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Digitization for Preservation and Access: Restoring the Usefulness of the Nitrate Negative Collections at the American Geographical Society Library

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Krystyna K. Matusiak and Tamara K. Johnston

ABSTRACT

Film-based photographic collections of nitrate negatives pose major challenges to preservation and access because of unstable media and the lack of item-level indexing. Digitization offers an opportunity to capture the content of deteriorating negatives, to extend access to them, and to restore their usefulness as information resources. Digitization as a preservation strategy has been the subject of ongoing debate. This article contributes to the discussion by exploring access to and the preservation of film-based photographic collections and by presenting the digitization project at the American Geographical Society Library as a case study. The project, Saving and Sharing the AGS Library's Historic Nitrate Negative Images, was undertaken from 2010 to 2012 to preserve and provide access to over 69,000 nitrate negatives from its historic collections.

KEY WORDS

Preservation, Metadata, Online Collections, Film and Moving Images

Digitization has introduced new dimensions to the interplay between access and the preservation of cultural heritage materials in archives, libraries, and museums. The concepts of access and preservation are closely related but can sometimes be at odds when the state of original materials restricts their use. The relationship between access and preservation is particularly entangled in the case of film-based photographic materials, where fragile and difficult-to-access analog formats not only create barriers to use, but also pose preservation risks. Digitization has alleviated some of the tension between the desire to provide access and the need to protect originals. Digitized versions support preservation functions by serving as surrogates for immediate access or as backup copies if original materials are lost or damaged.[1] In addition, digitization offers new technical capabilities for reformatting and capturing the content of deteriorating analog nontextual materials, such as film negatives, audio, and video tapes. Digital technology, while opening new possibilities for access and reformatting, has also created a set of new challenges in regard to the preservation of digitized objects. The challenges associated with digital preservation are at the heart of the debate about using digitization as a reformatting strategy.[2]

Archival film-based photographic collections provide rich and often untapped sources of historical evidence, but their preservation is problematic due to complex and deteriorating formats. Historically, visual resources were recorded on fragile and unstable media, including glass plates and nitrate and acetate-based film negatives. The degrading analog formats lead to unrecoverable information loss, can damage other archival materials, and, in the case of nitrate negatives, may pose health risks and environmental hazards. Researchers emphasize that the preservation of audiovisual collections, including film-based photographic materials, remains a major challenge of the twenty-first century.[3] Preservation methods, such as photo duplication, have been applied to a small number of photographs, but the majority of film-based photographic collections remains on unstable nitrate or acetate negatives. In addition, collections of visual materials have not benefited from the same level of information organization and intellectual control as paper-based books and periodicals. In a definition of archival preservation proposed more than two decades ago, Paul Conway highlighted multiple aspects of preservation activities, including the protection of cultural resources of long-term value, prevention of further deterioration, and access and usability for present and future generations.[4] This definition, still valid today, also takes on new meaning in the current digital environment.[5] Digitization, although not capable of slowing down the deterioration of original materials, offers an opportunity to recover the content of unstable film negatives, to extend access to them, and to restore their usefulness as information sources by enhancing intellectual control and providing item-level description.

This article explores issues of digitization for the preservation of and access to film-based archival photographic collections. It focuses on cellulose nitrate film negatives, a particularly challenging format because of its inherently unstable and highly flammable nature. The authors present the recent digitization project at the American Geographical Society (AGS) Library as a case study to share lessons learned from the project and to address the issue of using digital reformatting as an approach to preservation of deteriorating film formats. The two-year project (2010–2012), funded by a grant from the National Endowment for the Humanities (NEH), aimed at preserving and providing access to over 69,000 nitrate negatives from the historic photo collections at the AGS Library.

Film-Based Photographic Collections: Limitations of Access

Film-based historic photographic collections represent a major preservation challenge due to their inherently unstable physical nature, but access to them is also limited because of difficult-to-access formats and the lack of comprehensive indexing and standardized access points. The nature of photographic collections, their organization and physical storage in archives and libraries, and the difficulty in accessing them contribute to the lack of awareness of those unique resources and pose significant challenges to using them in research. Prior to the development of digital photography, still photographs were recorded on a variety of analog formats including glass plates and different types of film from nitrate to acetate and polyester negatives. Photographers printed a limited number of images for publications and exhibits, but the vast majority of photographic images remained on inaccessible film negatives (see Figure 1).

The technology of early photography and the print environment were not conducive to producing a large number of copies. Some archival photographic collections include subsets of "killed negatives" that were deemed to be inappropriate for public viewing because of duplication or other selection criteria set at the time of their creation. As Allen C. Bensen demonstrated, even the images in the killed negative category represent a valuable visual record of historical and social significance.[6] The majority of film-based photographic collections, however, remain unseen and inaccessible not because of the kill practice, but rather due to the limitations of the film format and the small number of copies that could be created in the print environment. The negative film format represents a physical barrier to accessing the visual content of photographs. Examining strips of negatives to find an image on a particular topic can be rather daunting.

The physical arrangement of original collections in archives and libraries and the lack of standardized item-level indexing and access points, especially in regard to subject, compound the difficulty of access. Archival photographic

FIGURE 1. These are examples of film-based photographic collections at the American Geographical Society Library prior to digitization.

collections are usually arranged by original creators or donors and generally have limited subject, date, or place access points. The collections are often far removed from users. The negatives are filed in drawers or are boxed up and stored out of sight. The nitrate negative collections, if processed according to archival standards, are placed in cold storage and removed from user access. Film-based collections have limited textual description and generally lack individual indexing records and contextual information.[7] Professional photographers and even scholars who took images during their scientific expeditions varied in their documentation and annotation practices. In some cases, the accompanying records have been lost or separated from the negative collections.

Even if original annotations of individual images have been retained, the levels of consistency and accuracy of description vary from item to item.

The efforts of the library community in organizing, describing, and cataloging print-based textual resources have generally not been extended to collections of visual materials. Archival photographic resources are usually processed and described on the collection level. The lack of item-level description and standardized access points, such as title, date, subject, or location, hinders the discovery and use of photographic materials. James M. Turner attributed the lack of item-level indexing records to the perception of audiovisual resources as "second class materials."[8] Margery S. Long and Mary Lynn Ritzenthaler noted a similar attitude among archivists and historians, who "did not always recognize photographs as primary source materials." The authors added, "In the formative years of archives, only written records were regarded as archival and deserving preservation."[9] The role of perceptions cannot be underestimated, but other factors also contribute to the limited intellectual control of nontextual resources in libraries and archives. Visual materials are inherently difficult to describe, and the text-based indexing approach is often insufficient to capture rich visual content.[10]

Digitization draws attention to photographic collections that have been neglected over the years, and it offers an opportunity to address their preservation and access. However, the conversion of analog materials to a digital format represents only the first step in making the unique body of historical sources available to scholars. Digitized versions provide immediate access to visual content, but the challenges of intellectual control can only be addressed by the consistent and comprehensive indexing of images at the item level. Digitization, de facto, is forcing the item-level indexing of visual resources and other nontextual materials, since it is impossible to create a useful digital collection without providing subject terms and other access points. Libraries and archives involved in building collections of digitized visual materials face many challenges in indexing those resources, providing item-level description and contextual information, and presenting them in a meaningful way to enable their discovery and future scholarly use.

Photographic Nitrate Negative Collections: Preservation Challenges

Archives and libraries hold collections of still photographs on a variety of analog formats. Nitrate film negatives represent a significant portion of archival holdings since this format was used by professional and amateur photographers for more than fifty years. The introduction of cellulose nitrate negative film by Eastman Kodak in 1887 represented a revolution in photography.[11] Nitrate negatives were more flexible and durable than previously used glass plates and

allowed photographers to take more pictures and in a variety of conditions. Cellulose nitrate film was first used for roll films and later for sheet films in a variety of formats. Nitrate film also presented fewer breakage problems and was portable, which meant it could have been more readily used for travel photography and for documenting geographic and scientific expeditions. The advantages of nitrate film outweighed its drawbacks and contributed to its widespread use and the development and proliferation of documentary photography. Because of its durability, quality, and availability, nitrate film negatives continued to be used by photographers long after the introduction of acetate-based safety film. The production of nitrate sheet film ceased in the late 1930s. By 1950, nitrate film was no longer produced in rolls.

The instability of cellulose nitrate film and safety risks were the main reasons to discontinue the production of nitrate negatives, but safety and preservation challenges remain for vast photographic collections in library and archives settings. Nitrate is highly flammable, and the gas produced by burning nitrate is hazardous. Cellulose nitrate, if ignited, cannot be extinguished. The film burns in the absence of oxygen, producing its own supply.[12] The risk of fire cannot be underestimated, and several fires have occurred, especially with nitrate-based moving picture film, earning nitrate film the reputation of "the film stock from hell."[13] There is also a relationship between nitrate film decomposition and combustibility, as fires can be caused by spontaneous combustion of nitrate film in the late stages of decay.

Cellulose nitrate–based film inevitably decomposes with age, leading to image alteration, eventual loss of visual content, and additional health and safety hazards. The preservation community has identified six levels of nitrate decomposition.[14] Nitrate negatives begin losing photographic detail at level three; at level six, the film turns into brownish acid powder. The rate of deterioration depends on environmental conditions and accelerates with exposure to heat and humidity. During the decomposition process, nitrate film produces acidic gases that can have a damaging effect on other library materials in close proximity, causing the embrittlement of other film and paper (see Figure 2). Nitric acid gases can also create a potential health risk for library staff, as extended exposure can cause rashes, nausea, headaches, respiratory problems, and eye irritation.

The guidelines for care and storage in archival settings recommend separating cellulose nitrate negatives from other negatives and archival materials.[15] Since the decomposition of nitrate film varies greatly by manufacturer and production date, some nitrate film has survived in very good condition, and some has degraded beyond use. Fluctuations and high levels of temperature and humidity also speed up the decomposition process; thus, negatives should be kept in cold storage to slow down deterioration. Photo duplication to

FIGURE 2. These are examples of embrittled film found in the collection.

stable polyester safety film has been recommended as a traditional reformatting method for film-based photographic materials at risk of deterioration.[16] However, photo duplication is not feasible in large-scale conversion projects and does not address the issue of usefulness in regard to access points and description. Duplicating negatives onto polyester safety film still keeps the images "hidden" from ready use. It also is not a suitable reformatting method for negatives in various stages of decomposition, as photographic processes may not be able to capture the content from a damaged image.[17]

Digital conversion offers an opportunity to capture the visual content of unstable nitrate negatives before they deteriorate even further. Undertaking digitization for preservation purposes, however, has been controversial and the subject of evolving debate in the preservation community.

Digitization as a Preservation Strategy

The cultural heritage community has been discussing digitization as a preservation strategy since the early days of digitization projects. The debate focuses on the tension between long-term preservation and extending access. Initially, digitization was accepted as a form of copying for wider and easier access, but

not as a method for creating preservation-quality copies of original materials. While highlighting the benefits of digitization in providing access, Abby Smith argued at the same time that "digitization is not preservation, at least not yet."[18] Several years later, Janet Gertz (2007) echoed this opinion, but also noted that digitization can aid in preservation by protecting fragile and valuable analog materials from additional handling.[19] Both proponents and opponents of digitization as a preservation method recognize that digitization assists traditional preservation and conservation efforts by expanding access and reducing the handling of fragile originals.[20]

The concerns about using digitization as an option for the long-term preservation of analog materials focus on the integrity and authenticity of digital data as well as the stability of digital formats and the digital storage media. Digital conversion projects undertaken according to digitization standards not only provide copies for immediate access and use, but also create a new valuable asset in the form of archival master files that require long-term digital preservation.[21] In contrast to established preservation methods such as microfilming, paper facsimiles, or photo duplication, digital technology is relatively new and raises questions about access to and retrieval of digitized data due to the possible obsolescence of hardware and software. Digital media is simply not as stable as paper or other media used for recording information in the past. Unlike their analog counterparts, digitized objects are not affixed to a permanent storage medium. In examining the challenges of digital preservation, Kenneth Thibodeau noted an inherent tension between "digital," which is fluid, polymorphous, and unstable, and "preservation," which attempts to keep things unchanged.[22] Digital formats, especially in the early days of digitization, were still evolving and often proprietary, and the members of the preservation community were concerned about their stability.

The endorsement of digitization as a preservation reformatting strategy by the Association of Research Libraries (ARL) in 2004 represented a turning point in the discussion, although it focused primarily on paper-based materials.[23] The proposal recognized digital conversion as one of the viable preservation options and pointed out that each preservation reformatting technique has its strengths and weaknesses. Microfilming, for example, a method often recommended because of the medium's longevity, is at the same time limited in distribution, access, and functionality, and is characterized by low user adoption and satisfaction. The authors of the endorsement tried to address the concerns of the preservation community by emphasizing the progress in the standardization of file formats, the development of digitization standards and best practices, the commitment of the cultural heritage institutions to preserving digital objects, and finally, growing experience in the refreshing and migration of digital data.

Digitization as a preservation method has been gradually gaining acceptance among the members of the cultural heritage community. The Endangered Archive Programme (EAP) at the British Library supports digitization as the preferred means of copying archival materials in danger of destruction or physical deterioration. This recommendation is particularly relevant in developing countries where other preservation methods, such as microfilming, may not be available. The EAP's guidelines emphasize the quality of digital images and standardized formats to facilitate long-term preservation of digitized objects.[24] The Preservation Reformatting Division of the Library of Congress considered digital reformatting as a preservation method for at-risk archival materials among other options, such as microfilm and paper facsimiles copies.[25] Deana Marcum emphasized that the Library of Congress takes advantage of digitization to meet preservation needs and pays particular attention to the preservation of audiovisual materials.[26] Even the critics of the ARL endorsement recommended using digitization as a reformatting method when it offers the best or only chance for saving endangered information sources.[27] The recognition of digitization as one of the options in the set of reformatting methods also reflected the progress in the development of digital preservation standards and best practices, a growing experience in preserving digital resources with more stable digital formats, and a broader thinking about curating archival materials in the digital environment.

The debate on digitization for preservation has recently shifted from the emphasis on reformatting to the issues of usefulness, the quality of preserved items, and the crisis in the preservation of audiovisual collections.[28] Paul Conway examined the concept of preservation and made a clear distinction between digitization for preservation and digital preservation. He defined digitization for preservation as "activities that result in the creation of digital products worthy of long-term preservation," while digital preservation is understood as a set of policies and technologies aimed at protecting the value of objects created as a result of digitization as well as those that are born in the digital format.[29] The activities associated with digitization for preservation include not only the conversion process, but also selection, the creation of a full and accurate description, and digital collection building. Digital assets worthy of digital preservation should be comprised of high-quality digital master files and added intellectual value.

The concept of usefulness is particularly relevant in the context of digitization for the preservation of deteriorating film-based photographic collections and archival collections of audio and video recordings. The format of original materials and the level of intellectual control are important factors in formulating the goals for digitization initiatives. Audiovisual materials recorded on unstable physical media and lacking item-level description require a different approach than cataloged print-based materials. As Oya Rieger pointed out, the

large-scale digitization projects of print-based resources, such as the Google Book project, have been undertaken primarily for extending access.[30] The quality of digitized books and the long-term preservation of the digital content that results from large-scale digitization initiatives are important concerns, but not so much the preservation of original materials. Libraries own multiple print copies of books that have been converted to the digital format as a result of the Google Book project. In contrast to print resources, film-based photographic materials are rare, unique, and less stable than those recorded on acid-free paper.

Digitization as a preservation strategy, for example, has been successfully tried for a film-based photographic collection by archivists at the University of Southern Mississippi.[31] The goal of the project was to recover the visual content of highly damaged acetate-based film negatives from the Robert C. Waller Photograph Collection at McCain Library and Archives. After reviewing various strategies for capturing and preserving the visual content of the deteriorating negatives, the archivists determined that digitization was the most suitable option, despite concerns over long-term digital preservation.

Archival film-based photographic collections may include both acetate and nitrate negatives. Acetate negatives, a type of "safety" film, were introduced in the mid-1920s with the intention of replacing more hazardous nitrate film. The AGS Library includes in its holdings extensive photographic collections of both nitrate and acetate film negatives. Nitrate negative collections, however, were identified as a top preservation priority because of the health and environmental hazards associated with nitrate film. After reviewing the available reformatting methods and concerns, the staff at the AGS Library decided to use digitization as an approach to saving and sharing the large body of nitrate negative photographs in its holdings. Digitization was selected as an option not only for providing access to the unique photographic collections, but also as a preservation strategy, since other methods such as photo duplication were not feasible in such a large-scale project. The first digitization for preservation initiative at the AGS Library was undertaken to address the problem of deteriorating nitrate negatives. After completing Saving and Sharing the AGS Library's Historic Nitrate Negative Images in 2012, the AGS Library received a second NEH Preservation and Access Grant to digitize acetate negatives and motion picture film collections.

The Nitrate Negative Photographic Collections at the AGS Library

The AGS Library serves as a repository of photographs taken by AGS fellows and associated researchers during their expeditions around the world. The AGS Library, one of America's oldest, largest, and most distinguished geographical

research libraries, was established in New York City in 1851. The library and its photographic collections were moved to a new location at the University of Wisconsin–Milwaukee (UWM) in 1978, and they are now part of UWM Libraries.[32] The AGS Archives, with additional photographic resources, was transferred to Milwaukee in 2011.

The AGS Library's photographic collections consist of 440,000 images in a variety of formats, including glass plate negatives, film negatives, slides, lantern slides, and prints. The collections include the work of historic photographers as well as explorers, surveyors, journalists, geographers, travelers, and scientists in various disciplines. The extensive photography collection of the AGS Library dates from early photography in the 1860s to the present. Those historic photographs serve as a visual memory of the world as they document the history and culture of regions and countries where visual representation could not have been recorded or has been destroyed. The early photographs recorded on nitrate negatives are particularly valuable since they come from an era when camera ownership was not widespread and imagery today is scarce. In some cases, landmarks have been destroyed so these images are even more significant as historical documents. Figure 3 depicts an image of the large Bamiyan Buddha. The picture was taken by Frederick G. Clapp in 1936. The statue, one of the most impressive Buddhist monuments in central Asia, was destroyed by the Taliban in 2001.

The nitrate negative collections of still photographs represent a significant portion of the AGS Library's collections. Initially, it was estimated that AGS Library's photographic collections contained approximately 52,000 nitrate negatives. However, with the identification and inventory undertaken as part of the digitization project, the number of known nitrate negatives grew significantly, totaling 69,625. Some collections were found to include more nitrate negatives than originally thought. The Pendleton Collection, for example, first estimated at 4,000 images, yielded 16,817 by the project's end. In addition, other nitrate negatives and collections were discovered in the AGS-New York Archives, of which the AGS Library became the custodian in 2011.

Photographic images were, for the most part, acquired to serve the research and publication needs of the American Geographical Society. Included were images from notable geographers/photographers such as Isaiah Bowman, Frederick Clapp, Helmut De Terra, Alexander Forbes, Richard U. Light, and Robert L. Pendleton. Many of the AGS Library's nitrate negatives come from these sources. Other collections, such as those of Theodore deBooy, William O. Field, Mary Jo Read, and Harrison Forman were donated to the AGS Library by the photographers or their families. The nitrate negative holdings contain a large number of unique images that have never been published and rare images that cannot be easily accessed.

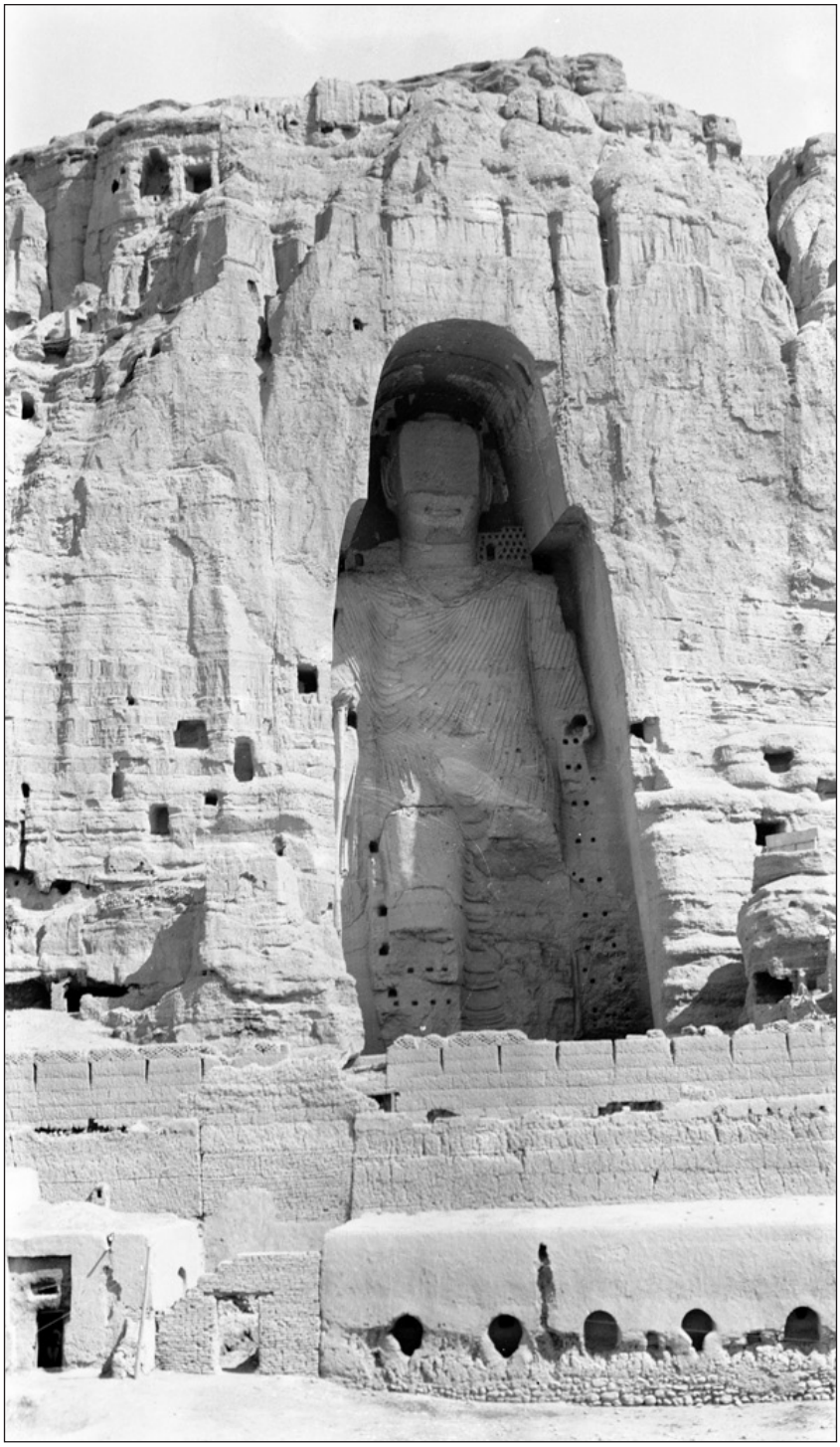


FIGURE 3. This is a 1936 view of the large Bamiyan Buddha in Afghanistan. Frederick G. Clapp Collection. American Geographical Society Library, University of Wisconsin–Milwaukee Libraries. The record is available at http://collections.lib.uwm.edu/cdm/ref/collection/agsphoto/id/19240.

The AGS nitrate negative collections represent over forty years of documentary photography starting with Isaiah Bowman's photographic record of the Yale South American Expedition in 1907 to Bert Krawczyk's photographs in the Yunnan Province in China between 1943 and 1945. The images span all continents, with the exception of Antarctica, and document a global range of peoples, cultures, and landscapes as seen through the eyes of geographers and photojournalists. The highlights of the collections include a remarkable set of early twentieth-century images of archaeological sites in Tibet, India, and Chinese Turkestan from the Helmut De Terra Collection; images of Iran and Afghanistan by Frederick Clapp in the 1930s; William Field's photographs of Russia and the Caucasus region from 1929 to 1933; the first aerial photographs of Africa and South America taken by Mary Upjohn Light Meader (1937); Robert L. Pendleton's extensive photography of Thailand from the 1930s through the 1950s; and a unique photographic record of Tibet and China in the 1930s provided by photojournalist Harrison Forman. [33]

Nitrate negatives were identified in seventeen different photographic collections held at the AGS Library. The number of nitrate negatives varies from collection to collection with several hundred in the Mary Jo Read Collection, for example, to over 15,000 in the Harrison Forman and over 16,000 in the Pendleton Collections. Some collections exclusively contain nitrate negatives, while in others nitrate film was interfiled with safety film and required additional identification, separation, and processing. Prior to undertaking the digitization project, approximately two-thirds of the nitrate negatives in the AGS Library's holdings were stored in original envelopes and containers. Large collections of nitrate negatives were separated from other library materials and stored in an isolated room, but none were placed in cold storage.[34] The digitization project provided an opportunity to capture the visual content of deteriorating negatives and at the same time to address the preservation and conservation of the original source materials.

The Digitization Project: Saving and Sharing the Nitrate Negative Images

The two-year project (2010–2012), Saving and Sharing the AGS Library's Historic Nitrate Negative Images, was funded by a grant from the National Endowment for the Humanities. The goals were to reformat the AGS Library's large collection of cellulose nitrate photographic negatives, provide access to the collection, safely rehouse it and ensure its proper storage, and provide long-term preservation of its digital representation. The project built on the library staff's previous experience in digitization, the knowledge gained from the prior preservation survey of the AGS Library's photographic collections, and

a successful pilot project. The pilot digitization project was an excellent primer for setting up a system to handle safely, digitize, and preserve the negatives for long-term storage. The project team consisted of a full-time project coordinator with expertise in preservation, a full-time metadata librarian, a half-time metadata librarian, two graduate student assistants, one undergraduate student assistant, and one full-time technician who was responsible for in-house scanning and image processing. The AGS Library Photographic Collections curator and digital collections librarian assisted the project team, devoting 30 percent of their time to the project over two years.

The focus of the two-year project was the digitization for preservation of all nitrate negatives in the AGS Library's holdings. The project involved a number of activities that aimed at preservation and providing access, including

- Identifying and inventorying nitrate negatives in the AGS Library's photographic collections;
- Preparing nitrate negatives for scanning and rehousing;
- Digital reformatting with the creation of archival master files for long-term preservation and derivative images for access;
- Creating item-level metadata for all digitized objects;
- Integrating selected images with associated metadata into digital collections for online delivery;

FIGURE 4. Nitrate negatives stored in original paper envelopes.

- Packaging and placing nitrate negatives in cold storage;
- Transferring archival master files to the campus digital repository for long-term preservation; and
- Documenting the project.

The Work Plan Matrix in Appendix A provides a timeline and detailed description of the project's workflows.

Preparation and Rehousing of Negatives

Most of the nitrate negatives in the AGS Library's collections identified for this project were stored in original envelopes and containers and required processing and rehousing prior to digital reformatting. Approximately a third of the collections was processed according to archival standards prior to undertaking digitization or as part of the pilot digitization project. The majority of negatives, however, were either enclosed in brittle, deteriorating envelopes, or rolled in cans or over acidic paper cores. See Figure 4 for an example of a collection of nitrate negatives stored in a metal box and brittle paper enclosures.

The process of rehousing consisted of inserting the negatives into acid-free envelopes, assigning identifiers, and placing the envelopes into archival boxes.

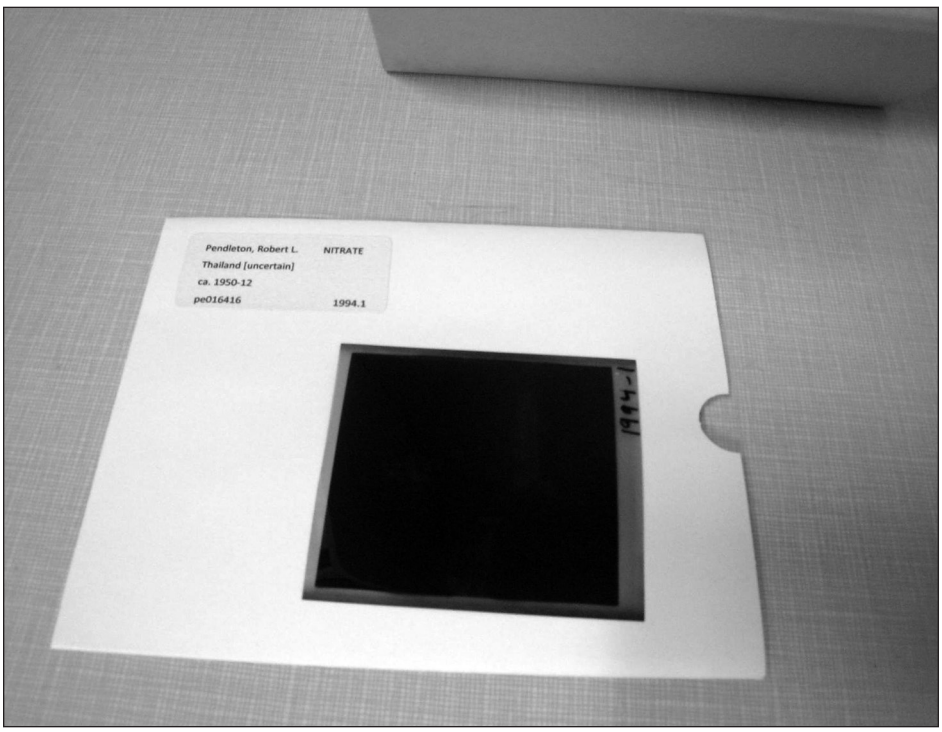


FIGURE 5. First, the nitrate negatives were rehoused.

As demonstrated in Figure 5, each negative was sleeved in a buffered, acid-free, lignin-free paper enclosure. An original ID, if available, and a unique digital ID were recorded on the envelope. The envelopes were in turn placed into acid-free storage boxes. When necessary, negatives were cleaned before rehousing and before scanning. Long strips of film were unrolled, relaxed, and cut into sections to fit standard sized envelopes.

Nitrate film in the Platt and Forman Collections posed major challenges during the preparation and rehousing process. Roll film in these collections was uncut and rolled around oblong cardboard cores or rolled into metal cans. This film had been rolled onto cores or in cans for over sixty years, and it resisted straightening by traditional means without damaging it. The project staff found that mild humidification relaxed the film sufficiently to unwind it and then roll it in reverse until it relaxed (depending on the film, this could take anywhere from one to six months).

Digital Reformatting

The goal of digital reformatting was to capture the visual content of the nitrate negatives and to create accurate digital representations of original materials. The guidelines for the project were based on digital library standards and best practices to ensure a consistent level of image quality and to create high-quality digital objects in support of current and future use.[35] Digital master files were created as a direct result of the image capture process. General recommendations for digital master file creation included scanning at the highest quality affordable, assigning unique digital IDs, and saving the original scans without any enhancements.

The technical scanning specifications were based on the format and characteristics of source items. The negatives were scanned in 8-bit grayscale or 24-bit color mode, and the resulting digital master files were saved uncompressed in the TIFF format. The scanning resolution was based on the size of the original negative. For example, 35mm film was scanned at 4,000 pixels per inch (ppi) on the long side, while 8-x-10-inch sheets were scanned at 400 ppi. All individual scans were assigned a unique file name (digital ID) based on the previously established AGS Library's file naming convention. Digital IDs were also inscribed on the envelopes to provide reference between a negative and its digital representation.

The original project plan was to outsource scanning of all negatives to a digitization vendor. However, this plan had to be modified because of the challenges in the preparation, packing, and transportation of nitrate film. Nitrate negatives are considered a hazardous material, and, as such, transporting them imposed rigorous packaging standards that took extra time and required the

purchase of expensive packing containers. In addition, the processing of negatives in a variety of sizes proved to be time consuming. In the case of the Forman Collection, the photographer's sequencing intermingled the various photographic formats in which he worked. To have sent these images to the vendor would have required separating the formats, which would have led to the disarrangement and mismatch of pictures and descriptions. To preclude this risk, the library purchased a new Hasselblad scanner and digitized this collection in-house. All in all, of the 69,625 negatives scanned, 50,655 were digitized by the vendor and 18,970 were scanned in-house.

Digital reformatting provided an opportunity to recover the visual content of the negatives. The scanning process also demonstrated the problems with nitrate film decomposition and revealed the degree of image degradation. Most of the nitrate negatives in the AGS Library's holdings were in relatively stable condition, and nearly all were suitable for scanning. In fact, curly roll film presented more challenges for digital conversion than decomposed negatives. In only a few instances of advanced-level film decomposition were the negatives too disintegrated to be scanned.

The loss of visual content due to nitrate film instability, however, became evident in many images after scanning. A significant portion of the digitized images exposed some degree of fading and even the loss of legible photographic detail. The rate of deterioration varied from collection to collection and even

FIGURE 6. Scanned from a nitrate negative, this photograph shows some image fading due to the deterioration of the negative. Afghanistan, Amanullah House of Parliament on hill in Dārulāmān, 1936. Frederick G. Clapp Collection. American Geographical Society Library, University of Wisconsin–Milwaukee Libraries. The record is available at http://collections.lib.uwm.edu/cdm/ref/collection/agsphoto/id/19261.

from negative to negative within the same collection. The extensive Harrison Forman Collection proved to be in relatively stable condition, although Forman used nitrate film in his photojournalistic work for more than a decade and tried a variety of formats including rolls and sheet negatives. Digital conversion of his collection rendered a large body of high-quality images with a minimum loss of photographic detail. On the other hand, 40 percent of the images scanned from the Mary Jo Read Collection turned out to be illegible or revealed significant image degradation. The scanning of negatives in the Frederick G. Clapp Collection also exposed various degrees of image alteration (see Figure 6). The information about image degradation was recorded in the project database. The images that displayed a considerable loss of visual content were not included in digital collections for public access unless they were unique and exceptionally noteworthy.

All digital master files created as a result of digital reformatting were retained regardless of the image deterioration detected during the conversion process. All scans were reviewed for quality and saved as uncompressed TIFF files. They serve as preservation copies and as sources for derivative images. A second copy of the TIFF files, so-called service files, were created if digitized images had to be processed to remove dust marks and scratches, and to improve contrast in faded images. The archival master files remain uncompressed, while the service copies are preserved as LZW lossless compressed TIFFs. The archival master and service files require a significant amount of storage (1.39 TB for masters and 970 GB for service files). Both digital master files and service copies were transferred to the campus digital repository for long-term storage. The AGS Library follows the UWM Libraries policies for digital storage and archiving and participates in the centralized university digital repository. UWM Libraries, which houses the AGS Library, is committed to long-term preservation of digital master files, long-term archival preservation of original nitrate negatives, and sustaining the digital collections created as a result of this project.

The master files created as a result of all digitization projects are stored in the UWM digital repository and follow standard campus procedure for archiving, backup, and refreshing. Archival master files that serve as preservation copies are stored in the "dark digital archives" with restricted access. The AGS Library staff has networked access to the service files. Long-term archiving of digital master files is assured by University Information Technology Services (UITS). However, current university and UWM Libraries policies do not address preservation metadata. Project staff recognized the importance of recording preservation metadata, but the limited project resources would not allow for recording consistent technical metadata on the item level. The project documentation and an internal database include limited preservation metadata on the collection level. Standardized item-level preservation metadata were not

recorded, which represents a significant limitation of the project and an area that requires further attention.

Cold Storage

Although all of the film has been scanned at a high resolution, it was decided at the outset of the project that the original nitrate negatives would be preserved in cold storage in perpetuity. The AGS Library staff found compelling reasons not to destroy the negatives after digitization. The first is their obligation to their donors and their commitment to preservation; the second is the difficulty in legally disposing of a large quantity of nitrate; the third was the

FIGURE 7. These boxes of nitrate negatives are ready for cold storage.

fact that the AGS Library has the space and means to provide cold storage; the fourth was the need to reference the negatives in the future. The fourth reason may not seem compelling at first, but the past three years have proven it necessary to be able to retrieve the originals to determine film type and film sequencing. Because of the history and age of the photographic collections, loose negatives have been disassociated from their collections. There are also issues of mislabeling by well-meaning secretaries, assistants, family members, and sometimes even the photographers themselves. Comparing originals for film type and sequence is sometimes the only way to determine the identity of a negative.

Rehousing was the necessary first step in the process, but long-term archival preservation of the negatives would require maintaining the film at low temperatures. Sleeved, labeled, and boxed negatives were packaged according to the latest research on the cold storage of nitrate negatives,[36] which is now the standard in packaging for cold storage. Figure 7 provides an example of boxes of nitrate negatives prepared for cold storage. The boxes are stored in two cold storage units installed in the library, including an explosion-proof freezer, which is being used for nitrate negative collections in later stages of degradation.

Creating Descriptive Metadata on the Item Level

Metadata creation represented a significant part of the digitization project and was undertaken to provide access points to digitized images and to extend their usefulness as information resources. Metadata records were created on two levels:

- Minimum item-level metadata were recorded for all digitized negatives.
- Extensive descriptive metadata were created for images selected for online presentation in the AGS Library's digital collections.

Minimum metadata were recorded for all 69,625 digitized negatives to capture photographers' original designations and descriptive notes. The data were entered into the locally stored database. In addition to the photographers' notes, the minimum records include the date of creation, original negative ID or accession number, digital ID, notes on the negative condition, nitrate negative location, and original collection name. Digital IDs serve as record identifiers since the numbers or descriptors assigned to original negatives were not unique. The minimum metadata records formed the basis of more extensive descriptive metadata for selected images.

The images selected for online presentation in the AGS Library's digital collections were provided with extensive metadata. The intent of metadata was to record and present all pertinent descriptive and administrative information regarding a particular scanned image including what it is, its location in the world, who is responsible for it, its physical attributes, where it came from,

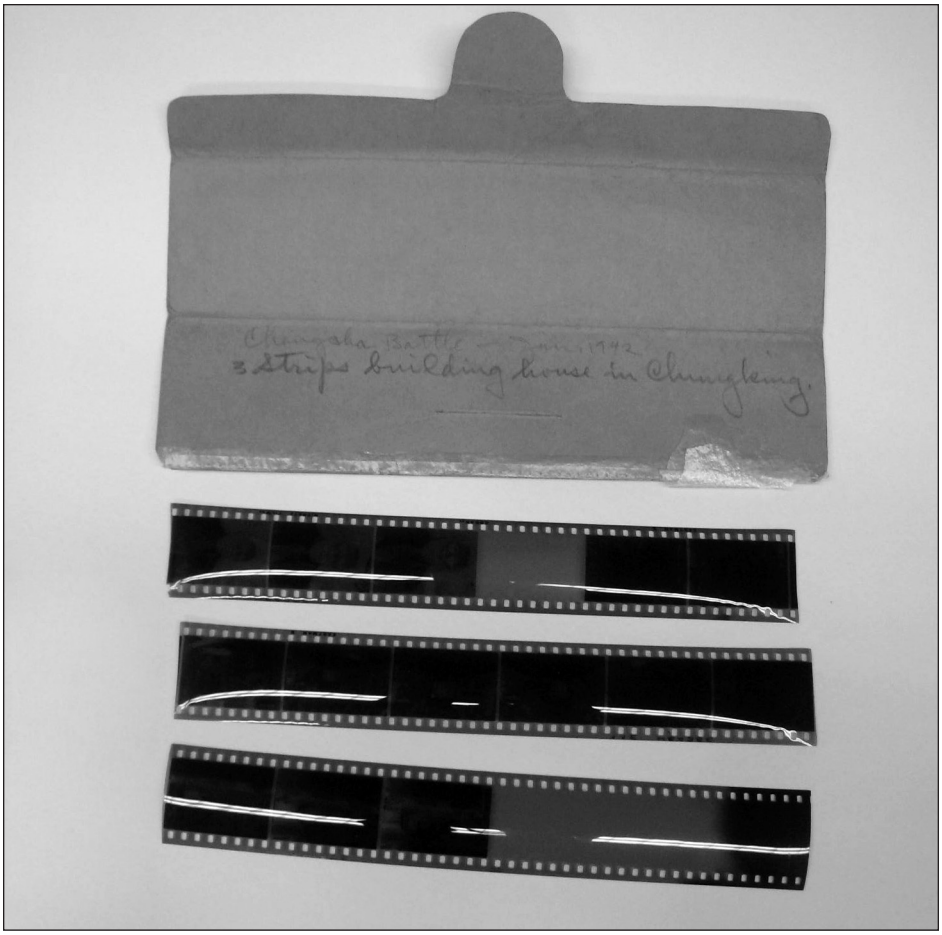


FIGURE 8. This is an example of the limited description of original negatives in the Harrison Forman Collection. The pictures were taken by Harrison Forman in Chongqing, China, in 1942.

where it is now, when it was created, its intellectual property rights, its digitization details, grant funding credit, and where it now resides online and as a physical object.

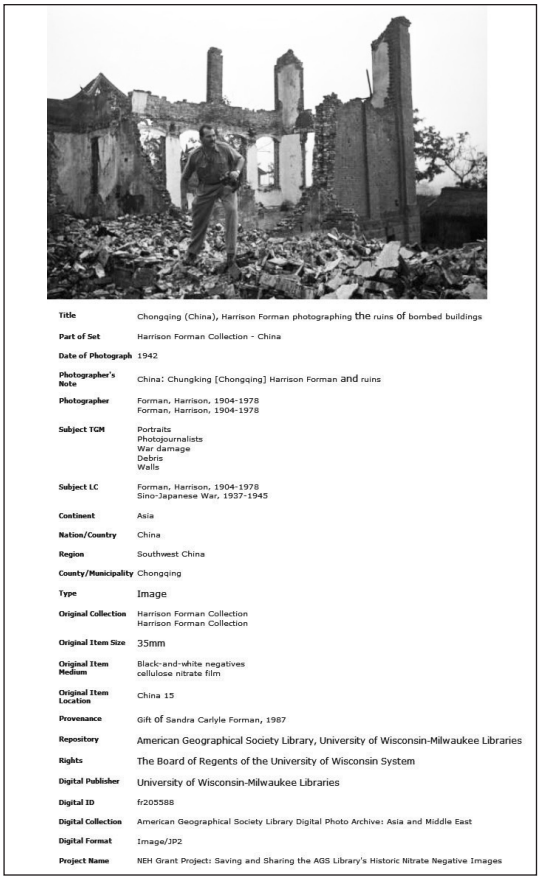
The completeness of the descriptive metadata varies from collection to collection, reflecting the detail of a photographer's annotations. In some cases, negatives came with little or no descriptive information but were rich historical images that warranted additional research (see Figure 8). The metadata records of some collections were augmented with ancillary information. In the case of the Forman and Field Collections, for example, the photographers' field diaries served as additional sources of descriptive information. The diaries were digitized as well and are presented as part of the AGS Library's digital collections as valuable adjuncts to the photographic images.

The metadata structures for the AGS Library's digital collections are based on a qualified Dublin Core schema. The natural language field labels in the public display are internally mapped to Dublin Core schema to ensure cross-collection searching and metadata harvesting. The customized metadata template consists of thirty-eight fields, including descriptive elements such as Title, Date of Photograph, Photographer's Note, Photographer Name, Description, Related Resources, and two subject fields. The two fields are designated to capture different concepts and use different controlled vocabulary tools: Subject TGM covers topical subjects and derives terms from the *Library of Congress Thesaurus for Graphic Materials* (*LC TGM*), while Subject LC indicates proper names of people and objects depicted in images and uses Library of Congress Subject Headings (LCSH).

The description of geographic coverage required special attention in creating metadata records because of the nature of the AGS Library's photographic collections documenting geographic expeditions and scientific exploration around the world. The fields related to geographic location include Continent, General Region, Country, Region, Province/State, County/Municipality, City/Place, and Geographic Feature. The controlled vocabulary is selected from the *Getty Thesaurus of Geographic Names* (*TGN*). The terms are not precoordinated, and the records are not always complete due to the gaps in the original item description. The metadata creators often needed to conduct in-depth research on the geographic details because the need for geographic specificity frequently exceeded the extent of published thesauri.

In addition, metadata records include information about the size, medium, location, and provenance of nitrate negatives, creating a link between original items and their digital representations. As demonstrated in Figure 9, the metadata records created as a result of this project provide rich descriptive information for selected images and enable access to a large body of historical visual records that was previously inaccessible.

Metadata creation represented the most challenging aspect of the project because of fragmentary textual descriptions of original source materials and the difficulty in identifying geographic locations for historic photography. The NEH project metadata team created all metadata records in-house. The director and the photographic collections curator at the AGS Library served as consultants and provided collection, photographer, and subject expertise when needed. The digital collections librarian, who committed 30 percent of her time to the project, reviewed the majority of records.



Title	Chongqing (China), Harrison Forman photographing the ruins of bombed buildings
Part of Set	Harrison Forman Collection - China
Date of Photograph	1942
Photographer's Note	China: Chungking [Chongqing] Harrison Forman and ruins
Photographer	Forman, Harrison, 1904-1978 Forman, Harrison, 1904-1978
Subject TGM	Portraits Photojournalists War damage Debris Walls
Subject LC	Forman, Harrison, 1904-1978 Sino-Japanese War, 1937-1945
Continent	Asia
Nation/Country	China
Region	Southwest China
County/Municipality	Chongqing
Type	Image
Original Collection	Harrison Forman Collection Harrison Forman Collection
Original Item Size	35mm
Original Item Medium	Black-and-white negatives cellulose nitrate film
Original Item Location	China 15
Provenance	Gift of Sandra Carlyle Forman, 1987
Repository	American Geographical Society Library, University of Wisconsin-Milwaukee Libraries
Rights	The Board of Regents of the University of Wisconsin System
Digital Publisher	University of Wisconsin-Milwaukee Libraries
Digital ID	fr205588
Digital Collection	American Geographical Society Library Digital Photo Archive: Asia and Middle East
Digital Format	Image/JP2
Project Name	NEH Grant Project: Saving and Sharing the AGS Library's Historic Nitrate Negative Images

FIGURE 9. This is an example of a digitized image from the Harrison Forman Collection with associated metadata. The record is available at http://collections.lib.uwm.edu/cdm/ref/collection/agsphoto/id/10137.

Digital Collection Building

Digital collection building involved selecting images, extracting metadata records from the local database, and uploading the images with associated metadata into CONTENTdm, the digital collection management system used for constructing AGS Library's digital collections. Approximately 64 percent of digitized images were selected for the online publication in the AGS Library's digital collections.[37] The reasons for elimination were 1) poor image quality that was the result of nitrate film decomposition or initial defect, such as poor focus or light balance, and so on; 2) duplication that is related to the fact that photographers would often shoot several similar pictures; or 3) inappropriate subjects, including scientific specialties such as petroleum geology or soil science, which were heavily represented in some of our photographers' output. Such photos, while of potential interest to the specialist, were deemed inappropriate for extensive publication online.

It was determined during the pilot project that scanning all images en masse and selecting from high-resolution scans was more cost effective than undertaking selection prior to scanning. This approach also ensured streamlining of the scanning workflows by making selections from a complete set of digital images. Selection for online presentation from a group of related high-resolution images is much more efficient than trying to guess from a group of negatives. Conducting selection prior to scanning represents a sound approach in the case of print-based materials where the content and quality of resources can be judged easily. However, the selection process of film-based materials is more challenging since the visual content of negatives is not easily accessible even with the use of a light table. It is difficult to determine the image quality, its level of degradation, or even its relevance. From a project management point of view, scanning all images on a film strip (rather than selecting one or two) and assigning sequential file names is also easier and reduces the risk of errors. The time spent by professional staff poring over the negatives or troubleshooting incorrect scans or file names outweighs the cost of scanning and digital storage. It also leaves a complete archives of each geographer/photographer's collection of images, representing a survey, event, research project, or a lifetime of images.

The digital objects created as a result of this project were added to several digital collections based on their geographic location. Digital collections of the AGS Library are arranged by geographic location according to continent following the standards of geographic organizations. This approach resulted in six major portals, including Africa, Asia and the Middle East, Europe, North and Central America, South America, and Oceania. Organizing the collections by geography rather than by a photographer or collection name meets the information needs of end-users who tend to search by subject or geographic location. This approach also allows the AGS Library to bring together images of the same location from different time periods and from multiple collections. The AGS Library's digital collections are open to the public and are available from the UWM Libraries Digital Collections page.[38] In addition, the website dedicated to the project, the American Geographical Society Library—Photo Archive: Saving and Sharing the AGSL's Historic Images, provides descriptions of individual collections and access to records by photographers' names and major topical themes.[39] Individual metadata records also include links to original collections and photographers' names.

Lessons Learned

Saving and Sharing the AGS Library's Historic Nitrate Negative Images was the first large-scale digitization project undertaken at the AGS Library. The project staff had substantial prior experience in digitization and had run a

successful pilot; nonetheless, this project proved to be complex and challenging. The first complexity was the scale of the project both in size and number of collections included. The other challenges included the lack of processing of the original collections, the difficulty of outsourcing negative scanning—especially nitrate negatives—the initial lack of professional staff, and the limited resources for metadata creation.

Pre-WWII photographic collections that have not been thoroughly processed and rehoused to current preservation standards will most likely yield collections of cellulose nitrate negatives. Negative collections with no dates, and even those thought to be post-WWII, can also contain nitrate negatives. Unprocessed collections with negatives in their original enclosures can be difficult to count accurately, as was the case with some of the collections in the AGS Library.

One of our first lessons learned in the process is the value of having a collection thoroughly processed and rehoused before planning a digitization project. In our case study, the addition of approximately 17,000 nitrate negatives to process, digitize, and describe had a profound impact on the project workflows. We decided to include the large increase to complete the conversion and preservation of all the nitrate negatives. This allowed us to complete the digital archives of nitrate negative images in the AGS Library. As a result, the library had to commit to increasing professional staff, and the project had to sacrifice metadata creation for some of the collections. We selected fewer images for full metadata and online presentation from the Pendleton Collection than we had planned, and we had to defer the Platt Collection metadata entirely. The metadata records for the Platt Collection were not completed as part of the first NEH grant and had to be incorporated into the second NEH grant awarded to the AGS Library.

The second lesson learned is the importance of having adequate professional staff for a time-sensitive project. When the AGS Library wrote the grant to the NEH, the plan was to outsource *all* scanning. Hiring professional staff to digitize in-house was not part of the original budget. With the discovery of almost 17,000 additional negatives to scan, the question of which collections would be outsourced came down to a decision to identify collections that were more homogeneous in format and larger in size. Smaller, more complex collections (due to lack of documentation) were digitized in-house. Professional staff and equipment necessary to scan negatives in-house needed to be quickly acquired and implemented to keep up with the NEH grant timeline. The fact that we had collections being scanned in-house at the same time we were outsourcing scanning allowed us to compare the time, resources, quality, and errors between outsourcing and in-house scanning. In the end, we found that outsourcing was more time consuming than we had anticipated for a number of reasons. The time spent packing, transporting, and subsequently reviewing the quality of

the scanned products—and in some cases having to return negatives to be rescanned with the outsourcing company—most strongly supported our decision to scan select collections in-house. In our case study, in-house scanning of film negatives saved time in preparing the negatives, assured high-quality scans, and reduced an error rate in file naming that some of the more complex, semi-processed collections would have inevitably caused.

The final lesson learned is the lack of worldwide, hierarchical authority for geographic metadata. The main online resource, *Getty's Thesaurus of Geographic Names*, part of the CONTENTdm vocabulary package, is an excellent starting point but is not complete and had to be supplemented with the National Geospatial-Intelligence Agency (NGA)'s GeoNames and the Geographic Names Information System for the United States and Antarctica. The NGA's databases do not provide geographical hierarchies; the project staff had to build these and keep track of them in their own database. This, along with the additional 17,000 negatives, slowed the creation of metadata and added another element to the project workflow. Again, additional professional staff were added to the project to help keep to the grant schedule.

We incorporated the lessons learned into the second NEH grant proposal in which in-house scanning is being used for the collections of acetate film negatives; three-and-a-half full-time professionals are implementing the project with the aid of three students and volunteers; all collections were processed and rehoused before scanning began (and yes, we found nitrate negatives in the process); and a full geographic metadata guideline and authority builder, developed during the first grant, are being used. The second NEH grant project, Saving and Sharing the AGS Library's Historic Film Collections II: Monochrome Acetate Negatives and Motion Picture Film began in June of 2012 and was completed by the end of 2013.

Conclusion

This article examined the issues of preservation and access of film-based photographic collections and the use of digitization for capturing the content of deteriorating negatives. It supports the view that preservation not only protects deteriorating archival materials, but also restores their usefulness as information resources. We discussed the concept of digitization for preservation in light of a large-scale digitization project aimed at preserving and providing access to over 69,000 nitrate negatives at the American Geographical Society Library.

The article contributes to the debate on digitization for preservation by exploring the ways in which digitization brings a renewed attention to preservation of endangered historic photographic collections and by presenting a case study of using digitization for access and preservation of film-based

photographic collections. The case of digitizing nitrate negative collections at the AGS Library demonstrates that digitization enables capturing and preserving the content of film negatives before they deteriorate and fade beyond recovery and use. In addition, digitization contributes to restoring the usefulness of film-based photographic collections by providing consistent access points and making them available online. Prior to digitization, the nitrate negative collections at the AGS Library had been virtually unknown and inaccessible. It is too soon to see the full impact of this project. However, the AGS librarians have documented an increase in inquiries from museums and researchers requesting images for publication, students seeking images for class projects, and filmmakers requesting still images for their films. The AGS Library experienced an overall 22 percent increase in the use of its digital collections during the first year, with spikes in the number of visits from countries that are now represented in the digital collections.

Access and preservation goals are closely connected in the digitization of film-based photographic collections. Digitization is imperative for collections that have been hidden but can be useful to researchers, especially thorough photographic documentations of places and cultures such as found in the De Terra, deBooy, Forman, Pendleton, and Platt Collections. Digitization is a viable preservation strategy for collections of any size and condition, and is especially important if original materials are fragile, damaged, and recorded on unstable film formats. Digitization should be part of a comprehensive approach to access and preservation that ensures the creation of high-quality digital master files, extends the usefulness of digitized objects by providing full and accurate descriptions, and addresses sustainability and long-term preservation of digital masters.

Notes

This article originated as a conference presentation, "Digitization as a Preservation Strategy: Saving and Sharing the American Geographical Society Library's Historic Nitrate Negative Images," presented by the authors at the UNESCO International Conference: The Memory of the World in the Digital Age: Digitization and Preservation, Vancouver, British Columbia, September 28, 2012. The article has been revised and expanded. The authors would like thank the anonymous peer reviewers who provided constructive and helpful suggestions for improving this article.

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[32] For more information about the AGS Library and its holdings, visit the library website, https://www4.uwm.edu/libraries/AGSL/.

[33] For more information about the collections, please check *The American Geographical Society Library—Photo Archive: Saving and Sharing The AGSL's Historic Images*, http://www4.uwm.edu/libraries/digilib/NEHgrant/.

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[39] See *American Geographical Society—Photo Archive, Saving and Sharing the AGSL's Historic Images,* UMW Libraries, http://www4.uwm.edu/libraries/digilib/NEHgrant.

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Tamara K. Johnston served as the coordinator of the project, Saving and Sharing the AGS Library's Historic Nitrate Negative Images and also co-authored the grant submissions to the National Endowment for the Humanities. Johnston has worked in museum collection management for the past twenty years, focusing on preservation and intellectual access issues. Currently, she works as a project manager and preservation specialist at the American Geographical Society Library. Previously she spent twelve years at Bryn Mawr College's Art and Archaeology Collection in Bryn Mawr, Pennsylvania, where she was the collections manager of "a museum without walls." She also worked with museum data management and preservation projects at the Kohler Foundation, the Penn Museum of Archaeology and Anthropology, the Pennsylvania Academy of Fine Arts Museum, and the Milwaukee Public Museum.