

British Geological Survey

## Gateway to the Earth



#### www.eurare.eu

#### Kathryn Goodenough and the EURARE partners



## exploitation scheme for Europe's REE deposits

- Over 20 partners, Europe-wide, research & industry
- 5-year EC-funded project from 1 January 2013
- Characterising European REE resources and developing new ore beneficiation technologies
- Aims to safeguard EU supply of REE raw materials



















#### Work package 1: **Assessment of European REE resources** and REE demand

- Task 1.1 Compiling current knowledge on REE resources and REE demand within Europe
- Task 1.2 Developing a knowledge base of potential deposits and occurrences, including new research on poorly-known occurrences
- **Task 1.3** Development of an integrated knowledge management system



WP1 lead; Denmark & Greenland resources

IKMS lead; France

resources

Finland resources



UK & non-partner country resources



Market survey

ges geologiska undersökning Geological Survey of Sweden

Sweden resources

Norway resources



Greece resources



#### Task 1.1

- Table produced showing all known REE deposits and significant occurrences in Europe. > 100 individual deposits/occurrences
- Based on geological experts critically assessing all knowledge on REE in their country – specifically done for EURARE
- Range in size from large economic deposits (e.g. Kvanefjeld, Norra Kärr) to small and currently of academic interest only. Few formal resource/reserve estimates
- Information about key countries and deposits is disseminated via the website <u>www.eurare.eu</u> (over 20,000 visitors in 2014)
- REE market survey in progress (d'Appolonia)



#### Map of European REE occurrences



#### Key : alkaline igneous rocks : carbonatite : hydrothermal : iron ore : laterite/bauxite : marine : pegmatite/granite : placers

Rare

sustainable exploitatio



### **Types of European REE resources**



Range of tectonic settings

are

- c. 100 total occurrences assessed: includes <10 deposits with formal resource estimates, many smaller occurrences
- Europe here = EU countries & candidate countries, Norway, Greenland



#### **European alkaline igneous provinces**



Important REE deposits/ occurrences - 1: Sarfartoq; 2: Qeqertaasaq; 3: Kvanefjeld, Kringlerne and Motzfeldt; 4: Fen; 5: Norra Kärr; 6: Alnö; 7: Sokli; 8: Aksu Diamas





#### Anatomy of a magmatic rift system



Primary deposits in southern Europe are likely at depth below surface



#### Task 1.2: European REE research

Within the context of the EURARE project, the surveys are engaged in research at a number of localities:

- Finland Sokli carbonatite, livaara alkaline complex
- Greece bauxites and placers
- Greenland Ilimaussaq and Motzfeldt syenite complexes
- Norway Gloserheia pegmatite and Biggejavri albitites
- Romania Ditrau alkaline complex
- Sweden Bergslagen district, Alnö carbonatite, pegmatites
- Turkey Aksu diamas placer and bauxites

Review paper in preparation – collaboration with ASTER

#### Every deposit is different! Type, mineralogy, size, REE ratios..







### Major challenges for European REE industry

- Work in WP1 shows that Europe has many REE resources
- However, every REE deposit is different in mineralogy, grain size, texture, U and Th content....
- Beneficiation and extraction of REE is a major challenge
- Has to be environmentally friendly and economically worthwhile
- Addressed in EURARE by WPs 2-5





Coarse grain size, simple texture: Benefication relatively easy Finer grain size, complex texture: Beneficiation more difficult



## WP2 – Ore beneficiation

Progress on beneficiation & production of concentrates for:

- Kvanefjeld (Greenland)
- Kringlerne (Greenland)
- Norra Kärr (Sweden)
- Olserum (Sweden)
- Fen (Norway)





Representative Ore Sample

Quantitative Mineralogy

Trial a Range of Beneficiation Methods

Optimise the Best Method (Bench Scale)

Locked Cycle Testwork

Demonstration or Pilot Plant Scale (tonnes of ore)

#### Pilot plant stage now reached: Kvanefjeld ore









### **WP3: REE extraction technologies**

- Successful leaching of low grade concentrate with low mineral acid consumption, under atmospheric conditions
- Leaching REEs in water-free lonic Liquid (IL) systems successful first results
- Selective leaching of REE from red mud using lonic Liquidssuccessful first results





# WP3: Innovative REE separation technologies

- Innovative water-free IL liquidliquid REE separation systems – successful first results
- Innovative separation through the use of suface modified Magnetic Nano Particles -successful first results
- Investigation of state-of-the-art solvent extraction (S-X) systems successful first results











# WP4: Innovative / optimized REE metal production technologies

- Investigation for optimization of state-of-the-art molten salt electrolysis cell (Chinese technology)
- Successful La electrodeposition at atmospheric conditions in water-free Ionic Liquid system







## Summary

- The EURARE project aims to set the basis for an European REE industry, and is half-way through 5 years of funding
- The project has assessed European REE resources and is carrying out research on those resources
- Beneficiation, extraction, and separation techniques are all under development
- Regulation and environmental aspects are also studied
- <u>www.eurare.eu</u>

