Basinal Assessment

Bringing Alaska’s CORE-CM Potential into Perspective

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Alaska hosts an immense amount of carbon ore, including more than half of the estimated coal resource in North America.

Unlike the continental U.S., characterization of carbon ores for their REE/CM content in Alaska’s many basins is still in its infancy.

As such, an essential component of this project is to create a robust statewide dataset on the REE/CM content of carbon-based ores.
Three principal sources

1) Existing published and unpublished data
2) New data from archived legacy samples
3) New data from newly acquired field samples
PHASE I WORKFLOW

Historical Publications, Data & Sample Sources
- DGGS/GMC
- Industry
- Native Corporations
- USGS
- BLM
- USBM
- UAF/MIRL
- Others

New Analytical Data For Historical Samples
- Procure/Calibrate HHXRF
- Define “anomalous values” for REE/CM (ppb/gpm)
- ID Favorable Samples
- Obtain HHXRF Analyses
- Screen Analyses for Elevated REE/CM
- Document Samples
- Geochemical Analyses

New Analytical Data For New / Historical Samples
- Geochemical Analyses
  - Full-Suite Inorganic Geochemistry (major/ minor oxides, trace elements including CM), and REE; ICPMS - full digestion
  - + Total Organic Carbon
  - + Vitrinite Reflectance
  - + Coal Quality

Age Analyses
- Palynology (Pollen)
- Ar/Ar (Volcanic Flows)
- U-Pb (Provenance)
- U-Pb (Detrital Zircon)
- U-Pb (Max. Deposition)
- U-Pb (Tephra/Ash)

New Geologic Field and Office Work
- Measure Coal-Bearing Stratigraphic Sections
- Geochemical Sampling
- In-Field HHXRF Analyses
- REE/CM Sampling & Geochemical Analyses
- Sandstone Point Counts
- Petrography
- SEM/Microprobe

New Geologic Interpretations & Reports
- Geologic Reports
- Geochronological Reports
- Peer Reviews

Collaboration & Phase II Preparation
- Communicate with NETL, Collaborators & Stakeholders
- Provide Alaska Geological, Geochemical & Geophysical Expertise/Advice
- Construct Stratigraphic Model(s)
- Identify Stratigraphic Horizons (units) & Alaska Basins with Highest REE/CM Potential
- Prioritize Areas Needing Additional Geological, Geochemical and/or Geophysical Work
- Feed Information into Scoring Matrix

Publications (Databases, Reports, Metadata)
- DOE NETL Database
- Alaska DGGS Coal Database
- Alaska DGGS Publications, Databases, Website
- Journals

https://dggs.alaska.gov/
HISTORICAL PUBLICATIONS, DATA & SAMPLE SOURCES

- DGGS/GMC
- Industry
- Native Corporations
- USGS
- BLM
- USBM
- UAF/MIRL
- Others
National Coal Resources Data System (NCRDS)

- Cooperative project between the USGS and state geological surveys
- National database of coal data, focusing on the stratigraphy and chemistry of coal
- DGGS has been annually uploading new modern analytical data on Alaska's coal resources
NEW ANALYTICAL DATA FOR HISTORICAL SAMPLES

Geologic Materials Center

- 3096 Alaska energy wells
- 26,500,000 feet of energy strata drilled
- 16,700,000 representative feet of energy core and cuttings
- 76,000 linear feet of energy core
- 22,000 Alaska minerals boreholes
- 766,000 feet of mineral rock drilled
- 617,000 representative feet of mineral core and cuttings
- 354,000 linear feet of mineral core
- 250,000 processed slides and thin sections
- 507,000 surface samples
New Analytical Data for Historical Samples

Screening Approach for New Data

• Procure and calibrate SciAps X-555 HH-XRF
  – 55 kV X-ray tube
  – Specifically developed for REE
  – Calibrated for Y, La, Ce, Pr, Nd, Sm, Eu and Gd
  – Excellent detection limits measured on whole rock hand samples (down to lower tens of ppm)

• Define “anomalous values” for REE/CM

• Identify favorable core or samples

• Obtain rapid, qualitative elemental data with HH-XRF
NEW ANALYTICAL DATA

Based on promising HH-XRF results

• Submit for inorganic geochemistry via full digestion ICP-MS
  – Major / minor oxides
  – Trace elements (including CM’s)
  – REE’s
• +/- Total organic carbon
• +/- Vitrinite reflectance
• +/- Coal quality
Based on gap analysis and promising preliminary data, conduct targeted field studies

- Samples for HH-XRF and ICP-MS analyses
- TOC, Ro, CQ analyses
- Measured stratigraphic sections
- SEM/Microprobe
- Geochronology
FOLLOW THE GEOLOGY . . .

- 50+ coal fields deposited in a variety of tectonic settings – which ones might be the most prospective?
- Slow deposition during peat formation results in limited clastic dilution
- Airfall volcanic material is interpreted to be an important control on REE/CM detrital concentrations in coal
- Common mineral phases include phosphates such as monazite and apatite, various titanites, and zircon, among others
Sedimentary basins provide reliable record of waxing and waning of arc volcanism

- Robust signal of zircon crystallization in the Paleocene and late Eocene
- Notable early to middle Eocene gap coincident with proposed ridge subduction
- Very few Oligocene and Miocene zircons suggesting minimal igneous activity
Preliminary REE data

Gupta et al., 2017
USIBELLI COAL MINE

- Alaska’s sole operating coal mine for last 50 years, producing 50+ million tons of coal
- Currently averaging 1-2 million tons/yr depending on circum-Pacific export demand
- Eocene-Miocene section with 30+ coal beds from 2.5 to 30 feet thick
- 7,570-9430 Btu/lb on an as-received basis, 17.8% moisture, 3.5-13.2% ash yield and 0.1-0.3% sulfur

Usibelli.com
Flores et al., 2004
Barnes, 1967
Usibelli Group Type Section at Suntrana Creek

Wartes et al., 2013

Modified from Ridgway et al., 2007
• Thick Eocene(?) devitrified tuffs

Modified from Ridgway et al., 2007
• Two thick Late Miocene reworked tuff beds that buried large trees in growth position

Modified from Ridgway et al., 2007
**PALEogene FOREarc (mATANUSKA VALLEY AND TYOnek AREAS)**

- Thick Paleocene and Eocene coal-bearing sections deposited in a forearc setting

- Basins controlled in part by transtentional tectonics associated with the Castle Mountain fault system

Ridgway et al., 2012
Paleogene Forearc (Matanuska Valley and Tyonek Areas)

- Abundant and thick subbituminous to anthracite coal in the Wishbone Hill district
- Between 1915 and 1970, area produced $7.7 \times 10^6$ short tons
- Stratigraphy includes locally abundant and thick airfall and reworked tuff deposits

Gillis et al., 2022
LePain et al., 2011
Ridgway et al., 2012
Flores et al., 2004
DATA DISTRIBUTION

- QA/QC analyses and database
- All sample information and organic and inorganic geochemical data will be captured in DGGS databases and exported to NETL’s Energy Data Exchange platform
- Representative sample splits secured for DOE archival
- Additional supporting geologic information (sedimentology, stratigraphy, provenance, geochronology, etc.) will be published in refereed DGGS reports that are freely available on our website
Results feed into team’s priority matrix to assist selection of most promising basin(s) for further consideration in Phase II

**ID initial criteria for inclusion in the Priority Matrix (Geology-specific)**

- Which elements are present
- Abundance/concentration of element
- Mineral phase?
- Layer anomaly vs. high average?
- Likely stratigraphic or areal extent
- How organic rich is carbon ore
- Coal quality
- Thermal maturity