AKANVAARA FACT SHEET

• Reservation 100% owned by Magnus Minerals Oy (from January 2018)

• A mafic layered intrusion located on the SE end of Central Lapland Greenstone Belt (CLGB) in eastern Lapland, ~60 km to the NE from the city of Kemijärvi

• Belongs to the prospective 2.44 Ga aged layered intrusions of the eastern Fennoscandian shield with a surface area of 50 km²

• Extensively studied by the Geological Survey of Finland (GTK) during the 1990’s
  • Including > 100 diamond drill holes and comprehensive assay data for ore metals

• Several metal-enriched layers of economic interest:
  • vanadium-enriched layers in the upper part of the intrusion (The Magnetite Gabbro, MTGB)
  • chromitite layers throughout the stratigraphical succession of the intrusion (currently 23 known layers)
  • specific zones enriched in PGE, Cu and Au
2.44 Ga LAYERED INTRUSIONS IN THE FENNOSCANDIAN SHIELD

- **The Tornio-Näränkävaara belt (TNB)**
  - Many Cr-V-PGE deposits, including the Kemi Chromitite (currently mined)

- **The Lapland Intrusion Belt (LIB)**
  - Several subeconemic Cr-V-PGE deposits + younger (2.06 Ga) Ni-Cu deposits

- **The layered intrusions of the Kola Peninsula (LIK), Russia**
  - Several large Cr-V-PGE and Ni-Cu-PGE deposits

From Lauri et al. 2012
HISTORICAL WORK @ AKANVAARA

- **112 drillholes, tot. 17370 m**, during 1990-1998 by GTK
  - Alltogether 2271 XRF analyses

- Geophysics by GTK in the 1990’s
  - Low-altitude (40m) and detailed ground magnetic, electromagnetic & gravity surveys

- Metallurgical tests for the recovery of V & Cr by the Technical Research Center of Finland (VTT) in 1995-1998

- Previous work by e.g. Outokumpu Oy and Kylylahti Copper Oy (now Boliden)
  - Kylylahti Copper Oy gave up their claims without any field work in the beginning of the last economic crisis in 2008

From Mutanen 1998
AKANVAARA GEOLOGY

• Block-faulted mafic layered intrusion with monoclinic structure dipping to SE
• Surrounded by volcanics of the CLGB
• 3.1 km thick layered sequence*
• Consists mainly of pyroxenitic, gabbroic and anorthositic cumulates

*In layered intrusions this refers to the thickness and location of the stratigraphical sections, not to real topography/depth dimensions; same with overlying/underlying units etc.
AKANVAARA ORE ZONES

- Vanadium-rich magnetite gabbro (MTGB) in the Upper zone (UZ)

- Alltogether 23 chromitite layers in the Upper (UZ), Main (MZ) & Lower zones (LZ)

- PGE enrichment in all chromittites + two PGE enriched succession in the UZ

- Minor Au-Pt-Rh-Ag enrichment at the base of the MGTB in the UZ
VANADIUM POTENTIAL OF AKANVAARA

- The basal part of the MTGB hosts two V-rich layered units
  - Intersected by only a few drillholes
  - Strike length of > 6km

Drillhole 303:
- 6.3m-thick unit with avg. 0.34% V

Drillhole 307:
- 27m-thick unit with avg. > 0.3% V
VANADIUM GRADES FROM THE MTGB HORIZONS

Table 2. Vanadium grades of the drill intersected magnetite gabbro horizons on the Akanaara layered intrusion.

<table>
<thead>
<tr>
<th>Hole</th>
<th>From (m)</th>
<th>To (m)</th>
<th>Intercept (m)</th>
<th>V$_2$O$_5$ (%)</th>
<th>Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>R303</td>
<td>362.70</td>
<td>378.87</td>
<td>16.17</td>
<td>0.46</td>
<td>XRF</td>
</tr>
<tr>
<td>R307</td>
<td>62.00</td>
<td>77.90</td>
<td>15.90</td>
<td>0.50</td>
<td>XRF</td>
</tr>
<tr>
<td>R404</td>
<td>49.65</td>
<td>62.40</td>
<td>12.75</td>
<td>0.43</td>
<td>ICP</td>
</tr>
<tr>
<td>R405</td>
<td>44.30</td>
<td>55.76</td>
<td>11.46</td>
<td>0.43</td>
<td>ICP</td>
</tr>
<tr>
<td>R406</td>
<td>50.70</td>
<td>63.69</td>
<td>12.99</td>
<td>0.61</td>
<td>XRF</td>
</tr>
<tr>
<td>R407</td>
<td>59.80</td>
<td>65.40</td>
<td>5.60</td>
<td>0.43</td>
<td>ICP</td>
</tr>
</tbody>
</table>

From Vesanto 2009
CHROMIUM POTENTIAL OF AKANVAARA

• Altogether 23 monocumulate chromitite layers are known
  • Individual layers have 6-32 wt.% of Cr$_2$O$_3$
  • Chromites are rich in Fe and low in MgO

• Cr-layers are divided into five zones from roof to base:
  1) The Upper Chromitite layer (UC)
  2) The Uppermost Lower Chromitite layer (ULC)
  3) The Middle Chromitite layers (MC)
  4) The Lower Chromitite layers (LC)
  5) The Lowermost Lower Chromitite layers (LLC)

From Mutanen 1998

After Mutanen 1997
THE UC CHROMITITE

- Very uniform, avg. 1.25 m thick
  - Intersected by 30 diamond drillholes

- Weighted avg. for massive ore is 22.7% of Cr$_2$O$_3$

- The UC is also V- & PGE-rich
  - Massive ore has avg. of 0.4% V and 0.9 ppm PGE

- Continuous, with a strike length of 8km

From Mutanen 2005
THE ULC CHROMITITE

- Tectonically disturbed, max. recovered section 1.08m-thick
  - intersected by 13 drillholes
  - traced for 8.2km but extends longer

- Weighted avg. for massive ore is 22.30 % of Cr$_2$O$_3$

- The overlying peridotite unit
  - chromitite bands a few mm to 9cm in size
  - net-textured chromite-rich rocks with 9-12 % of Cr$_2$O$_3$

THE MC-CHROMITITE

- Approximately 0.5 m thick
- Extends to the base of the ULC
THE LC- & LLC-CHROMITITES

• The LC
  • Two groups of layers
  • Pinch and swell structured, badly disturbed by faults
    • Load cast structures, similar to Bushveld’s Cr-PGE-rich “potholes”

• The LLC
  • Varying thickness (5m in DHR376)
  • Sparsely drilled; very good potential to find more thickened layers (Mutanen 1998, 2018)

Massive chromitites in the LC & LLC have 18-34% (avg. 24.55%) of Cr$_2$O$_3$ + 0.2-1.4 ppm (avg. 0.639 ppm) of PGE

From Mutanen 2005
THE LC & LLC

From Mutanen 2005
PGE POTENTIAL OF AKANVAARA

- PGE has elevated concentrations in the chromitites and below the MTGB
  - PGE in the chromitites
    - UC has avg. 0.9 ppm of PGE
    - LC & LLC have 0.2-1.4 ppm (avg. 0.639 ppm) of PGE
  - PGE below the MTGB
    - 50-75m below the MTGB:
      - Upper 14m-thick* and lower 18-21m-thick** sequences of enriched PGE in pyroxene-plagioclase cumulates (DDH307 max. 1.26ppm PGE/1 m)**
      - ca. 200 m below the MTGB a 16m-thick sequence of enriched PGE in plagioclase cumulates near the base (max. 453 ppb PGE/2m)***
      **Note**: DDH303 & 307 are analyzed for total PGE, others only for Pd.
  - PGE is not typically associated with sulfides, but oxides & "plain" silicate cumulates
    - The Platinum Group Minerals (PGM) are small (3-10 µm) and occur as inclusions in chromite & silicates

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* See also the cross-section in the slide 8
GOLD POTENTIAL OF AKANVAARA

• Au (Pt-Rh-Ag)-enriched basal part of the MTGB
  • Assayed only in two holes (DDH303 & 307)

DDH303:
• a 23m-thick layer with 20-100 ppb Au, including a 1m-thick layer with ~1.5 ppm Au and minor PGE (~55 ppb)

From Mutanen 2005
BENEFICIATION AND METALLURGICAL STUDIES

• Akanvaara is not an ordinary Cr-deposit
  • The low MgO content and high Fe content in chromite signifies increased reactivity both in pyrometallurgy and hydrometallurgy, as compared with chromites from conventional chromite deposits

• Results of the beneficiation tests:
  • The weak-magnetic concentrate from the MTGB (10-12% of the feed) from the basal part of the magnetite gabbro unit contains 1.55 - 1.59 wt.% V with a 50-60% recovery. The Cu-sulphide concentrate obtained from a preliminary test showed 8 - 14 wt.% Cu, 1.4 g/t Au, 53-57 g/t Ag, 0.073 g/t Rh and 0.068 g/t Pt.
  • The chromite concentrates from the UC & ULC yielded a chromite concentrate with 33.8 wt.% Cr₂O₃ and 0.55 wt.% V and 38.3 wt.% Cr₂O₃ and 0.26 wt.% V respectively. The recovery of total Cr for the UC was 92 % and 88 % for V, and for the ULC 86% for Cr and 83% for V.
    • The PGM (Platinum-Group Minerals) particles can be liberated by grinding and concentrated only insofar as those parts that are not included in chromite grains

• Also, vanadium contained in the silicate gangue (hornblende, biotite) of the MTGB may be worth extraction, to be studied
ORE RESERVES IN AKANVAARA

Estimated ore reserves by Mutanen (1998):

• THE MGTB:
  • **20 Mt down to 100 m with 0.34% V, 0.1% Cu and 2.5 g/t Ag** (For 6–13 m basal part, the other, stratigraphically overlying V-unit not considered)

• THE CHROMITITES:
  • **18.1 Mt down to 300 m with 33.8% Cr₂O₃, 0.4% V and 0.912 g/t of PGE in the UC**
  • Also chromite resources in the LC & LLC have been verified, but confirmation of continuity of various chromitite layers demands additional drilling
PROSPECTIVITY IN AKANVAARA

• For Chromium:
  • The LC and LLC have only been intersected by < 10 drillholes
  • Especially the LLC layers have potential for new findings of thickened parts of individual layers

• For Vanadium:
  • The MTGB is very sparsely drilled (11 drillholes), and especially eastern and western extensions of the unit are understudied (only one drillhole each)

• For PGE, Au, Cu:
  • The shear zones (pseudotachylytes, blastomylonite zones) contain indications of mobilized sulfides and may host considerable amounts of PGE, Au and Cu
  • Extensions of the LC, LLC and ULC chromitites in the SW-part of the intrusion may host PGE-rich zones

• Other aspects:
  • The northern wing of the intrusion is totally unexplored
REFERENCES


Mutanen, T. 2018. Personal communication
