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REVIEW ARTICLE

Research and Educational Geological Collections in Brazil: the Conflict Between the Field's Paradigms of Heritage's Conservation and Geology

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Abstract
The increase in research within the scope of science collections has enabled a greater visibility of the problems and solutions applied to their preservation. Geological collections, as any scientific heritage, are a powerful resource for education. There are many adversities in preserving this type of heritage. Any geological collection has inherent in its practices the most diverse challenges, from the storage itself, through the documentation and information retrieval, the valuation of its goods, to the internal dialogue between its parts. The purpose of this article is to evaluate the particularities and fragilities of preservation practices in universitary research and educational collections in Brazil. Preservation in the heritage field is perceived and practised differently from scientific collections. Differences in how objects are preserved exist within the scope of the geological collection itself. An analysis of preservation practices is carried out, using as a guide the critical view permeated by the paradigms of the heritage field.

Keywords Preservation · Research collections · Educational collections · Geological heritage · Palaeontological heritage

Introduction

Geology and palaeontology are complex fields whose objects of study are intertwined at various levels. Every research institution developing, innovation and educational programmes generally produce objects. Instruments, artefacts, tools, samples and specimens are used daily in university departments and laboratories. The production, transit and disposal of objects are embedded in the *ethos* of these institutions. For many of these objects, one can attribute values and meanings at local, national and even international levels, but not necessarily it will be recognize as heritage. For a variety of influences, the institutions have ambivalent views on the function and preservation of its scientific heritage (Lourenço and Wilson 2013; Lima and Carvalho 2020).

It is a common practice among these academic fields to constitute and maintain collections of various typologies. Besides, the historical paradigms involved, in the development of these disciplines, collecting and preserving for academic purposes, has always been guided by scientific *ethos*. The huge number of samples acquired in field trips turns this method the most common form of acquisition.

Collections are, in general, a gathering of cultural goods that preserve their individuality while gathered in an intentional way, according to a specific logic. The collection starts from the selection of its components by a process of signification, directly linked to the valuation of its items. They can be more thoroughly understood as any set of natural or artificial objects, held temporarily or permanently out of the circuit of economic activities, subject to special protection in an enclosed space prepared for this purpose, and exposed to the public eye (Pomian 1985). Here the concepts of preservation, exhibition and collection are cleared intertwined.

When transporting this analyses to the scientific collections, the preservation is easily recognized in the incorporation of the object to a collection, once the process itself imposes intrinsically a "special protection". On the other hand, the

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public eye can be perceived as researchers, students, even their own curators, not only the general public, common in museums.

Collections are representations of memory, and they carry in themselves values assigned by their collectors, being this an individual or a social group (Ribeiro 2010). For the author, when the collector withdraws from an object its value of use and associates it with a symbolic value, it is instituting a character of exceptionality to this object. From Ribeiro's (2010) view, collections contain intrinsic values assigned by those who assembled them. So the collector is always an interlocutor between the individual and group. Collections of geology and palaeontology are no exception.

This paper is part of a PhD research in curatorial and preservation policies in universitary geological and paleontological collections at the Geology graduate programme in the Universidade Federal do Rio de Janeiro. In order to better understand the curatorial and preservation practices of such collections, 38 collections belonging to 20 institutions were interviewed during the years 2018 and 2019. These collections, representative of the general Brazilian universities practices, belonged to nine distinct states.

In a university environment, in addition to subdivisions based on research lines (palaeontology, geology, mineralogy, etc.), we can generically classify the collections into two groups: research collections, those whose objects serve the purpose of scientific research, and educational collections, in which the objects serve as practical examples for classes. Each one of them possesses its specificities.

Among the collections interviewed, 42.10% have educational and research functions. In these collections, preservation and curation practices are different considering its purpose. In general, research collections had more practices in common with heritage collections than the educational ones, such as how they store and use their objects. This conflict between the paradigms of heritage's conservation and geology fields, we are going to show throughout the text.

The life cycle of the collection object typified here involves activities such as acquisition, preparation, incorporation, study of the specimen, dissemination and preservation. This movement of the object is understood as vital for maintaining the values associated with it.

Collections that are not exposed or studied for a while lose their scientific, cultural and leisure value (Barbosa 2000). A while can mean a lot of time. For the purposes of understanding the sentence, let us use a while as a period long enough for a group of individuals to retain the memory of its existence. Such inert objects can be valued in other ways; however, their scientific value is intrinsic to their use and specially to the knowledge that society has about its existence. Values can only be assigned if the object has a role in society. The act of preservation exists only through the diffusion of its importance and meaning. We only preserve what we value, and that is why, awareness of all extrinsic values to goods is established as paramount (Lima 2017).

The object linked to scientific and technological production site (laboratories, research institutes, universities and similar) has a life consisting in its use and disposal, away from the general public. These entities do not have the habit of associating with institutions or professionals of preservation and memory (Granato et al. 2018). So, how can a scientific collection be preserved? The preservation of such objects occurs by rules and legislations from its country.

In Brazil, there are specific laws, decrees, ordinances and conventions regulating fossil and mining practices. We will focus here on those dealing with ex situ heritage.

Since the Decree-Lawn° 4.146 of March 04, 1942, fossiliferous deposits are mentioned as the property of the Brazilian people. Its collection as provided for in this legislation depends on prior authorization from the National Department of Mineral Production/DNPM (today National Mining Agency (ANM)–Law n° 13.575, of December 26, 2017), whose function also included the inspection of mineral and paleontological deposits (Brazil 1942, Brazil 2017).

Decree-Law n°. 277, of February 28, 1967, regulates the rights over individualized masses of mineral or fossil substances, found on the surface or inside the earth, forming the country's mineral resources. In Art. 10, this law states that the following will be governed by special laws: (I) deposits of mineral substances that constitute a state monopoly; (II) mineral or fossil substances of archaeological interest; (III) mineral or fossil specimens, destined for museums, educational Institutions and other scientific purposes; (IV) mineral waters in the mining phase; and (V) the groundwater deposits (Brazil 1967).

The General Conference of the United Nations Educational, Scientific and Cultural Organization, meeting in Paris from 17 October to 21 November 1972, aimed to contribute to peace and security in the world through education, natural sciences, science social/human and communications/information. Decree n°. 80,978, of December 12, 1977, promulgates the 1972 Convention Relating to the Protection of World, Cultural and Natural Heritage (Unesco 1972).

One of the nation's basic laws, the 1988 Federal Constitution, includes fossils in mineral resources (in Articles 20, 23 and 24), demonstrating that the protection of the subsoil is the responsibility of the federal government. In Article 216, paleontological sites are also clearly mentioned as heritage, and their preservation is considered an obligation of the public power (Brazil 1988).

Any geological collection has inherent in its practices the most diverse challenges, from the storage itself, through the documentation and information retrieval, the valuation of its goods, to the internal dialogue between its parts. There are a number of challenges to preserve this type of heritage. Here, we propose an overview analysis of preservation practices,

using as a guide the critical view permeated by the paradigms of the heritage field.

Preservation in Universitary Collections

Preservation is perceived as a group of activities, with the aim of guaranteeing the integrity or continuity of one or more objects. It does not have a single aspect; it represents a set of tools and actions taken by those who deal with the collections daily, either directly or indirectly. It can be understood as an even greater group of activities whose action aims to guarantee the integrity or permanence of one or more cultural objects (Pinheiro and Granato 2012; Lima 2017).

In the concept of preservation, there are several museological activities, such as documentation, management, research, communication and exhibition. The preservation of heritage leads to a series of practices beginning with the establishment of procedures and criteria for the acquisition of material. The continuity of the chosen ones are ensured through the management of cultural goods and its conservation (Desvallées and Mairesse 2013; Lima 2017).

Musealizing an object is one of the oldest forms of preservation. It means the selection and valuation of objects under the museological gaze, the very processes of preservation to which they are subjected, responsible for the attribution of values to the detriment of the elements that were not selected (Cury 1999). The characteristic actions of this process represent a milestone in the trajectory of an object through the displacement of the original context and deprivation of the functions of use that in this new space begin to perform the function of document. They must be collected, classified, preserved and documented, becoming research source or element of an exhibition (Loureiro 2007; Mensch 1992; Lima 2017).

The preservation practices in the heritage field have been guided by principles listed in heritage charters, declarations and recommendations, since the Athens Charter for the Restoration of Historic Monuments (1931). With the development of collections management within museological institutions and the development of the role of collections care as an extension of preventive conservation, a more pragmatic and holistic approach in the treatment of objects has been practised (Newey 2000).

Besides the subjective particularities involved, one should consider among the main principles of cultural heritage's preservation the minimal interference. The concept says an object valorised has to remain, as intact as possible, over the years, made professionals of this field moved away from practices related to the recurrent use of objects.

Within a heritage context, preservation can be conceived in different forms. Collections both valued as geological heritage can be treated differently, mainly because there is a gap between the heritage field and the sciences. On one hand, there are collections in contact with museological professionals that benefit from its practices. On the other hand, there are the educational collections, in which the constant use deviates the object from the musealization process. This dichotomy permeates the preservation practices creating a paradigm.

Objects being preserved in collections or studied in laboratories find their common denominator in the practices of conservation, documentation and communication, to which they are submitted. The process of musealization is not totally free of problems. The withdrawal of objects from their original context, even if it is aimed at special protection, leads to a potential loss of information, insofar as it decontextualizes the object of past environments (Araújo and Granato 2017). If we perceive it as a process of preserving objects of heritage, we must rethink the criteria that allow it to loss information in order to minimize them.

Normally musealization is easily perceived in research collections (Fig. 1), mostly because of its preservation practices. However, it can also be observed in educational geological collections (Fig. 2). Mostly, because they are also removed from their original location and included in a new context, gaining a new function; and also, because apart from the preservation methodology, all other process mentioned as part of the musealization are present. Selection will take place along the acquisition; usually in the field collections, management and conservation involve the daily process of the curator/professor responsible in deciding which pieces are preserved enough to remain exposed and which need to be replaced; and finally, in a unique way, research and communication occur during the classes.

Collections of geological heritage require preservation actions, such as inventories, conservation status assessments and monitoring (Haag and Henriques 2016). Within geological practices, choosing whether or not the material should remain in situ is fundamental for the establishment of its preservation. This decision is usually made by the collector, considering the degradation aspects and the possibility of retaining as much information as possible near the object.

Ex situ preservation occurs through withdrawing the fossil from its geological context towards a new reality, usually it goes to scientific collections or exhibitions, partially removing the context external to the object, losing extrinsic information. In situ preservation, on the opposite, is done without moving the object from its environmental context (Carvalho 2018).

Several authors (Renaud 2002; Loureiro 2012; Carvalho 2018; Ponciano et al. 2011; Mansur et al. 2013; Lima and Carvalho 2020) affirm that both in situ and ex situ preservation have their particularities and that in both cases there are pros and cons. While in situ preservation is possible to work contextualization in an immersed way, the preservation ex situ tends to prolong the time of existence of the goods. Once the object is in a collection, valued as heritage, it will receive specific treatment for its preservation, while the object in loco tends to be vulnerable to degradation due to weathering.

Fig. 1 The research collections at the Universidade Federal do Rio de Janeiro (UFRJ) are located in a separated room where the musealization process (identification, documentation, preservation) occur to every sample. The macrofossil collection, exposed here, is one example. **a** Overview of sliding fossil material packing modules. **b** Overview of packaging for small fossils. **c** Individual fossil packaging modules in laminated micro-corrugated paper boxes with identification paper

Preservation ex situ is not always an effective method for paleontological heritage once the withdraw may lead to a potential loss of tafonomic information. Otherwise, the interference of nature and human action can also lead to destruction in loco and, in certain cases, to the complete loss of large fossiliferous deposits (Carvalho 2018; Lima and Carvalho 2020). Both should be considered complementary in order to highlight the potential of goods in all spheres, from the academic field to the public interest.

Up to now, it is clear that in the processes involving the preservation of collections, both research and teaching, are complementary. There are no right or wrong option in

Fig. 2 The educational petrographic collection at the Universidade do Estado do Rio de Janeiro is located within the microscopic class. **a** Overview of wood cabinet with drawers where the rock and mineral samples are safeguarded. **b** Drawer with multiples samples of the same type of rock. **c** Individual fossil packaging modules in micro-corrugated paper boxes with identification paper

choosing among these practices. Only an analysis of the scenario will provide the curator with the right answer.

The Preservation Route of the Scientific Goods

Understanding that all the objects belonging to Brazilian universitary research or educational collections have the potential to be considered as scientific heritage, it is questioned why they are treated in a differentiated way as to their preservation. Research collections are mostly often linked to museological institutions. Of the 38 collections visited, 22 were dedicated only to research. Among these, approximately 82% has some kind of link with a museological institution.

Usually their preservation takes place using many of the precepts present in the field of heritage conservation. On the other hand, educational collections, especially those of use in geology and palaeontology undergraduate and graduate courses, do not enjoy this close relationship. Their objects generally are taken care by professionals with little affinity with the heritage field.

Considering the heritage professionals and the interns, scholarship holders of courses associated with the heritage area, only 29% of the collections interviewed have such professionals. Despite the low number of heritage professionals, it is emphasized that most of the collections interviewed here had support from museological institutions, so that, to a certain extent, some demands that are originally generated by the heritage professional are met through partnerships. Eighteen per cent of the interviewed collections do not have any type of technical support or museological link.

About 20 years ago, there were a small number of professionals with expertise in the field of preservation involved in geology subjects. It is understood that much has changed in recent years (Doughty 1999). This reality is very similar to the Brazilian universitary collections. Two distinct groups of professionals cohabit in these safeguarding places. The first and most common is professionals who despite working in geoscience institutions do not have the specific scientific knowledge to deal with this type of object, such as the chemical processes that cause the loss of specimens. The second group is more specialized, being formed by geologists or geoscientist who have more knowledge about the object, but little or almost none on the preservation and museological processes (Azevedo 2013). These professionals should whenever possible seek to work together, in order to the preservation of these collections to be ensured in the best way. From this perspective, it will be presented from this point on an analysis in the research and educational collections, seeking to paragon them. This comparison will be structured through the life cycle of the scientific good, from the selection of the good through transportation, inventory, documentation, use, communication and, eventually, disposal.

Selection of the Good

Erosion is the main natural factor that makes geological and palaeontological objects available for collecting, but it is also the main cause of its deterioration. This imminent danger to which goods tend to suffer can be a justification for the gathering. In this case, it can be understood as a preservation action, when tied to the musealization (Wever and Guiraud 2018).

In Brazil, collections of geological or paleontological material are safeguarded through current legislation. Decree n°. 98,830 of January 30, 1990 (and Ordinance n°. 55, of March 14, 1990-MCT, which regulates it) subjects to field activities, for the collection and selection of materials (including biological and mineral specimens) by natural or legal foreign person to the control of the Ministry of Science and Technology (current Ministry of Science, Technology, Innovations and Communications-MCTIC), which must evaluate, authorize, as well as supervise and analyse the results of the collection works (Brazil 1990a). The text of Ordinance n°. 55/1990 also determines that, in the case of collection by an international institution, the MCTIC, through the Brazilian institution co-participating and co-responsible, will retain the collected material (neotypes and all the standard fossil material), giving it to a destination to Brazilian scientific institutions (Brazil 1990b).

Since the geological and paleontological heritage, as described in the Federal Constitution of 1988, is a public good, the illegal collection of this material is regulated by Law 8176 of February 8, 1991. It is defined as a crime against the economic order, in the modality of usurpation, the exploitation of raw material belonging to the union, without legal authorization or in disagreement with the obligations imposed by the authorization title (Brazil 1991). The fossil, as a good of the union, and without ANM legal authorization for its exploration, falls under this type of contravention.

Decree n°. 62,934 of July 2, 1968, (Repealed by Decree n°. 9,406 of June 12, 2018) regulates Decree-Law n°. 227. Decree No. 9406/2018 informs the rules by which the survey of geological assets should be conducted in Brazil (Brazil 1968). The research authorization is granted to a Brazilian, a company incorporated under Brazilian law and headquartered and managed in the country or the cooperative, upon request to ANM, which must contain the elements of instruction contained in Art. 16 of Decree-Law No. 227, 1967-Mining Code, and meet the requirements established in ANM Resolution (Brazil 2018).

Returning to the focus of Brazilian universities, the selection of an object is intrinsic to their musealization. This process is fairly similar in research and educational geological

collections, in its first steps. In a geological collection, the selection usually involves the use of scientific-specific methodology, on the field, by the research team or students supervised by professionals.

In the gathering stage (Fig. 3), until its preservation, the object acquires an increasingly important documentary value. This occurs because regularly the object has been collected to answer a particular question or to file a response (Lourenço 2003). The more information is collected and later documented, the greater its value, within the scientific study.

Once the object is collected, what defines whether it will be part of the research collection, the educational collection or the exhibition? There are many different procedures depending mostly on the objective of the research. If the specimen has scientific values (was collect respecting the scientific methodology, providing enough information), it will probably be sent to the research collection. Otherwise, the lack of information turns the specimen only viable to use in class when it has some characteristic important to be learned or, if it has good aesthetic, probably will go the exhibition.

One aspect to be considered is rarity. Many research collections have objects with rare values present in them, as in type series (holotypes, paratypes), and extraordinary values, as in the most unusual fossils. The presence of this value, when recognized by the professional working in the collection, usually causes this type of object to receive documentary treatment, adequate packaging, exhibition, research, and so on. However, the rarity value is not known in the moment of the selection. In this sense, the rarity value will not appear until the object has been studied.

In a generalized way, the aspect of rarity is little or absent in educational collections. Since their specimens are already selected and valued with the intention of use, and being aware of the possibility of degradation by handling, it is not common among this type of collection rare specimens. Research collections, on the other hand, may even be recognized as reference collections, where the concept of preservation is intrinsically the main concern, since they contain notorious representative and unique samples.

Collections will always be needed in the academic field, especially in the teaching of natural sciences. It is, however, unrealistic to believe that collections can grow indefinitely. Acquisition is only one part of the process, and it should be planed beforehand.

The national scenario through the interviewed collections shows that for the research collections there is an absence of acquisition and discard policies in 68.18% of the institutions, while in the collections that contained educational collections,

Fig. 3 Field trip to the Araripe Basin with undergraduate students from the Universidade Federal do Rio de Janeiro (UFRJ). The experience in collecting fossils enrich the educational and scientific collections, as well as training new geoscience researchers. **a** Students learning how to remove a fossil from its rock. **b** Students at *Casa da Pedra* learning the selection process. **c** Students using specific tools in the retrieval of the fossil

this percentage is slightly lower, at 56.25%. The collection policy should be defined more narrowly, and material that has no use for them must be redirected or donated to other collections. An acquisition and disposal policy is a vital document correlating the purpose of the collection to its objects. It contains rules as well as the parameters to be followed, the amount of goods supported by the safeguard site, and the previous growth planning.

The entire selection process must occur in order to think about the security and integrity of those objects. They should be handled with care from the time they are acquired in the field to the final storage location.

Handling and Transportation

On the object's history, the transfer follows the acquisition and encompasses every step until its arrival in a technical storage or collection. This process is most often the same for both types of collections dealt here.

Due to its nature, paleontological and geological materials are treated differently. It is common, in this stage, to plan in detail the preservation of fossils rather than rocks and minerals. Fossil transit is most commonly reported in general literature on the subject. Transportation practices are common in the midst of scientific articles with case studies (Hunt-Foster 2009; Nolan et al. 2009; Press et al. 2006; Seguin 2015). A parenthesis is needed in some cases, such as in unstable minerals. They need special conditions for collection and conservation during transport. Factors such as oxidation, relative humidity and rapid drying can destroy or change the original mineral.

The transport of paleontological materials can be very tricky and is mainly one of the main agents of deterioration (Fig. 4). Techniques, such as the "linear collapsible foam," are vital for the collection, because it allows the modelling of ichnofossils, with accurate information, allowing more than the production of facsimiles after (Nolan et al. 2009). It should not be forgotten that there are other methods, for example, which may be more effective depending on the situation.

Poorly done transportation can have long- and short-term consequences for the heritage. The damage caused to the object during transport may become doubts in its taphonomy. In the long run, minor cracks are capable of turning into points of weakness and lead to the separation of unwanted parts or even the total loss of the object.

Regarding the movement of cultural objects (including collections of mineralogy and palaeontology) inside and outside Brazil, we cannot fail to quote Decree n°. 72.312/1973, created in response to the 1970 UNESCO Convention. This document deals with measures to be adopted, aiming to prohibit and prevent imports, export and transfer of illicit property of cultural objects.

The information on how the transport was carried out and preferably the photographic record is essential for the object's documentation. A specimen without information cannot be valued, and so it will rarely be considered scientific heritage. The objects documentation permeates the practices from the acquisition to its study in the collection.

Inventory and Documentation

Once the good is in the laboratory or technical storage, it must be inventoried (simplified listing of identification) and documented (detailed record of intrinsic and extrinsic characteristics), in order to gather as much information as possible to a future research (Fig. 5).

The process of musealization through the displacement of their function and origin confers on objects' neutrality, creating gaps in meanings (Uzeda 2018). Several techniques are used to minimize the information gaps provoked in this process; the documentation is a fundamental source of meaning for these objects. The complete documentation of an object is essential. However, not all information is important. The parameters in which the selection of information relies must dialogue with the purpose of the collection.

The inventory should be considered as one of the first steps towards preservation. It is a common practice of systematization and organization of information. It consists on a simple identification and registration of each object, listing the main characteristics, enabling its identity in the collection. The inventory is a consequence of the selection and attribution of value to the material culture (Granato et al. 2018).

Regarding the organization of scientific collections, in both cases, there is an effort by the professionals responsible for these collections to identify and catalogue the objects, at least in its minimal characteristics. This is perhaps one of the activities that bring the field of museology and preservation closer to the sciences.

Within the field trip practices, it is common for the researcher, in loco, to describe through a listing (initial inventory) all the samples. If incorporated into educational collections, these samples probably will not have another identification treatment. If integrated into research collections, they are most likely to be deeply documented.

Documentation is the primary way of safeguarding an object. It is the most complete way of collecting and making available information about it, as well as the history of the object in the collection. Museological documentation is the set of information about each of the items, represented by words and pictures. It operates with entries (selection and acquisition of items), organization (registration, classification, indexing, etc.) and outputs (retrieval, dissemination). This information retrieval system, created to preserve the documented information, turns the collections into sources of scientific

Fig. 4 Field trip to the Araripe Basin with undergraduate students from UFRJ. Transportation of fossils. **a** First step in separating the fossil from its rock. **b** Students transporting the heavy fossil to be packed. **c** Fossil being accommodated so it can be packed

research and consequently into instruments of knowledge transmission. A documentation system means a process whose objective is to preserve the items in the collection and to maximize the access and use of the information contained in them (Ferrez 1994).

Inventory is a very common practice in Brazilian university collections. Approximately 36% reported that their collections were fully inventoried, while 62.52% had their inventories incomplete; only one collection did not have any type of inventory record. On the other hand, when asked about the existence of a database, a form that allows for more in-depth documentation, the rate in the research collections was approximately 25 percentage points higher. The research collections had 81.81% of the them using a database, while only 56.25% of the educational collections had one. Showing that for the practice of documentation, the research collections are closer to the reality of the field of heritage.

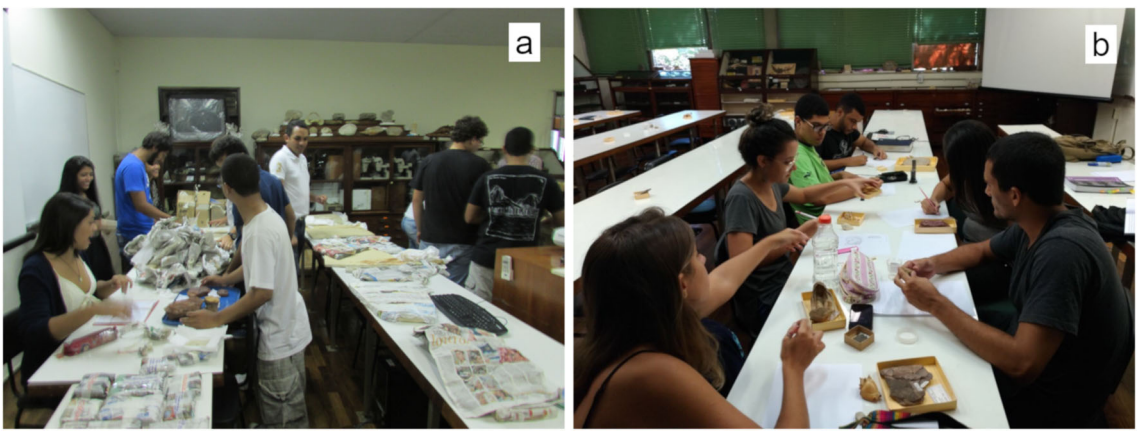

Fig. 5 Students sorting, identifying and documenting samples gathered in the field trip. **a** Students sorting the samples gathered in the field trip, in this stage they evaluate the sample deciding whether it goes to the educational or scientific collection. **b** Students identifying, documenting and putting the samples in specifics boxes to preserve the sample

Collection organization systems linked to the existence of inventories and databases are useful tools for both scientific and didactic collections. The educational collection of the Universidade de São Paulo (USP) is an excellent example of systematization and organization of didactic collections (Fig. 6). It is a vast collection with geological and paleontological samples and scientific equipment and models. The collection, which is available to several departments as auxiliary material to compose the university's classes, has a request system when filling out a form, where the professor describes the material. The professionals who work in the collection retrieve the location and existence information of the material through computerized consultation. Finally, samples or materials are separated and delivered on loan to the teacher.

The availability of the database in a virtual environment is an essential preservation and security action to maintain its scientific role. Documenting is assigning values, and this action is always arbitrary and subjective (Mansur et al. 2013).

Use–Geological and Paleontological Research

When the scientific good is already duly registered in its collection, it starts to perform the function of the collection. Thus, the dynamics of use are very different among the collections analysed here. Regardless from which collection it belongs, it is emphasized that its valuation as a scientific heritage goes beyond this dichotomy.

The dynamics in educational collections occur through the objects' use as real examples in disciplines. Their use on a daily basis has consequences that directly affect their preservation. The classroom routine leads to degradation caused by continued student manipulation. From the heritage's point of view, these collections in active use have little in similarities with the research collections.

The use of research collections is intended to serve as a basis and aid for scientific advancement; this process enables the objects belonging to them to actively witness this progress. These collections mostly have preservation practices linked to their use, such as the use of gloves, lightning and environmental control. It is also understood that in these collections the preservation and storage are thought as part of its use. On the other hand, in teaching collections, the storage is not motivated by preservation but rather by the systematics it represents.

When asked if there were documentation about use and research policy, the interview provided us some data, illustrating the paradigm here analysed. Research collections gave 36.36% positive answers and educational collections 28.57% (considering that two collections did not answer this question). Again research collections approach regulatory practices for the preservation of the heritage field.

Scientific heritage cannot be preserved, much less used if we do not know what exists and where. Disseminating research is an essential tool for planning, policies, managing and preserving collections (Lourenço and Wilson 2013).

Communication

The management of geological heritage and geodiversity should include the dissemination of its importance as a method to broaden the general awareness regarding the conservation of geological values (Carcavilla et al. 2007). The communication of these collections is understood as the set of actions

Fig. 6 Educational Collection at Universidade de São Paulo (USP). **a** Overview of part of the room of the educational collection. **b** Organizing system in boxes and shelves. **c** diversity of organized samples aiming at their recovery efficiency

aimed at transmitting their value to the general and specialized public, in order to promote their understanding and stimulate attitudes towards the conservation of their goods. A collection that does not communicate with a public is not is a complete collection. If we view the heritage as a human body, we will see that the dissemination is the lung, which keeps the good alive.

In a universitary environment, communication normally occurs in museums (Fig. 7), when the university has one, but it can also occur through extension projects, connected to the foundations of the university. These projects allow not only the dissemination of collections but also the communication between students, teachers and various technicians who surround this institution, promoting in distinct ways the valuation of their scientific heritage.

This activity, although fundamental in the life of the object, presents failures in the collection's security. The difficulty lies in finding a fair middle ground that does not endanger the scientific heritage but allows the dissemination and use activity promoting vocations and sensibilities in the public.

Discard

The life of a scientific object is also marked by its discarding, when necessary. All existing mechanisms in scientific institutions postulate that when obsolete, objects must be replaced, adapted, cannibalized or dormant in attics and basements, often for decades, and finally discarded (Lourenço and Wilson 2013).

In Brazilian universities, common objects that are automatically incorporated administratively by the institution already have some kind of rule regarding discarding. However most, if not all items in collections, do not enjoy this rule, since their recognition as an administrative object is not common. This dynamic is taken to the collections by the professional scientist, juxtaposing these practices to their preservation.

The discard dynamics in educational collections occur more flexibly than in the research collections. We can attribute this difference mainly to the use and constant handling of the educational collections explained before. Discarding in teaching collections occurs by necessity. For example, if the specimen is too degraded to serve as an example, it is "thrown away" and replaced by another. The replacement is not very different in both collections. Once the object undergoes any degradation process, such as the decay of pyrite, its use is no longer viable.

The difference is in the way the disposal takes place. In research collections, it is common to keep the complete documentation of the good, even if the item is discarded. While in the educational collections, it is more common to simply discard, since the documentation is limited to identifying them with labels, due to the little compromise with documentation with a normally seen "daily used object".

Fig. 7 Communication in an museological environment inside an university. **a** Exhibit room at the Museu de Ciência e Técnica da Escola de Minas da Universidade Federal de Ouro Preto. **b** Exhibit room at the Museu de Geociências da Universidade de Brasília

Research collections that enjoy proximity to museological institutions have an intrinsic characteristic in the making of a policy of acquisition and disposal. This policy allows the establishment of criteria that will be used in the acquisition and disposal process, always leaving all the decisions taken documented.

Conclusion

Despite not being part of this paper's focus, we cannot forget to consider the existence of geological and paleontological collections at non-university educational levels (schools) that can awaken vocations and respect for geology in general and palaeontology in particular from an early age. These collections have not yet enjoyed a nationwide assessment of their practices.

The evolution of science and technology through research is continually adding new meaning to collections, in a greater degree for the research collections, for its uses destined to new discoveries, and in a smaller for the educational ones. The professionals who deal with them must be sensitized in order to know the potential of the goods and indicate the best preservation methodologies possible. This article demonstrated the main differences found in the preservation of Brazilian universitary research collections comparing the geological and paleontological teaching collections. The analyses were based on the literature mentioned throughout the article and using part of the data collected in the PhD project.

The preservation practices such as documentation, management, research, communication and exhibition were described in the life cycle of the geological or paleontological heritage. It was possible to see a paradigm in terms of how collections are treated, be they educational or research. It is clear that such collections have different functions that guide their practices to approach or depart from the practices common to the field of heritage.

The boundary between educational and research in universities is not always clear, many objects pass from one collection to another, losing and gaining new values. How to preserve this fluid heritage? It is understood here that this dynamic involves the basic activities of the university and that the best way to ensure the preservation of these collections is through detailed museological documentation. A systematic and consistent record should be kept of all the steps by which the good passes, as well as details of all investigative cleaning (preparation) and conservation treatment, including all scientific data.

Internal mechanisms such as policies, selection criteria and procedures are lacking, to the academic institutions, jeopardizing the preservation and documentation of its objects. Although many researchers and theorists have advocated in favour of geologists and palaeontologists as heads of scientific collections, it is necessary to emphasize that these, in most cases, do not have the knowledge to propose the best way of preserving collections. Whenever it is possible, it should exist a multidisciplinary team working on it.

Since the teaching environment is conducive to the dissemination of good practices, teaching collections should serve as a valuation and methodology laboratory. In addition to the theory and practice of each discipline, these future professionals will come into contact with the preservation of the collections, creating a cycle of good practices. In general, the collections analysed here suffer from the lack of specialized preservation staff; using the classroom to disseminate the necessary technical knowledge can be a fundamental step in solving this problem.

This alone is not enough. The absence of preservation policies in the management of collections, especially teaching ones, reflects that although geologists and palaeontologists are considered essential in the training of professionals, they are rarely thought of as scientific heritage.

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