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Introduction

1 The collection of the Ethnographic Museum at the University of Zürich (EMZ) dates back to the one of the Ethnographic Society of Zürich, founded in 1888. In accordance with the society's aim to promote theoretical and practical ethnological studies, a study collection was created to address primary and middle schools in Zürich as well as "commercial circles", meaning merchants who travelled to colonial territories. Initially comprising some 500 objects from private collections, in the following decades the collection grew rapidly and in the year 1913 was donated to the Canton of Zurich, becoming the Ethnographic Collection of the University of Zürich. In 1979 the collection was moved to its current location in the Old Botanical Garden in the heart of Zürich, and in 1980 opened as the Ethnographic Museum (EMZ, webpage). Today the museum houses a cultural heritage collection of around 50'000 objects, photographs, film documents, audio recordings and archival materials. As a part of the Department of Social Anthropology and Cultural Studies (ISEK) the EMZ today is a social anthropology science museum at the interface between the university and the public, committed to research- and practice-saturated teaching, collections conservation, object research and knowledge transmission EMZ webpage).

2 Since 2022, due to redevelopment works planned in the museum's onsite storage facilities, a significant part of the collection is undergoing a re-packing campaign, allowing the conservators to get an overview of the collection's condition. In this

context, they identified several composite objects made of copper-based alloys and organic materials such as leather and wood, presenting similar degradation products. These blue-green efflorescence were especially noticeable on some objects that were in contact with greasy substances, the identification of which was non-trivial (Fig. 1).

Fig. 1: Wooden sculpture from the Democratic Republic of the Congo

Wooden sculpture from the DRC (EMZ Inv Nr. 10315), showing the presence of green-blue degradation products in correspondence with greasy parts of the objects.

Credits are missing

3 Questions about the origin, composition and stability of these products arose, which brought about the collaboration between the EMZ and the research unit of the Haute Ecole Arc Conservation-Restoration (HE-Arc CR) in Neuchâtel. Many actors from the field of cultural heritage have to work with the collections, bringing specific expertise and raising different questions. A multidisciplinary discussion such as the one undertaken at the EMZ can offer a better understanding of the context in which the object altered and help decide how to address conservation issues (Renshaw-Beauchamp 1983; ter Keurs 1999; Feest 2014). This work inserts itself in a context where scientific literature tries to make discoveries accessible to both conservation professionals and scientists, and provide tools for recognising alterations when availability to appropriate scientific analyses cannot be granted (Burnstock 2019).

Ethnographic collections: understanding the context

4 When approaching the study of ethnographic objects, it is of primary importance to consider how and in which context such artefacts entered museums. Most ethnographic collections and museums in Europe and in the so-called West were created at the time of colonialism in an attempt to represent, describe and study scientifically non-European societies and cultures (Malefakis 2009; Macdonald 2011; Owen 2006; Lightfoot 1983; Stanton 1999). Since then, museum practices and expectations directed at museums, especially with regard to their relationships with

their audience and the originators of the objects (or their descendants), has come a long way (Macdonald 2020; Schorch 2019; Stanton 1999). Whilst in former times often the practices of conservation, research and exhibition in Western museums did not include the views, knowledge and skills of members of the originator communities of the objects, today, collections are increasingly understood as object diasporas from non-European societies in Western museums (Basu 2011) that can only be researched meaningfully in collaboration with members of the respective cultures and societies they stem from (Flitsch et al. 2020). For all parties involved in such collaborative research, objects are valuable as material sources through which to gain insights into past and contemporary live worlds, to study the knowledge and skills encapsulated in objects, to be able to reconstruct historical moments of encounter between collectors and communities of origin, and to forge new relationships across cultural worlds. An object's material composition, manufacturing techniques, types of use, cultural meanings as well as its biography in different contexts of private or museum collections (Appadurai 1986) are important aspects of this kind of research.

5 Once the objects are in the collections, the conservators are those most likely to encounter alterations. In fact, it is within their tasks to "undertake responsibility for, and carry out strategic planning, diagnostic examination; the drawing up of conservation plans and treatment proposals; preventive conservation; conservation-restoration treatments and documentation of observations and any interventions" (E.C.C.O. 2002). In the diagnostic examination, the composition and stability of the objects and their alterations must be first clarified. Degradations of these materials are then identified and their products are characterised when possible. A prognosis is presented, assessing if the object is at risk and, if so, what is the expected degradation rate in the current conditions. A conservation-restoration plan proposes ways in which the situation can be improved (E.C.C.O. 2002). Note that this plan can include preventive and/or curative measures.

6 The practice of conservation-restoration evolved a lot through the years, also for what concerns ethnographic collections (Petrova 2013). Early restoration plans were different in terms of level of intervention and choice of material, as key concepts such as authenticity, minimal intervention, detectability and reversibility were introduced and redefined later on (ICOMOS 2023, webpage). For instance, although the use of modern materials was recommended in the Athens' chart in 1931, caution was already advised in the Venice chart of 1964 (ICOMOS 2023, webpage). This is an evolution to keep in mind when studying collections that have potentially been restored in the early 20th century.

7 When it comes to caring for collections, conservators are now aware of the implication of any intervention on the object, removal or addition of material, because it might alter or remove precious material information. Renshaw-Beauchamp gives a specific example of tools, found in an archaeological context, that still had enough blood residues on them to determine the species of mammal that was last cut up with the tool (Renshaw-Beauchamp 1983). This is something to weigh up when assessing the need for cleaning an object. Residual materials, suspected to date from the time of use of the object, are kept not only for their research value, but also for the potential cultural or spiritual significance that people have attached to them (Izard Martinez and Celigueta 2022). Considering this, conservators have found themselves in the position to also advocate for the intrinsic values of objects, having specific knowledge of their

materiality and given their privileged position to act as a mediator between other museum professions (Szmelter 2013).

8 Keeping in mind the history of both ethnography and conservation-restoration, one can appreciate the challenges in understanding the origin and the significance of the alteration observed. It is for instance necessary to ask if the degradation products identified are part of the object's "patina", a material trace hinting at the cultural practices of which the object was a part, such as sacrificial rites, and therefore might be an important aspect of the object's cultural aesthetic and spiritual value. Other questions might concern whether the reaction is intrinsic to the object, meaning that all agents of the degradation are considered part of the object itself, or due to material accumulated (i.e., dust or deposits) or added (prior conservation treatment) during the museal life of the object (Schrenk 1991). If the latter, is it a part of the object's history that needs to be preserved? How does it impact the public and the originator community's perception of the object? One could go a step further and take advantage of the presence of an alteration to ask further questions and learn from the object: does it contain information otherwise inaccessible or lost? In other terms, can we consider the alteration as an opportunity instead of a problem? Answers will vary depending on the existing documentation, or lack thereof, as well as potential display or research plans.

Conservation practices and metal soaps

9 Metal soaps are degradation products that can form whenever metals or metallic compounds are put in contact with a fatty material (Hermans et al. 2017). They are known to be problematic when formed on paintings (between the metallic pigment and organic binder) since their growth forms blisters and can lead to the flaking of the painted layer. Hence, there is an increasing interest in detecting them, understanding their formation process and finding appropriate treatments (Casadio et al. 2019).

10 On ethnographic objects, metal soaps developing on copper-based materials are often found and identified by visual inspection (Russo et al. 2023). They form voluminous blob-like, sometimes curly-shaped, corrosion products, with translucent, shiny, or waxy appearance and colour varying from green to blue (Werner et al. 2012).

11 For metal soaps formed on traditional paintings on canvas, where they contribute to the degradation of painting through formation of blisters and paint delamination, intervention is required when these alter the appearance and readability of the objects. In some cases, such as the ones cited by Burnstock (2019), when metal soaps are particularly disfiguring for the artwork, removal might be necessary. After having acquired knowledge about the composition and water-sensitivity of the painting, metal soap removal entails a combination of mechanical and chemical treatments using appropriate and tested solvents, chelating agents and gels, with low affinity for the original paint layer components and which pH is adequate (Burnstock 2019).

12 In the case of metal artworks, mechanical cleaning and metal soap removal is normally preferred, sometimes in combination with organic solvents, e.g., mineral or white spirits, or turpentine oil (Werner et al. 2012).

13 It being a form of corrosion of metals, metal soap removal can often reveal a damaged or heavily pitted metal substrate (Werner et al. 2012). Like in other corrosion processes, depending on the external conditions of relative humidity and pH, unstable metal soap

forms could redissolve and the metal cations interact and catalyse the degradation of neighbouring materials like cotton or leather (Werner et al. 2012).

Impact on cultural values

14 Questioning the impact of an alteration on cultural values is part of the standard procedure before any conservation treatment. In the case of metal soaps, their presence is often linked to residues of original materials that may have cultural significance to the communities of origin of the objects (Meier 2022). Removal of such alterations should therefore be carried out only after consultations with the respective community of origin of an object. However, the degradation can also be caused by the presence of a more recent coating of wax or oil, added after the acquisition of the object by the museum or private collector.

15 It can therefore be challenging to determine the specific meaning of such corrosion products for the biography and cultural value of an object, and to differentiate between what is "authentic" material and what is museum intervention. That might be the reason why this alteration is seldom addressed, and the corrosion products are not systematically removed.

Materials and methods

Description of the objects

16 Visual assessment was carried out by E.G. at the EMZ. 13 objects including their components have been selected to represent the various problems in the collections (Table 1).

17 The corpus selected for sampling, counted three categories of objects:

- 8 edged weapons with leather sheaths or wooden scabbards and metallic functional or decorative elements such as buckles and inserts;
- 3 anthropomorphic wooden statues with metal ornaments and evidence of greasy coating of unknown origin;
- 2 leather accessories with copper threading and decorative embroidery.

18 The selected objects were examined visually and described before samples were taken by removing some of the superficial products to be analysed.

Table 1.

Object description	Inventory number	Relevant images
Horn handle with decorative wire art, Sahara Tamanrasset, Algeria. Wooden scabbard covered with red leather, secured with Cu-based wire.	11127b	
Wood handle with decorative wire art, Sahara Tamanrasset, Algeria. Wooden scabbard covered with red leather. Cu-based buckle and leather loop.	11127c	
Wood handle with decorative wire art, Sahara Tamanrasset, Algeria. Wooden scabbard covered with red leather. Cu-based buckle and leather loop.	11127d	
Sword in a leather scabbard, D. R. Congo. Decorated with 2 different Cu-based thick wires. The surface of the scabbard appeared very dry with localised white powdery deposits.	09733b	
Sword and scabbard, Ethiopia. Sword in a thick leather scabbard with a leather belt and Cu-based buckle	12137c	
Wooden statue with decorative Cu-based elements, D. R. Congo. Looking at the aspect of the wook, it was probably waxed or oiled.	11228b	

Description of the 13 objects selected for this study.
Picture credits: Elodie Granget

Analytical methodology

19 The µATR-FTIR analyses were performed with a Thermo Nicolet iN10 spectrometer coupled with a microscope that allowed collection of 16-scan spectra, with a resolution of 4 cm^{-1}. The germanium slide-on micro-tip ATR accessory having a refraction index of about 4 provided an analysed spot size of about 37.5 x 37.5 µm. Data acquisition and processing were performed using Thermo Fisher Scientific Inc.'s proprietary software Omnic 9.2 for visualisation and interpretation, and Matlab 2020b for graphic representation.

Results and discussion

20 The information available from the EMZ's documentation suggested that the objects have been kept in storage for about four decades and they have not been treated during this time.

21 Products suspected to be metal soaps were mostly found on weapons at the interface between the metal (blade, buckles, decoration) and the scabbard (leather, wood) or handle (wood) and on wooden or leather objects with metallic decorations.

22 The products identified on the weapons had various appearances. Some were intensely green greasy compounds (e.g., sword with fur scabbard Inv. no. 12205e), as well as powdery greenish products (e.g., leather scabbard with buckle, Algeria, Sahara Inv. no.

11127c and sword with leather scabbard, D. R. Congo Inv. no. 09733b). They always developed at the interface of the copper-based alloy (blade or ornament) and the organic material and grew thicker in confined places (Fig. 2).

Fig 2: Corrosion

Corrosion developing under the fold of the leather belt and expanding on the side (Inv. no. 12137c).
Picture credits: Elodie Granget

23 The anthropomorphic statues of the corpus are carved in wood, and darkened with an unknown coating. Voluminous and vibrant green efflorescence have developed around the copper-based pins (Fig. 3) . These confined spots are indeed offering a good environment for the development of corrosion since moisture and exogenous compounds can easily accumulate locally.

Fig 3: Green efflorescence

Green efflorescence around the copper pins (Inv. no. 11228b).
Picture credits: Elodie Granget

24 The two leather accessories had no documentation attached to them. They are objects made out of leather pieces sewed together and decorated with metal treads, of which very little remains. Due to their thinness an important surface contact with the leather, itself a source of fatty acid (Werner et al. 2012), blue (oNr. 0564) or green (oNr. 0563) powdery products sometimes replaced the totality of the metal making the structure crumble away (Fig. 4-6).

Fig. 4 Pulverised metal thread

Nr. 0564 with powder from pulverised metal thread.
Picture credits: Elodie Granget

Fig. 5 Detail of remaining thread

Heavily brittle (on oNr. 0564).
Picture credits: Elodie Granget

Fig. 6 Heavily degraded thread

Detail of oNr. 0563
Picture credits: Elodie Granget

25 From the μATR-FTIR spectra, all the 13 objects analysed were found to contain metal soaps that were formed directly between the metal and a source of fatty acid (Table 2). Such fatty-acid-rich material was not always easy to identify and the hypothesis relied mostly on prior knowledge of the history of the objects. For the wood-metal composite objects, for instance, the conservators suspect the fatty acids may have come from the material used to stain or oil the wood. In a few instances, wood parts could have contributed to the presence of fatty acids that could have interacted with the metal (Łucejko et al. 2018).

26 For what concerns the type of metal soaps encountered, the copper-based objects making the totality of the objects analysed, showed high susceptibility to metal soap formation, with a prevalence of copper palmitate alone (objects Inv. no. 11127b, 12137c and 10315) and in combination with copper oleate (objects Inv. no. 11127d, oNr. 0564, oNr. 4096 and Inv. no. 12687). These were identified based on their characteristic signal of the asymmetric stretching of the carboxylate group (νCOO^-) at 1589 cm^{-1} and the doublet at 1558 -1536 cm^{-1}, respectively (Fig 7-8).

27 Interestingly, zinc soaps, with νCOO^- at 1540 cm^{-1}, were also found in association with copper ones on brass objects (objects Inv. no. 11127c, 09733b, 11228b, oNr. 0563, 12205e and 17982, Fig. 9).

28 In some instances, these were identified as zinc stearate, after comparison with reference spectra of pure compounds from industrial databases. However, it is important to stress that the distinction between zinc stearate and palmitate through FTIR analysis is not reliable (Osmond, 2019). In the study of paintings, where both compounds are present, authors often refer to both soaps with the term stearates for convenience (Osmond 2019).

29 The presence of zinc soaps helped us understand the composition of the alloy indirectly, and hinted towards the presence of competition between zinc and copper ions composing the metal in the reaction with fatty acids.

30 It is difficult to assess the origin of the fatty acid simply by visual inspection and the documentation on these objects doesn't include technical information on the manufacturing or care practices.

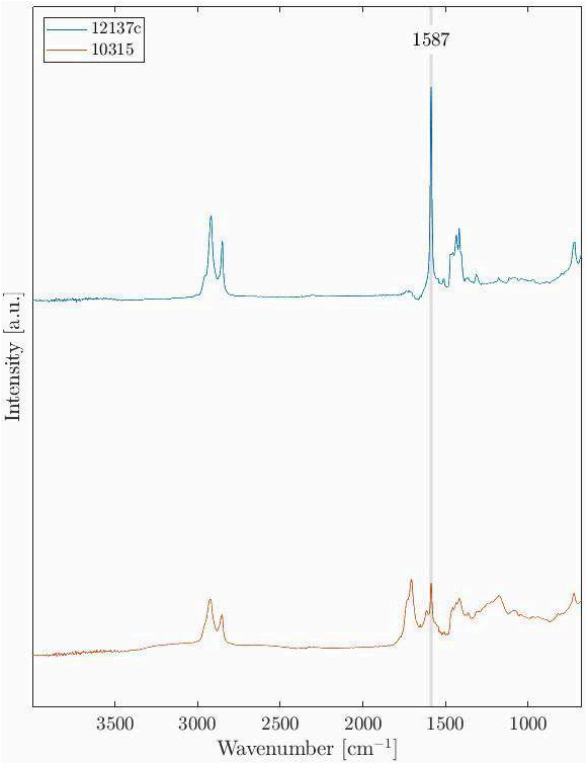
31 Some objects could have been treated with metal protectives (oils or wax coatings). As previously mentioned, this could have happened at the beginning of the object's life as part of the cultural practices to which the object was associated, such as rituals, or treatments associated with the manufacturing or maintenance of the object, or could have been added afterwards during previous conservation treatments. Other studies have recently highlighted how conservation practices for the preservation of ethnographic collections often encounter situations where the application and periodic renewal of traditional coatings reflect important cultural practices undetachable from the object, and can also represent an effective preservation method for these objects (Meier 2022). These protectives are commonly added as a barrier against reactive compounds (e.g., water molecules in the form of moisture and oxygen, as well as gaseous pollutants) that are typically present in the surroundings of the object and could interact with, damaging it, or against harming due to the handling of the object. Protective waxes are still utilised, as coating or infills for reintegration, both in their natural colour, or pigmented in such a way that would allow to achieve desired appearance for the object (Moffett 1996; Russo 2022).

32 Alternatively, the presence of fatty acid can be attributed to the potential presence of oil residues from maintenance products added during the time of use (Schrenk 1991; Jefcoat Burton 2020). From simple observation, and without documentation available for these objects, the conservators cannot safely propose a hypothesis on the origin of the alteration.

33 When the metal was directly attached to leather parts, the interaction could be due to waxes, oils and fats that are used in the treatment of leather (Jefcoat Burton 2020; Russo 2022). These stearic and palmitic acid-rich wax dressings serve the purpose of lubrication or softening of the leather and tend to undergo migration through the porous structure of the leather grain to the surface in the form of “bloom” (Jefcoat Burton 2020; Russo 2022).

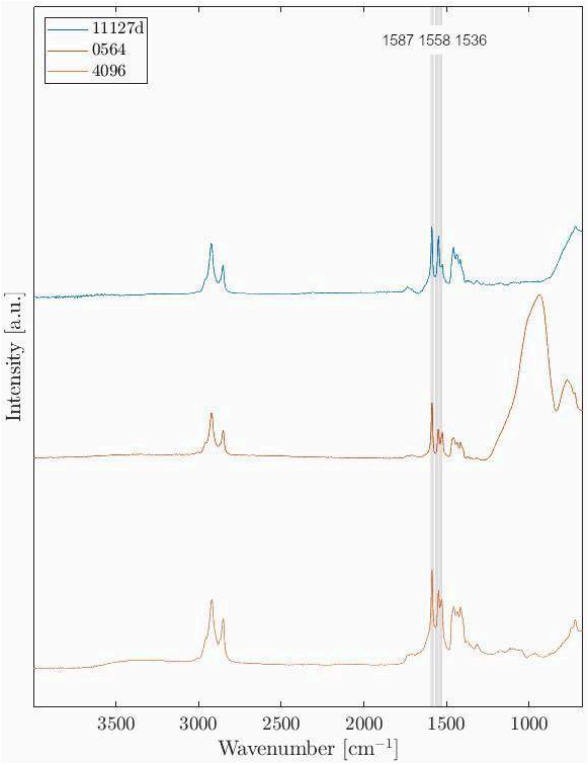
ATR-FTIR relevant spectra for the 13 objects analysed are provided in Fig. 7-9.

Fig 7. µATR-FTIR spectra of samples Inv. no. 12137c and 10315



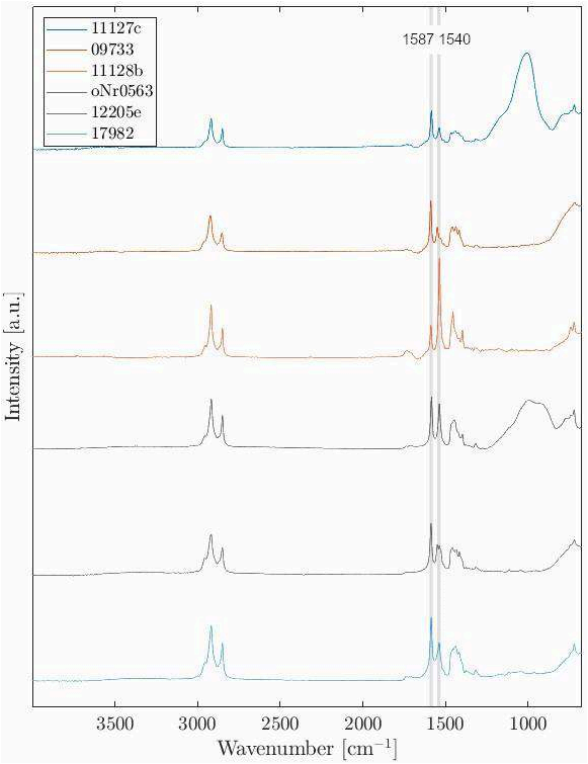
µATR-FTIR spectra showing the presence of copper palmitate (**ν**COO- at 1587 cm-1).

Fig 8. μATR-FTIR spectra



μATR-FTIR spectra showing the presence of a mixture of copper palmitate and copper oleate (($\boldsymbol{\nu}$COO- at 1587 and 1558-1536 cm-1, respectively).

Fig 9. μATR-FTIR spectra



μATR-FTIR spectra of samples showing characteristic peaks of copper palmitate and zinc stearate (**ν**COO- at 1587 and 1540 cm-1, respectively).

Table 2.

Object description	Inventory number	Metal soaps found
Horn handle with decorative wire art, Sahara Tamanrasset, Algeria. Wooden scabbard covered with red leather, secured with Cu-based wire.	11127b	Copper palmitate
Wood handle with decorative wire art, Sahara Tamanrasset, Algeria. Wooden scabbard covered with red leather. Cu-based buckle and leather loop.	11127c	Copper palmitate and zinc stearate
Wood handle with decorative wire art, Sahara Tamanrasset, Algeria. Wooden scabbard covered with red leather. Cu-based buckle and leather loop.	11127d	Copper palmitate and copper oleate
Sword in a leather scabbard, D. R. Congo. Decorated with 2 different Cu-based thick wires. The surface of the scabbard appeared very dry with localised white powdery deposits.	09733b	Copper palmitate and zinc stearate
Sword and scabbard, Ethiopia. Sword in a thick leather scabbard with a leather belt and Cu-based buckle	12137c	Copper palmitate
Wooden statue with decorative Cu-based elements, D. R. Congo. Looking at the aspect of the wook, it was probably waxed or oiled.	11228b	Copper palmitate and zinc stearate

Main results of the campaign of analysis (μATR-FTIR).

Conclusions

34 Metal soaps have specific morphological characteristics that can be accurately recognised by a trained conservator. In presence of this alteration, certain inferences can be drawn about the characteristics of the object. First, simply by visual observation, identifying blue-green shiny and curly corrosion products on these types of objects can indicate that there is a source of copper and a source of fatty acids. From this, hypotheses can be drawn. If the origin or the nature of the fatty acids is unclear, samples can be taken and analysed by a conservation scientist using appropriate analytical techniques.

35 The µATR-FTIR analysis confirmed the hypothesis of the conservator on the presence of metal soaps in all cases. In the 13 samples from EMZ studied by HE-Arc, copper soaps, but also zinc soaps were found, giving an indirect indication of the composition of the alloy, most of them being made of brass. When possible to distinguish between each other, the type of fatty acids found were mainly oleates, palmitates and stearates of zinc and copper ions. These results allowed the conservator and the curator to start a discussion about the composition of the objects and to understand better the nature of the interaction, while hastening the decisions-making process on the preventive conservation of these and other similar objects in the collection.

36 For the moment, a detailed study on the interactions between organic and metal components of ethnographic objects is missing. With more systematic observations on the ageing of different organic materials in the presence of copper alloys, both modern and traditional, it could theoretically be possible to establish the relationships between the type of material and the type of metal soaps formed, or conversely, determine what kind of material was the source of the degradation pattern observed on an object.

37 This would be of common interest to conservators, curators and conservation scientists, giving each field essential tools that would allow to fill in gaps in the object's history or to understand the degradation processes.

38 The combination of expertise offered the opportunity for curators, conservators and conservation scientists to exchange perspectives around the implication of the presence of these alterations and the preservation recommendation for these objects. The successful collaborative nature of this work hopes to be part of the dialogue on multidisciplinarity in caring for museum collections, and especially to showcase those collections that are often neglected from a conservation science viewpoint. The authors hope that this research opens the way to further investigations on metal soaps forming in ethnographic collections, on copper or other metals, since it is a context favouring their development on a large scale. This could in term not only profit the conservation practice for these objects, but also offer material knowledge transferable to other art and cultural heritage media such as classic and modern artworks.

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ABSTRACTS

This article discusses the value of ethnographic objects in museums and collections, and the challenges of preserving them due to their complex composition and poly-materiality. Specifically, the study focuses on the formation of metal soaps on objects made of metal in contact with leather or wood parts. The study proposes a collaborative approach between conservators and scientists to identify and understand the metal soaps present on a selection of objects from the Ethnographic Museum at the University of Zurich. The authors wish to raise awareness about material alteration in ethnographic collections and museum contexts and to promote communication between different actors in the field, while enabling conservation professionals to confirm the formation of a class of degradation products in the absence of specific analytical techniques.

Cet article discute de la valeur des objets ethnographiques dans les musées et les collections, ainsi que des défis liés à leur conservation en raison de leur composition complexe et de leur poly-matérialité. L'étude se concentre sur la formation de savons métalliques sur des objets en métal en contact avec des parties en cuir ou en bois. Elle propose une approche collaborative entre conservateurs-restaurateurs et scientifiques pour identifier les savons métalliques présents sur une sélection d'objets du Musée ethnographique de l'Université de Zurich. Les auteurs souhaitent sensibiliser à la dégradation matérielle dans les collections ethnographiques et promouvoir la communication entre les différents acteurs impliqués, tout en permettant aux professionnels de la conservation de confirmer la présence de savons métalliques en l'absence de techniques analytiques spécifiques.

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Mots-clés: collections ethnographiques, savons métalliques, objets composites, conservation, µATR-FTIR
Keywords: ethnographic collections, metal soaps, composite objects, conservation, µATR-FTIR

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