

# Argonne Premium Coal Sample Bank



[www.energy.psu.edu](http://www.energy.psu.edu)

## Key Contacts

Jonathan P. Mathews  
(814) 863-6213

Bradley Maben  
(814) 865-3899

[csb@ems.psu.edu](mailto:csb@ems.psu.edu)

## Background

The need for a premium coal sample program led to the organization of a coal sample bank workshop in 1981. Funding for the sample bank was later made available from the Division of Chemical Sciences of the Office of Basic Energy Sciences of the U. S. Department of Energy. From 1983–1985 Argonne National Laboratory designed and built a facility to house the samples.

In 2013, the EMS Energy Institute at Penn State acquired the Argonne Premium Coal samples. This acquisition complements the Penn State Coal Sample Bank and Database already housed at the Institute.

The premium coal samples produced from each coal and distributed through this program were mined, transported, processed into desired particle and sample sizes, packaged in humid nitrogen environments as free of oxygen as possible, and carefully characterized by a variety of techniques. Five-gallon carboys hold about 80% of the batch in reserve for filling more ampoules after the original samples are depleted.

One of the reasons for preparing these samples was to permit workers to determine if the apparent difference in results between two laboratories was due to sample integrity or experimental technique.

## Overview

The Argonne Premium Coal (APC) Sample Bank can supply researchers with highly uniform, well-protected coal samples unexposed to oxygen. Researchers investigating coal structure, properties, and behavior can benefit greatly from these samples.

The sample bank consists of eight coals, including lignite, subbituminous coal, high volatile, medium volatile, and low volatile bituminous coal, as well as a liptinite-rich, an inertinite-rich, and a coking coal. Coals from the collection have been placed in sealed glass ampoules or 5-gallon carboys and have been stored under carefully controlled conditions.

Representative splits from each coal sample are chemically and physically as identical as possible, and will be stable over a long period of time. Because of the sample uniformity and premium quality of APC samples, researchers are assured that analysis results they generate are comparable with results generated by other workers using APC samples.

Since 1985 over 33,000 ampoules have been shipped to researchers in academia, industry, and government worldwide. In addition, there are well over 600 peer-reviewed journals articles addressing the structure and behavior of the Argonne coals.



Five-gallon carboys filled with samples for long-term storage.

## Results

The eight coal samples were selected to represent significant differences among the available coal types mined in the United States and to maximize our understanding of the fundamental properties of coal. The Argonne National Laboratory completed a cluster analysis of whole coal seam data from the Penn State Coal Sample Data Base with data from 200 samples. The cluster analysis provided identification of compositional characteristics for eight coal samples.

With help from the U. S. Geological Survey, individual coals were identified for collection. The compositional characteristics, primarily carbon content, were used to guide the selection of five of the coals, which provide a rank range from lignite through low volatile bituminous. Anthracites were not included because of their low reactivity and relative scarcity. The other three were selected to give a range of sulfur contents, a larger content of macerals other than vitrinite, and a range of bituminous coals with varied paleobotanical source material.

A staff geologist from the U. S. Geological Survey supervised the collection of each sample and documented the seam for later description in USGS Circulars. The samples were each collected in about 1 to 1 1/2 ton quantities, placed in steel drums, purged with argon and taken to Argonne National Laboratory for processing. After transfer to a nitrogen-filled enclosure, the coals were crushed and pulverized to -20 mesh, and the entire ton-sized batch was mixed. Half of the batch was placed in sealed 5-gallon pails for regrinding to -100 mesh and subsequent packaging. About 80 percent of each half-ton was sealed in 5-gallon glass carboys for long-term storage and the remaining sample was sealed in amber borosilicate ampules for distribution to researchers.

## Analyses

The APC samples underwent three types of analyses to indicate homogeneity of mixing, elemental and proximate analysis data, and stability of the samples as well as integrity of the seals.

For the homogeneity analysis, a series of 39 samples was taken during the processing of each coal sample to determine any differences in composition during the processing and packaging of the thoroughly mixed material. Additional samples were submitted to a range of analysis, including proximate, ultimate, major, and minor elements in the ash, heat content, forms of sulfur, and maceral analysis.

## Sample Availability

Coal samples from the APC Sample Bank are available to all members of the coal research community. The Institute can provide assistance in identifying samples that match specifications or that best suit the research needs of the requester. Coals from the collection are distributed at a reasonable cost plus shipping and handling in two different mass/particle size quantities, 5g of minus 0.15 mm or 10g of minus 0.85 mm).



Coal samples sealed in borosilicate ampules sitting on storage shelves at the EMS Energy Institute.

## Coals in the Argonne Premium Coal Sample Bank

Sample	Seam	ASTM Rank	State	Ash, dry	S, dry	C, daf	H, daf	V.M. daf	Vit. %	VRo %
APCS-1	Upper Freeport	mvb	PA	13	2.3	86	4.7	31.6	71	1.16
APCS-2	Wyodak-Anderson	subbit	WY	9	0.6	75	5.4	49.0	89	0.32
APCS-3	Illinois #6	hvCb	IL	15	4.8	78	5.0	47.4	85	0.46
APCS-4	Pittsburgh #8	hvAb	PA	9	2.2	83	5.3	41.7	85	0.81
APCS-5	Pocahontas #3	lvb	VA	5	0.7	91	4.4	19.5	89	1.68
APCS-6	Blind Canyon	hvAb	UT	5	0.6	81	5.8	48.2	87	0.57
APCS-7	Lewiston-Stockton	hvAb	WV	20	0.7	83	5.3	37.3	73	0.89
APCS-8	Beulah-Zap	lig	ND	10	0.8	73	4.8	49.8	-	0.25

Abbreviations: S=total sulfur, C=carbon, H=hydrogen, V.M.=volatile matter, Vit.=total vitrinite, VRo=maximum vitrinite reflectance; lig=lignite, hvAb=high volatile bituminous C,B or A, mvb=medium volatile bituminous, lvb=low volatile, daf=dry ash free

## Key Publications

- Vorres, K.S., Users handbook for the Argonne premium coal sample program; ANL/PCSP-89/1; October 1989; can be purchased from NTIS Website (<http://www.ntis.gov/search/product.aspx?ABBR=DE90004991>).
- Vorres, K.S., The Argonne premium coal sample program, Energy & Fuels, 1990, 4, 420-426.
- The Chemical Analysis of Argonne Premium Coal Samples, 1997, Edited by Curtis A. Palmer, U.S. Geological Survey Bulletin 2144, Supt. of Docs. No.: I 19.3:B2144107 pg.