Bjerkreim – Sokndal Norway`s largest field

[Image: Photo: G. Meyer, NGU]
Bjerkreim - Sokndal, Key Facts

- This is a very large mineral resource containing Apatite, Ilmenite, vanadium-containing magnetite and anorthosite. The Occurrence is the largest unused mineral resource in Norway based on In Situ value. Conservatively we have estimated it to app. USD40 billion. This is based on the following split of minerals: 52.6 million tons of Apatite, 70 million tons Ilmenite, 42.7 million tons of magnetite, 0.44 million tons ferrovanadium and 552 million tons of anorthosite.

- However, based on the work the Geological Survey of Norway (NGU) has conducted they believe the resource potentially is 4 times as large and holds app. 1 bn tons of minerals in total, excluding anorthosite.

- Institute for Energy Technology (IFE) has researched the possibility for a co-extraction of Apatite, Ilmenite and magnetite and has concluded positively on this. IFE has also found that anorthosite, which were previously seen as waste substance, now can be recovered and utilized. Thus, almost everything in the resource can be utilized, and waste will be negligible.

- The Geological Survey of Norway (NGU) has achieved positive results through core drilling in 2006. They found that apatite is of very good quality, and are able and happy to help with new surveys.

- IFE and NGU are very interested in working on the development of the deposit in Bjerkreim-Sokndal. NGU has stated that they will equally split exploration spending with us.

## Bjerkreim – Sokndal, In situ values, base case

<table>
<thead>
<tr>
<th>Minerals</th>
<th>Total mill ton</th>
<th>Price USD</th>
<th>Mill USD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ilmenite</td>
<td>70</td>
<td>190</td>
<td>13 300</td>
</tr>
<tr>
<td>P2O5</td>
<td>52,6</td>
<td>180</td>
<td>9 468</td>
</tr>
<tr>
<td>Magnetite</td>
<td>42,7</td>
<td>250</td>
<td>10 675</td>
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<tr>
<td>Ferrovanadium</td>
<td>0,44</td>
<td>2600</td>
<td>1 144</td>
</tr>
<tr>
<td></td>
<td><strong>165,74</strong></td>
<td></td>
<td><strong>33 443</strong></td>
</tr>
<tr>
<td>Anortosite</td>
<td>552</td>
<td>14</td>
<td>7 507</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td><strong>40 950</strong></td>
</tr>
</tbody>
</table>
Bjerkreim – Sokndal, In situ values, upside

<table>
<thead>
<tr>
<th>Minerals</th>
<th>Total mill ton</th>
<th>Price USD</th>
<th>Mill USD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ilmenite</td>
<td>280</td>
<td>190</td>
<td>53 200</td>
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<tr>
<td>P2O5</td>
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<td>180</td>
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<tr>
<td>Magnetite</td>
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<tr>
<td>Ferrovanadium</td>
<td>1,76</td>
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<td>4 576</td>
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<td></td>
<td>662,96</td>
<td></td>
<td>133 772</td>
</tr>
<tr>
<td>Anortosite</td>
<td>2 210</td>
<td>14</td>
<td>30 028</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td>163 800</td>
</tr>
</tbody>
</table>
Bjerkreim Sokndal, The area
Bjerkreim - Sokndal, landscape
Bjerkreim Sokndal, Geological setting

- The Bjerkreim-Sokndal Layered Intrusion is the largest layered intrusion in Western Europe. It covers 230 km$^2$ and encloses a more than 7000 m thick Layered Series. In comparison the Bushveld Complex in South Africa with an immense areal extent of ca. 65 000 km$^2$ represents a thickness of 7000-9000 m of layered mafic rocks (Eales & Cawthorn, 1996), and the Skaergaard Intrusion in eastern Greenland forms a ca. 50 km$^2$ large body and a vertical section of 3500 m (McBirney, 1996).

- **Mineralisation**

- All three lobes of the intrusion contain ilmenite deposits of variable grade, character and quality, and active mining has taken place at several locations in the Sokndal lobe. The mining took place in oxide-rich parts of zone e (ilmenite, magnetite, apatite, two pyroxenites and plagioclase) but also in smaller, high-grade deposits in less evolved cumulates. Zone e of MCU IV in the Bjerkreim lobe is exceptionally voluminous and constitutes a huge low-grade resource for ilmenite with significant amounts of accompanying apatite and magnetite. The most mafic and oxide-rich zone e cumulates in the Bjerkreim-Sokndal Intrusion contain 7-11 % TiO$_2$. 
Bjerkreim Sokndal, deposits

• The deposits of apatite + ilmenite + magnetite constitute a 273 million tons probable resource (calculation based on density 3 g/cm\(^2\) and to a depth of 100 m) and cover an area 91 million m\(^2\). The average amounts of the three minerals in the Bjerkreim-lobe deposits are: apatite 8.5%, ilmenite 13 % and magnetite 8%, giving a total of almost 30%.

• **Logistics**

• There are three discharge harbours in the province to serve the comprehensive mining activity at Tellnes and the aggregate production at Hellvik and Rekefjord. The distance from the Hellvik discharge harbour for white anorthosite to the nearest deposits in the Bjerkreim-Sokndal intrusion is no more than 20 km by road. The most remote location is 30 km (in a straight line) from the mine at Tellnes. From Tellnes refined ore is transported to the shipping harbour at Jøssingfjord. The railroad connecting Stavanger with Oslo virtually runs within and parallel to the Zone C deposit and crosses the Zone B deposit at Helleland. The discharge harbour at Hellvik is situated less than 1 km from this railroad. All parts of the deposits are easy accessible by roads or tracks and most sequences are relatively well exposed with only minor cover and vegetation. Most low-lying areas are snow-free during winters.
Bjerkreim – Sokndal, zones of interest

Zone A
- 14.6% ilmenite
- 8.3% apatite
- 10.2% magnetite
- 33.0% total

Zone B
- 12.1% ilmenite
- 8.1% apatite
- 7.4% magnetite
- 27.4% total

Zone C
- 11.9% ilmenite
- 9.8% apatite
- 7.1% magnetite
- 28.8% total
Bjerkreim – Sokndal, Mineral separates
Bjerkreim – Sokndal, Mineral evaluation

• 50 km$^2$ of the surface expression of the Bjerkreim-Sokndal layered intrusion is enriched in apatite, ilmenite and magnetite. In the northern part of the intrusion an area of about 1.1 km$^2$ consists of rocks in which apatite, ilmenite and magnetite make up 25-35 %. The grade (c. 10%) of each of the three value minerals is insufficient for any of the minerals to be mineable alone. Marketable mineral products have to be made from two or three minerals.

• The ore-zones in the Bjerkreim lobe, cover a total area of 1.1 km$^2$ and contain ca 270 Mt of "probable ore resources". "Possible ore resources" within the Bjerkreim-Sokndal intrusion would be several times larger.

• **Apatite**: The apatite is a fluor-apatite with very low contents of U, As and Cd. The mineral therefore constitutes a high quality raw material for the production of phosphorus fertilizers. Apatite is characteristically disseminated in the rock.

• **Ilmenite**: The ilmenite grades in the ore-zones of the Bjerkreim-Sokndal intrusion commonly lie between 10 and 15 %.

• **Vanadium-bearing magnetite**: The magnetite grade in the ore zones is around 10 %. Within the ore-zones the $V_2O_3$-content in magnetite typically varies from 0.8 % to 1.05 %.
Bjerkreim - Sokndal, Advantages of Norway

• Norway has had minimal focus on mining, but have the same geology as its neighboring countries Sweden and Finland.

• Following a downturn in the oil activities the current conservative government is having the mineral industry as one of their key focus industries.

• Last year, 2 controversial development projects, Engebø (Nordic Mining) and Nussir were approved. Both these projects includes seabed tailings only allowed in very few countries.

• The Geological Survey in Norway has been given increased funding in order to support exploration. Exploration companies can in some cases obtain matching funding from the state.
• **GREAT POTENTIAL**
  • Norway has taken less care about its enormous mineral resource deposits in contrast to its Scandinavian neighbors. There are no large scale mining operations at present. Therefore the Norwegian Geological Survey (NGU) invested in recent years into developing the mining and exploration industry, through increased governmental funding.

• **UNIQUE POSITION**
  • Norwegian government has decided to boost mining. This decision implies financial support from the Ministry of Industry for exploration Projects. In addition Norway has unique logistic and shipping opportunities to key future customers.

• **ECONOMIC STRUCTURE**
  • Norway is a politically stable country with very low levels of risk across the three categories: Economic, Political and Financial System Risk. While not a member of the European Union, Norway does have access to European markets and relies heavily on trade with its European neighbors.
Geopolitical Stability, Economic, Regional and Environmental Sustainability.

New minerals act to promote mining in Norway on 1st January 2011.

Trond Giske, the Minister of Trade and Energy, announced a new mineral strategy for Norway on 20th May, 2011. The conservative coalition in charge now has further strengthened the focus on mining.

Norway is highly underexplored compared to its neighboring countries in Scandinavia. There is increased, government support and acceptance for exploration and mining in Norway.

Upon entering the production phase of a mine there is only a 0.5% royalty to the landowner. That royalty level is constant and is irrespective of who the landowner is. Thus royalty is equal on private, municipal or state owned land.
Bjerkreim - Sokndal, map and zones