PROJECT SUMMARY

Team:
- University of North Dakota (UND) Energy & Environmental Research Center (EERC) and Institute for Energy Studies (IES)
- University of Kentucky (UK) Center for Applied Energy Research
- Kentucky Geological Survey (KGS)
- North Dakota Geological Survey (NDGS)
- Microbeam Technologies Inc. (MTI)

Objectives:
- Advance the characterization of rare earth elements (REEs) in coal.
- Develop a comprehensive understanding of REE distribution in coals.
- Promote research and development in the field of REE technology.

SCOPE OF WORK

Identify specific sources of coal and coal-related materials that have potential >300 ppm on a dry mass basis of REEs based on databases, literature, and input from coal-mining companies.

PERFORM sample collection, preparation, initial analysis of coal and coal-related materials that are likely to exceed >300-ppm REEs.

Characterize >600 samples for REEs using conventional and advanced analyses.

Coordinate round-robin interlaboratory studies (RRIS) as an efficient, statistically armed evaluation of REE quantification at select laboratories.

Determine lab-to-lab and method-to-method variability.

Estimate or update estimates of the total domestic REE reserves using the characterization results for each targeted region.

Upload sample data to DOE NETL EDX.

PROJECT TASKS

Task 1 – Perform Project Planning and Management
Task 2 – Identify Proposed Sources, Field Samples, and Procedures for Sampling and Field Preparation/Preservation of Samples
Task 3 – Perform Sampling
Task 4 – Perform Sample Preparation and Characterization in the Laboratory
Task 5 – Identify Laboratories and REE Samples to Be Used in the RRIS
Task 6 – Develop the RRIS Plan
Task 7 – Define and Distribute Samples, Calibration Standards, and Procedures to Laboratories Participating in the RRIS
Task 8 – Perform the RRIS
Task 9 – Provide Project Reporting to NETL and Sample Retention

WESTERN U.S. COAL SAMPLING TARGETS (80%)

- Center Mine – Kinneson Creek Coal
  - High REE content in lignite, roof, and partings.
  - Only La, Ce, Pr, Sm, Eu, and Yb analyzed with high levels of Th and U.
  - Volcanic ash deposits in lignite.

- Freedom Mine – Buckskin Coal
  - Seams interbedded with nonorganic clastics.
  - Rhyolite in quartz, zones, and clays of volcanic origin.
  - Total REE contents of 150–200 ppm observed.

- Buckskin Mine – Anderton–Canyon Coal
  - Powder River Basin, Fort Union Group.
  - USGS reports 200–300-ppm total REEs.
  - REEs in rhyolite and andesite coal minerals.

- Savage Mine – Pust Coal
  - Limited characterization data.
  - Part of the Upper Fort Union Formation.
  - Volcanic ash in shale beds near the coal seam.

- Buckskin Mine – Anderton–Canyon Coal
  - Powder River Basin, Fort Union Group.
  - USGS reports 200–300-ppm total REEs.
  - REEs in rhyolite and andesite coal minerals.
  - Volcanic ash in the Anderson coal bed.

- Lone Wolf - Center Mine - Kilman Creek Lignite
  - High REE content in lignite, roof, and partings.
  - Only La, Ce, Pr, Sm, Eu, and Yb analyzed with high levels of Th and U.
  - Volcanic ash deposits in lignite.

- Freedom Mine – Buckskin Coal
  - Seams interbedded with nonorganic clastics.
  - Rhyolite in quartz, zones, and clays of volcanic origin.
  - Total REE contents of 150–200 ppm observed.

- Buckskin Mine – Anderton–Canyon Coal
  - Powder River Basin, Fort Union Group.
  - USGS reports 200–300-ppm total REEs.
  - REEs in rhyolite and andesite coal minerals.
  - Volcanic ash in the Anderson coal bed.

SOURCES, FIELD SAMPLES, AND PREPARATION

- Source locations (literature, mines, etc.):
  - Strip mine channel samples.
  - Coal mine exploratory core samples.
  - Outcrops.
  - Sample banks UND, UK, Penn State.
  - Mine breaker samples.
  - AMD (eastern coals).
  - SBZ samples of coal and coal-related materials.

SAMPLE PREP, CHARACTERIZATION, AND MODE OF OCCURRENCE ANALYSES

- ASTN prep and analyses.
- Inductively coupled plasma–mass spectrometry (ICP–MS) and ICP–OES.
- Optical emission spectroscopy for REEs.
- Mode of occurrence analyses:
  - Field emission scanning electron microscopy (SEM) for REE analysis.
  - Selected-droplet separation and modified chemical fractionation.
  - Previous work shows 85%–95% organic association of REEs in ND lignites.
  - REEs in coordination complexes.
  - Small fraction of REEs in silicate clays.

ROUNDBOARD INTERLABORATORY STUDY

- Moisture, wt%.
- Ash, wt%.
- Individual replicate results for 14 laboratories + 1 blank.
- Reported on a mg/kg (ppm) basis.
- Calibration information.
- Requested turnaround time >2 months.

- Statistical analysis of reported data using ASTM E 691.
- Repeatability (within-laboratory variability).
- Reproducibility (between-laboratory variability).
- Bias (deviation from known values of standard reference materials).
- Method-to-method variability.

SUMMARY OF RESULTS TO DATE

- All management, sampling, preparation, and characterization plans completed.
- Advanced fractionation and SEM analyses initiated.
- Round-robin laboratories being contacted.

CONTACT INFORMATION

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