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RARE EARTH AND URANIUM MINING POTENTIAL IN THE STATES

The collage features several images: a large rock formation at the top; a wind turbine; a person holding a smartphone; a boat on water; a woman talking on a mobile phone; a green leaf; a scientist in a lab coat; a modern building; and a construction site with a crane.

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Dig it! Rare Earth and Uranium Mining Potential in the States

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Preface



This report discusses the strategic and economic importance of so-called rare earth elements (REE) and uranium to the United States. Several of the various states blessed with such mineral resources can expand domestic production while simultaneously benefiting their own economies and state budgets. At the heart of the opportunity are 17 little-known elements with whimsical names like europium and praseodymium, which are found in a variety of products from computers to defense equipment to CAT scan machines to wind turbines. Traces of the metals can be found around the world, but rarely in high enough concentration for profitable mining. Uranium serves an even more pervasive role in daily life, providing almost 20 percent of the nation's electricity.

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EXECUTIVE SUMMARY

While rare earth and uranium mining strike many as esoteric topics, the fact is that rare earth and uranium are crucial to modern life in the United States. Rare earths are necessary for a wide array of everyday products from iPhones to advanced medical support to defense equipment, and to our digital society. Uranium fuels fully 20 percent of our electricity. Unfortunately, we are overly dependent on foreign sources, some friendly and some not so much. We currently import more than 96 percent of our rare earths and 92 percent of our uranium, adding to a devastating trade imbalance. Fortunately, the United States can expand domestic production of both rare earths and uranium, reinvigorating our economy, adding jobs, and adding revenues to suffering state budgets.

The key to capturing these opportunities lies with reforms to the permitting of mines. Obtaining the permits and approvals needed to build a mine in the United States takes an average of seven years, among the longest wait times in the world. So, despite having

a vast underground store of raw materials, the United States is one of the last places miners go to start a project.

The U.S. mining industry continues to excel at mine safety and environmental performance. Improvements in technology are continuously being made, and because of this both federal and state governments should continuously seek to acknowledge such improvements in mine safety legislation.

New mines need to be developed in the next few years. Processing and mining methods are becoming more sophisticated, and exploration activities are increasing. This will result in more mines in the future, because demand will continue to grow. Technology-driven environmental improvements should eliminate public opposition and concerns, strengthening the social license to operate and expand mines. The future of rare earth and uranium mining in the United States remains to be written.

INTRODUCTION

America's prosperity depends on our vast mineral wealth, coupled with ever-improving productivity in developing that wealth. The contributions to America's standard of living made by minerals mining are unprecedented. The United States is one of the world's largest users of minerals and one of the world's largest producers. Without minerals and mining, our homes, schools, appliances—our very existence—would be unrecognizable.

Unfortunately we are losing ground. The United States has experienced decades of slow growth in mining. America has grown increasingly dependent on foreign and often hostile sources for minerals vital to our security—including minerals for which we have proven reserves. Now, the United States depends on and imports 100 percent of twenty critical minerals, and over 90% of numerous others.

Currently more than 250,000 people work directly in metals and non-metals mining throughout the United States. 650,000 supporting jobs elsewhere in the economy only exist because of mining. The average annual wage for mining jobs is the highest of any industrial category—33 percent higher than the combined average for all industrial jobs. Job creation associated with mining should be encouraged, not stifled.

The situation is not rosy for rare earths and uranium mining, although economically developable resources can be found in several states, including Virginia, California, Utah, Colorado, Idaho, Wyoming, Alaska, and Montana. In fact, rare earths or uranium mining operations in several states could expand significantly if mining regulations were rationalized. Permits take too long, and operational directives focus on meeting bureaucratic and political demands rather than actual environmental protections. Habitat and wildlife protections are applied indiscriminately, and officials often play favorites for some industries and technologies over others. Further complicating the issue is a patchwork of regulations dealing with mining on federal, state, tribal, and private property.

At the heart of the opportunity are 17 little-known elements with whimsical names like europium and praseodymium, which are commonly found in computers, CAT scan machines, and wind turbines. Traces of the metals can be found around the world, but rarely in high enough concentration for mining to be practical. Uranium serves an even more pervasive role in daily life, providing about 20 percent of our nation's electricity in the form of nuclear energy, but 92 percent of the necessary uranium is imported.

“America has grown increasingly dependent on foreign and often hostile sources for minerals vital to our security—including minerals for which we have proven reserves.”

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Section 1 of this report discusses the current strategic and economic importance of so-called rare earths and uranium to the United States. Section 2 discusses the permit hurdles that impede entrepreneurs and land owners from capitalizing on potential opportunities. Section 3 discusses how several of the various states that are blessed with such mineral resources can expand domestic production while simultaneously benefiting their own economies and state budgets. Section 4 compares the worker safety and environmental impacts of domestic mining with worldwide experience, putting to rest the fear that mining is hazardous here in the United States. Section 5 concludes with some recommendations for the states. Lastly, an appendix discusses the experience of, and commitments made by, a mine owner to resurrect and re-permit a rare earth mine in California, the single domestic rare earth mine issued a permit during the last 10 years.

Global Status of Rare Earths and Uranium Reserves and Production

The rare earths, or lanthanides, comprise 15 of the 118 elements on the periodic table, with atomic numbers 57 to 71. Uranium, atomic number 92, is a member of the actinides, which is a similar chemical group, but it is dealt with separately in this report given its different uses and economic importance.

The rare earths are actually a moderately abundant group. The elements range in crustal abundance from cerium, which is more abundant than copper, at 60 parts per million (ppm), to thulium and lutetium, the least abundant rare earth elements, at about 0.5 ppm. The elemental forms of rare earths are iron gray to silvery lustrous metals that are typically soft, malleable, and ductile, and usually reactive, especially at elevated temperatures or when finely divided. They naturally occur most often as rare earth oxides (REO).

The recoverable amount of individual rare earth oxides depends on the deposit composition. Generally, the light rare earth elements (LREE) are more common and more easily extracted. In most rare earths deposits, the light rare earth elements constitute 80 to 99 percent of the total. Therefore, deposits containing relatively high grades of the scarcer and more valuable heavy rare earths are particularly desirable.

The world's largest REO producer country is China. Its major source is the iron-niobium-REE deposit at Bayan Obo, where REO has been mined as byproduct of iron ore. Lateritic ion-adsorption clay deposits in southern China are important sources for heavy rare earth elements (HREE). These ion-adsorption ores are advantageous for their relatively high proportions of HREE, and especially for the ease with which they can be mined and the REE extracted. Small amounts of REO have also been produced in the United States (from stockpiles), as well as in Russia and India.

Various estimates of the market dominance of Chinese producers of rare earths place the HHI,¹ a measure-

ment assessing supply risk, at more than 9,400. Scores between 1,000 and 1,800 have been defined as benchmarks for moderate supply risk, scores above 1,800 are problematic, and scores below 1,000 are relaxed.

Close to 5 million tons of naturally occurring uranium is known to be recoverable. Australia leads, with more than 1 million tons (about 24 percent of the world's known supply), followed by Kazakhstan, with more than 800,000 tons—or 17 percent of known supplies. Canada's supplies are slightly less than 10 percent of the world's total, while the United States and South Africa have about 7 percent each.

Still, the overall amount of uranium is less important than the grade of uranium ore, according to a 2006 background paper by the German research organization Energy Watch Group. The less uranium in the ore, the higher the overall processing costs will be for the amount obtained. The group contends that worldwide rankings mean little, then, when one considers that only Canada has a significant amount of ore above 1 percent—up to about 20 percent of the country's total reserves. In Australia, approximately 90 percent of uranium has a grade of less than 0.06 percent. Much of Kazakhstan's ore is less than 0.1 percent. Also, geologic features in addition to ore grade are important such as depth and presence of water. The super high grade deposits in Canada, greater than ten percent, are often very deep and surrounded by sandstone filled with water under high pressure making for very challenging mining conditions. The low grade deposits (around .06 percent) being mined in Africa and Namibia are near surface deposits and thus are easy and cheap to mine.

The world uses 67,000 tons of mined uranium per year. At current usage, this is equal to about 70 years of supply. The World Nuclear Association says demand

¹Market concentration (market power) can be measured by the Herfindahl-Hirschman Index (HHI). The Herfindahl-Hirschman Index is the sum of squared values of raw materials production (in percentage terms) in each country (Rosenau-Tornow et al. 2009). Scores between 1,000 and 1,800 have been defined as benchmarks for moderate supply risk (U.S. Department of Justice and Federal Trade Commission, 1997), scores above 1,800 are problematic, and scores below 1,000 are relaxed. A score of 9,400 is universally seen as problematic and a sign of monopoly power.

is projected to grow by 33 percent in the next decade to correspond with a 27 percent projected growth in nuclear reactor capacity. Experts say that spent fuel can be reprocessed for use in reactors, but currently is less economical than new fuel. Presently, there are nearly 1,000 commercial, research, and ship reactors worldwide; more than 50 are under construction, and 130 are in planning stages.

More than half of the world's uranium-mining production comes from Australia, Kazakhstan, and Canada. In December 2009, Kazakhstan announced that it had pulled ahead of Australia to become the largest uranium producer in the world. Although Australia has the largest supply, access had been constrained by a 1982 law that limited uranium mining in the country, which was only lifted in the last two years. The province of Queensland in Australia lifted its moratorium on uranium mining in the fall of 2012, while the province of Western Australia lifted its ban in 2010. On the other side of the world, the Canadian province of Labrador ended its moratorium on uranium mining in 2011. This trend sets an example for the United States as well. States should consider following suit and rationalize their permit processes.

Recent increases in uranium demand have sparked debate in Australia, pitting the mining industry and nuclear advocates against environmentalists and activists for indigenous land rights. Other impediments to increases in mining in Australia and elsewhere include the need for infrastructure, environmental concerns, and a lack of experienced workers.

Because of the upswing in uranium prices, some places are seeing a mining boom despite the aforementioned obstacles. The United States has experienced steep rises in mining claims even though almost all of the nation's identified reserves are of a quality that puts the nation on the more expensive end of process costs. Going forward, more global exploration to locate uranium—especially ore lower in cost to recover—is expected, as long as market prices remain high.

Ten U.S. uranium mines produced 4.1 million pounds of U3O8 (also referred to as "Yellowcake," the product of an intermediate step in uranium processing) in 2011, 3 percent less than in 2010. Five underground mines produced ore containing uranium during 2011, one more

than during 2010. This uranium ore is stockpiled and shipped to a mill, to be milled into uranium concentrate (a yellow or brown powder). Additionally, five In Situ Leachate (ISL) mining operations produced solutions containing uranium in 2011 that were processed into uranium concentrate at ISL plants.

U.S. producers sold 2.9 million pounds of U3O8 in 2011 at a weighted-average price of \$52.36 per pound. The United States imported approximately 55 million pounds of uranium in 2011 at a cost of \$3 billion.¹

Total employment in the U.S. uranium production industry was 1,191 person-yearsⁱⁱ in 2011, an increase of 11 percent from the 2010 total.

Total expenditures for land, exploration, drilling, production, and reclamation were \$319 million in 2011, 15 percent more than in 2010. Expenditures for U.S. uranium production, including facility expenses, were

"Total employment in the U.S. uranium production industry was 1,191 person-years[1] in 2011, an increase of 11 percent from the 2010 total."

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the largest category of expenditures, at \$169 million in 2011, and were up by 27 percent from the 2010 level. Uranium prices have experienced significant increases during the last two decades, with most of that increase occurring since about 2006, as shown in Figure A. Similarly, rare earth prices have increased, owing largely to China's monopoly position, as shown in Figure B.

ⁱⁱ A "person-year" is one person working for one year, as distinguished from "jobs," which can be of indeterminate duration.

FIGURE A.
Weighted Average Price of Uranium Purchased by Owners and Operators of U.S. Civilian Nuclear Power Reactors, 1994–2011 Deliveries²

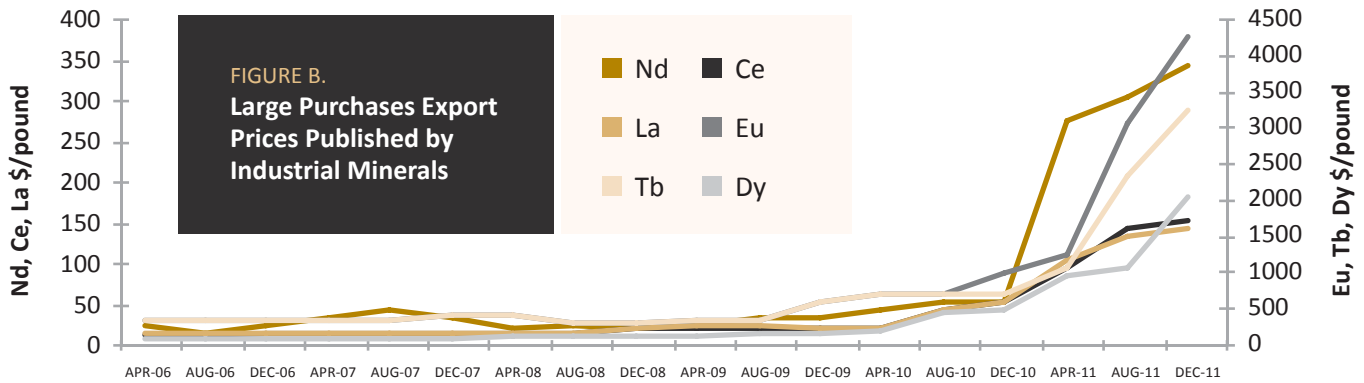
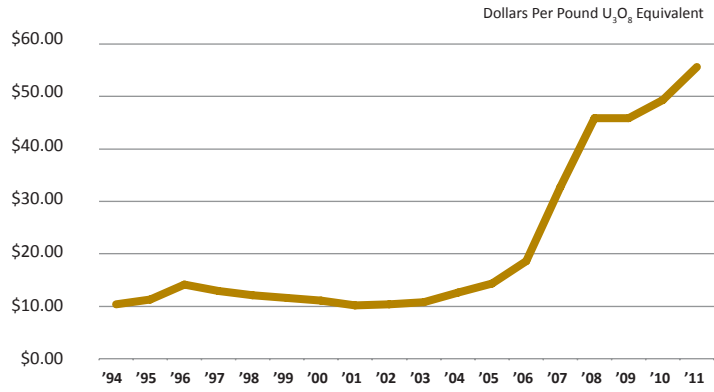


FIGURE C.
Rare Earth Production by Country/Region (Production in Tons)³

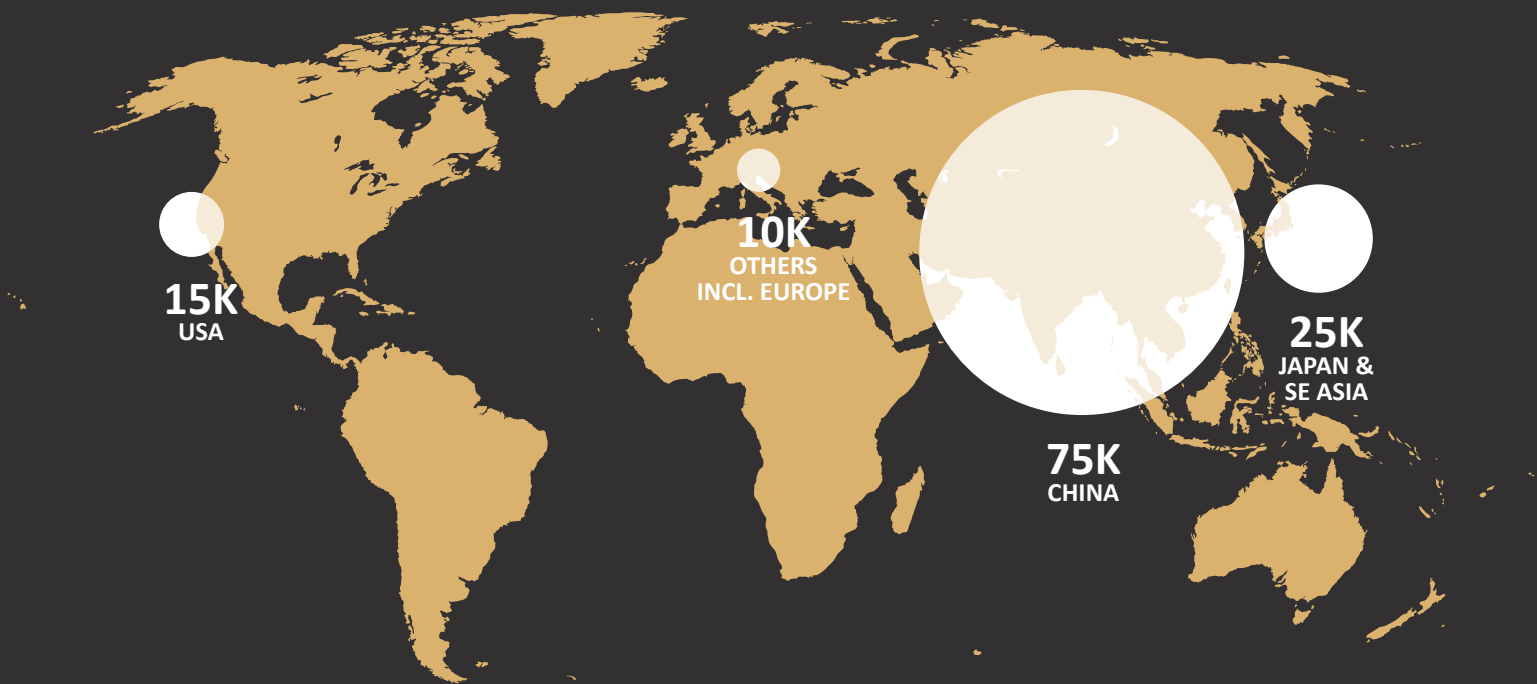
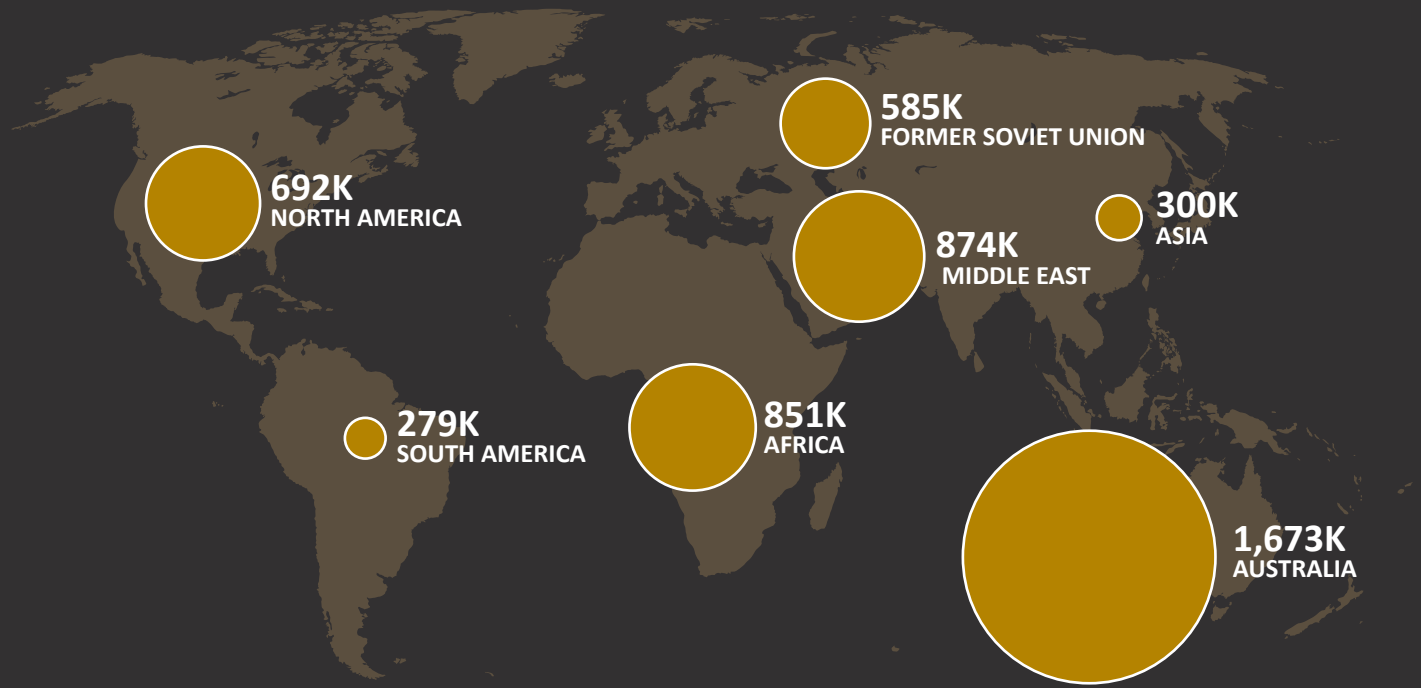


FIGURE D.

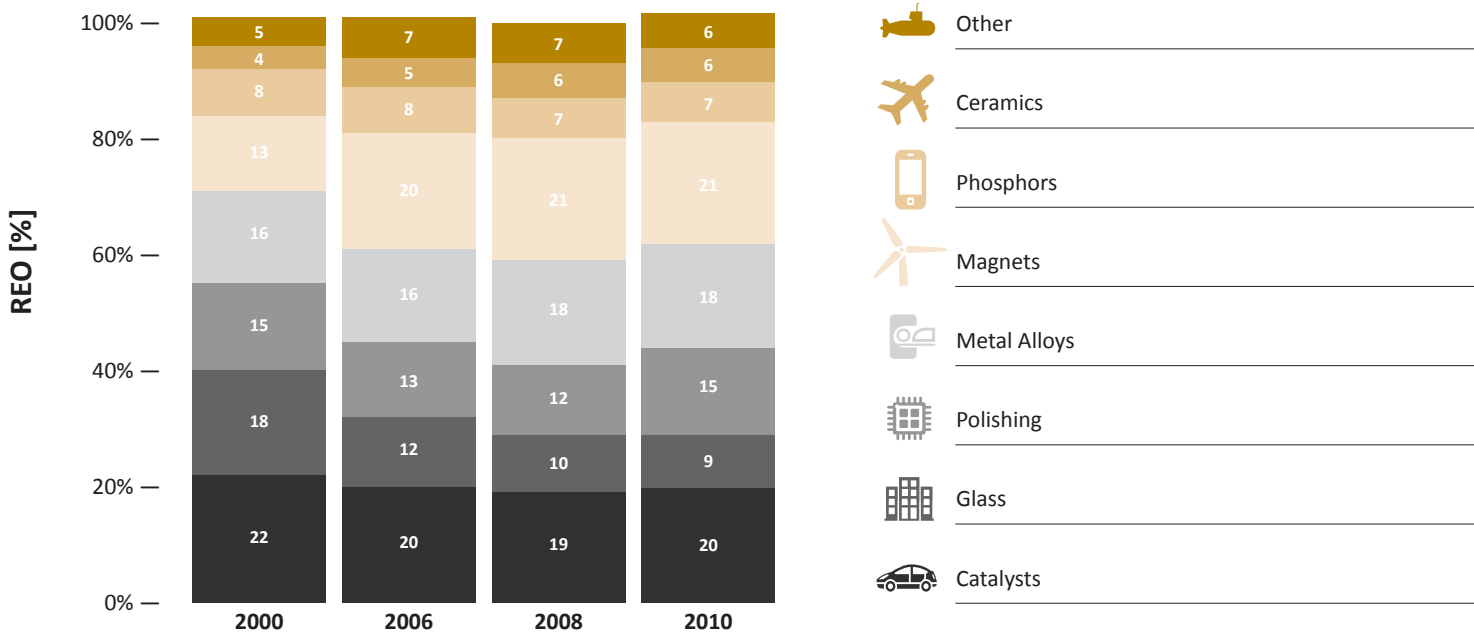
Known Recoverable Resources of Uranium (Figures in Thousand Tons)⁴



Source: www.world-nuclear.org/education/mining.htm

FIGURE E.

Rare Earth Consumption by End Use⁵



Totals may not add to 100% due to rounding

Source: Kingsnorth, D. J. (2010): Meeting the Challenges of Rare Earths Supply in the Next Decade- Presentation The Hague Centre for Strategic Studies, December 2010.

State-Level Review of Permitting and Regulatory Hurdles

Obtaining the permits and approvals needed to build a mine in the United States takes an average of seven years, which is among the longest wait times in the world. So, despite having vast underground stores of raw materials, the United States is one of the last places that miners go to start a project. Overall, the United States is tied with Papua New Guinea for the longest approval process among the 25 top mining countries in the world, according to Behre Dolbear Group, an international mining and mineral advisory group. In contrast to this wait time, in Australia, a huge mining center and the world's leader in uranium production, the permit process takes an average of one to two years.

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“Obtaining the permits and approvals needed to build a mine in the United States takes an average of seven years, which is among the longest wait times in the world.”

One of the most tightly regulated industries in the United States today is uranium mining. In fact, if the Virginia General Assembly decides to lift its current uranium mining moratorium, a total of eight different state and federal agencies are in place to oversee the entire uranium mining and milling operation. Of the eight regulatory agencies that would oversee these operations, at least two of them—the Environmental Protection Agency (EPA) and the Nuclear Regulatory Commission (NRC)—already have laws in place for the safe regulation of mining and milling. The EPA, for instance, has a regulatory measure called the National Pollutant Discharge Elimination System (NPDES), and it requires industrial facilities in any state, including Virginia, to obtain an NPDES permit through the respective state. Compliance with this regulation prevents storm

water discharge originating at uranium mining facilities from entering water supplies. As for vulnerability to storm weather, the NRC provides continued oversight of mining and milling operations through its own periodic licensing reviews, inspections, assessments, and enforcement. In general, these inspections address a variety of topics, including management organization and controls, radiation protection, chemical processes, radioactive waste management, emergency preparedness, fire safety, environmental protection that includes groundwater protection, and onsite construction. These inspections occur anywhere from several times a year for operating facilities to once every two years for facilities that are in standby mode or decommissioning, and through them companies are required to demonstrate that their facilities and operations are capable of withstanding severe weather events, such as hurricanes, earthquakes, tornadoes, and flooding.

Unfortunately, the current ban on mining one of Virginia's best natural resources unnecessarily deprives the nation of an efficient, carbon-free source of electricity that is one of its best-available long-term energy sources, and holds back hundreds of employment opportunities that would benefit both the state's and the country's energy outlooks.

The states with rare earths and uranium resources do not all have identical permit processes or requirements. Some are less onerous than others. A comparison of the average time to receive a mine permit (including other types of mines) and the extent to which litigation (e.g., by environmental groups) impede the permit process are shown in Table A, along with those states' reserves.

The issue addressed here is not the strength of the regulations but the timeframe involved in obtaining permits. Contributing to delays is intervention by non-governmental organizations (NGOs) opposed to mining development of any sort and groups with legitimate concerns about the effect a project will have on a community or lifestyle. As communication is facilitated by the Internet, issues regarding the operations in one location become the source material for concerns and examples used against a completely unrelated mining project elsewhere. As this situation continues to evolve, the business environment will likely favor firms that aggressively take a proactive stance concerning societal and environmental issues. Permitting delays are the

Table A.

Uranium and Rare Earth Deposits by State (Uranium Reserves in Million Tons @\$100 Forward Price; RE in Million Tons)⁶

Uranium/Million Tons	Permit Hurdle Level	Rare Earth/Million Tons	Permit Hurdle Level
Arizona, Utah Colorado (22)	2.5 (3 state average)	Alaska (34)	3
		California (13.7)	3
		Colorado (2540)	3
Wyoming (145)	2	Idaho (0.1)	2
New Mexico (64)	2	Illinois (14.7)	3
Virginia (119)	4	Missouri (0.6)	n.a.
Texas (15)	2	Nebraska (39.4)	2
Other (28)	n.a.	New Mexico (2.4)	2
		New York (9)	3

Key to permit hurdles:

- 4 = effective or real moratorium/prohibition
- 3 = possible but extremely difficult and time consuming
- 2 = straightforward; comparative to any other industrial permit
- 1 = expedited and encouraged; "fast track."

most significant risk to mining projects in the United States. A few mining-friendly states (Nevada, Utah, Kentucky, West Virginia, Idaho, and Arizona) are an exception to this rule, but are often negatively impacted by federal rules that are added on top, resulting in a seven- to 10-year waiting period before mine development can begin. Delays imposed by federal permitting are not reflected in the hurdles shown in Table A, which provides only a comparative evaluation of each state's process.

The state of Arizona has recently issued multiple permits for three uranium mining sites, but the mines must now receive federal permits.⁷ All three sites are relatively near the Grand Canyon, which has had uranium mines in the past but ones that used out-of-date technology. The environmental legacies from those past operations should provide learning opportunities for improved environmental protection—not, as some interest groups argue, to further delay or prohibit mining. However, the federal government has banned uranium mining on more than 1 million acres of federal land in Arizona.⁸

Colorado has been mining uranium for more than 100 years, and is a good example of responsible permitting for other states. Mine permit opponents point to Cotter Corporation's Cañon City mine as proof that mining is unsafe. The Colorado site began operations in 1958, and was declared a Superfund site in 1984 as stored tailings contaminated surface soil and water sources. Little was known then about how best to manage radioactive tailings, and the early methods that the corporation used to store tailings would not even be considered under current NRC regulations. Instead of banning uranium mining, Colorado learned from past mistakes. The state rewrote health and environmental regulations to reflect new knowledge, thereby ensuring the safety of mining operations, which have consequently become continuously safer over the years. To date, there are 33 active uranium-mining permits in Colorado and 71 prospect notices of intent.⁹

In Colorado, Energy Fuels' facility at Pinon Ridge will support 200 existing uranium and vanadium mining jobs in the region. Opponents filed a lawsuit that has forced the state health department to hold new public

hearings on the operating license it had already issued to the company.¹⁰ An activist environmentalist group argued that air quality in the resort town of Telluride, 65 miles away, could be threatened “if anything goes wrong.” Others worry about the mining-dependent region’s historical boom and bust cycles, never mind the irony that, if they were successful in preventing mining operations, they would force the region into perpetual bust. Still others worry that mine operations will reduce local property values, although that has not been demonstrated. Energy Fuels—and the state—insist that today’s tougher safety controls minimize any risk to mill workers and area residents. It will use plant and personal detectors to track airborne radioactivity, according to documents filed as part of the permit.

“We just live in a different world that controls all this [dust, radiation, waste, etc.] much better,” said Steve White, Montrose County’s planning and development director, who helped issue a permit allowing agricultural land to be used for the mill. Over the decades, many area miners contracted lung disease from poor mine ventilation and from smoking. Despite that legacy, some residents insist that the project should go forward. “If it wasn’t safe, we would be the first people to not want it here,” said John Reams, who owns a construction company nearby.¹¹

This year, Australia and Canada were ranked¹² the best places to invest in minerals mining. Both countries have environmental laws for mining that are similar to U.S. regulations, but have permitting timelines of approximately two years—compared to the seven to 10 years in the United States.

Specific measures used in Canada and Australia to achieve such expeditious permit timelines may or may not be applicable to situations in the United States. However, some general principles should be embraced:

1. Process permitting issues and concerns in a concurrent manner rather than sequentially.
2. Acknowledge that there have been problems in the past, and use them to drive technological solutions.
3. Where multiple agencies (e.g., air and water per-

mitting) and multiple levels of government have separate permitting authority (e.g. state/provincial and federal), combine all permitting into a single “one-stop” authority.

4. Rapidly dispense with non-substantive issues raised, and place some financial burden on the interest group raising them, to avoid spurious delay tactics.
5. Once a permit is issued, any “re-opening” or reconsideration of that final decision should only be done if compelling evidence shows an error in the original process or facts. The burden of proof must be entirely on the entity requesting re-opening or reconsideration.

Economic development and environmental protection occurs best under a system of clear and strong property rights. The job of government is to protect those property rights. As artfully articulated by Jack Spencer and Katie Tubb of The Heritage Foundation:¹³

“The job of the government should not be to ban or promote mining, but rather to set strong regulations that protect public health and safety. Then, given those regulations, private investors can determine whether the mining is worth pursuing. Doing so is not an endorsement of uranium mining. It is an endorsement of private property rights, free economic activity, and government responsibility to protect public health and safety. If developed and applied correctly, regulations will help to ensure that uranium is mined safely and that public health is protected. It will allow private property owners to steward their property as they see fit, and to use their resources to promote economic activity that will surely benefit them, but will also benefit the region, even the country.”

Doing otherwise is, in effect, a taking of that property by the government. Similarly, once issued, permits create property rights in the permission to participate in an activity like mining. Re-opening or reconsideration of an issued permit should be treated as an impairment of that property right.

Economic and State Budget Benefits From Developing Reserves (By State)

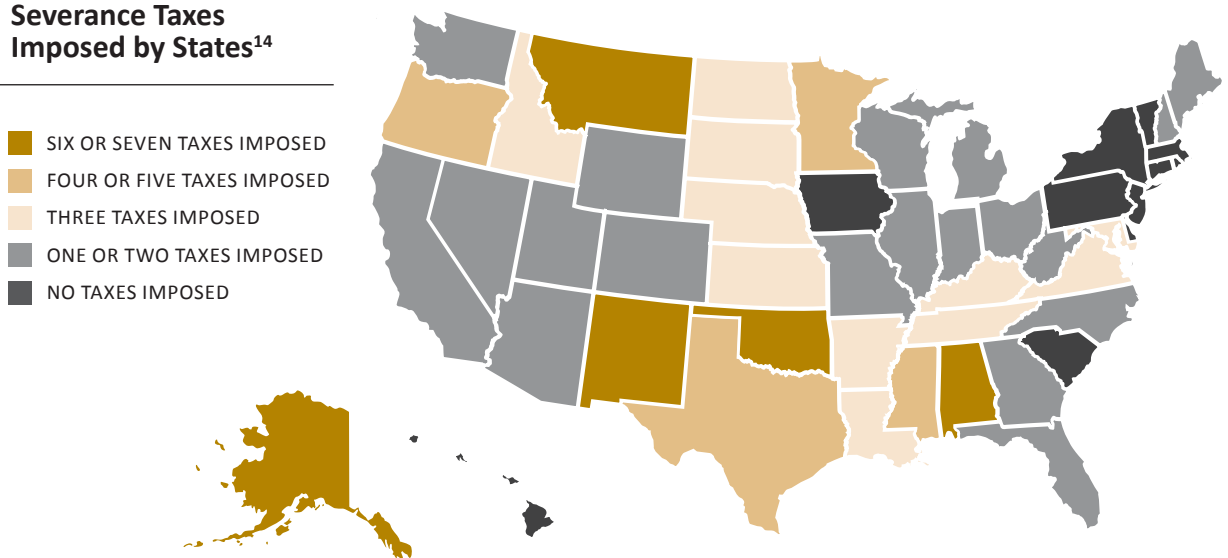
Along with the economy, state budgets are in extreme straits. The Center on Budget and Policy Priorities (CBPP) reports that the budget gaps that states have had to close for fiscal year 2013 total \$55 billion in 31 states. These gaps result principally from weak tax collections combined with auto-pilot spending. The Great Recession that started in 2007 caused the largest collapse in state revenues on record. Since bottoming out in 2010, revenues have begun to grow again but are still far from fully recovered. As of the first quarter of FY 2012, state revenues remained 5.5 percent below pre-recession levels, and are not growing fast enough to recover fully soon. Meanwhile, states' education and health care obligations continue to grow. To the extent that these shortfalls are being closed with spending cuts, they are occurring on top of past years' deep cuts in critical public services like education, health care, and human services. The additional cuts mean that state budgets will continue to be a drag on the national economy, threatening hundreds of thousands of private- and public-sector jobs, reducing the job creation

that otherwise would be expected to occur. Potential strategies for lessening the impact of deep spending cuts include more use of state reserve funds in states that have them, more revenue through tax-law changes, and economy-growing policies at the state level.

According to the CBPP, some states initially were not affected by the economic downturn. Resource-rich states—such as New Mexico, Alaska and Montana—saw revenue growth in the beginning of the recession as a result of high oil prices. Later, however, the decline in oil prices affected revenues in these states. The economies of a handful of other states have so far been less affected by the national economic problems. Only two states, North Dakota and Montana, have not reported budget shortfalls in any of these years. One other state—Alaska—faced shortfalls in FY 2010, but has not projected gaps for subsequent years. States that rely on natural resources for a substantial share of state revenues derive them from both state severanceⁱⁱⁱ taxes and resource leases on federal lands within their borders.

ⁱⁱⁱSeverance taxes are excise taxes on natural resources “severed” from the earth. They are measured by the quantity or value of the resource removed or produced. In the majority of states, the taxes are applied to specific industries such as coal or iron mining, and natural gas or oil production. They are usually payable by the severer or producer, although in a few states payment is made by the first purchaser.

FIGURE F.
Severance Taxes Imposed by States¹⁴



An evaluation of the potential economic benefits from development of each state’s resources is shown in Table B. Each state shows increase to gross state product (GSP), number of jobs created (including direct and indirect, but not induced), and increases to state revenue from corporate and worker income tax—and severance tax, where applicable—but with no rate or structural change to current taxes. Sales taxes are included, but not property tax, so the estimates should be considered conservative. GSP and revenue estimates

are in annual millions of dollars. Estimates are provided assuming full development and at full operation (i.e., after initial construction and ramp up).

For example, Virginia is estimated to benefit from an increase in state GSP of \$7 billion, an increase in person-year employment by 1,900 per year (shown as jobs), and an increase in state revenue by \$500 million. Each state’s GSP for 2011¹⁵ is shown for comparison.

TABLE B.
Potential Economic Impacts of Resource Development

Uranium/ Millions of Tons	Econ Development (\$million), Jobs, Revenue (\$million)	Gross State Product (\$million)	Rare Earths/ Millions of Tons	Econ Development (\$million), Jobs, Revenue (\$million)	Gross State Product (\$million)
Arizona, Utah Colorado (22)	<ul style="list-style-type: none"> • \$1,300 • 350 • \$110 	\$570,000	Alaska (34)	<ul style="list-style-type: none"> • \$11,000 • 1,000 • \$160 	\$44,700
			California (13.7)	<ul style="list-style-type: none"> • \$4,500 • 400 • \$108 	\$1,735,400
			Colorado (2,540)	see note	
Wyoming (145)	<ul style="list-style-type: none"> • \$8,550 • 2,300 • \$810 	\$31,500	Idaho (0.1)	Not estimated	
New Mexico (64)	<ul style="list-style-type: none"> • \$3,765 • 1,020 • \$360 	\$70,500	Illinois (14.7)	<ul style="list-style-type: none"> • \$4,800 • 430 • \$116 	\$582,100
Virginia (119)	<ul style="list-style-type: none"> • \$7,000 • 1,900 • \$500 	\$375,800	Missouri (0.6)	Not estimated	
Texas (15)	<ul style="list-style-type: none"> • \$630 • 240 • \$10 	\$1,149,900	Nebraska (39.4)	<ul style="list-style-type: none"> • \$12,900 • 1,150 • \$250 	\$79,900
Other (28)	Not Estimated		New Mexico (2.4)	Not Estimated	
			New York (9)	Not Estimated	

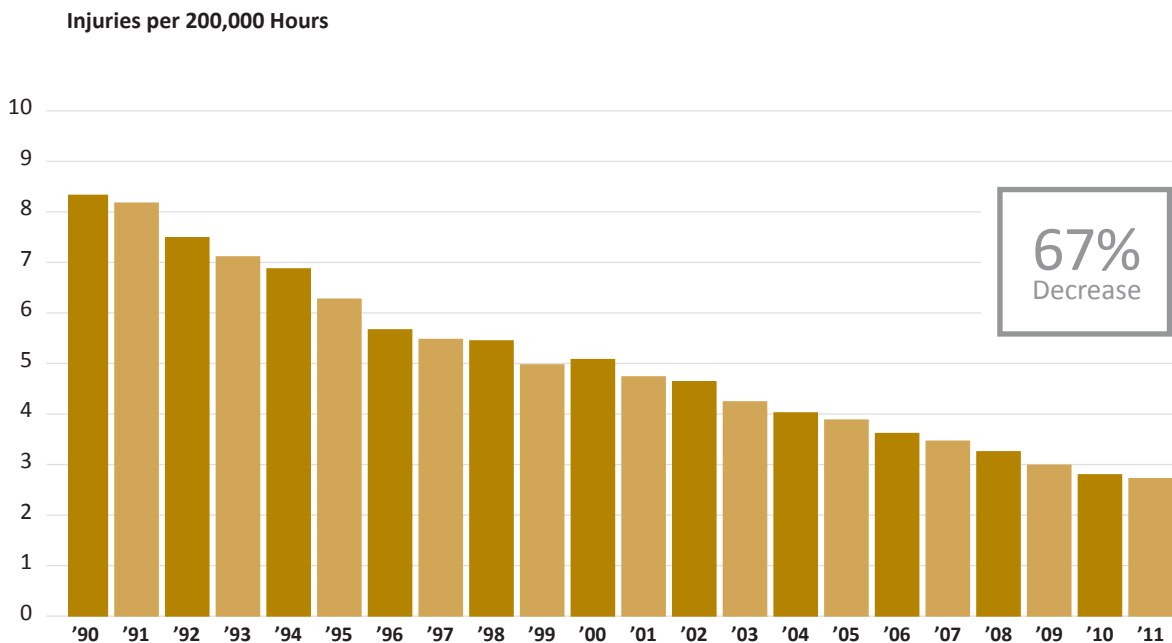
Note to table: Colorado’s REE resource estimate, from the USGS Report,¹⁶ is “undefined,” and a broad level estimate with no drilling or detailed geology yet performed, and it is therefore premature to provide economic estimates.

Environment and Safety Records of Domestic Mining Compared to Global Experience

Worker safety and environmental protection are crucial to the future of mining, and by extension to the wealth and health of America. Worldwide, thousands of miners die each year working with only a small sliver in domestic operations.

Mines in the United States are some of the safest in the world. According to the Mine Safety and Health Administration (MSHA), from 1991–1999, 93 people were killed in mining related deaths in the United States in mining operations of all types. In 2011, there were 16 deaths in American metal and non-metal mines.¹⁷ Despite the relative safety of American mines, there continues to be further improvement in their safety, as shown in Figure G, which displays figures for injuries of all types in mines of all types, and exhibits a 67 percent reduction in injuries since 1990.¹⁸

FIGURE G.
U.S. Mining Record of Reduction Total Injury Rate, 1990–2011



The problems of American mines, however, are minor compared to mine safety in the rest of the world. The status of mine safety in China and South Africa gives the greatest cause for concern. China has the worst safety record in the world. According to China Daily, the State Administration of Work Safety reported that, in 2003, China produced 35 percent of the world’s coal, but reported 80 percent of the total deaths in coal mine accidents. Officially, about 5,000 miners died in China

in 2006. However, according to a recent report in Time magazine, unofficially, the number of miners killed in Chinese mines is much greater.¹⁹ To put this into perspective, China has a coal output 2.2 percent greater than the United States, but the death rate for every 100 tons of coal is 100 times that of the United States.

South Africa’s main issues come from gold and platinum mines. South Africa is the world’s largest platinum pro-

ducer, and one of the largest gold producers. In 2006, South Africa recorded 113 deaths in gold mining operations and 40 deaths in platinum mining operations.

The Sago Mine disaster was a coal mine explosion on Jan. 2, 2006, in Sago, West Virginia. The blast and collapse trapped 13 miners for nearly two days; one miner survived. The National Conference of State Legislatures²⁰, an advocate for the interests of state governments before Congress and federal agencies, reports that soon after the Sago Mine disaster, several states took action to modernize their mining safety laws. States that reevaluated their mine safety regulations and enforcement soon after include Alabama, Illinois, Kentucky, Missouri, New Mexico, Ohio, Pennsylvania, West Virginia, Utah, and Virginia.

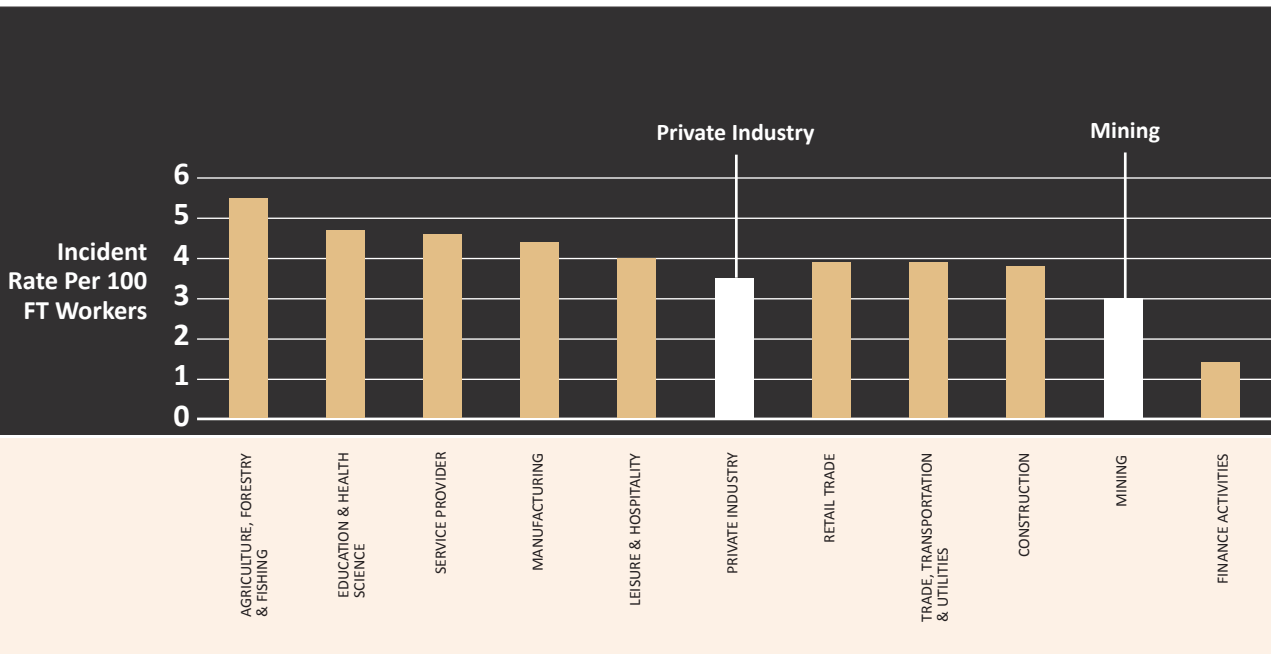
In addition to state laws, improvements have been made to federal mine safety regulations. On June 15, 2006, the Mine Improvement and New Emergency Response Act of 2006 (MINER Act) was signed by President George W. Bush. According to the Mine Safety and Health Administration (MSHA), the MINER Act was the

most significant mine safety legislation in 30 years. It amends the Mine Safety and Health Act of 1977, and contains a number of provisions to improve safety and health in America's mines (MSHA). When speaking about the signing of the MINER Act, President Bush stated that, in signing the act, "[America] honor[s] the memory of all lost miners..."

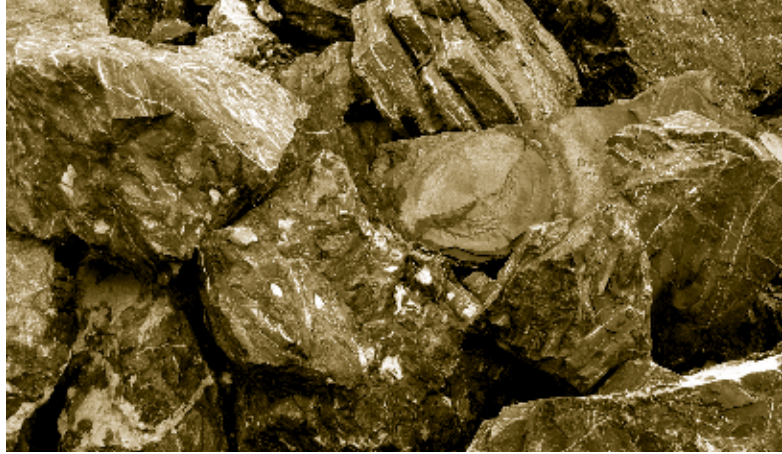
Mine safety in the United States is improving. The MINER Act has updated outdated legislation. The Sago Mine disaster has caused many state legislatures to reevaluate and update their mine safety legislation. However, tragedies are not required to bring about changes in mine safety legislation. Improvements in technology are continuously being made, and because of this federal and state governments should continuously look to improve mine safety legislation.

As shown in Figure H, U.S. mining safety also compares favorably to other U.S. sectors.²¹The mining sector has the second lowest injury rate of the categories tracked by the Bureau of Labor Statistics, and below the average for all private industry.

Figure H.
Incident Rates of Non-Fatal Occupational Injuries Compared to Other Industrial Categories, 2011



Source: Bureau of Labor Statistics



While much of the global attention is paid to underground coal and metal mining safety and hazards, comparable safety excellence is shown in other mining types.

Opponents of mining in general, or of specific mining permits, frequently use faulty science, assume behavior in conflict with specific regulations, or promote outright falsehoods in order to push their agenda—to deny permits to mine safely. They have claimed, for example, that the wetter climate in Virginia poses environmental risks vastly different from drier climates in the West, “where all uranium mining takes place.”

Digit!

“Imposing outright bans on uranium mining eliminates fair and impartial evaluation of the science behind environmental safety, and drives policy to an emotional chaotic basis, rather than setting policy based on reality.”

The Coles Hill ore deposit in Virginia is the largest undeveloped uranium deposit in the United States, and the 14th largest in the world, containing about 119 million pounds of uranium oxide. It sits entirely on private property, but the Virginia moratorium discussed earlier is keeping the owners from developing the resource. In February 2011, the city of Virginia Beach released a study conducted by Michael Baker Corp. that attempted to measure the impact of a catastrophic release of tailings—the crushed rock left over from the milling process—at the Coles Hill site on downstream communities, including Virginia Beach. In May 2011, Kleinfelder West Inc. released a technical review of the Baker study identifying numerous flaws in the study’s assumptions, methodology and input data, which grossly exaggerated the possibility that tailings material could be released from Coles Hill and contaminate downstream water sources, including Lake Gaston. Two main flaws identified by Kleinfelder:

- The Baker study incorrectly assumed that tailings would be stored in primitive above-ground impoundments that would be susceptible to flood-

U.S. Mines Win Safety Awards

American mines have won awards from the U.S. Department of the Interior (DOI) for the mines’ outstanding contributions to the environment, mine reclamation, and community outreach. The awards were presented by officials from the U.S. Bureau of Land Management (BLM) and the Office of Surface Mining, Reclamation, and Enforcement (OSM). All award-winning operations were selected by DOI judging panels. The two federal agencies sponsor the annual awards recognizing the best environmental and reclamation practices throughout the year for coal and mineral mining. The Department of the Interior began the environmental awards program for mining in 1986 with the OSM “Excellence in Surface Coal Mining Reclamation Award.” A parallel program for abandoned mine land reclamation was launched in 1992. BLM first presented its mining awards in 2003 to recognize sustainable development practices that include separate categories for environmental practices throughout the mining community.

“NMA is proud of these award winners for the commitment they have demonstrated to modern mining methods and for the progress U.S. mining has made in practicing sustainable mining in cooperation with local communities,” said NMA President and CEO Hal Quinn.

“Today more than ever before, ‘good mining’ means ‘good neighbor.’ The economic development fostered by our mines in the areas where they operate is a tangible demonstration of our commitment to sustainable development,” said incoming NMA Chairman Frank McAllister, chairman and CEO of Stillwater Mining Company.

ing and storm-induced damage. This assumption ignored the company's repeated commitment to below-grade tailings storage and clear U.S. Nuclear Regulatory Commission (NRC) regulations requiring, in most cases, the safer below-grade method. Kleinfelder concluded that it would be extremely unlikely for the company to receive a license to operate such a primitive tailings structure.

- The Baker study placed both hypothetical tailings impoundments immediately next to and in direct alignment with the Roanoke and Banister Rivers, disregarding explicit NRC regulations requiring that tailings be placed at far greater distances from river channels and flood plains.

As the National Academy of Sciences and other independent experts have concluded, placing tailings in below-grade cells with multiple heavy-duty liners and multi-layer covers eliminates the risk of any releases caused by heavy storms or flooding. Before Virginia Uranium, the company that would like to develop the Coles Hill site, can receive a license to operate, the U.S. Nuclear Regulatory Commission (NRC) must certify that tailings cells are designed to withstand a Probable Maximum Precipitation (PMP) event and a resulting Probable Maximum Flood (PMF)—both more extreme weather events than the worst-case scenario events used in the Baker study—without releasing material into the environment.

According to a joint report by the National Academy of Sciences and the National Research Council:²²

“Full below-grade disposal of mill tailings is an option that has been developed specifically to eliminate concerns over the release of tailings due to catastrophic failure of a construction retaining berm or tailings dam. ... As shown at Elliot Lake, Canada [a fairly wet climate by the way] and elsewhere, lined and capped storage repositories can prevent the spread of tailings by erosion and control contamination of groundwater and surface water systems by seepage.”

And, contrary to the claims of uranium opponents that safe uranium mining has only occurred in “dry” climates, the facts are that uranium recovery has occurred in Florida, Louisiana, and Elliot Lake (in Ontario, now a thriving recreational and retirement community)—all east of the Mississippi. Other semi-arid and even wet climates have hosted uranium mining in France, Australia, Canada, Texas, and South Africa.

Imposing outright bans on uranium mining eliminates fair and impartial evaluation of the science behind environmental safety, and drives policy to an emotional chaotic basis, rather than setting policy based on reality.

U.S. mine safety is no accident. Safety, and environmental protection, is the result of institutional arrangements, use of best practices, and a commitment for the long haul. It is best accomplished by establishing performance criteria, not ever-changing prescriptive “how to” standards.

Conclusions and Recommendations

Developing U.S. natural resources would provide economic and security benefits, but this is currently hampered by unnecessary regulatory and political barriers. State economies and budgets would benefit from expanded mineral development that would simultaneously improve national trade deficits and energy security. States should look to Australia and Canada for permitting advice, and dramatically shorten domestic permitting time. It may be advantageous to arrange a trade mission to both countries to find out

how they can permit mines in one-quarter the time it takes here, while meeting similar worker safety and environmental protection goals. Virginia, with one of the world's largest untapped uranium resources, should eliminate prohibitions on uranium mining, and develop appropriate regulations to protect workers and the environment, again looking to Australia and Canada for guidance.

States with rare earths and uranium resources could benefit by more than \$40 billion in increased GSP, add nearly 9,000 good paying jobs, and improve their state revenue take by almost \$2 billion, with no change to tax rates or imposition of new taxes. These are truly shovel-ready opportunities, just waiting for permission.

Appendix: How Did Mountain Pass Resume and Expand Operations?

Located along Interstate 15 in California, 15 miles south of the Nevada state line, a giant mine and processing complex is about to regain significance on the international commercial stage. Once the world's main source for rare earth elements, and closed since 2002, the Mountain Pass Mine is now scheduled to resume operations. Molycorp stated in a early November 2012 press release that, even with some delays, the Company still expects to be in full operation by the end of 2012²³.

Mining rare earth elements is inherently risky. Radioactive ores often occur along with the rare earth elements. In the case of Mountain Pass, sludge from evaporation ponds containing uranium and thorium was of sufficient concentration that the corporation was seeking permits to ship it to Utah for milling. Wastewater is toxic, and has high salinity. Molycorp processes 14 individual rare earth elements dug out of an open pit, currently 1,500 feet across and 400 feet deep, smallish when compared to some pits, and destined to become larger as mining resumes. An extensive history of wastewater spills is perhaps the most notorious of the mine's environmental mishaps. Approximately 600,000 total gallons of wastewater were spilled between 1984 and 1998 through multiple ruptures in a pipe transporting the water to a final evaporation pond at Ivanpah Flats, 13 miles to the northeast. The pipe passed through several washes, crossed National Park Service lands, and was

adjacent to a critical tortoise habitat in BLM-stewarded land. Materials in the waste (and possibly groundwater) may have included uranium, manganese, strontium, cerium, barium, thallium, arsenic, and lead. Given this history, permitting of mining and milling operations was closely scrutinized by multiple agencies, the public, and several NGOs (including the Sierra Club) throughout the EIR/EIS process for which the county of San Bernardino was the lead agency. This itself concerned some environmentalists who questioned the rigor of a county-led process. Risks assessed included possible human health impacts. A primary school right next to the mine was closed in 2003. Only a few residences of state employees are immediately adjacent to the mine, but fugitive dust, windblown tailings, and groundwater contamination could impact the neighboring communities of Baker, Nipton, and beyond. The final EIR/EIS was released in June 2004. It concluded that the Molycorp facility would result in significant aesthetic, air quality, biological resource, geology/soils, and hydrology/water quality effects. Nevertheless, final permitting occurred in the third quarter of 2010.

According to Molycorp literature, modernizing the mine and processing facilities includes pioneering technological breakthroughs to minimize wastewater emissions and boost mineral recovery rates, while driving down production costs to half that of Chinese rare earth mines. It will be recycling wastewater within the facility to reduce emissions and fresh water usage. This will eliminate 120 acres of evaporation ponds. The infamous wastewater pipeline leading offsite is gone. Instead of requiring a tailings dam, a patented process at the facility will form a paste with the tailings by removing most of the water from the slurry, then deposit the paste in stable layers. It will be reducing CO₂ and par-

ticulate emissions by replacing diesel-fired equipment with natural gas-fired equipment. Onsite recycling and salts recovery will reduce transportation impacts. The company says that it will employ up to 300 workers once the mine is back in full swing. Its goal is to achieve a production rate of 20,000 tons of rare earths per year.

New rare earth mines will be developed during the next few years in Australia and Canada. Processing and mining methods are becoming more sophisticated, exploration activities are increasing and will result in more mines in the future since demand will not abate. Let's hope that Molycorp's environmental improvements turn out to be effective and will be emulated, and that consumer commitment to conservation and recycling all mineral products will result in fewer giant holes in the earth. The future of rare earth mining remains to be written.

Now, the new investors that own Molycorp Inc. are eager to prove that producing rare earths can be both clean and economical. They say that they will invest \$531 million to modernize the mine's facilities, spending about a third of the total on a system designed to recycle nearly all wastewater.

The lessons learned include:

- Be committed to listening to and addressing the environmental concerns of neighbors.
- Be committed to using best practices and environmental technologies.
- Keep potential risks to a minimum, and keep them entirely on site.
- Constantly look for opportunities to improve safety and environmental performance.

Author Biography

Tom Tanton, President of T² and Associates

Mr. Tanton is President of T² & Associates, a firm providing consulting services to the energy and technology industries. T² & Associates are active primarily in the area of renewable energy and interconnected infrastructures, analyzing and providing advice on their impacts on energy prices, environmental quality, and regional economic development. Mr. Tanton is a strong proponent of free-market environmentalism and consumer choice, and frequently publishes and speaks against alarmist and reactionary policies and government failures. Most recently, Mr. Tanton presented invited testimony to the House Energy and Commerce Committee regarding energy technology focused Federal policies, and provided Hill briefings on the critical nature of rare earths markets.

Mr. Tanton has 40 years of direct and responsible experience in energy technology and legislative interface,



having been central to many of the critical legislative changes that enable technology choice and economic development at the state and federal levels.

As the general manager at Electric Power Research Institute from 2000 to 2003, Mr. Tanton was responsible for the overall management and direction of collaborative research and development programs in electric generation technologies, integrating technology, market infrastructure, and public policy. From 2003 through 2007, Mr. Tanton was senior fellow and vice president of the Houston-based Institute for Energy Research.

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