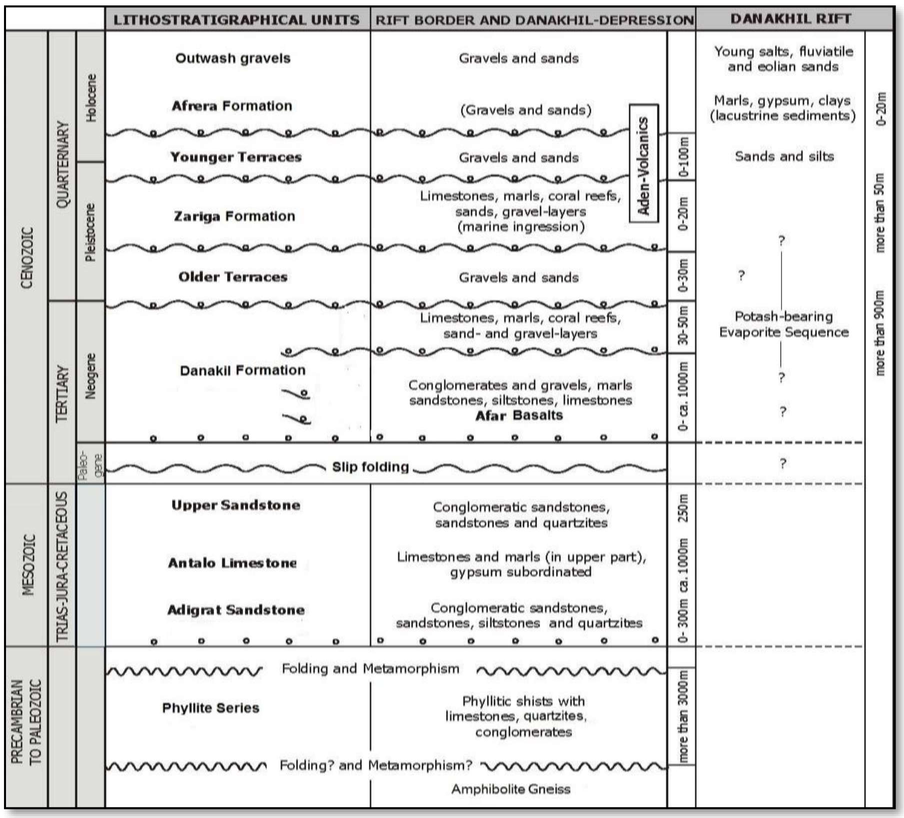
These are unconformably overlain by Tertiary and Quaternary Danakil Formation sediments. The lower sequence includes fluvial and lacustrine conglomerates, sandstones, siltstones, limestones, and basalts (~1,000 m thick), while the upper sequence (30–50 m) (98-165 ft) consists of marine limestones, marls, coral reefs, and gravels.

The Depression's stratigraphy includes Pleistocene Older Terraces (sand and gravel, up to 30 m (98 ft)), overlain by the

Zariga Formation (limestone, marls, coral reefs, ~20 m (65 ft) thick), deposited during a marine transgression. Above that lie the Younger Terraces (50–100 m (165-328 ft) sands and silts), followed by Holocene Afrera Formation and outwash gravels, deposited by lakes and flash floods.

Within the basin, these are replaced by ~20 m (65 ft) of salt crust, sands, marls, gypsum, and clays. Volcanic intrusions from Tertiary Afar Basalts and Quaternary Aden Volcanics are linked to the ongoing extensional tectonic regime.

Figure 2-3: Stratigraphic Section of the Dallol Area (Source: Brinckmann and Kürsten 1971)



2.3 Deposit Geology

The evaporite series of the inner Danakil Basin was estimated to be of Quaternary (Pleistocene) age (Holwerda, 1968). This age was indicated by fossils within an intercalated silty marl bed enclosed by halite. The assumed age of the Sylvinite Member from the fossils was too young for confirmation by potassium/argon [K/Ar] dating (Holwerda and Hutchinson 1968) and the lack of organic material precluded using Carbon-14 dating. This finding suggests that the evaporite sequence is contemporaneous with the limestone of the Zariga Formation that was deposited on the basin margins. In the Musley Area, the evaporite stratigraphy was defined by Parsons (1968) and confirmed by exploration drilling since 2011. The Lower Rock Salt exceeds 150 m (492 ft) and consists of halite with clay and anhydrite. It is overlain by the Houston Formation, which hosts five potash-bearing members (from deepest):

- Kainite
- Lower Carnallite/Kieserite
- Bischofite
- Upper Carnallite
- Sylvinite.

2.4 Exploration

Ethiopotash successfully conducted a significant exploration drilling and seismic survey program on the license areas Musley, North Musley and Crescent from 2010 through 2016. Core extraction with geochemical assays were also completed in exploration wells. Rock mechanical testing and modelling was performed to identify suitable cavern design.

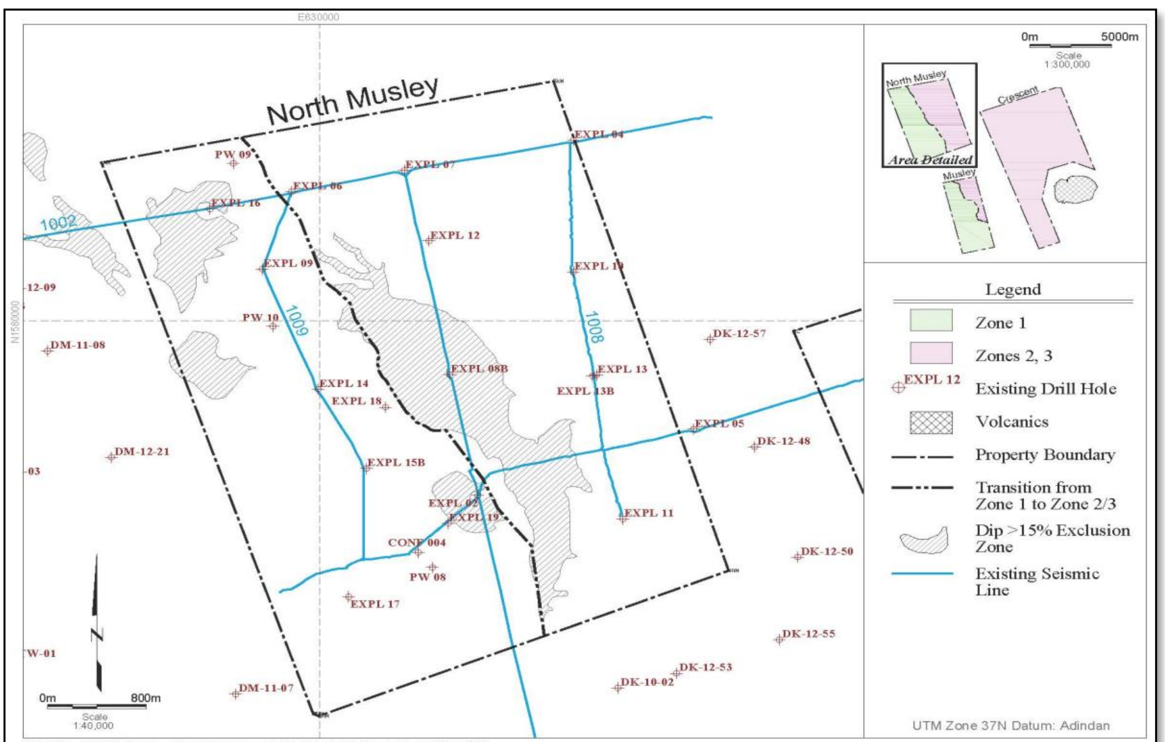
The exploration activities included 2D seismic surveys as shown in Figure 2-4. No further exploration drilling is planned as Phase 1 concentrates on Zone - 1 in North Musley with coverage of measured and indicated resource category. Zone - 1 is the preferred area for mining start up as the deposit features without bischofite makes this location favourable for mining. Zone - 2/3 featuring bischofite within the deposit making mining more complicated.

- Total of 53 drill holes were drilled since 2010 which covered the project license area in Musley, North Musley, and Crescent.
- Total of 17 2D seismic lines were surveyed in the project license area since 2011.

Based on the results of the exploration program and rock mechanical modelling, the following were established:

- The fault features were inferred from corelatable reflection-event terminations.
- The absence of bischofite in Zone - 1 of North Musley makes the area favourable for solution mining.
- The licensed area was separated in three zones with the following constraints:
  - Eliminate mining locations where the dip of the beds exceeded 15%,
  - No minimum deposit thicknesses were applied,
  - A minimum mining depth of cover was set at 80 m (262 ft) to maintain a minimum 40 m (131 ft) thickness of Upper Salt and Marker Beds between the overburden and the top of the Sylvinite Member.

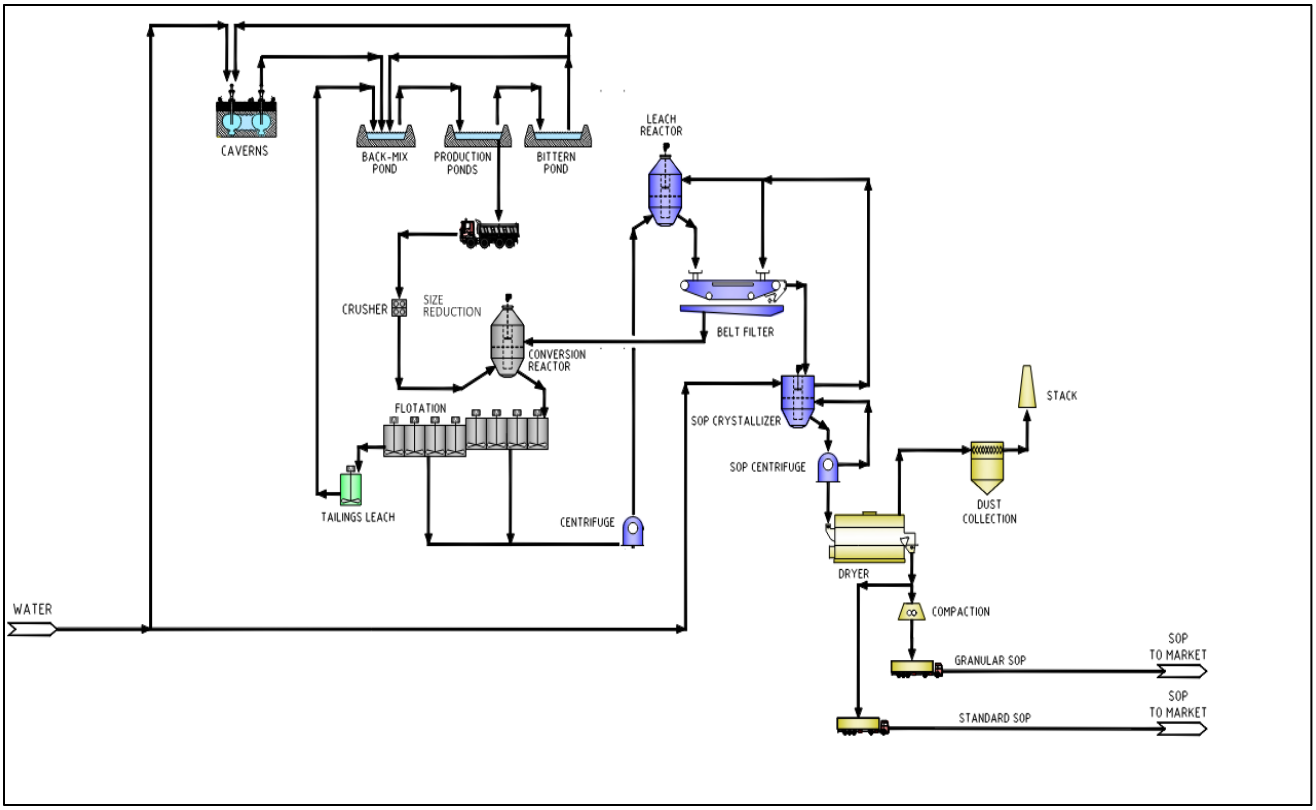
Figure 2-4: North Musley Area Seismic Lines and exploration Boreholes (Source: Agapito in (Sedgman Novopro, 2025)



3 Process Development

The overall process involves solution mining, evaporation ponds, conversion, leaching and crystallization as shown in the block diagram in Figure 3-1. All unit operations were tested and confirmed by the process development program.

Figure 3-1: Process Block Diagram (Source: Sedgman Novopro)



The process design was based on test work and mass balance modeling. A robust bench-scale test program was carried out to verify both established operating parameters and previously untested steps in the process. The test results were used to develop a METSIM model, incorporating key equilibrium data and process conditions. The unit operations listed below were the most thoroughly tested and explained in the following sections.

- Pilot well testing
- Core dissolution testing
- Pond evaporation
- Pond chemistry, including salts precipitation
- Conversion
- SOP crystallization

3.1 Pilot Well Testing

In 2014, a pilot cavern test program was commenced with the operation of the pilot wells PW 08, PW 09 and PW 10. All three pilot caverns were developed to planned cavern radii, blanket control and mining cut lifts were tested. The total duration of the test program was from May 2014 to April 2016. The target of the pilot well program was to demonstrate the solution mining technology with the results outlined in Table 3-1.

- Demonstrate methods to drill, install and cement casing capable of sustaining pressures suitable for solution mining operations.
- Maintain control of the cavern roof by blanket oil.
- Demonstrate levels of solubility and brine grade composition while mining in the Kainite, Carnallite and Sylvinite Members.
- Confirm the ability to develop a cavern with 60 - 80 m (197 – 262 ft) diameter over the full height of the mineralization.

The total operating time, solvent injection and brine production, as well as salt production of the pilot caverns can be summarized as outlined in below.

Figure 3-2 below shows pilot well PW 09 connected to solvent supply and instrumentation.

Table 3-1: Pilot Cavern Production

Well ID	Operation days	Total Solvent injected	Total Brine recovered	Salts produced				
				$CaSO_4$	KCl	NaCl	$MgCl_2$	$MgSO_4$
	d	m³	m³	mt	mt	mt	mt	mt
PW 09	640	215414	201702	163	14371	41979	8803	20498
PW 08	276	72527	70079	101	3872	9915	2968	5847
PW 10	365	117077	111121	127	7487	23699	2881	12133

Figure 3-2: Pilot Well Operation PW 09 at Dallol (Source: Sedgman Novopro)

3.2 Pilot Pond Testing

The solar pond evaporation brine processing is one of the major benefits of the project and thus, testing of the production brine processing in small scale ponds was part of the pilot program at the site. To simulate the initial step of processing, production brine was transferred from pilot wells to evaporation ponds at the well pads. Figure 3-3 shows the solar ponds with visible salt precipitation. The expected salt precipitation sequence in the evaporation ponds was confirmed. The harvested salts were shipped to laboratories for process testing, which yielded positive results.

Figure 3-3: Solar Evaporation Test Pond at Dallol (Source: Sedgman Novopro)

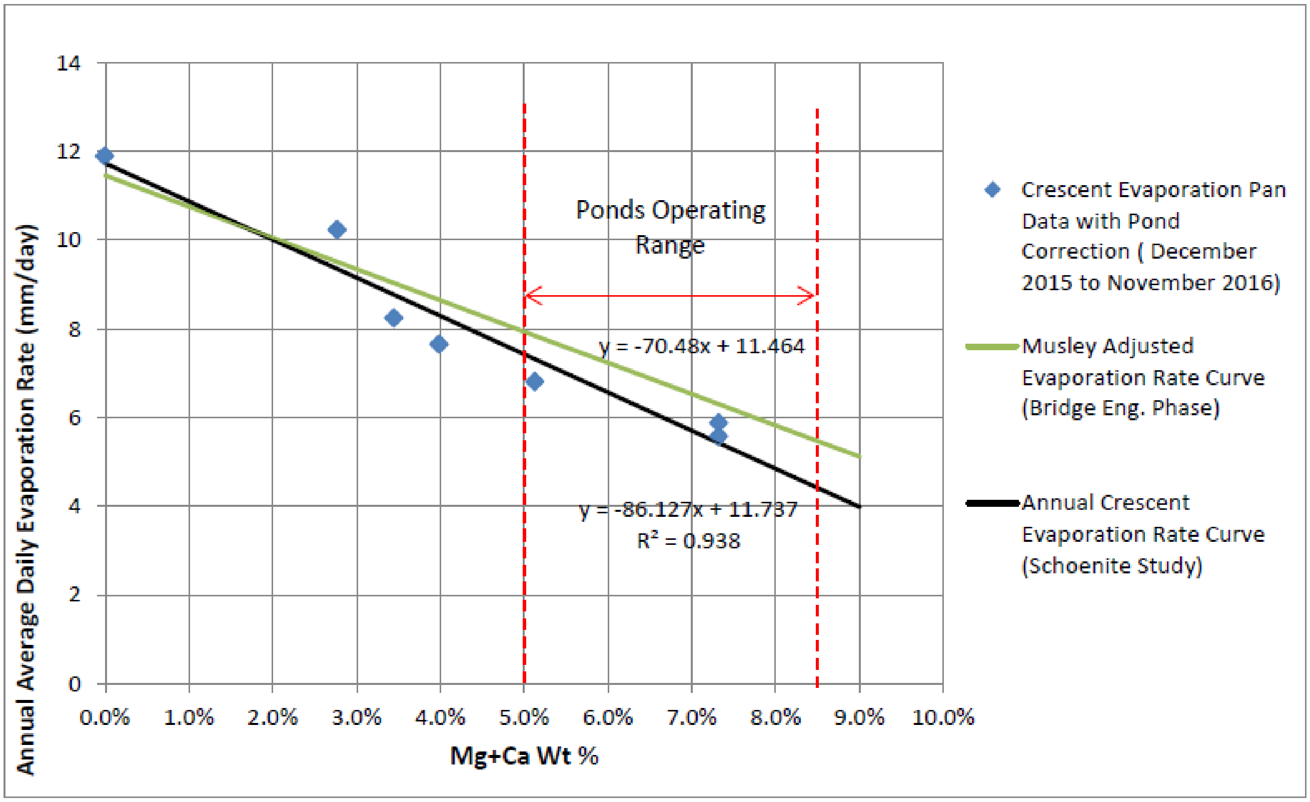
3.3 Evaporation Rate Testing

For pond sizing, the evaporation rate needs to be investigated and determined as precise as possible. Pan evaporation tests combined with meteorological data are suitable instruments for pond design.

The on-site pan evaporation testing aimed to measure evaporation rates of both freshwater and brines of varying concentrations. Starting in May 2014, the program was planned to run for at least one year. It involved using controlled evaporation pans, where brines of known composition were filled to a fixed level and refilled with freshwater at regular intervals to maintain volume.

The volume of water added indicated the amount evaporated. By limiting refill intervals to no more than two days, brine composition remained stable, allowing long-term evaporation rate measurements. The data was used to develop an evaporation rate curve for pond modelling in relation to the pond brine Mg and Ca content, as shown in Figure 3-4. The curve covers the brine composition operation range of the entire pond system.

Figure 3-4: Site Evaporation Curve applied to Pond Modelling (Sedgman Novopro, 2025)



3.4 Dissolution Testing

To improve the data and confidence in solution mining technology, dissolution tests were conducted on drill core samples from the North Musley area. The efforts focused on North Musley Zone - 1, the target for initial commercial operations. Sedgman Novopro Projects Inc. carried out dissolution tests to confirm the suitability of solution mining for potash extraction.

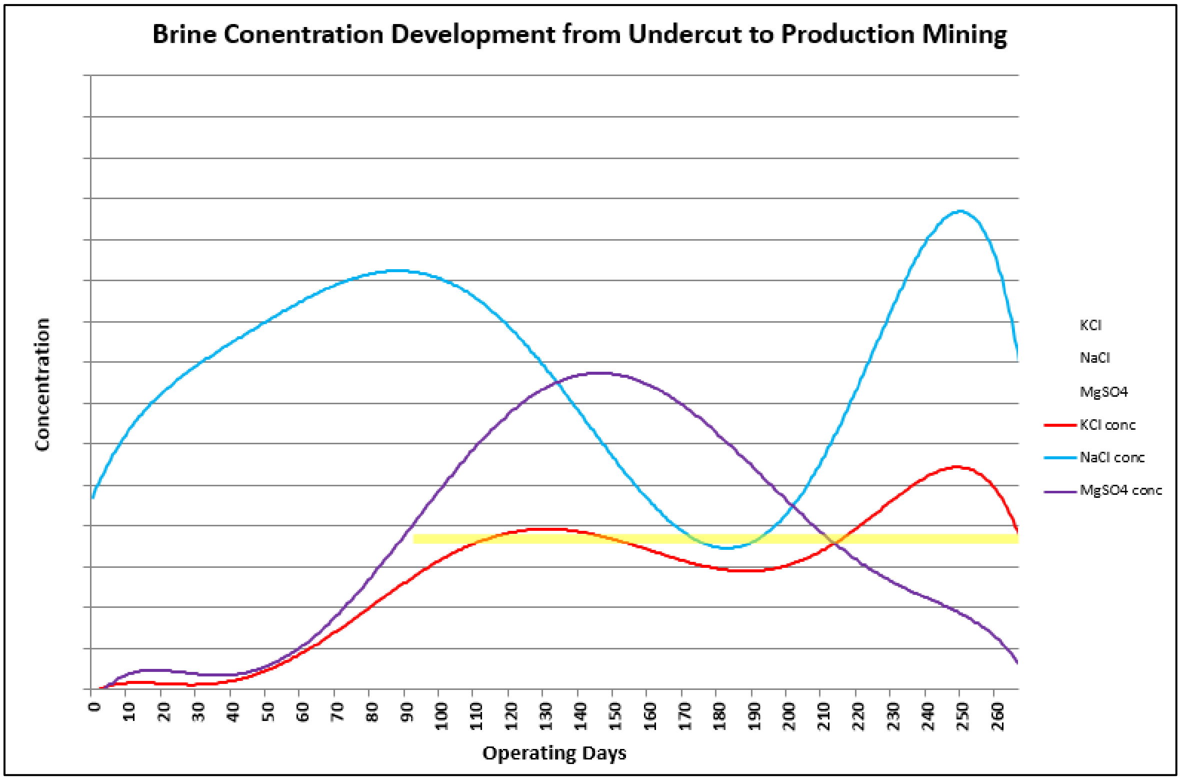
Tests focused on kainite, carnallite, and sylvinite, aiming to validate a non-selective dissolution process between 40–55°C. The goal was to predict brine composition (KCl, NaCl, $MgCl_2$, $MgSO_4$) and assess potential impurities like $CaSO_4$, $CaCl_2$, and trace elements. A total of 51 samples from exploration cores were tested, including mixed mineral combinations.

Figure 3-5 depicts the concentration development of a pilot cavern. The curve shows the typical NaCl, MgSO4 and KCl development when the different potash members are mined out. The yellow line shows the expected average KCl concentration as modeled based on the dissolution tests. It can be concluded that average KCl brine composition reached the modelled KCl brine grade.

The test work covers dissolution rates, brine analyses, kinetics, and phase diagram evaluation. Key findings on dissolution kinetics and brine phase chemistry are summarized in the following sections.

Figure 3-6 shows the test set up with drill core in the leaching cell during an ongoing test.

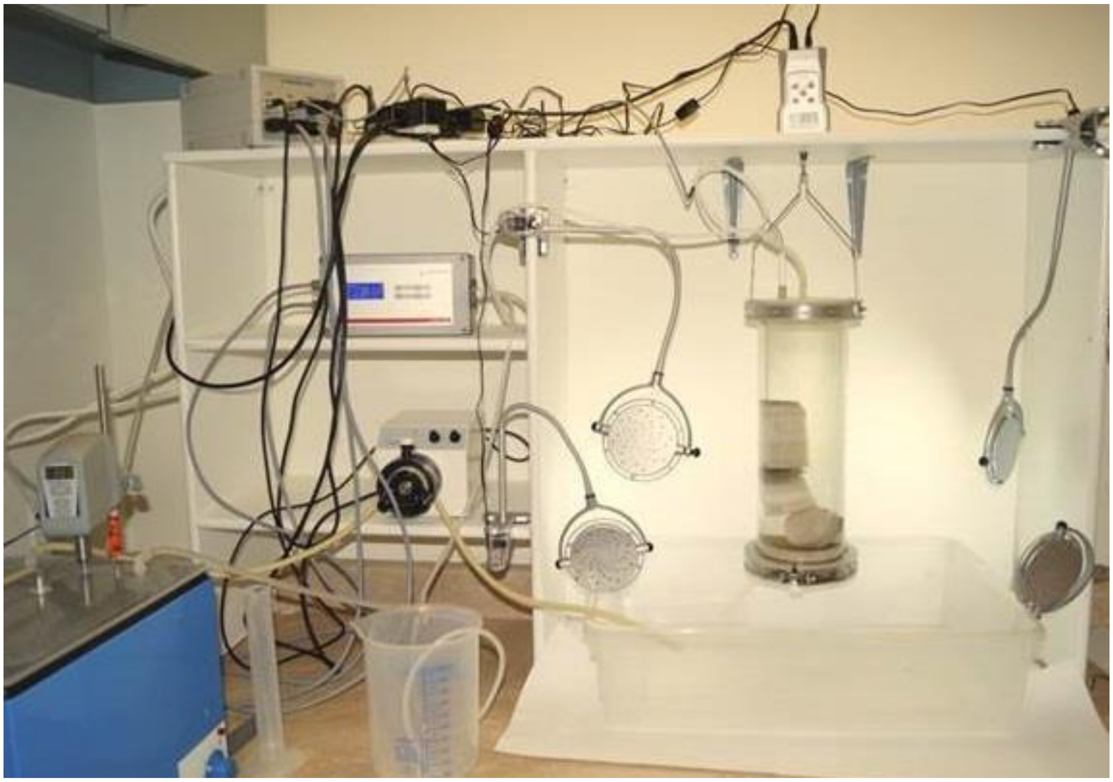
Figure 3-5: Brine Development of Test Cavern (Source: Sedgman Novopro)



Key findings from the test work include:

- Dissolution rate decreases as brine concentration increases.
- At 40°C and 55°C (104 and 131°F), kainite dissolves at similar rates as halite and sylvinite. Carnallite generally dissolves faster, though this depends on insoluble content.
- Kainite samples had low insoluble content, showing no negative effect on dissolution rate.
- Sylvinite had an average insoluble content of 9.14%, leading to lower dissolution rates.
- Increasing temperature from 40°C to 55°C (104 to 131°F) had only minor effect; KCl and residue content had a greater impact.
- The data from the dissolution test work covered the typical dissolution paths for kainite, carnallite and sylvinite.
- The dissolution path of all kainite samples is a more or less a straight line following the KCl/NaCl content of the sample.
- Considering some enrichment due to longer residence time inside the cavern - compared to the dissolution test – an increase of kainite and carnallite saturation is likely.

Figure 3-6: Core in Dissolution Cell (Source: Sedgman Novopro)



3.5 Conversion Testing

Conversion test work conducted by HAZEN as shown in Figure 3-8, confirmed that pond salts could be efficiently converted into schoenite, a potassium-bearing salt. Tests showed the reaction occurred within 30 minutes at design temperatures, though reactors were sized for a 2-hour residence time to accommodate varying feed compositions.

Using recycled mother liquor and added water, halite was dissolved while potassium was converted to schoenite. The process was tested at 20°C (68°F) and 25°C (77°F), with better recovery observed at the lower temperature. improving recovery in a single pass.

Key findings:

- Kainite and other K-bearing minerals convert effectively to schoenite.
- 20°C (68°F) showed better performance than 25°C(77°F).
- Dallol salts are suitable for this conversion process.

3.6 Crystallization Testing

The SOP crystallization process was tested in both batch and continuous modes at HAZEN to assess recovery and residence time.

A crystallizer recovery of 45% (solid basis) was achieved, with a required residence time of two hours. This recovery rate was adopted for the commercial design. The mother liquor from crystallization is recycled to the leach stage. Figure 3-7 shows the test set up at HAZEN. The key findings are:

- Tests were conducted at 50°C (122°F), and 55°C (131°F) to gather kinetic and equilibrium data.
- Schoenite can be selectively dissolved to crystallize SOP.
- Recovery improved at 55°C (131°F).

- Dallol salts were suitable for SOP production.
- Locked cycle tests confirmed the design water ratios for the two crystallization stages.
- Equilibrium was reached between 75 and 125 minutes.

Figure 3-7: Crystallization Test (Source: Hazen in (Sedgman Novopro, 2025))

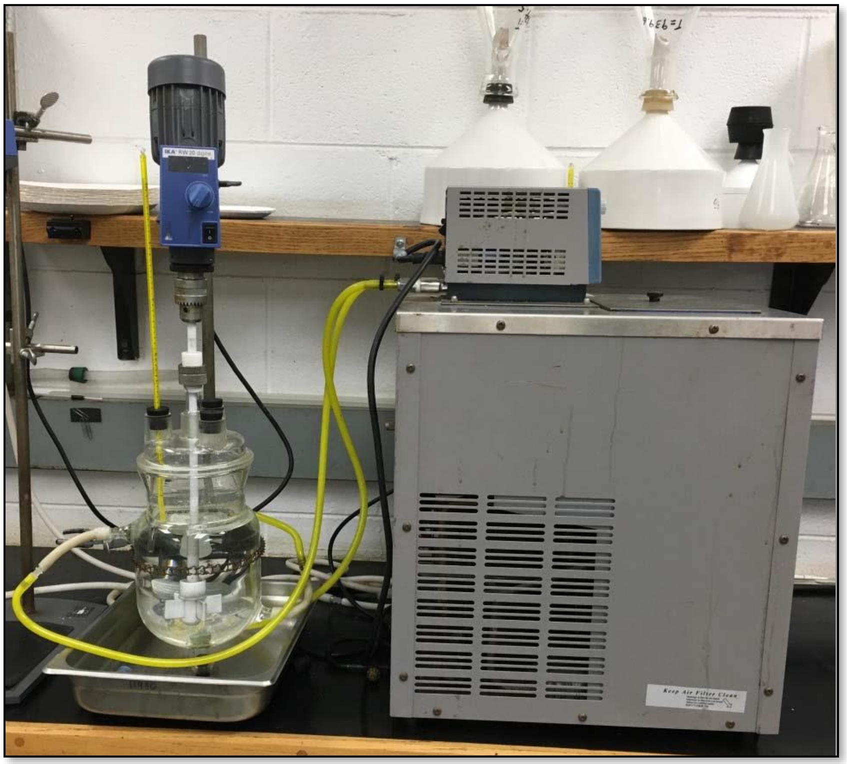


Figure 3-8: Conversion Test (Source: Hazen in (Sedgman Novopro, 2025))

4 Mining and Processing

All the pilot and testwork that was conducted lead to the current planned mine and process design. In the following details of the cavern and pond operation, as well for the processing will be provided.

4.1 Mine Design

The project will use solution mining to extract potash, injecting water to dissolve underground potash beds and pump the brine to the surface for SOP production. An inert gas blanket will prevent roof dissolution and direct cavern growth horizontally. Oil based blanket was used in the pilot operation, but for safety and environmental reasons, gaseous blanket material is preferred. Mining will proceed in 2 m (6.5 ft) steps, lifting the leach string gradually to dissolve each layer.

Due to roof instabilities observed in pilot caverns, the production cavern diameter was reduced from 80 m (262 ft) to 60 m (197 ft), shortening individual cavern life but increasing the number of caverns required.

Targeted potash layers include the Kainite Member, Intermediate Member (Lower Carnallite/Kieserite and Upper Carnallite), and Sylvinite Member. Mining begins below the potash beds and progresses upward in 2 m increments.

Contingency plans cover risks such as cavern leakage or collapse, including omitting sylvinite mining in shallow areas and using ESPs or airlift systems if needed. Although oil blankets were used in pilot tests, air blankets were chosen for this project due to lower cost and greater efficiency, despite some operational risks.

- If the air pressure in the blanket is not adequately controlled, it can lead to a pressure imbalance within the well, and cause wellbore instability, fracturing, or collapse, potentially halting operations and requiring expensive repairs.
- Leaks in the system can occur due to poor seals, corroded pipes, or mechanical failures. Escaping air can reduce the efficiency of the operation and may cause solution mining cavern roof collapse.
- Maintaining consistent air pressure and ensuring proper distribution within the blanket can be technically challenging. This may cause operational inefficiencies and the need for constant monitoring and adjustments.

Mitigation strategies for the using of air blanket at Ethiopotash are as follows.

- Regular monitoring of air pressure and system integrity.
- Use of corrosion-resistant materials in critical components.
- Sufficient annular space for the cemented casings to ensure good cement bond between the formation and the casing.
- Use high quality cement.

4.1.1 Well Completion

Production wells are completed with a 219.1 mm (8.625") casing drilled to the base of the Kainite Member and cemented using salt-saturated, sulphate-resistant Class G cement. After curing, a Casing Integrity Test (CIT) ensures a proper seal. The cement shoe is then drilled out with a 165 mm (6.5") bit, extending 5 m below the Kainite Member base, followed by a Formation Integrity Test (FIT) to confirm no pressure loss along the cement bond. A Cement Bond Log (CBL) is used to verify proper cement placement. Once confirmed, a 139.7 mm (5.5") leach string and an 88.9 mm (3.5") tubing are installed. Final steps include wellhead setup, circulation, and sump development.

4.1.2 Production Mining

After developing the roof at the base of the Kainite Member, solution mining advances in 2-m (6.5ft) horizontal lifts by injecting water and maintaining air pressure to control the air blanket. Once a lift is finished, the blanket is raised, and the next lift begins. This process continues upward through the Lower and Upper Carnallite and Sylvinite Members using the same method. During sylvinite mining, production tubing may be raised to minimize the roof-to-extraction point distance.

To prevent upward dissolution, compressed air is injected into the annulus between the leach string and casing. Before mining lift interventions, blanket material is removed to avoid disrupting rock dissolution. The air blanket is also removed during cavern depressurization for maintenance or other interventions.

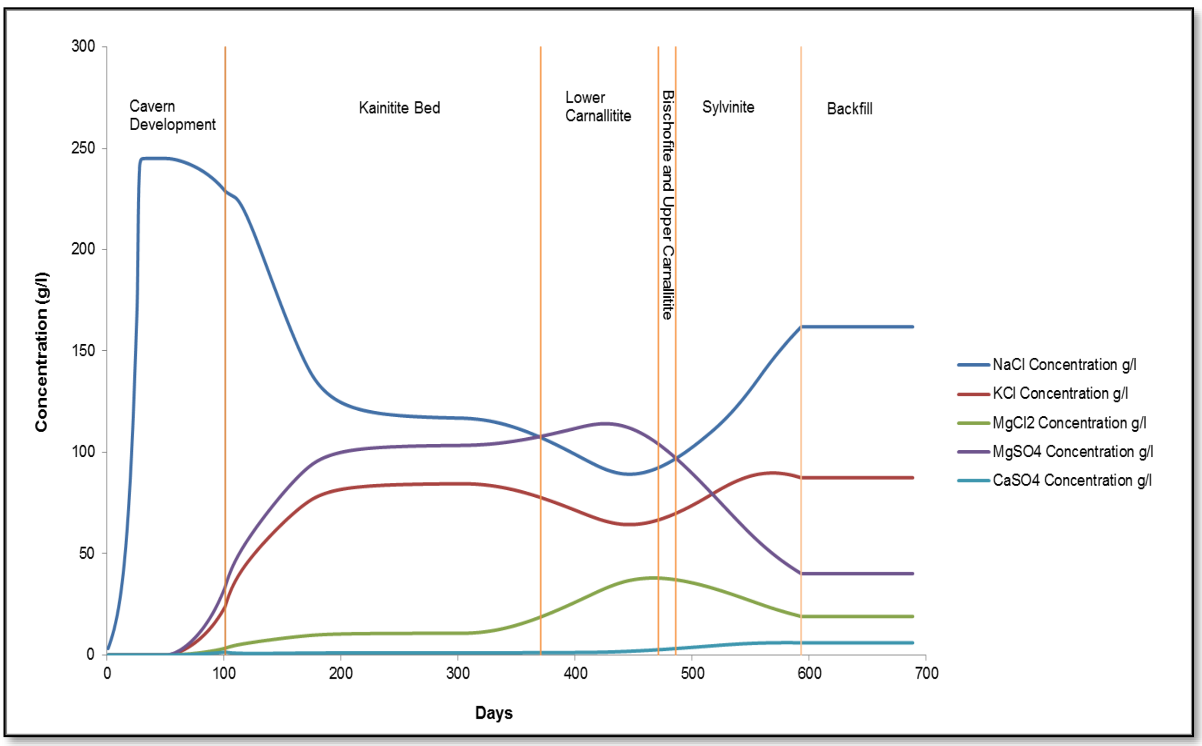
Figure 4-1 shows grade changes of NaCl, KCl, $MgCl_2$, $MgSO_4$, and $CaSO_4$ during cavern development, mining, and backfilling over cavern life (assuming 80 m diameter cavern size). Primary operations will involve about 20 caverns, delivering production brine at different stages of cavern development. The combined flow and composition will be fed to the evaporation ponds, with a stable brine composition. For replacement, 21 caverns will be developed per year.

Maintaining well casing integrity is crucial, as it faces axial force, pressure, bending, and torsion from surrounding rock deformation. Axial force at the mining horizon is most critical due to potash and salt creep. If this force exceeds the casing's strength, tension failure may occur.

The axial strain on well casing during solution mining was assessed using FLAC3D modeling of cavern and pillar sizing, though the casing itself was not physically modeled. Vertical rock strain along the well was used to estimate casing strain, assuming it moves with the rock. The maximum axial strain predicted was 0.0015. For K55 steel casing (stiffness 200 GPa), the strain limit is 0.0019, indicating no risk of tension failure in the sylvinite, carnallite, or kainite zones, even with lower-grade casing.

Other loads were not evaluated but are unlikely to threaten casing integrity due to shallow deposits and minimal mining-induced stresses.

Figure 4-1: Brine Grade History of a typical Cavern (Source: Agapito, in (Sedgman Novopro, 2025))



4.1.3 Bischofite Wellfield

During operation of the solar evaporation ponds, a continuous recycling of bittern brine from the end ponds to the front ponds is maintained to keep $MgCl_2$ levels above a minimum, so that the pond chemistry remains within the target operating range. Therefore, the ponds must be initially "primed" with bischofite brine to adjust $MgCl_2$ concentrations.

For this, dedicated bischofite solution mining wells will be developed in the North Musley concession area. The priming requires a bischofite brine supply over a 20-month start-up period, peaking at 235 mtph (259 stph), with 3 caverns operating at full capacity and 9 replacement caverns needed during this time - totaling 12 bischofite caverns. Each cavern has a 30 m (98 ft) radius and 60 m (197 ft) height (matching the local bischofite thickness) and produces 70 m^3/hr (2500 cft/hr) of bischofite brine. The cavern lifespan is approximately 80 days, using weak brine from production cavern development as the solvent.

4.2 Pond Design

The project uses two types of solar evaporation to evaporate the solution mine brine to produce crude potash salts. Back mix ponds for recycling of bittern brines and brine composition adjustment, and harvest ponds in which the precipitated raw potash salts will be harvested by mobile equipment and discharged to the salt crushing area.

Evaporation pond sizes and operating chemistry are developed based upon the results of pond simulation modelling. The main input parameters of the pond model include the solution mine brine mineral composition, the evaporation rate, brine temperatures, the leakage rate in the ponds, and the brine entrainment factor.

The magnesium and calcium concentrations in the pond brines are used as a marker of the overall brine concentration and are correlated to the evaporation rate of brine at a particular geographical location. The correlation between the evaporation rate at a particular site and the magnesium and calcium concentration in brine is known as the site evaporation curve, compare section 3.3.

Minerals deposited in the back-mix ponds and in the harvest ponds trap a certain mass of brine, which is a phenomenon known as brine entrainment, and is accounted for in the design of these Ponds. Typically, the entrainment factor is 0.33 mt (0.36 st) entrained brine/mt (st) of dry salt. Using windrowing and draining, the entrained brine will be recovered.

4.3 Process Design

The process aims to produce SOP by evaporating and treating brine from solution mining. The extracted brine is pumped into evaporation ponds, where crude salts are formed, harvested, and transported to the processing plant. The plant uses a proven method that converts potassium minerals into schoenite, which is then processed into SOP. The wet side of the processing is depicted in Figure 4-2. The first processing step is conversion.

4.3.1 Conversion

The crushed salt slurry from the harvest ponds is fed into the conversion circuit, which includes two vacuum-operated closed reactors using cooling for better process efficiency. Cooling is maintained through evaporative cooling via a barometric condenser using chilled water, with condensed vapor recycled back to the system.

4.3.2 Flotation

The conversion slurry is first mixed with flotation reagents in a conditioning tank, where a mineral-specific collector promotes attachment to the schoenite particles. The conditioned slurry is then sent to rougher flotation cells, where schoenite is separated from the gangue. The concentrate is centrifuged and washed to remove brine and residual reagents. Washed solids proceed to the schoenite leach reactor, while tailings are directed to the tailings leach circuit. No scavenger or cleaner stages are needed, as Sedgman Novopro's patented leaching process follows this flotation step.

4.3.3 Schoenite Leach

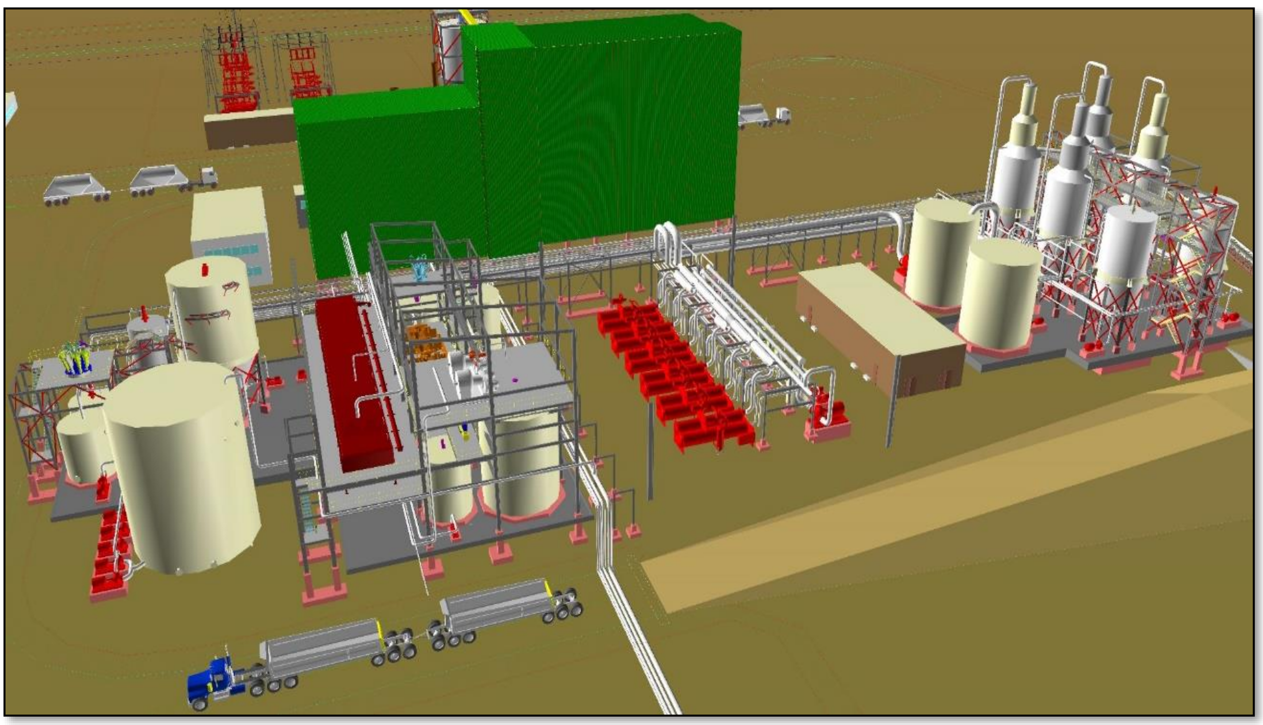
The flotation concentrate slurry is leached with hot SOP mother liquor in two parallel schoenite leach vessels. Each vessel is equipped with a barometric condenser that provides evaporative cooling, lowering the slurry temperature. This temperature control is part of Sedgman Novopro's patented process, ensuring selective crystallization of schoenite in the next conversion stage. Cooling also promotes secondary schoenite crystallization from the mother liquor. The leached slurry is then filtered, and the solids are washed with additional SOP mother liquor to remove magnesium-rich brine. The washed schoenite is sent to the SOP crystallizer, while the cooled filtrate is recycled to the crushing and conversion circuit.

4.3.4 SOP Crystallization

Schoenite cake from leaching is mixed with heated water in repulp tanks to form a slurry. Crystallization occurs at elevated temperature, maintained by heated process water from heat management condensers. The system maintains cooled and heated vessels in complete balance without the use of any steam or cooling water making it the most energy efficient process currently available for SOP production in the world.

The SOP crystallization takes place in specially designed vessels to promote the size of crystals suitable for making high purity product after dewatering, drying followed by other dry processing processes to make for saleable product.

Figure 4-2: Wet Processing Area 3D model (Sedgman Novopro, 2025)



5 Summary

Solution mining is the most effective method for extracting the potash from the kainite, carnallite and sylvinite deposit at Dallol. The recovered production brine will be sent to the evaporation ponds. A process will be applied, developed and patented by Sedgman Novopro which is based on the proven process at Compass Minerals. This process is in operation since the 1970´s. Applied improvements are the recovery and efficiency by modernizing this process through the addition of heat management system as well as other process optimization steps. The process has been optimized to fit the project's specific conditions, including not requiring any fuel for processing other than the use of abundant Ethiopian generated cost-effective hydroelectric generated electric power and while avoiding the need for any natural gas.

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