Exploration for Base Metals in the Harz Mountains, central Germany

The Gosetal anomaly in the Harz Mountains, a Rammelsberg twin?
Executive summary

A newly found EM anomaly in the Harz Mountains has the potential of being a World Class Deposit

Harz Minerals GmbH, a fully owned subsidiary of Scandinavian Highlands Holding A/S in Denmark, holds an exploration license for a large part of the Harz Mountains in central northern Germany, covering ca. 1250 km²

A sizable, but previously unknown airborne TEM anomaly was found in the Gosetal, two kilometres west of the historic Rammelsberg mine in the Harz Mountains

The TEM anomaly is located in the same middle Devonian stratigraphic sequence as the mineralisation in the Rammelsberg mine

Soil Gas Hydrocarbon geochemistry analyses from the Gosetal area give a strong indication of a SEDEX deposit

Geophysical and geological modelling suggested two alternative solutions for the TEM anomaly: a shallow conductor (100 - 400 m) or a deep conductor (500 - 800 m) with interference of shallow infrastructure

After test drilling of the shallow target in 2009, the second phase of exploration drilling for the deep target will commence fall 2010
The Harz Mountains in central northern Germany

The Harz license is about 60 to 100 km southeast of Hannover
**Introduction**

The Harz is a very prospective region and mining for SEDEX and vein type mineralisations has occurred for more than 1000 years.

The Harz Minerals licence includes the now exhausted World Class Rammelsberg mine.

Airborne and ground EM surveys indicate the presence of a conductor in the same stratigraphic level as the Rammelsberg mineralisation, two kilometres west of the mine.

The footprint of the Gosetal anomaly is of a similar size as the combined Rammelsberg ore bodies.

The Gosetal anomaly lies in the same sub-basin on the margin of the Devonian Goslar Trough.

The TEM anomaly (the Gosetal anomaly) coincides with a pronounced soil gas hydrocarbon (SGH) geochemistry anomaly that suggests the presence of a SEDEX mineralisation.

**The Gosetal anomaly has the potential of a World Class Deposit**
The Harz license

The 1250 km² license covers much of the historic Harz mining district

Several hundreds smaller historic mines in the area are not indicated
Framework and setting of the exploration area

Very stable political and judicial environment in Germany

Positive local political attitude towards the project

The target area is located two kilometres south of the historic mining town of Goslar

Good infrastructure – industrial area and railway system within few kilometres

Some of the industries are remnants from the mining era
Rammelsberg mine

A classic SEDEX deposit, situated at a shelf edge on the transition between the Goslar Trough (Middle Devonian shales) and the West Harz Rise (lower Devonian sandstones and shales)

Source: Large and Walcher, 1999
Rammelsberg mine
More than 1000 years of mining history

Closed in 1988 after exhaustion of the resources
Last operated by Preussag Metal AG since the 1920’s
Now a UNESCO World Heritage site
Rammelsberg mine

Total production: 27-30 M tonnes ore
Average grade:
2% Cu, 6% Pb, 14% Zn, 1 g/t Au, 140 g/t Ag and 20% barite

(Large and Walcher, 1999)
Rammelsberg mine

Gross in-situ value
(total production – present day value):
19.3 – 21.4 billion USD
(= 713 USD/tons) – excluding barite

(based on spot price,
LME, 22 January 2010)
### Economic potential of the Harz project

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<th>Base case</th>
<th>Sensitivity analysis</th>
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<tr>
<td></td>
<td>100%</td>
<td>-50%</td>
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<tr>
<td><strong>Tonnage (Mt)</strong></td>
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<td><strong>Grade</strong></td>
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|                      | 30        | 15                  | 45      | 30        | 15      | 45      |

| **Grade**            | Au (ppm): | 1                   | 1       | 1         | ½       | ½       | ½       |
|                      | Ag (ppm): | 140                 | 140     | 140       | 70      | 70      | 70      |
|                      | Cu (pct): | 2                   | 2       | 2         | 1       | 1       | 1       |
|                      | Pb (pct): | 6                   | 6       | 6         | 3       | 3       | 3       |
|                      | Zn (pct): | 14                  | 14      | 14        | 7       | 7       | 7       |
|                      | Barite (pct)* | 20                 | 20      | 20        | 10      | 10      | 10      |

| **Recovery**         | pct       | 90                  | 90      | 90        | 90      | 90      | 90      |
| **Net Smelter return** | pct      | 65                  | 65      | 65        | 65      | 65      | 65      |

| **Variable mining costs** | USD/t     | 60                  | 75      | 50        | 60      | 75      | 50      |
| **Investments**         | mill USD  | 400                 | 300     | 450       | 400     | 300     | 50      |

| **Gross In-situ Value:** | mill USD | 20 893               | 10 446  31 340 | 10 446 | 5 223 | 15 670 |
| **Net smelter value**   | mill USD  | 14 267               | 7 133  21 400 | 7 133  | 3 566 | 10 700 |
| **Net CF before int & tax** | mill USD | 12 067               | 7 508  18 700 | 4 933  | 2 141 | 8 000  |

Economic potential of a Rammelsberg-like deposit (based on spot metal prices of 1 March 2010)
The base case shows a net cash flow before interest and taxes (corporate tax and royalties) of USD 12 billion

*Barite is not given any value in this calculation
Profitability classification of mineral deposits

Based on determined resources of 230 deposits (gold and base metals)
Exploration activities in the Harz

Data mining - 2008-2009
- collection, digitising and evaluation of data
- entering in GIS and database systems
- 3D modelling

Airborne TEM survey in the Goslar Trough and West Harz Rise – May 2008
- outlining of the Gosetal anomaly
- Ground inspection of the area – mapping and sampling
- Maxwell modelling

Soil Gas Hydrocarbon geochemistry – spring 2009

3D modelling of a shallow conductor in the Gosetal area – combining geological and geophysical data – spring 2009

Exploration drilling for the shallow target – three holes completed - fall 2009

As a result of the early success of the TEM survey, the activity in the Harz license was concentrated on the Gosetal/Rammelsberg area
Airborne TEM survey
140 km² survey of the Goslar Trough and West Harz rise, May 2008

= Rammelsberg
The Gosetal Anomaly

Almost 2 km long footprint 1-2 km west of Rammelsberg
Strong conductor
Unique in the surveyed area

= Rammelsberg

1D inversion - Resistivity slice 200-220 masl.
The Gosetal anomaly lies within the Wissenbacher shales, similar to the Rammelsberg ore deposit. Geological map from Preussag archives, 1:5000.
New geological model

The Rammelsberg ore bodies are bound to the north and south by two large faults, named the eastern and western main faults. Much of the Gosetal anomaly is constrained between the same two faults. The northern limit of the Gosetal anomaly coincides precisely with the northern main fault.

The new geological model assumes that the two main bounding faults are reactivated faults that defined a sub-basin within the Devonian Goslar Trough during deposition of the Rammelsberg ore. The Gosetal anomaly (assumed mineralisation) and the Rammelsberg ore lie within the same sub-basin.
The Gosetal Anomaly

One-two kilometres west of the World class Rammelsberg mine
Lies within the Wissenbacher shales, similar to the Rammelsberg deposit
Almost two kilometre long footprint
Strike-parallel with the geological layering
Strong conductor, unique in the surveyed area
Shallow crustal level
Same depositional sub-basin as the Rammelsberg ore

Harz 2008 SkyTEM resistivity slice 200-220m masl
Integrated geological and geophysical modelling

Geological and geophysical modelling in an iterative process to approach each other within the boundary conditions of geological and geophysical data. Three dimensional Maxwell modelling of 3D conductor plates of the shallow conductor, based on the airborne TEM data.

TEM data along one of the flight lines as black lines. Red lines are calculated response based on the modelled plates A to F.
Modelled conductors

Geological profile along one of the TEM flight lines. The modelled upper conductor (blue dashed line) forms a synform-antiform pair at 100-400m depth. An alternative model with a deeper drill target is formed by the ore equivalent layer (same stratigraphic level as the Rammelsberg ore) at greater depth in red. A deep synform with the ore-equivalent layer was intersected in a near-by drill hole from the 1980’s.
Folded mineralised layer in green, overturned anti- and syncline, plunging shallowly to the southwest. Top of anticline ca. 100 m below surface.

Geological/geophysical profiles of the shallow conductor were combined in a 3D model of the folded conductor. Model seen viewing towards the northeast.
The concentric ellipses indicate a nested halo anomaly, and mark a redox cell above a SEDEX mineralisation. The white lines are the contoured TEM anomaly, of which the western part coincides with the SGH anomaly. The SGH anomaly is rated 6 out of 6, i.e. it strongly suggests a SEDEX mineralisation.
The core of the SGH anomaly is projected down as an elliptical cylinder. It fits perfectly with the steep limb of the syn-/antiform pair, which is the strongest conductor.
The first drilling phase

From October to December 2009 three holes were drilled to test the model of an upper folded conductor

First drill site: one hole at 70° to 372 m, one hole at 45° to 360 m, both plunging northwest

Second drill site: one hole at 45° to 245 m, plunging northwest

Down hole EM surveys in holes 1 and 3

Ground EM surveys along lines crossing the TEM anomaly

Up to six other holes are planned, testing the model of a deeper conductor and other parts of the anomaly
Drilling phase 1: three holes testing the upper target

Four holes were planned, but the planned steep hole at drill site 2 was not drilled
Results of the first drilling phase

The folded structure was confirmed

Two significant thrust faults were discovered

The folded conductor at 100-400m depth was not found

No ore-equivalent type layers were found

EM surveys found no conductors close to the drill holes or in the upper 200 m in the vicinity of the holes

The airborne TEM signals, on which the model was based, are now assumed to be an interference of a deep conductor and surface infrastructure

A strong EM signal in the area and EM soundings in the drill holes suggest the presence of a deep conductor
A deep conductor

The alternative solution of the collective data suggests the presence of a conductor at deeper levels.

A low-pass filter of the airborne TEM data removes the high frequency part of the signal mainly caused by the infrastructure at surface.

The filtered data show a large conductor in the Gosetal area, that is unique to the surveyed area.

The measured EM signal is very strong in the Gosetal area.

EM soundings in the drill holes suggest a conductor at about 500 m depth.

Extrapolation of drill hole data to the anomaly area indicate that the ore equivalent layer forms a deep synform, with a normal limb rising up to 500 m depth.

4% base metal mineralisation over 20 cm was found in the ore-equivalent layer in a drill hole few hundred metres from the target area.

The SGH geochemistry anomaly also fits with a deep conductor.
Low Frequency TEM anomaly at Gosetal

Low-pass filtered TEM anomaly overlain on the geological map. Note that the footprint of the anomaly is much larger than the conductor.
Latest geophysical survey

In order to obtain a better definition of the deep target at Gosetal, a down-hole and a ground EM survey was carried out, as well as a down-hole IP survey.

The down-hole EM survey, carried out with improved equipment since the previous time, confirmed the measurements from November/December 2009, indicating that no conductor occurs in the vicinity of the drill holes.

IP-down-hole measurements showed a conductivity level that was overall slightly higher than in previous measurements in the region in the 1980’s. No layers with significantly elevated conductivity were measured.

A 2 km long line across the Gosetal was surveyed by CSAMT. Unfortunately, the data could not be used as a result of high noise levels.
Present status of the project

The shallow conductor model has been tested and rejected

The alternative deep conductor will be the next drill target

Modelling of the deep conductor is still ongoing, based on the TEM data

The second drilling phase in the Gosetal area is planned for the fall of 2010
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