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TREM11 Panel
Linking the Supply Chain
Strategies Beyond the Mine

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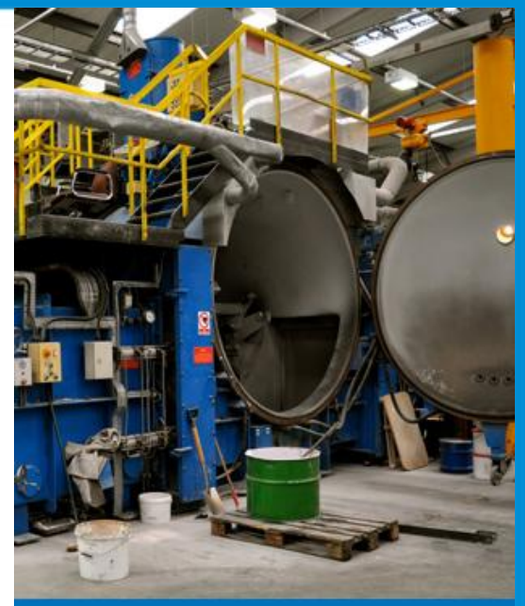
TECHNOLOGIES INC

LCM
less common metals

Rare Earth Supply to LCM.
The Benefits of a Mine Supply Policy.

- Less Common Metals has been operating since 1992 in North West England.
- LCM manufactures metals and alloys for many industries, in particular permanent magnet alloys.
- Founded and run by former Johnson Matthey technologists.
- A counter view – this was not a mine looking for market, this is a manufacturer seeking materials supply.
- In 2007 LCM decided that a squeeze on materials supply was inevitable.
- In 2008 GWMG purchased LCM as a good fit with their “Mine to Markets” policy



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Rising Demand for RE Materials (REO t)

REE Application	REO	2008 Demand	2015f Demand
Permanent Magnets	**Nd,** Pr, **Dy**, Tb, Sm	26,500	48,000
NiMH Batteries	**La**, Ce, Pr, Nd	22,500	35,000
Catalysts	**Ce, La**, Pr, Nd	23,000	28,500
Phosphors	**Eu, Y, Tb**, La, Dy, Ce, Pr, Gd	9,000	13,000
Polishing Powders	**Ce,** La, Nd, mixed	15,000	30,500
Glass Additives	**Ce, La**, Nd, Er, Gd, Yb	12,500	11,000
Ceramics, other	Mixed	15,500	19,000
Total		**124,000**	**185,000**

Source: IMCOA 2010

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Technical Outlook

The unique physical properties of rare earths with iron and cobalt are proving increasingly irreplaceable in the field of permanent magnet technology.

Permanent magnet materials are seen as the drivers in the rare earth industry.

In perspective, the rare earths have only been available in economic quantities for 50 years. This opens 15% of the periodic table to expoitation.

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Working Backwards from the Market to the Mine

- LCM and its sister company in the US, Great Western Technologies of Troy, Michigan, consume a variety of rare earth oxides, chemicals and metals to produce alloys for customers.
- Most notably given the worldwide reputation that LCM has for permanent magnet alloys (NdFeB and SmCo), demand from customers for integrated rare earth supply from the mine is extremely strong.
- Expansion in production capacity for permanent magnet alloys will consume all of the first phase rare earth production of relevant RE's from the GWMG Steenkampskraal mine operation.

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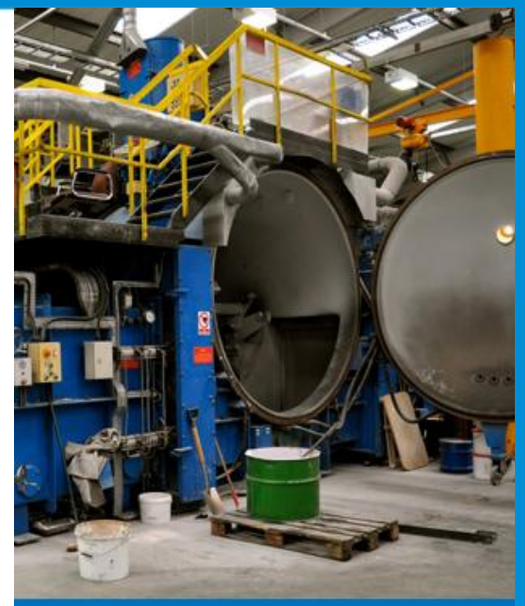
Producing Metals and Alloys

- LCM and GWT consume RE oxides metals and fluorides for metal and alloy production.
- Processes in development, to increase production and consume future mine supply is the fused salt electrolysis of rare earth oxides, particularly applying to lanthanum, neodymium and praseodymium.
- LCM will also expand capability in calciothermic reduction of rare earth fluorides, particularly for dysprosium, terbium and yttrium.
- LCM currently operates a co-reduction process for converting samarium oxide to samarium cobalt and we will rebuild facilities to produce samarium metal.



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Samarium Cobalt by Co-Reduction

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Projected Alloy Production for LCM/GWTI

REO	Metal to LCM/GWTI	Alloy Produced
Lanthanum	64	160
Praseodymium	112	373
Neodymium	386	1,061
Samarium	54	180
Dysprosium	16	225
Yttrium	6	8
TOTAL (Tonnes)	**638**	**2,077**

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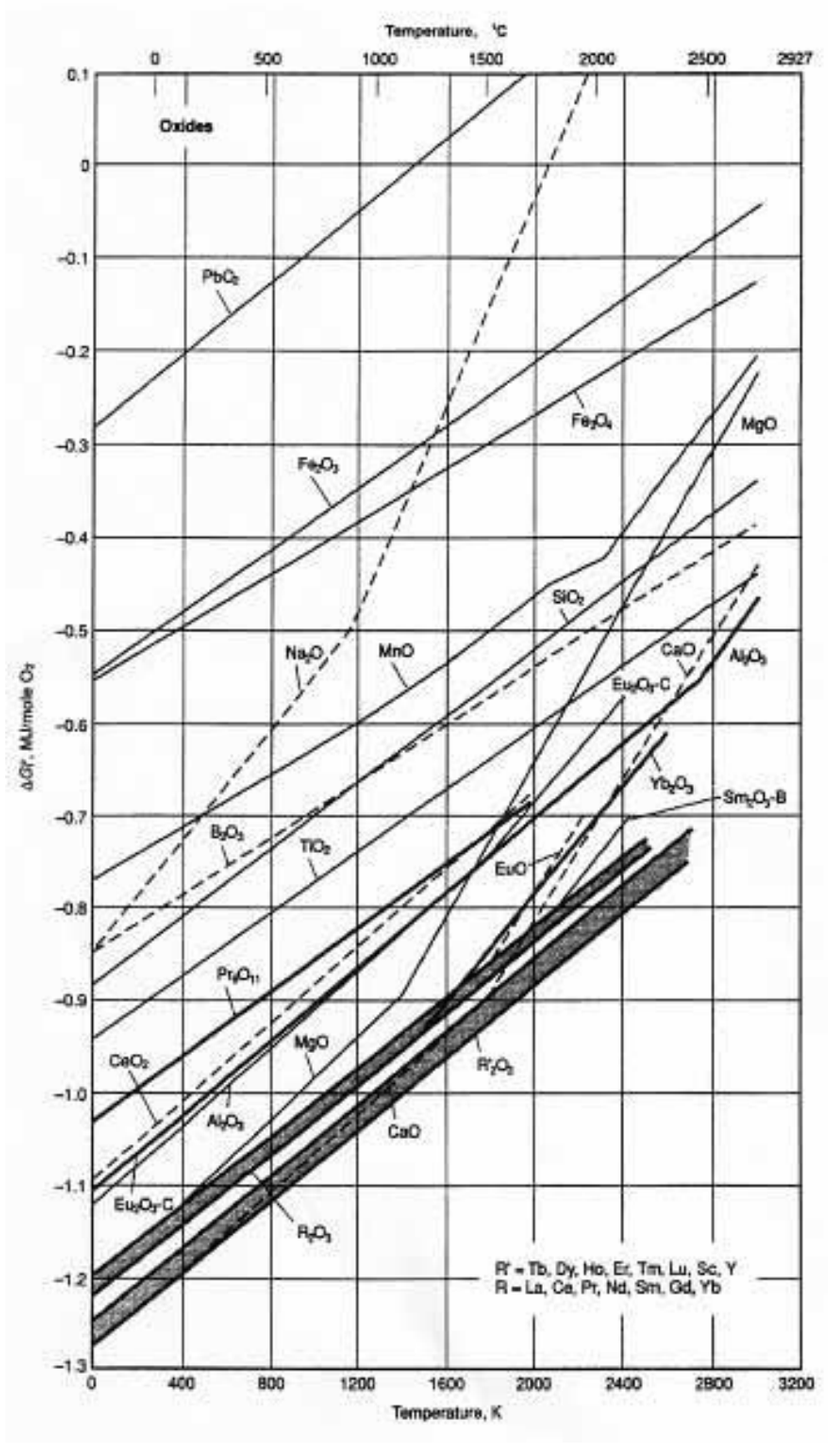
A Reminder. Rare Earth Metals Processing is Challenging

Ellingham Diagram

- Free energy of formation of oxides.
- Rare earths are difficult to reduce.
- Chemical properties are bunched together.
- RE metals will react with their environment.



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Projected Processing Outputs Phase 1

REO	Total Hypothetical REO Feedstock	REE Converted to Metal	REE Metal to LCM/GWTI
Lanthanum	585	75	64
Cerium	1,261	0	0
Praseodymium	135	135	112
Neodymium	450	450	386
Samarium	68	63	54
Europium	2	0	0
Gadolinium	45	0	0
Terbium	2	0	0
Dysprosium	18	18	16
Holmium	1	0	0
Erbium	2	0	0
Thulium	2	0	0
Ytterbium	2	0	0
Lutetium	0	0	0
Yttrium	135	8	6
TOTAL (Tonnes)	**2,708**	**749**	**638**

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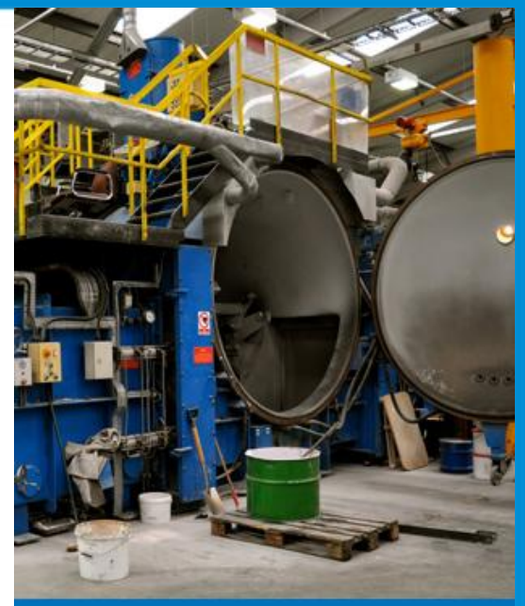
Separating the Rare Earth Mixture

- Individual rare earths are hard to separate one from another.
- The method of choice is “Solvent Extraction” which is a continuous chemical process that exploits the trivial differences in solubility of rare earths in aqueous and organic phases.
- Originally developed in the UK by government laboratory and Thorium Ltd. The T2 plant was used for Eu, Tb and Y production for phosphors in colour television applications.
- GWMG will run Solvent Extraction of rare earths in South Africa.



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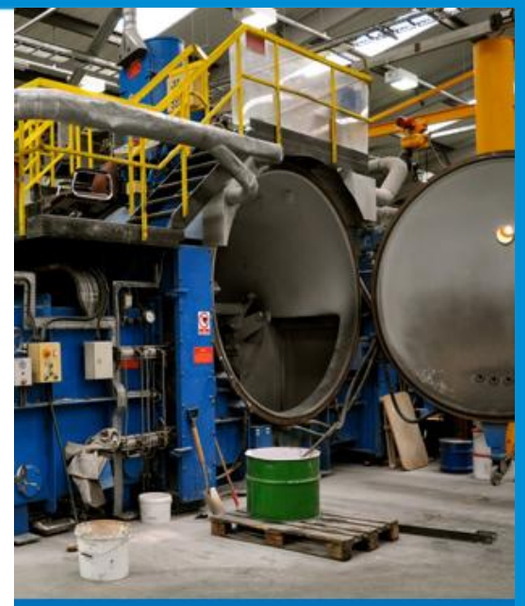
Breaking the Mineral for Solvent Extraction

- Monazite from Steenkampskraal is one of the three types of minerals that have routinely been processed, along with Bastnaesite and Xenotime.
- Feed to the solvent extraction is generated as a chloride from leaching of hydroxides produced from cracking of the mineral concentrate with caustic soda.
- By-products of copper and tri-sodium-phosphate will be sold separately.



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Steenkampskraal

- First Phase 2,700t per year for 10 years.
- Next step is feasibility and drilling to measure resource.
- Reassessment of target capacity. Probably building processing for 5,000t per year.
- Monazite of estimated composition from earlier mining:

  Ce: 46.5%

  La: 21.5%

  Nd: 16.5%

  Pr: 5%

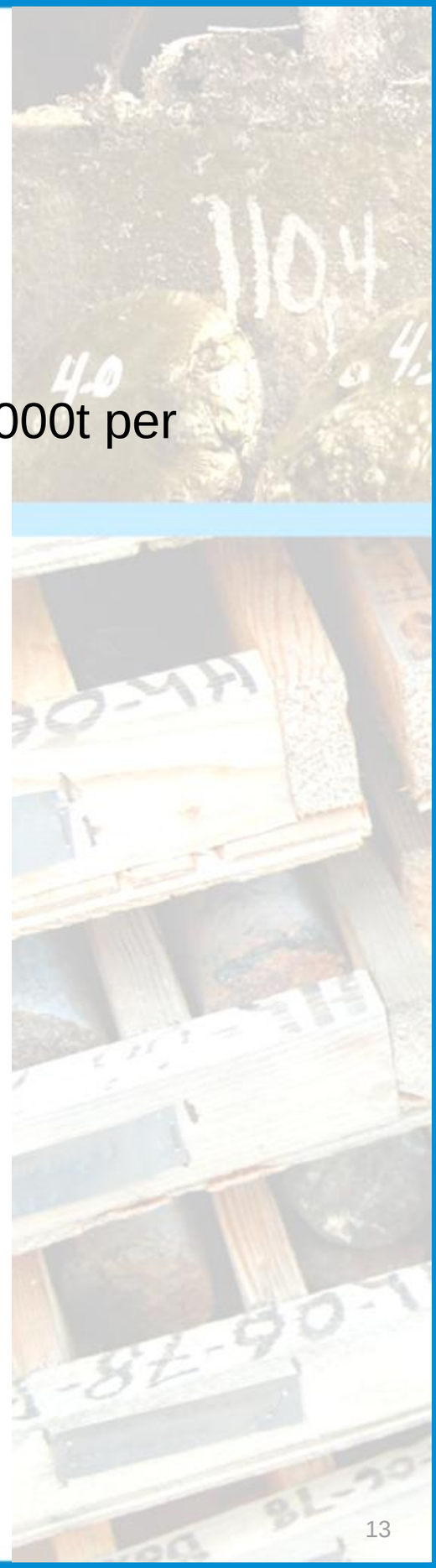
  Y: 5%

  Sm: 2.5%

  Gd: 1.5%

  Dy: 1%

  Others: Balance.



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A Rare Earths company creating a self-sufficient supply chain through exploration, mining and value-added processing.

Recent highlights include:

- **Raised $35 Million in an oversubscribed issue.**
- **Moving forward to production at Steenkampskraal South Africa.**
- **Agreement in place to take 100% of Steenkampskraal RE's.**
- **Acquired over 90% ownership of Rareco.**
- **100% expansion of RE alloy processing capacity underway.**

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