TREIBACHER INDUSTRIE AG

Innovation is our tradition.

SELTENE ERDEN RECYCLING UND EXTRAKTION

Rare Earths Recycling and Extraction

-

REREX

Produktion der Zukunft – Kritische Rohstoffe

19.03.2014

Dr. Stefan Pirker, Head of R&D

Carl Auer von Welsbach
Rare Earth Scientist, Entrepreneur and Company Founder

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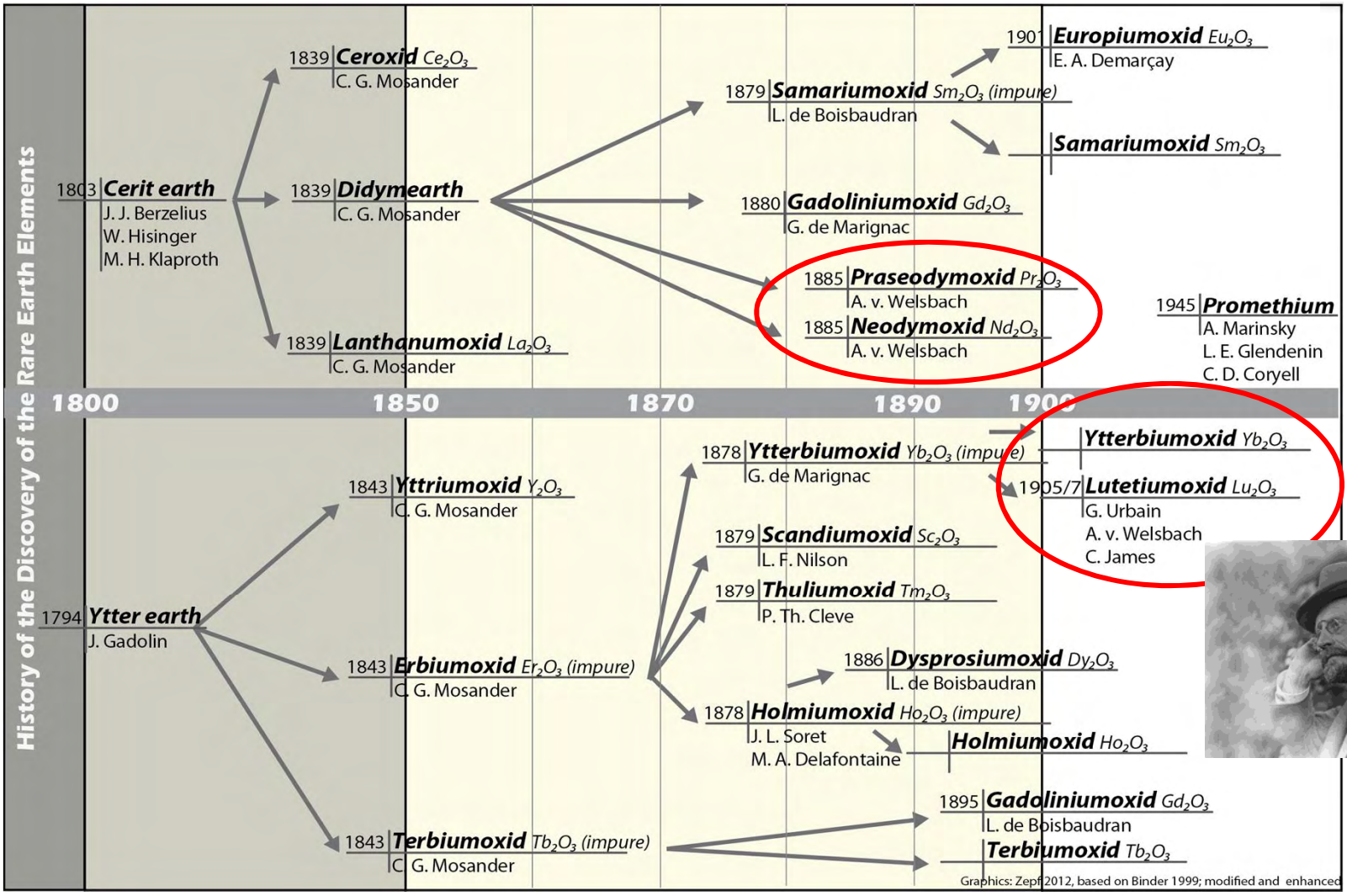


Source:
PhD thesis,
V. Zepf, 2012,
Univ. Augsburg

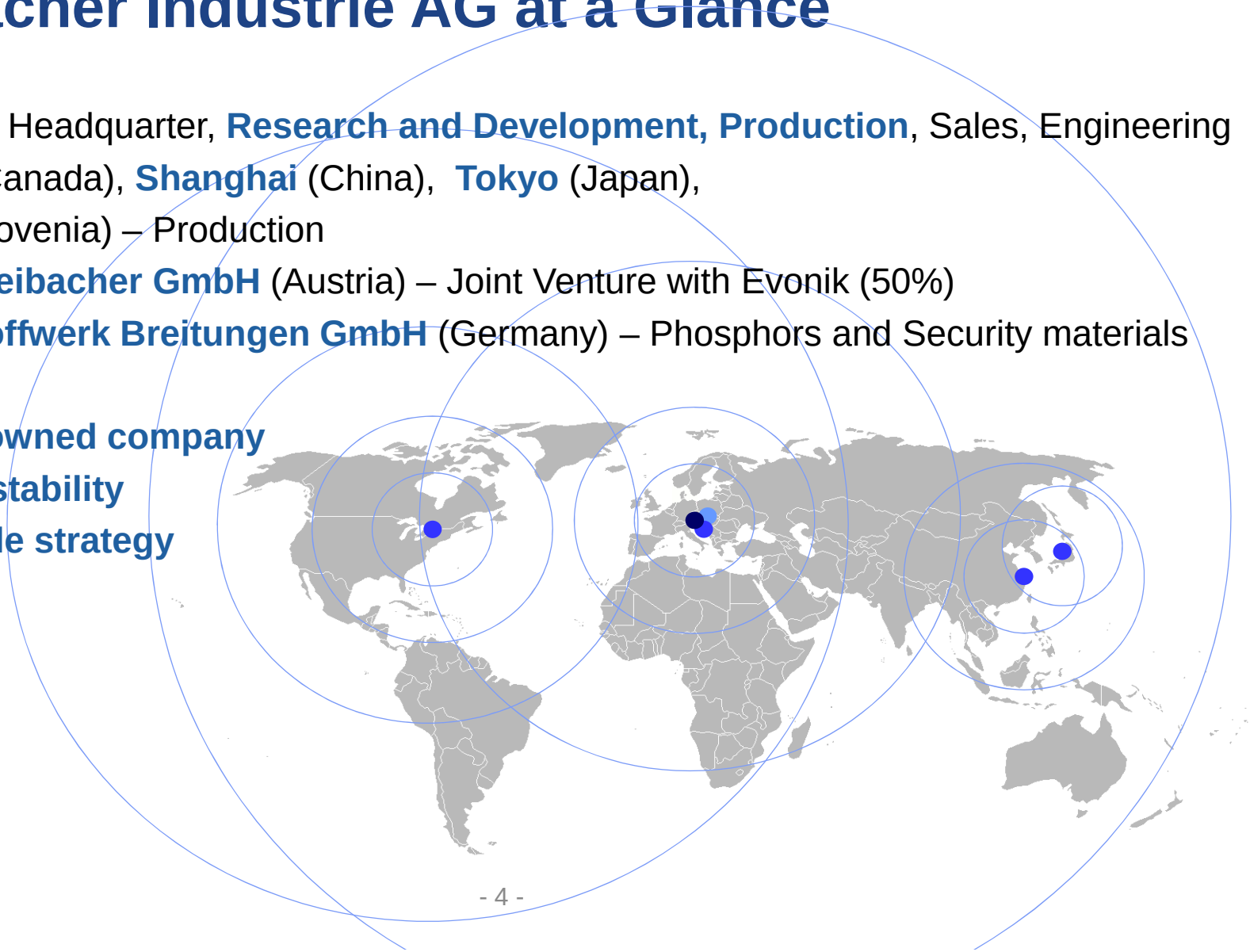
Our History – Rare Earths from the Beginning

- **1898** **Carl Auer von Welsbach founds the company**
- **1903** Production of **Rare Earth containing Mischmetal** and **lighter-flints**
- 1916 Ferro alloy production
- **1949** Production Sodium Perborate and **Rare Earths Compounds**
- 1959 Production of Hard Metal Powders
- 1969 Vanadium Oxide Production
- **1978** **Recycling activities** of metal-containing waste
- 1985 Vacuum alloy production
- **1983** Production of **Rare Earths containing Storage Alloys** for batteries
- **1992** Production of **Rare Earths containing materials** for investment casting
- 1995 ISO 9001 Certification
- **1996** Production of Materials for **Rare Earths** and Vanadium **containing catalysts**
- 1996 Treibacher Auermet d.o.o. in Ravne/Slo is founded
- **2002** **Acquisition of Rare Earths Business** from Meldform/UK
- **2004** Supply of API **Rare Earth** starting material for the pharmaceutical industry
- 2004 Production of nickel based alloys
- **2008** Production of **Rare Earths** containing feed additive
- 2012 GMP certificate is awarded
- **2013** Acquisition of Leuchtstoffwerk Breitungen GmbH – **Rare Earths materials**

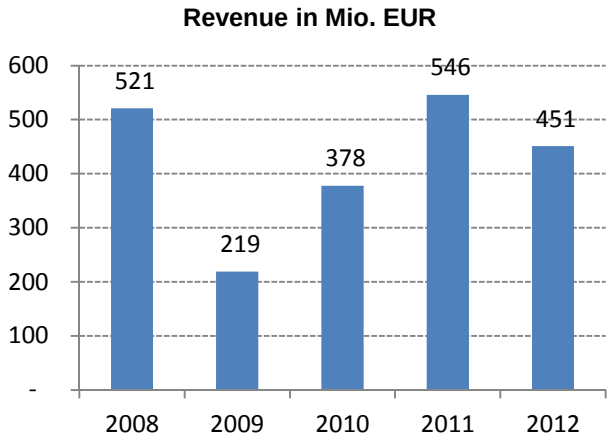
Treibacher Industrie AG at a Glance

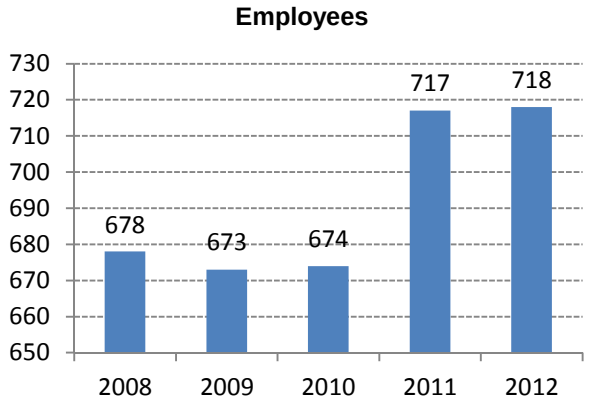
- **Althofen** – Headquarter, **Research and Development, Production**, Sales, Engineering
- **Toronto** (Canada), **Shanghai** (China), **Tokyo** (Japan),
- **Ravne** (Slovenia) – Production
- **Evonik Treibacher GmbH** (Austria) – Joint Venture with Evonik (50%)
- **Leuchtstoffwerk Breitungen GmbH** (Germany) – Phosphors and Security materials

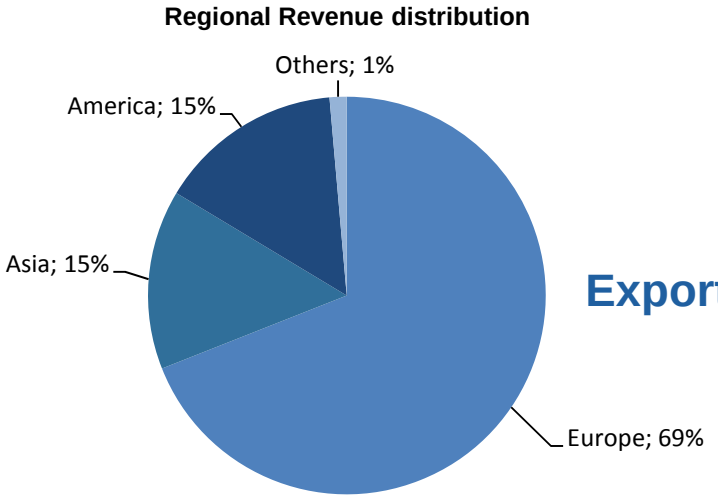
- **Privately owned company**
- **Financial stability**
- **Sustainable strategy**



Facts and Figures 2012







Exportquota >85%

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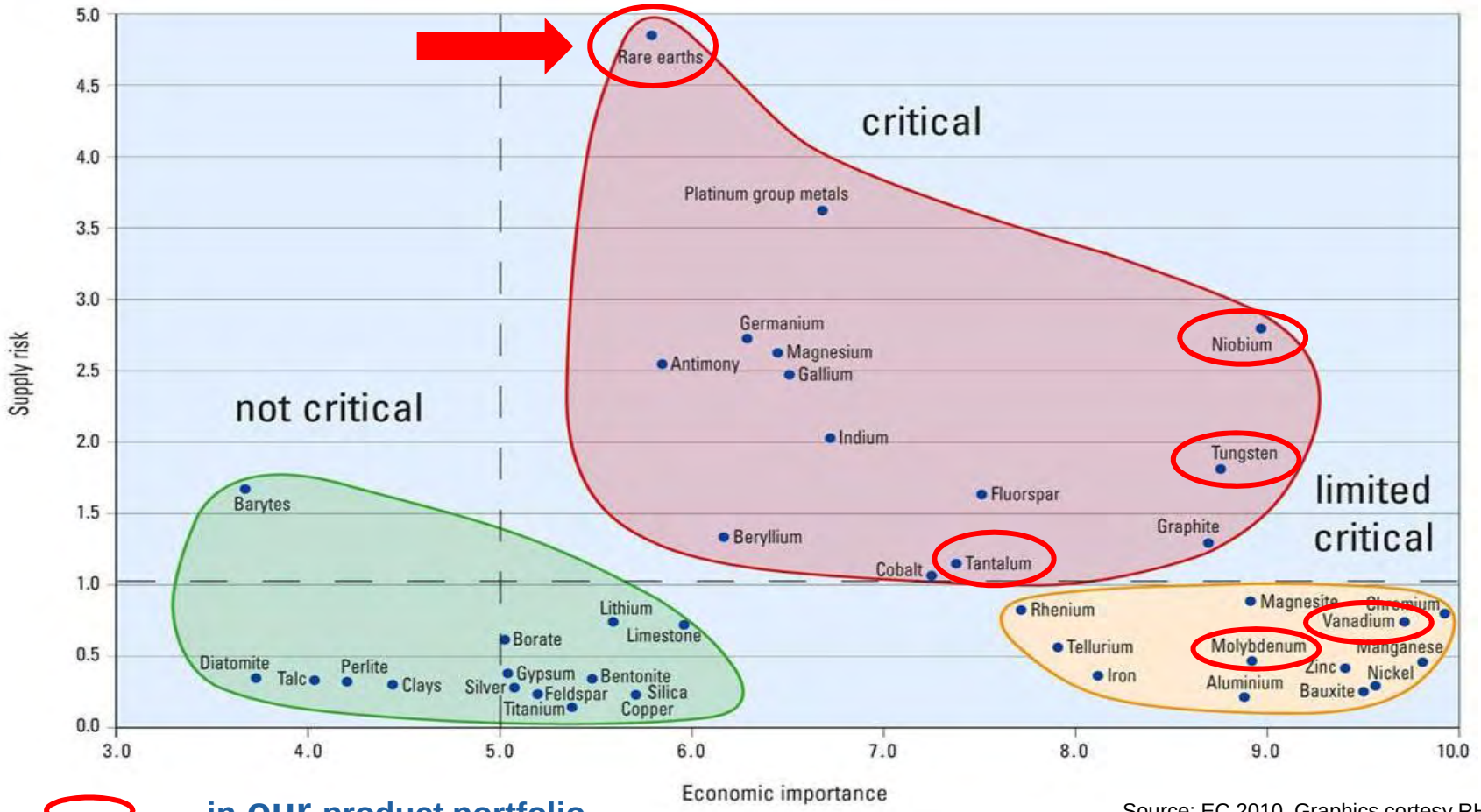
EC Rawmaterials Initiative - 14 critical Rawmaterials



… in our product portfolio

Source: EC 2010, Graphics cortesy RHI AG

Rare Earths ?

“the vitamines for modern life”

Group of 17 closely related chemical elements (f-elements)

Exceptional properties for high performance materials

- Fluorescence
- Colouring
- Oxygen On/Off-take
- Magnetic Moment
- Conductivity
- Hydrogen Storage Capacity
- …

Traded as:

Oxides, Carbonates, …

Pure Metalls:
Y, Nd, Ce, Dy > 99%

Alloys
Didym = Nd/Pr
Mischmetall = Ce/La/Pr/(Nd)
FeNd

Sc

Y

Light *Middle* *Heavy*

La Ce Pr Nd Pm Sm Eu Gd Tb Dy Ho Er Tm Yb Lu

RE Applications

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Phosphors, Luminescence
~ 8%

- Energy efficient lighting
- LED, LCD, plasma diplays
- Laser

Ce, La, **Eu, Tb, Y,** Gd

Others
~ 6%

- Water treatment
- Pigments
- Fertilizers, animal feed
- Nuclear technology
- Defence

Ce, La, Gd, Y

Glass, Polishing, Ceramics
~ 26%

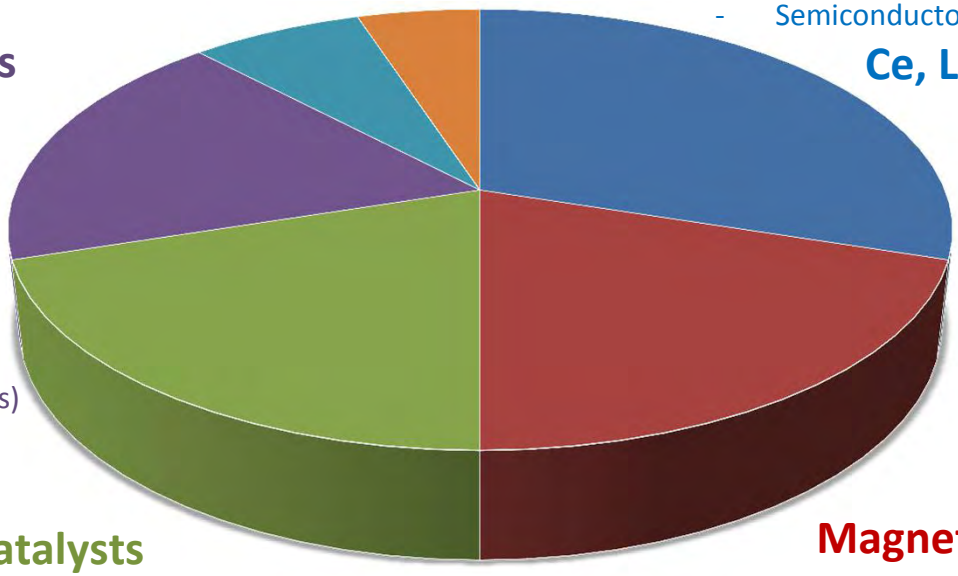
- Polishing compounds for glass
- Colouring, decolouring in glass mft.
- Ceramic stabilizers (bio-, structural-)
- Electroceramics (e.g. MLCCs)
- Ion conductors (eg SOFC, membranes)
- Semiconductor mft.

Ce, La, Y, Sc, Ho, Dy

Metal alloys, batteries
~ 20%

- Steel and iron casting
- Super alloys
- Flintstones
- NiMH batteries
- Fuel cells
- Hydrogen storage
- Light weight constr. (e.g. cars)

Ce, La, Pr, Nd, Sm, **Sc**



Catalysts
~ 19%

- Automotive for TWC, DOC
- Refining, chemical processing
- Fuel additive for DPF

Ce, La, Pr, Nd, Y

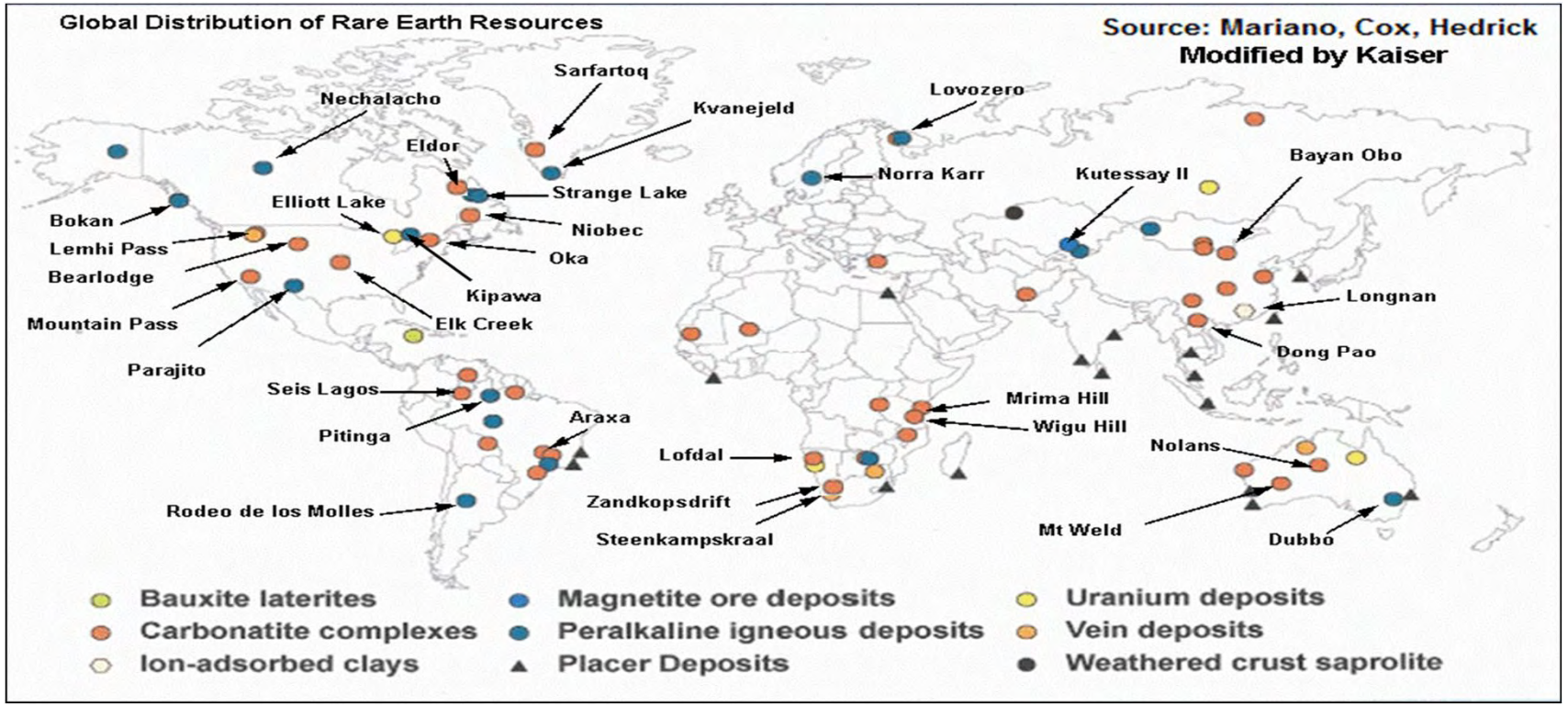
Magnets
~ 21%

- Motors and generators (windturbines, electric cars, hybrids)
- Hard discs
- MRI
- Speakers
- Magnetic cooling

Nd, Pr, Dy, Sm, Tb, La

Source: Öko-Institut, TIAG, 2012-14

RE Mining Projects – Need for Separation Technologies



More than 400 RE-projects being (mainly financially) developed

Demand for extraction and separation technologies needed esp. for HREE (Y, Sc, Dy)

China still >90 % market share, Lynas and Molycorp struggle (esp. LREE, cost bench-mark)

Past price hike not sustainable, HREE special situation

RE-Recycling – Challenging Conditions

Most RE-applications are highly diverse and dissipative

Demand for complex physical and chemical extraction and separation technologies needed

Bench-mark – primary production

Past price hike not sustainable

HREE of interest

Legislative pressure

RE-waste typically not toxic, no hazardous waste, no radioactivity
Limited legislative pressure to collect RE

REREX – Our Project

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Target: Technology	Workpackages
Development of new manufacturing processes for recycling and mining concentrates focused on Heavy Rare Earths (HREE), e.g. Yttrium, Scandium and Dysprosium	▸ **RE Cracking of HREE feeds for concentrates** (e.g. Yttrium, Scandium and Dysprosium) ▸ **Extractiontechnologies for HREE** New and improved fluid-extraction processes Supercritical CO_2 Extraction ➔ **one main institutional Italian partner** ➔ **project volume of approx. Euro 2.5 mio**

Source: ENEA

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