Rare Earth Elements (REE) exploration opportunities in Morocco
Summary

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A. Rare Earth Elements (REE)

Executive summary

Rare earth elements (REE) include the lanthanide series elements (La, Ce, Pr, Nd, Pm, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, and Lu) plus Sc and Y. Currently these metals have become very critical to several modern technologies ranging from cell phones and televisions to LED light bulbs and wind turbines.

Despite their designation as "rare" metals, they can have an abundance of the same order as that of common elements (e.g. cerium has the same order abundance like copper ≈ 33 to 66 ppm).

This flyer summarizes general properties of REE, distribution of REE occurrences in Morocco, their mineralogy, resources and types of deposits from the standpoint of the data obtained until the end of 2020.

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<th>Types of structures encountered in Morocco</th>
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<td>In Morocco REE are mainly associated with alkaline rocks. Several occurrences are known in Southern Provinces, High Atlas and in Anti-Atlas.</td>
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<td>REE-bearing U, Nb &amp; Ta mineralization is Archean age (Glibat Lafhouda deposit)</td>
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<td>REE-bearing U &amp; Nb mineralization is Cretaceous age (Twihinate, Lamlaga &amp; Lahjeyra deposits)</td>
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B. Main REE deposits in Morocco

6 Tamazirt (REE, Ta)
- REE in the Tamazirt massif are genetically related to the nepheline syenite complex, mainly to pegmatite veins and pegmatitide syenites; and carbonatites.
- The preliminary resource estimate shows a potential of 3 to 4 million tons at 0.74% Nb2O5; 0.18% Ta2O5 and 0.67% "Tr2O3 + Th".

7 Maden N'Kouiane (REE)
- In the Tamazirt massif, the monzodiorite dykes are included within the carbonatite. Which is overlapped by a large uranium anomaly.
- The resources estimation of Twihinate are 618 million tons at 0.84% REE and 0.28% Nb2O5.

5 Aghracha (U, REE)
- Aghracha prospect is located 180 km south-east of Dakhla city. The exploration work carried out on this prospect has revealed uranium and rare earth mineralization linked either to pegmatite dykes or to ancient placers.
- The results showed average REE contents of 1.3%, 1.5%, 3% and 4.6% on respective thickness of 25 m, 15 m, 3 m and 2.6 m.

2 Lamлага (REE, Nb)
- This deposit is hosted in the Paleozoic gneiss. The Landsat image shows the high contrast between the carbonatites and the gneiss. Iron oxide breccias are included within the carbonatite. Which is overlapped by a large uranium anomaly.
- The resources estimation of Twihinate are 596.7 million tons with an average grade of 0.9% REE, 0.32% Nb2O5 and 111 ppm U3O8.

3 Twihinate (REE, Nb)
- This deposit is hosted in the Paleozoic gneiss. The Landsat image shows the high contrast between the carbonatites and the gneiss. Iron oxide breccias are included within the carbonatite. Which is overlapped by a large uranium anomaly.
- The resources estimation of Twihinate are 596.7 million tons with an average grade of 0.9% REE, 0.32% Nb2O5 and 111 ppm U3O8.

4 Glibat Lafhouda (Nb, REE)
- This deposit is hosted in the Archean gneiss. The Landsat image shows the high contrast between the carbonatites and the gneiss that is also crossed by basic dykes oriented NE-SW. Iron oxide breccias are included within the carbonatite. Which is overlapped by a large uranium anomaly.
- Resources estimation of Glibat Lafhouda and Drag-Al Faman are 114 million tons at 0.3% Nb2O5, 272 ppm Ta2O5, 400 ppm U3O8 and 0.2 ppm in light rare earth elements.

1 Lahjeyra (REE, Nb)
- Lahjeyra prospect, discovered in 2011 by ONHYM, is located about 50 km NE of Lamлага at about 250 km south of the city of Dakhla. Geologically, it’s an oval structure at least 4 km long and 2.5 km wide with raised outcrops of vacuolar silica and iron oxide dykes.
- The estimated mineral resources show a potential of 372 million tonnes at 0.62% LREE, 613 ppm HREE, 0.34% Nb2O5 and 461 ppm Th.
## Twihinate (REE, Nb)

**Location**
This prospect, discovered by ONHYM in 2006, is located 260 km south of Dakhla.

**Geology**
The geological survey shows an annular structure over 5 km in diameter which crosses a Paleozoic basement. The complex includes vacuolar silica breccia, iron oxides and carbonatites.

**Work and results**
In this prospect, mineral resources are estimated at about 584.5 million tonnes with average grades of 0.7 % REE, 0.37 % Nb2O5 and 193 ppm U3O8. However, two high-mineralized zones can be delimited cumulating of about 216.2 million tons with 1.25 % REE and 0.34 % Nb2O5.

## Lamлага (REE, Nb)

**Location**
Lamlaga prospect is discovered in 2008 by ONHYM. This prospect is located 10 km north of Twihinate at about, 260 km south of Dakhla.

**Geology**
Geological survey carried out on this prospect shows an annular structure of approximately 2.5 km in diameter which crosses a gneissic Proterozoic basement. The complex is composed of various vacuolar silica breccia and iron oxides.

**Work and results**
Mineral resources are estimated at about 618 million tons at 0.64% REE and 0.28% Nb2O5. However, an area with resources of about 46 million tons with 0.95% REE, 0.12% Nb2O5 can be delineated.

## Lahjeyra (REE, Nb)

**Location**
Lahjeyra prospect, discovered in 2011 by ONHYM, is located about 50 km NE of Lamлага at about 250 km south of the city of Dakhla.

**Geology**
Geologically, it’s an oval structure at least 4 km long and 2.5 km wide with raised outcrops of vacuolar silica and iron oxide dykes.

**Work and results**
The estimated mineral resources show a potential of 372 million tonnes at 0.62% LREE, 613 ppm HREE, 0.34% Nb2O5 and 461 ppm Th.
### Glibat Lafhouda (Nb, REE)

**Location**
Glibat Lafhouda prospect, discovered in 2006, is located 70 km SW of Aousserd town.

**Geology**
This prospect is a mass made up of carbonatites and mineralized iron oxides. The exploration works carried out in this zone allowed to circumscribe the volume of iron oxides.

**Work and results**
Mineral resources are estimated at about 114 million tons at 0.3% Nb2O5, 272 ppm Ta2O5, 400 ppm U3O8 and 0.2 ppm in light rare earth elements. (Ce + Eu + La + Nd + Pr + Sm).

### Aghracha (U, REE)

**Location**
Aghracha prospect is located 180 km south-east of Dakhla city.

**Geology**
The exploration work carried out on this prospect has revealed uranium and rare earth mineralization linked either to pegmatite dykes or to ancient placers where grades reach 10% REE and 0.1% uranium. Core drilling campaign totalling 1,340 m was carried out in 2014.

**Work and results**
The holes intersected rare earth mineralization at a depth of less than 50 m. The results showed average REE contents of 1.3%, 1.5%, 3% and 4.6% on respective thickness of 25 m, 15 m, 3 m and 2.6 m. The rare earth mineralization of Aghracha is contained in allanite and epidote.

### Tamazirt (REE)

**Location**
In the High Atlas, some REE occurrences are known in the Tamazirt massif which is located 15 km south-east of Midelt town.

**Geology**
Rare earth minerals in the Tamazirt massif are genetically related to i) the nepheline syenite complex, mainly to pegmatite veins and pegmatitide syenites which may also contain high levels of radioactive elements; ii) and carbonatites characterized by high grade of thorium, tantalum, niobium and rare earth elements.

Tafrout prospect is the most interesting in this area. It is located in the southwest part of the north carbonatite zone. It presents great concentrations irregularity in both surface and depth.

**Work and results**
The preliminary resource estimate shows a potential of 3 to 4 million tons at 0.74% Nb2O5; 0.18% Ta2O5 and 0.67% "Tr2O3 + Th".

### Maden N’Kouiane (REE)

**Location**
In the l’Maden N’Kouiane prospect which located in Oumjerane region at Anti – Atlas,

**Geology**
Apatite in galena barite veins are particularly enriched by rare earth elements. This enrichment is explained by the primary presence of these elements in the host rocks.

**Work and results**
At l’Maden N’Kouiane prospect, rare earths elements are concentrated in barite veins mainly in the apatite.
D. Contact information

Data packages
A variety of information and data packages are available. These packages contain well, geological and geophysical data together with short reports describing the mining potential.

Add the redirection to the online platform GIS when operational

References
Add the documentary sources used in geological descriptions and analyses (e.g. scientific publications, technical reports, etc.)

More information
Interested parties are invited to get in touch with ONHYM for further information concerning technical, legal and contractual details or for any other queries regarding participation in exploration and production in Morocco. Further information regarding legal and contractual details is available in the general promotion booklet.

Please visit us on: www.onhym.com

Add the links to ONHYM's social networks when operational

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