

Penn State maintains a suite of 39 well-preserved Department of Energy coal samples (DECS), collected in an ongoing effort begun in 1989 as well as about 500 Penn State Coal Sample Bank (PSOC) samples dating back to April 1967. In April 2013, Penn State acquired the eight Argonne Premium coal samples (APCS) to complement this collection.

The coals in these collections represent an array of major coalfields of the United States and were selected to achieve a useful distribution of important coals by rank, geologic province, maceral composition, sulfur content and forms, ash yield, and composition. Economic importance and researchers' prior use of these coals was also considered. The DECS and APCS listed on the right are recommended for research owing to more efficient preservation techniques. PSOC samples have geological and historical value but are no longer recommended for basic research.

Most DECS and APCS coals were collected as full-seam channel samples (Chan-Seam) or drill cutting (Drill-Seam); however, working section of seam (Chan-Work), bench (Chan-Bnch), lithotype (Chan-Lith), run-of-mine (ROM), cleaning plant (Cleaning-Plt.), and Grab samples also were acquired.

APCS samples are available in two particle sizes and three mass amounts:

Ampoules:

- 10 g (0.35 oz.) at -20 mesh (minus 0.85 mm)
- 5 g (0.18 oz.) at -100 mesh (minus 0.14 mm)

Carboys:

- 14-20 kg (30-45 lbs.) at -20 & -100 mesh

DECS samples are available in three particle sizes and mass amounts:

- 50 g (3 oz.) at -60 mesh (minus 0.25 mm)
- 250 g (1/2 lb.) at -20 mesh (minus 0.85 mm)
- 2.0 kg (5 lb.) at -1/4 inch (minus 6.3 mm)

The Penn State Coal Sample Bank

| Sample | Seam | ASTM Rank | Sample Type | State | County | Year | Ash, dry | S, dry | Btu/lb, dmmf | C, dmmf | H, dmmf | V.M., dmmf | Vit, % | VR, % |
|----------|-------------------|-----------|---------------|-------|------------|------|----------|--------|--------------|---------|---------|------------|--------|-------|
| DECS-1 | Bottom | subC | Chan-Seam | TX | Freestone | 1989 | 15.8 | 0.99 | 13239 | 75.9 | 5.8 | 55.5 | 78 | 0.36 |
| DECS-2* | Illinois #6 | hvCb | Chan-Seam | IL | Randolph | 1989 | 16.2 | 4.52 | 14556 | 81.8 | 5.7 | 43.8 | 87 | 0.52 |
| DECS-3 | Coal Basin M | mvb | Chan-Seam | CO | Gunnison | 1990 | 5.4 | 0.65 | 15831 | 88.1 | 5.9 | 28.2 | 94 | 1.28 |
| DECS-4 | Blue | hvCb | Chan-Seam | NM | McKinley | 1990 | 6.2 | 0.46 | 13951 | 78.9 | 5.8 | 48.1 | 88 | 0.51 |
| DECS-5 | Hiawatha | hvCb | Chan-Work | UT | Sevier | 1990 | 8.5 | 0.56 | 14073 | 80.4 | 5.5 | 43.6 | 66 | 0.59 |
| DECS-6 | Blind Canyon | hvAb | Chan-Work | UT | Emery | 1990 | 5.8 | 0.40 | 14874 | 81.9 | 6.3 | 46.9 | 69 | 0.66 |
| DECS-7 | Adaville #1 | hvCb | Chan-Seam | WY | Lincoln | 1990 | 4.2 | 0.98 | 13710 | 77.8 | 5.6 | 47.8 | 95 | 0.45 |
| DECS-8 | Smith-Roland | subC | ROM | WY | Campbell | 1990 | 13.8 | 0.73 | 13148 | 75.8 | 5.3 | 51.8 | 79 | 0.37 |
| DECS-9 | Dietz | subB | Drill-Seam | MT | Bighorn | 1990 | 6.4 | 0.41 | 13251 | 76.1 | 5.2 | 47.1 | 88 | 0.38 |
| DECS-10 | Rosebud | subB | Chan-Work | MT | Rosebud | 1990 | 12.6 | 1.16 | 13378 | 79.7 | 4.3 | 46.9 | 74 | 0.42 |
| DECS-11 | Beulah | ligA | Chan-Seam | ND | Mercer | 1990 | 9.6 | 0.74 | 12350 | 74.1 | 4.5 | 61.6 | 74 | 0.35 |
| DECS-12* | Pittsburgh | hvAb | Chan-Seam | PA | Greene | 1990 | 10.3 | 1.12 | 15259 | 84.7 | 5.8 | 39.4 | 83 | 0.87 |
| DECS-13 | Sewell | mvb | Chan-Seam | WV | Greenbrier | 1990 | 4.2 | 0.62 | 15604 | 88.8 | 5.0 | 25.7 | 77 | 1.35 |
| DECS-14 | Upper Kittanning | hvAb | Chan-Work | WV | Barbour | 1990 | 10.5 | 1.80 | 15503 | 87.0 | 5.6 | 35.4 | 89 | 1.07 |
| DECS-15 | Lower Sunnyside | hvAb | Chan-Seam | UT | Carbon | 1991 | 10.1 | 1.67 | 14967 | 84.3 | 5.7 | 41.3 | 77 | 0.80 |
| DECS-16 | Blind Canyon | hvAb | Chan-Work | UT | Emery | 1991 | 13.9 | 0.47 | 14749 | 82.4 | 6.0 | 47.3 | 77 | 0.64 |
| DECS-17 | Blind Canyon | hvAb | Chan-Sect | UT | Emery | 1991 | 6.6 | 0.44 | 14897 | 82.3 | 6.3 | 49.7 | 80 | 0.59 |
| DECS-18 | Kentucky #9 | lvBb | Chan-Seam | KY | Union | 1991 | 12.3 | 4.21 | 14773 | 82.2 | 6.0 | 45.6 | 86 | 0.56 |
| DECS-19 | Pocahontas #3 | lvb | Chan-Seam | VA | Buchanan | 1991 | 4.6 | 0.74 | 15819 | 90.6 | 4.9 | 18.7 | 89 | 1.71 |
| DECS-20 | Elkhorn #3 | hvAb | Chan-Seam | KY | Floyd | 1991 | 5.5 | 0.97 | 15173 | 85.0 | 5.9 | 39.2 | 78 | 0.87 |
| DECS-21 | Lykens Valley #2 | an | Chan-Seam | PA | Columbia | 1992 | 11.2 | 0.50 | 15122 | 91.5 | 4.1 | 3.9 | 87 | 5.19 |
| DECS-22 | Upper Kittanning | hvAb | Chan-Lith | PA | Armstrong | 1993 | 23.3 | 1.71 | 15827 | 87.8 | 6.1 | 37.8 | 30 | 0.77 |
| DECS-23* | Pittsburgh | hvAb | Chan-Seam | PA | Washington | 1994 | 9.4 | 3.87 | 15307 | 84.6 | 5.8 | 42.3 | 79 | 0.73 |
| DECS-24* | Illinois #6 | hvCb | Chan-Seam | IL | Macoupin | 1994 | 13.4 | 5.53 | 14407 | 80.1 | 5.6 | 45.5 | 90 | 0.49 |
| DECS-25 | Pust | ligA | Chan-Seam | MT | Richland | 1994 | 11.9 | 0.72 | 12569 | 75.8 | 5.3 | 46.9 | 74 | 0.23 |
| DECS-26 | Wyodak | subB | ROM | WY | Campbell | 1994 | 7.6 | 0.43 | 13237 | 76.2 | 6.2 | 48.1 | 86 | 0.29 |
| DECS-27 | Deadman | subA | Drill-Seam | WY | Sweetwater | 1994 | 13.9 | 0.72 | 13757 | 79.2 | 5.4 | 40.6 | 74 | 0.46 |
| DECS-28 | Green | hvCb | Chan-Seam | AZ | Navajo | 1994 | 6.1 | 0.40 | 13648 | 77.8 | 5.5 | 47.9 | 76 | 0.43 |
| DECS-29 | Upper Banner #3 | hvAb | Chan-Seam | VA | Dickenson | 1995 | 6.4 | 0.59 | 15638 | 87.4 | 5.6 | 36.2 | 71 | 1.00 |
| DECS-30 | Splash Dam | mvb | Chan-Seam | VA | Buchanan | 1995 | 3.9 | 0.79 | 15751 | 88.5 | 5.4 | 30.9 | 77 | 1.16 |
| DECS-31 | Pond Creek | hvAb | Chan-Seam | KY | Pike | 1995 | 10.9 | 0.60 | 15538 | 86.8 | 5.5 | 36.6 | 73 | 0.99 |
| DECS-32 | Stockton-Lewiston | hvAb | Chan-Seam | WV | Kanawha | 1995 | 20.3 | 0.73 | 15213 | 85.4 | 5.8 | 38.2 | 68 | 0.90 |
| DECS-33 | Ohio #4A | hvAb | Chan-Seam | OH | Meigs | 1995 | 12.0 | 3.74 | 14630 | 81.8 | 6.0 | 47.8 | 77 | 0.51 |
| DECS-34 | Pittsburgh | hvAb | Cleaning-Plt. | PA | Washington | 2004 | 7.4 | 1.58 | 14662 | 85.7 | 5.7 | 40.4 | 83 | 0.83 |
| DECS-36 | Powellton/Eagle | hvAb | Cleaning-Plt. | WV | Raleigh | 2006 | 7.2 | 1.04 | 14637 | 88.1 | 5.6 | 36.5 | 74 | 1.03 |
| DECS-37 | Indiana #5 | hvBb | Cleaning-Plt. | IN | Gibson | 2008 | 7.8 | 3.92 | 14166 | 82.1 | 5.4 | 45.0 | 89 | 0.47 |
| DECS-38 | Dietz | subB | ROM | MT | Bighorn | 2008 | 4.8 | 0.44 | 13000 | 77.0 | 5.4 | 46.3 | 86 | 0.38 |
| DECS-39 | Anderson/Canyon | subC | Grab | WY | Campbell | 2008 | 8.0 | 0.53 | 12269 | 74.7 | 5.4 | 64.6 | 84 | 0.30 |
| DECS-40 | Illinois #6 | hvCb | Chan-Seam | IL | ----- | 2015 | 13.0 | 4.52 | 14439 | 80.9 | 5.8 | 44.9 | 88 | 0.50 |

Argonne Premium Coal Samples

| | | | | | | | | | | | | | | |
|----------|-------------------|------|------------|----|-----------|------|------|------|-------|------|-----|------|----|------|
| APCS - 1 | Upper Freeport | mvb | Chan-Seam | PA | Indiana | 1985 | 13.0 | 2.32 | 15980 | 88.1 | 4.8 | 30.1 | 71 | 1.16 |
| APCS - 2 | Wyodak-Anderson | subB | Drill-Seam | WY | Campbell | 1985 | 9.0 | 0.63 | 13020 | 76.0 | 5.4 | 48.5 | 89 | 0.32 |
| APCS - 3 | Illinois #6 | hvCb | Chan-Seam | IL | St. Clair | 1985 | 15.0 | 4.83 | 14696 | 80.7 | 5.2 | 45.7 | 85 | 0.46 |
| APCS - 4 | Pittsburgh #8 | hvAb | Chan-Seam | PA | Greene | 1986 | 9.0 | 2.19 | 15336 | 85.0 | 5.4 | 40.8 | 85 | 0.81 |
| APCS - 5 | Pocahontas #3 | lvb | Chan-Seam | VA | Buchanan | 1986 | 5.0 | 0.66 | 15908 | 91.8 | 4.5 | 19.0 | 89 | 1.68 |
| APCS - 6 | Blind Canyon | hvAb | Chan-Seam | UT | Emery | 1986 | 5.0 | 0.62 | 14728 | 81.3 | 5.8 | 47.8 | 87 | 0.57 |
| APCS - 7 | Lewiston-Stockton | hvAb | Chan-Seam | WV | Kanawha | 1986 | 20.0 | 0.71 | 15247 | 85.5 | 5.4 | 36.2 | 73 | 0.89 |
| APCS - 8 | Beulah-Zap | lig | Drill-Seam | ND | Mercer | 1986 | 10.0 | 0.80 | 12370 | 74.0 | 4.9 | 49.2 | - | 0.25 |

* Samples for which no 6.3 mm (-1/4 inch) coal remains

Sample Collection and Processing

The collection of the APCS and DECS series was similar; samples were placed in steel drums with high-density gaskets and purged with argon shortly after collection. The APCS were transferred to a nitrogen-filled enclosure where they were crushed, homogenized, and packaged in heat-sealed glass ampoules or carboys (<100 ppm O₂). The DECS were processed in air then sealed under argon in foil multilaminar bags and kept in refrigerated storage (3°C), a procedure which has been shown by annual monitoring to preserve samples successfully. PSOC samples were collected, shipped, and processed in air. 300 g samples were placed under argon in polyethylene bags and sealed in steel cans for distribution.

Analysis

Each of the Penn State Sample Bank coals has been subjected to the following analytical procedures: proximate analysis, ultimate analysis, sulfur forms, calorific value, maceral analysis, vitrinite reflectance (VRo), ash fusion determination, free swelling index, Hardgrove grindability, major inorganic and trace elements, equilibrium moisture, and CO₂. Gieseler plastometry and a standardized liquefaction test were performed on appropriate samples. NMR and Py/gc/ms results were obtained on selected samples.

Sample Availability

Coal samples from these collections are available to members of the coal research community. Research agencies most often request the APCS ampoules and the DECS 250 g containers. Large quantities and special preparations have additional costs.

| Sample costs (does not include handling & shipping): | |
|--|-------------------------------|
| DECS fees: | Internal/ External PSU |
| 50 g of -60 mesh (-0.25 mm) | \$25.29/\$40.00 ea |
| 250 g of -20 mesh (-0.85 mm) | \$37.93/\$60.00 ea |
| 2.0 kg of -1/4 inch (-6.0 mm) | \$113.79/\$180.00 ea |
| APCS fees: | Internal/ External PSU |
| 5 or 10 g of -100 or -20 mesh (-0.14 or -0.25 mm) | \$12.64/\$20.00 ea |
| 14-20 kg Carboys of -20 & -100 mesh | \$758.58/\$1,200.00 ea |
| PSOC fees: | Internal/ External PSU |
| -20 mesh coal | \$31.61/\$50.00 ea |
| -60 mesh coal | \$37.93/\$60.00 ea |

Coal Database, Printouts, and Searches

The EMS Energy Institute maintains a computerized database on DECS and PSOC samples. In addition to analytical data, the coal database includes details on sample history, location, geology, and seam strata.

Full (four to five page) printouts are available for any sample and one-page printouts listing sample location, geologic information, proximate analysis, equilibrium moisture, calorific value, sulfur forms, ultimate analysis, maceral composition, reflectance data, rank parameters, technologic properties, and physical properties are available for select samples. EMS Energy Institute staff can assist with database searches to identify samples meeting specified criteria. For more information on what data are available as well as costs associated with this service, visit our website.

APCS data are available in published form and can be purchased from the NTIS website ntis.gov.

Vorres, K.S., *Users handbook for the Argonne Premium Coal Sample Program*, ANAL/PCSP-89/1, October 1989.

Ordering and Assistance

Request forms and assistance in acquiring samples and data can be obtained from:

EMS Energy Institute
The Pennsylvania State University
C-211 Coal Utilization Laboratory
University Park, PA 16802

Phone: (814) 863-1333

E-mail: csb@ems.psu.edu

Website: <https://www.energy.psu.edu/services/penn-state-coal-sample-bank>

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