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RARE EARTH IONIC CLAYS - PROVIDING SECURE AND DIVERSE HREE SUPPLY TO OEMS

By

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ABSTRACT

Today the global rare earths industry faces a herculean task to meet the growing rare earth needs of the high technology manufacturing industry. Why 'herculean'; because quite apart from COVID19, rare earths end users are faced with the twin issues of security of supply and rising prices.

Nevertheless, despite COVID19, the forecast demand for rare earths in 2022 will be >25% than last year; an unprecedented increase that has not been seen since the last century.

Rare earths used in the production of high strength permanent magnets (REPMs) is the main driver of the industry; constituting 30% by volume and 90% of the consumption. Complicating the rising demand for the seventeen rare earths is the fact that the ratio in which they are consumed does not match the ratio in which they occur or are produced. Furthermore, the two rare earths, terbium and dysprosium, enable REPMs to function at high temperature and are only produced in China from ionic clays.

The recent discovery of ionic clay deposits in Australia is therefore strategically significant and provides us with unique metallurgical opportunity to bring them into production within the next 5 years.

Dudley Kingsnorth's presentation will trace the history of the industry over the past decade to explain the rationale behind the current status quo. This will be used as the basis to forecast demand through to 2030, thereby identifying the prospects for Australian heavy rare earth projects.

Keywords: Rare Earths, high strength permanent magnets (REPMs) ionic clays, terbium, dysprosium, Australian deposits

"Rare Earth Ionic Clays - Providing Secure and Diverse HREE Supply to OEMs"

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1

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2

2

SUMMARY OF PRESENTATION

- The Rare Earths Market Today
- China's 50 Year Journey to Rare Earths Market Dominance
- The Global Situation in the ROW Rare Earths Industry
- The Challenges Facing ROW Rare Earth Projects
- Rare Earth Ionic Clays Provide Security of Supply

NOTES:

1) RE refers to rare earths
2) REO refers to rare earths oxides, the accepted form of expressing demand and supply
3) REPM refers to rare earth permanent magnets
4) ROW refers to Rest of the World (outside China)
5) LREEs refers to Light Rare Earth Elements
6) HREEs refers to Heavy Rare Earth Elements

3

THE RARE EARTHS MARKET TODAY

4

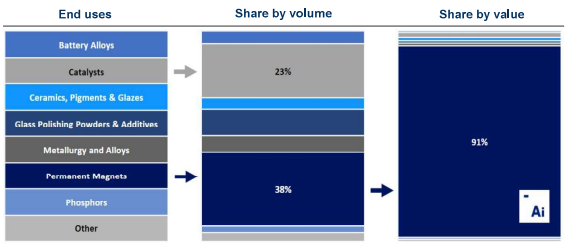
THE RARE EARTHS MARKET TODAY

- Estimated demand 2022 : ~250,000tpa REO
- Global Rare Earths Market 'Value': US$8-10B
- China is dominant (supplying 85-90% and consuming 70-80% of global demand)
- Magnet REs are ~30% by volume and >90% by value of the market
- Several non-Chinese projects are being evaluated; hampered by high capex and long developments times

5

RARE EARTHS – CRUCIAL FOR THE PERMANENT MAGNETS USED IN ELECTRIC DRIVES

- **Rare earth elements include the 15 lanthanides plus scandium and yttrium**
- REEs are **used in many high tech, green applications,** such as magnets in EVs and wind turbines, generally in small volumes but **critical to performance**
- **NdFeB magnets contain about 30% NdPr, 5% Dy,Tb** & 65% iron
- Forecast shortages of NdFeB as soon as 2023, with **demand increasing from ~200,000tpa in 2021 to over 400,000tpa by 2030,** with shortages in the order of 30% predicted as soon as 2025



EVs — Electric vehicles use between 1-2kg of NdFeB

Wind turbines — Direct-drive wind turbines can require upwards of 3 tonnes of NdFeB

6

7

CHINA'S SUCCESSFUL RARE EARTHS TRANSFORMATION

(Successful Goal: to maximise the benefits of China's rich endowment of rare earths to the Chinese people through long term downstream job creation)

- 1970s: Rare earth mineral concentrates
- 1980s: Mixed rare earth chemical concentrates
- Early 1990s: Separated rare earth oxides and metals
- Late 1990s: Magnets, phosphors, polishing powders
- This Century: Electric motors, computers, batteries, LCDs, mobile phones, EVs, hybrid vehicles
- The Goal: *Made in China 2025:* Downstream process >50% of domestic rare earths through to final products (OEMs) by 2025

8

"LINES IN THE SAND"

- 2000 onwards China has sponsored and encouraged the vertical integration of the rare earths sector; while ROW sector has continued to segregate
- In July 2010 China reduced the Rare Earth Export Quotas by 40%: which meant that ROW demand exceeded the sum of ROW supply plus the export quotas
- In September 2010 when China suspended shipments of rare earths to Japan to support a territorial dispute - it marked the drawing of a line in the sand. ROW recognises that it could no longer depend on China's commitment as a long term supplier of rare earths free of political considerations.
- In 2020 the unhealthy dominance (>90%) of China as the supplier of chemicals for COVID testing became evident – ROW adopts *diversity for long term sustainability*
- In February 2022, MIIT allocated >95% of the China Rare Earth Mining Production Quotas to 2 SMEs

CHINESE RARE EARTH PRODUCTION QUOTAS*

2020 – 2022 (TONNES REO)

GROUP	2020 TOTAL		2021 TOTAL		2022 TOTAL (BASED ON DOUBLING 1H2022 QUOTAS – ROUNDED)	
	MINING	SEPARATION & SMELTING	MINING	SEPARATION & SMELTING	MINING	SEPARATION & SMELTING
NORTHERN RARE EARTH	70,750t	60,984t	88,250*	76,550t*	120,425t	107,550t
CHINA RARE EARTH (CHINALCO)	16,850t	21,879t	20,450t*	28,650t*	73,800t	69,400t
GUANGDONG RARE EARTH	2,700t	10,604t	3,250t	12,700t	3,250t	12,700t
XIAMEN TUNGSTEN	3,440t	3,963t	4,150t	4,750t	4,125t	4,750t
SOUTHERN RARE EARTH	36,250t	23,912t	49,500t	32,550t	Nil	Nil
CHINA MINMETALS	2,010t	5,658t	2,400t	6,800t	Nil	Nil
TOTALS	**132,000t**	**127,000t**	**168,000t**	**162,000t**	**201,600t**	**194,400t**

NOTES:

* The Quota is actually the volume of RECO3, allowing for recoveries during primary processing the actual volumes mined are ~25% greater.

1) Over the past 2 years the Chinese Rare Earth Production Quotas have increased by >50% (compared with 6-8%p.a. over previous years), which is a clear reflection of China's commitment to increasing it's share of the global rare earths sector through rapid expansion.
2) * Consolidation of the industry continues, with only the two major SOEs receiving increased Quotas, with a combined total >95% of the Mining Quota
3) In spite of the impact of COVID19 China is forecasting growth in demand in 2022 of 25%p.a. Given the status of current ROW projects under consideration and the times to start-up China's share of the global market will increase over the next 3-5 years.

CHINA IS THE ONLY COUNTRY WITH A COMPLETE SUPPLY CHAIN

	MINING	MREC	REO SEPARATION		OXIDE TO METAL	MAGNETS
			LREE	HREE		
CHINA	✔	✔	✔	✔	✔	✔
JAPAN				✔	✔	✔
AUSTRALIA	✔	✔				
UNITED KINGDOM					✔	TBA
UNITED STATES	✔	✔	In development		Idle	
ESTONIA			✔			
GERMANY						✔
FRANCE			Idle			
MALAYSIA		✔	✔			
RUSSIA	✔	✔	✔			
INDIA	✔	✔	✔			
VIETNAM					✔	✔
OTHER	✔	✔	✔		✔	✔

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11

11

CHINA'S RARE EARTHS AGENDA TODAY

- Vertical Integration: *Made in China 2025: Goal is to process 50% of domestic rare earths through to final products by 2025.*
- Today, China is mining ~300ktpa REO to meet its downstream needs (allowing for recovery) – which is likely to increase to ~400ktpa by 2025, placing pressure on the sustainability of domestic rare earth resources in China.
- Production quotas increased: *Production driven by Nd/Pr demand leading to surplus of La, Ce, while hiding the real exploitation of resources, dictating the importation of ROW ores/concentrates.*
- *Estimated 2022 demand ~250kt REO: But SX capacity is >400ktpa REO (excluding illegal mining and processing). This capacity is "offered" to ROW Projects as a low cost source of SX Processing – very successful – China retains value-add control. The excess (idled) capacity also provides China the capability to increase output and reduce prices to "discourage" ROW projects.*
- Chinese producers receive full refund of VAT on *improved* rare earth exporters; ROW exporters to China need to reduce price by ~16% to compensate for this tax.

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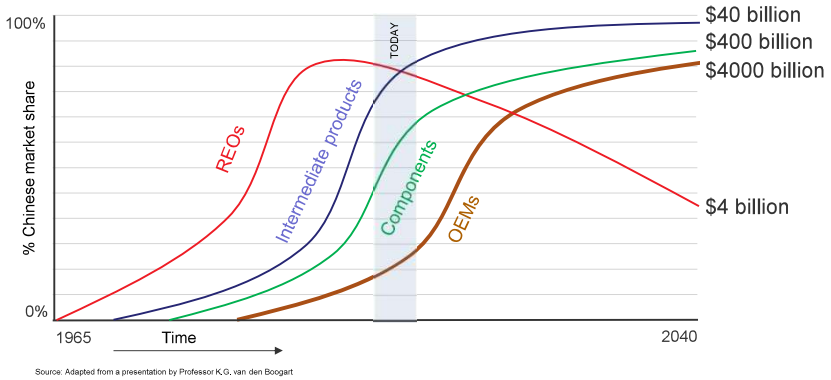
12

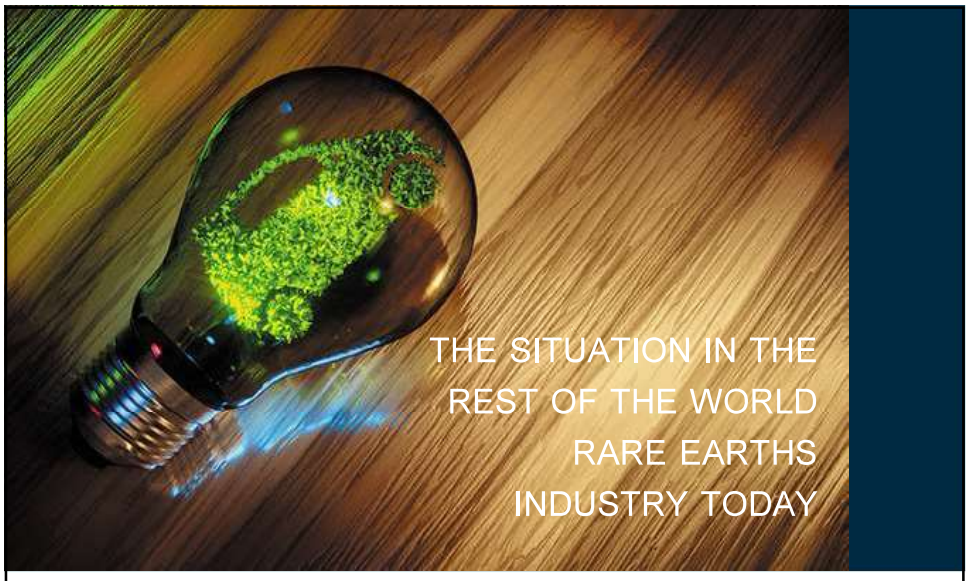
12

LONGER TERM IMPACT OF CHINA'S VALUE-ADD POLICIES ON GLOBAL MANUFACTURING (2021 PRICES)



13

13



14

THE SITUATION IN ROW TODAY

- Concern that *Made in China 2025* will lead to massive migration of manufacturing jobs to China – particularly from the UK, Europe and the USA.
- "China" and Lynas, as the major global producers are not deemed adequate diversity of supply. In particular, the supply of Tb/Dy for REPMs for is inadequate
- Europe, UK, USA and Asia moving to establish hybrid and EV supply chains that are wholly based in their geographical region and independent of China.
- Rising prices for rare earths coupled with the recognition that China's rare earth resources are finite will facilitate the development of ROW projects.
- Increasing investment by Chinese companies in overseas rare earth projects

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15

15

THE POTENTIAL ROW OPPORTUNITY IN 2030

- Total Global Demand: ~500,000tpa REO
- Potential Total ROW Demand: 150-200,000tpa REO
- Global magnet rare earth demand: 150-200,000tpa REO
- China total (primary) supply: 300-350,000tpa REO
- Required ROW total supply for *independence*: 150-200,000tpa REO
- Required New ROW supply (post 2022): >100,000 tpa REO

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16

17

RARE EARTHS – COMMERCIAL CONCEPTS

- Outside China no single country has a *Rare Earth Mine to Showroom* Capability.
- Rare earths are not commodities – customer specific
- Western rare earths enterprises are generally single project companies, so debt has to be recourse project funded with support from OEMs.
- Capital intensive (>US$100/kg REO annual capacity + working capital)
- Long start-up: limited expertise outside China
- Supply and demand for individual REOs is not in balance
- Used in small quantities:
  - REO price has negligible impact on most applications
  - Security of supply is the real issue
  - Recent high prices have lead to recycling as a viable option

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18

18

RARE EARTH IONIC CLAYS

1. A single mineral capable of yielding Nd, Pr, Tb and Dy
2. Negligible radioactivity as low in thorium and uranium
3. Potentially low capital operating costs due to nature of the clays that do not require large scale hard rock mining and processing.
4. China is the only country processing ionic clays
5. Ionic Clays Ltd has the most advanced ionic lay project based on the Makuutu Project in Uganda.
6. In Australia Koppamurra, 100% owned by Australian Rare Earths Limited, is the most advanced project. There are other deposits in Western Australia, Victoria and Queensland undergoing exploration by other companies.
7. The challenge is the development of technically and economically viable processing to match the technology in place in China

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THE PRESENT GLOBAL SITUATION

1. China will remain the rare earths dominant supplier and consumer for the foreseeable future
2. China will continue to consolidate the Chinese domestic rare earths industry and move downstream to create employment
3. China's rare earth resources are finite so it is investing capital, off-take contracts and technology in ROW projects to ensure domestic production meets domestic and export demand
4. There are LREE projects in production and development, but there is a lack of HREE projects a necessity for REPMs.

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IONIC CLAY RARE EARTH PROJECTS ARE LOWER RISK AND FASTER TO COMMERCIALISE

	Ionic clays (Koppamurra)	Hard rock projects
Location	• **Only producing assets in China and Myanmar**	• **Majority in China**, other projects in USA and Australia
Rare Earth Assemblage	• **Contains both light (Pr, Nd) and heavy (Tb, Dy) rare earths**	• Contains **predominantly light (Pr, Nd) rare earths**
Capital Intensity	• **Low –** typically ~US$20–40/kg TREO annual output	• **High –** typically ~US$150/kg TREO annual output
Exploration	• **Rapid, inexpensive –** aircore drilling, soft sedimentary	• **Lengthy, costly –** diamond drilling, hard rock
Mining	• **Shallow deposit, progressive mining and rehabilitation**	• **Large open** pit with significant fleet and significant **closure costs**
Processing	• **Proven metallurgy** with inert tailings **– low radionuclide levels in clays will not raise disposal issues**	• **Complex metallurgy** at high temperature and pressure **with radioactive tailings** complicating environmental approvals
Risk / Economics	**Fast to drill and develop, low capex and high value product**	**Expensive and slow to develop, lower value product**

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21

21

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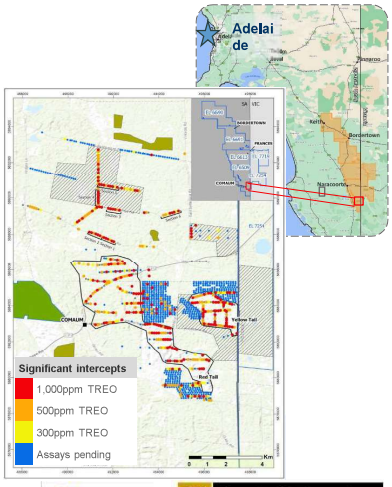
22

KOPPAMURRA MINERAL RESOURCE

- ~4,000km² of granted tenure in South Australia and Victoria, of which ~5% has been drilled to date
- Rare earth mineralisation in a clay layer ~10m from surface, deposited above a limestone base
- Drilled ~25,000m and ~2900 holes in eight campaigns since Oct 2021
- Initial bulk density of 1.40 g/cm3 lifted to 1.80 g/cm3
- Observing consistent grade and clay thickness over extensive area
- Commenced proof of concept mining and reclamation trial
- Inferred Resource of 40Mt at 725 ppm



23

AR3 ACHIEVEMENTS & PROGRESS MILESTONES

FEB 2020
Koppamurra discovery

APR 2021
Maiden inferred mineral resource

JUL 2021
A$12m IPO and AR3 listing

OCT 2021
Appointment of Pauline Carr (NED) and Don Hyma (MD)

DEC 2021
9,900m drill program completed

Official opening of Naracoorte office/warehouse

MAR 2022
New tenements in WA and QLD

Southeast Fair Exhibit

APR 2022
Metallurgical results released

APR 2022
10,000M drill programme completed

MAY 2022
Proof of concept mining and reclamation

JUN 2022
Mineral resource estimate update

Target 2026
First production

ONGOING
Evaluation of downstream processing opportunities

24

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PRESENTATION TO ALTA CONFERENCE MAY 2022

25

A BRIEF INTRODUCTION

PROFESSOR DUDLEY JOHN KINGSNORTH
B.MET (HONS), M.SC., *FAICD, FAUSIMM, FIMMM*

- Over 50 years experience in the international mining industry through positions in operations, project development, marketing, consulting and business development.
- Dudley was Project Manager of the Mt Weld Rare Earths Project (now operated by Lynas Rare Earths) between 1990 and 2000, managing the project from the status of a potential resource to completion of a feasibility study including pilot plant studies, with draft off-take MOUs in place
- Over the past 20 years he has been an independent rare earths consultant, providing advice on the global rare earths markets to exploration, production and OEM companies and Government Agencies worldwide.
- Dudley is the Non-Executive Chairman of Australian Rare Earths Ltd (ASX:AR3), and Executive Director of the Industrial Minerals Company of Australia Pty Ltd ("IMCOA").
- In 2017, Dudley was appointed a Professor at the Western Australia School of Mines, a faculty of Curtin University in Western Australia.
- In 2021 Dudley was awarded the Australasian Institute of Mining and Metallurgy Professional Excellence Award for his contribution to the global understanding of the rare earths industry.

26

26