MINERAL RESOURCES OF TEXAS – HISTORICAL PERSPECTIVE, FUTURE POTENTIAL

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Historical Perspective

- University of Texas Mineral Survey 1901-1905
- Mineral Exploration and Mining originally an important component to BEG mission
- Program output reduced considerably when Jon Price and Chris Henry left TX for Nevada in early 1990’s
- Hiring Brent Elliott in 2012 was a commitment to restart that program

Shafter mine, ca. 1890
Resources (million tons)

- Cement: 11.1
- Clay: 4.8
- Salt: 9.1
- Other*: 2.5
- Sand & Gravel: 91.9
- Crushed Stone: 148.2

* Natural gemstones, crude gypsum, dimension stone, lime, crude helium, grade-A helium, crude talc, zeolites.
Resources (million $)

- Crushed Stone: 1,291.4
- Sand & Gravel: 947.2
- Lime: 94.5
- Salt: 156.5
- Other*: 66.4
- Clay: 89.5
- Cement: 1,111.0
Texas ranks #5-#8 in mineral resource production, providing the U.S. with more than 4% of total material annually.
Texas Mineral Resources Today

Texas mineral resource value has doubled in the last 25 years to over $3 billion per year.

![Annual Texas Mineral Resource Value](image)
Texas Mineral Resources Today

- Texas population growth rate is 8.1%, 3rd in US since 2010
- Mineral resource revenue projected to double over the next 25 years
Mapping Mineral Deposits – Leveraging Funds, Diversifying Outputs

- Existing funding sources
  - Federal STATEMAP Program – competitive grants program administered by USGS
    - Projects based on state requirements for geologic map information in areas of greatest need or where mapping is required to solve critical Earth science problems.
  - BEG STARR Program
    - Administered through Texas Comptroller’s office, providing funds for BEG activities that directly contribute to tax base
Mineral Resources Program – Uranium

Uranium resources research includes:

• Exploration techniques
• Estimation and reserve calculations
• Economic potential and supply chain mapping
• Supply and demand balances
• Application and integration with energy outlooks
• Country risk assessments and extractive issues
• Environmental risk and regulatory compliance issues (chemical mitigation, water issues, subsurface monitoring, etc.)
Mineral Resources Program – Rare Earth’s

- Program addresses aspects from mineral genesis to exploration, extraction, processing, and economics
- Particularly relevant to governmental and industry partners who consider REE’s as critical elements to energy and industrial activity
Mineral Resources Program – Industrial Minerals

• Market will continue to grow in Texas and in emerging markets

• One example: frac sands
  • We are developing exploration and logistics models and studying ways to make natural sands more efficient and cost effective in oil and gas production
Optimizing Frac Sand Transportation

- Transportation logistics and optimization studies are significant to all commodities.
- A study of basin closure stress and commercial frac sands, for example, help make the strongest argument for local frac sand resources.
Mineral Resources Program - Lithium

- Developing research on lithium and other critical minerals to battery storage technology and renewable energy technologies
A Market Driver for Lithium? Transport

EV Sales: China overtook Europe and USA; many companies in the sector, different companies dominate each market

- **China**: 161,778 EVs sold Jan-Jul 2016
  - BYD: 40%
  - BAIC: 20%
  - SAIC: 10%
  - Zoye: 5%
  - Zhidou: 5%
  - Cherry: 2%
  - JMC: 2%
  - Geely: 2%
  - Kandi: 2%
  - Changgan: 2%
  - Tesla: 1%
  - Lifan: 1%

- **Europe**: 100,862 EVs sold Jan-Jul 2016
  - Volkswagen: 20%
  - Renault: 15%
  - BMW: 10%
  - Nissan: 10%
  - Mitsubishi: 5%
  - Volvo: 5%
  - Tesla: 5%
  - Mercedes: 5%
  - Audi: 2%
  - Kia: 2%
  - Porsche: 2%

- **USA**: 86,214 EVs sold Jan-Jul 2016
  - Tesla: 30%
  - Chevy: 20%
  - Ford: 10%
  - BMW: 5%
  - Nissan: 5%
  - Audi: 5%
  - Volkswagen: 5%
  - Porsche: 5%
  - Kia: 5%
  - Mercedes: 5%
  - Cadillac: 5%
  - Smart: 5%
  - Mitsubishi: 5%
  - Toyota: 5%
  - Honda: 5%

2016 sales appear on track to surpass 2015 sales in all three markets. If sales continue at the same pace, 2016 EV sales can exceed 700,000.

- **Lithium carbonate** content requirement would be 12,000 metric tons (mt) LCE. 2015 Global lithium production was approximately 173,000 mt LCE.
- To reach BNEF's forecast of 41 million EV sales in 2040, the annual sales will need to grow at 18% annually, putting significant strain on the lithium supply chain.
- **Cobalt** content requirement would be 3,700 mt. 2015 Global cobalt production was 124,000 mt.
- Cobalt demand will grow more slowly than lithium demand as many battery manufacturers are moving to low-cobalt chemistries.

Data sources: EV Obsession, U.S. Bureau of Transportation Statistics, IEA, Argonne National Laboratory, company financial reports
How Will the Lithium Supply Chain Evolve?

Developing research on:

- commodity markets
- upstream costs and benchmarking
- midstream logistics
- downstream end use
BEG is restarting the Minerals Circular series of publications, and we’ve also revamped a dynamic website: http://igor.beg.utexas.edu/txmineralresources/
Economic Minerals Program – the Future

Developing stronger ties between Economic Minerals Program in Austin and CEE in Houston:

- Austin group conducts rigorous geologic analysis of resource potential, quality, recovery and operational issues like environmental compliance.
- CEE conducts rigorous economic and commercial frameworks analysis including value chains; market and outlooks; policy/regulatory considerations.
Thank you!!