“Update on the Future of Mineral Resources”
18 November 2011

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Azurite & Malachite, Ely, NV (J. Scovil photo)
Round Mountain, NV (2007)
Demand is high.

China is #1.

The trends will help guide exploration.
Iron demand is high for nearly every mineral resource, due to rising population and average standard of living. 

- ~18X more production than 100 years ago
- ~4X more population than 100 years ago
- ~4X more per capita consumption than 100 years ago

Data source: USGS
Demand is high for nearly every mineral resource.
Global copper production in 2010 (16.2 million metric tons) nearly equaled over 100 years of production from the Bingham Canyon mine (17.0 million metric tons).
Demand is high for nearly every mineral resource.
Global gold production in 2010 (2,500 metric tons) approximately equaled the cumulative production from the Carlin trend (2,400 tons), one of world’s top regions.
Coal

Demand is high for nearly every mineral resource.

Data source: EIA
Annual global coal production (~7.0 billion metric tons) equals approximately 4.9 km$^3$ of coal, or ~1,600 km$^2$ of land with an average coal thickness of 3 m.
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China produces ~44% of the world’s coal.
The amount of CO\(_2\) released from burning of coal in 2009 would have been enough, without natural reduction from plant growth, rain, and other processes, to raise the concentration of CO\(_2\) in the atmosphere by ~2.6 ppmv, a bit more than the recent global trend of CO\(_2\) increasing ~1.8 ppmv per year.
There has been a great recession in the USA, but not significantly in China, Australia, or India (by this measure – iron ore).

With 19% of the population, China produces ~38% of the world’s iron ore and ~45% of the world’s steel.
China produces only ~6% of the world’s copper but is aggressively seeking resources elsewhere.
China has been the #1 gold producing country since 2007.
The current boom (1981-2010) = 232M oz Au
(mostly Carlin and other Nevada deposits = 162M oz)

Goldfield (NV), Black Hills (SD), Cripple Creek (CO), porphyry Cu (AZ & UT) = 95M oz Au

‘49ers = 29M oz Au

We are in the midst of the biggest gold-mining boom in American history.
China has approximately 19% of the world’s population.
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Commodities for which China produced $\geq$19% of the world’s total in 2010:

- Aluminum*, 41%
- Cadmium, 25%
- Diatomite, 25%
- Indium, 52%
- Lead, 43%
- Molybdenum, 40%
- Tin, 44%
- Zinc, 29%
- Arsenic, 46%
- Cement, 55%
- Germanium*, 67%
- Iron ore, 38%
- Manganese, 22%
- Phosphate, 37%
- Tungsten, 85%
- Barite, 52%
- Coal, 45%
- Gypsum, 31%
- Steel*, 45%
- Mercury, 79%
- Rare Earths, 97%
- Vanadium, 41%

*refined, not mined

Data sources: CIA, USGS, EIA
In production of 46 mineral commodities, China ranks well above all others.

<table>
<thead>
<tr>
<th>Country</th>
<th>Number of commodities for which this country is the #1 producer</th>
<th>Number of commodities for which this country is among the top 3 producers</th>
</tr>
</thead>
<tbody>
<tr>
<td>China</td>
<td>25</td>
<td>31</td>
</tr>
<tr>
<td>Russia</td>
<td>3</td>
<td>12</td>
</tr>
<tr>
<td>USA</td>
<td>2</td>
<td>13</td>
</tr>
<tr>
<td>Australia</td>
<td>2</td>
<td>10</td>
</tr>
</tbody>
</table>

2010 production statistics from USGS
Of these 46 commodities, in 2010 China was the #1 producer of 25 and among the top three producers of 31.
Of these 46 commodities, in 2010 USA was the #1 producer of two and among the top three producers of 13.
Of these 46 commodities, in 2010 Russia was the #1 producer of three and among the top three producers of 12.
Of these 46 commodities, in 2010 Australia was the #1 producer of two and among the top three producers of 10.
So what?

And who cares?
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The trends will help guide exploration.
There is a general trend that rarer elements are more expensive than common elements.

For which commodities do you want to explore?

Source of data: USGS, EIA, CRC Handbook of Chemistry and Physics, others
There is a general trend that rarer elements are more expensive than common elements.

In general, consider exploring for commodities for which prices are relatively high.

Source of data: USGS, EIA, CRC Handbook of Chemistry and Physics, others
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The average annual price of gold is reaching the inflation-adjusted historical high; $613/ounce in 1980 = $1,689/ounce in 2011, when adjusted for inflation.
In general, the prices of commodity prices have risen in recent years.
In general, gold has kept its purchasing power over the years. Gold is money.
Of these 46 commodities, in 2010 China was the #1 producer of 25 and among the top three producers of 31.

Consider exploring for commodities for which China may control the market: REEs, W, Sn, In, barite.
"Forget gold. Strategic metals are where it's at."
Our consultant will tell us how we can secure a long-term supply of rare earth metals for our products.

China has most of the rare earth metals. Try dying and reincarnating. There's a 20% chance that you'll be born Chinese.

What's plan B?

If the only part that goes wrong is the Chinese part, you can try dying again.
Consider exploring for mineral resources that will likely be in higher demand in the future.
Energy-critical elements (ECEs) are a class of chemical elements that currently appear critical to one or more new energy-related technologies. A shortage of these elements would significantly inhibit large-scale deployment, which could otherwise be capable of transforming the way we produce, transmit, store, or conserve energy. We reserve the term ECE for chemical elements that have not been widely extracted, traded, or utilized in the past, and are therefore not the focus of well-established and relatively stable markets.
Some ECEs today
New Energy Technologies

- Renewable
- CO₂ neutral

Tellurium
Indium

Gallium
Germanium

Terbium
Europium

Neodymium
Dysprosium
Praseodymium
Samarium

Helium

Lithium
Lanthanum
ECEs – less common and more expensive

Source of data: USGS, EIA, CRC Handbook of Chemistry and Physics, others
ECEs that are byproducts from Cu-Mo, Cu-Mo from Cu, Cu from natural gas, Zn from Zn, and Al from several metals.
<table>
<thead>
<tr>
<th></th>
<th>Main product</th>
<th>Byproduct</th>
<th>Byproduct</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cu</td>
<td>Se</td>
<td>Te</td>
</tr>
<tr>
<td>Global production</td>
<td>16,200,000</td>
<td>2,260</td>
<td>~500</td>
</tr>
<tr>
<td>(metric tons)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Price ($/kg)</td>
<td>$7.54/kg</td>
<td>$77.16/kg</td>
<td>$210/kg</td>
</tr>
<tr>
<td>Value of global</td>
<td>$122 x 10^9</td>
<td>$174 x 10^6</td>
<td>$105 x 10^6</td>
</tr>
<tr>
<td>production ($)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ratio of values of</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>global production</td>
<td>Cu:Se = 700:1</td>
<td></td>
<td>Cu:Te = 1200:1</td>
</tr>
</tbody>
</table>

Securing more mineral resources that are recovered as byproducts will require either exploration for new types of resources or research on metallurgical extraction.
Copper resources are broadly distributed, but not much is known about the byproduct-element concentrations in many copper ores.

Data source: USGS
Reid Yano, UNR M.S. student, in collaboration with the USGS, is investigating trace elements in copper ores related to porphyry systems, with samples collected by himself and from the Mackay-Stanford Ore Deposit Collection. He’s following up on various anomalies, including high Te at Cananea (Mexico), Bingham (UT), Chuquicamata and El Teniente (Chile), and Bisbee (AZ).
China is the Number One Producer for 25 of these 46 commodities.

Consider exploring for commodities for which China doesn’t have enough to meet its likely domestic demand: Au, Cu, Co, K, PGEs, Ni, Cr.
China’s economy will likely drive up the demand for those commodities for which it can’t mine enough domestically.

<table>
<thead>
<tr>
<th>Commodity</th>
<th>% from China</th>
<th>% from Canada</th>
<th>% from US</th>
<th>Leading Producer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Platinum</td>
<td>0</td>
<td>3</td>
<td>2</td>
<td>South Africa (75%)</td>
</tr>
<tr>
<td>Potash</td>
<td>9</td>
<td>29</td>
<td>3</td>
<td>Canada (29%)</td>
</tr>
<tr>
<td>Chromium</td>
<td>~0</td>
<td>~0</td>
<td>~0</td>
<td>South Africa (39%)</td>
</tr>
<tr>
<td>Copper</td>
<td>6</td>
<td>3</td>
<td>7</td>
<td>Chile (34%)</td>
</tr>
<tr>
<td>Nickel</td>
<td>5</td>
<td>10</td>
<td>0</td>
<td>Russia (17%)</td>
</tr>
</tbody>
</table>

For example, the leading producers of nickel are Russia (17% of 2010 mine production), Indonesia (15%), Philippines (10%), Canada (10%), and Australia (9%).

Spinifex texture in serpentinite, Honeymoon Well nickel deposit, Western Australia - indicator of bladed crystals of olivine, from quenching of an ultramafic lava flow

Mount Keith Ni mine, Western Australia: 323 million metric tons @ 0.56% Ni

Production statistics from USGS
Watch for competition in the regions of resource-rich Precambrian cratons, which are major sources of iron, manganese, nickel, chromium, titanium, copper, cobalt, zinc, gold, palladium, platinum, and uranium. This includes parts of Africa, Australia, South America (particularly Brazil and Venezuela), Russia, and Canada.
World’s leading nickel producer (Russia, 17%)

Countries with 4% or more of global production

Other countries with production or major reserves

(China 5%)
World's leading cobalt producer (Democratic Republic of Congo, 51%)

Countries with 4% or more of global production

Other countries with production or major reserves

(China = 7%)

Data source: USGS
World's leading platinum producer (South Africa, 75%)

Countries with 4% or more of global production

Other countries with production or major reserves

(China ~none)

Data source: USGS
Also watch for competition in the resource-rich current and past continental and island-arc settings that are major sources of copper, molybdenum, tungsten, gold, and silver. This includes the Pacific Rim of Fire, particularly the Cordillera of South and North America, Mongolia, and several other locations.
Critical and strategic minerals will change with time.
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$\text{CuIn}_x\text{Ga}_{(1-x)}\text{Se}_2$ or CIGS, for solar panels? CdTe, GaAs, and Ge for solar panels? Nd for magnets for wind and other electrical turbines? Li and V for different types of batteries?
Why explore in Nevada?

Among many other reasons, Nevada is the US leader in gold, barite, and lithium; a significant historical producer of copper, silver, and zinc; and a key source of industrial minerals for construction (gypsum, cement resources, aggregate).

Lithium-brine evaporation pond, 2008, Clayton Valley (Silver Peak), Nevada
5.3 million ounces* in 2010
73% of U.S. and 7% of world production
Nevada is certainly one of the best places, if not the best, to explore for and mine gold.
18 plants at 12 sites sold ~$145 million of electricity in 2010, up from ~$110 million in 2009.
Net output lags behind capacity. Current projects should add 2,100 to 2,400 Mw of capacity within 10 years.
Nevada is a great place to explore and mine: $7.7 billion production in 2010, #1 nonfuel mineral producer in the U.S.
Demand is high.

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Thank you!

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