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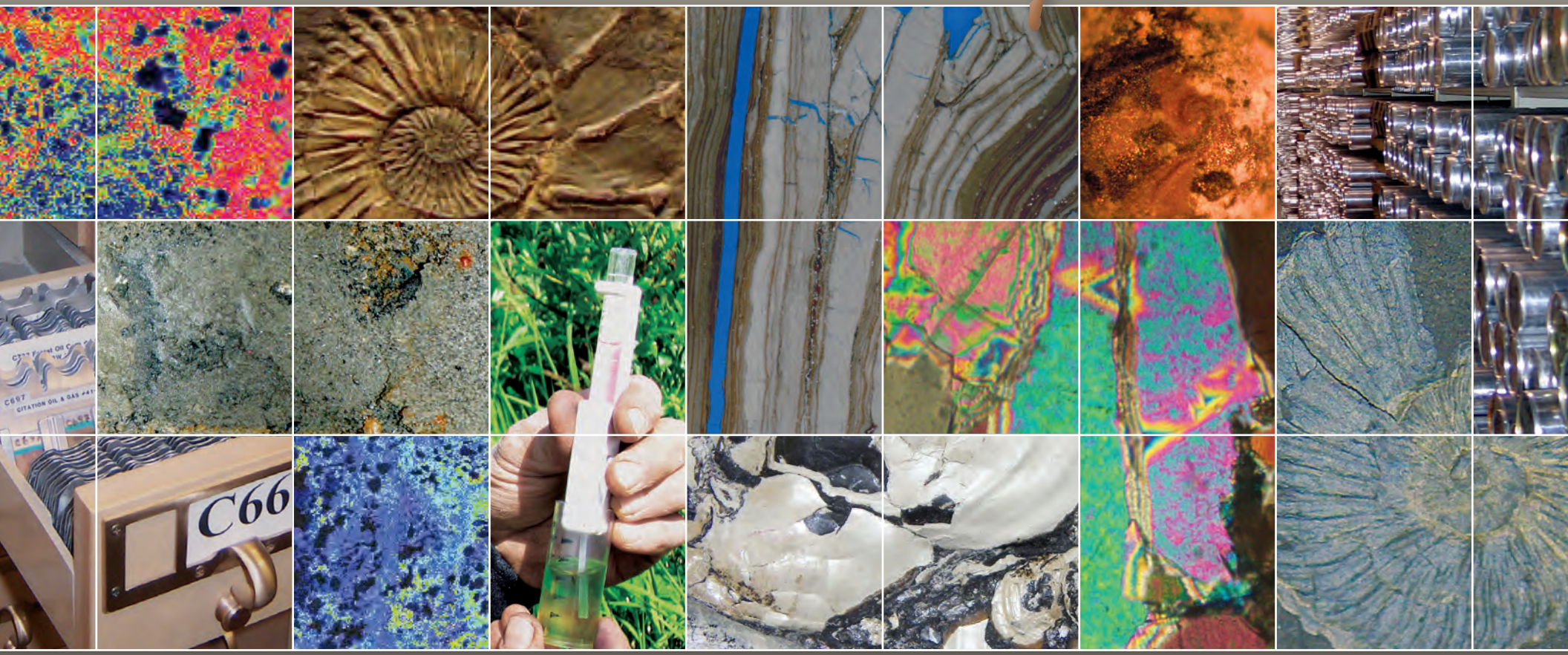
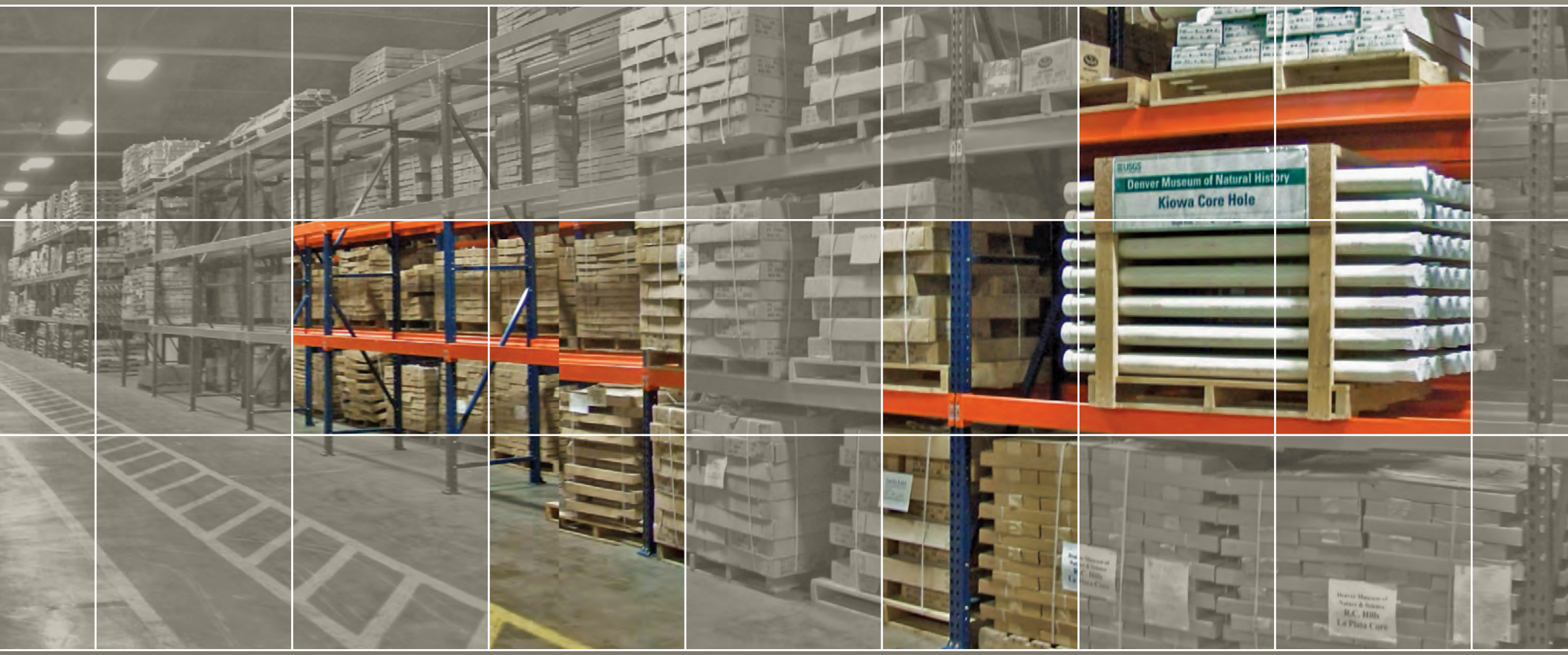
The U.S. Geological Survey Geologic Collections Management System (GCMS)

A Master Catalog and Collections Management Plan for U.S. Geological Survey Geologic Samples and Sample Collections



Circular 1410

U.S. Department of the Interior
U.S. Geological Survey


Denver Museum of Natural History
Kiowa Core Hole

The U.S. Geological Survey Geologic Collections Management System (GCMS)

A Master Catalog and Collections Management Plan for
U.S. Geological Survey Geologic Samples and Sample Collections

By the Geologic Materials Repository Working Group

Circular 1410

U.S. Department of the Interior
U.S. Geological Survey

U.S. Department of the Interior
SALLY JEWELL, Secretary

U.S. Geological Survey
Suzette M. Kimball, Acting Director

U.S. Geological Survey, Reston, Virginia: 2015

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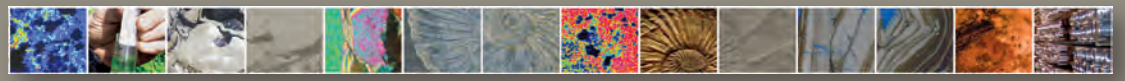
Suggested citation:
The Geologic Materials Repository Working Group, 2015, The U.S. Geological Survey Geologic Collections Management System (GCMS)—A master catalog and collections management plan for U.S. Geological Survey geologic samples and sample collections: U.S. Geological Survey Circular 1410, 108 p., http://dx.doi.org/10.3133/cir1410.

ISSN 1067-084X (print)
ISSN 2330-5703 (online)
ISBN 978-1-4113-3915-6

Authors' Note



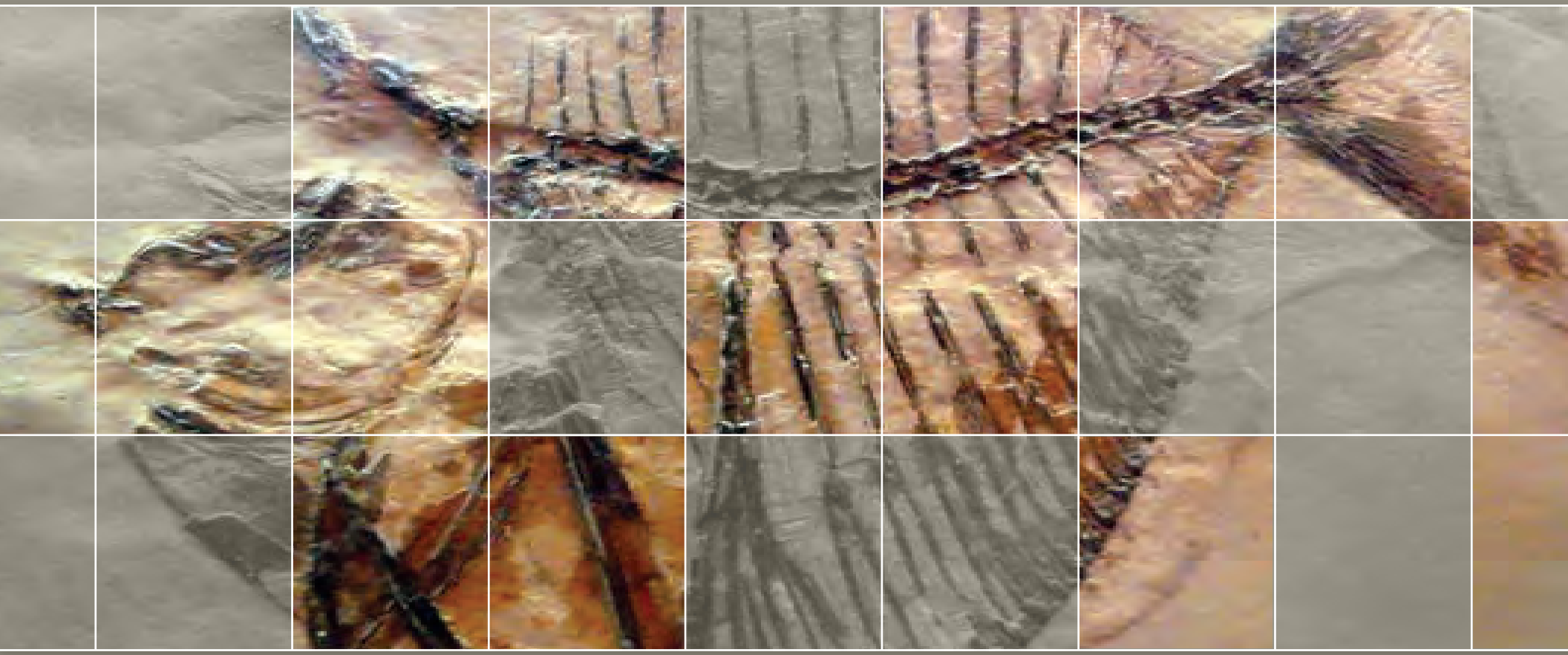
The National Geological and Geophysical Data Preservation Program Act of 2005 (Public Law 109-58, Sec. 351) enjoined the U.S. Geological Survey (USGS) to catalog and preserve the Nation's geoscience data and collections. At that time, the USGS was organized into divisions that reflected the major disciplines of the agency: geology, geography, hydrology, biology, and geospatial information. Because the act specifically addressed geoscience data and collections, the Geology Discipline was directed to explore options and propose a plan to best carry out the mandate of the act. The Geologic Materials Repository (GMR) Working Group was convened in 2008 to address that mandate. The findings of the Working Group were formalized in materials that preceded this report and sent to USGS Headquarters for review in July 2010.

In October 2010, the USGS restructured its research from a disciplinary to a thematic approach that would better engender integrated science, more clearly reflect the work being done, and directly connect to the USGS Science Strategy (U.S. Geological Survey, 2007). The resulting mission areas—Climate and Land-Use Change, Core Science Systems, Ecosystems, Energy and Minerals, Environmental Health, Natural Hazards, and Water—all rely on the collection of data, samples, or specimens to document their findings; and the preservation of these data and materials is integral to long-term research. Therefore, the USGS recognizes the need to implement a cohesive strategy for cataloging and archiving all data and material into accessible and systematic collections that can provide a basis for science in the future.

Realizing early on in the process that their work could apply to all manner of scientific collections, the original Working Group structured the Geologic Collections Management System (GCMS) to be a template that could be modified and used by any repository wishing to document and preserve its research materials. Some organizations within the USGS have already begun to apply the principles, strategies, and methodologies of the GCMS outlined in this report: the Meteor Crater Collection in Arizona is featured on page 38, and appendix 6 features the U.S. Extended Continental Shelf Project, USGS fossil collections at the National Museum of Natural History, and the NURE (National Uranium Resource Evaluation) program samples in Denver.

To reach a wider audience, the GMR Working Group is publishing this report in order to distribute the information and methods developed in the course of constructing the GCMS. To promote the creation and implementation of similar systems for all types of scientific collections throughout the USGS and beyond, the concepts herein may be modified to reflect the needs and conditions of any materials repository that wishes to organize and preserve its collections for future use. The GMR Working Group has chosen to retain the emphasis on geologic samples (including, but not limited to, rocks, soils, fossils, or marine sediments) in order to reflect the original mandate under which the report was written.

The information and methods provided in this report are not intended to be interpreted as official USGS policy, but rather as guiding principles which may aid in the development of policies in the future.



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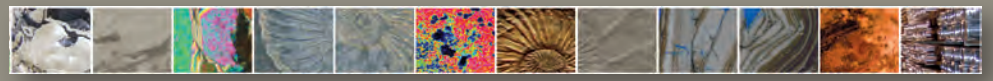
Preface



Acting on a request from the U.S. Department of Energy (DOE), the National Research Council (NRC) established the Committee on the Preservation of Geoscience Data and Collections (CPGDC) in 1999 to develop a comprehensive strategy to manage and preserve geoscience data and collections in the United States. Because this issue concerned the geoscience community as a whole, numerous professional organizations, private corporations, and government agencies cooperated to sponsor this committee. The CPGDC used questionnaires and site visits to conduct its research and focused its effort on physical geologic materials and their supporting documentation.

The resultant report, "Geoscience Data and Collections—National Resources in Peril," was issued in 2002 (National Research Council, 2002). The committee stressed that geoscience data and collections have both immediate and long-term value for resources and engineering needs, but they warned that many of those collections are in danger of being lost through mismanagement, neglect, or disposal. Recognizing that not all materials can be kept forever, the report offers recommendations on how to evaluate collections, where they might be stored, and how to provide access to the materials.

In 2005, at the behest of the Executive Office, an Interagency Working Group on Scientific Collections (IWGSC) was convened, its members representing various departments and agencies throughout the Federal Government. The group's purpose was to examine the state of Federal object-based scientific collections and to make recommendations for their long-term preservation and use. The IWGSC reviewed pertinent literature, surveyed Federal agencies, and had briefings, presentations, and discussions on a variety of relevant topics.

In August of that same year, the Energy Policy Act of 2005 (Public Law 109-58) was passed. Section 351 of the act directed the Secretary of the Interior to carry out a National Geological and Geophysical Data Preservation Program (NGGDPP) with the stated goals of archiving pertinent geoscience data and collections, providing a national catalog of those materials, and providing technical and financial assistance related to those activities. A data archive system, comprised of State agencies and agencies within the U.S. Department of the Interior (DOI) that maintain geoscience materials, was to be established to accomplish those goals. The act also mandated a national catalog to identify the samples and data in the data archive system, the repository where the samples are kept, and the means of accessing the materials.

The implementation plan for the NGGDPP (Data Preservation Working Group, 2006) envisions a national network of cooperating State and Federal repositories that operate independently but are guided by a set of common standards and practices. The U.S. Geological Survey (USGS) will oversee the program to (1) coordinate the data archive system of Federal and State repositories, (2) administer the National Digital Catalog (NDC), and (3) provide financial assistance where possible. For the repositories, three critical actions entail increasing storage capacity, improving operations, and providing access to the materials. The NGGDPP will also establish working groups to provide the expertise, training, and protocols needed to carry out its mission. Interactions with State geological surveys began in 2007, and metadata standards for the NDC were established by early 2008.

The IWGSC completed its report, "Scientific Collections—Mission-Critical Infrastructure for Federal Science Agencies," in 2009 (Interagency Working Group on Scientific Collections, 2009). The paper echoed the 2002 NRC report in its emphasis on the importance of scientific collections for both present and future research needs. Because many samples prove impossible or prohibitively expensive to re-collect, it is critical to preserve and maintain present and future collections in the best of all possible circumstances. Collections need to be well documented and accessible to researchers if they are to have any value to the scientific community. Recommendations include incorporating repository costs into stable budget elements, improving and standardizing repository operations across the Federal Government, and creating an online clearinghouse for information on the collections.

The USGS Geologic Materials Repository (GMR) Working Group was convened in April 2008 to investigate the best approach for addressing the concerns of the IWGSC and for implementing the NGGDPP mandate within the Geology Discipline. The group used the above publications, philosophies, and actions to guide its own operations in determining how best to improve the management of USGS geologic collections.

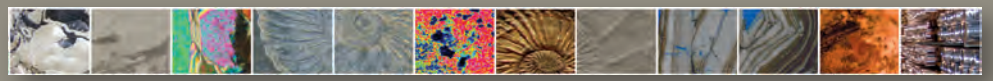
In 2009, the DOI Office of Inspector General issued its report, "Department of the Interior Museum Collections—Accountability and Preservation," stating that it found the DOI failing to fulfill its stewardship responsibilities over its museum collections (Office of Inspector General, 2009). Specific complaints addressed shortcomings of accessioning, cataloging, inventorying, preservation, and storage, all deficiencies that prohibit adequate access to the collections. These issues echo the concerns discussed in the IWGSC report, imparting even more significance and urgency to the efforts and recommendations of the NGGDPP's GMR Working Group.

Also in 2009, the Executive Office issued the Open Government Directive, which asks Federal agencies to identify specific steps toward making government more open and responsive to the American people:

> *The three principles of transparency, participation, and collaboration form the cornerstone of an open government. Transparency promotes accountability by providing the public with information about what the Government is doing. Participation allows members of the public to contribute ideas and expertise so that their government can make policies with the benefit of information that is widely dispersed in society. Collaboration improves the effectiveness of Government by encouraging partnerships and cooperation within the Federal Government, across levels of government, and between the Government and private institutions. (Office of Management and Budget, 2009, p. 1)*

In order to create a more open government, Federal agencies are directed to improve the quality of their information and to publish it online in open formats. The effort to organize USGS geologic materials collections by implementing the policies and procedures laid out in this document will contribute to the achievement of this goal.

Acknowledgments



The Geologic Materials Repository Working Group wishes to thank the following people for their contributions during the process of defining and elaborating the issues, policies, and procedures that will govern the U.S. Geological Survey (USGS) Geologic Collections Management System (GCMS):

Tamara L. Dickinson
USGS Program Coordinator for Data Preservation

For her presence at our early meetings to get us started in the right direction, for her expertise in clarifying various issues along the way, for the financial support that allowed face-to-face meetings in Denver and Reston, and for her review of the draft report that assured us we were making progress.

Carol R. Butler
Assistant Director for Collections, National Museum of Natural History, Smithsonian Institution

For her reviews of the working and final drafts of this report that allowed us to sharpen our focus and be more specific in the details of the operating plan for the GCMS, and for elucidating the Smithsonian's curatorial responsibilities for USGS collections.

Linda Gundersen
Senior Advisor, USGS Office of Science Quality and Integrity

For her thoughtful and constructive review of this report, and for her dedication and support of the USGS National Geologic and Geophysical Data Preservation Program.

Kevin T. Gallagher
Associate Director for USGS Core Science Systems

For championing the progress of managing USGS scientific collections, and for his guidance and insight that provided the finishing touches to this report.

Jann W.M. Thompson
Department of Paleobiology, National Museum of Natural History, Smithsonian Institution

For her advice on establishing minimum standards of care and how best to evaluate the work needed to bring organization to collections.

Terry Huber
Physical Science Technician, USGS Core Research Center

For her talents as tireless recorder of the group's teleconference calls.

We would also like to thank the following people for the facility tours that allowed us to observe the systems and practices that served as models for the GCMS, as well as any additional insights that they provided throughout the process:

National Museum of Natural History, Smithsonian Institution

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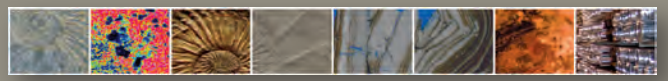

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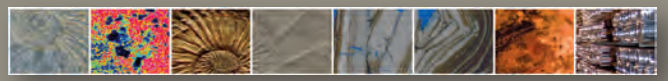

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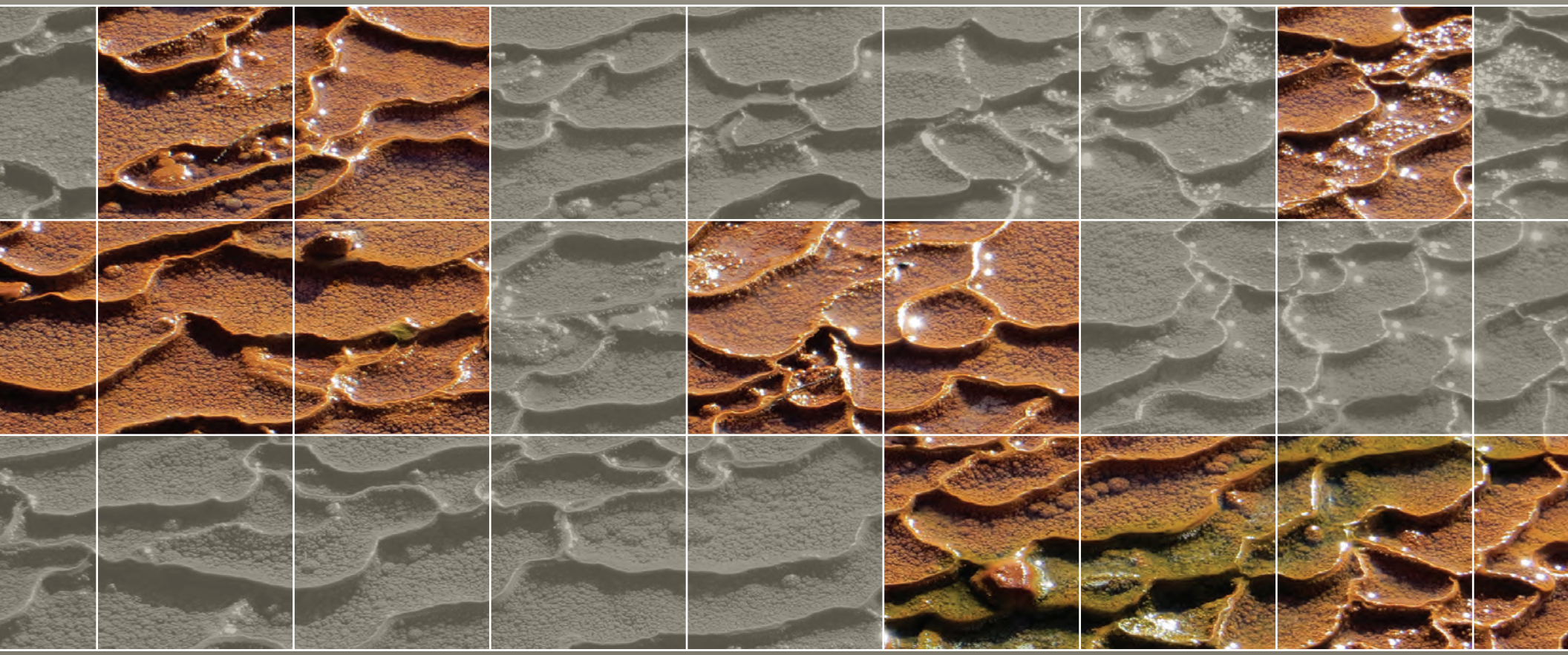
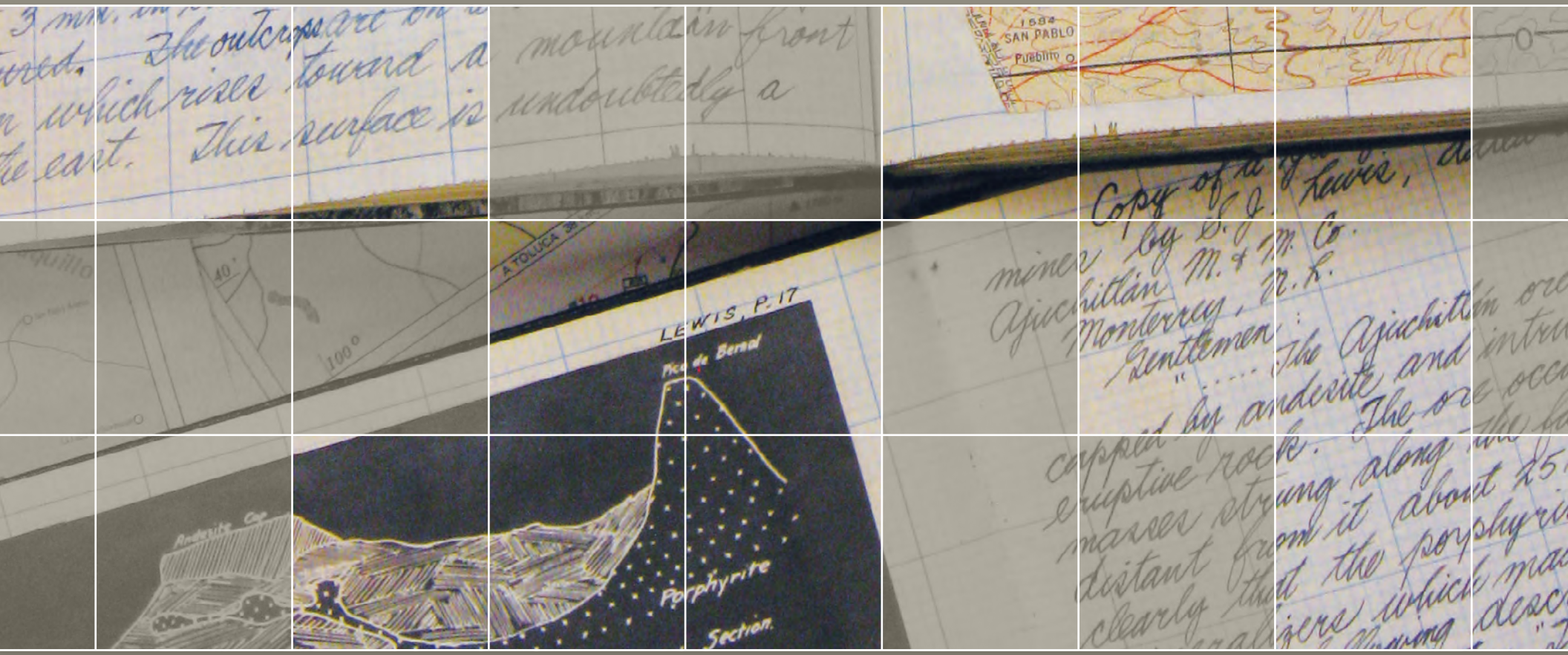


Abbreviations

CPGDC	Committee on the Preservation of Geoscience Data and Collections
CRC	Core Research Center (USGS)
DEM	digital elevation model
DOE	U.S. Department of Energy
DOI	U.S. Department of the Interior
ECS	U.S. Extended Continental Shelf
GCMS	Geologic Collections Management System (USGS)
GD	Geology Discipline (USGS)
GIS	geographic information system
GMR	Geologic Materials Repository
GUI	graphical user interface
ID	identifier
IGSN	International Geo Sample Number
IWGSC	Interagency Working Group on Scientific Collections
NDC	National Digital Catalog (USGS)
NGGDPP	National Geological and Geophysical Data Preservation Program (USGS)
NGSA	National Geochemical Sample Archive
NMNH	National Museum of Natural History (Smithsonian Institution)
NOAA	National Oceanic and Atmospheric Administration (Department of Commerce)
NRC	National Research Council
NURE	National Uranium Resource Evaluation
SESAR	System for Earth Sample Registration
SI	Smithsonian Institution
USDA	U.S. Department of Agriculture
USGS	U.S. Geological Survey
UUID	universally unique identifier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The U.S. Geological Survey Geologic Collections Management System (GCMS)

A Master Catalog and Collections Management Plan for U.S. Geological Survey Geologic Samples and Sample Collections

By the Geologic Materials Repository Working Group

Executive Summary

The U.S. Geological Survey (USGS) is widely recognized in the earth science community as possessing extensive collections of earth materials collected by research personnel over the course of its history. The National Geological and Geophysical Data Preservation Program (NGGDPP), established in the USGS by the Energy Policy Act of 2005 (Public Law 109-58, Sec. 351), provided the opportunity to improve storage and access to USGS collections. In 2006, a Geologic Collections Inventory was conducted within the Geology Discipline (GD) to determine the extent and nature of its sample collections. In 2008, a working group was convened to examine ways in which these collections could be coordinated, cataloged, and made available to researchers both inside and outside the USGS. Most group members were active research scientists or collections managers who have practical experience with the issues surrounding the organization and preservation of geologic materials.

The charge to this working group was to evaluate the proposition of creating a Geologic Collections Management System (GCMS), a centralized database that would (1) identify all existing USGS geologic collections, regardless of size, (2) create a virtual link among the collections, and (3) provide a way for scientists and other researchers to obtain access to the samples and data in which they are interested. Additionally, the group was instructed to develop criteria for evaluating current collections and to establish an operating plan and set of standard practices for handling, identifying, and managing future sample collections. Policies and procedures would be based on extant best practices established by the National Science Foundation and Smithsonian Institution (SI).

Issues

The GCMS's potential customers and their needs were considered. Two critical definitions were clarified: a repository is a facility for the long-term management of geologic collections, and a collection is a set of specimens that have been brought together on the basis of some common characteristic. Required sample metadata were stipulated: for older samples to be retained, the minimum data required are the sample's field number and geographic coordinates; more detailed information, such as the collector's name or the date of collection, is required for newer samples. The need for each sample to have a unique identifier was taken into account, and various schemas were discussed. Finally, the GCMS was defined as the physical materials component of the USGS NGGDPP data preservation strategy.

Policies

Several basic policies, summarized below, are recommended in order to standardize operations among the physical repositories where collections are currently housed.

- A national governing board should be established to direct and coordinate the GCMS effort.
- Each repository should establish a local advisory committee to oversee GCMS implementation.
- Each repository should formulate a collections management plan that conforms to the GCMS standards established in this document.
- Each repository should evaluate its own collections for retention or disposal according to strategies outlined in this report.
- Each repository should be responsible for metadata capture and sample registration.
- Each repository should establish procedures for access (including loans and re-sampling) to its collections.
- All samples remain USGS property unless properly transferred to another entity.

Procedures

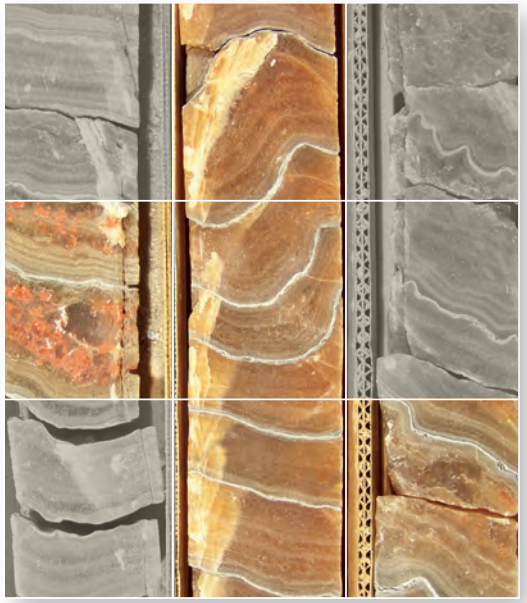
The GCMS Collection Management Plan provides a set of protocols and templates for the collection, including access, storage, transfer, and disposal of physical geologic samples and data. The plan is flexible to allow each repository to adapt the practices best suited to its collections.

To evaluate the collections already in USGS custody, a "decision tree," outlined in this report, was developed to use the sample data to determine the disposition of any collection. Each major step in the process has standard forms for documenting the decision to retain, transfer, or discard a collection. A checklist was also developed that can be used to evaluate future collections.

For newly collected samples, scientists will enter pertinent information into the local repository's database upon return from the field. This database will be modeled on the GCMS template, but it can be customized for each repository to allow collections managers to ensure the quality and completeness of sample metadata at the local level. Metadata elements for each new sample will include field number, geographic location, collector, date collected, sample type, reason for collection, project name, and other significant attributes.

While being used in active research, the sample should be labeled with its field or laboratory number and stored appropriately; each procedure (thin sectioning, geochemical analysis, and so forth) should be noted. When the samples are no longer needed for active research, the collection should be transferred to its local repository and evaluated for long-term retention. The GCMS will assign a unique identifier to each sample that is retained for its master catalog.

Most collections considered suitable for long-term retention will remain at their local facilities. However, if a local repository determines that a collection might have significant scientific or historic value, the Smithsonian Institution should be consulted to evaluate those samples for possible transfer to the National Museum of Natural History (NMNH) or other appropriate museum for permanent retention. Alternatively, if the samples should have no further research value, their disposition to an outside entity is allowed.



Implementation

The general consideration for implementation of the GCMS is that all active USGS geologic sample repositories will form the core of GCMS and that participating science centers will adopt proposed GCMS methodologies.

A national governing board should be formed to coordinate GCMS implementation and operation; the board would also provide direction and advice to science centers that lack the expertise or current capabilities necessary to institute GCMS practices. There should be at least one full-time employee at the national level dedicated to GCMS operation and maintenance.

Support for the database and physical infrastructure will also be derived from the NGGDPP and other supporting member programs. The governing board will stipulate standards for database design, and metadata standards would parallel those of the National Digital Catalog (NDC). In addition, policies and procedures for sample handling and preservation should be determined at the national level.

Each science center that has geologic collections should

1. establish a local advisory committee to evaluate the center's capabilities to implement GCMS policies and procedures as laid out in this document;

2. perform a generalized assessment of the center's geologic collections to decide if there is enough information available to warrant keeping some or all of them; and

3. consider the resources that will be needed in terms of personnel, materials, and storage space to evaluate, catalog, and preserve those collections.

These actions may be executed concurrently in order to obtain the most realistic evaluation of the center's collections.

Once a center has determined (a) which collections warrant inclusion in the GCMS and (b) that new collections will continue to accrue, the center should

1. register the center's repository with the GCMS;
2. develop a collection management plan for sample handling and preservation that adheres to GCMS protocols;
3. use the GCMS decision tree to evaluate individual samples and collections in order to determine which are appropriate for inclusion in the GCMS;
4. catalog the samples that are to be retained by entering the required metadata into the repository's database;
5. register the samples with the GCMS and label them with their assigned identifiers; and
6. implement procedures from the collection management plan to store samples for optimum preservation and develop access and loan protocols for future retrieval.

The policies and procedures of the GCMS should be reviewed periodically at the national level. In addition, the materials held by the separate repositories should be reevaluated at the repository level on a regular basis for appropriateness and retention. The GCMS is a collective resource for the entire USGS community and the users who discover the geologic materials kept in these repositories and seek to access them. Suggestions for improvements to this national asset should be solicited and examined for continuous improvement.

Conclusion

Developing common practices in the collection, retention, and disposal of geologic research materials in the USGS is critical to the management of those materials. Successful implementation of the GCMS business plan will allow for improved use of these resources, economy of effort through data sharing, and better accountability of USGS activities, past and present. It may also serve as a model for other programs in the USGS in the management of their research materials.

Introduction

Background

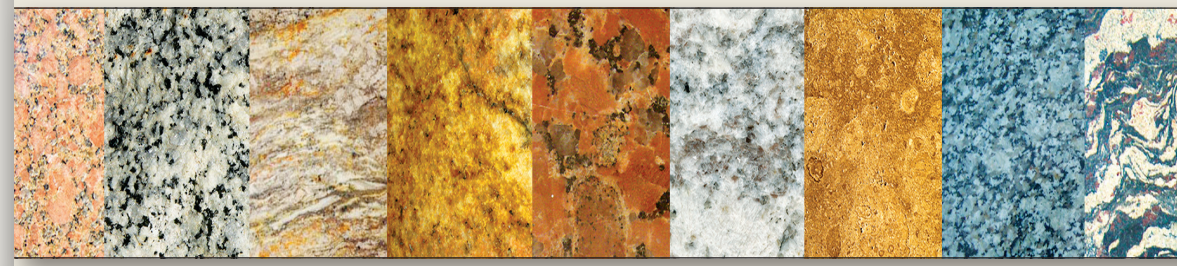
The U.S. Geological Survey (USGS) is widely recognized in the earth science community for its extensive collections of earth materials gathered during the course of scientific field work. From a geologic perspective, these materials include, but are not limited to, rock and mineral specimens; vertebrate and invertebrate fossils; drill cores of rock, ice, or sediment; and astrogeology, soil, sediment, and geochemical samples. These geologic materials are managed and maintained in multiple locations throughout the United States. The GCMS supports common management practices that improve access to these scientific collections.

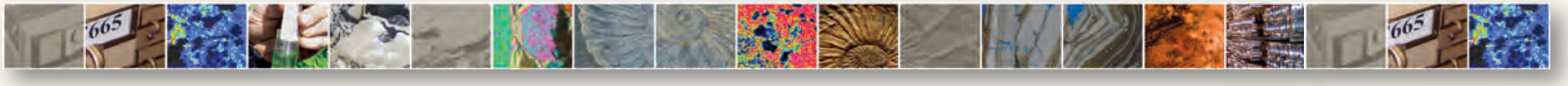
The Energy Policy Act of 2005 (Public Law 109-58, Sec. 351) established the **National Geological and Geophysical Data Preservation Program** (NGGDPP) in the USGS and outlined goals to (1) archive geological, geophysical, and engineering data, maps, well logs, and samples; (2) provide a national catalog of these archived materials; and (3) provide technical and financial assistance to State geological surveys and relevant bureaus in the U.S. Department of the Interior (DOI) for managing their archived materials. For the USGS Geology Discipline (GD), the initial step in the process to implement the NGGDPP was to conduct a Geologic Collections Inventory to determine how many repositories and collections of earth materials existed, where they were located, how well they were documented, and what level of staffing and budget support they received. The collections discovered in this inquiry are listed in appendix 1.

Once that information was gathered and analyzed, it was proposed that a system be created within GD that would connect and coordinate all USGS geologic collections, regardless of size or location. While individual collections would remain at their science centers, the system would establish a national governing body to standardize collection management practices, provide a template for a national catalog, facilitate access to collections and sample data, and assure long-term **preservation** of these resources. The initial title for this system was the USGS Geologic Materials Repository (GMR); the working group was convened under that name.

The Ideal *GCMS* in Action—
1. Access by Subject Matter

Reed Bailey, a student at a large Midwestern university, ponders the question of his senior thesis, which is to compare and contrast the general characteristics of granitic rocks in separate tectonic environments. He completes a field study of a granitic complex in New England, but he needs a second suite of rocks for comparison. Pulling up the USGS GCMS Web site (http://datapreservation.usgs.gov/GCMS.html) on his computer, he opens the database for the Geologic Collections Management System and starts his search. By entering several parameters to define his project, he finds three collections that will suit his purpose. He chooses one of the collections, fills out the form requesting 10 samples, and hits "enter." He receives enough of each sample to cut a thin section and perform some basic compositional analyses. After completing his research, he returns the thin sections, the remaining sample materials, and his analytical results to the originating repository.





History of the Working Group

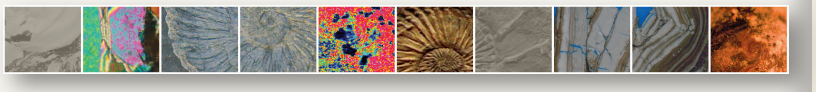
The GMR Working Group was established under the NGGDPP to examine the feasibility, funding, and management architecture of the proposed Repository. The USGS members were selected to represent the programs, regions, and science centers that contain the majority of the known collections in GD (appendix 1). Other members represent the USGS Biology Discipline, the National Science Foundation, the Smithsonian Institution, and the Association of American State Geologists. Most group members are active research scientists or collections managers who have practical experience with the issues surrounding the organization and preservation of geologic materials.

The charge to the Working Group (T.L. Dickinson, USGS, "Charter of the Geologic Materials Repository Working Group," written commun., 2008) was to (1) evaluate the pros and cons of a unified **Geologic Materials Repository** (GMR), (2) make a recommendation for or against establishing such a repository, and (3) if recommended, address four specific targets.

- Based on information from the Geologic Collections Inventory and input from GD teams and managers, assess the range of current and potential GD collections and recommend those that should be considered as candidates for inclusion in the Repository.
- Define who the customers are and what they need from the Repository.
- Establish the vision, general architecture, and responsibility for the timely development of a geographic information system (GIS)–based catalog for the Repository.
- Develop a mission statement, scope of activities, and implementation plan for the Repository, including recommendations on the number and location of facilities included in the Repository, management options, staffing options, and funding models. The funding model would need to address initial start-up costs, annual operating costs, and identification of potential funding sources.

The first meeting of the GMR Working Group was convened in June 2008. Because participants were in widely separated locations, the initial meeting and subsequent bi-weekly meetings were conducted via telephone conference calls and WebEx technology. In September 2008, a writing committee was formed within the group to flesh out the business plan that would govern the Repository. **Policies** and **procedures** were to be based on extant best practices and consultation with the National Science Foundation and Smithsonian Institution. This committee reported back to the larger group on a regular basis to solicit input and to review progress made. A face-to-face meeting of the whole group was held in Denver, Colo., in November 2008 to discuss issues and formulate a vision for the GMR. Beginning in January 2009, monthly Working Group meetings were interspersed with the weekly subgroup meetings to compile and refine the details of sample evaluation and **collection management**. A second face-to-face meeting was held in January 2010 in Reston, Va., to address issues brought to light during the review process. Additional WebEx sessions were conducted to finalize the paper in hand.

Historically, the term "repository" is indicative of a distinct physical location where samples or documents are housed and curated. The Working Group realized it was important to define the new entity not as a single location but rather as a virtual infrastructure that would connect and coordinate all the individual repositories and collections throughout the USGS. Therefore, in the interests of accuracy and clarity, the designation "Geologic Materials Repository" was dropped in favor of "**Geologic Collections Management System**" (GCMS).



Overview

Because the establishment of the GCMS was quickly recognized as something both desirable and necessary, the Working Group compiled a common vocabulary (Glossary, p. 42) that they could use to define the concepts and issues central to their initial discussions. The first part of this paper outlines those issues and provides answers to the questions raised during the process of establishing the rules and guidelines that will govern the GCMS. (Issues Addressed by the Geologic Collections Management System, p. 10)

Each repository currently has its own methodologies for handling its geologic materials. If the GCMS is to be successful, the repositories must act in concert with regard to collections management. The middle section of this paper stipulates the policies and procedures that will standardize the handling of **samples** and the **metadata** that will be required for their documentation. (Operating Plan for the Geologic Collections Management System, p. 22)

The initial effort that will be required to establish the GCMS cannot be understated. Collections will need to be evaluated, retained samples will need proper documentation, and data entry of pertinent information will be required. The final section of this paper discusses the best way to facilitate the implementation of the GCMS. (Implementation of the Geologic Collections Management System, p. 36)

How the *USGS Organic Act* Shaped the *GCMS*

The sundry civil expenses bill, the USGS Organic Act of March 3, 1879 (20 Stat. 394; 43 U.S.C. 31), established the U.S. Geological Survey. Also, as amended, it directed that

> *All collections of rocks, minerals, soils, fossils, and objects of natural history, archaeology, and ethnology, made by the National Ocean Survey, the United States Geological Survey, or by any other parties for the Government of the United States, when no longer needed for investigations in progress shall be deposited in the National Museum. (20 Stat. 394; 20 U.S.C. 59)*

Because any USGS collection is a possible candidate for transfer to the National Museum of Natural History, and to make those transfers as seamless as possible, the Working Group decided it was in the best interests of the USGS to align its collections management policies with those of the Smithsonian Institution.

Smithson's Legacy—USGS Collections at the National Museum of Natural History

The Smithsonian Institution's National Museum of Natural History is dedicated to preserving the Nation's scientific heritage through the curation of the fossil, rock, and ore specimens that illustrate important advances in the geologic sciences.

As stated in the USGS Organic Act (20 U.S.C. 59), the Smithsonian's National Museum of Natural History (NMNH) has been the designated facility for the long-term management and preservation of USGS rock and ore collections since 1879.

USGS collections of particular national importance have been transferred to the NMNH.

- H.S. Washington's Petrographic Reference Collection, assembled between 1896 and 1924, which includes the samples analyzed to develop the Cross, Iddings, Pirsson, and Washington (CIPW) system of igneous rock nomenclature (Cross and others, 1902).
- Waldemar Lindgren's and George F. Becker's collections of ore deposit samples used to assess the mineral resources of the western United States.
- E. Dale Jackson's Stillwater Intrusive Complex reference collection.

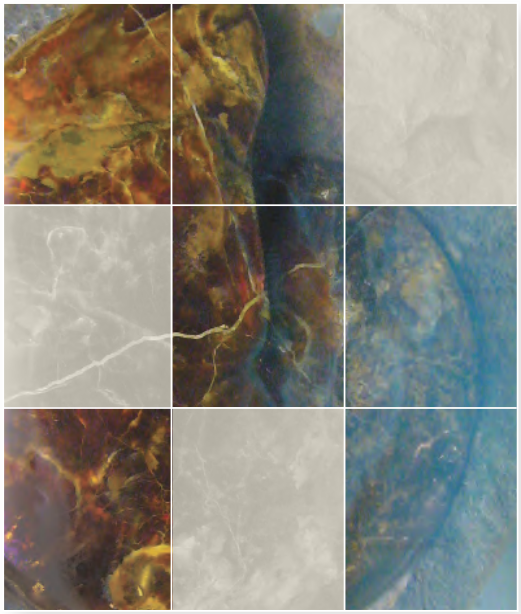
- Shoemaker-Chao impactite samples collected from meteorite craters around the world.
- Hawaiian Volcano Observatory (HVO) collections, documenting volcanic eruptions in the Hawaiian Islands from 1912 to the present.
- George H. Girty fossil collections documenting the Carboniferous formations and faunas of Colorado.
- Silicified fossils of Glass Mountain fauna from the Permian Reef Complex, host rock for the west Texas oil reservoirs.

The Smithsonian's Rock and Ore Collections staff works with USGS researchers and collections managers to ensure that collections of lasting scientific value and national importance are identified and transferred to the NMNH.

When a USGS research project has ended, the rocks that document the scientific conclusions are evaluated for retention. As part of this process, the NMNH is consulted as to the long-term value of the samples. Collections that are determined to have significant historic or scientific value are transferred to the Smithsonian or other appropriate museum for long-term management and preservation.

Issues Addressed by the Geologic Collections Management System

The questions below were addressed because the Working Group recognized that each member would have varying ideas of the purpose and function of the GCMS. By debating concepts and defining terminology, it became easier to reach agreement on the policies and procedures that were ultimately recommended to establish the GCMS.



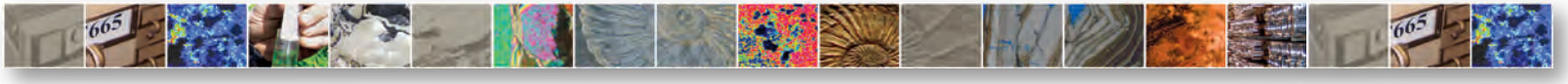
Why does the USGS need a Geologic Collections Management System?

Collections are acquired by the USGS using taxpayer dollars and constitute a valuable resource to the United States and its citizens. These collections remain the property of the Federal Government unless they are deemed to be of no further scientific value. Since the USGS was established in 1879, thousands of samples have been amassed in collections that range from localized, geographically based assemblages to collections that are national or international in scope. Although some of the collections have been archived at the Smithsonian Institution's National Museum of Natural History (NMNH), many more are currently located in various USGS offices and warehouses across the country. Some of the collections are well-established and well-documented, some with collections metadata available online, while other collections may be stored in poorly labeled boxes in a storeroom. At present, there are few commonalities among the collections with regard to sample data, collection inventories, or usage. If these resources are to be utilized effectively, the USGS needs a centralized clearinghouse that can govern the handling and maintenance of the collections. As that clearinghouse, the GCMS will provide common models for sample collection, data entry, and access by research personnel and will allow the collections' resources to be utilized to their full potential. Further, by providing standards for retaining collections and provisions for relinquishing them, the GCMS will facilitate an evaluation of the continuing benefits of the collections.

Because the collections are geographically far-flung, and because there is no intention to bring them all to one physical location, the GCMS will be a virtual entity that will coordinate the online catalogs of the physical collections and provide access to them through a graphical user interface (GUI). To meet the needs of potential customers, the user-friendly GCMS Web portal will support searches sorted by multiple criteria. The GCMS interface will also link to sample request pages that include clearly defined policies and procedures regarding sample availability and handling.

Benefits of establishing the GCMS go beyond the standardized business practices proposed in this report. The GCMS will be an extraordinary resource for the scientific community, not just within the USGS or even the United States, but on an international scale. It will level the playing field for all users, allowing access to collections metadata by any researcher, no matter where they are located. It will facilitate communication and hopefully enhance collaboration between a project's principal investigators and anyone interested in the same research topic. Scientists will be able to save both time and money by seeing what samples and analytical data are already available before using their funds to duplicate a previous effort. The GCMS will also facilitate the transfer of the most scientifically or historically important **specimens** to the NMNH or another appropriate museum for permanent retention.

The fundamental rationale for creating the GCMS is to better understand the range of geologic materials that the USGS has and to create policies and procedures for their governance. Optimally, this process will provide for a comprehensive accounting of the many **geologic sample** collections, allowing a broader utilization of the resources at hand. Ultimately, the GCMS may eventually serve as a model for the management of non-geologic USGS research materials as well.



Who are the customers for the GCMS?

Most of the customers who will use the GCMS will have a scientific interest in specific samples. These customers typically include scientists and researchers inside and outside the USGS who are interested in specific locations or topics and want to know what has already been collected. These traditional customers can be affiliated with any number of entities: the U.S. Department of the Interior or other Federal agencies, State geological surveys, academic institutions, private industry, environmental or health organizations, State or local governments, museums, or the U.S. military.

While the focus of the GCMS will be on scientific and intellectual queries, individuals or nonscientific entities may also have an interest in the samples or data held within the GCMS. Nontraditional customers could include forensic investigators, archeologists, anthropologists, farmers, ranchers, lawyers, or anyone else seeking information from the USGS.

What defines a repository?

Because USGS collections of geologic materials are so varied in size, organization, and location, it was important to establish what would constitute a **repository** within the larger GCMS. An **active repository** is considered a permanent facility that assumes responsibility for the long-term storage and maintenance of a collection (or collections) of related materials; it might or might not be climate-controlled. An active repository has a well-developed collections management plan, a physical space large enough to accommodate present and future collections, and a staff dedicated to preserving the collections while allowing access to the materials.

Active repositories where the sole purpose is to manage sample collections and their ancillary scientific materials already exist within the USGS. One such repository is the Core Research Center (CRC) in Denver, Colo., which contains not only rock cores, but also well logs, cuttings, and thin sections generated by drilling projects. The Woods Hole Coastal and Marine Science Center Samples Repository in Woods Hole, Mass., is another such facility. These USGS repositories are well-organized and well-documented and promote online access to their materials (see http://datapreservation.usgs.gov/links.shtml).

Conversely, many smaller geologic collections are often housed in a scientist's office or a nearby storage room to allow ready access to samples during the course of research. In some instances, mineral and **fossil** specimens are displayed on shelves in a hall. Because these arrangements are temporary, with no provisions for identifying or preserving the materials, the Working Group referred to these arrangements as **ephemeral repositories**. It is the goal of the GCMS to identify these ephemeral repositories and to provide an avenue for the samples to be evaluated for possible management by more permanent, active facilities.

Between the ephemeral and active repositories lies the condition of many USGS collections—samples from a finished project sit in cryptically marked boxes on a warehouse shelf. There might or might not be a list of the boxes, and box contents might or might not be noted. Because this type of facility has neither a curator nor management plan, it is more storage unit than repository and provides no services or long-term preservation. The Working Group considered a warehouse or other designated storage location that houses and monitors the boxes, but not the material within them, to be an **inactive repository**.

What defines a collection?

Geologic collections in the USGS range in size from a batch of field specimens in a geologist's office to a warehouse full of thousands of samples. Many of these collections fall into general categories that include, but are not limited to, hand samples (rock, mineral, and geotechnical), drill cores and cuttings, sediments, fossils, fluids, and ice cores; some of the collections may contain a mixture of several types. There are also collections that are the byproducts of analytical studies of field samples. Regardless of its composition, for the purpose of the GCMS, a **collection** is herein defined as a set of specimens that have been brought together on the basis of some common characteristic.

Because the geologic collections of the USGS vary so widely in size and type, the Working Group recognized that there exists a hierarchy of collections ranging from an individual geologist's project rocks to a larger assemblage of many such groupings. A **field collection** is most often gathered during the course of a researcher's field work and is considered the fundamental instance of "a set of specimens that have been brought together on the basis of some common characteristic." Within a field collection, a single sample broken into its component parts for study creates a **sample collection**. A **research collection** pulls together various field collections and is defined by disciplinary, temporal, or geographic parameters; a **directed research collection** is a specifically targeted variety of research collection, such as a group of samples from several different field collections that are used for a single research study. At the highest level in the GCMS, a **general collection** gathers research collections that exhibit similarities of sample type or geography. Figure 1 uses a research project on paleontological samples to show the relation of the various collection types.

Different from research collections, a **reference collection** contains samples of a distinct nature that provide an objective standard against which other samples are compared; the collection may be augmented with new samples as knowledge of the material grows. Collections of **type specimens** (fossils or rocks) are examples of reference collections.

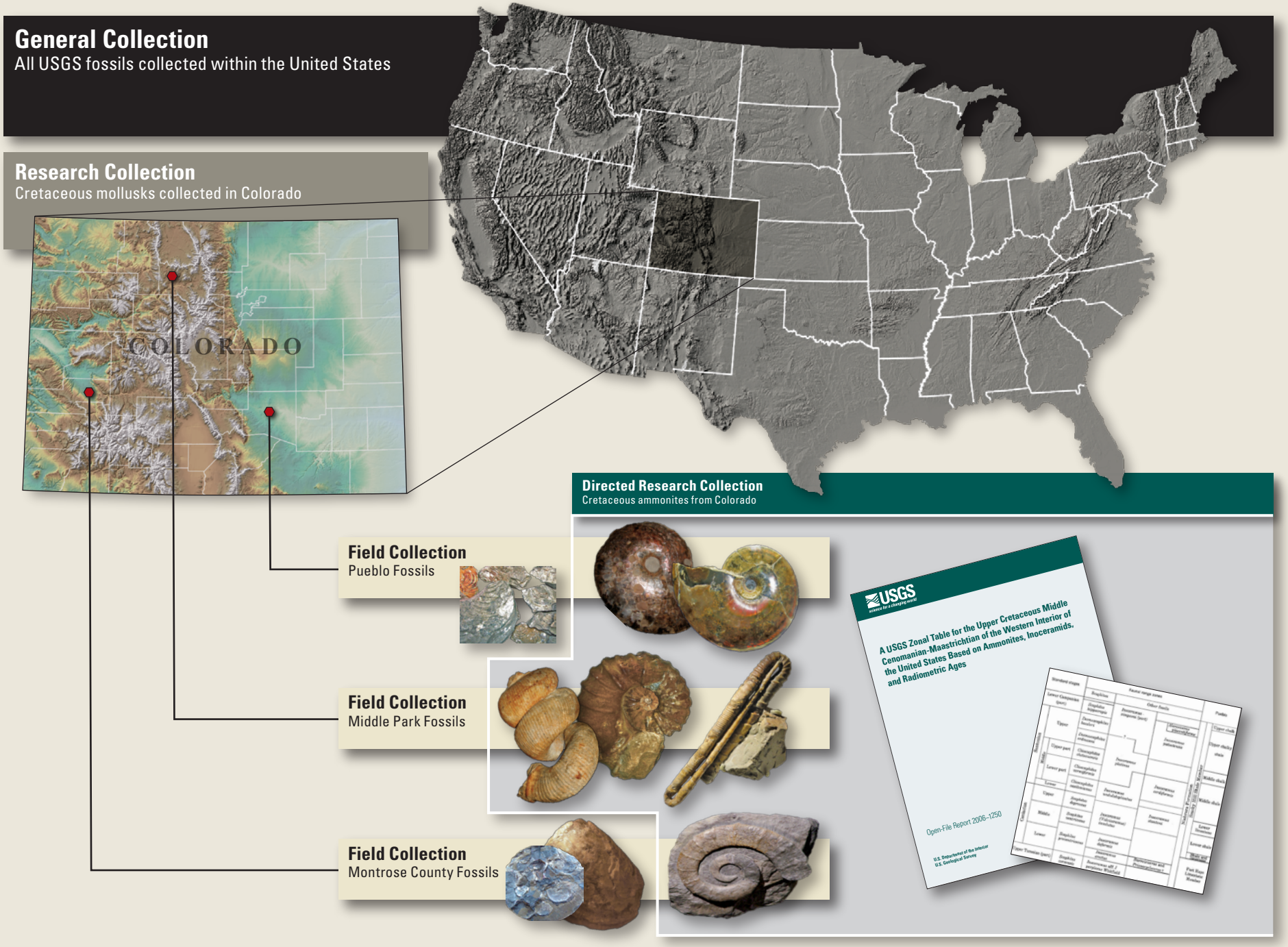
As an alternative to a collection's purpose, the group also defined collections by their status. **Active collections** (also known as **working collections**) contain materials from ongoing research that are actively used by the project scientists. New samples are added as the research continues. Upon completion of the research topic, the materials will be evaluated for long-term retention in a GCMS repository as a resource collection. **Resource collections** contain materials from completed research projects or topics that remain significant as research assets and are made available for current and future research. Often, the collecting scientist is still working at the Survey. Resource collections will form the bulk of GCMS materials and are expected to be preserved for an indefinite period of time. **Legacy collections** stored by the USGS contain samples that were collected by research scientists who are no longer with the Survey. If sufficient documentation is available, these collections will be incorporated into the GCMS and become resource collections.

Active, resource, and legacy collections refer to samples already in USGS custody. Collections that will be created and added to the GCMS in the future under the policies and procedures set out herein are referred to in this document as **new collections**. The samples in new collections will be documented and tracked from field to repository using protocols that are consistent throughout the GCMS.

Orphan collections are those that, due to a variety of reasons such as the lack of pertinent sample data, are deemed to have little foreseeable research value and will not be included in the GCMS; several options for their **disposition** are outlined in the "Deaccessioning Samples" section of this report (p. 34).

In addition to the object-based collections discussed above, analog materials such as field notes, sample location maps, analytical results, and other documentation are directly related to those samples. These are defined as **ancillary geologic records**.

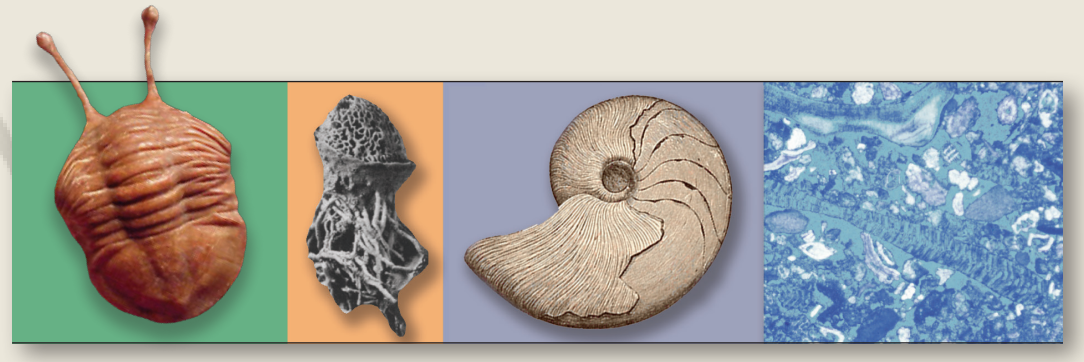
Figure 1 (facing page). The relationships between several types of collections in the Geologic Collections Management System, shown in terms of a research project based on paleontological samples.


General Collection
All USGS fossils collected within the United States
Research Collection
Cretaceous mollusks collected in Colorado
COLORADO
Directed Research Collection
Cretaceous ammonites from Colorado
Field Collection
Pueblo Fossils
Field Collection
Middle Park Fossils
Field Collection
Montrose County Fossils
USGS
A USGS Zonal Table for the Upper Cretaceous Middle Cenomanian-Maastrichtian of the Western Interior of the United States Based on Ammonites, Inoceramids, and Radiometric Ages
Open-File Report 2006–1250
U.S. Department of the Interior
U.S. Geological Survey

The *Paleontology Collections* in the *GCMS*

From the early days of the USGS, paleontology has played an important role in unraveling the geologic history of the United States. Between 1889 and 1995, all fossil samples, regardless of collector, were submitted to a paleontologist for identification. This identification was documented in an Examine and Report on Referred Fossils (E&R) report and commonly was used in published reports. Planning is underway to make the complete set of E&R reports available in .pdf format on the World Wide Web.

The fossil specimens on which these reports were based form the reference collections on which modern-day identifications rely. These paleontological materials have the advantage of long-term oversight by the National Museum of Natural History, which applied standardized practices in sample registry and documentation to create collection catalogs. These data catalogs can be transferred easily into the new collections management system.



The bulk of extant USGS fossil specimens are cataloged and housed in two major collections with the Department of Paleobiology at the Smithsonian Institution and the Museum of Paleontology at the University of California, Berkeley. For the remaining specimens, the process of correlating written reports and data with the identified samples is in progress.

For more information, please refer to Wardlaw and others (2001).

What sample metadata are needed?

A geologic sample has little research value without the information that defines what it is and where it was collected. At a minimum, a sample needs a unique identifier and the geographic coordinates of the **location** where it was collected. The name of the person who collected the sample (the **collector**) and the **date** on which it was collected are also critical pieces of information for locating the ancillary records associated with the sample, such as the field notes, station location map, and associated analytical results. If these data points—what, where, who, and when—are not available, there may be little reason to retain that sample.

For many legacy collections, **sample data** might not be available beyond the number, location, collector, and date. For resource, active, and new collections, however, GCMS guidelines stipulate that data such as sample type, reason for collection, project name, and analyses performed should also be entered into the database. In the catalog, locations might be physically described as well as geospatially defined; photographs or petrographic descriptions can also be included. Appendix 2 lists the sample data (attributes) that the GCMS will compile for its catalogs of geologic materials. Additional information that the GCMS will provide to customers will be the repository in which the sample is housed, how to access the sample, and whom to contact for further information.

How will samples be identified?

Sample identification numbers have never been standardized among the geology-related mission areas. Field geologists number their samples according to project protocols, but these protocols vary widely among the projects, regions, and programs. There is nothing to prevent different collectors from assigning the same **sample identifier** (ID) to two or more samples from widely varying locations. In addition, a single sample could be given a new number every time a different scientist handles it. Lack of consistency among projects and researchers creates a major problem in tracking all the data associated with a sample once the information about the sample is shared outside a given repository.

For the GCMS to be successful, sample identification will need to be standardized. As each active repository contributes the **metadata** for its sample inventories through the GCMS to the centralized registry, each sample will be assigned a **universally unique identifier** (UUID). A UUID will allow the GCMS to systematize sample designation, prevent duplication of numbers, and ensure that all information associated with a sample is preserved. It will also facilitate internal database integrity within the GCMS and unique registration of GCMS samples with external registries.

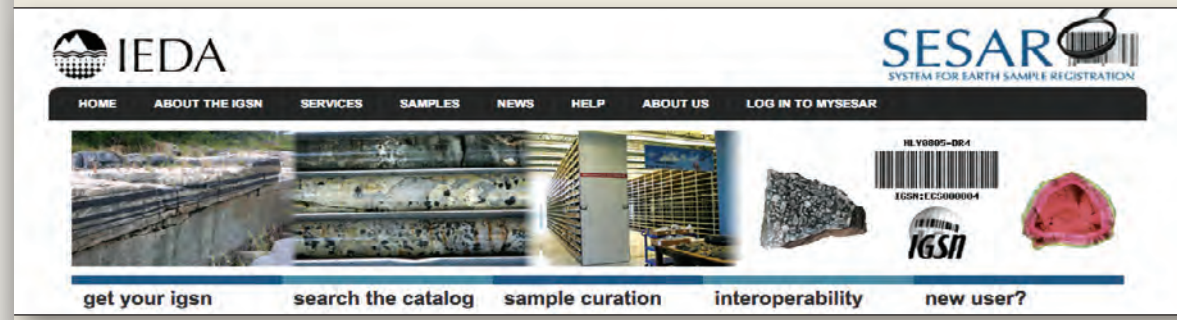
The current, internationally-recognized identification system in rapid adoption across the geosciences is the **International Geo Sample Number** (IGSN). The GCMS will facilitate registry of IGSN identifiers for all samples through the **System for Earth Sample Registration** (SESAR), a capability funded by the National Science Foundation and provided by the Integrated Earth Data Applications project at Columbia University's Lamont Doherty Earth Observatory. It was suggested initially that GCMS samples managed by USGS repositories in legacy, resource, current, and new collections would be assigned IGSNs as their UUIDs, but this might not be necessary if an internal schema supported by the National Digital Catalog is devised.

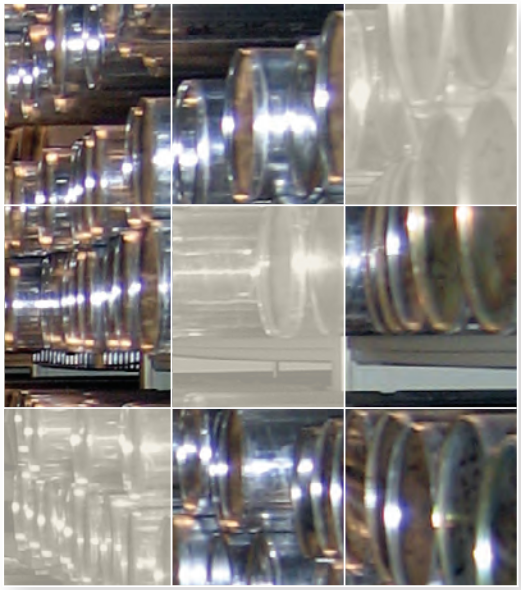
Internationally Recognized

The System for Earth Sample Registration (SESAR) was developed by the Geoinformatics for Geochemistry Program, with support from the National Science Foundation. Operated by the Lamont-Doherty Earth Observatory at Columbia University, SESAR attempts to address errors that result from different and sometimes overlapping naming conventions used throughout various collections, or even within collections.

The SESAR program is responsible for distributing and tracking International Geo Sample Numbers (IGSNs), which are assigned to individual samples to provide a unique identifier that can link a sample to any data derived from it, where it is physically located, where it has been analyzed, and any relationships it might have to subsamples or associated materials.

For more information, see http://www.geosamples.org/.





What will not be included in the GCMS?

Geoscience materials can be thought of as having two main components: (1) the physical samples collected by research personnel and (2) the data generated by analysis of those samples, by instrumentation-based field surveys, and from engineering research. The GCMS will deal primarily with the physical samples and their ancillary documentation—what the samples are, where they are located, how they are managed, and how to access them. Because many of the analytical results associated with the samples are already being captured in various formats and are available online, links to those databases, as well as links to publications resulting from the research associated with USGS sample collections, will be provided where possible.

The GCMS will not specifically address the preservation of digital data (seismic, magnetic, electric) or conventional library materials (books, journals, monographs); other groups in the USGS are already addressing these concerns. The USGS is developing, however, a larger cyberinfrastructure that eventually will integrate metadata for all databases of physical objects and digital information, and links between samples and data will be established where needed. Please refer to the section below for a discussion of how the GCMS contributes to the overall USGS strategy for preserving geologic data and materials.

How does the GCMS fit into the USGS data preservation strategy?

One of the goals of the NGGDPP is to provide a system that not only preserves geologic materials and data, but also provides the means to make them available to the public. As part of this effort, the USGS is developing a comprehensive data management structure called **ScienceBase**, a cyberinfrastructure that organizes and connects the various catalogs, data, and information within the USGS and the larger geoscience community (fig. 2). ScienceBase will facilitate access to the information within that network.

As part of the physical infrastructure of the NGGDPP, the GCMS will be the management system that indexes and preserves the geologic collections of the USGS. Sample repositories that already provide online access to their catalogs include the Core Research Center and the Woods Hole Coastal and Marine Science Center Samples Repository (http://datapreservation.usgs.gov/links.shtml).

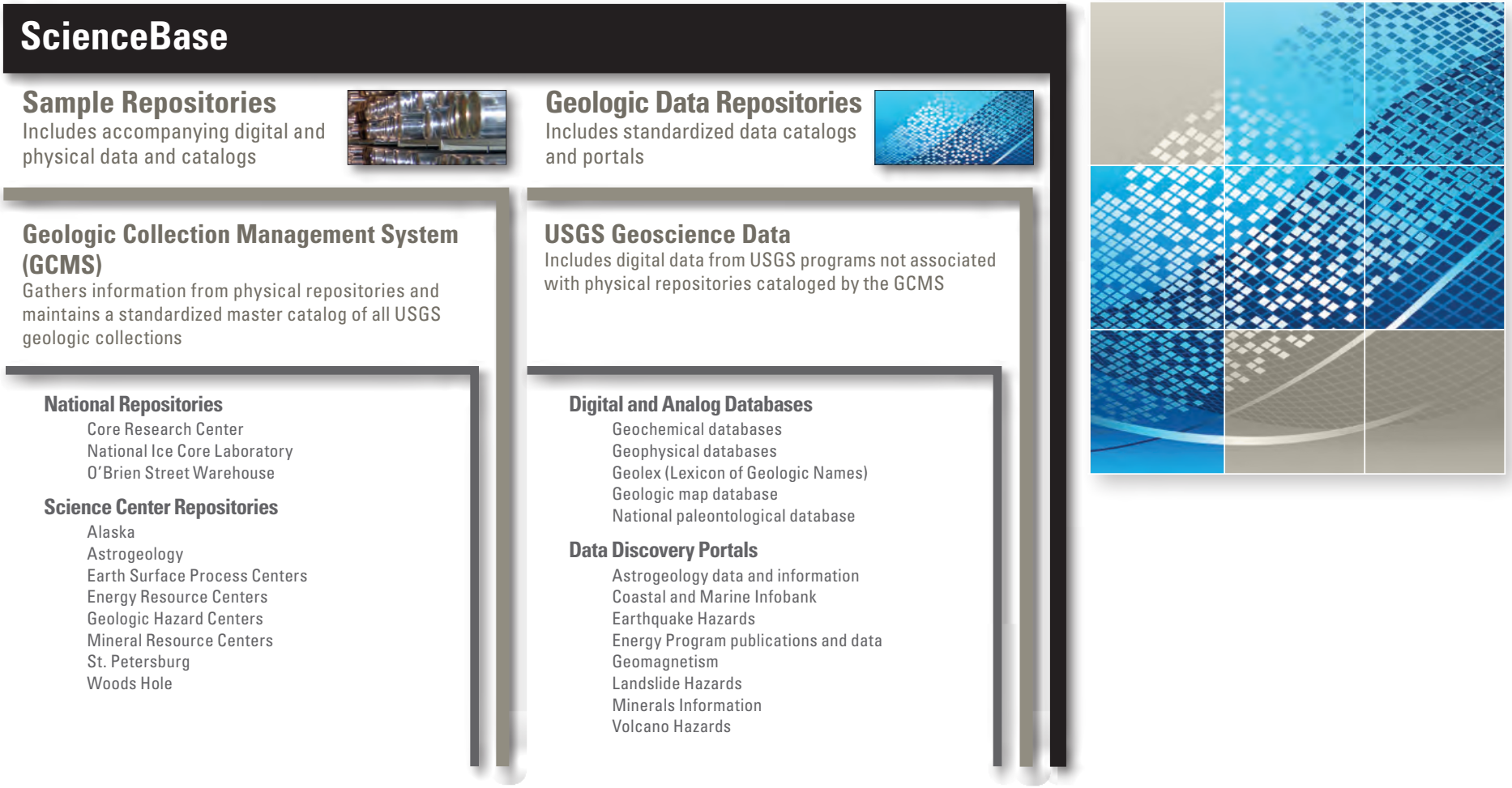
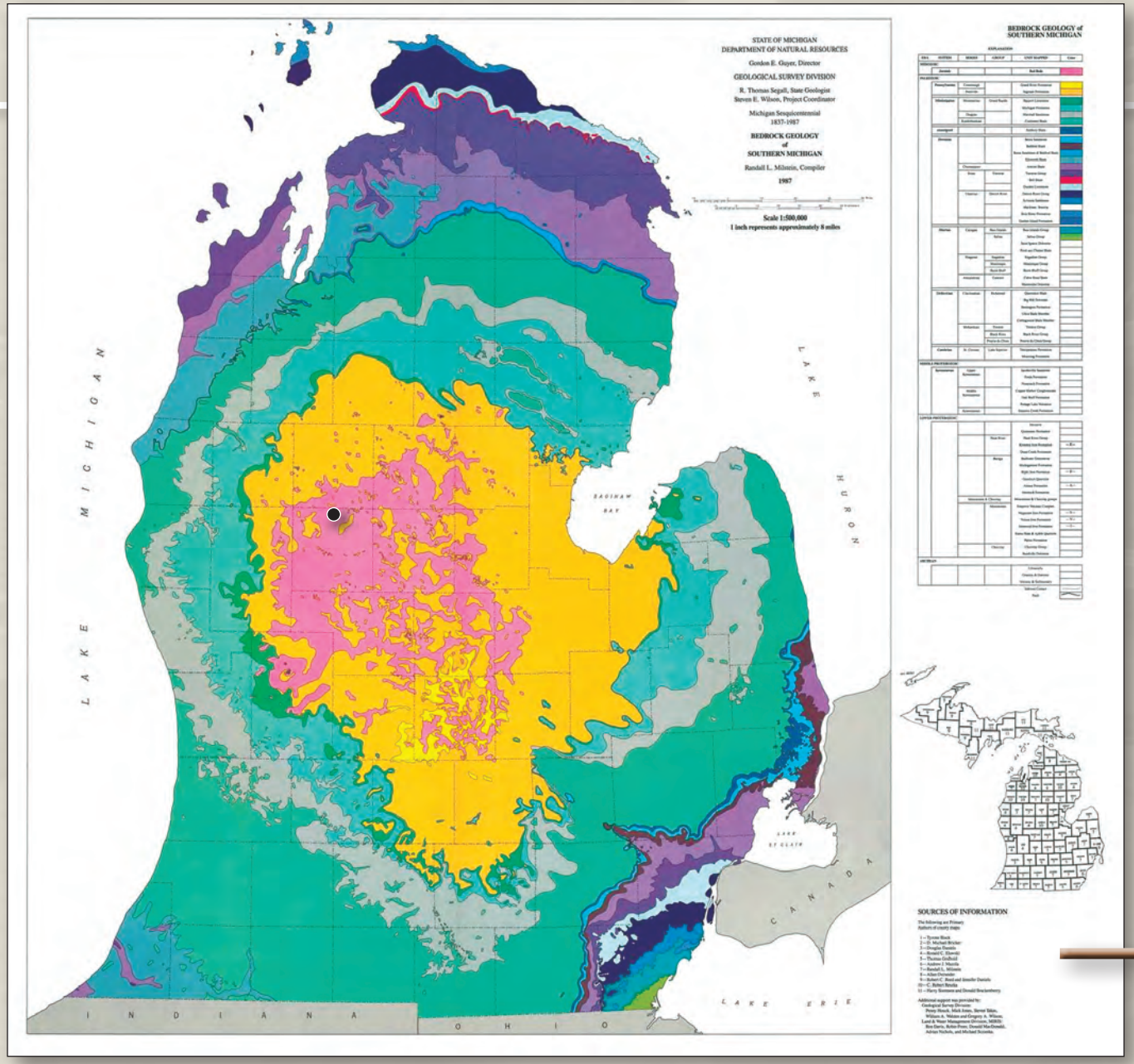


Figure 2. ScienceBase is cyberinfrastructure developed by the U.S. Geological Survey (USGS) that organizes, catalogs, and integrates scientific data for USGS and partner programs and projects (https://www.sciencebase.gov/catalog/). As a part of ScienceBase, data collected by the Geologic Collections Management System will be accessible in context with complementary USGS geoscience data.

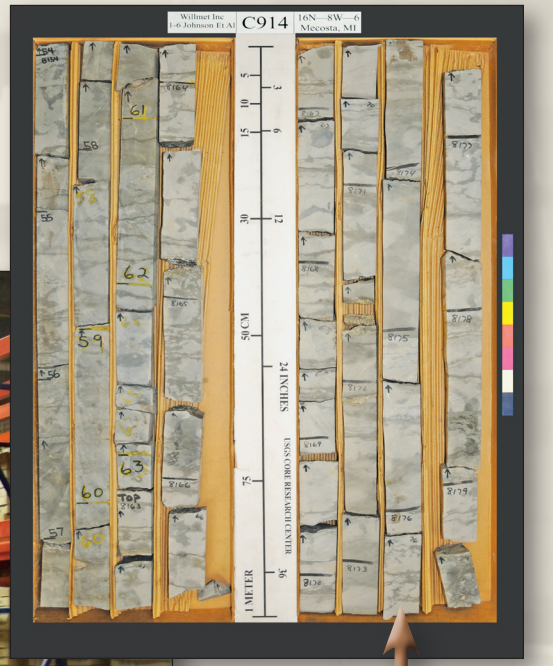


(Modified from Milstein, 1987)

Elizabeth Sanchez, the new geologist for XYZ Exploration, is tasked with finding possible targets for natural resources development in the central part of the state. She reads tons of geologic literature about the area but knows it is no substitute for getting out and looking at the rocks. She also knows her company will not fund an expedition without some concrete indicators. Staring at the geologic map on the wall, she thinks that one area looks promising, but she needs a bit more data before proposing the project to her boss.

The Ideal *GCMS* in Action—*II. Access by Map Interface*

Many of the papers she reads about these rocks are USGS publications, so she pulls up the agency's Geologic Collections Management System Web site (http://datapreservation.usgs.gov/GCMS.html) on her computer. She outlines her area of interest on the map and hits "Enter." She finds that the samples described in the USGS literature are available for loan, plus there are links to all the analytical results. After scrutinizing the various data tables, she requests to borrow the samples that she thinks will provide an answer to her question. Because the rocks have already been analyzed, she just needs to see them, up close and personal, to determine if what she suspects is true. Her proposal is accepted on the basis of her conclusions, and she is looking forward to getting out into the field to test her hypothesis. She returns the samples to the repository, appreciating that the resources of the GCMS allow her to begin her field work before she even leaves the office.



Operating Plan for the Geologic Collections Management System

Mission Statement

The U.S. Geological Survey (USGS) characterizes the geological landscape and provides the Nation with fundamental geochemical and geophysical data necessary to address major societal issues involving geologic hazards and disasters, climate variability and change, energy and mineral resources, ecosystems and human health, and groundwater quality and availability. The Geologic Collections Management System (GCMS) supports this mission through the agency's data integration effort by creating a uniform infrastructure and standardized master catalog of all geologic sample collections. Further, as a virtual network linking physical collections, the GCMS facilitates access to these samples by USGS personnel and the public through a Web-based portal. By developing and sharing a set of common business and management practices, the GCMS helps to promote the long-term preservation of these national resources.

Vision Statement

The GCMS establishes a virtual network connecting USGS geologic sample collections that are housed in various locations throughout the United States (see appendix 1) and provides a platform for uniform business practices in the collection, description, and management of those samples. The GCMS addresses three areas of concern in making these collections as useful as possible.

Collection

- The GCMS provides a template for standardized and consistent procedures in the collection and description of samples by USGS scientists in the course of their fieldwork and research.
- The GCMS stipulates and defines the categories of information that are used to describe an individual sample, such as an identifying number; where, when, and by whom it was collected; sample type and purpose; and other significant pieces of metadata.
- The GCMS specifies protocols for future use of the samples.
- The GCMS provides standards for incorporating samples from sources outside the USGS.

Management

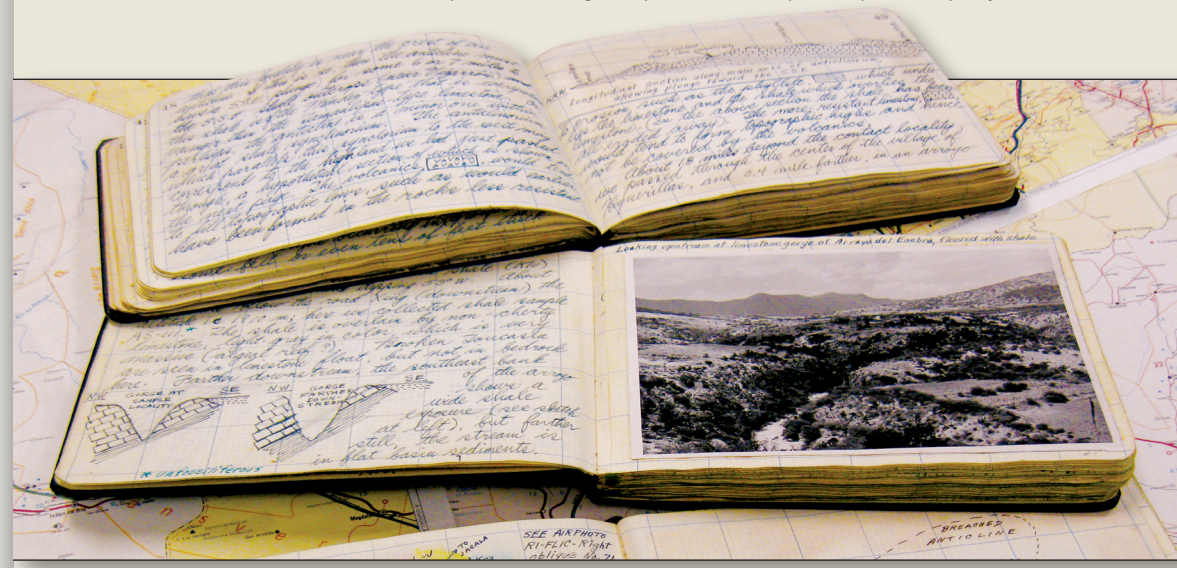
- The GCMS promotes the long-term preservation of geologic collections by identifying the individual samples, where they are kept, and how they are stored.
- The GCMS provides for the transfer of significant collections to the National Museum of Natural History (NMNH) or other appropriate museum or entity, when recommended by the local advisory committee.
- The GCMS provides guidelines for the deaccessioning or disposal of samples from collections, including provisions for transfer to other repositories.

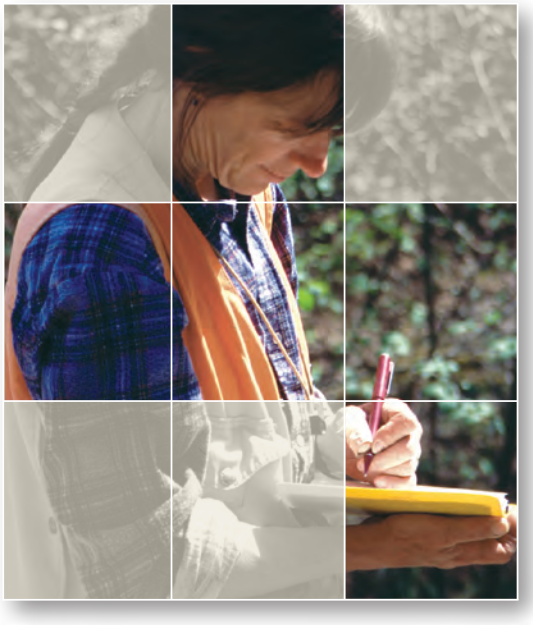
Access

- The GCMS provides data through the ScienceBase virtual interface to allow customers to locate samples within a geographic area or topic of interest or scientific expertise.
- The GCMS promotes and provides methods for linking to the analytical and petrographic data associated with a sample, where possible.

USGS *Field Records Libraries*

Ancillary geologic records are critical for the documentation of research projects and sample collections. Consequently, the USGS maintains archives of the unpublished field notes, maps, correspondence, manuscripts, and other records created by its researchers during their field studies and other project work. The Denver Field Records Collection represents project work undertaken in the contiguous 48 states and Hawaii; field and project records for USGS field work in the state of Alaska are housed in the Technical Data Unit in Anchorage. Materials in the collections represent 130 years of scientific investigations by over 1,500 scientists, from the earliest days of the agency to recently completed projects.





Policies Governing the GCMS

Because of its extensive collections of geologic materials, the USGS is undertaking the development of standard methodologies for handling physical samples collected with public funds. To this end, the Geologic Materials Repository Working Group has developed a blueprint for a national geologic materials database that will improve both tracking of, and access to, the samples and their ancillary information. This blueprint stipulates a minimum set of standards to improve the identification, maintenance, and preservation of physical geological samples. It is flexible and open to modification by the individual repositories, and it should be reviewed periodically at the national level for updates, amendments, and improvements. All users will have the opportunity to provide input for continual improvement. Finally, the protocols and templates provided by the blueprint for the collection, storage, access, transfer, and **disposal** of physical geologic samples embody the desired best practices for USGS repositories.

The following suggested policies were formulated to help establish a framework and standardize operations among the varied repositories:

1. A national governing board should oversee the governance, implementation, and operation of the GCMS. Policies and procedures established by this board would be binding, yet flexible enough to give local repositories the necessary leeway to adapt the methodologies to their particular collections.

2. Each science center that maintains collections of geologic materials should be deemed an active repository and should establish a local advisory committee to oversee implementation of GCMS standards at that center. Committee members could include the center director or operations manager, the collections manager, and individual research scientists. Committees should be kept small (3–5 members), and the research scientists would serve limited terms of appointment.

3. Each active repository should have a policy document and collection management plan that governs and guides the organized handling, storage, preservation, and tracking of samples; the plans should conform to the basic standards of the GCMS. Appendixes 3–5 provide templates for these documents that should be modified as needed to fit the requirements of the individual repositories. The GCMS database template should be used for **cataloging** the samples.

4. Each active repository should be responsible for evaluating its own collections for retention, transfer, or disposal according to the guidelines laid out in this document. All materials should be assessed on the basis of their long-term research value and the existence of ancillary geologic records. Collections that do not meet the minimum criteria should not be retained or transferred; options for disposal are spelled out.

5. As the GCMS is developed and implemented, researchers should enter the required sample data into their local database when they return from their field seasons. The scientists should have exclusive use of the samples for the tenure of the project for which they were originally collected, but registration of the samples in the GCMS should occur no later than publication of the first research paper associated with those samples. When that project is over, or within a predetermined period from the time of collection, the samples should be physically **accessioned** into the local repository and digitally uploaded into the GCMS master catalog, allowing public access to both samples and ancillary data.

6. A unique identification number should be assigned to each sample when it is formally registered in the system. Although this assignment may occur at different times for different sample types, it should occur prior to publication of the first research paper associated with those samples in order to ensure access to the physical samples in a timely manner.

7. All collections should be deposited into their designated repository when the samples are no longer actively used, either at the end of the research project for which they were collected or on the occasion of the principal investigator's departure from the USGS. At no time should the samples leave USGS custody without evaluation by the repository and documentation for their transfer or disposal.

8. Access to samples after they have been deposited in a repository should be determined on a case-by-case basis and would be based on the policies of that specific repository. If samples are loaned out, any data or analytical results derived from these additional studies should be reported back to the repository within one year's time.

Recommended Procedures

The protocols outlined below are recommended practices developed for repositories participating in the GCMS. These procedures are in compliance with the policies of the GCMS and provide guidance to repositories for developing their own methodologies. It is understood that each repository and its holdings require different methods of archiving, but this framework maintains uniformity in their operations. The protocols are not meant to be onerous, but are meant to serve as examples and guidelines for the local advisory committees and collection curators overseeing the implementation of the GCMS.

Repository Identification

Each science center or location that actively maintains geologic collections should have a unique designation assigned to it by the GCMS. This designation will provide a link to information on the locality and size of the repository, the types of materials being curated, and the contact information for the curator or facility manager.

Evaluation of Collections—Applying the 4-Point Standard

Geologic collections and samples throughout the USGS should be considered for inclusion in the GCMS: legacy, resource, active, new, and donated collections will all be evaluated. The preliminary criteria for these evaluations can be found in figure 3. This decision tree was based on the GCMS preferred sample data specifications (appendix 2) and provides a graphic representation of the disposition of a collection in the **chain of custody**. Each major component in the tree (inventory and evaluation, retention, transfer, or disposal) has standard forms for documenting the relevant process (appendix 5). Use of the tree allows collections managers and administrators to establish the appropriate course of action regarding the indexing and disposition of samples.

It is recommended that legacy collections be evaluated first. For these collections, it should be determined if the minimum ancillary data exist for the individual samples to be useful. There are four required data points for these samples, known as the **4-point standard**: the identification number assigned in the field, where it was collected, who collected it, and when it was collected. The Inventory and Evaluation form in appendix 5 will be used to record pertinent details about the collection and whether the materials will be retained.

If the criteria cited above are not met, there should be compelling evidence to justify keeping the sample. One example might be a unique fossil where the collection location is known, but for which no other data are available. In this case, the sample could be kept. Otherwise, most samples not meeting the 4-point standard may be made available for use outside the GCMS.

Active and resource collections are subject to the same standards as legacy collections. In most cases, however, the four required data points will be readily available for these samples, and the collector can provide additional pertinent information. For newly collected samples, the scientist should endeavor to gather as much information as possible that conforms to the GCMS preferred sample data criteria.

During the evaluation process, if any legacy or resource collection is determined to have possible long-term historic or scientific value, the Smithsonian Institution should be consulted for possible transfer of that collection to the NMNH or other appropriate museum. If samples in this collection are from Federal lands, appropriate documentation from that Federal agency shall be included with the sample prior to donation to the NMNH or other appropriate museum.

There are occasions when the USGS may be offered collections from outside entities, such as academic or industrial sources, because the care and preservation of those collections cannot be properly maintained by their current repositories. If they are of scientific value to the USGS, these donated collections should be evaluated in the same manner as legacy collections. If the minimum criteria are met, the collection may be accepted and ownership officially transferred to the USGS.

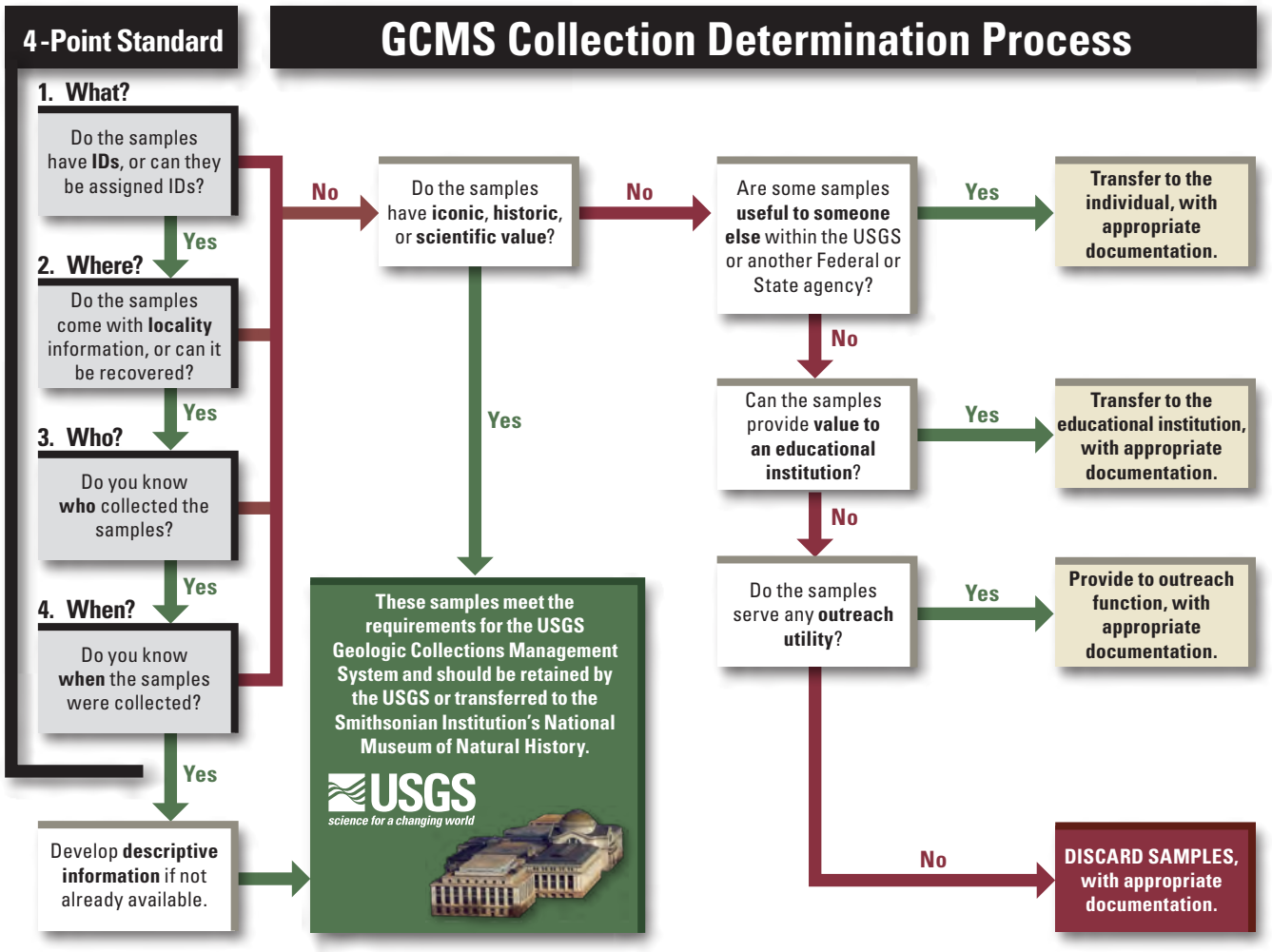


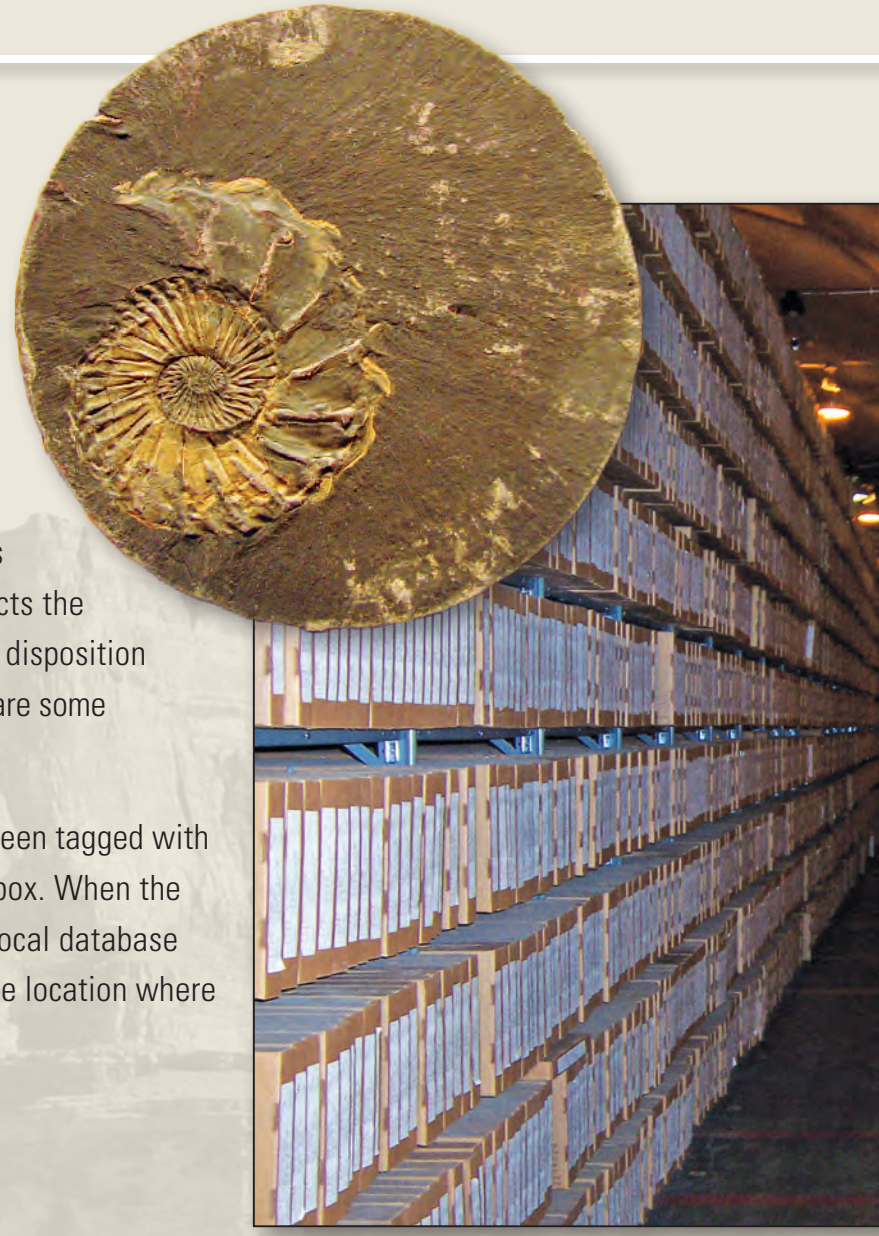
Figure 3. The Collection Determination Process used by the Geologic Collections Management System is a graphical representation of the factors to be considered and the steps to be taken when evaluating a sample for retention or disposal by the U.S. Geological Survey. (GCMS, Geologic Collections Management System; ID, identifier; USGS, U.S. Geological Survey)

USGS Rock Samples—*From Outcrop to Repository*

Jack has been doing geologic field work for some time now and has developed a consistent methodology for handling his samples. His field maps and notes are often used as a model to teach the new geologists how they are expected to conduct their own field research. When Jack examines an outcrop, he duly notes its geographic position on his topographic map and assigns it a station location number; the sample that he takes from the outcrop will bear that same number.

If there are several different rock types in the same outcrop, the sample number will be appended with an (a), (b), (c), and so forth, to reflect what he has collected. Samples are placed in labeled canvas bags for transport back to his office.

Once there, Jack unpacks the rocks and lays them out on his workbench. As he works, he enters the pertinent field locations and sample descriptions into his local database. He then decides what he is going to do with each sample: thin section, geochemical analysis, age determination, fossil identification—whatever is necessary to procure the information he needs. These decisions are also entered into the database. That way, any analytical result can be tied back to the individual sample without much difficulty.



When he is actively working on the samples, Jack stores them in rock cabinets in his office, usually lying on top of their corresponding bag or in a labeled tray. At least one piece of each sample is individually labeled to serve as a reference sample for that field location. The petrographic thin sections that have been cut are kept separately in numerical order in clearly labeled standard slide boxes.

At the end of his latest project, Jack decides that his cabinets are too full to hold any more rocks. After reviewing the contents, he decides he can clear out the drawers containing samples from an area that he knows he has finished mapping. He contacts the collections manager of his local repository and invites her to help strategize the best disposition for these samples. They decide that most of the samples are worth keeping, but there are some duplicates that can be made available for teaching or outreach.

The samples are put back in their canvas bags and are packed into boxes that have been tagged with content labels; the collector's name and project area are also on the outside of the box. When the boxes are received at the repository, the collections manager is able to access the local database and augment Jack's records with information on the date of accession and warehouse location where the boxes are shelved.

GCMS Data Catalogs

A coordinated approach to managing the digital inventories of the numerous and varied geologic collections will facilitate their integration into the GCMS. Currently, the Microsoft Office Suite is the standard software package used by the USGS for document, spreadsheet, and database production. With this in mind, the GCMS will provide through its Web site a Microsoft Excel template for the GCMS data catalog, based on the GCMS preferred sample data (appendix 2), which can be used for data input and sample registration in the GCMS inventory. This template provides fields for indexing the required attributes and provide drop-down options for some of the descriptive elements.

Many research scientists collect more sample material in the field than is ultimately necessary to retain for long-term use, and some samples may not be deemed appropriate for long-term retention. Therefore, there would be two tiers of data management in the GCMS, one at the local level and the other at the national level. Data for all samples would be entered into the local repository's basic catalog, and the local repository would be responsible for the quality and completeness of that data. Only the data for officially accessioned and managed samples would be integrated into the GCMS master catalog, and only these latter samples will have universal identifying numbers assigned to them.

Cataloging Sample Data

As the legacy collections are being evaluated, data for the samples deemed appropriate for retention should be entered into the GCMS inventory. In addition to the 4-point standard used to evaluate the samples, the sample's type and repository where it is housed would also be required. If additional descriptive data are available, that information should be recorded as well.

For current collections, data entry can begin immediately, inputting as many attributes as are applicable to the samples. For new samples, data input should be initiated upon return from the field. Again, the collector should endeavor to provide as much information as possible about the origin and nature of the sample. While it is true that some current or future samples may not be judged suitable for long-term retention in the GCMS, capture of their descriptive data at the beginning of their scientific lifecycle is the standard to which the scientists should adhere.

Sample Registration

The System for Earth Sample Registration (SESAR) is a centralized system that provides scientists and collections managers with universally unique identifiers (UUIDs) for research samples. These identifiers provided by SESAR, known as International Geo Sample Numbers (IGSNs), allow samples to be tracked on a global scale and are designed to maintain a permanent link between the sample and any resultant data that appear in publications and digital datasets. ScienceBase provides the ability to record unique identifiers. A seamless process for acquiring and assigning UUIDs for cataloged samples in ScienceBase may be pursued. Only samples that have been accepted for long-term retention in the GCMS would be given UUIDs.

It was proposed that, if IGSNs were to be used as UUIDs for retained samples, then SESAR would assign batches of IGSNs to the USGS for use in the GCMS. Registration of samples would be done individually or in batches of multiple samples through an internal GCMS Web site. Submission for registration will use a series of Microsoft Excel spreadsheets that data managers can fill out and return online or through email.

The type of sample collected can have a bearing on when an UUID is assigned to it. For example, large bulk samples of stream sediments and soils are often sieved into multiple size fractions, split, and sent off to one or more laboratories to be analyzed; while an additional 100-gram sample of each fraction is preserved in the USGS National Geochemical Sample Archive (NGSA; accessible through the USGS Central Region Mineral and Environmental Resources Science Center at http://minerals.cr.usgs.gov/). Because it is imperative that these various **subsamples** (also called **daughter samples**) be tied back to the original **parent sample**, an UUID should be assigned to the parent sample sooner rather than later, either upon return from the field or upon submittal for analysis. By doing so, the UUID will accompany the sample from post-collection through analysis, the NGSA, and the publication process.

A similar scenario for sample registration involves the collection of multiple samples from a single field locality, such as a measured section, drill core, or soil pit. Unlike samples in the above scenario, these samples are distinguished by the vertical horizon at which they are collected and may represent different rock types. In this case, a primary UUID could be assigned to the collection locality or to the samples, at the discretion of the collector, and would be modified by the addition of an alphanumeric suffix to identify each subsample collected from the site. This modification of the primary UUID must be systematic and logical so that it is easy to identify the sample splits and to track their **provenance**. Assignment of UUIDs would occur upon return from the field, prior to any sample processing.

There is a third common scenario to consider when determining when to register a sample. A geologist visits a particularly interesting site and ends up collecting rocks for a variety of purposes, such as reference hand samples, thin sections, and geochemical analyses. Additional miscellaneous samples are also brought back to show to colleagues, display in the hall, or give to the local school district. In this case, when some of the collected samples might or might not be used for project research, they should not be assigned UUIDs until the researcher can demonstrate that the data derived from them are significant to the project's outcome. Rocks not fitting this criterion most likely do not have enduring scientific value and would not be managed by the GCMS.

Although the timing to assign UUIDs may vary, registration of the samples should occur no later than publication of the first research paper associated with those samples.

Inclusion of Sample Metadata in ScienceBase

ScienceBase catalogs, indexes, and publishes records of geological and geophysical data and samples available within the USGS and provides a means to digitally access them. Samples and collections indexed in the GCMS master catalog would automatically be incorporated into ScienceBase.

Labeling Samples

Many GCMS samples will initially be labeled with a field or laboratory number assigned to them by their collector or analyst. Upon registration with the GCMS, the samples should also be labeled with their UUIDs. The number may be directly applied to the sample or written on a separate label and inserted into the bag or box containing the sample. If a separate label is used, it is recommended that both UUID and field or laboratory number be captured on the same label. The UUID should be sufficient to link that sample with all pertinent information in the GCMS master catalog. All sample identifiers, field or laboratory numbers, and UUIDs should be recorded in ScienceBase.

Recommended Sample Storage

The focus for any repository is to preserve the physical integrity of its holdings and maximize sample longevity for its use in future scientific research. It is recognized that various sample types will require varying methods of storage and climate control to maximize that longevity. It is also recognized that each contributing repository has unique storage capabilities and facilities for storing those samples. Therefore, the physical management of GCMS collections would be under the purview of each repository manager.

Ideal rock storage consists of large cabinets containing sample drawers, clearly labeled, that allow immediate access to any sample in the repository. Because this is an expensive proposition, most samples will probably be stored in rock boxes on pallets in the repository facility. In this case, boxes should be labeled with a local identifier or bar code, and the UUIDs of the samples should be contained therein. Additional information is not required, but to aid sample retrieval, the project name, collector's name, and year that the samples were collected may prove useful. The box's local identifier should be recorded in the repository's database.

Re-Sampling a Collection

Re-sampling (also known as **secondary sampling**) is the act of retrieving an archived sample for the purpose of additional scientific inquiry, be it a geochemical analysis, age determination, or testing of physical properties.

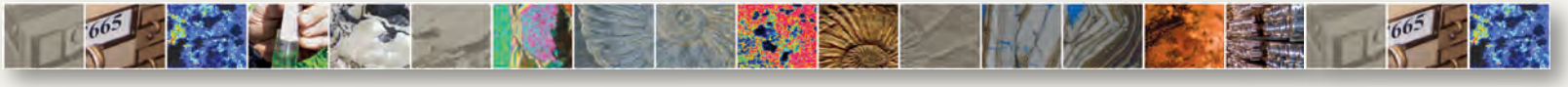
Each repository would have its own authority to approve a sample's suitability for re-sampling. Requests should be evaluated by the local collections manager or repository administrator on the basis of sample availability and the merits of the request; if possible, the collecting scientist should be consulted. No more than half of any sample should be given out at any one time, and a minimum sample remainder should be established at the repository level.

Protocols for Secondary Sampling

If a requested sample meets the repository's criteria for re-sampling, the borrower, collection manager, and scientist (if available) should sign a Sample Loan Agreement form (appendix 5) acknowledging the conditions of the loan. A copy of the Loan Conditions form will be provided to the borrower for their own records.

The borrowing party would be subject to the following conditions:

- Term of Loan—The sample should be returned to the host repository at the borrower's expense, no later than the negotiated due date stated on the Loan Agreement, or within one week after an earlier return is requested by the lending repository.
- Use of Samples—Samples loaned are for the sole use of the person or persons stated on the Sample Loan Agreement. The borrower should not loan, deliver, lease, or transfer the samples to any other entity. When displaying the samples or publishing the results of any resultant research, the borrower should clearly state that the samples belong to the USGS.
- Alteration of Samples—In the re-sampling request, the borrower should inform the lending repository of all tests and alterations intended for the samples while in the borrower's care. Loans may be denied if there is not enough sample material for the intended analyses. Samples loaned should be used only for the research and data extraction purposes stated on the Loan Agreement.
- Loss or Damage—It is recognized that many analyses are destructive in nature. However, unless it is agreed that the sample or parts thereof will not be returned to the repository, the borrower would be responsible to report any damage or loss of material.



Data Return

Any analytical data and findings derived from a USGS sample should be submitted to the original lending repository within one year from the date of the original loan and would be permanently associated with that sample.

Physical Remains

Upon return of the sample remains, the requestor and the repository manager should sign and date the original outgoing Sample Loan Agreement form to log the sample back into the holdings of the repository.

Deaccessioning Samples

Deaccessioning is the process by which a sample or collection is formally and permanently removed from the custody of its repository. Deaccessioning may take the form of either transfer to another entity or disposal.

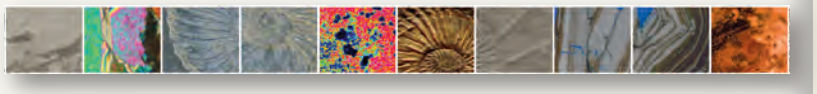
Deaccession Criteria

The Checklist for Deaccessioning Geologic Materials form in appendix 5 provides criteria for determining if a sample or collection should be removed from its repository. Some of these include:

- Poor condition—The sample has deteriorated or has been damaged beyond any useful value for further scientific study.
- Inadequate documentation—There are no ancillary geologic records to ascertain where, when, or by whom the sample was collected.
- Duplication—The sample is a duplicate of another sample currently stored in the repository.

Disposition of Samples

Samples deemed inappropriate for retention by the GCMS may still be valuable for education, outreach, or further scientific investigation. Such samples may be transferred to an appropriate party within or external to the USGS. The Record of Transfer or Disposal of Geologic Materials form (appendix 5) documents the removal of samples from the care and responsibility of the GCMS to a recipient institution or individual. This form requires the following information:



- proposed fate of the samples (education, research, and so forth),
- institution or affiliation of the recipient, and
- date of deaccession.

In conjunction with the Record of Transfer or Disposal of Geologic Materials, the repository should also complete the Approval for Deaccession of Geologic Materials (appendix 5). This form lists a detailed description of the materials and the reason for their removal from the repository.

Disposal Criteria

If samples proposed for deaccessioning are in such a state that they are deemed unusable for further study, because of natural deterioration or destruction of sample integrity by analytical procedures, said samples will be subject to appropriate disposal.

Samples of geologic materials may contain heavy metals, poisonous chemicals, or other hazardous pollutants. The collection manager, in conjunction with the samples' collector, should determine any special disposal needs and consult the appropriate authority (local safety officers and environmental disposal personnel) to determine the most suitable course of action.

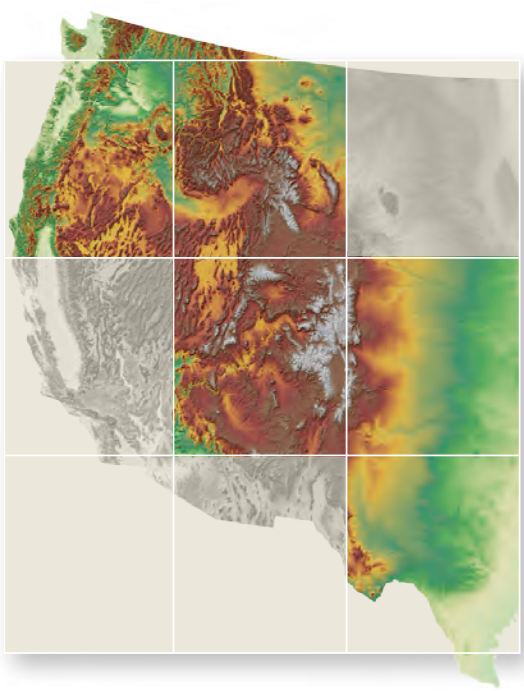
Documentation

All activities and decisions regarding research samples should be documented with appropriate forms and signatures. This documentation should be retained permanently by the host repository.

USGS *Records Retention*

The Geology Discipline Research Records Schedule is the legal document that identifies the process for organizing, disposing of, and maintaining USGS geoscience research information. In the scientific method, the validity of scientific results depends on thorough documentation of underlying data and methods so that other scientists can freely examine, question, and experimentally replicate them, as appropriate. For this reason, the USGS must carefully manage not only the publications and databases that are its products, but also the data that are acquired in laboratories and field work, records of data processing and analyses, and communications with other scientists during the review process. The Geology Discipline Research Records Schedule stipulates that significant research records, physical sample records, and indexes to permanent data are all considered permanent records and are to be retained indefinitely.

Implementation of the Geologic Collections Management System



National Accountability

The first two policy suggestions of the Geologic Collections Management System (GCMS) (see below) establish a national leadership that would provide and maintain guidance to support consistency across all member repositories. Further, this leadership would ensure that GCMS policies support not only internal consistency but also compliance with relevant external standards. In applying these measures, the GCMS can become an accountable institution nationwide.

The NGGDPP Coordinator and the Associate Director for Core Science Systems should have authority for approving and implementing the policies, procedures, and decisions enacted by the GCMS.

Further, a national governing board should oversee the governance, implementation, and operation of the GCMS. Policies and procedures established by this board would be binding, yet flexible enough to give local repositories the necessary leeway to adapt the methodologies to their particular collections.

To advise the National Geological and Geophysical Data Preservation Program (NGGDPP) Coordinator and the Associate Director for Core Science Systems, the USGS should form a national governing board to oversee GCMS governance, implementation, and operations. Initially, the board should be made up of the heads of the major geologic repositories, and the head of the Core Research Center should serve as the first chair. There should also be four at-large members on this board: two from the USGS, one from the Smithsonian Institution, and one additional at-large member, possibly from industry, academia, or state geological surveys.

The national governing board would be responsible for providing the overarching GCMS collections management policy. The policy document should delineate the authorities and duties of the national governing board, the local committees, the repository and collections managers, and the individual scientists. It should also provide guidance on the implementation of the individual policy elements that will govern the GCMS. Appendix 3 provides a basic policy document that may be adapted by the national governing board.

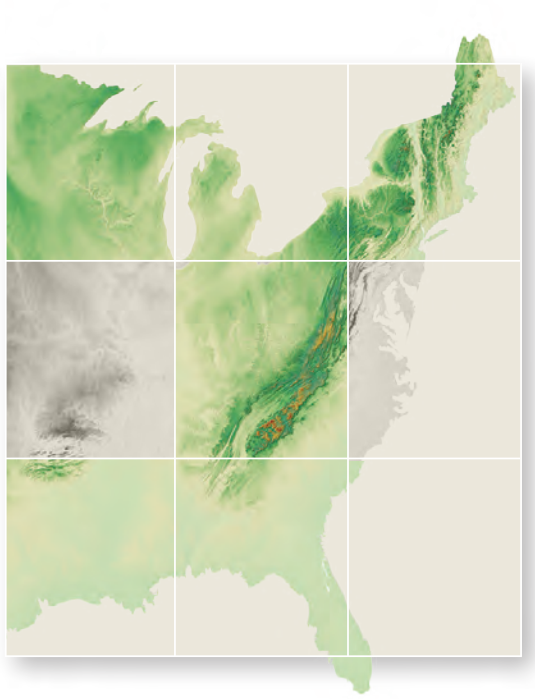
The governing board should be responsible for compiling the processing manual that will provide guidance at the local level for accession, **curation**, and preservation of a repository's geologic materials. The manual will expand on the procedures outlined in this document and will address sample handling from the time of collection to final disposition. Provisions in the manual will be adaptable to each repository's needs and capabilities. Appendixes 4 and 5 may be used as a template for the procedures and forms used in collections management.

The governing board should be responsible for coordinating the efforts of the local repositories that will be part of the GCMS. Design, development, and maintenance of the GCMS data catalogs and Web site would be at the national level, and metadata standards would parallel those outlined for the National Digital Catalog. Appendix 2 presents the preferred sample attributes that are to be captured in the databases. There should also be an internal Web site that repeats the policies and procedures laid out in this document and posts frequently asked questions about the implementation and operation of the GCMS.

By preparing policies, procedures, and database templates, the governing board would provide the GCMS with a model for compliance with the objectives of ScienceBase and the NGGDPP.

The policies and procedures of the GCMS should be reviewed on a periodic basis. The individual repositories are encouraged to be active participants in this process. The GCMS is a collective resource for the entire USGS community and the users who discover the geologic materials kept in the repositories and learn how to access them. Suggestions for improvements to this national asset should be solicited and examined for continuous improvement.

There should be at least one full-time employee dedicated to GCMS operations, funded as the GCMS Registrar of Collections. This person would be responsible for the accuracy and completeness of the data and records in the GCMS data catalogs and would be the liaison between the national governing board and the local repositories.



Local Responsibilities

The general consideration for implementation of the GCMS is that all active USGS geologic sample repositories would form the core of GCMS and that these repositories would need to conform to national criteria. Consequently, each repository should be responsible for ensuring the implementation of GCMS standards and protocols.

A local advisory committee should be established at each facility and a start-up plan formulated to ensure that operations will be fully compatible with the GCMS. Because each repository will have different issues and concerns while initiating GCMS policies and procedures, each center should be responsible for assessing its own capabilities and requirements.

Each repository should complete an initial, generalized inventory of its holdings and ancillary records to determine if any collections qualify for the GCMS. If so, the repository should draft a collections management plan in accordance with the minimum standards stipulated by the GCMS Procedural Handbook (see appendix 4, p. 67). Because the GCMS would be a virtual repository and rely on the operations of existing physical repositories, science centers would need to determine if current staffing levels are adequate to perform the detailed evaluation and cataloging of its legacy and inactive collections. The individual research scientists will be tasked with capturing the relevant data for current collections in their offices.

Each repository is responsible for the long-term management of its samples, including **acquisitions**, loans, and deaccessioning. To this end, materials held by individual repositories should be regularly reviewed for appropriateness and retention.

From Chaotic to Composed—The Meteor Crater Collection

The Meteor Crater, also known as the Barringer Crater, is a bowl-shaped depression 180 meters deep and 1.2 kilometers across in north-central Arizona on the southern edge of the Colorado Plateau. During the early 1970s, the USGS conducted a rotary drilling program on the rim and flanks of the crater, completing 161 drill holes and collecting over 2,500 meters of drill cuttings, spanning the entire extent of the crater's ejecta blanket. These samples were stored in cargo containers on the USGS Flagstaff campus and were largely neglected for several decades.

In 2007, Flagstaff personnel recognized the worth of making the samples and data more accessible for research purposes, so they enlisted the help of the Core Research Center in Denver, Colorado, to develop a plan to document, manage, and preserve the Meteor Crater collection. All necessary supplies were considered: new core boxes, new storage shelving, and new labels. Based on those recommendations, a successful proposal to the National Aeronautics and Space Administration (NASA) secured the funding to put the plan into action. Work began in 2008 to re-house and transfer the samples from the cargo containers to a more permanent and accessible location at the Flagstaff Science Center.

In addition to physical relocation of the samples, pertinent data were captured and integrated into a GIS-based digital elevation model (DEM) of Meteor Crater. A Web site was developed to provide access to the database, aerial photographs, topographic maps, isopach maps, the digital geologic map of Meteor Crater, photographs of each sample box, remote sensing data, and the GIS layers and DEMs. All digital layers will be viewable through an online viewer and will be available for download for further analysis in open and common GIS formats.

The Web site also includes a sample request page. Researchers will be able to pinpoint their samples of interest within the ejecta blanket and will have access to the available sample data. In the event that a researcher wishes to borrow a sample for further study, established protocols of the GCMS policies for checkout and return of samples will apply.

Appendix 6 describes three additional examples of GCMS influence on collections management.

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For More Information

- Geology Discipline Research Records Schedule: http://www.usgs.gov/usgs-manual/schedule/432-1-s5/gd.html
- National Digital Catalog: http://datapreservation.usgs.gov/catalog.shtml
- System for Earth Sample Registration (SESAR): http://www.geosamples.org/

USGS Repositories

- Coastal and Marine Geology InfoBank (Santa Cruz and Menlo Park, Calif.): http://walrus.wr.usgs.gov/infobank/
- Core Research Center (Denver, Colo.): http://geology.cr.usgs.gov/crc/
- Woods Hole Coastal and Marine Science Center Samples Repository (Woods Hole, Mass.): http://woodshole.er.usgs.gov/operations/ia/samprepo/

Glossary

4-point standard The minimum four data points for geologic materials in the GCMS: sample number assigned in the field (what), geographic location of field station (where), collector (who), and date collected (when).

A

accession The process by which a specimen or collection is formally and permanently accepted into custody.

acquisition An addition to the holdings of a repository by deposit or transfer.

active collection A suite of samples from ongoing research that is actively used by project scientists.

active repository A long-term facility with policies and procedures that govern the long-term management of the collections in its care. Geologic repositories contain both samples and their related metadata. *See also* ephemeral repository, inactive repository.

ancillary geologic records The field notes, maps, analytical results, and other documentary evidence that accompany an object-based collection.

C

cataloging The process of recording sample metadata in a centralized database, usually with some kind of index numbering system, in any medium.

chain of custody The documentation of sample ownership by successive parties.

collection A set of samples that have been brought together on the basis of some common characteristic. *See also* active collection, directed research collection, field collection, general collection, legacy collection, new collection, orphan collection, research collection, sample collection.

collection management The ongoing process of acquiring and maintaining a collection. It involves defining the policies and procedures that govern sample handling, labeling, storage, cataloging, conservation, and access to the samples.

collector The individual or field party that collected the original sample.

curation *See* collection management.

D

data Individual facts, figures, or other items of information organized for analysis.

date Year, month, and day that the sample was collected.

daughter sample A sample that constitutes a subset of the original sample.

deaccessioning The process by which a specimen or collection is formally and permanently removed from custody.

directed research collection A specifically targeted subset of a research collection, such as a group of field collections or a selection of samples from several field collections that is used for a common study.

disposal The permanent removal of an object from a collection when it is deemed to have no future research value.

disposition The outcome of the collection evaluation process that decides if a collection is to be retained, transferred, or thrown away. *See also* deaccession, disposal.

E

ephemeral repository A temporary storage arrangement with no provision for identifying, recording, or preserving the geologic samples contained therein. *See also* active repository.

F

field collection A suite of samples collected during the course of a researcher's field work and used for a unified study. Several field collections make up research collection.

fossils The remains or traces of living things from the geologic past preserved in rock, sediment, or other substrate (such as ice or tar).

Glossary *(continued)*

G

general collection A collection of samples and materials that require similar management practices and datasets, such as the Core Research Center in Denver, Colorado. A general collection may also contain several collections of disparate materials that are related geographically.

Geologic Collections Management System (GCMS) A management plan and online catalog for the coordination of USGS geologic sample collections from various locations within the United States.

Geologic Materials Repository (GMR) A digital catalog that documents geologic samples collected by the USGS that are housed in various facilities throughout the United States.

geologic samples Samples composed of solid-earth materials collected for scientific research in paleontology, mineralogy, geochemistry, petrology, and planetary geology.

geoscience Any science or study focused on earth-related systems and materials, including geology, oceanography, atmospheric sciences, ecology, and geography; geoscience samples and collections are not limited to solid-earth materials.

I

iconic value Important or special worth for historical or institutional reasons (for example, a former Director's field collections or collections from the founding surveys of the USGS).

inactive repository A sample storage facility that does not actively manage the collections stored there. *See also* active repository, ephemeral repository.

Interagency Working Group on Scientific Collections (IWGSC) A Federal committee convened to develop common strategies for the management of scientific collections. This group included representatives from the USGS and other Federal agencies with scientific collections.

International Geo Sample Number (IGSN) Unique international sample identifier administered by the System for Earth Sample Registration (SESAR).

L

legacy collection A suite of samples collected by a research scientist who is no longer with the USGS.

location The geographic site, defined in XY and sometimes Z coordinates, where the sample was originally collected.

M

metadata Documentation about a sample or collection that describes pertinent background information, including field information (original geographic location, collector, date, specimen number), the nature of the material, and any associated descriptive characteristics.

N

National Digital Catalog (NDC) Digital inventory and catalog of geological and geophysical data and collections held by agencies in the U.S. Department of the Interior, as well as by State geological surveys. Known informally as NatCat, it is administered by the National Geological and Geophysical Data Preservation Program (NGGDPP).

National Geological and Geophysical Data Preservation Program (NGGDPP) A program created by the Energy Policy Act of 2005 to develop a national network of cooperating State and Federal repositories of geoscience materials and data that are operated independently yet are guided by common standards, procedures, and protocols for metadata. Under this program, the holdings of all collections will be widely accessible through a common Internet-based catalog, the National Digital Catalog. The holdings of the individual repositories will complement each other to preserve the geoscience assets of the Nation and serve as a comprehensive source of geoscience data and materials to serve national needs today and in the future.

new collection A suite of samples that is new to the GCMS. It would be collected and maintained using the GCMS business plan template and would be accessible through the GCMS interface.

O

organic act Legislation that authorizes the establishment of any Federal agency.

orphan collection A collection that, for a variety of reasons (such as the lack of pertinent sample data), is deemed to have little foreseeable research value. This type of collection will not be included in the GCMS but may be made available to other entities for education or outreach purposes.

Glossary *(continued)*

P

parent sample The original sample from which daughter samples (subsamples) are derived.

policy The guiding principles designed to influence and determine decisions and actions.

preservation Various steps necessary to care for geoscience data and collections including data acquisition, organization and maintenance, user awareness of samples and data, data accessibility, and assurance that the data are useful and of sufficient quality.

procedure A set of established forms or methods for carrying out policy.

provenance The history of ownership of data or samples.

R

reference collection A group of samples that provides an objective standard against which other samples are compared.

repository A facility that assumes responsibility for the long-term management of physical collections.

re-sampling The act of retrieving an archived sample for the purpose of additional scientific inquiry.

research collection A subset of a general collection defined by disciplinary, temporal, or geographic parameters.

resource collection A suite of samples from a completed project or research topic that remains significant as research assets. Samples are housed in a GCMS repository and are made available for current and future research.

S

sample Any material collected for research purposes as a representative example of the field location.

sample collection A collection of materials from a single sample, such as multiple microfossils recovered from a single sample.

sample data Information that describes and defines a sample.

sample identifier Alphanumeric identifier (ID) assigned to an individual sample to differentiate it from other samples in its collection group. Different IDs may accrue to the same sample as a result of processing performed by various analytical labs.

ScienceBase The agency-wide cyberinfrastructure for the comprehensive management of digital information that catalogs, indexes, and publishes records of scientific data and metadata within the USGS and the greater geoscience community.

secondary sampling *See* re-sampling.

site ID Identifier (ID) of a specific sampling site in XYZ coordinates (such as for a sample site, core hole site, or measured sections site).

specimen *See* sample.

stewardship The responsibility to manage and preserve property in accordance with the policies and procedures of the sponsoring agency or institution.

subsample *See* daughter sample.

System of Earth Sample Registration (SESAR) A centralized registry that provides and administers International Geo Sample Numbers (IGSNs)—universally unique identifiers for geoscience samples. This registry is supported by the National Science Foundation and is managed as part of the Geoinformatics for Geochemistry Program.

T

type specimen A selected specimen that provides an objective standard of reference for geologic identification or taxonomic name.

U

universally unique identifier (UUID) A designation assigned to each sample to distinguish it from all other samples in the GCMS. Use of a UUID prevents ambiguity by systematizing sample designation and ensures that the accessibility of all information associated with a sample is preserved on a global scale.

W

working collection *See* active collection.

Appendixes

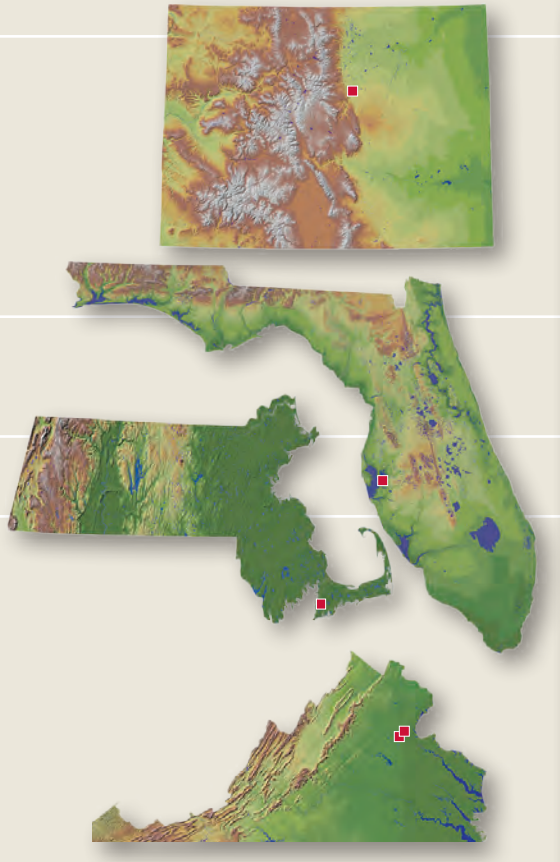
Appendix 1. USGS Geologic Sample Repositories and Collections (2008)

[Collection type: G, geologic; P, paleontological. AK, Alaska; AZ, Arizona; CA, California; CER, Central Energy Resources; CO, Colorado; ID, identifier; NPR4/NPRA, Naval Petroleum Reserve No. 4/National Petroleum Reserve–Alaska; PI, principal investigator; USGS, U.S. Geological Survey; WCMG, Western Coastal and Marine Geology; WESP, Western Earth Surface Processes]

State	City	ID	Collection Name	Type
AK	■ Anchorage	65	AK Rock Warehouse	G
		66	AK Technical Data Unit–Field Records	G
		209	AK Paleontologic Collection—hand samples	P
		210	AK Paleontologic Collection—Foraminifera reference collection	P
		211	AK—Blodgett mega-fossils collection	P
		212	AK Technical Data Unit–Thin Sections	G
		213	AK Petrographic Research—PI Collections	G
		229	AK—NPR4/NPRA well cores	G
AZ	■ Flagstaff	68	Eugene Shoemaker Research Collection—Meteor Crater sample collection	G
		69	David Roddy Research Collection—Impact Craters sample collection	G
	■ Tucson	228	Red Mountain AZ drill core	G
		270	Waldemar Lindegren Economic Geology Collection	G
CA	■ Menlo Park	81	WCMG—Marine, terrestrial, and lacustrine sediment cores	G
		226	WESP—Paleomagnetism Lab—oriented rock samples	G
		227	WESP—Tephrochronology Lab—tephra and obsidian samples	G
		232	WCMG—Foraminiferal Collection	P
		233	WESP—Radiolarian microfossil collection	P
		234	WESP—Foraminifera microfossil collection	P
		287	WESP—Drill Core Samples and Logs—Industry and USGS sources	P
		290	WESP—Invertebrate Megafossils (mollusks) collection	P
CO	■ Denver	70	Denver Paleontology Collections—Invertebrate Fossils	P
		71	Denver Paleontology Collections—Vertebrate Fossils	P
		72	Denver Paleontology Collections—Microfossils	P
		222	Conodonts (CER—Colorado Paleontological Collection?)	P
		223	Palynomorphs (CER—Colorado Paleontological Collection?)	P

Appendix 1. USGS Geologic Sample Repositories and Collections (2008).—*Continued*

[Collection type: G, geologic; P, paleontological; approx., approximately; CCWS, Center for Coastal and Watershed Studies; CESP, Central Earth Surface Processes; CIC, Crustal Imaging and Characterization; CO, Colorado; DFC, Denver Federal Center; ECMG, Eastern Coastal and Marine Geology; EESP, Eastern Earth Surface Processes; FL, Florida; ICDP, International Continental Scientific Drilling Program; ID, identifier; MA, Massachusetts; MRP, Mineral Resources Program; USGS, U.S. Geological Survey; VA, Virginia]

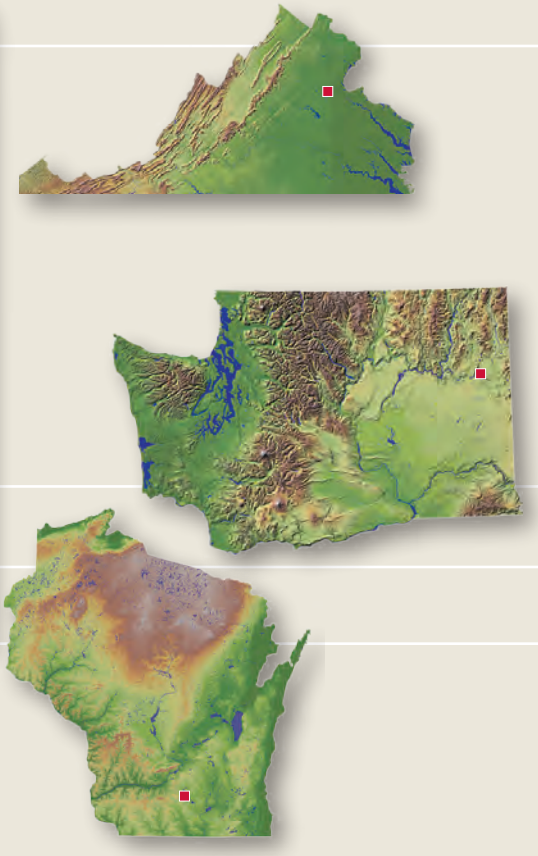


State	City	ID	Collection Name	Type
CO	■ DFC Lakewood	67	Ice Core Collection	G
		78	MRP Geochemical Lab samples (“prepared geochemical samples”)	G
		80	Rock Core samples and Well Cuttings	G
		103	Rock Samples	G
		217	CIC—USGS Geochemical Reference Materials	G
		231	CIC—National Geochemical Soil Survey samples	G
		268	CESP—Tephra and related samples + ancillary docs	G
FL	■ St. Petersburg	82	CCWS—Coral Cores	G
		83	CCWS—Sediment Cores (vibracores)	G
		235	ECMG —Gulf of Mexico marine benthic foraminifera	P
MA	■ Woods Hole	79	ECMG—Seabed Core and Sediment Sample Archive	G
		230	ECMG—Foraminifera microfossil collection	P
VA	■ Herndon	220	EESP—Borehole cores (approx. 40 localities) from Coastal Plain sediments	G
		221	EESP—Borehole cores (approx. 20 localities) of crystalline rocks	G
	■ Reston	73	EESP—Conodonts	P
		74	EESP—Cenozoic Nannofossils	P
		75	EESP—Mesozoic Nannofossils	P
		76	EESP—Palynology	P
		77	EESP—South Florida Paleoecology	P
		104	EESP—Quaternary Ostrocodes	P
		214	EESP—Chesapeake Bay impact crater project drill cores	G
		215	EESP—ICDP-USGS Eyreville drill core	G
		216	EESP—USGS Physics Building Rock Storage Area	G
		218	EESP—Borehole cores (approx. 45 localities) of Coastal Plain sediments	G
		219	EESP—Borehole cores (approx. 5 localities) of crystalline rocks	G

Appendix 1. USGS Geologic Sample Repositories and Collections (2008).—*Continued*

[Collection type: G, geologic; P, paleontological. DOE, U.S. Department of Energy; EER, Eastern Energy Resources; EESP, Eastern Earth Surface Processes; ID, identifier; MI, Michigan; PRISM, Pliocene Research, Interpretation, and Synoptic Mapping; TN, Tennessee; USGS, U.S. Geological Survey; VA, Virginia; WA, Washington; WI, Wisconsin; WMR, Western Mineral Resources]

State	City	ID	Collection Name	Type
VA	Reston	224	USGS—Dave Stewart collection	G
		236	EESP— PRISM Planktic Foraminifera collection	P
		237	EESP—Cenozoic pollen collection	P
		238	EESP—Modern and fossil pollen collection—microscope slides	P
		239	EESP—Modern and fossil pollen collection—processed residue archive	P
		271	EER—Drill core from DOE/TN Division of Geology wells	G
		272	EER—Geologic Sample Collection	G
		279	EER—Creede (MI) Collection	G
		291	EESP—Atlantic and Gulf Coastal Plain Upper Cretaceous & Cenozoic fossils	P
		292	EESP—South Florida Ecosystem History collection	P
		293	EESP—South Florida Geohydrologic core sample collection	P
WA	Spokane	225	WMR—Fluorospar Collection	G
		269	WMR—Spokane Geologic Collection	G
WI	Middleton	84	Wisconsin bedrock cores	G
		85	Wisconsin benthic invertebrates	G



The information in this appendix is the result of a survey administered by the U.S. Geological Survey (USGS) National Geologic and Geophysical Data Preservation Program (NGGDPP) in late 2007 and early 2008 to identify repositories actively managing geologic collections and to assess the state of geologic collections throughout the USGS. The repositories, locations, and acronyms listed here are what were provided by the original 2008 survey results; some information might have since changed.

Appendix 2. GCMS Preferred Sample Data

These attributes are the possible data points that should be collected for USGS samples and form the basis for the GCMS data catalog template.

[GCMS, Geologic Collection Management System; PLSS, Public Land Survey System; USGS, U.S. Geological Survey; UTM, Universal Transverse Mercator coordinate system; UUID, universally unique identifier]

Attribute	Definition
GCMS identifier	Universally unique identifier (UUID) assigned to the sample upon registration in the GCMS
Site identifier	Identifier given to the field station where the sample was collected
Other identifier	Any other identifier(s) assigned to the sample throughout its history from collection to analysis to storage
Repository number	Identifier assigned to the sample by the storage repository
Laboratory number	Identifier assigned to the sample by laboratory performing analyses
Field number	Identifier assigned to the sample in the field when collected
Other number	Any other identifier assigned to the sample
Latitude	Latitude where sample was collected, given in decimal degrees
Longitude	Longitude where sample was collected, given in decimal degrees
UTM x	UTM x coordinate where sample was collected
UTM y	UTM y coordinate where sample was collected
UTM zone	UTM zone where sample was collected
Quadrangle	Name of USGS topographic quadrangle where sample was collected (automatically generated from latitude and longitude or UTM coordinates)
Scale	Scale of map quadrangle used when sample was collected
Projection	Projection datum
Township	The 36-square-mile area of land defined by the Public Land Survey System (PLSS)
Range	The vertical column of townships in the PLSS
Section	1/36 part (640 acres) of the township in the PLSS
Fraction of section	Any subdivision of the section in the PLSS
Meridian	Line chosen as the starting point for all sectionalized land in the area
Federal land unit	Name of Federal land unit (park, refuge, wilderness, etc.) where sample was collected, if applicable
Collection permit	Permit number which authorized collection from Federal land unit
Other Location	Any other location identifier within the collection information
Cruise	Field activity identifier for research conducted at sea
Field party	Name of project under which the sample was collected

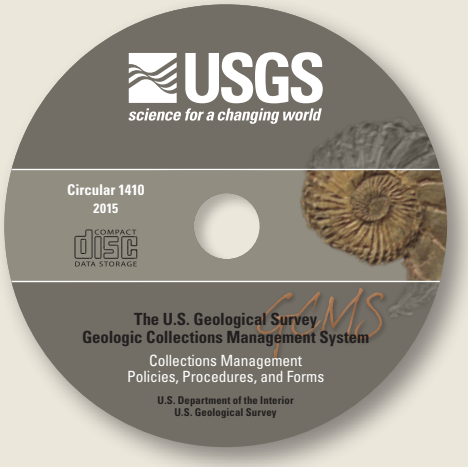
Appendix 2. GCMS Preferred Sample Data.—*Continued*

These attributes are the possible data points that can be collected for USGS samples and form the basis for the GCMS data catalog template.

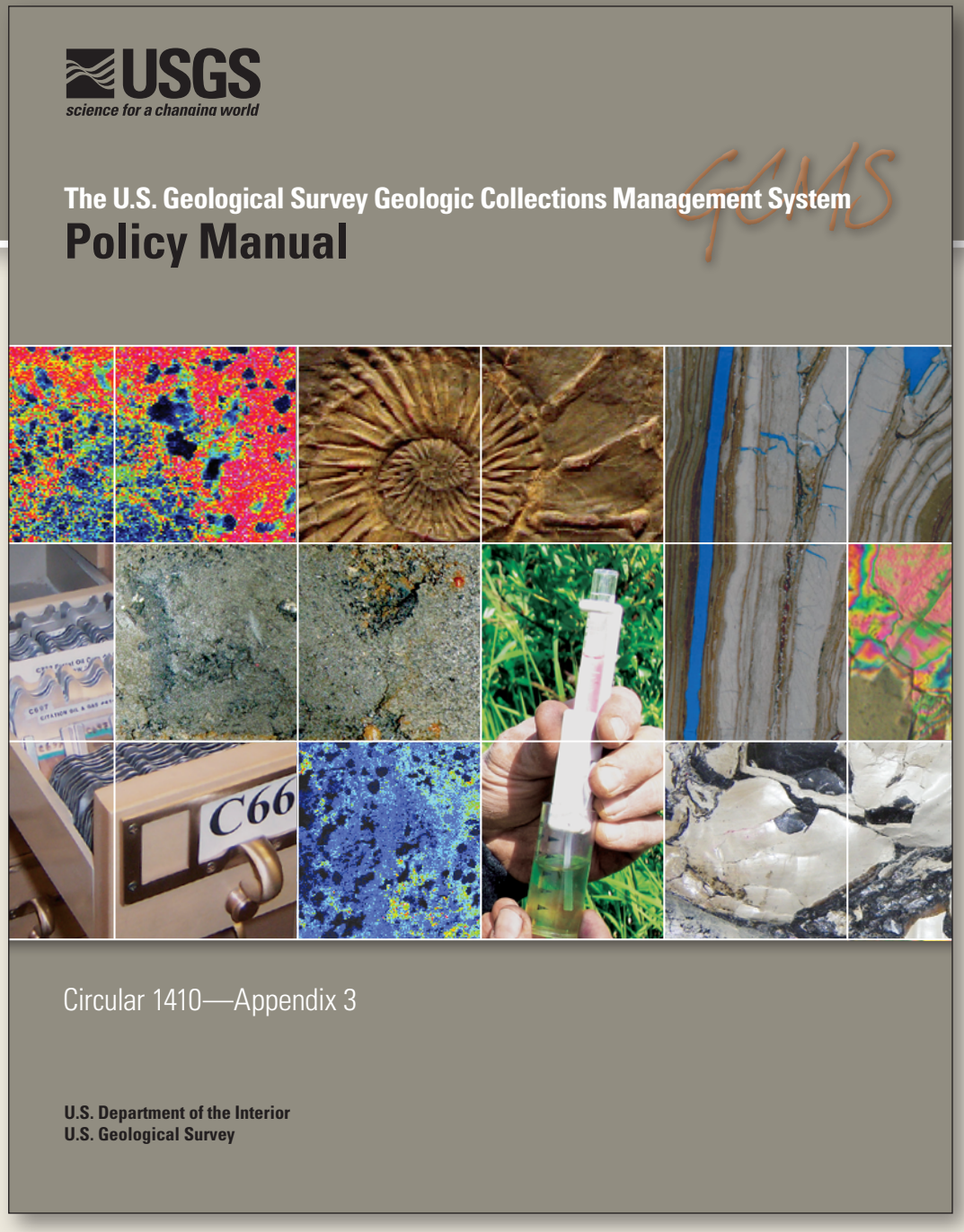
[GCMS, Geologic Collection Management System; PLSS, Public Land Survey System; USGS, U.S. Geological Survey; UTM, Universal Transverse Mercator coordinate system; UUID, universally unique identifier]

Attribute	Definition
ddmmyyyy	Date of collection given in the format dd, day; mm, month; yyyy, year
Julian day	Julian day of collection (automatically generated from *ddmmyyyy*)
Year	Year of collection (automatically generated from *ddmmyyyy*)
Purpose	Primary reason for collection or analyses to be performed
Fossil	Type of fossil sample (selection available from drop-down menu)
Rock	Type of rock sample (selection available from drop-down menu)
Sediment	Type of sediment sample (selection available from drop-down menu)
Soil	Type of soil sample (selection available from drop-down menu)
Core	Type of core sample (selection available from drop-down menu)
Sidewall	Type of sidewall sample (selection available from drop-down menu)
Cuttings	Cuttings category (selection available from drop-down menu)
Auger	Auger category (selection available from drop-down menu)
Water	Water category (selection available from drop-down menu)
Derivative	Derivative category (selection available from drop-down menu)
Other sample type	Any other type of sample not defined above
Group	Geologic name given to the group of rocks from which the sample was collected
Formation	Geologic name given to the rock formation from which the sample was collected
Member	Geologic name given to the formation member from which the sample was collected
Unit	Geologic name given to the member unit from which the sample was collected
Other geologic name	Any other geologic identifier not defined above
Facility name	Repository where the sample is physically located
Location of facility	Physical address for the repository where the sample is located
Repository code	GCMS-assigned repository identifier
Collector	Name of person who collected the sample

Appendix 3.
GCMS Policy Manual



*The **GCMS Policy Manual** is available for print as a PDF file included on a CD found at the back of this publication.*



GCMS Policy Manual
Contents

GCMS Policy Manual

This appendix provides an example of a collections policy manual developed for the Geologic Collections Management System (GCMS). It is intended to be used in conjunction with the suggested policies set out in the GCMS Operating Plan (Geologic Materials Repository Working Group, 2010).

Each repository or science center that maintains geologic collections will need to consider and address the following issues of responsibility and authority:

1. *Who will be on the Local Advisory Committee?*
2. *Who will be responsible for setting policies and procedures?*
3. *Who is, or will be, the Collections Manager?*
4. *What will the Collections Manager do?*
5. *Who will be the point of contact for information about the collections?*
6. *Will the Collections Manager be a member of the Local Advisory Committee?*

Clearly defined roles and duties for the personnel responsible for the collection materials will ensure that the repository is able to provide the necessary conditions for preservation, maintenance, reliability, accessibility, integrity, confidentiality, and security. In doing so, standards of accountability will be consistent throughout the GCMS.

Preamble

For over a century, the U.S. Geological Survey (USGS) has been dedicated to the study of earth history and the geologic processes that shape our physical world. Research personnel perform the tasks of field mapping and laboratory analysis to unravel the complex systems that govern resources, hazards, and landforms, as well as the interactions of the earth's surface with the biosphere and atmosphere. Research results are published in a timely manner so that government officials can incorporate the results into their policy-making decisions and the general public can apply relevant information to their everyday lives.

A major component of geologic research is tied to the physical samples that field personnel collect and analyze. These collections and their ancillary records serve as primary reference materials for understanding the solid earth and the processes that form our world. Materials range from fossils, rocks, and soil to stream and lake sediments, from mineral separates to analytical residues. Because these samples have both immediate and long-term value for research purposes, the USGS is committed to documenting, maintaining, and preserving its collections in the best of possible circumstances. By providing this long-term stewardship, the USGS guarantees their continued accessibility by staff scientists, outside researchers, and the general public.

Purpose

This document establishes policies and guidance for the management, use, and preservation of USGS geologic materials collections. These policies provide direction, define objectives, establish expectations, and develop consistency. They are intended to unify operations throughout the GCMS and have been designed to promote the long-term preservation of USGS geologic collections under minimum standards of care.

Mission Statement

The USGS characterizes the geological landscape and provides the Nation with fundamental geochemical and geophysical data necessary to address major societal issues involving geologic hazards and disasters, climate variability and change, energy and mineral resources, ecosystems and human health, and groundwater availability. The Geologic Collections Management System (GCMS) supports this mission as part of the agency's data integration effort by creating a uniform infrastructure and standardized master catalog of all USGS geologic sample collections. As a virtual network linking physical collections, the GCMS facilitates access to these samples by USGS personnel and the public through a Web-based portal. The set of common business and management practices developed by the GCMS promote the long-term preservation of these national resources.

Scope of Collections

Geologic collections at the USGS fall into general categories that include, but are not limited to, hand samples (rock, mineral, and geotechnical), drill cores and cuttings, stream sediments, fossils, fluids, and ice cores; some of the collections may contain a mixture of several types. There are also collections that are the result of analytical studies of field samples. These collections are retained because they are essential to the research mission of the USGS.

Relevant Concepts

Chain of custody is the documentation of sample ownership by successive parties; the principle of documenting where a sample originated, where it is currently located, and all intermediary steps that have occurred from acquisition through accession. This documentation begins with the collecting scientist, accompanies the sample throughout its research history, and is incorporated into the repository's permanent records.

Collecting units are those projects and personnel authorized by the Director, or Director's representative, of the U.S. Geological Survey (hereafter referred to as the Director) to conduct field studies and collect physical samples in the course of their research.

A **collection** is a set of samples that have been brought together on the basis of some common characteristic. These samples are grouped by project topic, geographic area, sample type, or another unifying theme. Collections are maintained in an orderly manner, governed by defined policies and procedures, and managed in the public trust for present and future research purposes.

Collections management is the ongoing process of acquiring and maintaining a collection. It involves defining the policies and procedures that govern sample handling, labeling, storage, cataloging, conservation, and access to the samples.

A **collections management plan** is a procedural manual with specific practices and protocols related to sample handling, management, and preservation within the repository. These procedures reflect the guiding principles specified in the collections management policy.

A **collections management policy** guides the content of the collections to be compatible with the USGS mission of earth sciences research and guides collection decisions to be prudent, responsible, and informed. By providing the basis for procedural actions, the policy presents a consistent context for decisions regarding the handling, retention, and disposition of samples and ensures that collections are managed according to specific standards and strategies.

The **GCMS Governing Board** is the national committee that advises the National Geological and Geophysical Data Preservation Program (NGGDPP) Coordinator in establishing policies and protocols for the handling of USGS geologic materials collections.

The **Local Advisory Committee** guides the implementation of GCMS protocols at the science center level.

The **Registrar of Collections** is responsible for the accuracy and completeness of the data and records in the GCMS data catalogs. The Registrar will be the focal point for information exchange and interoperability of all collections management plans and database quality and usability control.

Background

The USGS collects geologic materials in support of its mission to investigate earth systems and the processes that shape the physical world. This collection process is guided by scientific questions proposed by research projects. The USGS has also acquired collections from other agencies and private sources that further the bureau's mission. These collections form the intellectual basis for scholarship, discovery, and education. Because these materials may prove impossible or prohibitively expensive to re-collect, it is critical to maintain and preserve the collections for present and future research purposes.

The sundry civil expenses bill, the USGS Organic Act of March 3, 1879 (20 Stat. 394; 43 U.S.C. 31), established the U.S. Geological Survey. Also, as amended, it directed that

> *All collections of rocks, minerals, soils, fossils, and objects of natural history, archaeology, and ethnology, made by the National Ocean Survey, the United States Geological Survey, or by any other parties for the Government of the United States, when no longer needed for investigations in progress, shall be deposited in the National Museum [Smithsonian Institution's National Museum of Natural History]. (20 U.S.C. 59)*

Because many USGS collections are used and referenced on a regular and continued basis, it has not been practical to turn over major collections of geologic materials to the National Museum of Natural History (NMNH). It is the mission of the GCMS, however, that USGS collections be maintained and preserved in a manner consistent with NMNH policies and procedures so as to streamline the ultimate transfer of any scientifically or historically significant collections to the NMNH or other appropriate museum.

Applicability

This policy applies to all USGS personnel who collect geologic materials for research purposes or manage those collections for preservation and access purposes. All staff and volunteers are required to adhere to the collections management policies and procedures established in this document.

Authority and Responsibility

The USGS collections management authorities and responsibilities are delegated as follows.

USGS Director (or Director's Representative)

- Establishes performance measures for monitoring and reporting progress towards the implementation of collections management standards.

The direct line of authority from Director (or Director's representative) to NGGDPP Coordinator should be followed in all information and decision exchanges both up and down the line of authority.

NGGDPP Coordinator

- Recommends and approves GCMS collections management policies and procedures.
- Appoints USGS personnel to the GCMS Governing Board.
- Solicits outside participation in the GCMS Governing Board.
- Oversees the activities of the GCMS Governing Board.

GCMS Governing Board

- Advises the Director (or Director's representative) and NGGDPP Coordinator in establishing policies and protocols for the handling of USGS geologic materials collections.
- Oversees the administration, implementation, and operation of the GCMS.
- Reviews and approves local collections management plans developed by individual science centers.
- Reviews and revises the national collections strategy as needed.

GCMS Registrar of Collections

- Advises and assists the GCMS Governing Board in the establishment, implementation, review, and revision of the GCMS collections management policy.
- Advises and assists the Local Advisory Committees to develop, implement, and revise the science center collection management policies and procedures.
- Monitors and documents compliance of the local repository plans with the national strategy.
- Verifies the accuracy and completeness of the data and records in the GCMS data catalog.
- Ensures conformity of indexing and database format with the standards established by ScienceBase.

Local Advisory Committee

- Guides the implementation of GCMS protocols at the science center level.
- Reviews and approves the local repository's collections management plan.
- Advises the local collections manager on issues of sample access, loans, and disposition.

Science Center Director (or Equivalent)

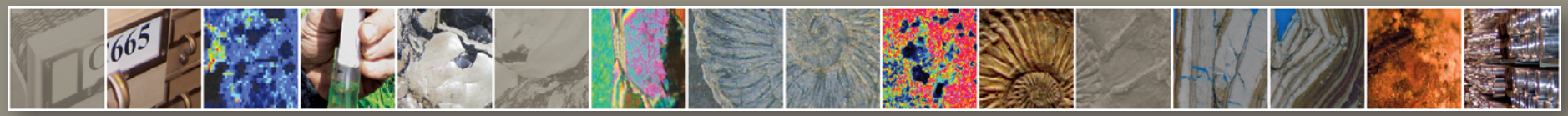
- Provides policy guidance and budget support needed to carry out the collections management responsibilities of their local repository in accordance with established protocols.
- Ensures compliance of project staff to policies and procedures of the local repository's collection management plan.

Collections Manager

- Develops the local collections management plan that provides for the long-term care and preservation of the Science Center's collections.
- Ensures that the local plan is consistent with the policies and procedures of the national strategy.
- Works in conjunction with project scientists to ensure that collected materials are adequately documented.
- Implements procedures to manage and preserve collections.
- Works with the GCMS Registrar to ensure conformity with metadata and indexing protocols outlined by the National Digital Catalog and established by the GCMS.

Project Leader

- As part of the project proposal process in BASIS+, develops a collection management plan that is consistent with the local repository's plan.
- Ensures that project personnel adhere to the policies and procedures of the collection management plan.



Project Scientist

- Follows the policies and procedures of the project's collection management plan.
- Deposits individual collections in the local repository at the end of the research process but no later than publication of the first research paper associated with those collections.

Policy Elements

The following policy elements are intended to establish protocols at all levels of collections management. They are designed to standardize operations among the physical repositories where collections are currently housed.

Overall Authority

- The Director (or Director's representative) has ultimate authority for approving the policies, procedures, and decisions enacted by the GCMS Governing Board.

Administration

- The GCMS Governing Board will oversee the administration, implementation, and operation of the GCMS. Policies and procedures established by this board are binding, yet are flexible enough to give local repositories the necessary leeway to adapt the methodologies to their particular collections.

Local Advisory Committee

- Each science center that maintains collections of geologic materials would be deemed an active repository and should establish a Local Advisory Committee to oversee implementation of GCMS standards at that location. Committee members could include the center director or operations manager, the collections manager, and individual research scientists. Committees should be kept small (3–5 members), and the research scientists would serve limited terms of appointment.

Collections Management Policy

- Each active repository will develop a written collections management policy to ensure the proper documentation, physical care, preservation, and accessibility of its collections. The policy should be specific to the nature, scope, and character of those collections. Components of the policy should include (1) a statement of purpose, (2) a primary statement of authority, (3) a definition of the collection, and (4) a statement of collection's scope. Upon completion, the repository's policy manual will be submitted to the GCMS Governing Board for review and approval. It will be periodically reviewed and revised, as needed.

Collections Management Plan

- Each active repository should have a collections management plan for the organized handling, storage, preservation, and tracking of samples; the plan must conform to the basic standards of the GCMS. Appendix 4 contains a procedural manual that may be modified to fit the needs of the individual repositories.

Repository Responsibility

- **Collection evaluation**—Each active repository should be responsible for evaluating its own collections for retention or disposal according to the procedures laid out in appendix 4. All materials will be assessed on the basis of their long-term research value and the existence of ancillary geologic records. Collections that do not meet the minimum criteria will not be retained, as collections, by the USGS. Options for disposal are spelled out.
- **Collections catalog**—Each repository should be responsible for data acquisition and sample registration. The repository might have information that is critical for a specific collection but might not be necessary for the GCMS database. Therefore, samples will be cataloged using a format that captures the data necessary to their collections. The database attributes include, but are not restricted to, those provided online through the GCMS Web site.
- **Sample data**—Researchers will obtain and record required data when a sample is collected. These data will be compiled and entered into a local database or GCMS database template when the researchers return from their field seasons.
- **Sample usage**—The scientists will have exclusive use of the samples for the tenure of the project for which they were originally collected.

- **Accession**—When projects are completed, or within a predetermined period from the time of collection, the samples will be physically accessioned into the local repository and sample metadata digitally uploaded into the GCMS master catalog, allowing public access to both samples and ancillary data. Any exceptions to this disclosure will require approval by the Director (or Director's representative).
- **Registration**—The GCMS will assign a unique identification number to each sample when it is formally registered in the system. Although numbers may be assigned at different times for different sample types, it should occur prior to publication of the first research paper associated with those samples.
- **Stewardship**—All collections should be deposited into their designated repository when the samples are no longer in active use, either at the end of the research project for which they were collected or on the occasion of the principal investigator's departure from the USGS. At no time should the samples leave USGS custody without evaluation by the repository and documentation of their transfer.
- **Access**—Each repository should establish procedures for the secondary sampling of its collections. Access to samples after they have been deposited in a repository should be determined on a case-by-case basis and will be based on the policies of that specific repository.
- **Loans and secondary sampling**—Samples may be loaned to appropriate parties for research, exhibit, or education. If samples are loaned for analytical purposes, resultant data will be reported back to the repository within one year's time.

All samples remain USGS property unless properly transferred to another entity.

Health and Safety

Repositories will work with their local safety officers to ensure compliance with the Federal standards and regulations designed to protect the health and safety of employees and visitors. Occupational hazards will be identified and eliminated or mitigated. Training will be provided for the recognition and avoidance of unsafe conditions and behaviors.

Hazardous Materials

Any repository containing materials of a hazardous nature (asbestos, heavy metals, radioactive substances, and so forth) will work with its local safety office to ensure that those samples are handled and stored under appropriate conditions. If required, permits will be obtained to comply with Federal and State regulations. Employees will receive the necessary training to ensure their safety when working with these materials.

Ethics

The USGS recognizes and accepts its responsibility to provide proper management, preservation, and use of its collections and ancillary documents for the benefit of the scientific community and general public.

Federal employees and contractors for the USGS are legally, ethically, and professionally obligated to maintain the highest standards of honesty, integrity, and loyalty to the agency while so employed. Unauthorized use of USGS resources is prohibited and may subject the party to penalties under USGS policies or applicable laws. Samples collected by USGS personnel remain property of the U.S. Government and should not be sold, bartered, or otherwise used for personal gain.

Accounting for Collections

Collections maintained by the USGS are held for research and education in the furtherance of public service. They are not treated as assets for the purposes of reporting in the agency's financial statements.

Exceptions

Prudent exceptions to the GCMS collection management policy may be permitted in appropriate cases when in the best interest of the USGS. Exceptions must be approved by either the GCMS Governing Board, the NGGDPP Coordinator, or the Director (or Director's representative), depending upon the exception. Requests for exceptions should be made to the GCMS Registrar, who will facilitate the required review.

Compliance

All USGS staff with responsibility for collecting or managing geologic materials should have an element in their performance plan that affirms compliance with national GCMS strategy and the policies and procedures of the local repository. Collections managers will develop a compliance checklist for sample handling and data input and will be responsible to the GCMS Registrar for documenting compliance by maintaining local databases that make up the national system.

References

Cook, J.A., Bogan, M.A., Dunnum, J.L., and Ramotnik, C.A., 2007, Collection management policy: Albuquerque, N. Mex., University of New Mexico, Museum of Southwestern Biology, Division of Mammals, 19 p., accessed May 6, 2014, at http://msb.unm.edu/mammals/PolicyDOM.pdf.

National Museum of Natural History, 2006, National Museum of Natural History collections management policy: Washington, D.C., Smithsonian Institution, 48 p., accessed May 6, 2014, at http://entomology.si.edu/Collections/NMNH_CMP_Sept-18-2006.pdf.

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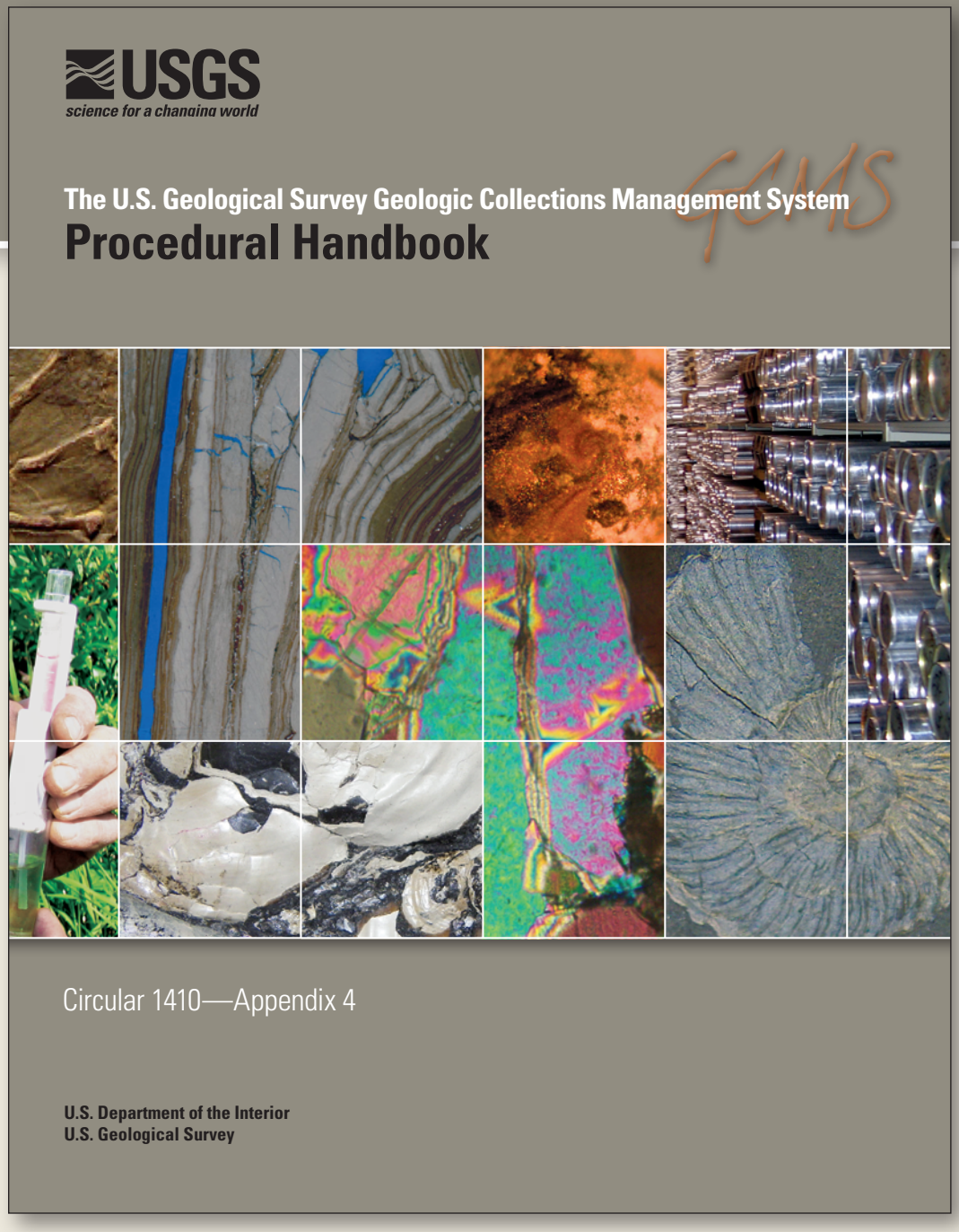
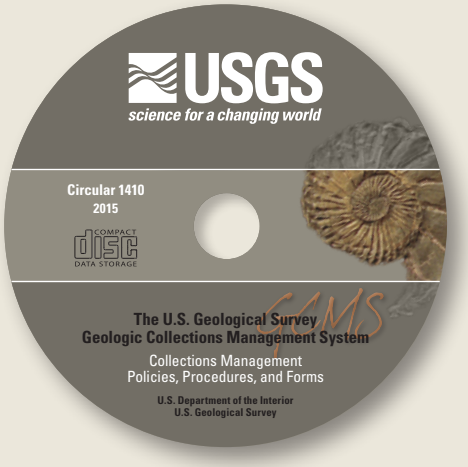


Appendix 4.
GCMS Procedural Handbook



*The **GCMS Procedural Handbook** is available for print as a PDF file included on a CD found at the back of this publication.*

GCMS Procedural Handbook
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GCMS Procedural Handbook

The primary responsibilities of any repository are to preserve the integrity and longevity of its collections, to offer access to the physical specimens, and to provide accountability for its practices. To accomplish these goals, the repository should address the physical conditions of sample storage, the cataloging of pertinent sample data, and the documentation of all actions and decisions affecting a collection.

This appendix and appendix 5 provide examples of a procedural handbook and forms (respectively) for development of a collections management plan. They have been designed to educate repository staff on the management of their collections according to minimum standards of care.

This handbook is organized into ten procedural elements of collections management. Each element, in turn, is described in three distinct aspects:

1. ***Principles**—the reasons for performing that activity.*
2. ***Policy**—the rules that govern that activity.*
3. ***Implementation**—the actions needed to carry out that activity.*

The Geologic Materials Repository (GMR) Working Group acknowledges that specific practices and methodologies for sample management will depend on the resources of the individual repositories and the nature of their collections. It is intended, therefore, that the local repositories use this handbook as a template and modify it as needed when preparing their governing documents. The procedures outlined herein are not set in stone, and each repository is encouraged to develop a procedural handbook that is specific to its collections.

The following questions and discussions should be given serious consideration when adapting the procedural models given here and the forms templates in appendix 5 to the individual repositories.

Evaluation of Collections

When accessioning collections into the repository, the collections manager will need to be able to answer the following questions:

1. What are these samples?
2. Do they have field or laboratory numbers associated with them?
3. Who collected them?
4. Where and when were they collected?
5. Why were they collected?
6. Are there nondigital records (such as field notes, collection permits, laboratory analysis folders, or metadata) that need to be preserved to provide additional sample documentation?

This information will be used in the GCMS Collections Determination Process (fig. 3) to evaluate a collection for retention or other disposition.

Collection Storage

It is imperative to evaluate collections in order to determine what the samples are and what is the best way to protect them from deterioration. Once the preservation needs of each collection have been identified, the storage conditions needed to adequately house the samples can be addressed. Managers should consider the following:

1. What are the physical natures of the samples in this collection?
2. Do the samples require specific storage conditions?
3. Are there hazardous materials in this collection that require permits or special handling?
4. Does this repository have the capability to store the samples in an optimum fashion?
5. How will the collections be stored for maximum ease of retrieval?
6. Should the collections be moved to a more permanent and (or) more suitable facility?

Labeling

A sample with a label can be associated with field records, analytical results, and publications; unlabeled samples have limited use for future scientific research. Repositories will need to decide on a consistent methodology to physically associate the GCMS Registration Number with its sample.

Indexing

The GCMS will provide the digital template that will be used in cataloging pertinent sample data. Repositories may incorporate any additional fields necessary to fully describe their collections. It is the responsibility of collections managers and project scientists to ensure the quality and completeness of the data entered.

Access to Collections

Although USGS collections The following issues should be addressed:

1. Are there restrictions on who has access to the collection?
2. How will onsite access to the collections be managed?
3. Are there safety issues to consider before granting access?
4. Do certain collections require safeguards to prevent contamination?

Re-sampling Collections

If samples are made available for study by personnel outside the science center, then the following issues should be considered:

1. Who has the authority to govern the loan process?
2. What policies should govern those loans?
    - What is the loan application procedure?
    - Who approves or denies loan requests?
    - How long will samples be loaned out?
    - Will there be restrictions regarding the amount of sample to be loaned?
3. How will resulting data be returned to the repository?

Documentation and Records Retention

All collections transactions and decisions are to be documented by written records in the repository's permanent files. An appropriate filing system will need to be set up to manage those records.

GCMS Procedural Handbook for Collection Repositories
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Figure

GCMS Procedural Handbook for Collection Repositories

Prologue

Once samples are deemed valuable and appropriate for retention, each repository develops and implements a written procedural handbook for the physical care and management of collection materials at that repository. The plan should detail the specific activities, procedures, and protocols that will be employed at the repository.

Working Definitions

- An **active collection** (also known as a working collection) contains material from ongoing research and is actively used by the project scientists. New samples are added as research continues. Upon completion of the research topic, the materials will be evaluated for permanent retention in a Geologic Collections Management System (GCMS) repository.
- A **legacy collection** contains samples from research scientists who are no longer with the U.S. Geological Survey (USGS). With proper documentation, these collections will be incorporated into the GCMS and treated as resource collections.
- An **orphan collection** consists of poorly documented samples with little foreseeable research value and do not warrant inclusion in the GCMS. They might still have value for education or outreach, however, and may be transferred to another entity with use for them.
- A **reference collection** contains samples of a distinct nature that provide an objective standard against which other samples are compared. This type of collection may be augmented with new samples to improve the standard.
- A **resource collection** contains materials, from completed research or projects, that remain significant as research assets and are made available for current and future research. These materials are expected to be preserved for an indefinite period of time.

Minimum Standards of Care

- **Identification**—The sample is easily linked to its documentation.
- **Documentation**—The metadata associated with the sample are useful for (1) placing that sample in space and time and (2) locating research results associated with that sample.
- **Documentation status**—The documentation associated with the sample is legible, physically stable, and correctly stored to preserve its utility.
- **Processing**—The samples are logged in, unpacked, sorted, and stored as is appropriate for their conservation.
- **Individual container**—The sample is housed in a container appropriate for its type.
- **Conservation status**—The physical state of the sample is stable.
- **Housing**—The samples are not crowded in their storage space and are arranged for easy retrieval.
- **Bulk storage**—The storage space is structurally sound and protects the samples from the environment, vermin, and tampering.

GCMS Procedural Elements

A. Acquisition and Accessioning

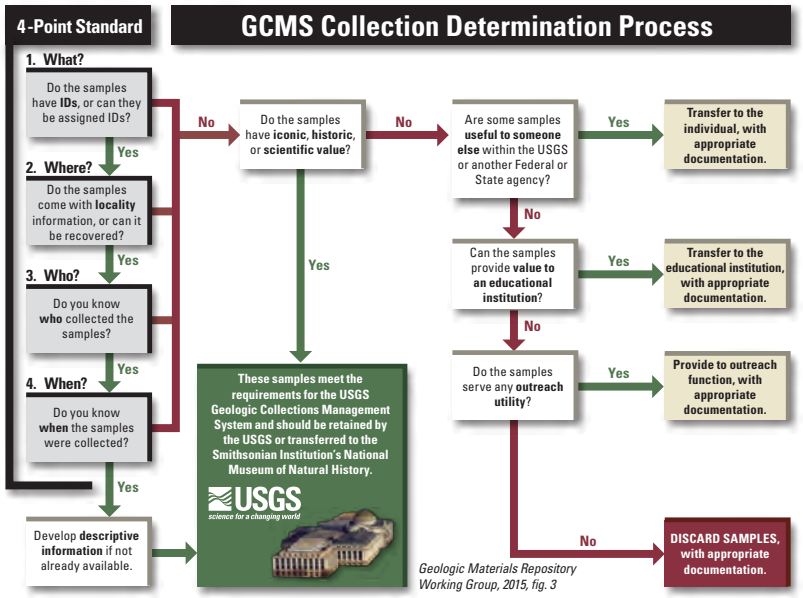
Acquisition of samples can occur through field collection, donation, or permanent transfer. **Accessioning** is the formal process used to deposit a physical collection into a USGS repository.

Principles

The acquisition of geoscience materials is critical to the science mission of the USGS. The USGS acquires geologic samples primarily through field collection by USGS scientists. Occasionally, the USGS acquires a collection from an academic or industrial source through the permanent legal transfer of ownership.

Policy

All collections acquired by the USGS, either through field work, donation, or permanent transfer, should be considered for accession into the GCMS. These collections would be evaluated using the GCMS Collections Determination Process flowchart. If these samples and collections meet the standard criteria proposed by the GCMS, the collections should be formally accessioned into the long-term care of the USGS and incorporated into the GCMS.



Geologic Materials Repository Working Group, 2015, fig. 3

Implementation

Active and Reference Collections

1. Work with project scientists to develop a collections management strategy prior to project proposal.
2. Educate project personnel about required sample data to be gathered in the field.
3. Once the samples are no longer needed for active research, follow procedures for evaluating and accessioning resource collections (see below).

Resource Collections

1. Once a research project has concluded, consult with the project scientists to determine which samples are still needed for active research.
2. Samples that are of no immediate use to active research projects will be considered for accession into the local repository.
3. Obtain field records from project scientists to compile ancillary documentation.
4. Using the 4-point standard (see flowchart at right), work with the scientists to determine which samples are appropriate for retention within the repository. It might not be necessary to retain all duplicate samples or bulk remainders; these types of samples may be considered for disposal.
5. Enter sample data into repository catalog and begin processing samples for permanent retention according to guidelines in Sections B, C, and D of this handbook.
6. Samples that are not suitable for retention may be removed from the repository according to guidelines in Section I of this handbook.
7. Complete and retain the evaluation and accessioning documents in the repository's permanent files.

Legacy and Orphan Collections

1. Define the scope of the collection to be evaluated, usually defined by the research project for which the sample was originally collected.
2. Consult the field records associated with the project to compile the ancillary documentation that pertains to the samples in the collection.
3. Using the flowchart on the previous page, determine which samples are appropriate for retention by the repository.
4. Enter sample data into repository's catalog and begin processing samples for long-term retention according to guidelines in Sections B, C, and D of this handbook.
5. Samples that are not suitable for retention may be removed from the repository according to guidelines in Section I of this handbook.
6. Complete and retain the evaluation and accessioning documents in the repository's permanent files.

B. Sample Data

Principles

Samples are most useful for research when they can be identified in space and time. Where and when the sample was collected, who collected it, and why it was collected are critical pieces of information that identify the uniqueness and character of the individual samples in a collection.

Policy

The GCMS recommends stipulated the information required for the identification and description of individual samples. Repositories are encouraged to use the GCMS data catalog (Microsoft Excel template, based on appendix 2) for their collections database. While not all metadata fields may be completed for every sample, the goal is to capture as much information as possible pertaining to the sample.

Implementation

1. For active collections, project scientists provide sample information for the repository's database when they return from the field, or as soon as may be feasibly possible thereafter.
2. For resource collections, sample information is gathered from the project scientists and incorporated into the repository's database in preparation for collections accession.
3. For legacy and orphan collections, required sample information is entered into the repository's database after the collections have been evaluated for retention or disposal.

C. Collections Information

Collections information is the documentation of the physical condition, storage location, research project, and any other pertinent information relating to collections items.

Principles

As a rule, the fundamental scientific value of any collection is enhanced as knowledge and information about it increases. Proper documentation serves to provide access to the physical samples, associated analytical data, and research results.

Policy

Collections information should be acquired and documented as collections evaluation proceeds. These records should be incorporated into the National Digital Catalog and would then be provided along with collections catalogs and inventories online. This information will be made available to the public to aid in locating samples for further research and study.

Implementation

1. Compile collections information during the collections evaluation process.
2. Enter pertinent data into the repository's catalog.
3. Upon completion of collection processing, forward collections information to the National Digital Catalog.
4. Complete and retain the collections information documents in the repository's permanent files.

D. Inventory

Principles

Collection inventories and catalogs provide a reference for searching each repository's holdings and provide accountability for collections management and care. These inventories are tools that access the extent and scope of collections and aid in the development of policies and procedures.

Policy

Each repository should maintain a collections inventory for its holdings. This inventory should document all collections accessioned by the repository and the pertinent collections information. These inventories and collections catalogs should be made available to the public through the National Digital Catalog.

Implementation

1. Compile a list that specifies all collections in the repository.
2. Provide copies of indexes and catalogs to the National Digital Catalog according to the guidelines set by the GCMS Governing Board.

E. Preservation

Principles

Collections are subject to diminishing scientific value through physical degradation. USGS repositories contain a wide variety of materials in their geologic collections, and each sample type (rock, sediment, cutting, fossil, and so forth) requires specific storage and preparation techniques for proper management and preservation.

Policy

Minimum standards of care would be required for sample preservation. Each repository should evaluate its holdings to determine the best methods of preservation for its collections. If the repository cannot meet these standards, alternate solutions for the storage and preservation of these collections may be made, including transfer to another GCMS repository.

Implementation

1. Inventory the different types of materials within the repository's collections.
2. Determine the minimum conditions needed for preservation of those materials.
3. Evaluate the repository's capabilities for supplying those conditions.
4. If the repository cannot provide adequate conditions for preservation, begin the process for transfer of collection to an alternate USGS repository (see the GCMS Web site [http://datapreservation.usgs.gov/GCMS.html] for an up-to-date listing of USGS repositories).

F. Risk Management and Security

Principles

Prudent collections management requires the identification, mitigation, or elimination of risks that have the potential to affect the collections. Risk management requires the thoughtful review of potential hazards from natural and manmade causes.

Policy

Each repository is encouraged to work with local safety and security personnel to develop a risk management assessment program. This program should identify potential threats to the repository's collections and attempt to address solutions to prevent damage or loss.

Implementation

1. Identify factors that affect the security of the repository's collections.
2. Take steps to minimize those risks as is appropriate to the repository's needs.
3. Provide the appropriate storage environment to protect the collections from damage, deterioration, or contamination.
4. Establish protocols for controlling access to the repository's collections.
5. Document and review risk assessment policies on a regular basis to ensure the safety of the collections; retain in repository's permanent files.

G. Access

Principles

The mission of the USGS is to provide scientific information and interpretation to the public. Open access to catalogs, metadata, and collections is integral to this mission.

Policy

Repositories using GCMS guidelines should provide access to their collections and collections information consistent with their stewardship responsibilities. Access to the collections should be balanced by concerns for preservation and security. Repositories should control, monitor, and document access to their collections.

Implementation

1. Establish and post protocols for allowing access to the repository's collections.
2. Require visitors to the repository to comply with these established protocols.
3. Monitor visitors during their period of access to the collections.
4. Document visitor activities and retain in repository's permanent files.

H. Loans

Principles

On occasion, the USGS allows samples to be used by outside parties for research purposes. These loans benefit the public by generating new data and ideas outside the purpose for which the samples were originally collected.

Policy

Samples in USGS repositories should be loaned in accordance with the recommended GCMS protocols. Samples may be lent for research, public exhibition, or educational purposes. To ensure the security of the collections, requesting parties should provide proof of credentials. All loan transactions should be documented through formal loan agreements.

Implementation

1. When a request is received, determine the affiliation of the requesting party and the validity of the request.
2. Determine if enough sample material is available for loan.
3. Establish the terms of the loan with regard to the timeframe, purpose, amount of sample, condition of material upon return, and deadlines for submitting any derived data to the USGS repository.
4. Use pertinent forms (see Geologic Materials Repository Working Group, 2015, appendix 5) to document the loan.
5. Obtain signatures from appropriate parties acknowledging the conditions of the loan agreement.
6. Upon return of samples, update all loan documents and retain in repository's permanent files.

I. Deaccessioning

Deaccessioning is the formal process by which collections are permanently removed from the custody of a USGS repository.

Principles

Ongoing evaluation of collections is an integral part of repository management. Samples and collections may be deemed unsuitable for continued preservation because of changes in the mission or focus of the agency's research goals or constraints in funding or space. Those samples will need to be formally removed from the repository's holdings.

Policy

Samples no longer suitable for retention should be made available to other repositories or groups within the USGS for research, education, or outreach. If there is no interest within the USGS, these samples may be offered to institutions outside the USGS. Disposal of samples degraded beyond utility may be allowed, but it should be the last alternative considered. Appropriate documentation should accompany all deaccession decisions.

Implementation

1. Establish the criteria that will govern decisions regarding sample retention or removal.
2. Conduct periodic evaluations of collections to ascertain their usefulness and physical stability of samples.
3. Determine if there are samples that should not be retained by the repository.
4. Provide appropriate documentation stating the reason for permanent removal of samples from the repository, and obtain approval from appropriate personnel to deaccession the identified samples.
5. Broadcast the availability of those samples within the USGS, then to outside institutions.
6. Document ultimate disposition of the samples and retain in repository's permanent files.

J. Special Considerations

Principles

Some collections and samples may require special handling because of Federal regulations or the presence of hazardous materials.

Policy

The USGS should adhere to the standards and procedures established by any relevant agencies for proper and safe handling of these materials.

Implementation

The following issues might need to be addressed by repositories holding certain materials. The topics detailed below provide general guidance in dealing with these special circumstances.

- **Chain of custody**—Samples that have been used as evidence in legal proceedings have specific handling, security, and storage needs. It is critical that these samples be secured to prevent tampering and to maintain evidentiary documentation. An example of chain of custody implemented within the USGS can be found in this document:

  http://pubs.usgs.gov/circ/1997/c1138/c1138.pdf

- **Soil samples**—The shipment and storage of all foreign soil and "regulated domestic" soil samples must comply with U.S. Department of Agriculture Federal quarantine(s) and (or) regulations. A repository can incur significant penalties for noncompliance. Additional information is available at these sites:

  http://www.aphis.usda.gov/plant_health/permits/organism/soil/downloads/soil-circular.pdf

  http://minerals.cr.usgs.gov/intranet/chem/USDA_shipping.htm

- **Vertebrate fossils**—Generally, vertebrate fossils may only be collected on Federal lands with a permit, and permits are only granted to persons who show a sufficient level of training and experience in collecting fossils. All vertebrate fossils that are collected under such a permit must be held in an approved repository.

- **Asbestos**—Some samples may contain asbestiform minerals that pose health risks (for example, fibrous amphibole, serpentine, and zeolite). Storage, handling, and disposal of these samples can be controlled by various Federal regulations. At a minimum, known asbestos-bearing samples should be stored in airtight containers resistant to breakage or puncture and marked with a distinctive warning label. Consider providing a specific segregated location for these samples. A repository with asbestos-bearing samples should inform and work with its local safety office. Additional information is available at these sites:

  https://www.osha.gov/Publications/OSHA3507.pdf

  http://www2.epa.gov/asbestos

- **Heavy metals**—Many samples collected for resource evaluation contain elevated concentrations of heavy metals. These samples pose a couple of problems for repositories.

  - **Cross contamination**—Samples that can be analyzed for their elemental content should be stored in such a manner as to prevent cross contamination and, if possible, should be labeled so that highly enriched samples are easily identified. Mercury-bearing samples require special containment because of volatilization.

  - **Disposal**—Materials containing elevated concentrations of arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver may fall under U.S. Environmental Protection Agency regulations for "characteristic hazardous waste" and require special handling for disposal. A repository with these types of materials needs to work closely with its local safety office before considering disposal options. Additional information is available at these sites:

http://www.epa.gov/epawaste/hazard/index.htm

http://www.epa.gov/wastes/hazard/testmethods/faq/faq_tclp.htm

http://www.epa.gov/wastes/hazard/testmethods/sw846/index.htm

- **Radioactive materials**—Geologic samples that contain radioisotopes are classified as naturally occurring radioactive materials (NORM). Storage requirements are regulated by both State and Federal agencies based on activity, exposure, or quantity. Samples with elevated NORM should be kept in a designated, labeled, and controlled facility that reduces public exposure to radiation and prevents the buildup of radon gas. The transfer, shipment, or disposal of radioactive samples may also be subject to Federal and State regulation. Employees overseeing a repository with NORM samples need to work with their local Radiation Safety Officer (RSO) to ensure that they are in compliance.

- **Other materials**—Some repositories may contain environmentally sensitive samples from disaster sites (such as the World Trade Center, Hurricane Katrina, and the Haiti Earthquake), industrial waste sites, residential remediation sites, and mine waste sites. These samples may contain hazardous or carcinogenic forms of heavy metals or organic chemicals that require special precautions and handling. Consider segregation and special labeling for these samples. Additional information is available at:

  http://www.epa.gov/epawaste/hazard/international/index.htm

  http://www.epa.gov/radiation/tenorm/oilandgas.html

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The following procedural handbooks were used as models when developing this document:

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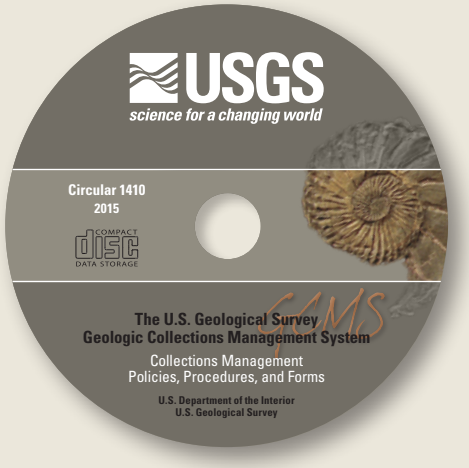
Thompson, J.W.M., 2010, Minimum standards of care for museum collections: Washington D.C., Smithsonian Institution, National Museum of Natural History, 1 p. [Jann Thompson, National Museum of Natural History, 2010, written commun.]

Appendix 5. Forms for the Long-term Management and Preservation of USGS Geologic Materials



*The **GCMS forms** are available as two sets of PDF files on the CD found at the back of this publication. The first set is formatted for **manual completion** and the second set is formatted for **electronic completion**.*

The forms in this appendix are provided as examples of documentation that each facility should maintain for the evaluation and tracking of its collections. They provide a uniform format for gathering the information necessary to fulfill the requirements of records retention. Each repository may customize the individual forms, as needed, to address the specific materials in its collections.

1. **Inventory and Evaluation of Geologic Materials**
   Used to perform initial evaluation of any collection
2. **Accession Record**
   Used to officially accept USGS materials into the repository
3. **Transmittal Agreement for Acceptance of Non-USGS Materials**
   Used to officially accept non-USGS materials into the repository
4. **Sample Check-Out Form**
   Lists samples being lent out to researcher
5. **Sample Loan Agreement**
   Lists terms and conditions of the loan
6. **Checklist for Deaccessioning Geologic Materials**
   Provides criteria for removing materials from the repository
7. **Approval for Deaccession of Geologic Materials**
   Used to request approval for removing materials from the repository
8. **Record of Transfer or Disposal of Geologic Materials**
   Documents ultimate disposition of materials removed from the repository; includes documentation for samples from Federal lands, as appropriate
9. **Record of Transfer of Geologic Materials to NMNH**
   Documents transfer of materials to the National Museum of Natural History

Inventory and Evaluation of Geologic Materials
(page 1 of 2)

Geologic Collections Management System
Inventory and Evaluation of Geologic Materials

GCMS Clear Page 1 Clear Form *(page 1 of 2)*

Name of Repository _____

Instructions:
1. *Complete one form for each pallet or group of materials.*
2. *Obtain appropriate signatures.*
3. *Attach a copy of this form to pallet and clearly mark materials with collector's name and office phone number.*
4. *Retain completed and signed form in repository files.*

Contact Information

Collector's Name _____ Current Science Center _____

Email Address _____ Phone Number _____

If Collector Is No Longer with the USGS

Custodian *(Scientist or Repository)* _____ Current Science Center _____

Email Address _____ Phone Number _____

Materials Information

Short Description of Materials *(include project name)*

Scientific Value *(current/future research, no longer collectable, one of a kind, none, etc.)*

Current Location of Materials _____

Is there adequate sample documentation? Yes No

Has an electronic inventory been provided? Yes No

Version 1.0—April 2015

Inventory and Evaluation of Geologic Materials
(page 2 of 2)

Geologic Collections Management System
Inventory and Evaluation of Geologic Materials

GCMS Clear Page 2 Clear Form *(page 2 of 2)*

Nature of Materials

Do these samples contain high metal content?
(TCLP[1] determinations exceed the trace-concentration limits listed below or total-analysis determinations exceed 10X the limits listed below) Yes No Maybe

If **Yes**[2] or **Maybe**[2], check the appropriate metals below.

arsenic (5 ppm) barium (100 ppm) cadmium (1 ppm) chromium (5 ppm)
lead (5 ppm) mercury (0.2 ppm) selenium (1 ppm) silver (5 ppm)

Do these materials contain asbestos? Yes No Maybe

Are these rocks radioactive *(greater than 3x background)*? Yes No Maybe

[1]For the Toxicity Characteristic Leaching Procedure, test Method 1311 (TCLP), refer to *http://www.epa.gov/osw/hazard/testmethods/sw846/pdfs/1311.pdf.*

[2]For up-to-date trace-concentration limits, refer to 40 CFR §261.24, "Toxicity Characteristic," *http://www.gpo.gov/fdsys/pkg/CFR-2012-title40-vol27/xml/CFR-2012-title40-vol27-sec261-24.xml.*

Are these materials scientifically or historically significant? Yes No

If **Yes**, consult NMNH staff for possible transfer to Smithsonian Institution; if **No**, proceed to next question.

Should these materials be retained by this repository? Yes No

If **No**, attach deaccession checklist, deaccession approval, and record of transfer forms.

Signatures

Signature of **Science Center Safety Officer** _____ Date _____

Signature of **Collector or Custodian** _____ Date _____

NOTE: This form is not valid unless signed by Science Center Director.

Signature of **Science Center Director** _____ Date _____

This section for use by repository staff only.

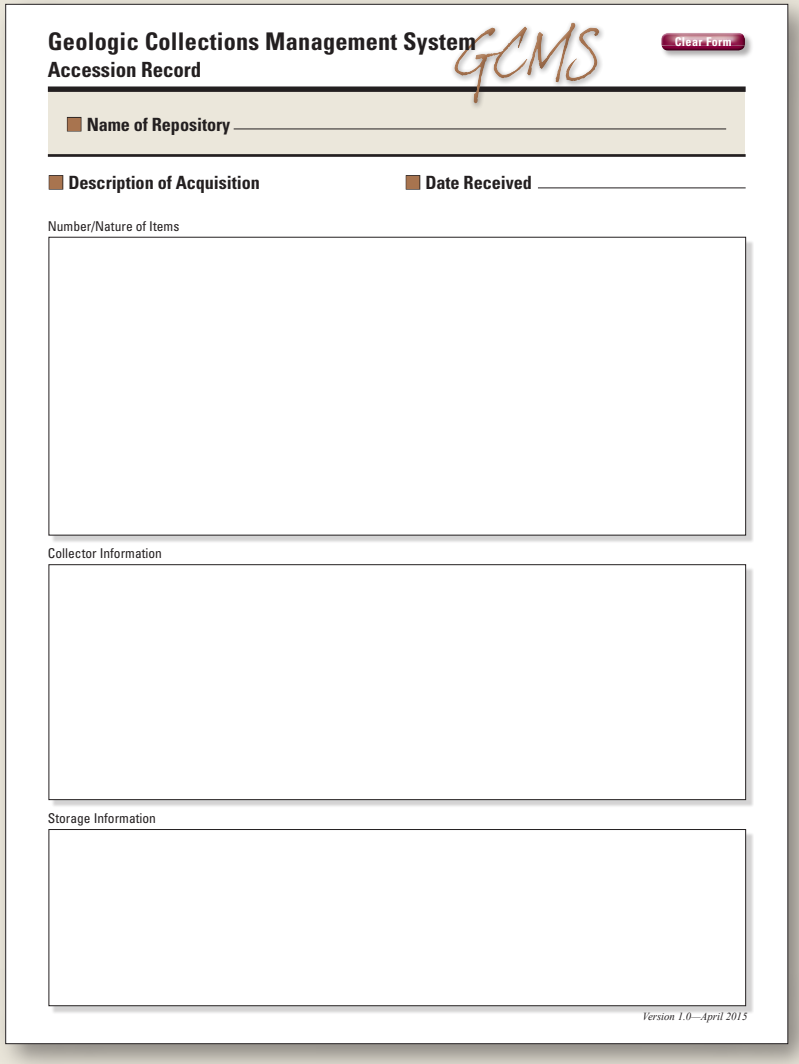
Retained? Yes No

Pallet Position _____ Pallet Control Number _____

Stored by _____ Date Stored _____

Version 1.0—April 2015

Accession Record



Geologic Collections Management System
GCMS
Clear Form
Accession Record

Name of Repository _____

Description of Acquisition

Date Received _____

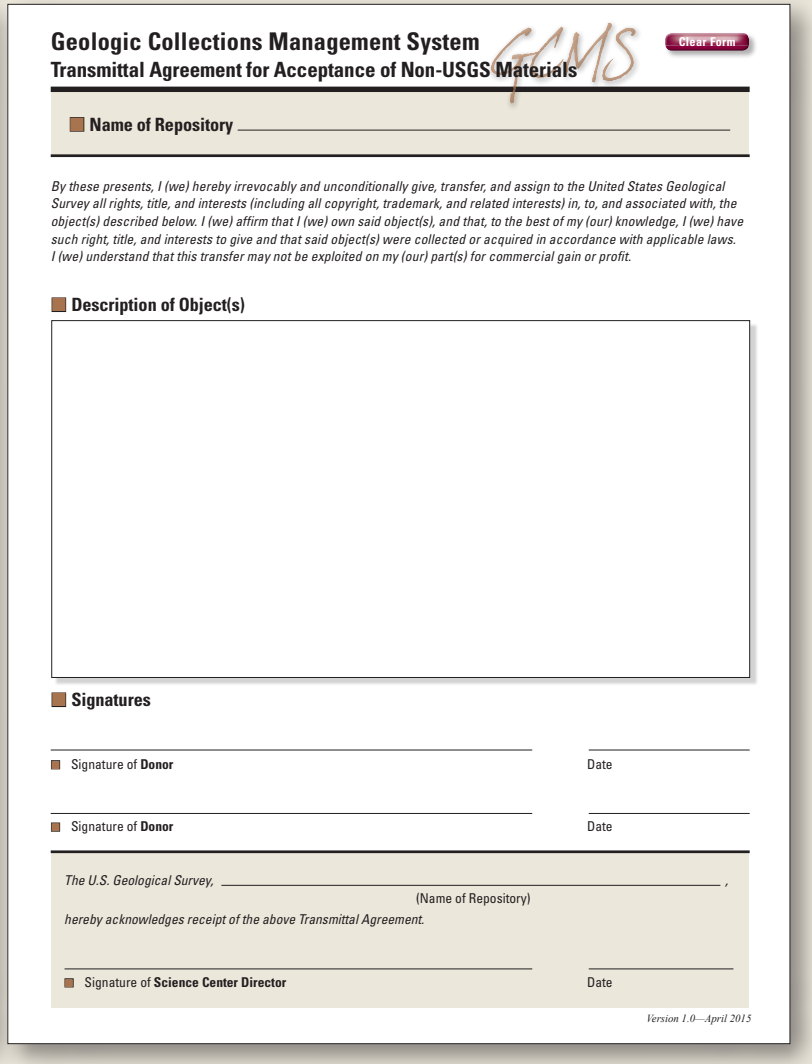
Number/Nature of Items

Collector Information

Storage Information

Version 1.0—April 2015

Transmittal Agreement for Acceptance of Non-USGS Materials



Geologic Collections Management System
GCMS
Clear Form
Transmittal Agreement for Acceptance of Non-USGS Materials

Name of Repository _____

By these presents, I (we) hereby irrevocably and unconditionally give, transfer, and assign to the United States Geological Survey all rights, title, and interests (including all copyright, trademark, and related interests) in, to, and associated with, the object(s) described below. I (we) affirm that I (we) own said object(s), and that, to the best of my (our) knowledge, I (we) have such right, title, and interests to give and that said object(s) were collected or acquired in accordance with applicable laws. I (we) understand that this transfer may not be exploited on my (our) part(s) for commercial gain or profit.

Description of Object(s)

Signatures

Signature of **Donor** _____ Date _____

Signature of **Donor** _____ Date _____

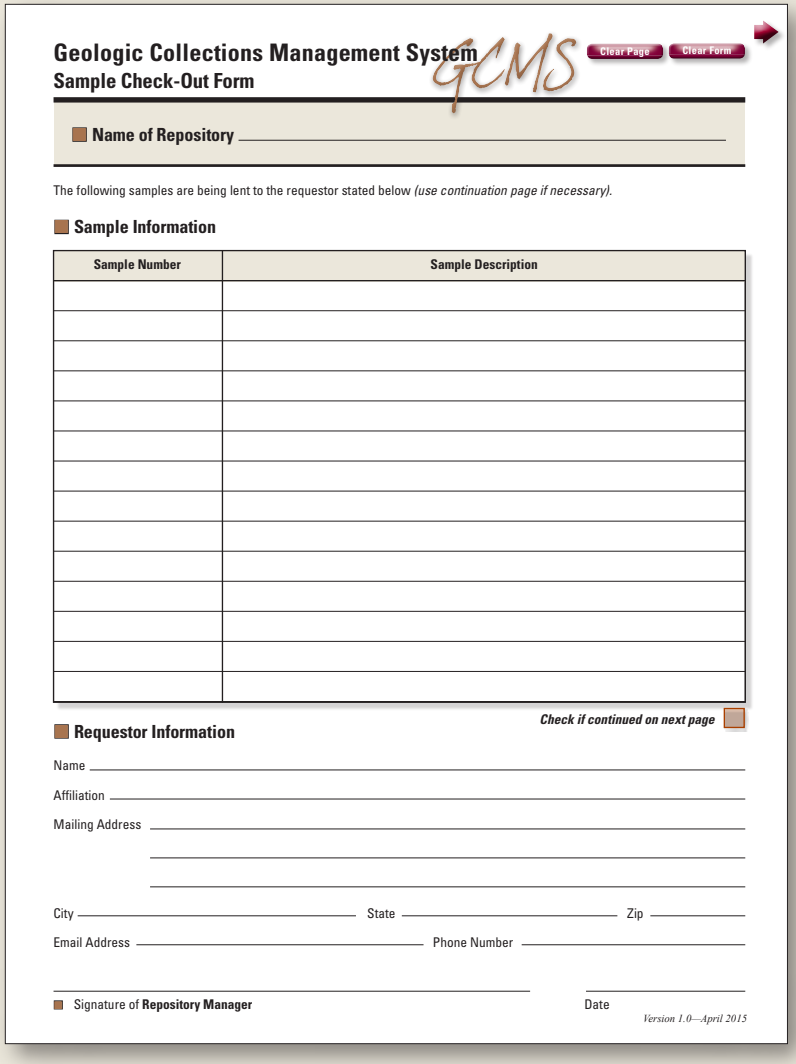
The U.S. Geological Survey, _____ ,
(Name of Repository)
hereby acknowledges receipt of the above Transmittal Agreement.

Signature of **Science Center Director** _____ Date _____

Version 1.0—April 2015

Sample Check-Out Form

Sample Loan Agreement



Geologic Collections Management System
GCMS
Clear Page Clear Form
Sample Check-Out Form

Name of Repository _____

The following samples are being lent to the requestor stated below *(use continuation page if necessary)*.

Sample Information

Sample Number	Sample Description

Check if continued on next page

Requestor Information

Name _____

Affiliation _____

Mailing Address _____

_____

_____

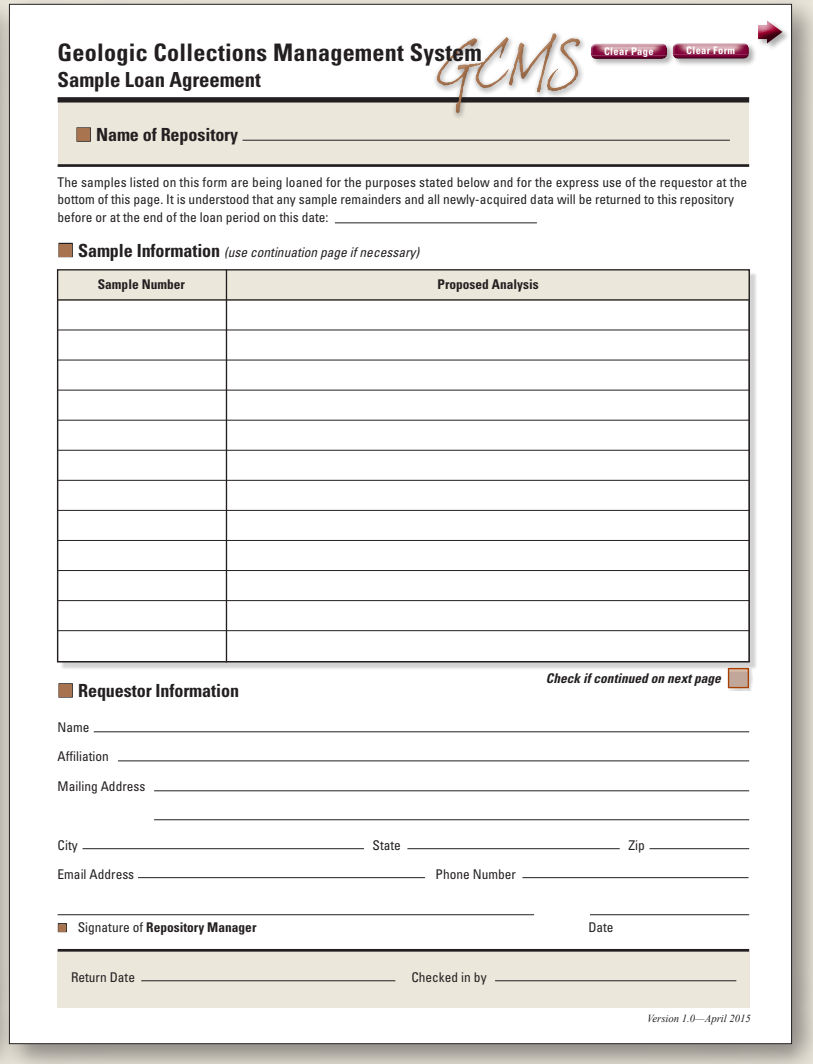
City _____ State _____ Zip _____

Email Address _____ Phone Number _____

_____ _____

Signature of **Repository Manager** Date

Version 1.0—April 2015



Geologic Collections Management System
GCMS
Clear Page Clear Form
Sample Loan Agreement

Name of Repository _____

The samples listed on this form are being loaned for the purposes stated below and for the express use of the requestor at the bottom of this page. It is understood that any sample remainders and all newly-acquired data will be returned to this repository before or at the end of the loan period on this date: _____

Sample Information *(use continuation page if necessary)*

Sample Number	Proposed Analysis

Check if continued on next page

Requestor Information

Name _____

Affiliation _____

Mailing Address _____

_____

City _____ State _____ Zip _____

Email Address _____ Phone Number _____

_____ _____

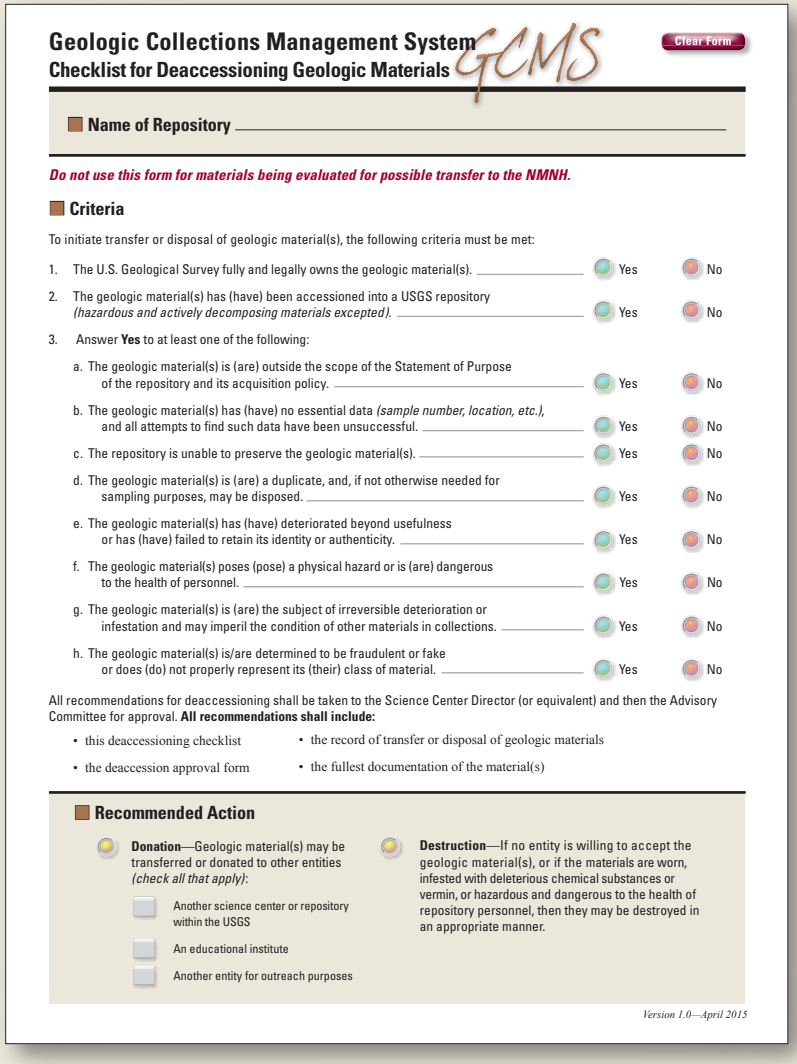
Signature of **Repository Manager** Date

Return Date _____ Checked in by _____

Version 1.0—April 2015

Checklist for Deaccessioning Geologic Materials

Approval for Deaccession of Geologic Materials



Geologic Collections Management System
GCMS
Clear Form

Checklist for Deaccessioning Geologic Materials

Name of Repository _____

Do not use this form for materials being evaluated for possible transfer to the NMNH.

Criteria

To initiate transfer or disposal of geologic material(s), the following criteria must be met:

1. The U.S. Geological Survey fully and legally owns the geologic material(s). _____ Yes No
2. The geologic material(s) has (have) been accessioned into a USGS repository *(hazardous and actively decomposing materials excepted).* _____ Yes No
3. Answer **Yes** to at least one of the following:
   a. The geologic material(s) is (are) outside the scope of the Statement of Purpose of the repository and its acquisition policy. _____ Yes No
   b. The geologic material(s) has (have) no essential data *(sample number, location, etc.),* and all attempts to find such data have been unsuccessful. _____ Yes No
   c. The repository is unable to preserve the geologic material(s). _____ Yes No
   d. The geologic material(s) is (are) a duplicate, and, if not otherwise needed for sampling purposes, may be disposed. _____ Yes No
   e. The geologic material(s) has (have) deteriorated beyond usefulness or has (have) failed to retain its identity or authenticity. _____ Yes No
   f. The geologic material(s) poses (pose) a physical hazard or is (are) dangerous to the health of personnel. _____ Yes No
   g. The geologic material(s) is (are) the subject of irreversible deterioration or infestation and may imperil the condition of other materials in collections. _____ Yes No
   h. The geologic material(s) is/are determined to be fraudulent or fake or does (do) not properly represent its (their) class of material. _____ Yes No

All recommendations for deaccessioning shall be taken to the Science Center Director (or equivalent) and then the Advisory Committee for approval. **All recommendations shall include:**

- this deaccessioning checklist
- the deaccession approval form
- the record of transfer or disposal of geologic materials
- the fullest documentation of the material(s)

Recommended Action

Donation—Geologic material(s) may be transferred or donated to other entities *(check all that apply)*:

- Another science center or repository within the USGS
- An educational institute
- Another entity for outreach purposes

Destruction—If no entity is willing to accept the geologic material(s), or if the materials are worn, infested with deleterious chemical substances or vermin, or hazardous and dangerous to the health of repository personnel, then they may be destroyed in an appropriate manner.

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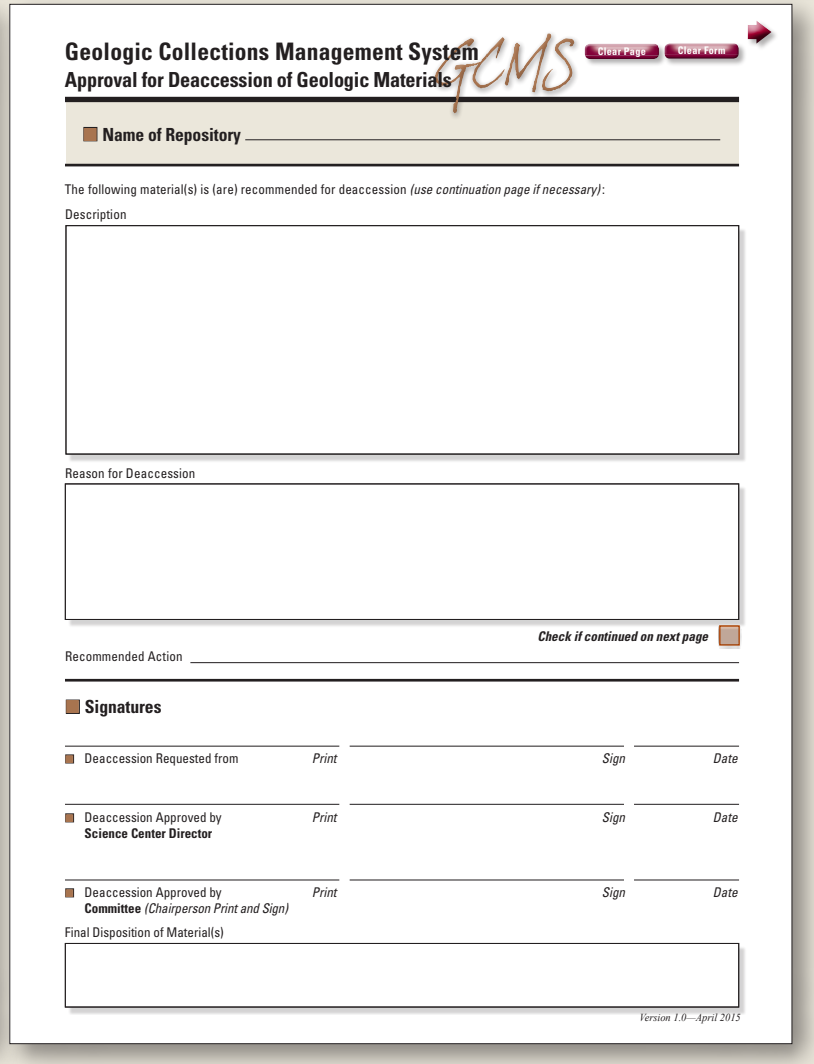


Geologic Collections Management System
GCMS
Clear Page
Clear Form

Approval for Deaccession of Geologic Materials

Name of Repository _____

The following material(s) is (are) recommended for deaccession *(use continuation page if necessary)*:

Description

Reason for Deaccession

Check if continued on next page

Recommended Action _____

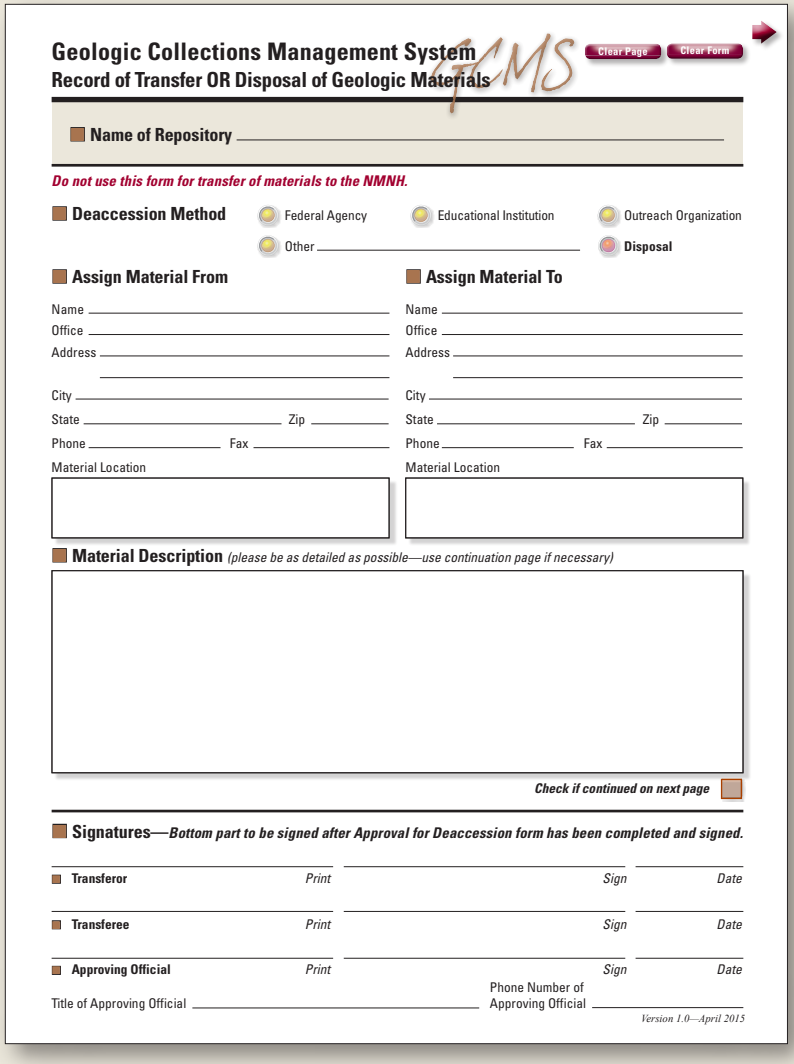
Signatures

Deaccession Requested from	*Print*	*Sign*	*Date*
Deaccession Approved by **Science Center Director**	*Print*	*Sign*	*Date*
Deaccession Approved by **Committee** *(Chairperson Print and Sign)*	*Print*	*Sign*	*Date*

Final Disposition of Material(s)

Version 1.0—April 2015

Record of Transfer or Disposal of Geologic Materials



Geologic Collections Management System
GCMS
Clear Page Clear Form
Record of Transfer OR Disposal of Geologic Materials

Name of Repository _____

Do not use this form for transfer of materials to the NMNH.

Deaccession Method Federal Agency Educational Institution Outreach Organization Other _____ **Disposal**

Assign Material From

Name _____
Office _____
Address _____
_____
City _____
State _____ Zip _____
Phone _____ Fax _____
Material Location

Assign Material To

Name _____
Office _____
Address _____
_____
City _____
State _____ Zip _____
Phone _____ Fax _____
Material Location

Material Description *(please be as detailed as possible—use continuation page if necessary)*

Check if continued on next page

Signatures—*Bottom part to be signed after Approval for Deaccession form has been completed and signed.*

Transferor *Print* _____ *Sign* _____ *Date* _____

Transferee *Print* _____ *Sign* _____ *Date* _____

Approving Official *Print* _____ *Sign* _____ *Date* _____

Title of Approving Official _____ Phone Number of Approving Official _____

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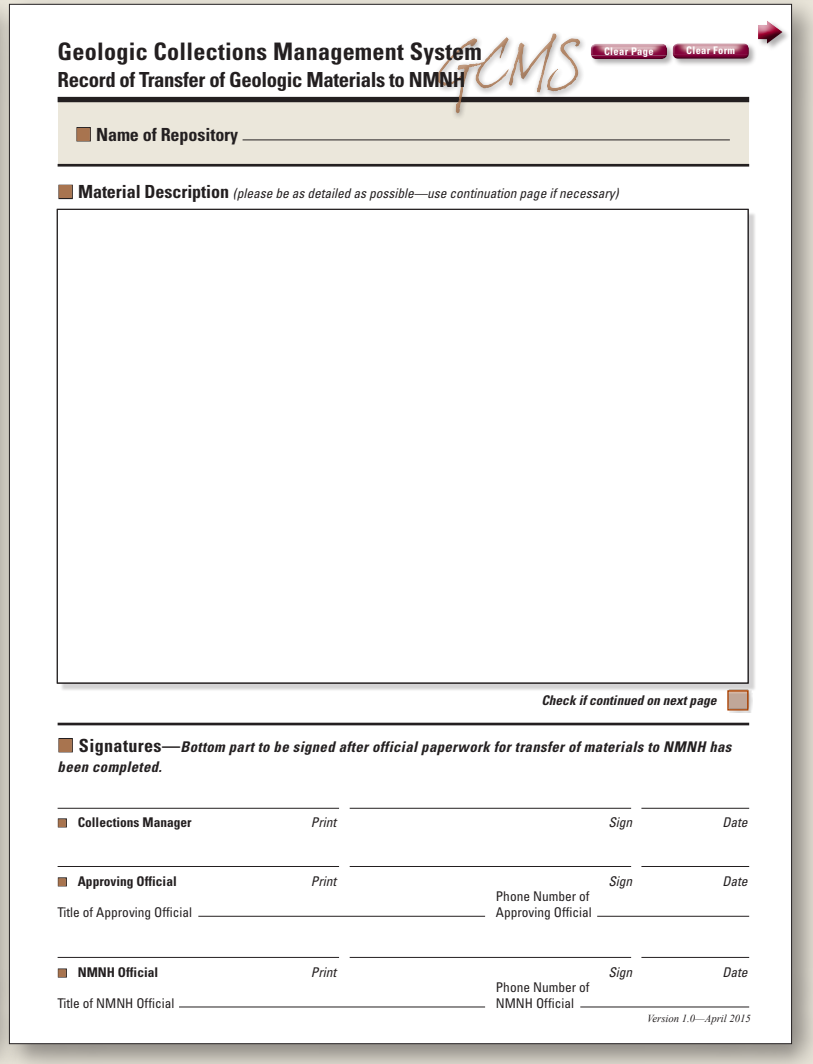
Record of Transfer of Geologic Materials to NMNH



Geologic Collections Management System
GCMS
Clear Page Clear Form
Record of Transfer of Geologic Materials to NMNH

Name of Repository _____

Material Description *(please be as detailed as possible—use continuation page if necessary)*

Check if continued on next page

Signatures—*Bottom part to be signed after official paperwork for transfer of materials to NMNH has been completed.*

Collections Manager *Print* _____ *Sign* _____ *Date* _____

Approving Official *Print* _____ *Sign* _____ *Date* _____

Title of Approving Official _____ Phone Number of Approving Official _____

NMNH Official *Print* _____ *Sign* _____ *Date* _____

Title of NMNH Official _____ Phone Number of NMNH Official _____

Version 1.0—April 2015

Appendix 6. Application of GCMS Protocols—Case Studies

The sidebar on p. 38 of this report highlights the Meteor Crater collection as an example of Geologic Collections Management System (GCMS) protocols and policies already in action in the U.S. Geologic Survey (USGS) This appendix presents three additional examples of GCMS influence on collections management: the U.S. Extended Continental Shelf project, collections at the National Museum of Natural History, and the National Uranium Resource Evaluation program.

Physical Samples Policy for the U.S. Extended Continental Shelf Project

In 2010, the interagency U.S. Task Force on the Extended Continental Shelf tasked a working group of scientists, data managers, and policy advisors to draft an official policy and procedures manual for the stewardship and release of data and physical samples collected for the U.S. Extended Continental Shelf (ECS) project. Because of the interagency nature of the project, the policy needed to standardize data and sample management practices among the various bureaus. By establishing specific roles and responsibilities for each of the agencies involved in the ECS project, the resultant manual provides clear guidance on the handling, distribution, and archiving of all original data, geologic samples and any data derived from them, and any ensuing publications or presentations. Consequently, the policy document ensures an integrated management plan for the project's materials, regardless of which agency is tasked with curating the various datasets or samples.

The USGS was designated as the participating agency responsible for the curation and distribution of ECS geologic samples. The authorities and responsibilities defined by the ECS data, publications, and samples policy and procedures were modeled after early GCMS materials that were sent to USGS Headquarters for review in July 2010; the ECS collections management forms also were based on forms included in this GCMS report.

The official ECS Data, Publications, and Physical Samples policy document, along with collections management forms and templates, is available online through the National Geophysical Data Center at http://www.ngdc.noaa.gov/mgg/ecs/samples_forms/.

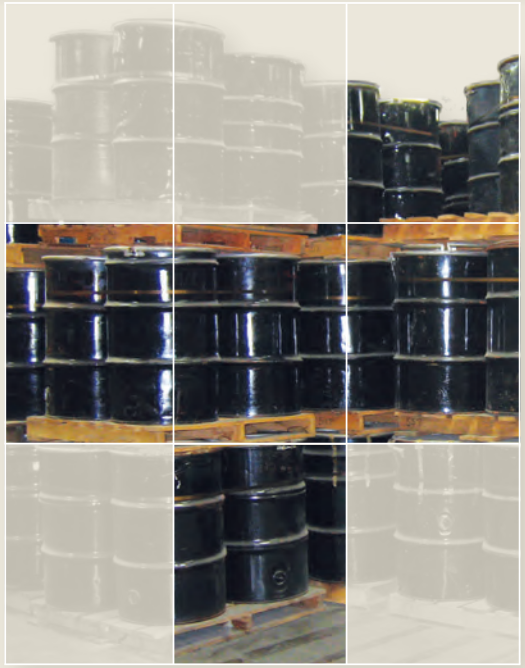
USGS Legacy Collections at the National Museum of Natural History

The Smithsonian's National Museum of Natural History (NMNH) has been the institutional residence for USGS paleontologists since the early days of the Survey. As these scientists retire, the fossil collections they have built are transferred to the NMNH according to the dictates of the USGS Organic Act (20 U.S.C. 59). Those collections, however, are not always cataloged or organized according to strict museum standards.

To remedy this situation, the USGS and NMNH's Department of Paleobiology are collaborating on a project to evaluate and process the USGS invertebrate fossil collections. Using the protocols developed for the GCMS, USGS staff and NMNH interns are reviewing, organizing, cataloging, and re-housing fossil specimens, hand samples, and thin sections, as well as the maps and manuscripts documenting them (fig. 6–1). Existing administrative reports are matched to individual samples, providing the necessary information to satisfy the 4-point standard, and these samples are then checked against the master inventory. Undocumented or duplicate samples are culled, unrelated materials are removed, and storage space is better utilized. At the end of the project, not only will the USGS collections be more organized and accessible for research, but the collections footprint will have shrunk by a third freeing up room needed for future collections.

Figure 6–1. Interns at the National Museum of Natural History learn to evaluate U.S. Geological Survey samples using Geologic Collections Management System protocols.

The NURE Barrels



The National Uranium Resource Evaluation (NURE) program was initiated in 1973 by the Energy Research and Development Administration (now the U.S. Department of Energy [DOE]) to identify potential uranium mineral resources within the United States. One component of NURE was a nationwide geochemical survey of stream-sediment, soil, surface-water, groundwater, and plant samples collected between 1975 and 1980. When the NURE program ended prematurely in the early 1980s, almost two thirds of the United States had been sampled.

In 1984, approximately 1 million archived splits of the NURE stream-sediment and soil samples were transferred to the USGS from the DOE. Samples delivered in boxes or trays were immediately accessioned into the National Geochemical Sample Archive (accessible through the USGS Central Region Mineral and Environmental Resources Science Center at http://minerals.cr.usgs.gov/); over the years, these samples have been extensively subsampled, reanalyzed, and re-used in numerous mineral-resource and environmental assessment projects. Part of the NURE collection, however, arrived in 331 sealed 55-gallon drums with no documentation of their contents (fig. 6–2). For over 25 years, the contents of these barrels were undisturbed, uncataloged, and inaccessible to researchers.

In 2010, the task of processing the contents of the NURE barrels became a pilot study to evaluate the proposed GCMS and 4-point standard. A survey of the 55-gallon drums classified them into three groups: 227 barrels of stream-sediment samples, 26 barrels of preserved plant samples, and 78 barrels of small polyethylene irradiation capsules known as “rabbits.” Each group was evaluated separately to determine sample value and ultimate retention or disposal.

The stream-sediment samples easily passed the 4-point standard test (fig. 3). The samples had been stored in well-labeled jars, and the label information was easily correlated with location, collector, sample date, and other descriptive information stored in the online NURE sediment database (http://mrdata.usgs.gov/nure/sediment/). Because these samples are useful for both geochemical and mineralogical analyses, they were removed from the barrels, placed in trays on new shelving (fig. 6–3), and cataloged into the National Geochemical Sample Archive database.

Figure 6–2 (facing page). Barrels of unprocessed sample material from the National Uranium Resource Evaluation project, stored in building 810 of the Denver Federal Center.


562

The plant samples in the second class of barrels consisted of canvas bags containing dried twigs and needles. Each bag was labeled with a NURE identification number and the plant's name. It was determined that most, if not all, of these samples could be correlated with location data in unpublished NURE digital data files, thereby meeting the minimum criteria of the 4-point standard. Although the future utility of these plant samples is not as certain as that of the stream-sediment samples, they were also accessioned into the National Geochemical Sample Archive.

The third class of barrels containing "rabbits" presented another problem. Each "rabbit" was engraved with a 4-digit number that was not unique; each number had to be matched with hand-written records of bag and barrel numbers to determine the original NURE identification number. Each sample contained 5 grams or less of ground sample material encased in a heat-sealed capsule, and that material could only be obtained by cutting open the "rabbit." Although the samples met the minimum criteria for retention, it was determined that (1) sample identification would be laborious and prone to errors because of the non-unique identifiers, (2) the samples were not stored in appropriate containers for future use, (3) the samples were already at a minimum size and of limited value for future work, and (4) the samples were duplicates of material that was already available in the National Geochemical Sample Archive. Discussions with several other researchers determined that these samples were not useful to others in the USGS, in educational institutions, or for outreach purposes. After a 2-year evaluation, the "rabbits" and their contents were discarded. Special care was taken to ensure that this disposal met all Federal and environmental regulations, and the disposal process was carefully documented.

Resolution of the NURE barrel problem was a success because of the policies and protocols set out in the proposed GCMS. Guidelines for the 4-point standard were applied, and the GCMS Collection Determination Process (fig. 3) supported clear-cut decisions to retain or dispose of samples. These samples are now clearly correlated with published data from the NURE project and are available for new analyses and research.

Figure 6–3 (facing page). Stream-sediment samples from the NURE barrels are labeled and organized on new shelving in the National Geochemical Sample Archive.


A01811
NYCL 229-237
NYCO 001-010
-40/+100
A01818
NYCY 012-026
-40/+100
A01930
NYOR 261-275
-40/+100
A01812
NYCO 011-054
-40/+100
A01819
NYCY 027-041
-40/+100
A01931
NYOR 276-290
A01813
NYCO 055-098
-40/+100
A01820
NYCY 042-056
-40/+100
A01932
NYOR 291-299
NYOS 001-006
-40/+100
A01828
NYDE 084-098
-40/+100
A01829
NYDE 099-113
-40/+100
A01830
NYDE 114-128
-40/+100
A01949
NYPU 211, 212
NYRE 001,002,010-045
-40/+100

Photograph Credits

Covers

Front (and repeated throughout)

A Thin section X-ray maps collected by scanning electron microscopy—Photograph by Justin Hagerty, U.S. Geological Survey

B Ammonite fossil (*Collignoniceras wollgari*)—Photograph by U.S. Geological Survey

C Thin section—Photograph by Core Research Center, U.S. Geological Survey

D Impact melt fragment from the Meteor Crater Sample Collection—Photograph by Justin Hagerty, U.S. Geological Survey

E National Ice Core Laboratory storage—Photograph by Core Research Center, U.S. Geological Survey

F Thin section cabinet—Photograph by Core Research Center, U.S. Geological Survey

G Split marine sediment core—Photograph by Brian J. Buczkowski, U.S. Geological Survey

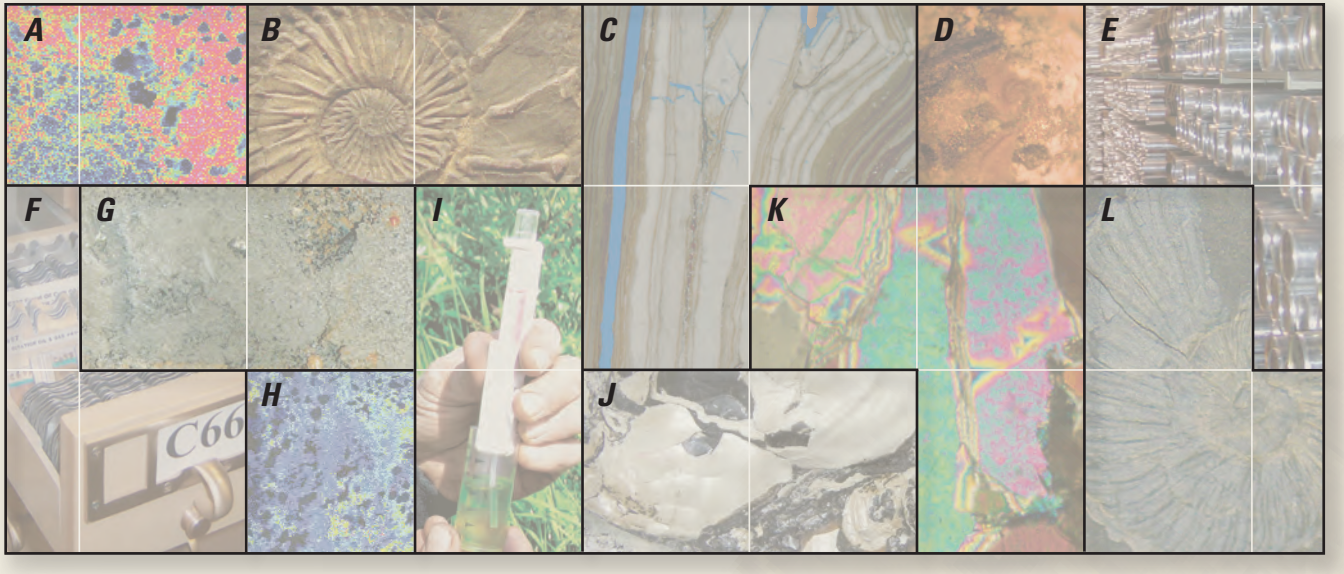
H Thin section X-ray maps collected by scanning electron microscopy—Photograph by Justin Hagerty, U.S. Geological Survey

I Measuring stream alkalinity—Photograph by Steven M. Smith, U.S. Geological Survey

J Fossil shell fragments—Photograph by Core Research Center, U.S. Geological Survey

K Polarized thin section—Photograph by Core Research Center, U.S. Geological Survey

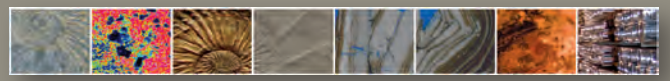
L Ammonite fossil—Photograph by Core Research Center, U.S. Geological Survey



Inside front

Sample storage at the Core Research Center, Denver —Photograph by Core Research Center, U.S. Geological Survey

Photograph Credits *(continued)*



GCMS

Page

iv Fish fossil (*Mene rhombeus*)—Photograph by Michael Brett-Surman, Smithsonian Institution–National Museum of Natural History (catalog number USNM V 3109)*

vi Ammonite fossil (*Collignoniceras wollgari*)—Photograph by U.S. Geological Survey

xiv Travertine formation at Crystal Geyser, Grand County, Utah—Photograph by Steven M. Smith, U.S. Geological Survey

xvi Field notes on display—Photograph by Field Records Collection, U.S. Geological Survey

2 Filtering a pond water sample—Photograph by Steven M. Smith, U.S. Geological Survey

3 Slabbed rock core—Photograph by Core Research Center, U.S. Geological Survey

8 National Museum of Natural History Building, Smithsonian Institution—Photograph by Bruce Wardlaw, U.S. Geological Survey

8 Petrographic Reference Collection, graphic granite—Photograph by Ken Larsen, Smithsonian Institution–National Museum of Natural History (catalog number NMNH 111123-1767)*

8 E. Dale Jackson Collection, ultramafic nodule—Photograph by Ken Larsen, Smithsonian Institution–National Museum of Natural History (catalog number NMNH 114358-15)*

9 Gene Shoemaker and Ed Chao—Photograph by U.S. Geological Survey

9 Gene Shoemaker and astronauts—Photograph by U.S. Geological Survey

Page

9 Impactite Collection, ejecta—Photograph by Ken Larsen, Smithsonian Institution–National Museum of Natural History (catalog number NMNH 117281)*

9 HVO Collection, Pahoehoe basalt—Photograph by Ken Larsen, Smithsonian Institution–National Museum of Natural History (catalog number NMNH 68415)*

9 Glass Mountain ostracodes—Photograph by I.G. Sohn, U.S. Geological Survey

10 Ammonite fossil (*Sphenodiscus lenticularis*)—Photograph by Michael Brett-Surman, Smithsonian Institution–National Museum of Natural History (catalog number USNM PAL 431079)*

Photograph Credits *(continued)*

Page

13 Cretaceous mollusk collection:

A Bivalve fossils (*Magadiceramus subquadratus*)—Photograph by U.S. Geological Survey

B Ammonite fossil with mosasaur bite marks—Photograph by Kevin McKinney, U.S. Geological Survey

C Ammonite fossil (*Placenticeras meeki*)—Photograph by Ghedoghedo—Wikimedia Commons; Creative Commons Attribution–Share Alike 3.0 Unported

D Ammonite fossil (*Bostrychoceras polyplocum*)—Photograph by H. Zell—Wikimedia Commons; Creative Commons Attribution–Share Alike 3.0 Unported

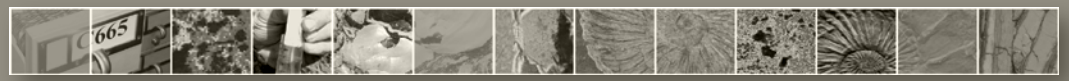
E Ammonite fossil (*Acanthoceras cenomanense)*—Photograph by H. Zell—Wikimedia Commons; Creative Commons Attribution–Share Alike 3.0 Unported

F Ammonite fossil (*Subptychoceras yubarense*)—Photograph by Daderot—Wikimedia Commons; Creative Commons CC0 1.0 Universal Public Domain Dedication

G Bivalve fossils (*Pseudoperna congesta*)—Photograph by U.S. Geological Survey

H Bivalve fossil (*Inoceramus* sp.)—Photograph by Mark A. Wilson—Wikimedia Commons; public domain

I Ammonite fossil (*Crioceratites* sp.)—Photograph by Woudloper—Wikimedia Commons; Creative Commons Attribution–Share Alike 1.0 Generic



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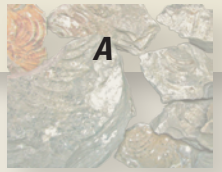

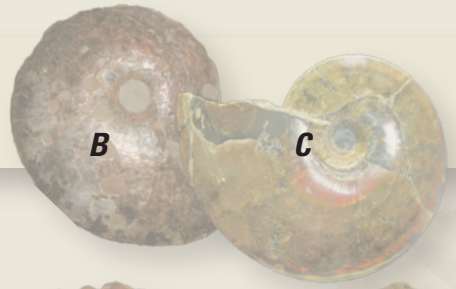

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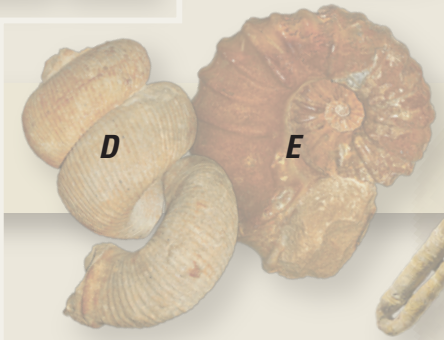

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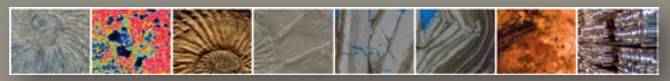

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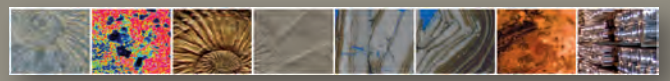

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National Geological and Geophysical Data Preservation Program

Publishing support provided by:

Denver Publishing Service Center
Edited by **Melanie J. Parker**
Layout and graphic design by **Carol A. Quesenberry**

For more information concerning this publication, contact:

Program Coordinator, National Geological and Geophysical Data Preservation Program
Box 25046, Mail Stop 975
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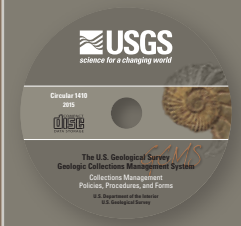

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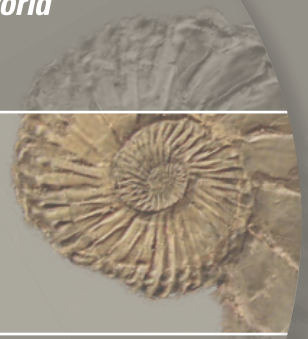


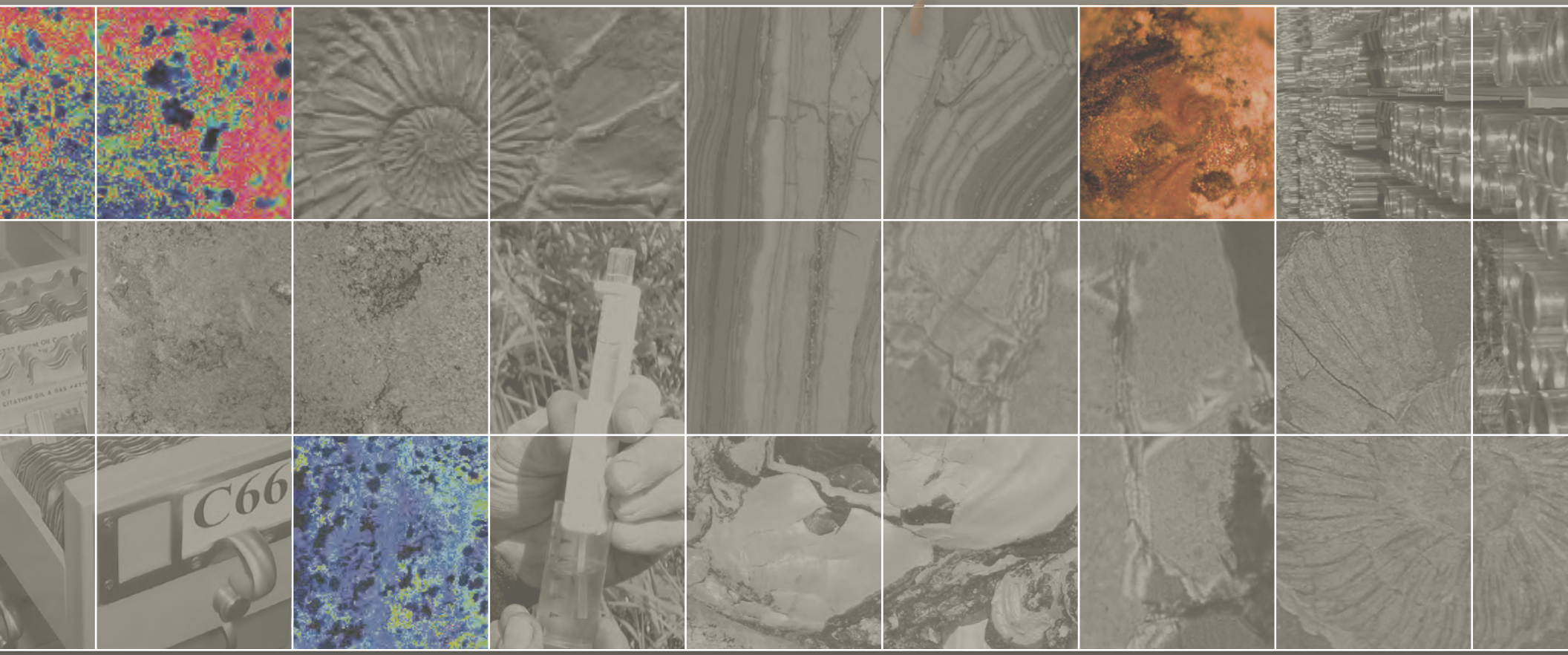
GCMS

The U.S. Geological Survey Geologic Collections Management System

Collections Management Policies, Procedures, and Forms

U.S. Department of the Interior
U.S. Geological Survey

The U.S. Geological Survey Geologic Collections Management System (GCMS)



ISSN 1067-084X (print)
ISSN 2330-5703 (online)
http://dx.doi.org/10.3133/cir1410