WE’RE ABOUT GROWTH

Polyhalite as an alternative potash source in Brazil
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THE EUROPEAN ZECHSTEIN DEPOSIT

Sedimentary rock layers of the middle to late Permian period

Key comments

- The disappearance of the Zechstein Sea was part of a general marine regression that preceded and accompanied the Permian-Triassic extinction.
- Polyhalite is an evaporate mineral deposited here 250-260 million years ago.
- Initially discovered in 1818 by Stromeyer.
- Polyhalite is a hydrated sulphate of potassium, calcium and magnesium with formula: $\text{K}_2\text{Ca}_2\text{Mg(SO}_4\text{)}_4\cdot2\text{H}_2\text{O}$.
- A triclinic crystal structure with a hardness index of 2.5-3.5 Mohs.
- Sirius Minerals will mine polyhalite to produce POLY4 fertilizer.

KEY TAKEAWAY: Sirius Mineral’s 2.66 billion tonnes resource represents 7% of the area of interest
THE PROJECT

POLYHALITE: JORC Resource of 2.66 billion metric tonnes of 65.7% polyhalite

1. MINE SITE
2. MINE SHAFTS
3. MINERAL TRANSPORT SYSTEM (MTS)
4. MTS ACCESS POINTS
5. MATERIALS HANDLING FACILITY (MHF)
6. HARBOUR FACILITY
A NEW BENCHMARK IN ENVIRONMENTAL IMPACT

Woodsmith Mine has been designed to minimise the impact on the National Park

Woodsmith Mine, North Yorkshire, UK

KEY TAKEAWAY: Traditional approaches to mining have historically been low cost, high impact
WHAT IS POLY4?

Polyhalite, a single source of bulk nutrients, is the foundation for POLY4.

Polyhalite nutrient composition¹

Polyhalite rock

Crushing & milling

Air classification

Granulating

POLY4 granules

Multi-nutrient content

<table>
<thead>
<tr>
<th>Nitrogen (N)</th>
<th>Phosphorus (P)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Potassium (14% K₂O)</td>
<td>Sulphur (48% SO₃)</td>
</tr>
<tr>
<td>Magnesium (6% MgO)</td>
<td>Calcium (17% CaO)</td>
</tr>
<tr>
<td>Boron</td>
<td>Zinc</td>
</tr>
<tr>
<td>Manganese</td>
<td>Molybdenum</td>
</tr>
<tr>
<td>Selenium</td>
<td>Iron</td>
</tr>
<tr>
<td>Copper</td>
<td>Strontium</td>
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</tbody>
</table>

KEY TAKEAWAY: POLY4 is a natural single source of K, S, Mg, Ca with valuable micro nutrients

Notes: 1) Based on 90% polyhalite grade. Remaining content consists of Halite, Anhydrite, Magnesite, Kieserite, Hexahydrite, Szabelyite, Gypsum, Syenite, Mica; 2) POLY4 is the trademark name for Sirius Minerals’ flagship polyhalite product.
POLY4 NUTRIENT CONTENT BASED ON TEST RESULTS

POLY4 minimum specification is 14% K₂O, 17% CaO, 6% MgO, 48% SO₃.

KEY TAKEAWAY: POLY4 nutrient content is consistently above the minimum specification

Notes: Confidence limits (CL) for each nutrient are based on analysis of 135 polyhalite samples. Sources: Sirius Minerals; SGS France.
The future of fertilizer.

SIRIUS MINERALS SCIENCE PROGRAMME

Global science programme has over 210 trials in 17 countries on 27 crops

Note: Trials as of May 2017.
POLY4 has been extensively trialled in several key Brazilian agricultural regions.

Key comments
- Brazil will become the single most important soybean producer by 2025 with production estimated to reach 135 million tonnes.
- Many of the agricultural active areas are also deficient in K, Ca, Mg and/or S.
- 20 trials have been conducted in Brazil over the past four years.
- Trials currently cover four provinces on both high value and broadacre crops.

Source: Sirius Minerals.
BRAZIL CORN RESULTS

POLY4 blends can maintain yields at lower K\textsubscript{2}O applications.

**KEY TAKEAWAY:** POLY4 blends support crop yields at lower application rates

Notes: 1) GENSTAT regression analysis; 2) Lower K\textsubscript{2}O options achieve crop nutrient offtake; 3) Initial soil analysis: pH 4.9; P 18 mg kg\textsuperscript{-1}, K 66 mg kg\textsuperscript{-1}, Mg 325 mg kg\textsuperscript{-1}, Ca 184 mg kg\textsuperscript{-1}, S 5 mg kg\textsuperscript{-1}; Sources: University of São Paulo 2015.
BRAZIL SOYBEAN RESULTS

POLY4 blends support high yields from reduced input costs

Key comments

- In Brazil, MOP is applied in advance of soybean emergence to lower negative impacts of chloride.
- By substituting for SSP with POLY4, as the S source, we improve crop fertilization balance with an additional 17 kg MgO, 21 kg CaO and 38 kg S ha\(^{-1}\) at 40 kg ha\(^{-1}\) K\(_2\)O.
- Potassium fertilizer replaces crop offtake at a recommended rate of 88 kg K\(_2\)O ha\(^{-1}\).

**KEY TAKEAWAY:** POLY4 delivers the option to reduce inputs
COMMERCIAL TOMATO YIELD

Improving tomato marketable yield leads to higher returns for growers

Key comments

- The addition of sulphur from SOP or SOP-M showed no yield improvement over MOP.

- POLY4 improved tomato yields by 8–9\% over other potassium fertilisers at recommended rate of 250 kg K$_2$O ha$^{-1}$.

- POLY4 supplied calcium which is important in improving commercial yield. At 350 K$_2$O from the POLY blend supplies an additional 18 MgO + 51CaO + 57S.

KEY TAKEAWAY: POLY4 highlights the crop need to access a broad range of nutrients

Notes: 1) GENSTAT regression analysis; 2) All plots received 300 kg N ha$^{-1}$ and 500 kg P$_2$O$_5$ ha$^{-1}$ from Urea and MAP. Initial soil analysis: pH 5.8, P 24 mg kg$^{-1}$, K 24 mg kg$^{-1}$, Ca 232 mg kg$^{-1}$, Mg 58 mg kg$^{-1}$, S 5 mg kg$^{-1}$. Source: University of São Paulo (4000-USP-4016-15).
POTATO BLEND FERTILIZER YIELD RESPONSE

POLY4 yield results compared to commercial NPK+S plan

Key comments

- Increasing K$_2$O application (75-300) resulted in increasing yields in a stable 150 N and 525 P$_2$O$_5$ background use 4:14 2-8 blends.

- At the recommended rate of 220 kg K$_2$O ha$^{-1}$, POLY4 NPK+S showed a yield improvement of 18% over MOP NPK+S.

- The removal of SSP lowers the Ca in favour of Mg and lower chloride from the more efficient POLY4 blend supporting yield improvement.


**KEY TAKEAWAY:** POLY4 can support the current yield from reduced application rates

Notes: 1) GENSTAT regression; 2) MOP NPK+S plan was made from urea, TSP, SSP and MOP; 3) POLY4 NPK+S plan uses Urea, MAP and POLY4; Initial soil analysis: pH 5.6, K 86 mg kg$^{-1}$, Ca 563 mg kg$^{-1}$, Mg 106 mg kg$^{-1}$, S 30 mg kg$^{-1}$. Source: University of São Paulo (4000-USP-4015-15).

![Graph showing commercial potato yield results compared to MOP NPK+S and POLY4 NPK+S.](image-url)
The future of fertilizer.

BALANCED FERTILIZATION SHOULD BECOME THE NORM

Sustainable food production is best served with balanced fertilization

Key comments

- Not all K sources are the same.
- Choose the right source for the circumstances.
- Balanced supply of crop nutrient requirements replenishes offtake.
- Consider a wider nutrient spectrum to obtain the best for all inputs.

KEY TAKEAWAY: Balanced fertilization optimizes crop performance and efficient use of Potash inputs

The ‘Law of the Minimum’ is the basis of balanced fertilization

A deficiency of any single nutrient will limit yield, just as the shortest stave will limit the barrel’s capacity

Sources: Heady et al, Iowa State University.