Creating a Multi-National Platform: Thorium Energy & Rare Earth Value Chain

Assessing Rare Earths and Global Imbalance

Chinese Industrial Policy vs. Adverse NRC/IAEA Policy = Market Failure

Will Thorium Energy Systems be next ?

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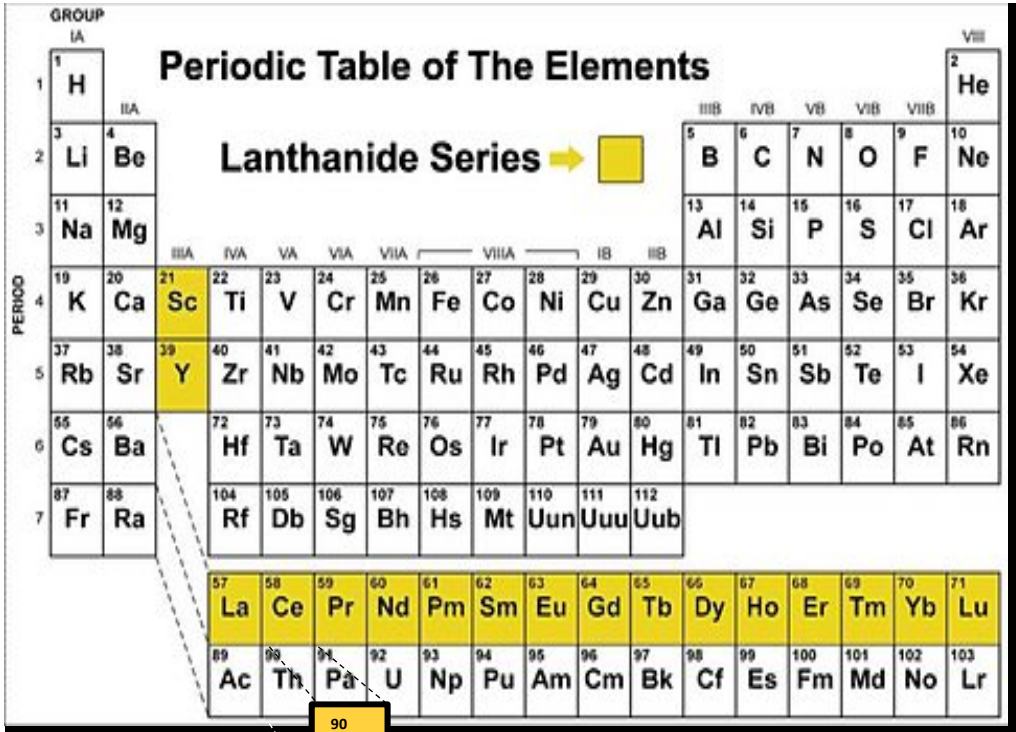
Rare earths and Thorium have become linked at the mineralogical and geo-political level

Regulatory changes pertaining to Thorium contributed to excessive market concentration in rare earths

This has resulted in economic dislocation and National Security issues for many countries

A solution is required



From the Periodic Table: Rare Earths = Lanthanides + Y & Sc

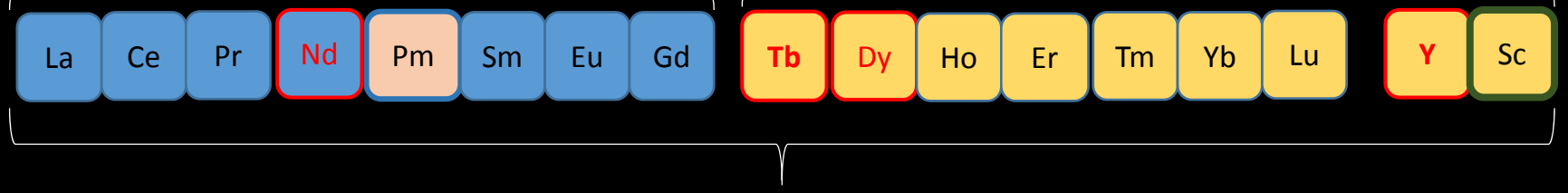
Below is the full spectrum of commercial Rare Earths

All 16* elements are necessary in the production of modern technologies and advanced weapons systems

Companion element typically associated with heavy rare earth elements

Light REs

Heavy REs + Y & Sc



Rare Earths consist of the full Lanthanide Series plus Yttrium and Scandium (Y + Sc)

* Pm – Promethium does not exist within the earth's crust, cannot be mined, has no uses or applications and will be eliminated from this discussion

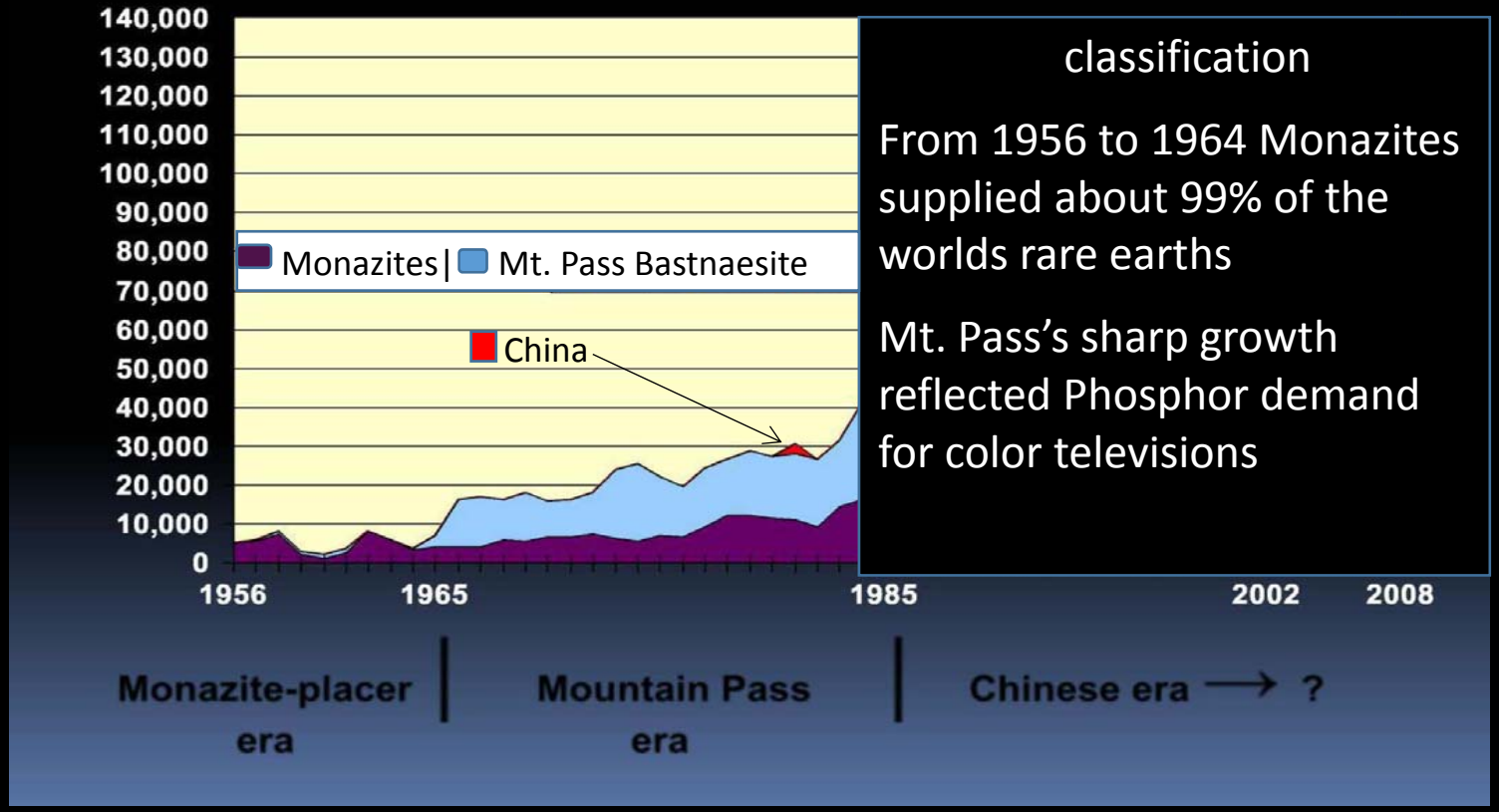
In The Beginning…

From the 1890s to the early 1900s Monazite was mined, not for its rare earth content, but for its companion element Thorium (for gas mantels).

Monazite was the primary source (99%) of rare earths from the early 1900s until about 1964.

- Monazites were primarily a byproduct of heavy mineral sands mining operations

In the early 1980s China could not meet western standards and had to exit the rare earth market. The U.S. and France remained global leaders in rare earth refining and metallurgy. At this time Monazite supplied nearly 100% of the worlds heavy rare earths.



Data Produced by USGS: James Hedrick, Gordon Haxel and Greta Orris

Beginning of the End…

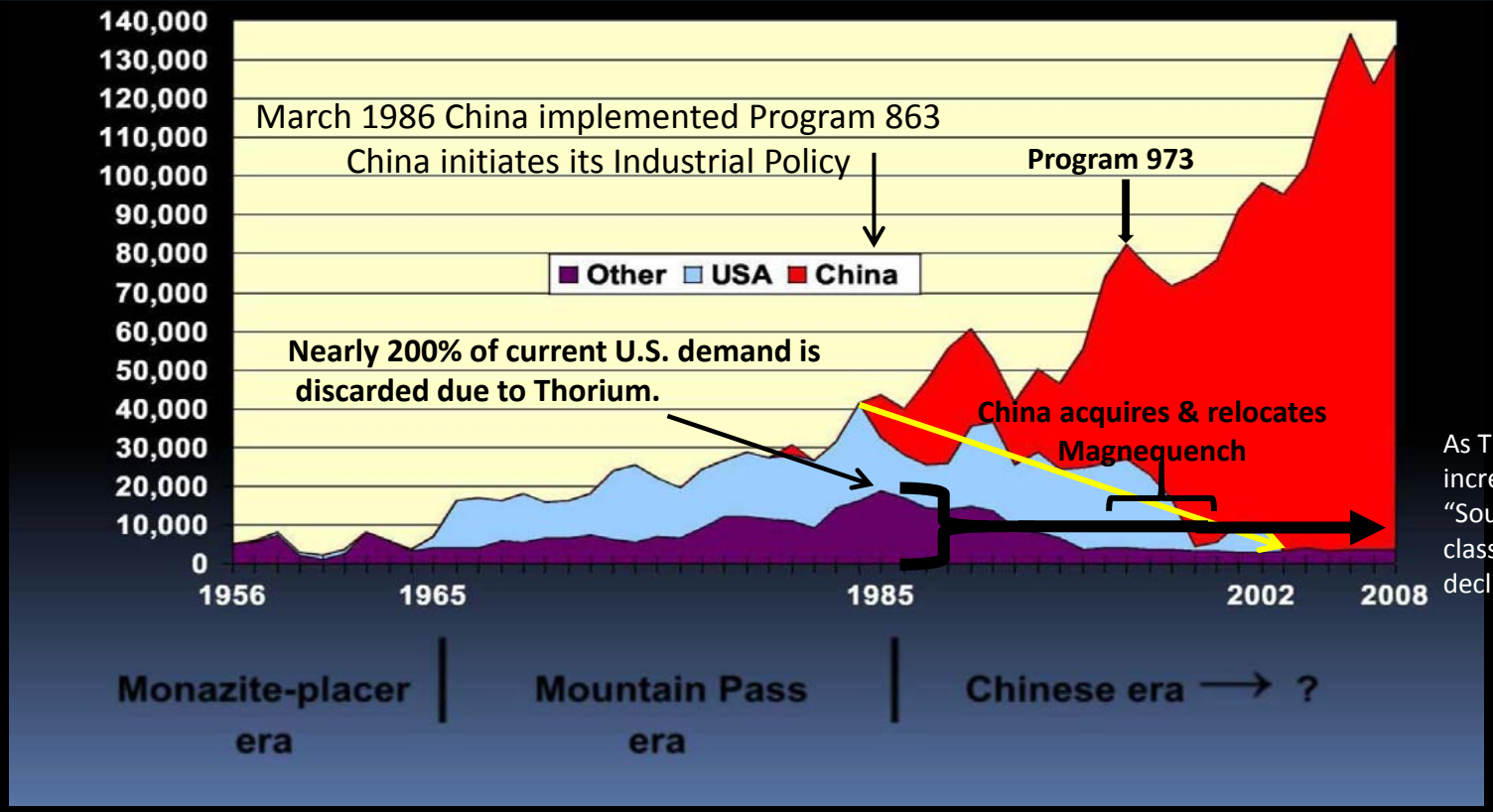
The end of commercial Monazite production began in the mid-1980s due to “classification” changes instituted by the NRC and the IAEA, effectively defining Monazites as “Source Material” due to its Thorium content

Just prior to these classification changes Monazite represented nearly 50% of global rare earth supply and close to 100% of the worlds heavy rare earths

China's market advantage evolved from changes in NRC / IAEA resource classification, defining Monazite as "Source Material," and China's implementation of an aggressive, top down, industrial policy

This Classification Ultimately Forced others to Exit the Rare Earth Industry

In 2002 the Mt. Pass Mine was shut down because of a Thorium discharge – not China



As Thorium Liability increased, due to "Source Material" classification, sales declined

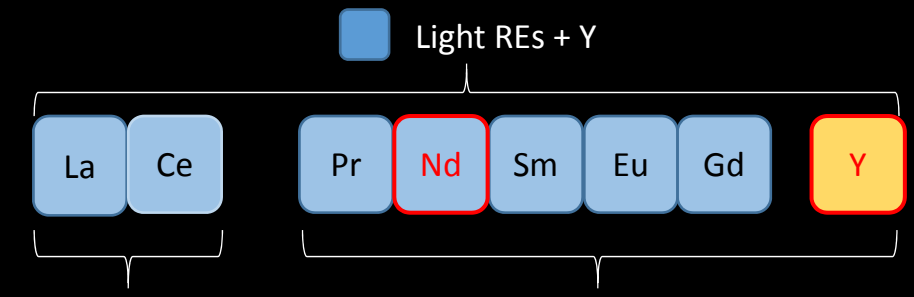
*Mt. Pass Decline (1984): With no high value heavy rare earths, high mining & environmental cost and price competition from China, Mt. Pass struggled to compete

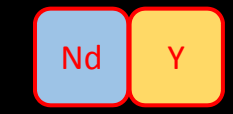
U.S. & Australian companies have invested over $6 billion into new rare earth projects -- with little prospects for success

Is This Free Market Failure, or Something Else ?

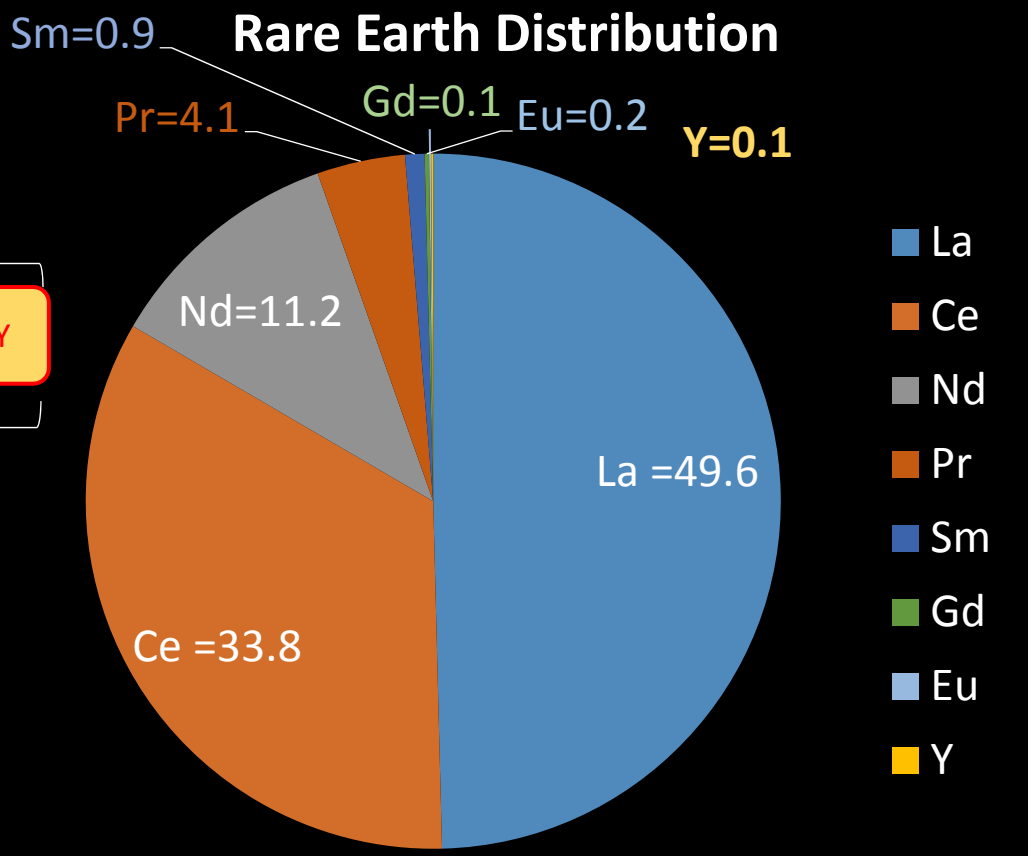
To avoid Thorium liabilities U.S. / global financial markets favored rare earth projects with low Thorium content, not high value rare earth distributions

The leading U.S. RE mine only produces ½ of the RE "elements" needed



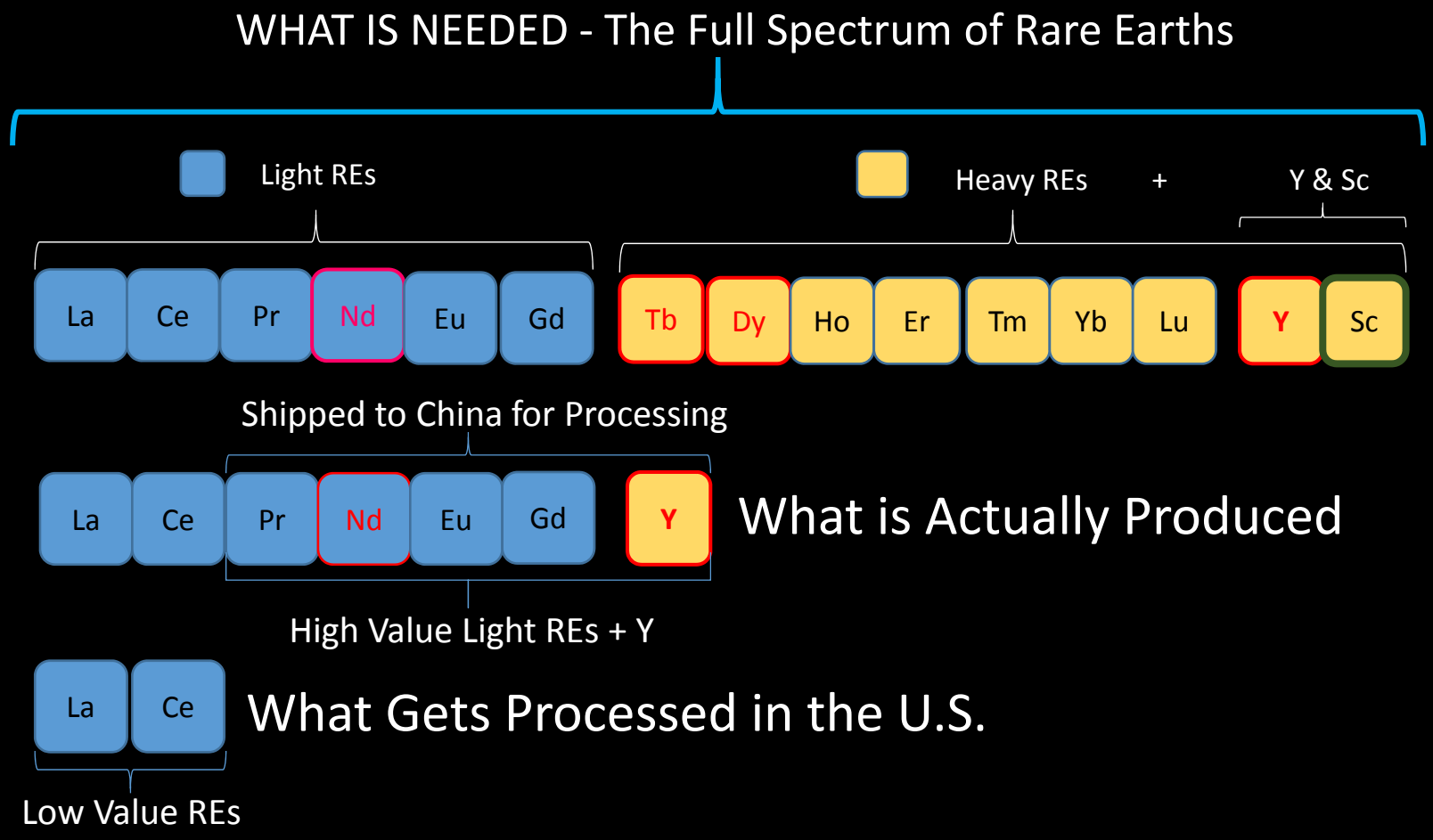


Red indicates DoE "critical" classification



This deposit does not have any recoverable heavy Lanthanides or Scandium, but the ore-body is low in Thorium. Yttrium recovery is limited by it's natural distribution within the ore-body. The Australian mining company has a similar low value light RE distribution

This U.S. corporation ships all of it high value REs to China for processing, refining and value adding



Why did this company become a Supplier to China?

Free Market Strategies facing failure ?

USA Approach: Balancing short term returns to its early investors vs. the cost of developing a RE value chain for its low-value rare earth ore dictated that this company acquire and supply refineries inside China (cementing its Thorium in place on-site in California)

Australian Approach: Choose to establish its own RE oxide refinery in Malaysia to get around ‘source material’ issues (leaving its Thorium in Malaysia) and to integrate itself into the OEM / end-user market in Japan

Why Can't They Compete ?

Today both companies are facing unsustainable losses & eventual bankruptcy, resulting from:

1. Large scale production of low-value rare earth that greatly undermine market pricing for all light REs
2. The high cost of direct mining (of low value resources) vs. China's lower mining cost and its heavy reliance on RE byproduct production (~ 70%)
3. Higher capital costs related to small mining ventures attempting to finance non-traditional / non-mining assets such as refining and value chain facilities
4. Leaving the high-value heavy rare earth market, and its enormous profits, to China

Full Spectrum Rare Earth Production & fully integrated Value Chain

Developing low value rare earth deposits with high direct cost is not economically viable.

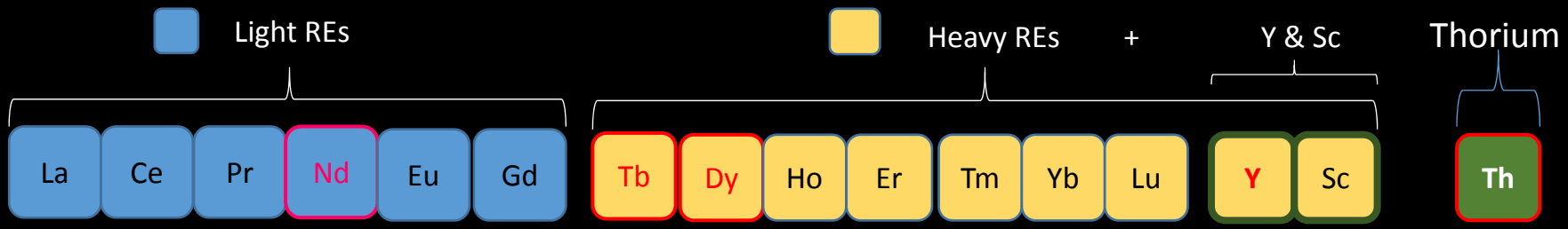
High value, low-cost, byproduct resources are abundant and available.

- Thorium bearing Rare Earth Phosphates could meet 50% or more of global demand if the Thorium issue could be resolved
- There is no need to develop any new RE mining operations – just fix the Thorium Problem

Fully Integrated Value Chain Capabilities are Paramount: All efforts must focus on developing a fully integrated value chain

High Value Rare Earths as Byproducts

U.S. mining companies alone currently mine as much as 50% of global Rare Earth demand every year.



Monazite and other Rare Earth Phosphates mineralization's typically contain all 16 of the Rare Earths + Thorium

Unfortunately these Monazites & RE Phosphates cannot be utilized because of the companion element Thorium

These resources are diverted in tailings lakes or are redistributed back into the host ore-body, due to Thorium

Introducing U.S. Congressional Bills H.R. 4883 & S. 2006

The National Rare Earth Cooperative Act (*& Thorium Bank)*

These Bills would Allow for the Utilization of Monazite and other Thorium bearing Rare Earth Resources Within a Structured Framework

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By Creating a Federally Chartered Multi-National Rare Earth Cooperative – Privately Funded, Operated and;

Authorized to accept Monazites and other Thorium bearing rare earth materials

- by allowing such resources, under existing regulations, to be sold and transported to the rare earth cooperative as:

  "unprocessed and unrefined ores", per 10 CFR 40

- all Actinides are passed to a Federally Chartered Thorium Bank, to ensure safe, long term storage and future use

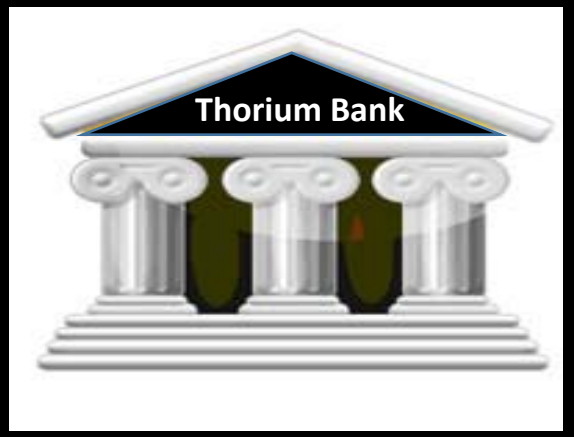
Multiple mining companies provide Monazite, Apatite & other Th-bearing REs to the co-operative, currently not commercial or are a waste byproduct of some other commodity

Multiple RE Suppliers – RE is a byproduct

RE Refinery Co-op / oxides, metals, alloys, etc.

Thorium liability

The Th-Bank assures that Thorium is no longer released into the environment



Thorium Bank holds all Actinide liabilities, but has Congressional authority to develop "Uses & Markets for Thorium, including Energy"

Not Endorsements – Potential Co-op Owners

U.S. Aerospace U.S. Defense Ind. U.S. Auto Ind.

Japanese Industry, Korean Industry, EU Industry, N.A.T.O

JOGMEC AIST

U.S., Japanese, Korean & EU Government Entities

European Commission

RE end-users own and control the Co-operative and off-take, but share profits with suppliers

U.S. Congressional Bills H.R. 4883 & S. 2006 Also Establish a Multi-National Development Platform for:

- The creation of a Thorium Bank that will take all liability and physically hold and safely store all Thorium and associated Actinide liabilities from the Rare Earth Cooperative.
- The creation of a Thorium Industrial Products Corporation with Congressional authority to develop industrial uses and markets for Thorium (including decay products) that include
    I. alloys
    II. catalysts
    III. medical isotopes
    IV. other uses

U.S. Congressional Bills H.R. 4883 & S. 2006
also establishes a
Multi-National Development Platform for:

The Commercial Development of Thorium Energy Systems, that include:

I. solid fuels from Thorium
II. solid-fuel reactor technology
III. beam / accelerator driven reactor technology
IV. liquid-fuel reactor technology, to include
    i. electric power
    ii. thermal energy
    iii. synthetic liquid fuel production
    iv. desalination
    v. nuclear waste reduction (actinide burners)
    vi. hardened and deployable energy systems

Thorium Storage | Energy | Industrial Products

Safe Storage

Energy

DARPA NASA

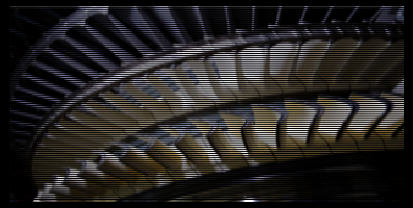
Defense & Space Applications

Th Bank

Storage | Energy | Industrial Products

Industrial Uses

Computing & Electronics



Advanced Alloys

Medical Isotopes

Energy Systems

A multi-national corporation to develop uses and markets for Thorium, including energy

Why is this new Multi-National Platform important? Consider This:

'no technologically important & wide spread industry ever began in a regulated environment…'

and the current environment demands conformity to the standard paradigm

This legislation would create an unrestrained R&D Platform for all IAEA member states to share and participate in the commercial development of true Next-Generation technology

Evolution or Revolution ?

Germany, Japan and politically active groups across the globe want an alternative to LWR / BWR and other solid fueled / water cooled reactors

-- *they demand something new*

Embrace it or oppose it, an alternative is just around the corner. Inaction will create just a single winner. Collaborative action assures that we all win.

This structure allows all IAEA member states to build that future together and share the rewards.

James Kennedy, President - ThreeConsulting.com
John Kutsch, Executive Director - ThoriumEnergyAlliance.com

End of Presentation
Supporting Data Follows

International Atomic Energy Agency
URAM - Symposium on Uranium and Raw Materials for the Nuclear Fuel Cycle:
Exploration, Mining, Production, Supply and Demand, Economics & Environmental Issues
IAEA Headquarters, Vienna Austria, June 23 – 27, 2014

A significant part of our Nations defense systems are heavy RE dependent

Heavy RE Dependent Technologies

None of these are currently produced in the USA

Tb	Magnets, Lighting & Phosphors, Fuel Cells – Automotive, Wind Turbines, Defense Applications: Terfenol-D Sonar , Guided Ordinance, Lasers
Dy	Magnets, Nuclear Control Rods, Lasers – Automotive, Wind Turbines Defense Applications: Terfenol-D Sonar , Guided Ordinance
Ho	Magnets, Nuclear Control Rods, Lasers, Microwave Equipment Defense Applications: Rail Gun, Direct Energy Weapons, EMPs, Electro-Lasers
Er	Industrial & Medical Lasers, Fiber Optics, Nuclear Control Rods, EU Currency Defense Applications: Infra-Red CM, LADAR, Communications
Tm	Super Conductors, X-Ray, Industrial & Medical Lasers, Optic Display, EU Currency Defense Applications: Magnets, CTH YAG Lasers
Yb	X-Ray, Optics, Steel Alloy, Stress Instrumentation, Solar Cells, Lasers Defense Applications: Advance Photonics Phase-Lock Array Lasers
Lu	Nuclear Dating, Metal Alloys, Catalysts, Medical Imaging and Treatments Defense Applications: Active / Passive Infra Red Cameras, Scintillators
Sc	Supper Aluminum Alloys, Specialty Lighting, Lasers, Fuel Cells Defense Applications: Air Frame Alloys and Missile Hardening
Y	Phosphors, Electrodes, Super Conductors, Lasers, Catalysts Defense Applications: Guided Ordinance, Lasers, Communication, Radar

Under the current *'free market'* approach (Molycorp's Mt. Pass) the problem is grossly exacerbated because Molycorp sends all of its valuable light REs to China also.

Rare Earth Distribution % | By Mineralization

	Mt. Pass Bastnaesite	China Byan Obo	HRE-China Laterite		Selected Monazite	Pea Ridge* Breccia	Pea Ridge** RE-Apatite	Florida Phosphate
Lanthanum	33.8	27.1	1.8		21	27.5	18.6	25.6
Cerium	49.6	49.8	0.4		45	38.8	34.6	21
Praseodymium	4.1	5.15	0.7	Light Lanthanides	5.0	4.4	3.5	5
Neodymium	**11.2**	**15.4**	**3.0**		**19**	**15.4**	**12.7**	**12.1**
Samarium	0.9	1.15	2.8		3.0	2.1	2.5	5
Europium	0.1	.19	0.1		0.2	0.3	0.3	0.7
Gadolinium	0.2	0.4	6.9		2.6	1.5	2.8	2.4
Terbium	**0.0**	**0**	**1.3**		**.29**	**0.3**	**0.5**	**0.7**
Dysprosium	**0.0**	**0.3**	**6.7**		**1.1**	**1.5**	**2.8**	2.8
Holmium	0.0	0	1.6	Heavy Lanthanides	.13	0.3	0.5	0.7
Erbium	0.0	0	4.9		.27	0.8	1.8	3.6
Thulium	0.0	0	0.7		.02	0.1	0.2	0.3
Ytterbium	0.0	0	2.5		.12	0.9	1.5	1.4
Lutetium	Trace	0	0.4		.02	0.1	0.2	0.5
Yttrium	**0.1**	**0.2**	**65.0**		**3.3**	**5.7**	**17.5**	**18**
Scandium	0.0	0.0	Trace		Trace	Trace	Trace	0.5
Percent Heavy	**0.0%**	**0.3%**	**18.1%**		**4.7%**	**4%**	**7.5%**	**10%**
Heavy + Y	**0.1%**	**0.5%**	**83.1%**		**8%**	**9.7%**	**25%**	**28.5**
RE in Ore	8%	5%	0.2%		+50%	12%	3%	3%
Percent Th	0.1%	0.3%	>.1%		8%	3.5%	1%	10.5%***

USGS Data - In order of Geologic Occurrence – Bastnaesite, HRE Laterite, Monazite, Apatite

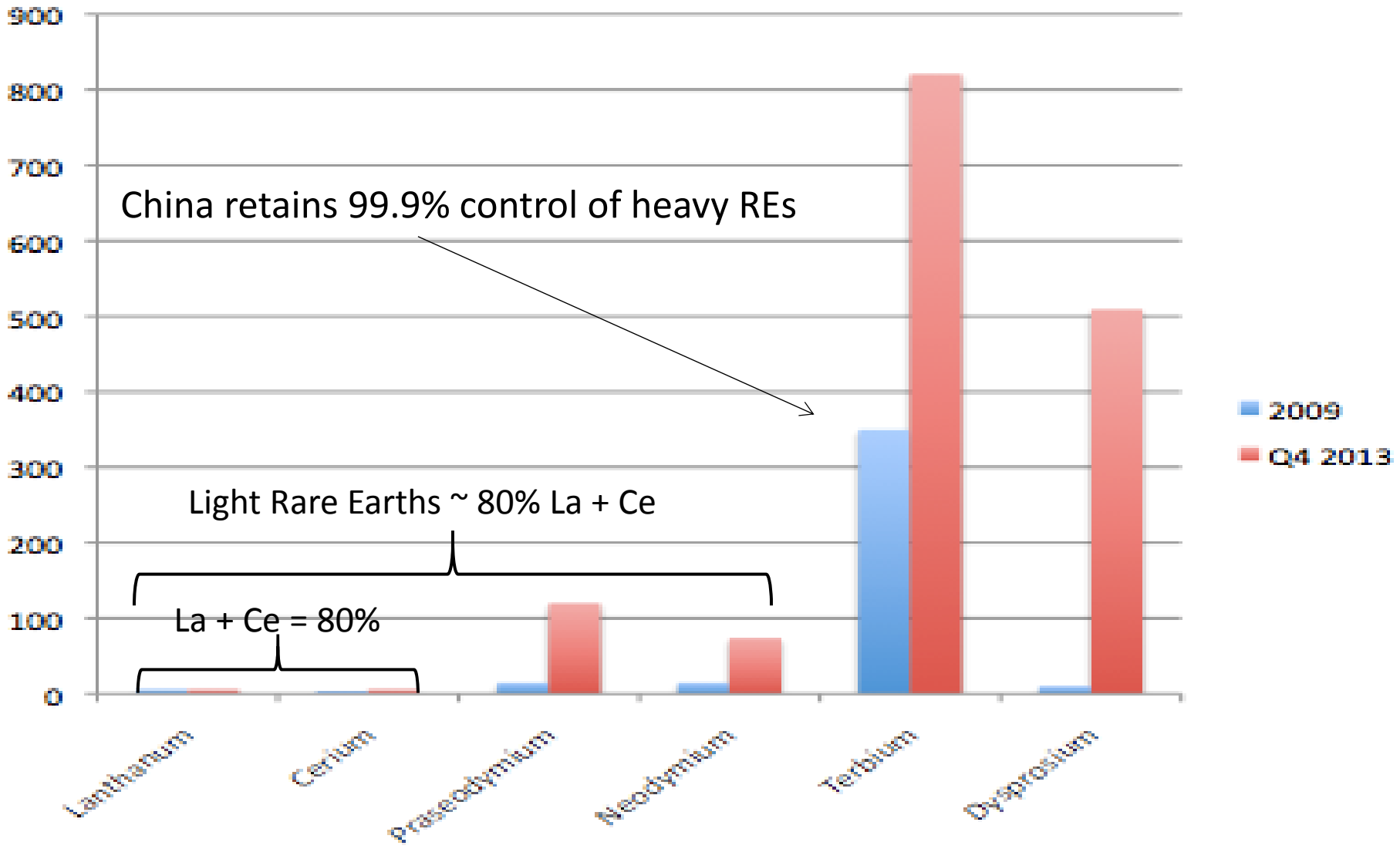
*Pea Ridge RE resources: Breccia Pipes (primarily Monazite / limited Xenotime).
**Rare Earth Enriched Apatite (Monazite / Xenotime), a no-cost byproduct of iron ore mining.
***Total Actinides = Thorium and Uranium (USGS data), but totals 2 times U.S. annual rare earth demand.

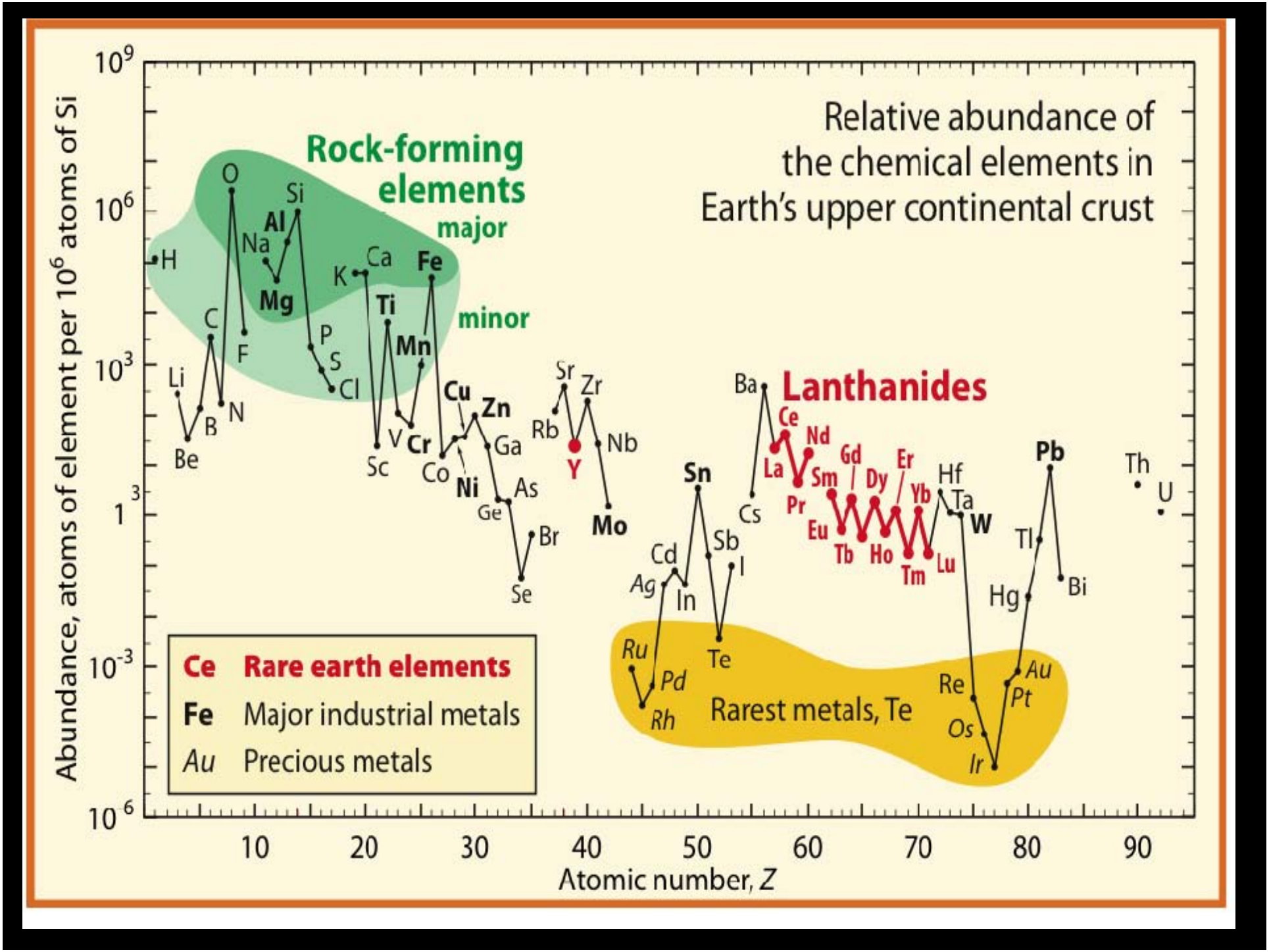
Just one non-rare earth mine in the U.S. dumps over 100% of U.S. annual consumption demand every single year. Historically this same mine was the exclusive domestic producer of all U.S. heavy rare earths.

Rare Earth Metals Pricing

2009 vs. 2013

Average FOB China $/Kg, most common REEs Oxide 99%




Relative abundance of
the chemical elements in
Earth's upper continental crust
Rock-forming
elements
major
minor
Lanthanides
Abundance, atoms of element per 10^6 atoms of Si
Atomic number, Z
10^9
10^6
10^3
1
10^{-3}
10^{-6}
10
20
30
40
50
60
70
80
90
H
Li
Be
B
C
N
O
F
Na
Mg
Al
Si
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Cl
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Ir
Pt
Au
Hg
Tl
Pb
Bi
Th
U
Cs
Ag
Cd
In
Sn
Sb
I
Te
Ru
Rh
Pd
Ce Rare earth elements
Fe Major industrial metals
Au Precious metals
Rarest metals, Te