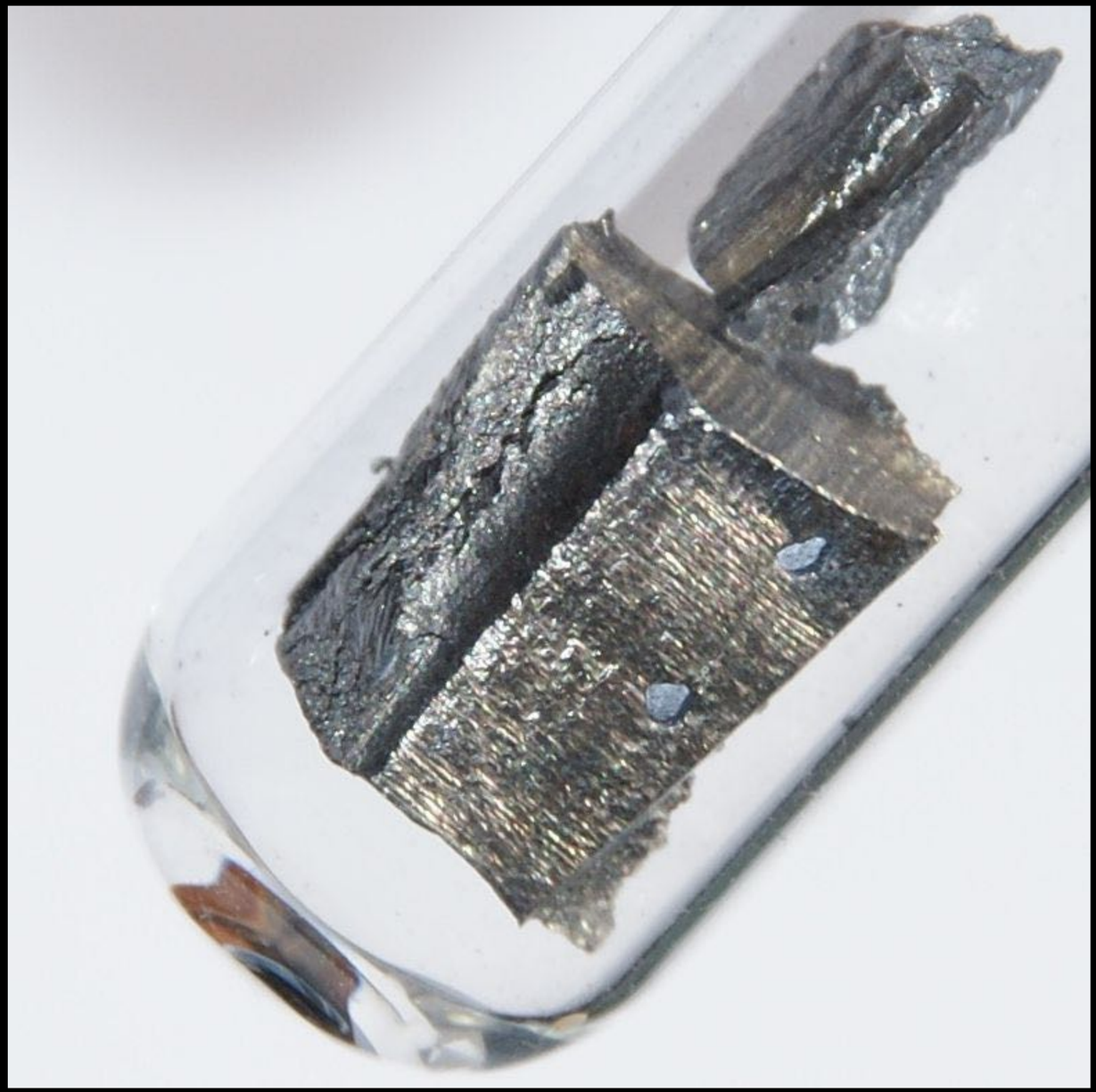
APPALACHIA AND EASTERN U.S. REGIONAL WORKSHOP ON CRITICAL MINERALS SUSTAINABILITY

IMPORTANCE OF CRITICAL MINERALS TO AMERICAN INNOVATION

JULIE MICHELLE KLINGER, PHD
UNIVERSITY OF DELAWARE DEPARTMENT OF GEOGRAPHY AND SPATIAL SCIENCES
MINERALS, MATERIALS, AND SOCIETY PROGRAM

PRESENTATION OUTLINE

- **Importance to American Innovation**
- Understanding our present predicament
- So what do we do?



Neodymium image source: Wikimedia Commons

Importance of Critical Minerals to American Innovation

- The US is import-dependent for 31 of 35 critical materials

- More importantly, the US relies on imports for CM-bearing technological components and finished products used in:
  - Information & Communication Technologies
  - Individual & Public Transportation Vehicles
  - Scientific & Medical Instrumentation
  - Energy Generation & Storage
  - Military Technologies

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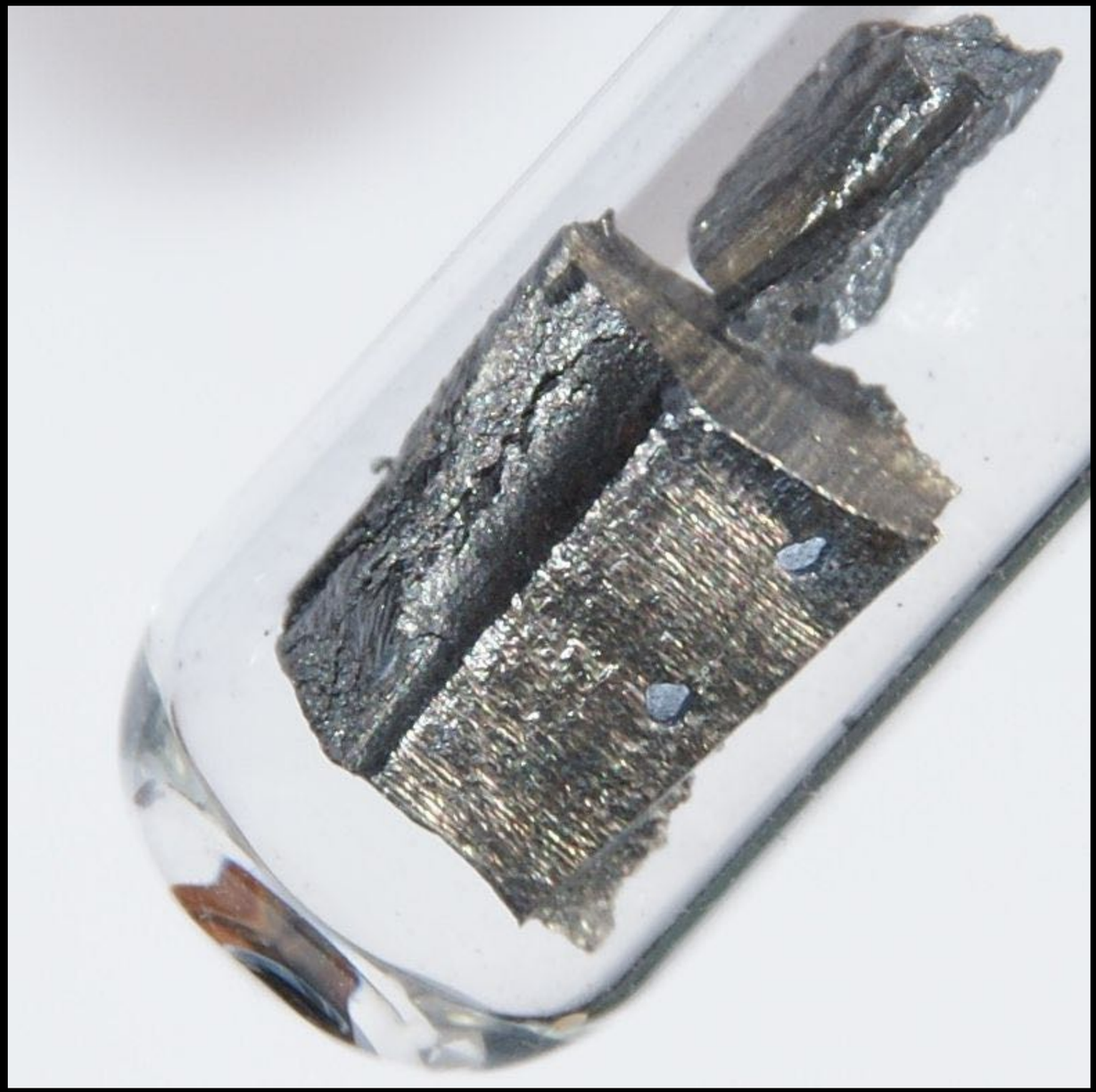

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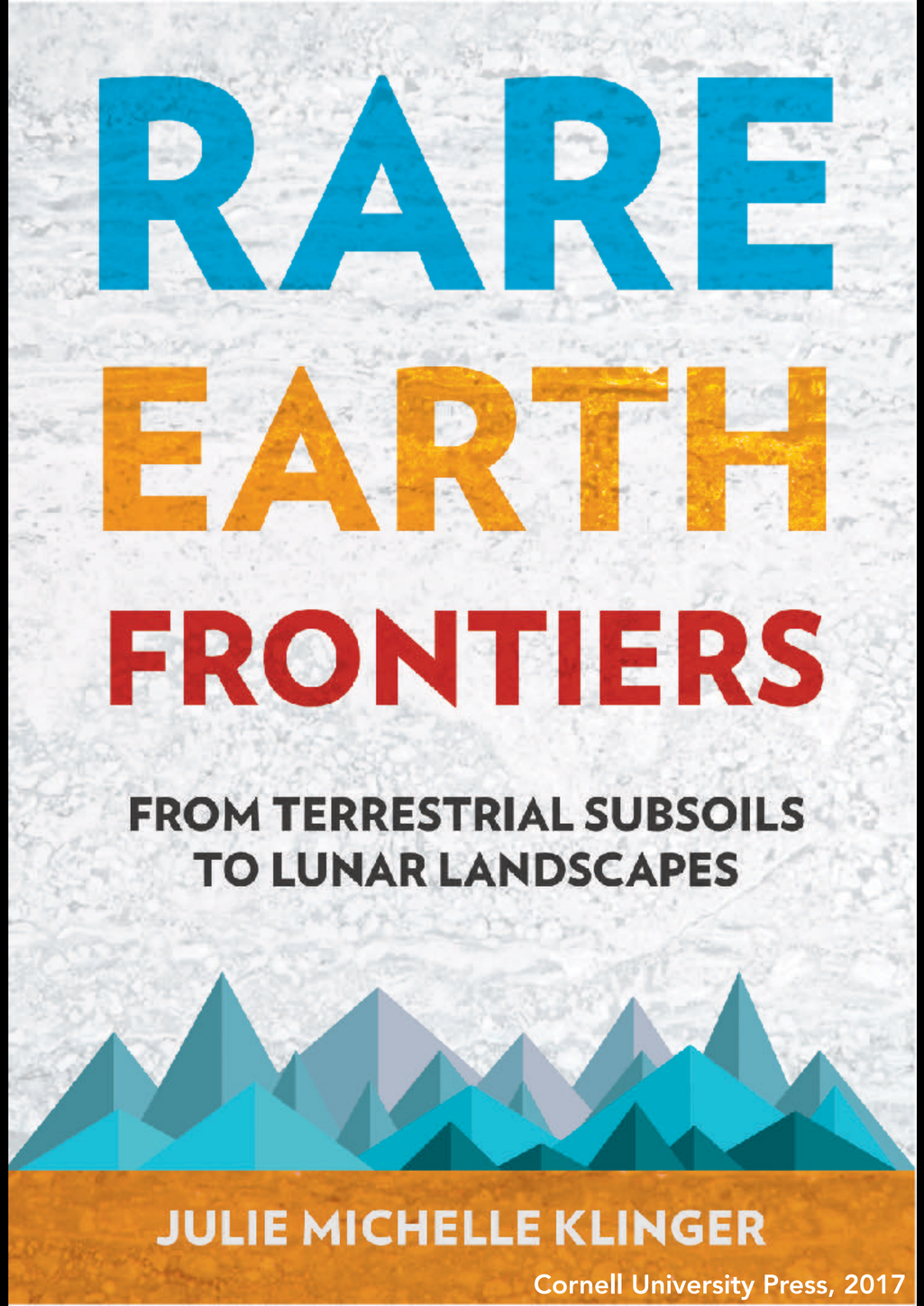
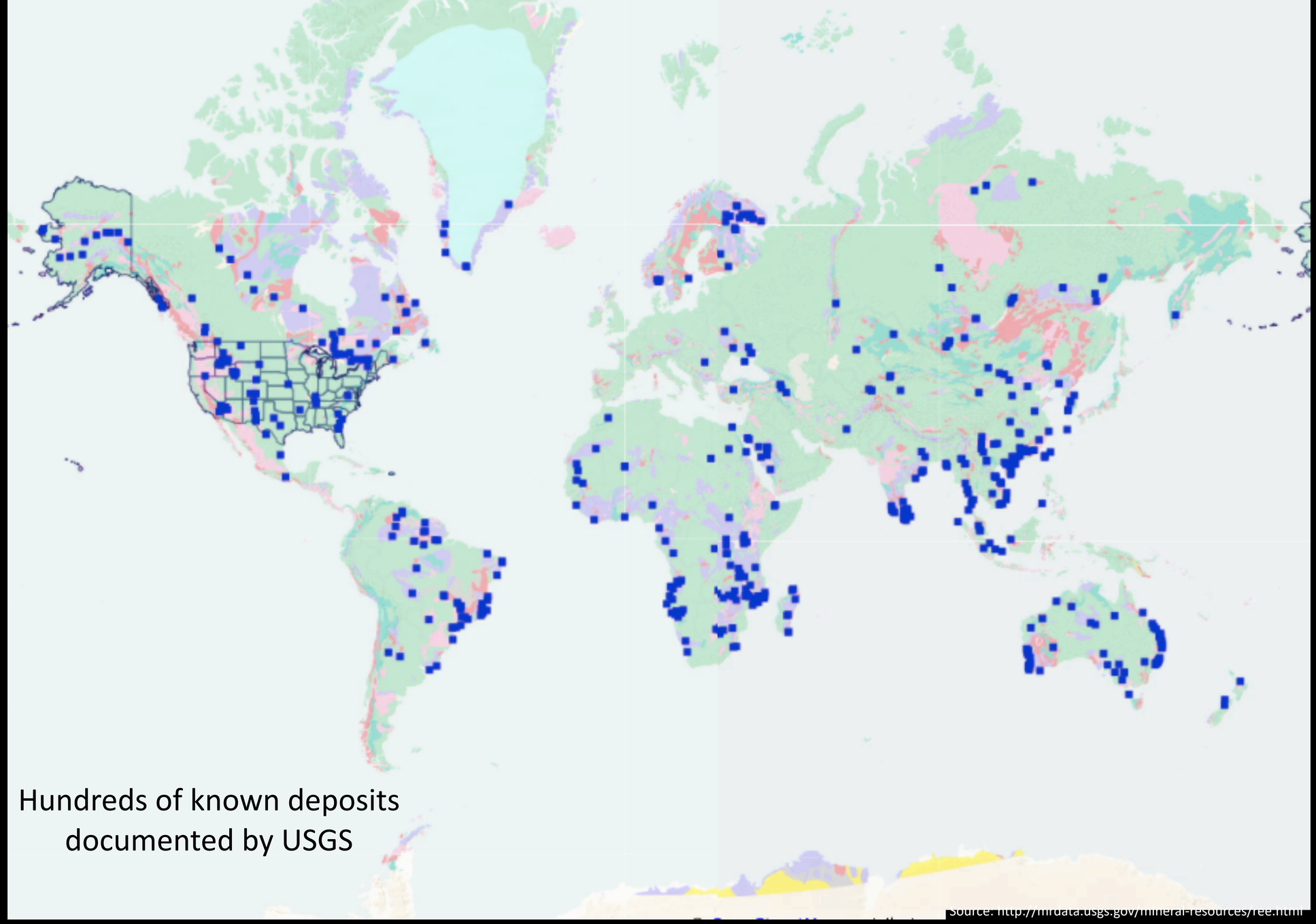


Highlights:

- Based on five years of in-depth fieldwork and mixed methods research in China, US, Brazil, and Germany
- Resource extraction is inseparable from the politics of sacrifice, but we can change this
- Basis of policy work to support sustainable rare earth sourcing
- Winner, 2017 Meridian Award (AAG)



Hundreds of known deposits documented by USGS

Source: http://mrdata.usgs.gov/mineral-resources/ree.html

Where should we get our rare earth elements?

Mine the moon?

Destroy a biodiversity hot-spot?

Dig under the Greenland ice sheet?

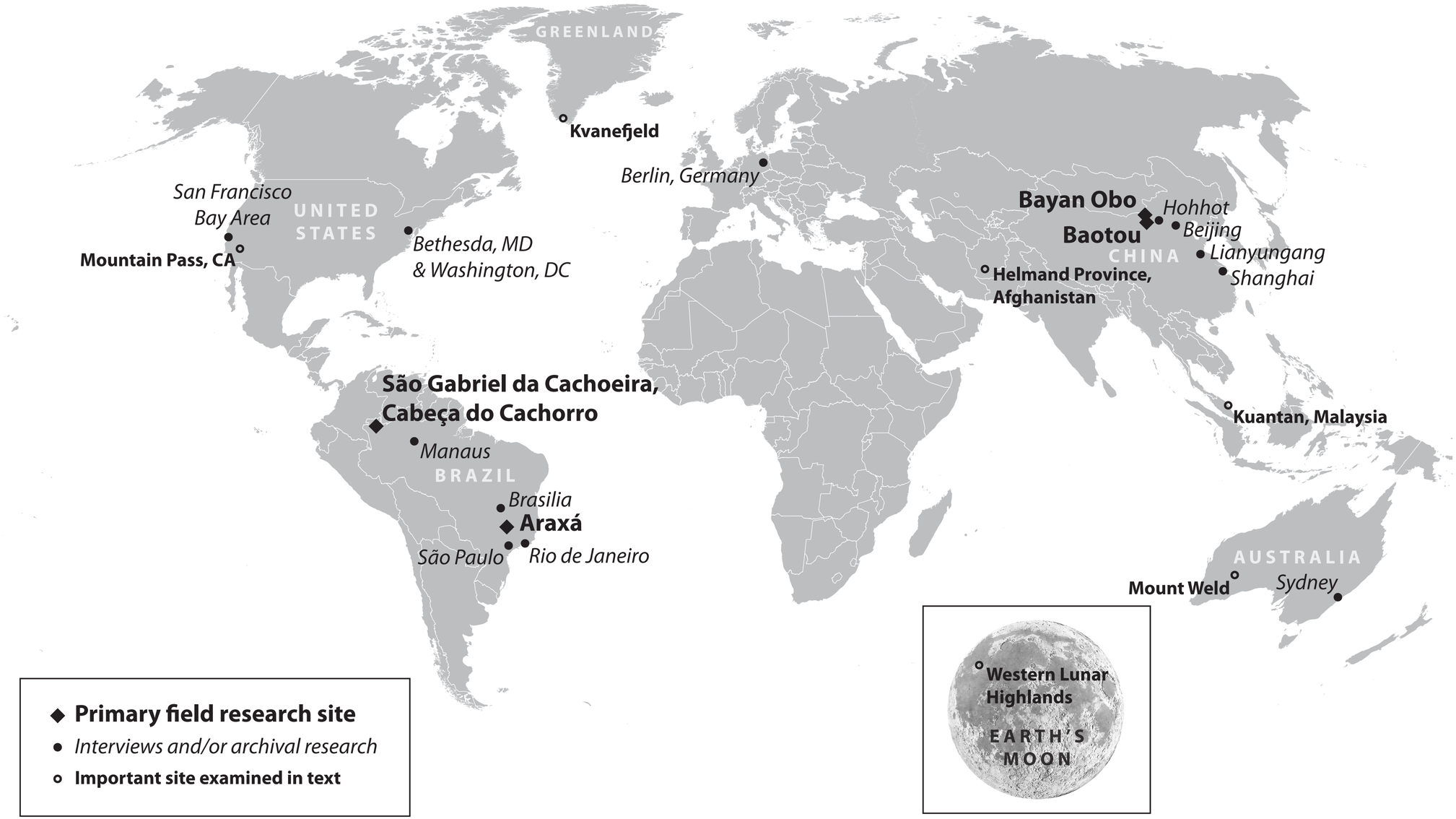
Dig up the amazon?

Re-invent 18th-century British Imperialism?

Charge into a war-torn region?

Scrape up the ocean floor?

RESEARCH SITES, 2010-2015

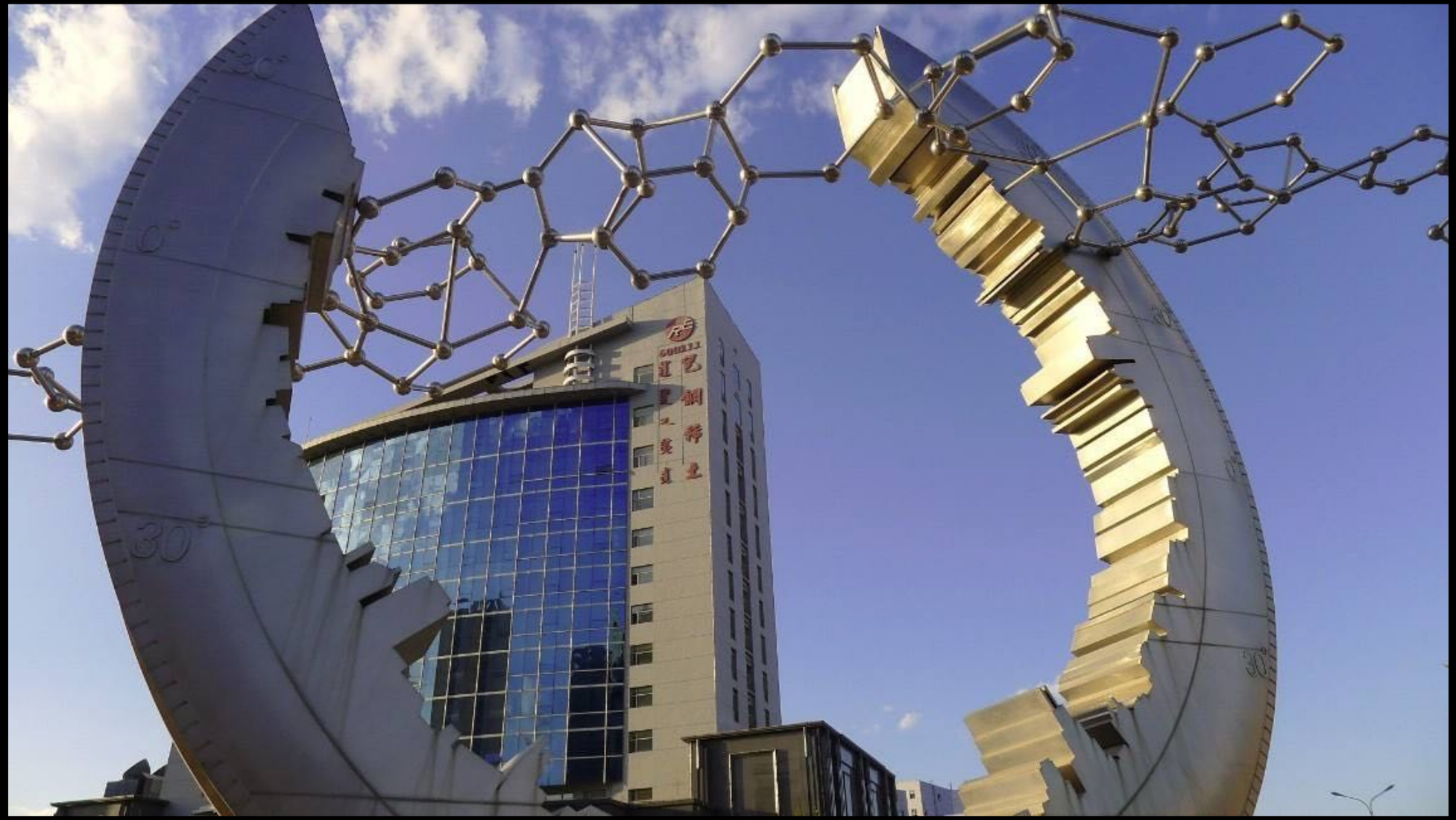


Day laborers take a lunch break in Bayan Obo

Source: http://assets.knowledge.allianz.de/img/china_workers_wind_turbine__17588.jpg

Small-scale miners in the Brazilian Amazon; photo courtesy of interviewee, 2014

Collecting soil samples downstream from a mining site in Northern China



China Northern Rare Earth Headquarters, Baotou


RUSSIA
KAZAKHSTAN
MONGOLIA
MONGOLIA
KYRG
TAJIK
INNER
Beijing
N. KOREA
S. KOREA
JAPAN
AFGHANISTAN
PAKISTAN
CHINA
NEPAL
BHUT
INDIA
BANG
MYANMAR
VIETNAM
LAOS
THAILAND
TAIWAN
PHIL
Baotou Municipality
Inner Mongolia Autonomous Region
People's Republic of China
0 250 500 km
0 250 500 miles

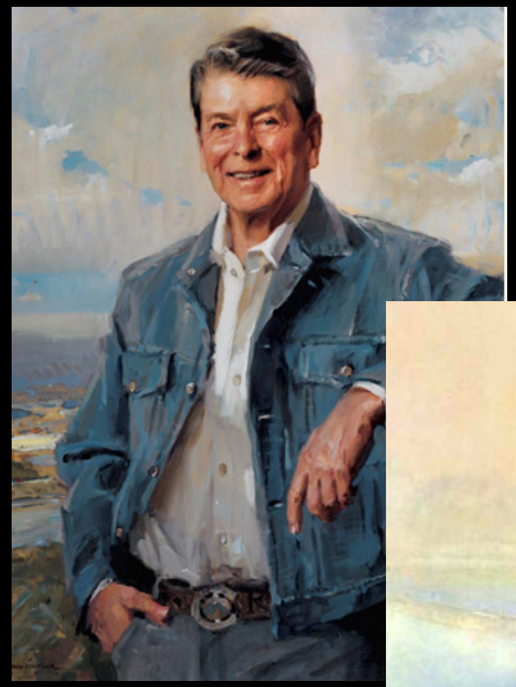
What does it actually take to build a global monopoly over rare earth mining and processing?

December, 1949, Mao Zedong travels to Moscow to discuss Sino-Soviet Friendship Treaty

Source: http://www.china-profile.com/history/indepth/id_3.htm

Planning, Investment, & International Cooperation

Extraction at the Bayan Obo Mine, 1959



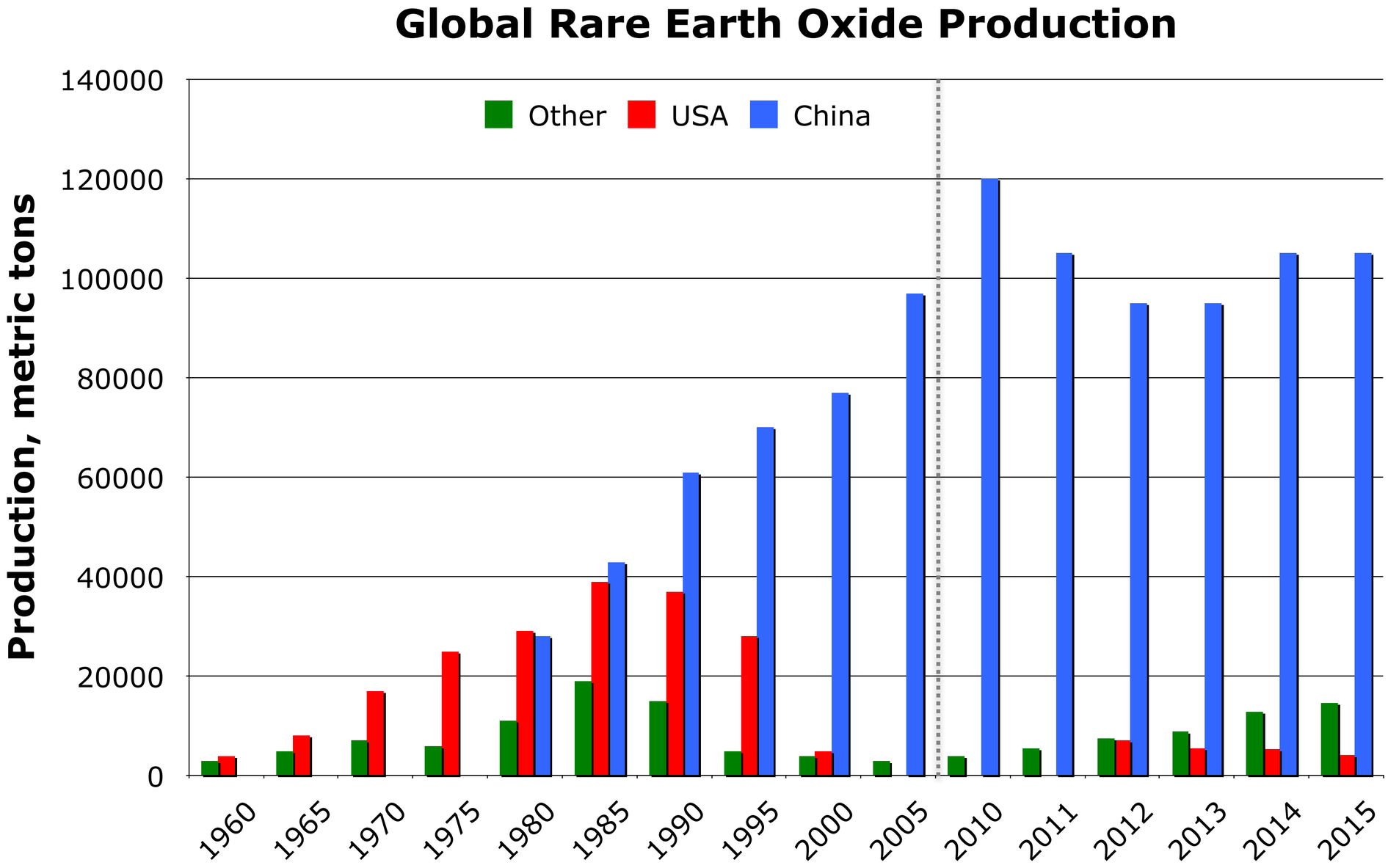
Other countries must choose to transfer their industries, disinvest in competitive R&D, and remove incentives for cleaner production at home

Sources: https://chineseposters.net/themes/dengxiaoping.php http://www.historicalportraits.com/Gallery.asp?Page=Item&ItemID=785&Desc=Margaret-Thatcher-PM-|-June-Mendoza http://www.artnet.com/magazineus/features/grant/painting-the-president6-24-10_detail.asp?picnum=12

Bayan Obo Mine, 1959

Bayan Obo Mining Complex, 2012

Source: NASA 2012


Global Rare Earth Oxide Production
Production, metric tons
140000
120000
100000
80000
60000
40000
20000
0
Other
USA
China
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2011
2012
2013
2014
2015

But at what cost?


N
0 2 km
0 2 miles
G6
Baogang Tailings Pond
Baogang Facility
BAOTOU CITY
Rare Earth High Tech District
Heavily Contaminated Soil
Agricultural Area
Aquaculture Area
YELLOW RIVER

“Western Electronics, Chinese Mines” Der Spiegel. October 27, 2010

http://www.spiegel.de/international/business/western-electronics-chinese-mines-german-industry-feels-rare-earth-metals-squeeze-a-725606.html

Skeletal Fluorosis - “Long Tooth Disease” - Acute Chronic Arsenic Toxicity

Tailings pond, Bayan Obo Mine, Inner Mongolia Autonomous Region
Klinger 2013

The Atlantic

Clean Energy's Dirty Little Secret

Hybrid cars and
tag.

LISA MARGONELLI MAY

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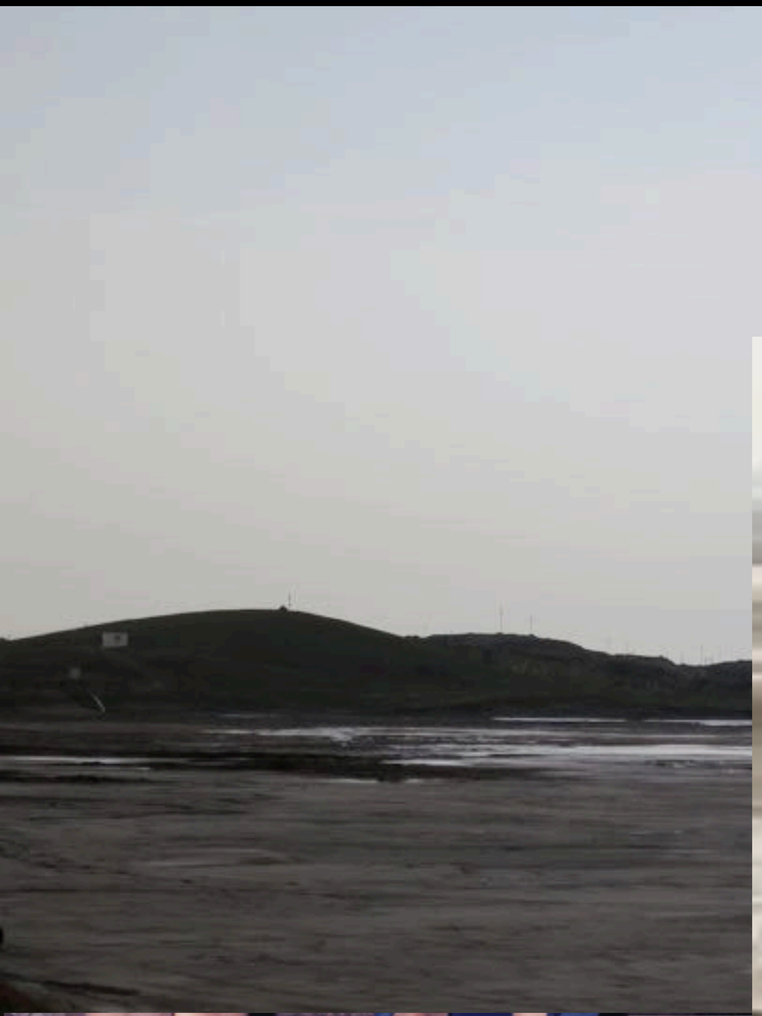
Big Wind'
and Radio

BY IER

OCTOBER 23, 2013

IER INSTITUTE FOR ENERGY RESEARCH

Every major form of energy generation—nuclear, fossil, big hydropower, and renewable—relies to some extent on rare earth elements



Let’s avoid re-creating this at home.

In the 21st century, this is a preposterous price to pay for innovation.

There is nothing innovative about the wholesale destruction of landscapes and lives—even in the name of critical materials security

Environmental Protection Official inspects tailings pipelines, 2015

Abandoned office building of private mine in Inner Mongolia, 2013

Mar 16, 2019 03:45 AM BUSINESS & TECH

China Became Net Importer of Rare Earths in 2018

- Reduce domestic mining output
- Clean up contaminated sites
- Import from new mines opening overseas
- Emphasize value-added processing
- Increase R&D in technological applications
- Enhance profile of high-tech exports

What do we do to achieve critical minerals sustainability in the United States?

The Status Quo

IMAR Museum

E-waste in Georgia

Rare earth elements are not destroyed in this process

Dig a big hole somewhere new → Build a trash mountain, but NIMBY

Re-imagine our future

Engage with communities in Appalachia and the Eastern U.S. to collaboratively envision and design our pathway forward

Dare to think beyond the election cycle, while addressing the livelihood needs of the present

Connect with established institutions and community organizers

Recycle

Currently, less than 1% of all rare earths (and 12% of all electronics) consumed are recycled

Important achievements by US researchers have not been scaled up to unlock new and sustainable sources of rare earths and other critical materials

Repatriate

Rebuild industrial and research capacity in the US

Invest in the entire supply chain, not just the first stages, in order to revive and stimulate innovative R&D

Develop programs to pilot and deploy innovations at a national scale

Create a regulatory environment that rewards upstream firms for socially and environmentally responsible mining and processing

Provide tax incentives for downstream firms to purchase certified clean rare earth elements

Work at local, state, regional, and federal level to create a clean, hi-tech, and functionally renewable rare earth supply chain in the US

Legislate

Seize the low-hanging fruit

Discarded cell phones, South Africa

Source: https://www.iol.co.za/mercury/there-is-gold-in-them-e-mountains-1357231

THANK YOU. QUESTIONS?

KLINGER@UDEL.EDU
TWITTER: @PROF_KLINGER