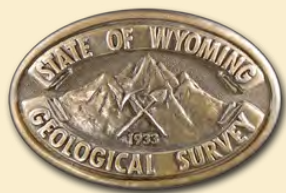


Processes and Procedures for Recording Mineral Exploration Data in Major Mineral-Producing Jurisdictions



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INTRODUCTION

The Wyoming State Legislature requested that the Wyoming State Geological Survey (WSGS) conduct a study of the processes and procedures for recording mineral exploration data in major mineral producing jurisdictions of the United States, Canada, and Australia (63rd Legislature of the State of Wyoming 2015 General Session Budget Bill, Section 42). This report is a result of that request. Basic findings illustrate state (province and territory) level legislation requiring the preservation of significant mineral exploration data, separate recordings of petroleum exploration and mineral exploration data, state geological surveys approach to data recording, storage facilities, and the expenses incurred while recording mineral exploration data.

The findings reveal that there is a wide range of requirements (from none to specific) and consequently great variability in the availability of data/information. Also, mineral and petroleum industry requirements are often different within and between jurisdictions. Usually requirements are better defined and more stringent on oil and gas related data than mineral data.

For minerals, when companies are legislatively required to provide data/information to the state, the geological surveys are often responsible for collecting the data, cataloging and storing it and providing it to industry and the public.

Apart from the Wyoming Oil and Gas Conservation Commission (which handles Oil and Gas related data), the USGS Core Research Center in Denver, Colorado is identified as the only public mineral exploration repository for samples from Wyoming wells. Unlike some jurisdictions, there are virtually no requirements enforced for the collection, storage and preservation of mineral related data and information in Wyoming and hence it is essentially unavailable.

A potential State of Wyoming mineral exploration data repository is estimated to have a \$10 to \$15 million startup and \$500,000 to \$1 million annual operating cost. A brief introduction to each jurisdiction's requirements, processes, procedures and facilities, for recording mineral exploration data, is provided.

RECORDING MINERAL EXPLORATION DATA

Processes and procedures for recording mineral exploration data reflect the following:

Why are mineral exploration technical data being recorded and stored?

Mineral exploration technical data can be used by industry, government and academia for economic, scientific, social and environmental benefit. Some uses have included mineral potential and occurrence studies, geologic mapping, hazards mitigation, new mineral exploration, and hydrogeologic

studies. Organized storage of mineral exploration data can potentially reduce unnecessary duplication of drilling expenses and exploration activities. Millions of dollars are saved annually by examining preserved samples and data. The USGS estimates the annual storage cost of mineral exploration data are half a percent of the original cost to drill and acquire the data. Repeated drilling activity in a given area may cause unnecessary disturbance to the environment. Preserved geologic samples will be available for future study as new mineral exploration technologies and concepts evolve. Investments by the petroleum industry in maintaining private core libraries may be indicative to the usefulness of public core storage facilities.

Who requires the recording of mineral exploration technical data, and who maintains the records?

State (province or territory) governments were most often found to be the responsible party for accumulation and maintaining mineral exploration data within their geographic region. State geological surveys tended to be the agency in charge of recording mineral exploration data. States with specific legislation regarding mineral exploration data and providing funds for repositories appear to have better facilities and collections when compared to states relying on donations, volunteers, and agency level policy without the supporting state legislation.

In most cases, the legislation and the processes and procedures, which outline the requirements for mineral exploration data recording are different from that of petroleum exploration. Petroleum data collection, storage, and access are usually provided by distinguishably separate state agencies at different facilities.

Unlike petroleum related activities, Wyoming does not have legislation other than Wyo. Stat. Ann. § 36-6-102(a) that requires companies and individuals to submit/turn in mineral related technical data and information (drilling reports, cores, samples, assay information, maps, etc.). The mineral exploration data from leased state school lands may not always be submitted to the state geologist as required by the board of land commissioners.

Where are mineral exploration technical data being recorded?

Mineral exploration data is often housed and cataloged at facilities known as core libraries, core research centers, or core repositories. Minimally, the facilities provide storage space protecting data from the elements. Most facilities provide a digital inventory of the collection, temperature controlled viewing areas, and some basic tools for examining the data. Modern facilities provide online access to the catalog or inventory of the samples and in some cases offer online access to the data itself.

Massive cost commitments – tens of millions of dollars – have been spent for a facility startup. State owned buildings are preferred because the physical data is considered to be a permanent collection; 30,000 to 50,000 square feet is a typical size building used to store and examine core and samples. Many repository buildings have been donated or partially donated to states by private industry in the U.S.

Permanently staffed facilities provide better access, generate more industry support, and lead to an overall professional operation. Staff members typically include an administrator, a curator, a geologist, and technicians. Equipment provided at a basic facility includes shelving, forklift, examination tables, microscopes, rock saws, core splitter, computer, staff workstations, and simple geology examination tools. Advanced facilities can have specialized software and hyperspectral mineralogical logging equipment. Support services, such as custodial and grounds keeping, help maintain the professional appearance of facilities. Operating costs are covered by legislative funding, endowments, donations, and to a lesser degree user fees. They could also potentially come from an allocation from severance taxes, bonus payments or other means.

What mineral exploration technical data and samples are recorded?

The amount of material recorded depends on the type and origin of mineral exploration data, relevant legislation, confidentiality considerations, the system used and the availability of resources. Mineral exploration data may include diamond drill core, well cuttings, chips, well logs, analytical reports, geologic samples, geochemical samples, lithologic descriptions, and thin sections or paleo/palynology samples.

While it may not be possible to collect all mineral exploration data due to space, labor, damage, loss, or practical restraints, focus is made on recording certain data. Assessments must be made as to whether or not submitted data is kept, how much of the data is retained and if destructive sampling of data is permitted. Selection criteria for mineral exploration data by data repositories include retaining representative drill core and associated data from:

- Significant mining projects or prospects.
- Mineralization that illustrates a range of mineral commodities or styles of mineralization.
- Intersections of significant lithological, stratigraphic, structural, geochemical or geophysical mineralization.
- Intersections at tectonic settings.
- Locations that are geographically spread throughout the state.

- Drilling projects that may be difficult, inaccessible, or expensive to re-drill in the future, such as in national parks, urban areas, or reserves.
- Exceptionally deep drill holes that are unlikely to be re-drilled.
- Excellent examples of local stratigraphy, significant structural features, or unusual geology.
- Prospects or areas popular with the mineral industry.

All facilities allowing destructive sampling of physical specimens require a copy of the analytical report that is generated to be given to the facility. Some facilities require unused samples to be returned. Policies vary as to how much of the specimen must remain, who may take samples, and what methodologies for analysis are permitted.

How are mineral exploration technical data being recorded?

Companies or individuals, often known as donors or contributors, submit a mineral exploration data submission request to the organization responsible for preserving the data. The organization then determines if the data is worthy of preservation based on the above criteria. Data is usually not allowed to be discarded before being offered to the organization. The qualifying donations are delivered to the organization in a format, order, and condition specified by policy. The donation is cataloged electronically. If the system has the ability to store ancillary digital information, that information is included with the record in the database.

Submission of mineral exploration data minimally requires the associated information:

- Well name/number/lease
- Operator
- Location
- Sample type
- Sample interval depths
- Formation or rock units
- Purpose of well
- Hazard (radioactivity, asbestos, etc.)
- Assay results
- Geologic descriptions

Packaging and labeling requirements for submitted data are provided in policy manuals or on submission forms to be filled out by the donor. The cost of packaging, labeling, and

transport to the facility are often the responsibility of the donor.

When are mineral exploration technical data recorded and when are they made available?

Typically, mineral exploration data submission is a requirement of a permit to explore for minerals. In some cases it is a requirement of the mineral lease. Penalties for not complying are sometimes enforced as fines, revoking of a permit or lease, or not granting future permits.

Confidentiality of mineral exploration data is addressed in several ways. Some facilities only accept non-confidential data. Others hold data confidential based on a predetermined time line. One year confidentiality with the option for a donor to request consecutive years in writing is typical. Some facilities hold data confidential as long as the mineral lease is active.

CONSIDERATIONS FOR A STATE OF WYOMING CORE CENTER

Existing Facilities

A state-run core center does not exist in Wyoming. Oil and gas exploration core is stored at the USGS Core Research Center in Denver. Well logs and digital information related to oil and gas wells is recorded and provided to the public by the Wyoming Oil and Gas Conservation Commission.

The USGS Core Research Center in Denver, Colorado accepts and stores core from Wyoming mineral exploration activities which are primarily oil and gas related. The facility is a permanent free-access repository. In addition to on-site examination and sampling, an online well catalog with access to digital data including images of thin sections, photographs of some core, chemical and physical analyses, core descriptions, and stratigraphic charts is provided. The USGS facility has established policies and developed a high degree of trust with its donors and users.

The creation of a State of Wyoming Core Center for oil and gas related activity would be somewhat redundant with the USGS Core Research Center in Denver. The creation of a data center for mineral exploration related core and samples would not be as redundant. Such a facility would have monetary requirements for startup and continued operation.

Estimated Startup Costs of \$10 to \$15 million

The rough estimate was based on using an existing 50,000 square-foot industrial building in Wyoming that would be purchased in the \$5 million (\$100/sq ft) price range depending on location and the economy. Renovating and equipping a building to properly receive, catalog, store, and retrieve mineral exploration data, provide safe examination areas, examination equipment, and staff offices may cost another \$6

million.

Annual Operational Costs of \$500,000 to \$1 million

The largest annual cost of operating a state run core center would most likely be the staff salary and benefits. If a state core center were administered by the WSGS the minimum staff required at a repository might consist of a curator, one or two geologists, two technicians and some administrative support. If the four to five management/technical positions averaged \$90,000 in salary and benefits the annual staff cost would be \$360,000 to \$450,000 (not including admin. support costs). Annual IT data storage, software and hardware, internet connection, office supplies, grounds keeping, building maintenance, and utility costs would also need to be considered.

The Alaska Division of Geological and Geophysical Surveys relocated its core samples and data from the Alaska Geological Materials Center to a new building in 2015. A 100,000 square-foot building located in Anchorage was purchased for \$16 million. It was previously a Sam's Club and required an additional \$8.5 million two-year renovation allowing for mineral exploration data collection and storage.

The Nevada Bureau of Mines and Geology constructed a building for its Nevada Great Basin Science Sample and Record Library. The 15,000 square-foot facility located in Reno, Nevada cost \$8.5 million to construct. Construction began in 2006 and it opened in 2009. A cost of \$7.8 million was estimated for capturing digital data and physical samples around the state and would take place over seven years.

FINDINGS BY JURISDICTION

The top 14 non-fuel mineral producing US states were studied in order to identify the processes and procedures used to record mineral exploration data. These 14 states include Wyoming and represent over two-thirds of the total U.S. non-fuel mineral production. In addition Idaho, Montana, South Dakota, and Nebraska were examined as they share state borders with Wyoming. The mineral producing countries of Canada and Australia and their respective states, provinces, and territories were also included in the review. The following information includes discoveries found on each jurisdiction's requirements, processes, procedures, policies and facilities for recording mineral exploration data. Further details regarding a specific jurisdiction's approach towards the recording of mineral exploration data can be found using the web links provided in the References section of this report.

United States

13 of the 18 states studied operate mineral exploration drill core repositories. Of these, 10 are responsibilities of the state geological surveys, two are university programs and one is run by the Department of Natural Resources Land and Minerals Department (not the state geological survey). Sixteen of

the 18 have separate oil and gas data stewards, policies, data access, and storage requirements.

Alaska

A permit is required for drilling and geophysical mineral exploration in Alaska, the licensee is required to submit all geologic and geophysical data obtained under the exploration license to the Department of Natural Resources. Data is kept confidential at the written request of the person supplying the information.

The Alaska Department of Natural Resources (DNR) Division of Geological and Geophysical Surveys maintains a central repository called the Geologic Materials Center (GMC). In 2015 the GMC moved from Eagle River, AK to Anchorage, AK to provide better access and more storage space. The GMC began operations in 1984. The material storage space grew to 30,000 square feet by 2013. Materials were stored in shipping containers and inventory was based on employee memories and a variety of notes. It took two years and \$24.5 million to renovate a 100,000 square-foot Sam's Club building into the new GMC. Alaska originally planned to take nine years to build a new building at a cost of \$45 million. The facility has three full time staff members, sometimes additional staffing is necessary.

The Alaska GMC houses both physical samples and electronic data. Physical samples include: 190,000 processed slides, over 280,000 linear feet of core from exploratory boreholes, over 76,000 linear feet of core and rock from oil and gas wells, and numerous surface rock and sediment samples. There are two open viewing areas and one private viewing area in the Anchorage facility. On-site equipment available to visitors includes a petrographic microscope with camera, lamps for photography, LED stereoscopes, and digital balances.

Digital data available online through the GMC website include: oil and gas well locations, well permits, digital logs, mineral prospect locations, sample types, box-level details, and geologic formation-top picks. Monthly reports are provided summarizing samples received, donations, processed samples, published data reports, and visitor information.

Samples may be checked out according to a policy that requires a certain amount of the sample to remain permanently in the GMC. Geochemical reports containing analytical and interpretive data resulting from testing by third parties on material borrowed from samples are available on the website.

Alaska DNR believes the analysis of archived samples is a cost-effective alternative to the expense of core drilling and resampling in the field. Models and interpretations developed from the samples have increased and will continue to increase economic development of Alaska's minerals.

Arizona

A permit is required for drilling and mineral exploration in Arizona. Upon termination of a mineral exploration permit, other than by issuance of a mineral lease, the permittee shall submit drill hole information, including total depth, lithologies and lithologic depths, gamma ray, resistivity, caliper, and deviation survey logs to the state land commissioner. Chemical analysis and other identification of minerals are not to be included. The drill hole information is held confidential for one year and may be extended another year upon request. Geologic and economic evidence of a mineral resource provided by a lessee seeking to renew a mineral lease is confidential.

The Arizona Geological Survey operates and maintains a central repository for rock cores, well cuttings samples, and data submitted to the state. The repository was organized in 1992 and is available to the public. The collection includes 150,000 linear feet of skeletonized core (20% -1% of original retained). The core came from over 300 geotechnical site assessments or metallic mineral exploration bore holes. Samples are accumulated through donations. A report is available online that summarizes the inventory and some core descriptions as of 1993. The repository also archives cuttings from over 1,000 oil and gas wells on behalf of the Arizona Oil and Gas Conservation Commission. The repository occupied 1,000 square feet in a basement of the Corbett Building in Tuscon, AZ, the building appears to have been for sale or lease in 2014. No further information on the repository was found.

Well logs, casing records, and data are held by the Arizona Oil and Gas Conservation Commission and available to the public. "Wildcat" wells are kept confidential for one year, the operator may request confidentiality for two more years. Online information includes well locations, permit numbers, scanned logs, well folders, LAS data, and production reports.

California

No laws or regulations were found requiring the reporting of mineral exploration data in California.

The California Well Sample Repository (WSR) is located on the campus of California State University at Bakersfield. It began in 1975 with a 6,000 square-foot prefabricated steel building built by a grant donated from Western Oil and Gas Association. The facility is now composed of two 6,000 square-foot buildings. They provide sample storage, examination space, rock processing equipment, and an administrative office.

Physical samples catalogued at the WSR include cores, ditch samples, and sidewall samples from over 6,000 exploration oil and gas wells. Ancillary data such as well histories, core descriptions, photographs, and electronic logs are available for some samples. Microscope slides have been processed for mi-

crofauna from over 2,000 samples. Other material includes foundation boring samples, ocean bottom sediments from water quality studies, and rock samples from mining districts and geothermal areas. The collection was accumulated and built through independent exploration, private industry, and academic donations.

Online catalogs or inventories are provided as Microsoft Excel files for download. The inventory includes main catalog of cores, lithology samples, paleontological reports, geologic reports, seismic velocity surveys, paleontology samples and slides, research results, thin sections, and well log files. Special publications prepared by repository staff and knowledgeable users are also available for download.

The California WSR operates on a reported annual budget of approximately \$35,000. Operating costs include a curator, temporary student help, supplies, shelving, and equipment. Volunteer help is depended upon to keep the facility running. It is open three days a week, Tuesday, Wednesday, and Thursday from 9 a.m. to 3 p.m. The funding comes from several sources, including user fees charged, interest from an endowment fund, individual donations, corporate sponsors, and professional association support. User charges for look up and handling are \$25 plus \$20 per box for examination. Twenty dollars per slide is charged for thin section examinations. Additional charges are defined on the California WSR fee schedule. An advisory board consisting of a chairman, director, curator and 11 other board members guides the WSR.

The California Division of Oil, Gas, and Geothermal Resources provides oil and gas well and production data online.

Colorado

No laws or regulations were found requiring the reporting of mineral exploration data in Colorado. There is no state maintained repository in Colorado. The USGS Core Research Facility is located at the Denver Federal Center and is summarized under USGS Core Research Center in this section of the report.

The Colorado Oil and Gas Conservation Commission provides well locations, well logs, and production information online.

Florida

Florida laws and regulations require a person conducting geophysical activities on state-owned lands to furnish a copy of non-interpreted information derived from the activities upon request of the Department of Agriculture and Consumer Services. The materials may be held confidential for 10 years upon request of the donor. The department may collect data on the extraction, production, importation, exportation, refinement, transportation, transmission, conversion, storage, sale, or reserves of energy resources.

The Florida Geological Survey (FGS) operates a Geologic Sample Repository in Tallahassee, FL. The facility is 12,090 square feet. It is open to the public by appointment only. Workspace and microscopes are available for visitors to use.

The FGS has a Geological Data Acquisition Program that obtains samples from outside contractors and in-house operations. Items held at the sample repository include 19,900 cuttings from exploration, water, and oil wells, as well as 1,150 core samples (205,000 linear feet), 5,900 outcrop samples, thin sections, and geophysical logs. The FGS describes the samples as becoming more and more important as development of the state becomes more prolific and access to field samples diminishes.

The online Lithologic Database contains over 5,000 lithologic descriptions of cores and cuttings available as downloadable ASCII files. The Florida Department of Environmental Protection Oil and Gas Program provides well locations, well logs, and production information online.

Idaho

No laws or regulations were found requiring the reporting of mineral exploration data in Idaho. There is no state maintained repository in Idaho. The Idaho Geological Survey provides historical oil and gas well locations and data from 1903 to 1988. There are approximately 150 wells in this data set. The Idaho Department of Lands Oil and Gas Conservation Commission regulates the drilling and production of current oil wells. Oil production is minimal compared to other producing states.

Michigan

Michigan laws and regulations require the mineral lessee retain and store exploration data, records, cores, and samples during exploration. The data is held confidential and can be examined by the lessor. When a lease is terminated the lessee provides the lessor all data, records, cores, samples, and a report of all exploration conducted.

Western Michigan University maintains a 27,000 square-foot Michigan Geologic Repository for Research and Education in Kalamazoo, MI. The facility consists of a 20,000 square-foot warehouse, examination and preparation area, offices, conference room, library, seminar room, and two microscope labs.

The repository houses over 500,000 linear feet of rock core from oil and gas wells, mineral wells, environmental research wells, as well as rotosonic cores of glacial sediments. Listings of the samples are available online for curated cores; 2,100 oil and gas core analyses, 20,000 drill cuttings, 4,400 oil and gas mud logs, 16,000 oil and gas wire logs, and 2,000 thin sections. Analytical, pressure, and production data is available online for 1,200 oil and gas wells.

Financial support to operate the repository is received from

135 different individuals, companies, and organizations. Fees are charged to use the facility and examine samples. A \$25 per hour examination fee or \$150 daily fee, a \$1 per foot (minimum \$50) core layout fee, \$15 per foot slabbing core fee, a \$25 per well plus \$5 per box retrieving fee for well cuttings and other fees may be charged.

The Michigan Department of Environmental Quality's Office of Oil, Gas and Minerals provides online data for well locations, oil and gas production, formation tops, permits, fields, and raster logs.

Minnesota

Minnesota has several statutes and regulations related to mineral exploration drilling and data. Specific requirements have been in place since 1980. Exploratory boring procedures are defined and a license is required by a person making exploratory drilling. Samples are specifically defined as at least two cubic inches of material per foot. Submission of samples and data must be submitted to the commissioner of natural resources. When a mineral lease terminates, the data and samples become public even if a new lease is activated on the same property. The samples and data are required to be stored by the Minnesota Department of Natural Resources (DNR) at a core library in Hibbing, MN. The library is managed by the DNR commissioner providing public access to exploration data, exploration drill core data, mineral evaluation data, and mining data.

The Minnesota DNR Lands and Minerals Division maintains Minnesota's drill core library. The facility consists of three buildings housing over 3 million linear feet of drilled core samples. Samples are from 7,000 mineral exploration cores, 1,500 roadway and bridge foundation cores, and 500 research cores. Heated examination space is available and sampling of core is encouraged within the set guidelines. Visitors are requested to give at least a two week notification before a visit so samples can be located and retrieved. Corresponding data files consisting of location maps, geologic descriptions, geophysical, and geochemical information are available for some samples.

Online information is provided in the form of an interactive map. The map includes a listing of the samples, sample location, state mineral leases, geologic maps of Minnesota, bedrock outcrops, depth to bedrock, aeromagnetic map, and some additional information.

Minnesota's drill core library has contributed to the discovery of three valuable nonferrous mineral deposits (the Birch Lake deposit, the Maturi deposit, and the Tamarack deposit). Drill core samples are reused several times in exploration and research projects. Reusing core samples limits the need of additional drilling disturbances. The Minnesota DNR estimates it costs \$100,000 to obtain 1,000 feet of core from drilling to analysis. The reuse of the publically available core samples and data in the library is much more cost effective for explor-

ers and researchers.

Missouri

No laws or regulations for mineral exploration, other than the requirement of a permit for coal exploration, were found.

The Missouri Department of Natural Resources' Geological Survey manages the McCracken Core Library and Research Center. The Core Library and Research Center began in 1989. Missouri statutes established a mine map depository in 1993. The Missouri Geological Survey maintains this depository in conjunction with the research center. It is located in a 21,000 square-foot building in Rolla, MO. An examination and study room was made possible from donations in memory of Clark S. Rhoden. The facility is open to the public by appointment. Visitors from industry, academia, and government are believed to save millions of dollars in exploratory costs annually.

There are over 2 million feet of core and well cuttings. The collection has over 3,000 drill core samples. The listing of library core holdings is available online. Donations of core samples came from individuals, the highway department, oil and gas exploration, mineral exploration, quarries, and landfills. The sample collection has an estimated replacement value of \$100 million.

The Missouri Geological Survey provides online oil and gas well data through a separate oil and gas web page.

Montana

A notice of intention to engage in geophysical exploration must be filed with the county clerk. An exploration permit is required but no requirements of reporting of mineral exploration data were found.

The Montana Department of Natural Resources and Conservation's Board of Oil and Gas provides oil and gas well locations, well logs, leases, statistics, and production information online.

Nebraska

The Nebraska Department of Environmental Quality (DEQ) issues permits for mineral exploration. An annual report including a geophysical description of each hole is required by DEQ.

The Nebraska Oil and Gas Conservation Commission provides oil and gas well locations, permit information, and other data online.

Nevada

The Nevada Commission on Mineral Resources Division of Minerals annually records the production of mining operations and oil and gas operations. State law requires companies

drilling oil and gas wells to give the state two sets of cuttings. Core and cuttings are kept confidential for six months.

The Great Basin Science Sample and Records Library (GBSSRL) is managed by the Nevada Bureau of Mines and Geology's Information and Publication Sales Office. It is located on the University of Nevada's Desert Research Institute campus in Reno, NV. The GBSSRL opened in April 2009 and is open Tuesday through Friday, 8 a.m. to 3 p.m.

The U.S. Department of Energy provided approximately \$3.5 million for phase I of the building. Phase I includes the construction of 9,000 square feet of the planned 15,000 square-foot building. An additional \$5 million was required for phase II. After the building was complete with shelving and furniture, additional funds were needed for digital data, to collect physical samples, and provide specialty equipment.

Specialty equipment the GBSSRL is requesting through donations include: large rock saw (new style), with extra blades - \$9,500; 18-inch rock saw with extra blades; \$3,500, trim saw/core saw, 14-inch, with extra blade; \$3,300, electric hydraulic core splitter; \$8,500, flat 20-inch vibrating lap for polishing slabs (with additional pans); \$1,000, and server(s) for their Information Office website; \$20,000 for two servers.

A three year effort to capture digital data and collect physical samples from key sites around the state was reported to cost \$2.8 million over three years. An additional \$2 million for each of the following two years after that would also be required. A total of \$6.8 million and five years for the data conversion and sample collection were estimated.

Online Information about oil and gas wells is available from Nevada Bureau of Mines and Geology and the GBSSRL. Well permits, completion reports, electronic logs, mud logs, various reports, and production data have been scanned using AAPG-OSU Boone Pickens funding.

New Mexico

No laws or regulations were found requiring the reporting of mineral exploration data in New Mexico.

The New Mexico Bureau of Geology and Mineral Resources manages the New Mexico Subsurface Data and Core Libraries. The facilities are located on the New Mexico Tech campus in Socorro, NM. Five warehouses store more than 4,000 cores, well cuttings from 15,000 wells, well records for more than 100,000 wells, electric and geophysical logs for 50,000 wells, and sample descriptions for 4,300 wells. Materials representing oil, gas, coal, and water exploration wells were obtained through hundreds of company and individual donors.

The libraries are open to the public and provide a processing area, tables for examination, and microscopes. Several hundred visitors from industry, academia, and state and federal agencies are reported annually. Onsite examination fees are

not charged if samples are pulled by the researcher. A \$5 per box fee is charged to pull and reshel samples. A partial digital data catalogue is available by contacting a staff member at the New Mexico Bureau of Geology and Mineral Resources.

Financial donations from industry allow for the building of insulated and ventilated warehouses that are designed and built to keep maintenance costs minimal. The cost estimated to build a 30 x 100 foot warehouse at the facility is \$100,000.

The New Mexico Oil Conservation Division maintains databases for oil and gas well information online.

South Dakota

An annual report of mineral exploration activities is required to be submitted by the operator to the Department of Environment and Natural Resources, but is not required to include mineral exploration data.

The South Dakota Geological Survey provides a Core and Cutting Repository Database online. The database contains information on sediment cores and cuttings that are stored in the Geological Survey core repository. Cores and cuttings collected throughout the state by commercial and government drilling are submitted to the core repository. Information such as location, company, county, and depth intervals are stored in the database. Information about the physical facility itself was not found.

The Sanford Underground Science and Engineering Laboratory is located in Lead, South Dakota. More than 39,000 boxes of core from the Homestake Gold Mine are housed at the lab. The material was donated to the South Dakota Science and Technology Authority by the Barrick Gold Corporation. Forty boxes of drill logs have been scanned and the Homestake Core Archive online database is under construction.

The South Dakota Department of Environment and Natural Resources provides an online oil and gas well database.

Texas

A permit for geophysical or geochemical mineral exploration on public school land is required in Texas. Mineral lease applicants provide geological, geophysical and other data or copies of the data, including interpretative data pertinent to exploration, to the land office. The data is held confidential until one year after the expiration of the lease, if a mineral lease is not issued the data is returned to the applicant.

The Texas Bureau of Economic Geology operates three core research centers. The three facilities store and curate over two million boxes of geologic material. The Austin Core Research Center is the main core repository for material donated to the University of Texas. The Austin facility contains more than 500,000 boxes of cores and cuttings. There is a core research center in Midland, TX which has approximately 500,000 boxes of core and cuttings. The Midland facility was

donated by Shell. The Houston Research Center is a climate controlled facility with over 900,000 boxes of core and cuttings. The Houston facility was donated by BP. The material in Houston was acquired through work supported by the National Science Foundation. The facility has offices for staff and two conference rooms. All facilities charge nominal fees to rent table space and view core. The Integrated Core and Log Database (IGOR) is available online to locate core, well cuttings, and geophysical logs.

The Railroad Commission of Texas' Oil and Gas Division maintains and provides oil and gas well permit information.

U.S. Geological Survey Core Research Center

The General Mining Act of 1872 does not prohibit or require reporting of hard rock mineral exploration data on federal rights, this is left up to individual states. The Federal Land Policy and Management Act (FLPMA) of 1976 (Sec 314) requires a claim that is filed with the state to also be filed with the U.S. Department of the Interior's Bureau of Land Management and does not prohibit or require reporting of mineral exploration data. Different legislation and requirements may exist for oil and gas exploration.

The USGS Core Research Center was established in 1974. It is located at the Denver Federal Center in Lakewood, Colorado. The center contains core from 9,000 wells representing 33 states. There are cuttings from 52,000 wells representing 27 states. Over 20,000 thin sections are cataloged at the center. The USGS estimates that the annual storage cost of the data is half a percent of the original drilling cost. Most of the material is from oil and gas wells in the Rocky Mountain Region.

A search performed in June 2015 using the center's on-line well catalog returned 5,661 entries out of 15,784 total cataloged cores as being from Wyoming (36%). Similarly a search of 52,686 cataloged cuttings returned 19,481 entries for Wyoming (37%). The online library includes analysis and images when available.

The center is open to the public by appointment, Monday through Friday, 8:30 a.m. to 4:30 p.m. Access to the center is free. There are approximately 2,000 visitors each year. The facilities include conference rooms, examination rooms, two petrographic microscopes, binocular microscopes, a photo stand, and flood lights.

The USGS Core Research Center employs nine employees. The employees consist of a director, three curators, and five technicians. The staff members determine if donations of core and cuttings are unique and desirable for the collection. Once samples are donated, no special rights are accorded to the donor. Destructive sampling is allowed within guidelines.

Utah

No laws or regulations were found requiring the reporting of mineral exploration data. Hole plugging requirements include the option of returning cuttings to the hole and tamping.

The Utah Department of Natural Resources' Utah Geological Survey manages the Utah Core Research Center in Salt Lake City, Utah. It was originally established in 1951. The state legislature authorized construction of a 12,000 square-foot state-owned building to house the geologic sample collection. There are cuttings from more than 3,500 drill holes and over 700 cores at the research center. Other geologic material includes: type oils from all producing formations in Utah, coal samples from coal mines, samples of metallic minerals, industrial rocks, tar sands, oil shale, geothermal wells, and surface stratigraphic sections. The Utah Geological Survey aggressively pursues new samples. They report that industry's response has been gratifying and donations increase each year.

An online catalogue provides a listing of cores available for viewing. The research center is open to the public with advanced reservations. Equipment made available includes: examination tables, drill press, binocular microscope, and a UV light. Destructive sampling is occasionally permitted. Fees are charged to examine the core: \$15 a day table rental; cutting and core boxes retrieved \$5 each; layout \$100 per day and core slabbing \$8-10 depending on thickness. Equipment maintenance and building costs are approximately \$40,000 per year. A trust fund, administered by the director of the Utah Geological Survey, was established to generate interest income to operate the research center.

The Utah Department of Natural Resources' Division of Oil, Gas and Mining provides oil and gas well information, production, logs, and well files online.

Wisconsin

The Wisconsin State Geologist may require reasonable amounts of core or drill cutting samples be released with a required report containing non-interpretive lithologic descriptions one year after an exploration lease has expired but no more than 10 years after drilling began. The Wisconsin State Geologist may also examine reported core samples or cuttings during exploration unless the licensee deems them proprietary or confidential. Exploration data and samples are kept confidential for three years. There is a penalty of up to \$50,000 to anyone who knowingly or willfully fails to comply with reporting requirements.

The core repository at the Research Collections and Education Center is managed by the Wisconsin Geological and Natural History Survey in Madison, WI. The facility is 20,000 square feet. Collections at the center include: core from over 2,000 drill holes, water-well cuttings from more than 11,000 water wells, and over 51,000 hand-sized rock samples. There is a computerized database containing field notes, geologic logs,

geophysical logs, thin sections, and assays. The replacement cost is estimated to be between \$120 and \$140 million, while some pieces are unique and irreplaceable.

Wyoming

The Wyoming Oil and Gas Conservation Commission (WOGCC) has the authority to require the making and filing of reports, well logs, and directional surveys. Exploratory or “wildcat” wells are kept confidential for six months. Contingent upon leasing of any state land for mineral exploration, the Board of Land Commissioners shall require copies of electrical, gamma-ray, neutron, resistivity or other subsurface log reports, and all assay reports for any rock cores or cuttings be submitted to the state geologist; reports submitted to the WOGCC satisfy these requirements. All subsurface log reports and assay reports will be held confidential for three years. Confidentiality may be extended in one year increments if requested.

There is no state maintained core repository in Wyoming. The USGS Core Research Center in Colorado is used to catalog core samples and data from Wyoming. WOGCC has oil and gas well locations, permits, logs, production, and additional information available online.

Canada

Laws requiring the reporting of mineral exploration data in Canada refer to Crown Minerals; 90 percent of Canadian minerals fall into this category. The Crown Minerals rights are government owned and cannot be purchased but may be leased. Mining activities of Crown Mineral leases fall under provincial/territorial government jurisdiction according to Canadian constitution. There is separate legislation for 13 jurisdictions (excludes Nunavut). A prospector’s license is required prior to mineral exploration in Northwest Territories, British Columbia, Manitoba, Ontario, Quebec, New Brunswick, and Nova Scotia. A prospector’s license may not be required in Yukon, Alberta, Saskatchewan, Prince Edward Island, and Newfoundland and Labrador. All jurisdictions require that a claim to mineral rights be approved before extraction may begin. Additionally, assessment work is required each year to retain a claim to mineral rights. Assessment work may include geologic mapping, core drilling, reports, and drill logs submitted to a mining recorder. These records are kept for future access by interested parties after the end of any required confidentiality period.

Legislation, in the form of a mineral act, varies for each jurisdiction as to the specifics required for the reporting of mineral exploration data. The amount, labeling, packaging, and delivery of material vary by jurisdiction. Some provinces provide assessment credits for the donation of drill cores.

All of the jurisdictions require preservation of exploration data. Abridged examples include:

- ...no person shall abandon, discard, dump, destroy, or otherwise reduce the original technical value of any drill core or cuttings obtained by drilling for the purpose of searching for minerals... (New Brunswick),
- ...provide regulations governing the keeping and disposing of cores, cuttings and samples obtained in exploration for or development of any mineral resource... (Saskatchewan),
- ...provide regulations respecting the submission of rock samples, drill cuttings, core samples, logs or the data obtained as a result of the conduct of exploration... (Alberta); and
- ...A person who drills a borehole ... for the purpose of searching for minerals shall preserve or dispose of the drill core, cuttings and samples in accordance with... (Manitoba).

The Geological Survey of Canada published “A Users’ Guide to Core Storage Facilities in Canada” in 1985 identifying 47 government run core repositories. Forty of the facilities are maintained by provincial governments and seven are maintained by federal agencies. Some of these facilities have changed names, locations, or are now maintained by government agencies under different names, but overall remain the same. Each province has at least one facility operated and located within its borders. Federal lands material such as from the Yukon Territory, Northwest Territories, offshore drilling, and soft sediment samples are maintained by federal facilities. The repositories provide public access to subsurface materials from wells drilled for a variety of geological and engineering purposes. Approximately one-quarter of the facilities store well core related to mineral (hard rock) exploration while the other three-fourths house petroleum well samples.

In addition to the storage and cataloging of cores and cuttings the repositories typically provide heated laboratory space, examination tables, water and electricity, open areas, confidential rooms, a seminar room, acid, equipment lockers, microscopes, cameras, computers with internet, splitting and sampling equipment. Most of the repositories provide ancillary information such as location, geophysical well logs, petrologic and geochemical analyses, core analyses, fluid analyses, results of drill stem tests, and petroleum-production data.

Sampling of non-confidential cores is allowed at most Canadian core repositories. The conditions for destructive sampling vary by facility. Most require a written request describing the research need for a sample and a description of the analytical approach that will be used. Permission is granted on the condition that the repository will always receive a copy of research results. Some repositories require the return of residual samples. The sample size is controlled by policy. A minimum sample size must always remain. Many policies only allow staff to remove the sample. Some facilities require sample

permission in writing from the company that donated the core. Some facilities only allow previously un-sampled cores to be sampled.

Storage space is a concern for repositories with rapid or predicted collection growth. Cored sections are often reduced to between 20 and 5 percent of the original size in a process known as skeletonizing. Data reduction policies of this nature generally require lithologic contacts and mineralized sections be preserved.

Confidentiality of mineral exploration data varies by jurisdiction. Some facilities only accept non-confidential data. Other confidential terms include 90 days in Ontario, one year in Quebec which may be renewed by donor upon request, three years in Northwest Territories, “as long as property is in good standing” in British Columbia, and potash cores stored in Regina remain confidential in perpetuity. Donation submittal forms may include the option for the donor to waive confidentiality and provide future sampling permission for requests approved by the facility operator. Data related to petroleum exploration for field wells remain confidential for 30-60 days and one to two years for wildcat wells.

Oil and gas exploration data preservation is regulated under a variety of petroleum acts, rather than mineral acts. Statutes and regulations were found requiring well drillers in Ontario, Manitoba, Saskatchewan, Alberta, and British Columbia to submit technical data on the wells, cuttings, and all core when exploring petroleum vested in the Crown. Most Canadian core repositories are financed by provincial and federal funds. Some facilities charge examination fees. Industry funding through administrative fees is obtained from the oil and gas industry such as is the case with the Alberta Energy Regulator and the British Columbia Oil and Gas Commission.

Australia

Exploration and mining of Crown Minerals falls under state/territory jurisdictions. There are 18 government run Australian drill core libraries. The state/territory governments operate 17 of the facilities and the federal government maintains one. Data from the core libraries are accessible through AuScope’s National Virtual Core Library (NVCL). NVCL is part of the Federal Government’s National Collaborative Research Infrastructure Strategy (NCRIS). It is a collaborative project between the Commonwealth Scientific and Industrial Research Organization (CSIRO), all state and territorial geological surveys, and AuScope.

The NVCL is an Australia-wide drill core database comprising high-resolution imagery and mineralogical data from spectroscopic scanning. The data for this project is being collected using CSIRO’s HyLogger-system and is made available to the public online through the AuScope Discovery Portal. The system uses visible, near infrared, and thermal infrared spectroscopy to identify and characterize minerals at a spatial resolution of one centimeter. Additional information such

as well location, logs, analytical reports, and photographs can also be accessed through the Discovery Portal.

Geoscience Australia operates the federal core facility in Symonston, a suburb of Canberra. It is a special purpose storage facility for rock mineral and core samples. There is a digital database for stratigraphy and minerals maintained at the facility. A separate database is kept for petroleum information.

New South Wales

Exploration companies are required to offer core upon relinquishing a mineral lease. There are two core libraries operated by the Geological Survey of New South Wales.

The WB Clarke Geoscience Centre is located in Londonderry, New South Wales. Core is evaluated to establish its scientific, educational, or economic value. Only key wells or sample intervals are collected, indexed, and stored. The facility is highly mechanized and contains 50 percent metalliferous exploration, 40 percent coal, and 10 percent geotechnical samples. Visits to the facility require a seven day prior notification. There is no charge to access the collection. Sampling is permitted according to policies which require 25 percent of the sample to remain in the collection and a report of the analysis to be given to the geological survey. A diamond saw is provided.

The EC Andrews Drill Core Facility is located in Broken Hill, New South Wales. The facility provides industry access to regional exploration drill core. A 48-hour notice is required to visit the facility and a \$60 (AUD) per hour fee is charged.

There are an additional four drill core libraries in New South Wales managed by New South Wales Coal and Petroleum Geoscience and intended for storing energy exploration data. They are located in Gunnedah, Gulgong, Wyee, and Yerrinbool.

Northern Territory

Section 93 of the Mineral Titles Act requires that all core recovered from a mineral title must be offered to the Northern Territory Geological Survey when the title ceases or earlier if the core is no longer of use to the titleholder. The transportation of core and/or cuttings to the nominated core library, including costs, shall be the sole responsibility of the submitting company. The Northern Territory Geological Survey operates three core storage facilities. They are located in Alice Springs, Darwin, and Tennant Creek. The Tennant Creek facility is dedicated to storing samples from the El Dorado mine. Sampling is permitted at these facilities within guidelines. The sampler must submit a digital analysis report within six months of sampling. All unused samples must be returned.

Geological samples from onshore and coastal petroleum wells must be submitted to the Northern Territory Core Facility if

directed under the Petroleum Act, Section 60 or Petroleum (Submerged Lands) Act, Section 122.

Queensland

Queensland has legislation requiring mineral exploration data, cores, cuttings, seismic, and geophysical data to be submitted to the Department of Natural Resources and Mines. The requirement includes coal and petroleum exploration.

There are four facilities administered by the Geological Survey of Queensland, two of which are dedicated to specific mines. The Charters Towers Core Repository maintains samples from the Charters Towers Gold Mine. The Rockhampton Core Repository stores samples from the Mount Morgan Mine.

The Queensland Exploration Data Centre is located in Zillmere (northern Brisbane). It was established in the 1950s to house coal cores and has been in its current location since 1979. While the coal drilling programs from 1950-1985 are the basis of the collection, some core dates back to 1890s and samples are continually added. The facility has an all-weather courtyard for viewing. Visitors must schedule 24 hours in advance. Acid, sample bags, tags, hammers, and picks are available. Sampling is permitted and a copy of the analysis report must be provided to the geological survey.

The John Campbell Miles Drill Core Storage Facility, also known as Mount Isa, is located in Mount Isa, Queensland. The facility cost \$4.8 million (AUD) to build. Three working days notice is required for viewing space and sample retrieval. Visitors are required to wear sun protection, protective clothing and covered footwear. Visitors are warned to be aware of possible spiders or snakes under and around pallets in the yard and building. A mobile phone for offsite communication is recommended. A diamond saw, acid, sample bags, tags, hammers, and picks are available. Requests for sampling must be submitted in writing, a report must be provided from samples taken and all remnant samples must be returned to the geological survey.

These two facilities continue to accumulate new samples. Incoming samples are vetted against existing samples to determine if they are to be kept. Limited storage space at the facilities prohibits duplicate samples to be catalogued.

South Australia

South Australia has legislation, the Mining Act 1971, requiring the submission of core and cuttings to the Department of State Development by exploration companies. The South Australia Geological Survey operates four drill core libraries currently located in Glenside (Adelaide), Thebarton, Moonta, and Whyalla. These four libraries will be combined into a new "world-class" State Drill Core Reference Library located in Tonsley. The new facility will cost \$32.2 million (AUD) to construct. It will include modern viewing rooms, access to geoscience information and service, an industry workshop,

education facilities, and a room with internet access.

The existing library at Glenside is the only permanently staffed facility. The others are staffed by appointment only. The Glenside facility began in 1978 and has been remodeled twice, once in 1982 and again in 2005, to accommodate the growing collection. There are procedures in place for handling radioactive core. Modern viewing facilities with controlled temperature, diamond saws, spray bottles, 10 percent acid solution, binocular microscopes, drying ovens and tables are available. A one week notice is required prior to visiting the facility. Sampling is permitted, a copy of the analyses report is required to be submitted.

Petroleum samples are submitted and accessed separately from mineral samples.

Tasmania

The Mineral Resources Development Act of 1995 requires drill core to be submitted to Mineral Resources Tasmania. Mineral Resources Tasmania manages the Tasmania Core Library in Rosny Park, Tasmania. Two day notification is required prior to viewing if core layout is done by the visitor, A five day notice is required if staff is necessary to layout the core. A fee is charged for viewing core. Sampling is permitted according to policy and the sampler must provide a copy of the reports and results on digital media. Reports become public six months after sampling date.

Western Australia

There are statutes in Western Australia requiring all drill core and exploration material from petroleum exploration to be provided to and stored by the Geological Survey of Western Australia. No statutes were found requiring the material from mineral exploration to be submitted. There are policies enacted in 1995 at the Department of Mineral and Petroleum Resources that describe the drill core to be stored. Drill core from significant mines closed or about to close, with significant mineralization, representing a wide geographic distribution, that would be difficult or expensive to re-drill (urban areas, parks, remote locations, deep wells, etc.), that display excellent or unusual geology, that is popular, or is in large demand for viewing shale are cataloged and stored.

There are two core libraries in Western Australia; the Joe Lord Core Library in Kalgoorlie and the Perth Core Library in Perth. The two libraries store only two to five percent of all core drilled each year in Western Australia. Companies must retain their own core archive, and make it available to the Department of Mines and Petroleum core library when requested. The company must provide three months written notice if they plan to destroy the core.

CONCLUSION

The WSGS studied the processes and procedures for recording mineral exploration data in major mineral producing jurisdictions of the United States, Canada, and Australia. The study revealed that legislation requiring the recording of mineral exploration data is made at the state level in most jurisdictions. State geological surveys are frequently tasked with providing processes, procedures, and policies for recording the required data. Specific policies, procedures, and facilities vary by jurisdiction. All jurisdictions recording mineral exploration data did so with the intent of reducing the need for re-drilling areas that had already been explored and making exploration data available to the public. Petroleum exploration data recording processes and procedures are usually handled separately from mineral exploration data. All facilities allowing destructive sampling of preserved specimens required analysis reports to be provided in return. Startup costs (\$10 to \$15 million) and annual operation costs (\$500,000 to \$1 million) for a Wyoming mineral exploration data storage facility were estimated using averages and approximate numbers.

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