China and India’s Ravenous Appetite for Natural Resources—Their Impact on Colorado

Vince Matthews, Ph. D.
Director
Colorado Geological Survey
Harris D. Sherman,
Executive Director
YOUR Geological Survey !!!

- Geology of Water Resources
- Promote Mineral and Energy Resources
- Colorado Avalanche Information Center
- Geologic Hazards
- Educate
- Assist State and Federal Agencies

COLORADO GEOLOGICAL SURVEY
Over 192,000 water wells in Colorado
Don’t ski outside the boundaries!
The CAIC is Fighting Back!

In the past 10 years we have provided:

• avalanche safety to 35,000 people
• safety message to 2.2 million callers
• services at low cost to the tax payer
Change in Avalanche Fatalities per 100,000 Population 1990-2003

Percent change

CO  UT  MT  WY

States with most fatalities

Colorado Avalanche Information Center
Post-Wildfire Mud Slides
Rockfall
Landslides on Unstable Slopes
Collapsible Soil
Swelling Soil
Earthquake/Fault Zones
Geologic Hazards

Conduct Land Use Reviews
Study geologic hazards
Emergency Assistance
Education of Practitioners and Planners
MESSAGES IN STONE
Colorado’s Colorful Geology

Edited by
Vincent Matthews, Ph.D.,
Randy Kofoid, and Betty Fry

COLORADO GEOLOGICAL SURVEY

Education

COLORADO GEOLOGICAL SURVEY

Colorado’s Magnificent POGIs
POGIs—Preschool Outings Geologic Interest Sites

In the spring of 2006, we worked with the Preschool Outings of Colorado, a non-profit organization, to create an innovative program that integrates early childhood education with the natural world. The program, called POGIs (Preschool Outings of Geologic Interest Sites), is designed to engage young children in outdoor activities that promote scientific thinking and environmental awareness. POGIs provide a unique opportunity for preschool children to explore the natural environment, fostering curiosity and a deeper understanding of the world around them.

POGIs aim to create meaningful learning experiences that align with early childhood education standards. They are designed to complement existing curriculum and provide a hands-on approach to teaching science, geography, and environmental conservation. Each POGI includes activities and resources that encourage children to observe, explore, and question their surroundings, promoting critical thinking and problem-solving skills.

POGIs are led by trained educators who guide participants through a variety of interactive activities, such as rock and fossil identification, nature scavenger hunts, and storytelling sessions that incorporate local geology. The programs are tailored to fit the needs of individual preschools, ensuring a personalized learning experience that meets the unique characteristics of each institution.

POGIs have been successfully implemented in numerous preschools across Colorado, fostering a love for nature and science among young learners. The program has received positive feedback from educators, parents, and children, who appreciate the opportunity to engage in outdoor activities that enhance their understanding of the natural world.

POGIs is an ongoing initiative that seeks to expand its reach and impact. The program is constantly evolving, incorporating new ideas and approaches to ensure that it remains relevant and engaging for preschool children. As POGIs continues to grow, it aspires to inspire a generation of curious minds who will become the stewards of our planet's natural resources.

COUNCIL STONE—More POGIs on CGS Web Page

Visit the CGS web page for more information and resources on POGIs. The website offers additional materials, including lesson plans, activity guides, and a directory of participating preschools. Through these resources, POGIs aims to provide teachers, parents, and other educators with the tools they need to create memorable and educational experiences for young learners. The POGIs website is a dynamic platform that encourages collaboration and innovation, allowing the program to adapt and grow as new ideas emerge and become available.

POGIs is a testament to the power of collaboration and the importance of engaging children in the natural world. By providing a platform for preschool educators to explore and learn about the geological wonders of Colorado, POGIs is helping to foster a new generation of environmentally conscious citizens who will work together to safeguard our planet for future generations.
Everything you need to know about Mineral and Energy in Colorado

Colorado Mineral and Energy Industry Activities, 2005

By:
James A. Cappa
Genevieve Young
John W. Keller
Christopher J. Carroll
Beth Wiedmann
Production of Natural Resources is an Important Part of Colorado’s Economy

Mineral and Energy Value, 1986-2005

$12.2 billion
Revenue comparison of Colorado’s Important Economic Sectors (2005)

<table>
<thead>
<tr>
<th>Sector</th>
<th>Revenue ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minerals &amp; Energy</td>
<td>12.2</td>
</tr>
<tr>
<td>Tourism</td>
<td>8.2</td>
</tr>
<tr>
<td>Agriculture</td>
<td>6.4</td>
</tr>
</tbody>
</table>

$ Billion
Distribution of Colorado Mineral & Energy Value 2005 ($ Billions)

- Natural Gas: 8.1
- Oil: 1.2
- Coal: 0.8
- Uranium: 0.007
- Minerals: 1.5
- CO₂: 0.200

COLORADO GEOLOGICAL SURVEY
Production of Natural Resources has *Always* been an Important Part of Colorado’s Economy
Boulder 1902

Just off 51st Street
China

India

U.S.
“I’ve taken a lot of people to Dalian, and they are amazed at how fast the economy is growing in this high-tech area. Americans don’t realize the challenge to the extent that they should.”

“All the years of socialism and controls had taken us downhill to the point where we had only $1 billion in foreign currency. Today we have $118 billion. We went from quiet self confidence to outrageous ambition in a decade.”
Land Area Comparison

- China
- U.S.
- India
GDP Comparison

- China
- U.S.
- India
GDP Growth Comparison

- China
- U.S.
- India
GDP Growth Comparison

Japan GDP

China GDP

13X

26X

COLORADO GEOLOGICAL SURVEY
World Electrical Growth

World
6.3

China/India/U.S.
3.4

Source: BP Statistical Review of World Energy 2006

COLORADO GEOLOGICAL SURVEY
World Electrical Growth

U.S. 1.1

India 0.4

China 1.9

Source: BP Statistical Review of World Energy 2006
World Electrical Growth

- Africa
- Europe-Eurasia
- South & Central America
- Asia-Pacific
- Middle East
- North America
China’s Share of World Mineral Production in 2003

<table>
<thead>
<tr>
<th>Commodity</th>
<th>Percentage</th>
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<tr>
<td>Coal</td>
<td>45</td>
<td>1</td>
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<td>4.7</td>
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<tr>
<td>Fluorspar</td>
<td>55</td>
<td>1</td>
</tr>
<tr>
<td>Rare earths</td>
<td>85</td>
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</tr>
<tr>
<td>Aluminum</td>
<td>18</td>
<td>1</td>
</tr>
<tr>
<td>Antimony</td>
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<td>3</td>
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<td>1</td>
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<tr>
<td>Tin</td>
<td>32</td>
<td>1</td>
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<tr>
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<td>83</td>
<td>1</td>
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<td>Zinc</td>
<td>22</td>
<td>1</td>
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Source: USGS, Kenzie, et al
China’s Production and Consumption of Copper

Source: USGS, Kenzie, et al
## China’s Share of World Mineral Production in 2003

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Source: USGS, Kenzie, et al

China’s growth in iron ore consumption in 2005 equaled ½ of the total U.S. production.
Trends in Demand for Steel

Source: International Iron and Steel Institute.
China

2005 – Opened 70,000 new supermarkets

2006 – Will become #3 car manufacturer

11th Five-year plan

- 42% increase in capital investment

- Plan to build the equivalent of three Manhattan Islands
World Energy Consumption

Colorado has 48 generating stations (5%)
OIL CONSUMPTION - China

Source: BP Statistical Review of World Energy 2006
49% Imported!
OIL- CONSUMPTION India

69% Imported!

Source: BP Statistical Review of World Energy 2006

COLORADO GEOLOGICAL SURVEY
OIL - U.S. Consumption

67% imported!


COLORADO GEOLOGICAL SURVEY
World oil demand has broken into new territory...
World oil demand has broken into new territory...

[Graph showing world supply million b/d from 1970 to 2015, with a notable increase in 2005. The graph indicates a significant contribution from Non-OPEC sources, with a highlighted change from 2002 to 2004 showing a rise in supply.]

COLORADO GEOLOGICAL SURVEY
...this has been an enormous challenge...

Simply to cope with the same amount of growth that we have seen between 2002 and 2004 would require the addition of another Iran (plus a bit) or two Venezuelas.
The majors’ recent exploration results have been poor...
In 1956, M. King Hubbert predicted that Lower-48 production would begin declining in 1969.
OIL- U.S. Production

[Graph depicting U.S. oil production over time]

*Statistical Review of World Energy, 2008*

COLORADO GEOLOGICAL SURVEY
In 1969, M. King Hubbert Predicted that World Production would Begin Declining in 2000.
Mexico’s declining production at Cantarell field accelerating

Mexican state oil company Pemex said Wednesday that production at its Cantarell oil field, the world’s second-largest, will drop faster than expected. 08/03/06

54 of the world’s 65 oil producing countries are in decline!
Wattenberg oil well near Longmont

22nd Largest oil field
Colorado Impact

Colorado’s production decline reversed in the last 5 years

Wattenburg is the largest oil field west of the Mississippi (outside of CA and TX).

Rangely still has large reserves (57R/65P).

Commerce City refinery will be processing Canadian oil sands.
Oil shale is being seriously re-appraised.
Major World Oil Shale Resources

(15 Gallons Per Ton)

Billion Barrels

<table>
<thead>
<tr>
<th>Country</th>
<th>Barrels</th>
</tr>
</thead>
<tbody>
<tr>
<td>Israel</td>
<td>5</td>
</tr>
<tr>
<td>Estonia</td>
<td>18</td>
</tr>
<tr>
<td>China</td>
<td>25</td>
</tr>
<tr>
<td>Australia</td>
<td>35</td>
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<tr>
<td>Morocco</td>
<td>58</td>
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<tr>
<td>Jordan</td>
<td>69</td>
</tr>
<tr>
<td>Brazil</td>
<td>90</td>
</tr>
<tr>
<td>United States</td>
<td>1200</td>
</tr>
<tr>
<td>Total World</td>
<td>1662</td>
</tr>
</tbody>
</table>
World Energy Consumption

Natural Gas

NATURAL GAS CONSUMPTION - China

Source: BP Statistical Review of World Energy 2006

COLORADO GEOLOGICAL SURVEY
NATURAL GAS CONSUMPTION - India

Source: BP Statistical Review of World Energy 2006
NATURAL GAS CONSUMPTION - U.S.

Source: BP Statistical Review of World Energy 2006

COLORADO GEOLOGICAL SURVEY
Natural Gas - U.S. (Production)

Source: IEA Statistical Review of World Energy 2006

COLORADO GEOLOGICAL SURVEY
NATURAL GAS: STRUGGLING TO KEEP PACE

U.S. natural-gas reserves are going nowhere fast. As production lags, gas consumption, fueled by gas-fired power plants and a hot economy, is climbing fast. Imports are struggling to fill the gap.

Source: Energy Information Administration

*Preliminary
NATURAL GAS - U.S. Price

$9.98
Mid-August

COLORADO GEOLOGICAL SURVEY
US gas supply is likely to be broadly flat despite more gas from the Rockies...
Lower 48 Onshore Production Forecast by Region

Source: U.S. EIA, "Annual Energy Outlook 2005"
State Distribution of Rocky Mountains Proved Reserves

- Colorado: 26%
- Wyoming: 38%
- Utah: 7%
- New Mexico-West: 25%
- Montana: 2%
- North Dakota: 1%

Source: U.S. Energy Information Administration, data for 2004
Colorado has all, or parts, of seven of the top 50 natural gas fields in the nation!
Colorado Drilling Rigs

13, 13, 18, 32, 28, 39, 64, 74, Today

COLORADO GEOLOGICAL SURVEY
Colorado Drilling Permits

163% Increase!
Colorado is the sixth largest gas producer in the nation.

Colorado has the fifth largest gas reserves in the nation.

Colorado has the largest reserves of coalbed methane in the nation.
World Energy Consumption

Coal

COLORADO GEOLOGICAL SURVEY
China’s Production and Consumption of Coal

![Graph showing coal production and consumption from 1990 to 2005.](image)

- Yearly data for coal production and consumption from 1990 to 2005.
- Coal production and consumption show an overall increase over the years.
- Key milestones and notable trends indicated on the graph.
In 2005
China built 117
government approved, coal-fired power plants
COAL - India

7% imported!

BP Statistical Review of World Energy 2006

COLORADO GEOLOGICAL SURVEY
COAL U.S.

COLORADO GEOLOGICAL SURVEY

(Chart showing coal production in the U.S. from 1985 to 2005, with data from BP Statistical Review of World Energy 2006.)
China/U.S. Coal

54% of world production.

51% of world consumption.
Colorado’s Coal is becoming increasingly desirable.
Increase in Coal Spot Price

- 2004: 17
- 2005: 37

Graph showing the increase in coal spot price from 2004 to 2005.

COLORADO GEOLOGICAL SURVEY
2005 Coal Price
Spot versus Contract

Spot: 37
Contract: 21
Colorado Impact

Spot prices increased 76% since 2003

Colorado is the sixth largest coal producer in the nation.

Colorado has the seventh largest bituminous coal reserves in the nation.

Colorado has the largest reserves of compliance coal in the nation.
World Energy Consumption

Nuclear
China: 27 new plants by 2020

India: 17 new reactors by 2012
NUCLEAR- U.S.

The last nuclear power plant came on line in 1996

Since then has U.S. nuclear generation --

Increased?
Decreased?
Remained flat?
NUCLEAR- U.S.

[Graph showing the increase in nuclear power plants in the U.S. over time.]
And, the largest nuclear power generator in the world?
The United States generates as much nuclear energy as France, Germany, Spain, Sweden, and the United Kingdom combined!
The world’s existing 435 nuclear reactors currently need 180 million pounds of uranium each year.
Uranium prices

$113

Source: Cameco
Uranium-vanadium districts and mines, Colorado

COLORADO GEOLOGICAL SURVEY
Colorado Impact

Four new mines opened in Colorado in 2004

Four new mines closed in Colorado in 2005

Western Colorado was in the heart of the uranium booms.

10,000+ claims filed on federal lands in Colorado in two years.

Possible In-Situ in Weld County
Renewable Energy

WIND
- 4th largest producer in the nation

SOLAR
- Xcel incentives
- Stapleton plant

BIOMASS
- Minimal at this point
- Colorado Biomass Clearinghouse
- Ethanol
  - Two plants
  - Four planned or constructing
Geothermal Energy

Direct Use

Many successful projects
DMO incentives

Electric Generation

New Technologies
CGS/COEMC Initiative
Working group
Below the 690 apartments—not to mention the gyms, bars, dry cleaners and movie theater—that make up the 15-acre Linked Hybrid residential complex in Beijing, China, are 660 geothermal wells that eliminate the need for air conditioners and boilers. Each well funnels water 325 feet beneath the ground into bedrock, where the constant 55ºF temperature either heats or cools it before it’s pumped back to the surface and piped through the building’s concrete floors. The system will reduce energy costs by up to 30 percent in the summer and up to 40 percent in the winter.
MOLYBDENUM Price

~ $2.00/lb in 2002

$40/lb in July, 2005!
Climax Molybdenum
Precious Metal Increases 01/03 - 3/07

Gold 128%
Silver 366%
Platinum 222%
Base Metal Increases  01/03 - 3/07

Zinc 416%
Copper 448%
Lead 308%
Nickel 497%
Aluminum 144%
Tin 198%
Antimony: 140%
Bismuth: 293%
Cadmium: 341%
Chromium: 145%
Cobalt: 312%
Germanium: 218%
Indium: 1079%
Magnesium: 110%
Manganese: 308%
Rhenium: 419%
Selenium: 1620%
Tellurium: 636%
Titanium: 600%
Tungsten: 532%
Vanadium: 2060%
Cement producers
1. China
2. India
3. U.S.

22% Imported

China Consumes ½ of all the concrete in the world

U.S. cement manufacturing is 81% foreign owned
“Chinese companies and their rivals are scouring the globe from Australia to Africa for access to the raw materials needed to sustain the Asian nation’s growth as commodity prices surge.”

--June 23, 2006 (Bloomberg)
Recent Examples

China and Chile have signed a free trade agreement, Beijing’s first in South America. The deal will give China better access to Chile’s extensive natural resources, such as copper.

-Aluminum Corporation of China plans to buy assets overseas to tap soaring demand.... Mr. Xiao had $1.5 billion cash on hand by June to fund purchases and increase metal supplies.

-Bloomberg, August 23, 2006

-Bloomberg, August 24, 2006
CHINA EXPANDS OIL TARGET LIST
Beijing - China has added nine oil and gas producers in North Africa, South America and the Middle East to a list of countries that it wants major Chinese companies to invest in. Kuwait, Qatar, Oman, Morocco, Libya, Niger, Norway, Ecuador and Bolivia are now on the list, which builds on previous ones issued in 2004 and 2005.

- Dow Jones, 01/03/2007
Production of Natural Resources has *Always* been an Important Part of Colorado’s Economy
Production of Natural Resources has *Always* been an Important Part of Colorado’s Economy
Central City Glory Hole
Cripple Creek Gold Mine
Overall Impacts

Coloradans will suffer from effects of inflation

Coloradans may see increasing shortages of critical raw materials

Pressures will mount to develop more of Colorado’s natural resources

Conflicts may arise with multi-national corporations operating in Colorado
BLM claims by country

Only 45% are U.S. corporations
The future is here!
Are we ready?
“The world is a football field now and you’ve got to be sharp to be on the team which plays on that field. If you’re not good enough, you’re going to be sitting and watching the game. That’s all.”

--Rajesh Rao, founder and CEO of Dhurva Interactive
2004 Bachelors degrees in engineering

- U.S.: 5
- China: 46
- Russia: 26
The End!
Of the talk, that is.
In March 2007 – 2,200 pounds of copper stolen from two different power substations in north metropolitan area
The Rockies Rising Profile

% of Lower 48 Reserves

Source: Data from U.S. Energy Information Administration web-site