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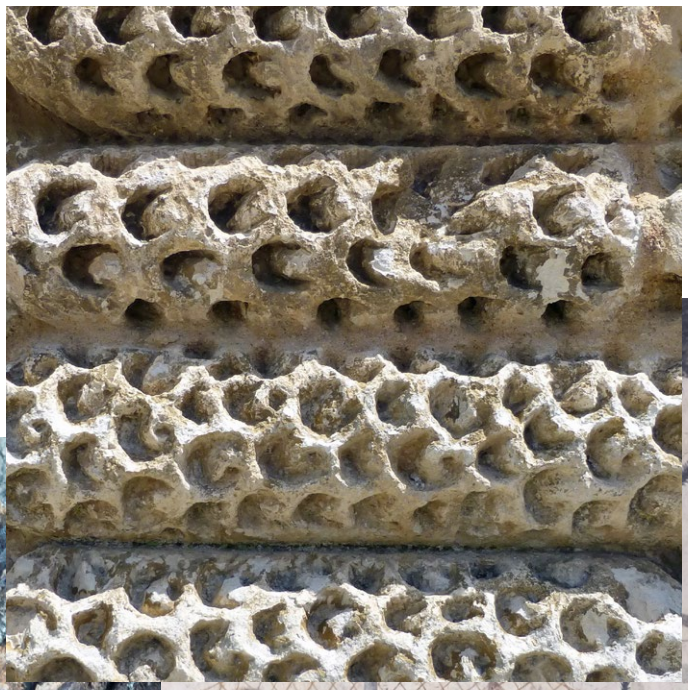
Mr Emmanuel MACRON
President of the French Republic

WORLD MEETING
PARIS 2019

Heritage Sciences and Technologies

Rencontre Mondiale Paris 2019 : Patrimoines, Sciences et Technologies

14>15 February 2019 • *14>15 février 2019*



INSTITUT DE FRANCE
Académie des sciences

IPANEMA ARCHAEOLOGY CONSERVATION SCIENCES PALAEONTOLOGY PALAEO-ENVIRONMENTS | ANCIENT MATERIALS RESEARCH PLATFORM

cnrs

GID Groupe interacadémique pour le développement

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Dans son livre *Au fondement des sociétés humaines* paru en 2007 chez Albin Michel, Maurice Godelier, nous livre cette phrase : « Il y a des choses que l'on donne, des choses que l'on vend, et celles qu'il ne faut ni vendre ni donner mais garder pour les transmettre. »

Que devons-nous donc garder pour transmettre ? Ce patrimoine légué par nos prédécesseurs, que certains humains trouvent parfois trop lourd à porter, est fragile. Une fois découvert, cet héritage est vulnérable. Devenu visible aux yeux de tous, il se trouve exposé à des destructeurs qui n'en acceptent pas la symbolique. Il apparaît alors important d'expliquer ces témoignages du passé, de les remettre dans leur contexte, de montrer que si nous sommes ce que nous sommes, c'est grâce à nos ancêtres, ces hommes qui ont inventé et construit des objets, des architectures, en harmonie avec leur vie. La société doit ainsi s'approprier les vestiges du passé comme une part intégrante de ses racines afin de la fondre dans son environnement présent. Se pose alors la question : que devrons-nous conserver de notre présent pour en faire le patrimoine de demain ? La réponse n'est pas évidente. La science est éminemment présente dans cette réflexion, elle déborde au-delà des disciplines qui la composent pour tenter une réponse. C'est pourquoi nous avons choisi ce lieu, le nouvel auditorium de l'*Institut de France* qui s'appuie sur la muraille de Philippe Auguste, ce lieu chargé d'histoire et de modernité où cinq académies se côtoient, pour notre rencontre *Patrimoines, sciences et technologies.*

Les technologies progressent. Les photographies numériques en trois dimensions, les reconstitutions virtuelles font considérablement évoluer notre connaissance des sociétés antérieures. L'archéologie d'urgence est à pied d'œuvre. En moins d'une décennie, les drones photographes, le développement de l'imagerie, ont transformé les méthodes de fouilles. Un nouveau type de patrimoine constitué d'images numériques, de données, est en train de naître. Les recherches sur les matériaux anciens utilisent des marqueurs d'ADN, des muons, des instruments, voire de très grands instruments, dont les performances accrues modifient en profondeur notre connaissance. Nous voyons le passé différemment. La France, pays de patrimoine, de science et de technologie, a su développer une synergie entre ces trois composantes et son leadership est internationalement reconnu dans ce domaine. Le centre de recherche et de restauration des musées de France (C2RMF), né dans les années 1930, aujourd'hui implanté au Louvre en est une belle illustration.

Cette dynamique en recherche sur le patrimoine constitue aussi un vivier de formation et d'emplois nouveaux pour la restauration des objets et monuments patrimoniaux, l'instrumentation scientifique, la diffusion des résultats, l'interface avec les musées, et même le tourisme culturel.

L'objectif de cette rencontre n'est pas de réaliser un recensement exhaustif du vaste ensemble des recherches sur le patrimoine, il est de regrouper des personnes d'horizons très divers, scientifiques, jeunes lycéens, grand public, face aux dernières avancées de la recherche internationale sur les matériaux anciens afin de provoquer une réflexion collective.

Portée par le CNRS et son laboratoire IPANEMA et par le groupe inter-académique pour le développement (GID) qui a pour devise de mettre « les savoirs au service du développement », cette rencontre est le premier évènement de portée internationale dans ce lieu magique qui appartient déjà au patrimoine de demain. Nous souhaitons une rencontre fructueuse et pleine d'espoir au cœur de sociétés en quête de stabilité.

Catherine Bréchignac
14 février 2019

In his book *Au fondement des sociétés humaines* (Albin Michel ed., 2007) Maurice Godelier, gives us food for thought: "There are things that we give, things that we sell, and those that we must neither sell nor give but keep to transmit them".

So what should we keep for transmission? This heritage bequeathed by our predecessors, which some successors find sometimes too heavy to carry, is fragile. When discovered, this heritage becomes vulnerable. Once visible to all, it is exposed to the destructive forces of those who do not accept its symbolic. It is therefore important to explain these testimonies of the past and to put them in their respective context. But also to elaborate that if we are who we are, it is thanks to our ancestors: human beings had invented and created objects and architectures in harmony with their way of life. Societies must therefore take ownership of the remains of the past as an integral part of their cultural roots in order to factor them into their current environment. Hence the question: what should we keep of our present to make it the heritage of tomorrow? The answer is not a given. Science is eminently present in this reflection, it spills over and beyond the different disciplines to try and find an answer. That is why we have chosen this place for our global meeting on *Heritage, Sciences and Technologies*: built on the ramparts of Philippe-Auguste, the new auditorium of the *Institut de France* where five Academies line together is at the crossroads between History and modernity.

Technologies are making progress. Three dimensional digital pictures and virtual reconstructions contribute to a considerable improvement of our knowledge of previous societies. « Emergency archaeology » is at work. In less than a decade, drones and the development of imaging have transformed excavation methods. A new kind of heritage made of digital images and data is nascent. Research on ancient materials uses DNA markers, muons, instruments and even very large facilities, whose increased performance is modifying our knowledge in depth. We look into the past in a different way.

France, as a country of heritage, science and technology, managed to develop a synergy between these three components; its internationally recognized leadership in heritage science must be strengthened. The Center for Research and Restoration of the Museums of France (C2RMF), created in the 1930's and currently located at the Louvre is a perfect illustration.

This dynamic in heritage research also creates opportunities for training and new jobs linked to domains such as restoration and conservation of heritage objects and monuments, scientific instrumentation, dissemination of results, interface with museums, and even cultural tourism.

The objective of this meeting is not to carry out an exhaustive inventory of the vast body of research on heritage. It is meant to bring together people from very diverse backgrounds, scientists, high school students and the general public, in the face of the latest developments in international research on ancient materials in order to generate a collective reflection.

Initiated by the National Center for Scientific Research (CNRS) and its laboratory IPANEMA and under the aegis of the Interacademic group for Development (GID) whose motto is to put "knowledge at the service of development", this meeting is the first global event in this auditorium, which is already part of tomorrow's heritage. We wish you a fruitful and hopeful meeting for societies looking for stability.

Catherine Bréchignac
February 2019

Bienvenue à tous,

Le patrimoine culturel et naturel est au cœur de nos sociétés. Rendre ce patrimoine plus accessible à tous, le protéger et mieux le connaître sont essentiels à une meilleure compréhension de notre histoire et favorisent le dialogue entre les cultures. Les dangers qu'encourt le patrimoine qu'ils soient liés à l'usure, au changement climatique, aux catastrophes naturelles, ou aux destructions volontaires constituent déjà un sujet de premier plan. Mais cette Rencontre mondiale vise également un autre objectif, dire que le patrimoine n'est pas « uniquement ce qu'il faut conserver ».

En apportant des connaissances fondamentales sur l'origine de la vie et celle de l'humanité, en nous renseignant sur nos sociétés et les relations de ces sociétés avec leur environnement, en décrivant les chemins tortueux de la création, la recherche sur les matériaux anciens produit de nouvelles sources d'interprétation et de nouvelles connaissances. Elle contribue fondamentalement à la cohésion sociale, à la paix dans le monde, au façonnage de notre humanité, à la simple joie de vivre. À travers des secteurs comme les industries de création et le tourisme, et les enjeux d'un tourisme responsable, la recherche scientifique sur le patrimoine engendre des retombées économiques importantes.

La recherche sur les matériaux anciens (matériaux de la paléontologie, de l'archéologie et du patrimoine culturel) connaît actuellement un profond renouveau. De nouvelles thématiques de recherche émergent, à l'instar de l'étude des environnements anciens qui permet de mieux comprendre des mécanismes comme la fossilisation et l'impact des sociétés sur leur milieu. Ce renouveau passe également par le développement de nouvelles méthodes, telles qu'en imagerie (scanner 3D, laser, grands instruments…) ou en sciences des données, par des applications à de « nouveaux objets » comme les matériaux protéiques anciens (protéomique) et les systèmes très altérés.

Ce sont des domaines de recherche ardus. La matérialité nous est accessible à travers des traces, corpus et restes matériels lacunaires et transformés. Les objets imposent leurs contraintes (hétérogénéité, faible échantillonnage, histoire inconnue). Ces « objets frontières » sont aussi une source d'inspiration pour de nouvelles approches analytiques, de nouveaux traitements de données et de nouvelles coopérations interdisciplinaires. Nous faisons le pari que la recherche sur les collections patrimoniales contribue et contribuera à révolutionner les modes de collaboration entre sciences expérimentales, sciences de l'homme et sciences de l'environnement.

En organisant cette Rencontre mondiale à Paris en février 2019, nous voulons accompagner l'exceptionnel dynamisme du large champ des disciplines œuvrant à l'étude des matériaux anciens. Nous voulons rendre compte de travaux qui nous ont paru emblématique de ces nouveaux développements qu'ils relèvent des différents champs disciplinaires ou du développement de nouvelles technologies et méthodologies d'étude, en parfaite interdisciplinarité.

Ce dynamisme est illustré par la mise en place, tant au niveau européen que national, de l'infrastructure européenne E-RIHS, dédiée aux sciences du patrimoine. Cette structuration nous semble emblématique de nouveaux modes de coopération entre équipes européennes et bien au-delà, équipes qui partagent objets d'étude et questionnements, et chose plus précieuse encore, elle vise à nous donner du temps pour travailler et créer, écrire et diffuser de nouveaux savoirs, comprendre et développer de nouvelles techniques ; ces techniques qui, comme l'écrivait Cornelius Castoriadis, ne sont pas simples instruments parce que leur « spécificité codétermine chaque fois de façon décisive ce qui est creusé ».

Nous sommes extrêmement reconnaissants à l'Académie des sciences et au Groupe interacadémique pour le développement d'avoir non seulement apporté toute leur confiance au projet initial mais également de l'avoir questionné, enrichi, développé, en permettant la construction d'un évènement riche et pluriel, ouvert à des publics complémentaires, et qui a suscité l'inscription de tant de jeunes collègues. L'apport des 19 académies participantes, issues du monde entier, est essentiel tant les travaux en sciences du patrimoine dépassent les frontières voire ont un caractère universel.

Nous avons demandé à chaque intervenant.e de placer « l'objet au centre » de leur présentation, de bien souligner l'aventure collective de leurs travaux qui s'étendent du terrain aux données en situant leur recherche au sein de la pensée contemporaine sur leurs objets d'étude et de conclure leur intervention par des perspectives. Nous souhaitons que ces perspectives constituent une ressource précieuse pour définir les agendas stratégiques de recherche des organismes de recherche, universités et institutions participantes, et espérons que des discussions nourries s'engageront à partir de ces contributions.

Très bon colloque à tous !

Loïc Bertrand
Denis Gratias
Philippe Janvier

Welcome,

Cultural and natural heritage is at the heart of our societies. Making this heritage more accessible to all, protecting it and knowing it better are essential to a better understanding of our history and to promote dialogue between cultures. The dangers to heritage from wear and tear, climate change, natural disasters, or deliberate destruction are already a major issue. But this World Meeting has a further objective, that of saying that heritage is not "only what must be preserved".

By providing fundamental knowledge about the origin of life and that of humanity, by learning about our societies and their relationship to their environment, by describing the tortuous paths of creation, research on ancient materials produces new sources of interpretation and new knowledge. It contributes fundamentally to social cohesion, world peace, the shaping of our humanity, the simple joy of living. Through sectors such as creative industries and tourism, and the challenges of responsible tourism, scientific research on heritage generates significant economic benefits.

Research on ancient materials (palaeontological, archaeological and cultural heritage materials) is currently undergoing a profound renewal. New research themes are emerging, such as the study of ancient environments, which provides a better understanding of mechanisms like fossilization and the impact of societies on their environment. This renewal also involves the development of new methods, such as in imaging (3D scanners, lasers, large-scale facilities, etc.) or data sciences, and applications to "new objects" such as ancient protein materials (proteomics) and highly altered systems.

These are difficult areas of research. Materiality is accessible to us through incomplete and transformed traces, collections and material remains. Objects impose their constraints (heterogeneity, limited sampling, unknown history). These "boundary objects" are also a source of inspiration for new analytical approaches, new data processing and new interdisciplinary cooperation. We bet that research on heritage collections contributes and will contribute to revolutionising the ways in which experimental sciences, humanities and environmental sciences collaborate.

By organizing this World Meeting in Paris in February 2019, we want to support the exceptional dynamism of the broad field of disciplines working on the study of ancient materials. We want to report on works that seemed emblematic to us of these new developments, whether they concern the different disciplinary fields or the development of new technologies and study methodologies, in perfect interdisciplinarity.

This dynamism is illustrated by the establishment, at both European and national level, of the European infrastructure E-RIHS dedicated to heritage sciences. This structuring seems to us to be emblematic of new modes of cooperation between European teams and far beyond, teams that share objects of study and questioning, and something even more precious, it aims at giving us time to work and create, write and disseminate new knowledge, understand and develop new techniques; these techniques which, as Cornelius Castoriadis wrote, are not simple instruments because their "specificity codetermines each time in a decisive way what is dug".

We are extremely grateful to the Académie des Sciences and the Inter-Academic Group for Development for having not only given their full confidence to the initial project but also for having questioned, enriched and developed it, allowing the construction of a rich and plural event, open to complementary audiences, and which has attracted so many young colleagues. The contribution of the 19 participating academies from all over the world is essential, as heritage science work transcends borders and is even universal in nature.

We asked each speaker to place the "object at the centre" of their presentation, to highlight the collective adventure of their work, which extends from the field to the data, by situating their research within contemporary thinking on their objects of study, and to conclude their intervention with perspectives. We hope that these perspectives will constitute a valuable resource for defining the strategic research agendas of participating research organizations, universities and institutions, and hope that many discussions will be initiated on the basis of these contributions.

A great conference to all!

Loïc Bertrand
Denis Gratias
Philippe Janvier

Bienvenue à toutes et à tous !

Les Rencontres mondiales « Patrimoines, sciences et technologies » auxquelles vous avez bien voulu participer revêtent une importance particulière pour le GID, Groupe Interacadémique pour le développement », sous l'égide duquel elles se trouvent organisées.

Ce recueil des résumés des interventions montre la diversité des problèmes abordés et des disciplines scientifiques concernées, ainsi que le dynamisme des recherches. Dynamisme soutenu par une exceptionnelle floraison de technologies.

La grande qualité des spécialistes qui ont accepté d'apporter leur contribution fera de cet événement une référence. Que tous les intervenants soient ici chaleureusement remerciés.
L'implication des membres de la trentaine d'Académies nationales d'Afrique et d'Europe du Sud qu'il rassemble, apporte au GID un éventail de compétences et de cultures qui lui permet d'aborder les problèmes de développement dans toute leur complexité scientifique, technologique, socio-économique et culturelle. Son ambition est de mobiliser les savoirs au service d'un véritable codéveloppement euro-africain. Avec la volonté permanente de contribuer à l'emploi des jeunes, et à leur formation à des activités offrant de réelles opportunités.

En 2015 à Dubrovnik, nous avons réfléchi au thème *« Technologies et patrimoines : valorisation des patrimoines pour le développement »*, avec la participation d'une centaine d'acteurs du domaine, parmi lesquels je retrouve avec plaisir dans ces Rencontres, des personnalités découvertes à cette occasion, devenues des amies du GID. Le CNRS-IPANEMA était déjà un contributeur notable aux recommandations qui ont résulté de ce Forum.

L'inventaire, la conservation, la restauration, la protection des patrimoines se sont trouvés au cœur d'une actualité douloureuse dans les dernières années. Pour autant leur appropriation par les populations, leur mise en valeur comme facteurs de développement n'ont pas encore été suffisamment explorées.

Néanmoins, le potentiel d'emplois contenu dans tous les aspects des patrimoines est considérable. Ces Rencontres contribueront à le renforcer. Le dynamisme des recherches et la floraison de technologies évoqués ci-dessus créeront des besoins nouveaux et des approches nouvelles dans la gestion des patrimoines. En conséquence des métiers apparaitront, d'autres se modifieront, et tous demanderont des formations adaptées. Je vois dans les suites de ce rendez-vous de très haut niveau *« Patrimoines, sciences et technologies »* une sorte de modèle pour la réalisation de l'ambition du GID. Nous allons prendre la mesure de l'évolution des sciences et des technologies dans ce champ particulier. Chacune des technologies émergentes fait appel à diverses sciences accessibles à un nombre restreint de spécialistes seulement. Elles vont pénétrer la société par la technologie qui les « métabolise », les met en œuvre dans des instruments utilisés dans des métiers novateurs, qui développent de nouvelles activités. Dans cette longue chaine entre les sciences et un métier, les sciences, le plus souvent masquées par la technologie qui les a métabolisées, ne doivent pas être oubliées. Ceux qui laisseront s'appauvrir leurs compétences scientifiques appauvriront leur capacité de développement.

Le GID considère comme essentiel de s'intéresser aux deux bouts de la chaine. C'est pourquoi je suis convaincu que ces Rencontres auront des suites. Que nous aurons beaucoup à travailler pour soutenir la poursuite des efforts de recherche, pour obtenir la reconnaissance par les décideurs de l'intérêt socio-économique et culturel du domaine des patrimoines, et pour anticiper les métiers auxquels il est en train de donner naissance. Il conviendra ensuite d'assurer les formations qu'ils demanderont.

Par conséquent, à bientôt pour les suites que nous aurons à bâtir ensemble !

Et bon travail pendant ces deux jours.

François GUINOT,
Président du GID,
Président Hon. de l'Académie des technologies.

Welcome to all of you!

The World Meeting on "Heritage, Sciences and Technologies" in which you have kindly participated are of particular importance to the GID, the Inter-Academic Group for Development, under whose auspices they are being organized.
This collection of the abstracts of the interventions shows the diversity of the problems addressed and the scientific disciplines concerned, as well as the dynamism of the research. Dynamism supported by an exceptional flowering of technologies.

The high quality of the specialists who have agreed to contribute will make this event a reference. We would like to thank all the speakers who are present.

The involvement of the members of the thirty or so national Academies of Africa and Southern Europe that it brings together provides the GID with a range of skills and cultures that enables it to address development issues in all their scientific, technological, socio-economic and cultural complexity. Its ambition is to mobilize knowledge in the service of genuine Euro-African co-development. With the permanent will to contribute to the employment of young people, and to their training in activities that offer real opportunities.

In 2015 in Dubrovnik, we reflected on the theme *"Technologies and Heritage: Valuing Heritage for Development"*, with the participation of about a hundred actors from the field, among whom I am pleased to meet again in this Meeting personalities discovered on this occasion, who have become friends of the GID. CNRS-IPANEMA has already been a significant contributor to the recommendations resulting from this Forum.
Inventory, preservation, restoration, and heritage protection have been at the heart of painful news in recent years. However, heritage appropriation by the populations and its benefit as factor of development has not been sufficiently explored yet.
Nevertheless, the employment potential contained in all aspects of heritage is considerable. This Meeting will help strengthening it. The dynamism of the research and the flowering of technologies mentioned above will create new needs and new approaches in heritage management. As a result, some professions will appear, others will change, and all will require appropriate training.

I see the follow-up to this very high-level meeting on *"Heritage, Sciences and Technologies"* as a kind of model for achieving the ambition of the GID. We will assess the evolution of science and technology in this particular field. Each of the emerging technologies benefits from a variety of scientific fields accessible to a limited number of specialists only. They will penetrate society through the technology that "metabolizes" them, implements them in instruments used in innovative jobs, which develop new activities. In this long chain between science and jobs, science, most often masked by the technology that has metabolized it, must not be forgotten. Those who allow their scientific skills to be impoverished will impoverish their capacity for development.

The GID considers it essential to focus on both ends of the chain. That is why I am convinced that this Meeting will have a follow-up. That we will have a lot to work on to support the continuation of research efforts, to obtain recognition by decision-makers of the socio-economic and cultural interest of the heritage field, and to anticipate the careers to which it is giving rise. It will then be necessary to provide the training they request.

Therefore, see you soon for the follow-up we will build together!

And good work during these two days.

François GUINOT,
President of the GID,
Hon. President of Académie des Technologies.

PLANNING

PLANNING

Thursday 14 February 2019

9:00 > 9:45 Welcome of Participants

9:45 > 10:15 Welcoming Address

Xavier Darcos, Chancellor of the Institut de France, France

Catherine Bréchignac, Secrétaire perpétuel honoraire of the Académie des sciences, Ambassador of science, technology and innovation, France

Laurent Petitgirard, Secrétaire perpétuel of the Académie des beaux-arts, France

Nicolas Grimal, Secretary General, Commission consultative des recherches archéologiques à l'étranger du ministère de l'Europe et des Affaires étrangères, Member of the Académie des Inscriptions et Belles-Lettres, France

Laurent Bili, Director General for Globalization, Culture, Education and International Development, ministère de l'Europe et des Affaires Étrangères, France

10:15 > 10:30 Introduction

Loïc Bertrand, Director, IPANEMA laboratory (CNRS, MiC, UVSQ) and Scientific Director of the European Research Infrastructure for Heritage Science (preparatory phase), Saint-Aubin, France

Denis Gratias, Emeritus Research Director, Institut de Recherche de Chimie Paris (Chimie ParisTech, CNRS), Corresponding Member of the Académie des sciences, France

Philippe Janvier, Emeritus Research Director, Centre de recherche sur la paléobiodiversité et les paléo-environnements (CNRS, MNHN, Sorbonne Université), Member of the Académie des sciences, France

MICRO-SYMPOSIUM - ARCHAEOLOGY

10:30 > 10:50

Thilo Rehren, A.G. Leventis Professor in Archaeological Sciences and Director of Science and Technology, Archaeology Research Centre, The Cyprus Institute, Nicosia, Cyprus

10:50 > 11:10

Mélanie Roffet-Salque, Royal Society Dorothy Hodgkin Fellow, School of Chemistry, University of Bristol, The United Kingdom

11:10 > 11:30

Philippe Dillmann, CNRS Research Director, Laboratoire Métallurgie et Cultures, Institut de Recherche sur les Archéo-MATériaux (CNRS, Université Bordeaux Montaigne, Université d'Orléans, Université de Technologie de Belfort-Montbéliard) and Nanosciences et Innovation pour les Matériaux, la Biomédecine et l'Énergie (CEA, CNRS), Saclay, France

11:30 > 11:50

Safaa Ahmed Abd El Salam, Professor, Head of the Department of Paintings, Faculty of Fine Arts, University of Alexandria, Egypt

11:50 > 12:05

Chairs' Conclusions

Hany Helal, Professor, Faculty of Engineering, Cairo University and President of Senghor University, Alexandria, Egypt

Anne Lehoërff, Professor, Archéologie et Littérature des Mondes Anciens (Université de Lille, CNRS, MiC), and Vice-chair of the Conseil national de la Recherche archéologique, Lille, France

Jean-Denis Vigne, CNRS Research Director, Deputy managing director for Research, Expertise, Innovation and Education at the Muséum national d'histoire naturelle, Archéozoologie, archéobotanique: sociétés, pratiques et environnements laboratory (CNRS, MNHN), Paris, France

12:05 > 13:45 Lunch Break and Poster Display

MICRO-SYMPOSIUM - METHODS

13:45 > 14:05

Uwe Bergmann, Distinguished Staff Scientist, SLAC National Accelerator Laboratory and Principle Investigator, Stanford PULSE Institute, Stanford, USA

14:05 > 14:25

Ilaria Bonaduce, Associate Professor, Department of Chemistry and Industrial Chemistry, University of Pisa, Italy

14:25 > 14:45

Caroline Tokarski, Professor, Protéome Platform, Institut de Chimie et Biologie des Membranes et des Nano-objets (CNRS, Université de Bordeaux, Bordeaux INP), Bordeaux, France

14:45 > 15:05

Paul Tafforeau, Researcher, European Synchrotron Research Facility, Grenoble, France

15:05 > 15:20

Chairs' Conclusions

Andrew King, Researcher, Synchrotron SOLEIL, Saint-Aubin, France

Anita Quiles, Head of the Archaeometry department, IFAO, Cairo, Egypt

15:20 > 15:50 Coffee Break

MICRO-SYMPOSIUM - THE OBJECT IN ITS HISTORY

15:50 > 16:10

Jean-Philippe Échard, Curator, Cité de la Musique – Philharmonie de Paris and Centre de recherche sur la conservation, Paris, France

16:10 > 16:30

Charlotte Guichard, CNRS Research Director, Institut d'histoire moderne et contemporaine (CNRS, ENS, Université Panthéon-Sorbonne), Paris, France

16:30 > 16:50

Dominique Pieri, Director, Département Archéologie et Histoire de l'Antiquité, Institut français du Proche-Orient, Beirut, Lebanon

16:50 > 17:05

Chairs' Conclusions

Étienne Anheim, Directeur d'études, Centre de recherches historiques (CNRS, EHESS), Paris, France

Sergey Sirro, Head of the Scientific department, The State Russian museum, Saint Petersburg, Russia

Dominique Vingtain, Director, Musée du Petit Palais, Avignon, France

ROUND TABLE - HERITAGE AND RESEARCH INFRASTRUCTURES

17:05 > 17:20

Setting the scene

Webber Ndoro, Director General, International Centre of the Study of the Preservation and Restoration of Cultural Property, Rome, Italy

17:20 > 18:20

Panellists

Alison Heritage, Heritage Science Officer, International Centre for the Study of the Preservation and Restoration of Cultural Property, Rome, Italy

Johanna Leissner, German Research Alliance Cultural Heritage, Fraunhofer Sustainability Network, Brussels, Belgium

Costanza Miliani, Senior Researcher and Scientific Coordinator of the mobile laboratory MOLAB, ISTM, CNR, Perugia, Italy

Laurent Romary, Inria Research Director, Team ALMAnaCH, Inria, Paris, France and Former Director general of DARIAH ERIC

Véronique Sorano-Stedman, Head of Restoration Department, Musée national d'Art moderne – Centre Georges Pompidou, Paris, France

18:20 > 18:35

Chairs' Conclusions

Loïc Bertrand, Director, IPANEMA laboratory (CNRS, MiC, UVSQ) and Science Director of the European Research Infrastructure for Heritage Science (preparatory phase), Saint-Aubin, France

Marei Hacke, Conservation Scientist, Swedish National Heritage Board, Visby, Sweden

Aliz Simon, Division of Physical and Chemical Sciences, International Atomic Energy Agency, Vienna, Austria

18:35 > 18:45

Intervention of **Luca Pezzati**, Interim Director General, European Research Infrastructure for Heritage Science (E-RIHS)

19:00 > 21:30 Reception

Piano Recital by Julie Alcaraz

Cocktail Reception until 21:30

Friday 15 February 2019

8:30 > 9:00 Welcome of Participants

MICRO-SYMPOSIUM - CULTURAL HERITAGE

9:00 > 9:20

Katrien Keune, Associate Professor, Van 't Hoff Institute for Molecular Sciences, University of Amsterdam and Painting Research Scientist, Rijksmuseum Amsterdam, The Netherlands

9:20 > 9:40

Piero Baglioni, Professor, Director, Centre for Colloid and Surface Science, University of Florence, Italy

9:40 > 10:00

Tarek Tawfik, Director General, The Grand Egyptian Museum, Giza, Egypt

10:00 > 10:20

Jean-Marc Vallet, Research Engineeer, Head of Research, Centre Interdisciplinaire de Conservation et Restauration du Patrimoine, Marseille, France

10:20 > 10:35

Chairs' Conclusions

Anne Bouquillon, Research Engineer, Centre de recherche et de restauration des musées de France (MiC) and Institut de Recherche de Chimie Paris (Chimie ParisTech, CNRS), Paris, France

Robert van Langh, Head of the Department of Conservation and Science, Rijksmuseum Amsterdam, The Netherlands

Philippe Walter, CNRS Research Director, Director of Laboratoire d'Archéologie Moléculaire et Structurale (CNRS, Sorbonne Université), Paris, France

10:35 > 11:00 Coffee Break

MICRO-SYMPOSIUM - DATA

11:00 > 11:20

Rob Erdmann,Senior Scientist, Rijksmuseum Amsterdam, and Professor, Institute of Physics and Department of Conservation and Restoration, University of Amsterdam, The Netherlands

11:20 > 11:40

Paul Messier, Head of Lens Media Lab, Institute for the Preservation of Cultural Heritage, Yale University, New Haven, USA

11:40 > 12:00

Patrice Abry, CNRS Research Director, Signaux, systèmes et physique, Laboratoire de physique (ENS Lyon, CNRS, Université Claude Bernard), Lyon, France

12:00 > 12:15

Chairs' Conclusions

Marin Dacos, CNRS Research Engineer, OpenEdition Centre (CNRS, Université Aix-Marseille, Avignon Université, EHESS), Marseille, France

Agnès Desolneux, CNRS Research Director, Centre de mathématiques et leurs applications (CNRS, ENS Paris–Saclay), Cachan, France

David Donoho, Professor, Department of Statistics, Stanford University, USA

12:15 > 13:45 Lunch Break and Poster Display

ROUND TABLE - WORKING IN HERITAGE SCIENCE

13:45 > 14:00

Setting the scene

Claire Barbillon, Director, École du Louvre, Paris, France

14:00 > 15:00

Panellists

Djillali Benouar, Professor and Director of research, Faculty of Civil Engineering, Université des Sciences et de la Technologie Houari Boumediene (USTHB), Algiers, Algeria

Sigrid Mirabaud, Conservation Scientist, Institut national d'histoire de l'art, Paris, France

Matija Strlic, Professor, UCL Institute for Sustainable Heritage, Faculty of the Built Environment, University College London, The United Kingdom

15:00 > 15:15

Chairs' Conclusions

Denis Gratias, Emeritus Research Director, Institut de Recherche Chimie Paris (CNRS, Chimie ParisTech) and Corresponding member, Académie des sciences, Paris, France

Nicolas Grimal, Secretary General, Commission consultative des recherches archéologiques à l'étranger du ministère de l'Europe et des Affaires étrangères, Member of the Académie des Inscriptions et Belles-Lettres, Paris, France

Michèle Gendreau-Massaloux, former Rector of the Academy of Paris, Councillor in charge of institutional relations, Interacademic Group for Development, France

15:15 > 15:45 Coffee Break

MICRO-SYMPOSIUM - PALAEONTOLOGY

15:45 > 16:05

Isabelle Kruta, Senior Lecturer, Centre de recherche sur la paléobiodiversité et les paléoenvironnements (MNHN, CNRS, Sorbonne Université), Paris, France

16:05 > 16:25

Ludovic Orlando, CNRS Research Director, Anthropobiologie Moléculaire et Imagerie de Synthèse (CNRS, Université Toulouse III Paul Sabatier), Toulouse, France, and Centre for GeoGenetics, Natural History Museum of Denmark, Copenhagen, Denmark

16:25 > 16:45

Sophie Sanchez, Associate Senior Lecturer, Department of Organismal Biology, University of Uppsala, Sweden

16:45 > 17:05

Emily Rayfield, Professor, Department of Earth Sciences, University of Bristol, The United Kingdom

17:05 > 17:20

Chairs' Conclusions

Philippe Janvier, Emeritus Research Director, Centre de recherche sur la paléobiodiversité et les paléo-environnements (CNRS, MNHN, Sorbonne Université), Member of the Académie des sciences, France

Jeremy Martin, Research Fellow, Laboratoire de Géologie de Lyon : Terre, Planètes et Environnement (CNRS, ENS Lyon, Université Claude Bernard), Lyon, France

Isabelle Rouget, Senior Lecturer, Centre de recherche sur la paléobiodiversité et les paléoenvironnements (CNRS, MNHN, Sorbonne Université), Paris, France

17:20 > 18:00

Adoption of the solemn declaration "Heritage, Sciences and Technologies: an Opportunity for our Societies and the Global Economy"

François Guinot, President of the Interacademic Group for Development, France

Catherine Bréchignac, Secrétaire perpétuel honoraire of the Académie des sciences, Ambassador of science, technology and innovation, France

Loïc Bertrand, Director, IPANEMA laboratory (CNRS, MiC, UVSQ) and Science Director of the European Research Infrastructure for Heritage Science (preparatory phase), Saint-Aubin, France

18:15 > 18:30 Closing Remarks

Valérie Pécresse, President, Région Île-de-France, France

Antoine Petit, Chairman and Chief Executive Officer, CNRS, France

« Patrimoines : enjeux d'avenir »
Journée de tables rondes ouverte à tous

16 février 2019

TEMPS 1 : « LES PATRIMOINES, QUELLES GRANDES ÉNIGMES ? »

Modérateur : Jean-François Achilli

9h00 > 9h45

Mots de bienvenue

François Guinot, Président du Groupe Interacadémique pour le Développement (GID), Président honoraire de l'Académie des technologies

Catherine Bréchignac, Secrétaire perpétuel honoraire de l'Académie des sciences, Ambassadrice déléguée à la science, la technologie et l'innovation

Daniel Rondeau, Écrivain, diplomate, représentant de l'UN University à Paris

Sylvie Retailleau, Présidente de l'Université Paris-Saclay

9h45 > 10h30

Conférences inaugurales

Marc Barani, Architecte du nouvel auditorium de l'Institut de France
Un auditorium au cœur de Paris

Gérard Mourou, Prix Nobel de Physique 2018
Lumière et peinture

10h30 > 12h15

Table-ronde

Mikhail Borisovich Piotrovsky, Directeur général du musée d'État de l'Ermitage

Hartwig Fischer, Directeur du British Museum

Catherine Pégard, Présidente de l'Établissement public du château, du musée et du domaine national de Versailles

Jean-Paul Demoule, Professeur émérite de protohistoire européenne, Université Paris 1 Panthéon-Sorbonne

Philippe Bélaval, Président du Centre des Monuments Nationaux

Francesco d'Errico, Directeur de recherche au CNRS, laboratoire PACEA (Université de Bordeaux, CNRS, Ministère de la Culture)

Nikolaï Andreïevitch Makarov, Directeur de l'Institut d'Archéologie de l'Académie des sciences de Russie

12h15

Les enjeux du patrimoine gastronomique par Guy Savoy

TEMPS 2 : « AVENIR DES PATRIMOINES : DU RÉEL AU VIRTUEL »

Modératrice : Audrey Pulvar

14h00 > 15h30

Table-ronde

Isabelle Alfandary, Professeur de littérature américaine et philosophe, Université Sorbonne Nouvelle

Bruno David, Président du Muséum national d'histoire naturelle

Serge Cohen, laboratoire IPANEMA (CNRS, Ministère de la Culture, Université de Versailles Saint-Quentin en Yvelines)

Judith Olszowy-Schlanger, Paléographe, Directeur d'études, École Pratique des Hautes Études

Mehdi Tayoubi, Vice-président Innovation digitale, Dassault Systèmes et Co-directeur de la mission ScanPyramids

Yves Ubelmann, Fondateur et CEO de la Startup Iconem

TEMPS 3 : « DEVENIR ACTEUR DES PATRIMOINES : DES MÉTIERS EN ÉVOLUTION »

Modératrice : Audrey Pulvar

15h45 > 17h15

Table-ronde

Anne Baud, Membre du Conseil scientifique du chantier de Guédelon

Loïc Bertrand, Directeur du laboratoire IPANEMA (CNRS, Ministère de la Culture, Université de Versailles Saint-Quentin en Yvelines), Directeur scientifique de l'infrastructure européennes E-RIHS (phase préparatoire)

Aurélia Chevalier, Restauratrice du patrimoine

Maryvonne de Saint-Pulgent, Présidente de la Fondation des Treilles, Membre correspondante de l'Académie des Beaux-Arts

Maria Gravari-Barbas, Professeur de Géographie, Directrice de l'Institut de Recherche et d'Études Supérieures du Tourisme (IREST) et de la Chaire UNESCO « Culture, Tourisme, Développement »

Manoelle Lepoutre, Directrice Engagement Société Civile et Déléguée Générale de la Fondation Total

Frédéric Létoffé, Co-président du Groupement des Entreprises de Restauration des Monuments Historiques, Pradeau-Morin

TEMPS 4 : « PATRIMOINES : FACTEURS DE DÉVELOPPEMENT »

Modératrice : Audrey Pulvar

17h30 > 19h00

Table-ronde

Roberto Bassi, Membre de l'Accademia dei Lincei (académie des sciences italienne) et de l'Accademia europea

Bernard Chevassus-au-Louis, Membre de l'Académie d'agriculture de France et de l'Académie des technologies

Jean-Michel Geneste, Conservateur général du patrimoine honoraire, Directeur du programme d'étude pluridisciplinaire de la grotte Chauvet–Pont d'Arc

Nicolas Grimal, Secrétaire général de la Commission consultative des recherches archéologiques à l'étranger du Ministère de l'Europe et des Affaires étrangères, Membre de l'Académie des Inscriptions et Belles-Lettres

Thierry Joffroy, Directeur scientifique de CRAterre – Centre international de la construction en terre

Bariza Khiari, Représentante de la France au sein du Conseil de l'Alliance internationale pour la protection du patrimoine dans les zones en conflit (ALIPH)

François Souq, Archéologue responsable d'opérations, Institut National de Recherches Archéologiques préventives

Stéphanie Thiébault, Directrice de l'Institut écologie et environnement, CNRS

19h00

Les enjeux du patrimoine cinématographique par François Barge-Prieur, Président des Fiches du cinéma

19h15

Clôture

SESSION ABSTRACTS
RÉSUMÉ DES SESSIONS

2

MICRO-SYMPOSIUM

ARCHAEOLOGY
ARCHÉOLOGIE

Thursday 14 February 2019 10:30 > 10:50

Thilo Rehren

A.G. Leventis Professor in Archaeological Sciences and Director of Science and Technology, Archaeology Research Centre, The Cyprus Institute, Nicosia, Cyprus

Structures in Archaeological Science

The application of scientic methods in archaeology is nearly as old as archaeology itself, and archaeological science is as diverse in its methods and aims as is archaeology. The talk will look at various aspects of Archaeological Science and its role and development as a discipline in its own right. It is argued that a dynamic equilibrium keeps Archaeological Science on the one hand as a distinct profession at one of the frontiers of archaeology, namely at its interface with the STEM subjects, and on the other hand is continuously being absorbed into archaeological practice, thus losing its distinct identity. It is further argued that not only one needs to advance the frontiers of archaeological science, but that there is an urgent need to develop disciplinary structures within and among the different manifestations of current practice. A discourse is called for that contributes to formulating aims and objectives, that helps formalizing methods of data generation and data documentation, and ensures data preservation and dissemination, without limiting innovation and diversity. It is proposed that a distinction is made between research that is concerned primarily with revealing aspects of past societies, namely Archaeological Science, and research that focusses on the preservation and valorization of cultural heritage assets, namely Heritage Science.

Despite these differences in purpose, both share much of the material basis to which the research is applied, and often use the same or closely related methods and are therefore inseparable and should work towards a common disciplinary canon. Lastly, it should not be forgotten that Archaeological Heritage Science is not a one-way street whereby advances from the sciences, technologies, engineering and mathematics flow into the humanities, historical and social sciences, but that the often unique challenges and opportunities posed by archaeological and cultural heritage assets often act as important stimulants and facilitators for developments in the STEM subjects, leading to a win-win situation overall.

Thilo Rehren is A.G. Leventis Professor of Archaeological Sciences and Director of the Science and Technology in Archaeology and Culture Research Center at the Cyprus Institute. Before that, he held the Chair in Archaeological Materials and Technologies at the UCL Institute of Archaeology (1999 to 2017), with a 5-year secondment to establish UCL Qatar as a postgraduate Center of Excellence in Archaeology, Conservation and Museology. From 1990 to 1999 he worked as a research scientist at the Deutshes Bergbau-Museum in Bochum. He has supervised more than 30 doctoral students, the majority of which have gone on to successful academic careers in the UK, Europe, the Americas, Africa and China. He has published more than 200 peer-reviewed papers in archaeometallurgy and ancient glass research, from the Neolithic to the 20th century AD, and continues to be amazed by the skills and expertise of those craftspeople and engineers that came before us.

Thursday 14 February 2019 10:50 > 11:10

Mélanie Roffet-Salque

Royal Society Dorothy Hodgkin Fellow, School of Chemistry, University of Bristol, The United Kingdom

Organic residues preserved in archaeological pottery open new windows on the past

It was realised in the 1970s that archaeological pottery vessels retain abundant biochemical residues of natural products, mainly foods, preserved within the porous fabric of vessel walls. The hydrophobic lipids, e.g. fats and waxes, are the major class of compounds observed and their molecular and isotopic characterisation are allowing a wide range of questions relating to human diet and subsistence to be revealed.

Animal fats are the most common organic residues in archaeological vessels from prehistoric Europe, Asia and Africa. Over the past 30 years, analyses of thousands of pottery fragments have enabled animal exploitation in prehistory to be investigated extensively, with early evidence for milk use and cheese-making being revealed. This has provided fundamental new insights into herd management, particularly the production of dairy products amongst early farming communities who were largely lactose intolerant.

The most recent developments have shown considerable potential exists for extending the use of lipid residues, notably in the development of paleoecological and paleoclimate records. A further development is compound-specific radiocarbon dating, which is critical at sites lacking other datable materials.

Mélanie Roffet-Salque completed a PhD in Chemistry in 2012 and then worked as a post-doctoral research associate (2013-2018) in the Organic Geochemistry Unit, School of Chemistry, University of Bristol with Prof. Richard P. Evershed FRS. Her main research has been focusing on the study of lipids preserved in archaeological artefacts, in order to reconstruct past exploitation of natural resources by ancient populations, using the molecular composition of extracts and compound-specific carbon isotope composition of fatty acids. She has been particularly interested in the major animal products acquired and processed in pottery vessels by prehistoric farmers in mainland Europe, with a focus on milk and bee products. She has been awarded a Royal Society Dorothy Hodgkin Fellowship in 2018. It recognises the untapped potential of archaeological pottery vessels to serve as a novel proxy for palaeoprecipitation and explores the link between climate change and human responses in the past.

Thursday 14 February 2019 11:10 > 11:30

Philippe Dillmann

CNRS Research Director, Laboratoire Métallurgie et Cultures, Institut de Recherche sur les Archéo-MATériaux (CNRS, Université Bordeaux Montaigne, Université d'Orléans, Université de Technologie de Belfort-Montbéliard) and Nanosciences et Innovation pour les Matériaux, la Biomédecine et l'Énergie (CEA, CNRS), Saclay, France

Armour, nails, rust, slag and chemistry : a review of ten years of innovative interdisciplinary research on heritagemetals and some perspectives

From the very beginning of its use, iron has been a key material in ancient societies.This material is particularly interesting because it concerns all levels of society. Indeed,it is used to make tools for agriculture, materials for construction, but also weapons such as armor or swords, which require highly skilled craftsmen. For this reason, studying its modes of manufacture, use and trade is of primary importance for different historical and anthropological disciplines (history of technology, economic history, material culture, war history, etc.). It is also crucial to preserve and protect the tangible evidence that are the archaeological objects made of iron and steel. Moreover, studying the degradation processes of these metals over centuries is also very useful for studies aimed at predicting the behaviour of materials intended to be used over the very long term by our contemporary societies. In fact, for decades, studies on ancient metals have been fundamentally interdisciplinary and have brought together historians, archaeologists and anthropologists as well as chemists, metallurgists and geologists. However, in recent years, crucial methodological developments have taken place, having used advanced analytical chemistry techniques that now allow us to renew questions about dating, about the study of the evolution of metallurgical processes, the circulation and trade of these materials, but also to advance our knowledge of degradation processes. The effectiveness of these approaches has been due, on the one hand, to the evolution of analytical techniques but also and above all to the fact that their development has taken place in appropriate environments, making it possible to integrate the questions of each of the disciplines involved. This will be illustrated by giving some key examples. In addition, some elements for discussion on the new perspectives of interdisciplinary research on the subject will be proposed, including the collection of massive data combined with a fine and multi-scale analysis of materials, but also the creation of appropriate databases and the use of articial intelligence.

Philippe Dillmann is "Directeur de Recherche" at the French CNRS, doctor and engineer in materials science. He is director of the "Laboratoire Archéomatériaux et Prévision de l'Altération" (CNRS and CEA), deputy director of the UMR3685 and UMR5060 of the CNRS. He conducts researches in archaeological science and archaeometry. His research deals with the understanding of manufacturing and trade routes of metallic artifacts in ancient societies and, on long term corrosion and conservation. He funded the Working Party 21 of the European Federation of Corrosion, dedicated to the study of Cultural Heritage Metals. His research programs and results were regularly awarded (GMPCA price, Société Française de Métallurgie et Matériaux, CASTRO prize, Société Française de l'Energie Nucléaire prize for the CIMETAL program, involving archaeological analogues for long term corrosion prediction).

Thursday 14 February 2019 11:30 > 11:50

Safaa Abd El Salam

Professor, Head of the Department of Paintings, Faculty of Fine Arts,
University of Alexandria, Egypt

Technologies Characterization & Identification of Painted Wall Plasters from Sabratha, Libya: Using Different Analytical Techniques

Heritage sites and artifacts are fundamental sources of knowledge about the culture of societies of the past. We will consider Sabratha, one of the three main historical regions of Tripolitania. The Sabratha excavations, unlike those of Lepcis Magena, uncovered a large number of private houses, from which one can get an idea of the domestic life of the citizens. These private homes include mosaics on the floor and painted plaster as wall decoration. Fragments were collected from the two different storage areas of the Sabratha site, dating from the 2nd century AD.

Several approaches can be considered to analyse archaeological material. We have chosen to employ simple methods, without expensive instrumentation, as these would often be sufficient to research most cultural material questions. Several optical, chemical and mineralogical methods have been applied to identify materials composition and structure. These are:

- OP: Optical microscopy was used as the initial examination of polished cross-sections to identify the structure and microstratigraphy of materials.
- MCT: Micro-chemical tests were used to identify the type of the plasters and mortars – calcium aluminum silicate and water-soluble salt.
- SM: Standard methods for chemical analysis to identify the quantitative and qualitative nature the mixture.
- XRD: X-ray powder diffraction to identify the mineralogical composition of the painted layers.
- PLM: Polarized light microscope to indentify the internal structure of the plasters.

Analytical methods provided a clear view of the type and mixing of plasters and the estimation of the proportions of lime in the aggregate with respect to the geological materials available for the manufacture of plasters. Painted layers of *intonaco* of different thicknesses, in some cases were quite thick and applied in paste and then polished on the surface, however, some were painted without a layer of *intonaco*.

In this perspective, we will recommend that further analytical work on pigments be performed and that organic media, if any, be identified.

Safaa Abd El Salam holds a PhD in archaeology from the University of Leicester in the United Kingdom. She is professor and head of department of paintings at the Faculty of Fine Arts of the University of Alexandria since 2017 where she teaches conservation science. Her research focuses on the physico-chemical characterization of wall painting materials in order to better ensure their preservation. As an artist, she had several solo exhibitions in Egypt, England, Greece, Vietnam and the USA.

Thursday 14 February 2019 11:50 > 12:05

Chairs' Conclusions

Hany Helal is a Professor of Rock Mechanics and Engineering at Cairo Faculty of Engineering. He is an expert in Higher Education Reform, Science & Technology, Innovation and Entrepreneurship. He has a long experience in international cooperation and cultural heritage. He is the President of Senghor University in Alexandria and the Secretary General of the Steering Committee of Egypt-Japan Education Partnership (EJEP). He used to be the Minister of Higher Education and Scientific Research. He was appointed the Secretary General of the Education Development Fund and worked as the Egyptian Cultural and Scientific Counselor in France, Belgium and Switzerland. He was the National TEMPUS Coordinator (EU Higher Education Enhancement program). He acted as UNESCO Consultant/Administrative Director, International Centre for Synchrotron-Light for Experimental Sciences and Applications in the Middle East (SESAME). He served as a Program Specialist Earth Sciences, UNESCO Cairo Office.

Anne Lehoërff is Professor (Lille University) in European Protohistory (Neolithic to Iron Age) and Deputy President of "Conseil National de la Recherche archéologique". Archaeometallurgist, she studies specifically Bronze Age Copper alloy. She published in 2018: *Par les armes. Le jour où l'homme inventa la guerre* (Belin); "The Imaginary Crested Helmet of Vercingetorix. What is Creativity in Bronze Age Metal Production?", J. Sofaer (ed.), *Considering Creativity*, Archaeopress, 67-82.

Jean-Denis Vigne is a Director of Research of the CNRS. He is a field archaeologist and an archaeozoologist. His research concerned the late prehistoric societies and their natural, technical and symbolic relationships with the animal biodiversity, with a special focus on islands. He worked on the southwestern Europe, the Middle East (especially Cyprus), central Asia and North China. He produced original results about the evolution of the exploitation of animal resources from the Mesolithic to the Bronze Age, including animal domestication and the dawn of milk exploitation. He also contributed to the dynamics of biodiversity under human pressures. He was the director of the laboratory of Archaeozoology and archaeobotany of the French National Natural History Museum (2002-2012), and leaded several international projects or networks. He is now the Director for research, expertise, valorization and teaching of the Museum. He wrote or edited 19 books and published more than 400 articles.

3

MICRO-SYMPOSIUM

METHODS
MÉTHODES

Thursday 14 February 2019 13:45 > 14:05

Uwe Bergmann

Distinguished Staff Scientist, SLAC National Accelerator Laboratory and Principle Investigator, Stanford PULSE Institute, Stanford, USA

Recent Advances in X-ray Fluorescence Imaging and X-ray Raman based Carbon Speciation of Ancient Materials

Synchrotron-rapid-scan X-ray fluorescence (SRS-XRF) imaging is a powerful technique to create elemental maps of large ancient objects. The SRS-XRF scanning instrument at beamline 6-2 at the Stanford Synchrotron Radiation Lightsource at SLAC National Accelerator Laboratory was originally built for the imaging of the Archimedes Palimpsest. Over the last 12 years the instrument had been used for many imaging studies on fossils and ancient books. Recently we replaced it by a new imaging station with enhanced capabilities based on improved hardware and software. We will describe the performance parameters of this new station a some of the most exciting recent results in SRS-XRF imaging of cultural and natural heritage objects. Here we will focus on the SRS-XRF imaging of the Syriac Galen Palimpsest, which contains the Syriac translation of work by the Greek physician, surgeon and philosopher Galen of Pergamon. Arguably the most accomplished of all medical researchers of antiquity, Galen influenced the development of various scientic disciplines, including anatomy, physiology, pathology, pharmacology, and neurology, as well as philosophy and logic. This Syriac translation is the only known link between the original Greek and the very popular Arabic translations. Using the SRS-XRF imaging combined with advanced data algorithms we were able to identify and read several previously non legible pages in the palimpsest. We will conclude the lecture by describing X-ray Raman scattering, a bulk sensitive probe to identify and image the carbon speciation in ancient materials. We will present recent results and discuss some of the properties and limitations of this powerful method.

Uwe Bergmann got his PhD in Physics from Stony Brook University and is a Distinguished Staff Scientist at SLAC National Accelerator Laboratory and Principle Investigator at the Stanford PULSE Institute. His research activities focus on the development and application of novel synchrotron, X-ray laser and ultrafast electron techniques. His scientific interests include studies of the structure of water and aqueous solution, active centers in metalloproteins in particular the photosynthetic splitting of water, hydrocarbons and fossil fuels, functional 2D materials, and imaging of ancient documents and fossils. Bergmann has done his graduate research at the National Synchrotron Light Source and since worked at the European Synchrotron Radiation Facility, the Lawrence Berkeley National Laboratory, the Stanford Synchrotron Radiation Lightsource, and the Linac Coherent Light Source, the world's first X-ray free electron laser, where he has been Deputy and Interim Director.

Thursday 14 February 2019 14:05 > 14:25

Ilaria Bonaduce

With Silvia Pizzimenti, Celia Duce, Anna Lluveras-Tenorio, Judith Lee, Bronwyn Ormsby, Aviva Burnstock, and Klaas van den Den Berg

Associate Professor, Department of Chemistry and Industrial Chemistry, University of Pisa, Italy

Conservation issues of modern oil paintings: a molecular study of the curing mechanisms of the paint binder

Modern painted art is a fundamental part of our Heritage. Modern paintings are now of global importance, exemplied by the huge demand for blockbuster exhibitions in museums across the world. Among modern paintings those manufactured using oil media are particularly at risk, as they have developed serious conservation issues and because their conservation poses challenges, several of which are distinctly different from those seen in paintings from previous centuries. These include formation and aggregation of metal soaps, fatty acid efflorescences, drips, ooze and melting impastoes, and development of solvent sensitivity. The molecular causes, the kinetics of their development, and mechanical implications are still subjects of debate among the scientic community. Our ongoing research, initiated in the context of the collaborative European research project CMOP (Cleaning Modern Oil Paints), is focused on the characterisation of the organic paint binder, and how curing mechanisms are influenced by the paint composition and the environmental conditions.

Data indicate that oil type, pigments, additives, and environmental conditions can be key in determining the curing process of the paint film, aecting the balance between oxidation and cross-linking reactions of (poly)unsaturated fatty acids. A high rate of oxidation and the formation of a polar and underdeveloped polymeric network appear to be the result of certain combinations of drying oils and pigments, as well as exposure to high relative humidity, leading to migration and phase separation phenomena, and lack of cohesion of the paint layers. Research is still ongoing, focussed on fundamental studies of curing processes, and formation mechanisms and kinetics of the polymeric network and oxidation products, based on the combined use of mass spectrometric, analytical pyrolysis and thermoanalytical approaches. Research outcomes are important to develop guidelines for treatment, preservation and display of modern

Ilaria Bonaduce received her Ph.D. in Chemical Science in 2006. She is currently Associate Professor in Analytical Chemistry at the Department of Chemistry and Industrial Chemistry, University of Pisa. Her research focuses on the characterisation of organic materials in artistic and archaeological objects. This research is dedicated at the at the development and implementation of analytical methods for a reliable identification of organic materials in paint and archaeological polychrome artifacts, to reconstruct painting techniques and technologies of the past. Another main focus of research is related to the study of changes undergone by in works of art and archaeological findings, as an effect of manufacturing processes (painting, cooking, etc.), interaction with the surrounding environment (pigments, paint support, vase, conservation treatment, etc.) and the external ageing conditions (temperature, light, RH% etc). She is author of about a hundred publications, 70 of which are in peer reviewed scientific journals and books.

Thursday 14 February 2019 14:25 > 14:45

Caroline Tokarski

Professor, Protéome Platform, Institut de Chimie et Biologie des Membranes
et des Nano-objets (CNRS, Université de Bordeaux, Bordeaux INP), Bordeaux, France

Chemistry and Cultural Heritage: Deciphering Natural Polymers by High Resolution Mass Spectrometry

The study of organic macromolecules in Cultural Heritage is key to decipher ancient materials in order to reveal new historical insights or help in preservation issues. Mass spectrometry-based omics has become a mainstream method in this field but remains challenging due to the limited sample amount available for analysis, the complexity of the composite art and archaeological materials and their degradation state. Besides the identification of proteins, lipids and polysaccharides, MS-based omics allows the identification of their biological origins and their chemical modifications related to ageing or reaction with other components within the sample. For art materials, such a molecular elucidation find direct implications on understanding how an artwork was created or how it has changed over time; improving conservation and preservation strategies; and addressing questions related to authentication. In archaeology, human habits and commercial exchanges from the past are revealed; information on extinct species and evolutionary linkages are drawn; and ancient pathologies and pathogens are studied. These methodologies are currently used in the most famous international museums (e.g. Metropolitan Museum of Art, New York).

This conference will describe the most robust and sensitive methods to analyze trace amounts of proteins, lipids and polysaccharides from artworks and archaeological objects and their main achievements. This presentation will show how the bottom up and the top down methodologies address the current challenges in structural elucidation of biopolymers with unknown structures and how they are employed to study their chemical modifications (e.g. historic art paintings, watercolors, archaeological ceramics). For example, protein lactosylation, a Maillard reaction signaling the potential heating processing of milk was identified in Ist century nursing bottles. Another example that will be discussed is the phylogenetic study of extinct archaeological species. First analytical evidence of molecular crosslinkings in historic artworks will be also presented. In particular, the use of protein chemistry to elucidate a secret recipe of restoration will be shown. The conference will be illustrated by the study of various outstanding samples from art but also from archaeological and palaeontological fields from the most famous museums and institutes in the world.

Caroline Tokarski is Professor at the University of Bordeaux. She is member of the Institut Universitaire de France and corresponding member of the National Academy of Pharmacy. She is head of the Proteome Plateform of Bordeaux-CGFB and co-head of the CNRS Associated International-Laboratory ARCHE (ARt and Cultural HEritage: Natural Organic Polymers by Mass Spectrometry) with the Metropolitan Museum of Art, New York (co-head Julie Arslanoglu). She was recognized in 2011 by the French Society of Chemistry for her developments in Cultural Heritage. CT published the first applications of proteomics to artworks and archaeological samples using peptide sequencing and mass fingerprint in early 2000s. She showed how high resolution mass spectrometry benefits to the characterization of lipids trapped in archaeological ceramics. She also published first application of omics for polysaccharides sequencing and fingerprint in artworks. More recently she introduced top down proteomics to the study of proteins in Cultural Heritage samples.

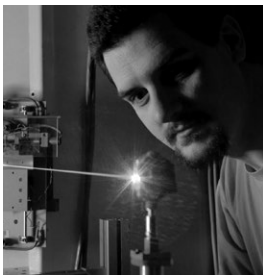
Thursday 14 February 2019 14:45 > 15:05

Paul Tafforeau

Researcher, European Synchrotron Research Facility, Grenoble, France

Synchrotron microtomography in palaeontology and archaeology, a bright future for the ESRF

The first application of X-ray synchrotron microtomography in palaeontology was performed in 2000 at the ESRF on the beamline ID19. This topic has been so successful that it has become one of the very visible research topics at the ESRF. Since 2006, other synchrotron light sources joined the game, making synchrotron microtomography the golden standard for non-destructive imaging of internal structure in fossils, when conventional microtomography reaches its limit. More recently, archaeological applications have joined this portfolio. Nevertheless, sample size is typically limited to few millimeters in most of the beamlines, with only a handful of them allowing specimens in the decimeter range. Larger specimens are typically imaged with high energy conventional X-ray tomographs, but with severe restrictions in term of resolution and sensitivity. There is a clear lack of solution for high-sensitivity imaging in large fossils. The BM18 beamline project at the ESRF aims to tackle these limitations all at once by making possible synchrotron multi-resolution imaging on much larger samples than today, with special emphasis on fossils and cultural heritage specimens. BM18 will be able to image specimens up to 1 m in diameter and 2.5 m vertically. It will cover a pixel size range from 100 m down to 1 m, thanks to a 35 cm wide polychromatic beam able to reach 300 keV, tunable in flux, spectrum and geometry through various in-line X-ray optics. The whole beamline is designed for multi-resolution investigations using semi-automatic multi-detector system. The exceptional coherence properties of the ESRF-EBS, coupled with the 38 m of propagation on BM18 will allow phase contrasts imaging capabilities without equivalent worldwide. BM18 should open tremendous new research capabilities for paleontology, but also for many other research fields, including archaeology, cultural heritage or evolutionary biology. The expected start of first user operations is planned for September 2021.



Paul Tafforeau (born in 1977) is a French paleontologist. During his PhD, he initiated in 2000 the use of X-ray synchrotron microtomography to image 3D structures of fossils non-destructively on the ID19 beamline at the ESRF. While working primarily on fossil primate teeth, he also successfully tested synchrotron imaging on several other kinds of fossils. In 2004, he started a post-doc at the ESRF, then became beamline scientist on ID19 in 2007, and beamline responsible in 2012. One of his core mission was to develop paleontological applications at the ESRF. In 2016, he was appointed as the project leader for the future BM18 beamline that aims to become the worldwide leader for synchrotron microtomography applied to large samples in palaeontology and archaeology.

Thursday 14 February 2019 15:05 > 15:20

Chairs' Conclusions

Andrew King is responsible for the x-ray tomography instrument at the PSICHE beamline of the SOLEIL Synchrotron. Tomography (non-destructive 3D imaging) is used for a wide range of applications, and the team works with many researchers in the heritage science community. His personal research actives are focused on combining x-ray imaging and diffraction techniques to gather more information from a given sample. Previously, he has worked at the European Synchrotron in Grenoble, and at the Petra III synchrotron in Hamburg. He also spent one year in the MATEIS group of INSA in Lyon. He obtained his PhD, in materials science, from the University of Manchester in the UK.

Responsible for the archaeometry department (conservation, material studies and radiocarbon laboratories) of the Institut Français d'Archéologie Orientale in Cairo (Ifao, French Ministry of Higher Education and Research), **Anita Quiles** completed her PhD dissertation in Physics at the Paris-Diderot University (LMC14 CEA Saclay) and got a Master degree in Egyptology at Paris Sorbonne University. She is also associated researcher at the *Astroparticules et Cosmologie laboratory* (UMR7164, Paris Diderot University).
Nuclear physics was her first research topic before extending it to archaeology. Her research in archaeometry deal with dating of past hazards and modelling of complex chronologies, focusing both on the Upper Palaeolithic period and on the Egyptian civilization. Such complex models aim to integrate chronological perspective using a global approach of archaeology. She is also involved in supporting archaeometric studies in Egypt, from a valuable insight into cutting-edge instrumental technologies and by developing strong collaborations with Egyptian laboratories.

4

MICRO-SYMPOSIUM

THE OBJECT IN ITS HISTORY
L'OBJET DANS SON HISTOIRE

Thursday 14 February 2019 15:50 > 16:10

Jean-Philippe Échard

Curator, Cité de la Musique – Philharmonie de Paris and Centre de recherche sur la conservation, Paris, France

Rethinking research on the history of the violin

The violin, as every musical instrument, is by essence an instrument, the tool used by the violinist to practice his art. Contributions on the history of the violin from academics are quite rare, compared to those by luthiers. First trained to the making of new instruments, some luthiers move indeed to the trade of used and antique violins. Based on visual examination and memory –by recognition of technico-stylistic features of the remaining original parts–, the expertise of violins is lead by a culture of attributionism. These experts progressively built the history of violins reconstructing genealogies of their makers, mostly based on surviving instruments. The question of the historical sources is central to this field. Documents from pre-1800 luthier workshops are very rare, and the extant primary sources are mostly material: the violins themselves. This has certainly induced biased representation of the relative production of various violin-making schools. In the last two centuries, Italian 16th-18th-c. specimens, by Stradivari, Guarneri and others, have become to exemplify the paragon of violin making. Their violins can transcend the role of instrument and have been promoted to the status of masterpieces. They are surrounded by an aura of mystery, as illustrated by the importance of Stradivari's name in popular culture. The cultural and heritage values of these violins now far exceed the sole frame of music. The history of the violin is thus manifold, and so study and reference for all its parts seems to be demanded.

This is what drives the study of its making, makers, musical and cultural history, history of conservation and expertise. To do these, we employ art technological source research and scientic analysis to describe the materiality of instruments in public collections, at the Musée de la musique in Paris among others. In parallel, archival research brings new knowledge on provenance and past restorations for certain individual instruments, which may help to understand their elusive qualities that capture admiration. The momentum generated by contemporary thinking allows considering a renewed approach to the history of violin, with stronger input from public research institutions, in interaction with the violin-making community.

Jean-Philippe Échard trained as a chemist, with a degree from the École Nationale Supérieure de Chimie, Paris (1998) and a PhD from the Muséum National d'Histoire Naturelle (2010). He also studied musical acoustics at the Paris Conservatoire National Supérieur and was a Research Fellow at the National Gallery of Art, Washington, DC. From 1999 to 2013 he was a conservation scientist in the laboratory at the Musée de la musique, Paris, where he was then appointed curator of bowed stringed instruments in 2014. Échard's current research is focused on organology in its cultural, social, economic, material context. His first book, on the provenance of the 1724 'Sarasate' stradivarius, was published in September 2018. He is a member of the Centre de Recherche sur la Conservation.

Thursday 14 February 2019 16:10 > 16:30

Charlotte Guichard

CNRS Research Director, Institut d'histoire moderne et contemporaine (CNRS, ENS, Université Panthéon-Sorbonne), Paris, France

The Picture as Thing? Materiality and Historicity of Art in Heritage Science

This paper takes place in the recent developments of a 'new connoisseurship', based on the growing collaborations between the humanities and heritage sciences in the field of art and visual studies. Traditionally considered through an aesthetic and iconographic approach, as pure images, pictures are now studied in their material history. The use of new analytical and imagery techniques has largely contributed to promote materiality in the field of art history: from attribution and authentication of pictures as in the Rembrandt Research Project (1968-2011) to their material life and history as artistic artefacts (Anderson, Dunlop, Smith, 2014). The change of scale (from macro to micro analysis) allowed new regims of visibility for components of pictures, such as oils, pigments, canvas, etc., and for their material transformations during their social lives.

This paper will present a collective project, supported by the 'DIM Matériaux anciens et patrimoniaux', led by the Institut d'histoire moderne et contemporaine (CNRS) and the C2RMF (Centre de Restauration des Musées de France) on a synthetic pigment, 'Prussian blue', created around 1706 and rapidly used in decorative arts and paintings in eighteenth century Europe (Gervais, 2013; Kirby, 1993 and 2004; *Technè*, 2007). It aims to shed light on the social actors involved in innovations around Prussian blue: painters, but also apothecaries, chemists, painters, but also grocers and entrepreneurs. How can one pigment help us redeem pictures as objects? How can heritage science help us reframe artistic creation and the social and material life of pictures?

The context of such a project is based on the changing conceptualization of artistic artefacts. Social sciences and anthropology of art have recently demonstrated the centrality of materiality in art — against the hegemony of aesthetics. To further researchs, institutional collaborations still need to be structured and developed between historians, art historians, museums and curators.

Charlotte Guichard is Directrice de recherche at the Centre national de la Recherche Scientifique and she teaches at the École normale supérieure (Paris) in the History Department. She is an historian of European artistic and visual culture in the eighteenth century. Her researchs intend to bridge gaps between history, art history and social sciences. She received fellowships from the Getty Research Institute, the Académie de France à Rome (Villa Médicis). Her publications include: *Les Amateurs d'art à Paris au XVIII^e siècle* (Seyssel, 2008), *Graffitis. Inscrire son nom à Rome (XVI^e-XIX^e siècles)* (Seuil, 2014); *La Griffe du peintre. La valeur de l'art (1730-1820)* (Seuil, 2018).

Thursday 14 February 2019 16:30 > 16:50

Dominique Pieri

Director, Département Archéologie et histoire de l'Antiquité (DAHA)
Institut français du Proche-Orient (Ifpo), Beirut, Lebanon

Bonum Vinum. Wine, trade and amphora in late antiquity (4th-7th centuries AD)

Our knowledge of the modalities of trade in the Mediterranean during late antiquity has in a few years dramatically evolved. The transition period (4th-7th centuries) is undergoing fundamental changes between the legacies of the ancient world and the early signs of the Middle Ages. Among the study materials that make it possible to evaluate the nature of trade in the Mediterranean, amphorae, the famous lost packaging of Antiquity make it possible to reveal the modes of production, the routes borrowed and the products exchanged. Wine, and in particular that produced in the East widely distributed throughout the Mediterranean basin, knows an unprecedented success where it occupies a privileged place in the current consumption, in the medical prescriptions and in the Christian liturgy. If archaeology has been able to bring important results, the research takes today a new dimension with the archaeometric studies allowing to characterize the clays and thus determine the places of production, as well as the physicochemical and archaeobotanical programs which propose certain types content.

Dominique Pieri
Professor of Byzantine archeology at the University Paris 1 Panthéon-Sorbonne and attached to the Collège de France (UMR 8167 Orient & Méditerranée). He teaches archaeology in early Christian times. He has been heading since September 2017 the Department of Archeology and History of Antiquity (DAHA) at the French Institute of the Near East (IFPO). Specialist of the Byzantine material culture, he studied the trade relations between East and West during late Antiquity.
Between 2007 and 2010, he conducted excavations on the prestigious Paleochristian sanctuary of Saint-Symeon (northern Syria), in the area of the *via sacra*, the famous path that pilgrims took to go to the martyrion. Since 2016, he has directed Jaouzé's Franco-Lebanese mission, which explores the remains of a medieval Roman village in the mountainous hinterland of Beirut.

Thursday 14 February 2019 16:50 > 17:05

Chairs' Conclusions

Etienne Anheim (b. 1973) is Professor at the Ecole des hautes études en sciences sociales (EHESS) in Paris. He was Editor-in-Chief of the journal *Annales. Histoire, Sciences Sociales* between 2011 and 2018, and is currently Director of the Editions de l'EHESS.
He is Vice-President of the Fondation des Sciences du Patrimoine and one of the three responsibles of the DIM "Matériaux Anciens et Patrimoniaux" (Key Research Sector Ancient and Heritage Materials).
His work focuses on the historical sociology of culture and arts, especially painting, in Europe between the 12th and 16th centuries, as well as on the historiography and epistemology of history and interdisciplinarity. He has published several articles in these fields, has edited a dozen of books and journal special issues, and is the author of two books, *Clément VI au travail. Lire, écrire, prêcher au XIVe siècle* (2014, Editions de la Sorbonne) and *Le travail de l'histoire* (2018, Editions de la Sorbonne).

Dominique Vingtain is a medievalist specialised in architecture and painting, and has a PhD in art history. She is chief curator of the Musée du Petit Palais and the Palais des Papes in Avignon.
She is a specialist of French heritage and restauration history and published many books on this subject: *Avignon Le Palais des Papes* (Editions Zodiaque, 1998), *Monument de l'histoire. Construire, reconstruire le Palais des Papes, XIVe-XXe siècle* (exhibition catalogue, 2002) et *Le Palais des Papes d'Avignon XVIII-XXe siècle L'invention d'un Monument Historique Français* (Editions Honoré Clair, 2015).
She supervised numerous restaurations of medieval sculptures, frescoes and paintings, among which the one of the Matteo Giovannetti's 14 century frescoes, recognized as one of the most important French operation in this field. She pledged to make scientific research work accessible to all through various actions, recently with a new enhanced reality device for the visitors of the Palais des Papes.

Sergey Sirro is Head of the Scientific Research Department (from 2008) of the State Russian museum, Saint-Petersburg, Russian Federation.
The collection of the museum is one of the most significant collections of Russian art in the world and the Department has a unique experience in researching, expertizing and attribution of Russian art-pieces including medieval icons, frescoes, goldsmiths works, huge academic style paintings, avant-garde masterpieces of Malevich, Suetin, Rodchenko, Filonov, etc.
Dr. S. Sirro holds a PhD in Nuclear Physics (1994) and in Art history (2004).
Issues of professional interest: non-destructive methods for old graphics papers, new research methods for historical glass works.
Dr. S. Sirro is a Chair of the MOLAB-RU project [Collaboration work of prominent French and Russian institutions: The State University of Saint-Petersburg, C2RMF, The State Russian Museum, LRMH and the Heritage science foundation (Fondation des sciences du patrimoine)].

5

ROUND TABLE

HERITAGE AND RESEARCH INFRASTRUCTURES

PATRIMOINES ET INFRASTUCTURES DE RECHERCHE

Thursday 14 February 2019 17:05 > 17:20

Webber Ndoro

Director-General, International Centre for the Study of the Preservation and Restoration of Cultural Property (ICCROM), Rome, Italy

Global research thrust what are challenges and opportunities

Given ICCROM Global membership (136 member states), this gives an opportunity to scan and enrich scientific research and facilitation at a world scale. Whilst this is an opportunity for dissemination and cross-pollination, it also presents some historical challenges, which need to be considered, given the scientist trust of democratization and free open access to knowledge and its use. The presentation will try to focus on some of these issues particularly the links between custodial institutions and research endeavors. How does this influence practice? Given the uneven terrain of research and facilitation in different parts of the world. ICCROM's potential role as an interlocutor will also be explored together with what it can offer in terms of research facilitation and knowledge sharing at a global level.

Webber Ndoro has been confirmed by ICCROM's 30th General Assembly in 2017 as the new Director-General. Dr Ndoro completed a BA in History at the University of Zimbabwe in 1982, a Master of Philosophy in Archaeology in 1987 from Cambridge University, and a Master in Architectural Conservation from York University. His formal education was completed at Uppsala University where he obtained a PhD in Heritage Management in 2000.
Dr Ndoro joined the National Museums and Monuments of Zimbabwe in 1985. He served as Co-coordinator of its Monuments Programme from 1992 to 1994, and then moved to the University of Zimbabwe as lecturer on heritage management. He has also lectured on heritage management at the University of Bergen in Norway, as well as at the University of Cape Town, South Africa, where he is Honorary Professor.
Dr Ndoro's first involvement with ICCROM came in1998, when he was tasked with implementing one of the first three site projects for the AFRICA 2009 programme. From 2002, Dr Ndoro worked as a full-time ICCROM staff member on AFRICA 2009, providing a very useful African perspective at ICCROM to the planning and implementation of the programme. He left ICCROM in 2007 to accept the position of Executive Director of the African World Heritage Fund (AWHF), a post which he has held until the present.
During his mandate at AWHF, Ndoro guided the fund to become one of the leading conservation organizations in the region, and has also raised a significant endowment. Under Dr Ndoro's leadership, AWHF has planned and implemented programmes and activities for heritage conservation aimed at improving World Heritage nominations, strengthening disaster risk management and traditional management systems, and promoting entrepreneurship related to heritage in the region.
Dr Ndoro's accomplishments in the field of heritage conservation have had a lasting impact on ICCROM as an organization, and on a generation of young heritage professionals in sub-Saharan Africa and worldwide.

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Panellists

Alison Heritage (BSc Hons, Dip. Cons, MSc, PhD, FIIC, ACR) is a heritage scientist and wall paintings conservator. She holds a PhD from University College London (2001), two postgraduate degrees from the Courtauld Institute of Art, University of London (MSc with distinction (1995), Dip. Cons Wall Paintings (1994)), and a BSc Hons in Environmental Chemistry (1989) from Edinburgh University. She is a Fellow of the International Institute of Conservation, and an Accredited Conservator-Restorer (Institute of Conservation, UK). She has been working at ICCROM since 2011, where she leads the heritage science programme, a core objective of which is to highlight strategic support needs within the heritage science sector and promote knowledge sharing to enhance research relevance and impact.

Johanna Leissner was trained as chemist in Germany and USA. She is working in cultural heritage research for over 20 years with a focus on climate change, environmental pollution, sensor development and sustainability. Coordinator of EU large scale project Climate for Culture (2009-2014; www.climateforculture.eu). German delegate for the Council of Europe Strategy "European Cultural Heritage in the 21st century". Since 2005 scientific representative for Fraunhofer-Gesellschaft at the European Union in Brussels. Co-founder of the German Research Alliance for the Protection of Cultural Heritage in 2008 and of the Fraunhofer Sustainability Network. From 2001 to 2005 National Expert of the Federal Republic of Germany responsible for "Technologies for the Protection of the European Cultural Heritage" in the European Commission in Brussels.

Costanza Miliani is senior researcher at CNR-ISTM (National Research Council Institute of Molecular Science and Technologies), Perugia, Italy. She received her MSc (1995) and PhD (1999) in Chemical Sciences at the Università Degli Studi di Perugia. She is the author of over 120 articles concerning the physical chemistry of materials of relevance to heritage science (H-index=40 from Google Scholar) and co-edited the RSC book "Art and Science: the painted surface". Costanza Miliani is currently the coordinator of the mobile platform MOLAB operating in Europe under the IPERION-CH project and the responsible for the access activity of the ERIHS.it Italian node. She is a member of board of the Center SMAArt (Scientific Methodologies applied to Archaeology and Art, Perugia) and the scientific board of NUACCESS of Art Institute and Northwestern University of Chicago.

Thursday 14 February 2019 17:20 > 18:20

Panellists

Laurent Romary is Directeur de Recherche at Inria (France), within the team ALMAnaCH, and former director general of DARIAH (2014-2018). He carries out research on the modelling of semi-structured documents, with a specific emphasis on texts and linguistic resources. He has been active in standardisation activities within ISO committee TC 37 and the Text Encoding Initiative. He has also been working since many years on the advancement of open access.

Graduated from the Ecole du Louvre of Art History and Museology in 1977, **Véronique Sorano Stedman** undertook studies of restoration at the University of Paris I , then at the IFROA (French Institute for restoration of cultural Heritage). She did an internship at the ISCR (Istituto Superiore per la Conservazione e il Restauro) of Rome.
From 1987 to 2010 she worked as a painting conservator in French Museums, under C2RMF supervision. She managed large projects of restoration of monumental heritage such as the Apollo gallery in the Louvre, the Hall of the Mirrors in Versailles or the "Grande Singerie" in Chantilly.
Since 2010, she is the Head of the conservation Department in the National Modern art Museum, at the Centre Pompidou. She is a member of the restoration Committee of the Louvre, of the Scientific Council of the C2RMF and board member of the INP (National Heritage Institute).

Thursday 14 February 2019 18:20 > 18:35

Chairs' Conclusions

Loïc Bertrand is a physicist, Director of the IPANEMA European research platform on ancient materials (CNRS, French Ministry of Culture, UVSQ) at University Paris–Saclay. He is the Scientific Director of the European Research Infrastructure for Heritage Science (E-RIHS) for the preparatory phase, and coordinates the participation of France to E-RIHS with I. Pallot-Frossard (C2RMF). He is a specialist of advanced methodologies to study ancient and historical materials, on which he has authored ~70 articles. His personal research is centred on the study of properties of ancient materials through their full-field and raster-scanning microimaging, via development of methodological approaches based on infrared, UV-visible and X-ray synchrotron radiation. Loïc Bertrand heads the Île-de-France Key Research Sector on Ancient and heritage materials (120 labs, SMEs and heritage institutions) and is the elected chair of the coming Gordon Research Conference on Scientific Methods in Cultural Heritage (2020). He teaches at the Paris National Museum of Natural History, and is a monitor for the European Commission.

Marei Hacke is from Berlin and studied textile chemistry and technology at the universities of Berlin and Manchester. She received her PhD in 2006 within a European research project on the monitoring of damage in historic tapestries. During a fellowship at the Smithsonian Museum Conservation Institute (2006-2007) Marei researched weighted silks and portable XRF for the identification of metal mordants. As a conservation scientist at the British Museum (2007–2015) and since 2015 at the Swedish National Heritage Board her areas of expertise include scientific investigations of cultural heritage and conservation methods with a focus on organic materials (textiles, paper, plastics, mordants and dyes) as well as the strategic development of heritage science. Marei is the Swedish national coordinator for E-RIHS.

Aliz Simon is Nuclear Physicist at the International Atomic Energy Agency (Vienna, Austria). Dr Simon coordinates and plays a lead role in international co-operation on the development of accelerator-based techniques and applications. She promotes exchange of scientific results and develops collaborations among various stakeholders, e.g. research institutes, universities, museums, governmental and international organizations. Dr Simon's expertise spans over 20 years in multi-disciplinary, transformative frontier research. She coordinates heritage projects by applying nuclear analytical techniques both at national and regional level including developing Member States from Europe, Asia-Pacific and Latin America.

6

MICRO-SYMPOSIUM

CULTURAL HERITAGE

PATRIMOINE CULTUREL

Friday 15 February 2019 9:00 > 9:20

Katrien Keune

With Joen Hermans[1], Piet Iedema[1], Petria Noble[2], Annelies van Loon[2], Susan Smelt[2], Gwen Tauber[2], Lambert Baij[1], and Michel Menu[3]

Associate Professor, Van 't Hoff Institute for Molecular Sciences, University of Amsterdam and Painting Research Scientist, Rijksmuseum Amsterdam, The Netherlands
[1] University of Amsterdam (UvA) | [2] Stichting het Rijksmuseum (Rijksmuseum) | [3] Centre de recherche et de restauration des musées de France (C2RMF) – Centre National de la Recherche Scientifique

Paintings as dynamic objects: scientific challenges to guide conservation treatments

Old master paintings, as well as modern and contemporary art are subjected to ageing from the moment they have been made. Discoloration, increased transparency, darkening, chalking, delamination and losses are just some alteration phenomena encountered in paintings. These phenomena affect the appearance and stability of paintings and as a consequence the field of conservation is faced with significant and varied conservation challenges. Furthermore, material changes can lead to art historical misinterpretations. It is also important to predict the future behaviour of artists' materials in order to define optimal display and storage conditions for preventative conservation. To address these conservation and preservation challenges, full characterisation of the painting and its alteration phenomena is necessary, including fundamental studies into the aging mechanisms and driving forces behind the alteration processes.

In the Rijksmuseum and many other museums, paintings and their alteration products are investigated at a macro-, microscopic and molecular level. The fast development of non-destructive imaging techniques, such as macroscopic X-ray fluorescence scanning, hyperspectral imaging and macroscopic X-ray powder diffraction scanning, makes it possible to generate chemical maps of paintings. Micro-sample investigations provide complementary information about the paint composition at a micro- and molecular level, including the layer stratigraphy of the painting. As paintings are eminently heterogenous multi-component objects, and samples are precious, conventional analytical techniques are challenged. Since the investigation of paint samples usually requires high spatial resolution and high sensitivity, synchrotron-based techniques provide a good solution.

The results of macro- and microscopic techniques form the basis for fundamental chemical studies performed in academic laboratories. We perform quantitative and qualitative spectroscopic and spectrometric studies on smart designed oil-paint model systems provide a detailed understanding about the mechanisms and the driving forces involved in the migration of paint components through paint layers. These experimental studies are supported and complemented by mathematical modelling that enlightens the complexity and rates of chemical reactions that take place in paintings.

The approach outlined above, will be illustrated on the basis of alteration phenomena that are induced by pigment-binder interactions and solvent cleaning methods on the chemical stability of paintings.

Katrien Keune, PhD, is the paintings research scientist at the Rijksmuseum Amsterdam, Netherlands. She also holds an appointment as Associate Professor of Chemistry at the University of Amsterdam (UvA) and contributes to the Netherlands Institute for Conservation, Art and Science (NICAS) at a scientific and organizational level. She is responsible for carrying out and developing scientific research projects with and providing analytical support to the conservation studios of the Rijksmuseum. She is specialized in degradation studies of pigments and oil paintings at the micro- and molecular level. She has (co-)authored to many publications focusing on degradation phenomena in oil paintings. From 2012-1026, she was the project leader of and researcher in the multi-disciplinary research project Paint Alteration in Time (PAinT) at the UvA. She supervises and participates in numberous (inter)national research projects such as NANORESTART (H2020), LeadART (JPI-JHEP), PREDAGIO (NWO-funded) and CuBISM (NSF-funded). She is co-supervising various PhD-students and post-docs.

Friday 15 February 2019 9:20 > 9:40

Piero Baglioni

Professor, Director, Centre for Colloid and Surface Science, University of Florence, Italy

Advanced Materials and Nanotechnologies at the service of Cultural Heritage Conservation

In the last decades, research in the field of Cultural Heritage conservation has produced valuable knowledge. Nanoscience has provided new approaches, based on advanced nanomaterials that ensure the maximum physico-chemical compatibility with the original artistic materials, to grant effective and durable restoration. Degradation processes occur at the interface of meso-scale domains (colloids and soft matter domain) within artifacts, materials with that dimensional scale are more effective than "classic" materials. The use of systems such as gels, microemulsions and nanoparticles, as well as composite or polyfunctional nanomaterials, is proving highly beneficial to both classic and modern art. In this lecture, I will review the most important methods and materials so far developed for conservation, focusing on systems of increasing complexity: from nanoparticles to oil/water (o/w) microemulsions to semi-interpenetrating hydrogels containing o/w microemulsions. In this lecture I will review the most meaningful achievements in the field, focusing on the application of colloidal dispersions of increasing complexity, from nanoparticles to o/w microemulsions to semi-interpenetrating hydrogels containing o/w microemulsions. These systems have been used on artifacts of the most diverse origins, from Renaissance frescoes to Picasso and Pollock. I will show how chemical and colloidal design can be implemented to meet the requirements of the end-users and how precise knowledge of structure, dynamics and interfacial interactions can contribute to overcome the traditional serendipitous approach used by conservators.

Piero Baglioni is the chair of Physical Chemistry at the Department of Chemistry of the University of Florence since 1994. He was appointed as Visiting Scientist/Professor by the Department of Chemistry of the University of Houston, the Weizmann Institute, the Collège de France, and the M.I.T. He is the Director of the National Center for Nanosciences (CSGI) and he is in the Editorial/Advisory Board of several intentional Journals and member of several national and international Institutions and Societies. Piero Baglioni is the author of more than 500 publications on books and largely diffused international journals. He is also the author of 25 patents. In the field of conservation, he has discovered a method to increase the metastable regime of nanoparticles, in particular of calcium and magnesium hydroxide and carbonates and applied these novel nanoparticles systems to the Conservation of Cultural Heritage (wall paintings, paper and wood de-acidification).

Friday 15 February 2019 9:40 > 10:00

Tarek Tawfik

Director General, The Grand Egyptian Museum, Giza, Egypt

Modern Museums based on Science and Technology

A substantial part of the budget of any new museum that is being built today is spent on using state of the art innovations in Science and Technology. This reaches from modern equipment and materials for restoration and conservation to interactive and multimedia installations. The modern museological display makes use of innovations in the fields of illumination, climate control, materials for fit out and flexible ICT connections as well as smart control systems.
Ensuring highest levels of security for the artefacts and visitors has also become a major field of applying up to date clever technologies. Yet with every innovation also new challenges emerge that have to be taken into consideration and keep us as Heritage guardians in constant interaction with achievements and solutions of Science and Technology.

Dr. Tarek Sayed Tawfik is associate Professor of Egyptology at the Faculty of Archaeology Cairo University. Since August 2014 he is Director General of the Grand Egyptian Museum Project in Giza. Dr. Tawfik was born in Giza 1971 and got his bachelor and master in Egyptology from the Faculty of Archaeology Cairo University. In 2008, he obtained his PhD from the University of Bonn in Germany on the thesis "The Vignette of the first Chapter of the Book of the Dead on Papyri and in Tombs". He is prominently present in international Conferences of Egyptology, Museology and Heritage preservation as well as international media. Since 2013 he is Member of the Arab-German Young Academy of Sciences and Humanities in Berlin. In 2015, he was chosen as Corresponding Member of the German Archaeological Institute and since 2014 he is Member of the editorial board of the British Journal of Egyptian Archaeology (JEA). He lectured in Germany, France, Great Britain, Switzerland, Italy, USA, Czech Republic, Malta, India, Japan and Jordan.

Friday 15 February 2019 9:20 > 9:40

Jean-Marc Vallet

Research Engineeer, Head of Research, Centre Interdisciplinaire de Conservation et Restauration du Patrimoine, Marseille, France

Heritage science and building heritage: how to deal with the diversity of materials, scales and approaches?

Since the last century, scientific developments dedicated to Building Heritage mainly follow different axes: techniques including large scientific instruments and facilities, new portable devices and 3D technologies. These instrumental and conceptual developments led to significant scientific advances in archaeometry and conservation.

Most of these technologies investigates the surface and finishes of building heritage. They have thus improved our knowledge on the origin of the materials, the manufacturing and artistic techniques, the partial or entire dating of the whole or a part of the studied object. They have enabled an accurate exploration of different degradation mechanisms and of the behaviour in time of new conservation treatments. They also have allowed investigating the impact of the environment including global climate change and natural hazard on built heritage.

In addition, tracing the origin of materials such as stones or degradation agents has become easier thanks for instance to the analysis of stable isotopes.

Other studies have explored the making of some pigments, the structure of some other that give them specific physical properties. Degradation mechanisms affecting some inorganic pigments used for centuries became now more easily understandable thanks to use of specific instruments such as synchrotrons beamlines or electronic microscopes, which make possible the exploration of material transformation at a nanoscale.

On the other hand, the recent advances in nanotechnologies led to the development of new conservation treatments such as nanoconsolidants or treatments before cleaning that are expected to be at least as efficient as the classical ones are.

These developments do not only concern laboratory researches but also on-site studies. A large variety of portable techniques is now available. Researchers and practitioners can then constitute sets of tools to meet various objectives such as: making punctual to global analyses of surface materials, giving valuable direct or indirect information coming from inner structure materials or on artist techniques. They also enable to characterize various environmental parameters, and to give precise geometrical measures in the three dimensions of space. These tool-boxes are now more and more accessible via technical platforms. They offer new research perspectives through the combination of multiples data and promising modelling developments.

Dr Jean-Marc Vallet is geologist-mineralogist. He is conservation scientist and scientific advisor at CICRP (Marseille, France) and researcher at LABCOM MAP-CICRP (UMR 3495 CNRS-MCC, Marseille). His main researches interests are focussed on the understanding of degradation mechanisms that affect wall paintings, polychromy and stones, and on the contribution to the development of non-invasive techniques (3D technical imaging, multidimensional databases, stimulated infrared thermography etc.).
He publishes in peer-reviewed journals and proceedings and presents his results in conferences. He is regularly invited for lectures and is involved in international and national research projects. He has been member of technical advisory of EU projects and is member of several scientific committees for the restoration of built heritage (Palais des Papes in Avignon, Palace of Monaco, etc.). He is expert for EC, ANR, and CNRS. He is regularly member of organisation and scientific committees of conferences, and reviewer for international science journals and research projects.

Friday 15 February 2019 10:20 > 10:35

Chairs' Conclusions

Anne Bouquillon is Research Engineer in the Centre de Recherche et de Restauration des Musées de France. She has a Phd in oceanology with a specialization on clay mineralogy and a HDR in chemistry. In the research department she was head of the group dealing with ceramics, stones, fine stones, metals, glass for over 20 years. She is member of the IRCP (PCMTH team - UMR 8247 CNRS) where she initiated and coordinated national and international research programs focused on Renaissance ceramics and stuccoes (characterization, authentication, alteration) and on consolidation treatments of unfired clay artefacts. She is teaching in different institutions and universities. At the end of 2019, she will become chief redactor of the Techne publication.

Dr. Robert van Langh (1968) has been head of the Department of Conservation & Science at the Rijksmuseum in Amsterdam since 2006. Beginning as a gold- and silversmith, Robert was subsequently trained as a conservator at the National Institute of Fine Arts in Antwerp. After working at the Museum of the Tropics, he became a metals conservator at the Rijksmuseum in 1995. During this time he developed the metals conservation training program now being taught at the University of Amsterdam. In 2012 he finished his PhD at Delft University of Technology combining Materials Science and Art History with the title: "Technical Studies of Renaissance Bronzes". As of 2015 Robert is also chair of NICAS (Netherlands Institute of Conservation, Art and Science), a new innovative multidisciplinary research center housed in the Rijksmuseum Conservation building, uniting art history, conservation and science.

Philipe Walter is director of research at CNRS and head of the Laboratory of molecular and structural archaeology (Sorbonne Université/CNRS) in Paris, France. He develops new instruments and analytical techniques adapted to the in situ and non-invasive study of ancient materials. His main research interests are focused on the use of analytical chemistry to understand the development of chemistry to create health and beauty products during Antiquity as well as pigments, binders and medium useful for the Old Masters. He is the holder of a PhD degree from Paul Sabatier University, Toulouse. Working at CNRS since 1995, he was the recipient of the CNRS silver medal in 2008 and the Grand Prix le Bel of the Société Chimique de France in 2017. He was appointed Professor at Collège de France for the academic year 2013-2014, holder of the Chair of Innovative Technology.

7

MICRO-SYMPOSIUM

DATA
DONNÉES

Friday 15 February 2019 11:00 > 11:20

Robert Erdmann

Senior Scientist, Rijksmuseum Amsterdam, The Netherlands and Professor, Institute of Physics and Department of Conservation and Restoration, University of Amsterdam.

The Big Picture: Data Fusion and Deep Analysis for Art Conservation and Technical Art History

Imaging in cultural heritage has increased dramatically in recent years, and the demand for extremely high-resolution and multi-modal images has increased along with it. Tens or even hundreds of images are collected for a single object, each of which may capture a specific region using a specific imaging modality. Neural network-assisted stitching and registration allows us to achieve subpixel accuracy across different image resolutions and across the full range of different imaging modalities – including visible photography, radiography, imaging spectroscopy, and topography – with results typically ranging from tens to hundreds of gigapixels. This process of high-precision data fusion results in a dataset for an object in which we can associate high-dimensional data with every pixel. By applying tools from machine learning, topological data analysis, and visualization, we can perform deep analyses of the data that are relevant for conservation and technical art history. Examples include canvas analysis, microstructural analysis, stratigraphic analyses of painting technique, comparisons of painterly style, and the analysis of iron-gall ink corrosion.

While these techniques allow us to dive deep into a single cultural heritage object, such analyses can benefit greatly from the ability to place an object into a larger context by "zooming out" to the scale of the entire oeuvre of an artist or to entire museum collections. Convolutional neural networks allow us to extract the semantics of an image at different levels of abstraction, from microstructural details up to the overall artistic composition of a work, and to use these analyses to perform semantic search or to construct semantic embeddings in which images of similar objects appear near each other.

The resulting analyses and registered imagery can then be explored using a variety of novel visualization strategies, each carefully designed to facilitate comparisons across scales, viewpoints, and wavelengths, with the ultimate goal of sparking meaningful insights. By utilizing open and standard web technologies, these strategies work across different browsers and devices, from mobile phones to dedicated desktop servers. Objects from the Rijksmuseum and the Bosch Project provide strong motivation for these techniques, including many works by Bosch, Rembrandt, Hercules Segers, and Vermeer.

Prior to earning his Ph.D. from the University of Arizona in 2006, Robert Erdmann started a science and engineering software company and worked extensively on computational materials science at Sandia National Laboratories. He subsequently joined the faculty at the University of Arizona in the Program in Applied Mathematics and the Department of Materials Science and Engineering as Assistant Professor and then Associate Professor, where he worked on multiscale material process modeling and image processing for cultural heritage. In 2014, he moved to Amsterdam to focus full-time on combining materials science and computer science to help the world access, understand, and preserve its cultural heritage. He is currently Senior Scientist at the Rijksmuseum, and he is Full Professor at the University of Amsterdam in the Institute of Physics and in department of Conservation and Restoration of Cultural Heritage.

Friday 15 February 2019 11:20 > 11:40

Paul Messier

Head of Lens Media Lab, Institute for the Preservation of Cultural Heritage, Yale University, New Haven, USA

Collections as datasets

Analytical tools and techniques are routinely employed to interrogate the physical and chemical properties of works of art and artifacts. Frequently, this work is focused on preservation - attempting to answer essential questions regarding the origin, detection, and possible remediation of deterioration. Characterization studies also can provide essential information on materials and techniques that illuminate the choices and intentions of makers. Deeply informative for a singular work of art or artifact, these data generally are not broadly collected across collections, mainly due to resource limitations of time and cost, but also stemming from problems regarding the repeatability and interoperability of methods across different collections. More fundamentally, however, is the simple fact that techniques derived from data science for the study and interpretation of material culture are new and unproven, making major investments in the creation of large cultural heritage datasets a speculative enterprise. Founded in 2015, the mission of the Lens Media Lab at Yale University is to test whether new approaches to humanities-based research questions, including social context, artistic intention, and authenticity can be addressed by approaching collections as datasets and, further, whether these new approaches can improve preservation practices. Case studies, mostly derived from research into the practices of individual photographers, show promise that meanings encoded into materials can be discovered through the assembly and interpretation of datasets using machine vision, signal processing, neural networks, and data visualization strategies, together with conventional statistical approaches. Preliminary research into the photographs of individual artists including F. Holland Day (1864-1933), August Sander (1876-1964), Man Ray (1890-1976), László Moholy-Nagy (1895-1946), Robert Mapplethorpe (1946-1989) demonstrate how data compiled from material references can form a baseline for understanding artistic practice. These results suggest that networked applications built on these approaches will provide researchers in the sciences and the humanities new tools for more nuanced and incisive interpretation.

Paul Messier is the founder and Pritzker Director of the Lens Media Lab at Yale's Institute for the Preservation of Cultural Heritage. Established in 2015, the focus of the LML is the creation, dissemination, and interpretation of large datasets derived from museum and reference collections of artist materials. Notable among these is the LML's collection of historic photographic papers which is the largest of its kind in the world and was assembled by Paul over the course of decades. The founder of three private companies dedicated to cultural heritage preservation, Paul has published widely, holds two patents covering innovative techniques for the characterization of cultural materials, served elected terms to the Board of Directors of the American Institute for Conservation, and recently completed a multiyear initiative to establish a department of photograph conservation at the State Hermitage Museum in Saint Petersburg, Russia funded by the Andrew W. Mellon foundation.

Friday 15 February 2019 11:40 > 12:00

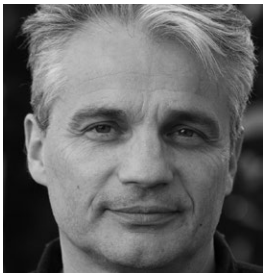
Patrice Abry

With H. Wendt, S. Jaffard, A. Klein, R. Johnson, P. Messier, J. Coddington and E. Hendriks

CNRS Research Director, Signaux, systèmes et physique, Laboratoire de physique (ENS Lyon, CNRS, Université Claude Bernard), Lyon, France

Image Processing for Art Investigations: 1- When B. Mandebrot meets V. van Gogh 2- When Wavelets meet Art Photographic Paper

In the past years, a growing interest has emerged for examining the potential of Image Processing tools to assist Art Investigations.
Capitalizing on recent experiences acquired in the conduction of two such scientific projects, the present contribution aims to report on potential interests, on achieved successes and on effective limitations in such interdisciplinary works.
The first work, conducted in collaboration with The van Gogh Museum, in Amsterdam, describes the use of multifractal analysis to assess and quantify Van Gogh's stylometry.
The second work, conducted in collaboration with the Museum of Modern Art, In New York City, reports on the use of anisotropic wavelet decompositions to cluster large collections of Art Photographic papers.



Patrice Abry was born in Bourg-en-Bresse, France in 1966. He received the degree of Professeur-Agrégé de Sciences Physiques, in 1989 at Ecole Normale Supérieure de Cachan and completed a PhD in Physics and Signal Processing, at Université Claude-Bernard University in Lyon in 1994. He is a CNRS Senior Scientist, at the Physics dept. of Ecole Normale Supérieure de Lyon, where he is in charge of the *Signal, systems and Physics* research team. Patrice Abry received the AFCET-MESR-CNRS prize for best PhD in Signal Processing for the years 93-94 and has been elected IEEE Fellow in 2011. He is the author of a book in French dedicated to wavelet, scale invariance and hydrodynamic turbulence and is also the coeditor of a book entitled "Scaling, Fractals and Wavelets" (ISTE). He has been elected IEEE fellow in 2011 and serve for the IEEE SPS Signal Processing Theory and Methods Committee. His current research interests include wavelet-based analysis and modeling of statistical scale-free dynamics (self-similarity, stable processes, multifractal, 1/f processes, long-range dependence, local regularity of processes, infinitely divisible cascades, departures from exact scale invariance...). Beyond theoretical developments and contributions in multifractal analysis and stochastic process design, Patrice Abry shows a strong interest into real-world applications, such as hydrodynamic turbulence, computer network teletraffic, Heart Rate Variability, neurosciences and art investigations.

Friday 15 February 2019 12:00 > 12:15

Chairs' Conclusions

David Donoho is Anne T. and Robert M. Bass Professor of Humanities and Sciences and Professor of Statistics at Stanford University. D. Donoho is a member of the American Academy of Arts and Sciences, the US National Academy of Sciences, and a Foreign Associate of the French Académie des Sciences. He has received a MacArthur Fellowship, and the Committee of Presidents of Statistical Societies Presidents' award. He was awarded the Norbert Wiener Prize of the American Mathematical Society and Society of Industrial and Applied Mathematics and the Gauss Prize of the International Mathematical Union and German Mathematical Society. He received the 2013 Shaw Prize in Mathematical Sciences.

Agnès Desolneux is director of research of the CNRS at the CMLA (Centre de Mathématiques et Leurs Applications) of the ENS Paris-Saclay. She is working in the field of mathematical methods for image processing, with a special interest in stochastic models. She is the co-author of two books: "From Gestalt theory to image analysis: a probabilistic approach", with Jean-Michel Morel and Lionel Moisan, and "Pattern Theory: the stochastics analysis of real-world signals" with David Mumford.

8

ROUND TABLE

WORKING IN HERITAGE SCIENCE

TABLE RONDE LES MÉTIERS DES PATRIMOINES

Friday 15 February 2019 13:45 > 14:00

Claire Barbillon

Director, École du Louvre, Paris, France

Pr Claire Barbillon has been director of the Ecole du Louvre since December 2017. She was professor of history of contemporary art at the University of Poitiers between 2014 and 2017. Her professional career was previously shared between museums and the university. Claire Barbillon is a specialist in the history of 19th century art, especially sculpture and historiography

Friday 15 February 2019 13:45 > 15:00

Panellists

Djillali Benouar is Professor of Earthquake Engineering and Disaster Risk Management at the Faculty of Civil Engineering and Director of Research at USTHB. He obtained his PhD at Imperial College, University of London (UK) and his Master degree at Stanford University, California (USA) and made his Postdoctoral studies at the University of Tokyo (Japan). He is a founding member of the Algerian Academy of Sciences and Technologies (AAST). He received two international awards for his research from UNESCO and Thomson Reuters. An award-winning teacher and mentor, he has acted as supervisor, co-supervisor, or advisor for over 40 Masters and PhD students. Publishing in English and French, he has published 45 publications in internationally reputed journals and has over 100 papers in international conferences. He is a member of the Integrated Research on Disaster Risk (IRDR) Science Committee, member of the Algerian Hazards Network (AHNet) and Coordinator of the Periperi U (Partners Enhancing Resilience to People Exposed to Risks) an African Consortium, composed of 12 African universities, which is an International Center of Excellence (ICoE) of the IRDR programme. He is member of several expert groups for disaster risk Reduction of the United Nations. He is active in advancing international research collaboration, including membership in several professional societies and organizations.

Dr. Sigrid Mirabaud is a conservation scientist, newly appointed resident scholar at the Institut national d'histoire de l'art, in the academic program History of art of the 14th to the 19th c. She was the head of the research laboratory at the national institute of cultural heritage, conservation department from 2012 to 2019, where she was especially in charge of the development of applied research. She participated in the elaboration of the Paris Seine graduate school Humanities, Creation and Heritage (ANR PIA3 2017), and was in charge of the practice-led PhD in conservation-restoration. She specializes in material science applied to cultural heritage painted objects. Her research focuses on the understanding of how materials are a major documentary source along with iconography, style and history to write the cultural biography of painted objects, from their creation to their re-enactment through time. She is the co-leader of a research project on the painting techniques in Christian Ethiopia (13th–18th c.)

Matija Strlic is Professor of Heritage Science at UCL Institute for Sustainable Heritage, of which he is the Deputy Director. In 2010, successfully established the successful MRs in Heritage Science and in 2014, the EPSRC Centre for Doctoral Training SEAHA, a collaborative effort between UCL, University of Oxford, University of Brighton, and more than 90 partners, a major international training initiative in heritage science. He is Fellow of the Royal Society of Chemistry, Fellow of the International Institute for Conservation, and recipient of the Ambassador of Science of the Republic of Slovenia Award for the outstanding achievements in science and international collaboration.

Friday 15 February 2019 15:00 > 15:15

Chairs' Conclusions

Denis Gratias is Emeritus Research Director of Research at the CNRS (Institut de recherche de Chimie-Paris) and former lecturer at the Ecole Polytechnique and the Ecole nationale supérieure de Chimie de Paris.
A specialist in materials science and crystallography, he has contributed to the discovery and description of quasicrystals, which were the subject of the 2011 Nobel Prize in Chemistry.
He was elected corresponding member of the Academy of Sciences in 1994 (Physics section).

Nicolas Grimal is an orientalist, professor of Egyptology. He was a lecturer (1970-1977), then assistant (1973) in Egyptology at the Sorbonne, agrégé de Lettres classiques (1971), doctor of oriental sciences (1976). Doctor of Arts and Human Sciences in 1984, he became Professor of Egyptology at the Sorbonne and Director of the Centre de Recherches égyptologiques de la Sorbonne (1988-2000). From 1989 to 1999, he was Director of the IFAO, from 1990 to 2005, Scientific Director of the Franco-Egyptian Centre for the Study of the Temples of Karnak and Co-Director of the UPR A1002 of the CNRS. From 1997 to 2000, he was scientific advisor to the Supreme Council of Antiquities of Egypt for the constitution of the collections of the Nubia Museum.
In 2000, he became professor of Egyptology at the Collège de France (chair of "Pharaonic civilization: archaeology, philology, history"). Elected in 2001 as a correspondent of the Académie des inscriptions et belles-lettres, he has been a full member since 2006. He was a member (1989-1999), then Secretary General (since 2014) of the Consultative Commission on French Excavations Abroad of the Ministry for Europe and foreing Affairs.
Nicolas Grimal is also a member of the Institute of Egypt (Cairo), the Deutsches archäologisches Institut (Berlin, correspondent), the Academy of Sciences of Vienna (Austria, correspondent), the French Society of Egyptology (Paris) and the Asian Society (Paris).

Michèle Gendreau-Massaloux PhD Dr, wrote her thesis on "Seneca in the Spanish literature of the Golden Age", and many books and articles on Mediterranean cultures and civilizations. Elected chairperson of the department of Spanish and Latin-American literature and civilization at the University of Limoges, she was, in 1981, appointed rector of the Academy of Orleans-Tours.
Technical adviser for education at the French Presidency of the Republic (1984-85), Deputy general secretary of the Presidency and spokesperson of the President (1985-1988), member of the French National commission for communication and freedoms – CNCL – (1988-89), she was rector of the Academy of Paris, chancellor of Universities between 1989 and 1998.
Appointed State Councilor in 1998, she was elected rector of the Agence Universitaire de la francophonie (AUF), a multilateral agency which associates more than 900 universities all around the world, which she ruled between 1999 and 2007. After that, she was in charge of training, higher education, research, health and culture in the French Mission for the Mediterranean (2008-2012) and Interministerial Delegation for the Mediterranean – Délégation interministérielle à la Méditerranée –, DiMed (2012-2015).
She is now Councilor of the Académie des Sciences de France, Vice-President in charge of institutional relations of the Inter-Academic Group for Development (GID).
Commandeur de l'Ordre national de la Légion d'honneur, Grand Officier de l'Ordre national du Mérite, Commandeur des Palmes Académiques.

9

MICRO-SYMPOSIUM

PALEONTOLOGY
PALÉONTOLOGIE

Friday 15 February 2019 15:45 > 16:05

Isabelle Kruta

Senior Lecturer, Centre de recherche sur la paléobiodiversité et les paléoenvironnements (MNHN, CNRS, Sorbonne Université), Paris, France

New lights on the clouded evolutionary history of cephalopods

One of the major topics of paleontology is the study of evolution of organisms and ecosystems and how it interplays with environmental changes. Technological advances in the last decades allowed a profound renewal of our knowledge of past organisms. For instance the increasing use of imagery techniques based on X-ray properties has provided high-resolution data on remains still preserved in the sediment, unravelling the morphology of delicate internal structures. As a consequence, the concept of exceptional preservation is also changing, questioning some protocols for fossil sampling and preparation used in the past. Good examples are recent advances made in cephalopod paleobiology. New data on the internal anatomy are slowly changing the perception of the ecological position of this group and the causes of their extinction or diversification. Cephalopods (Class including the extant squids, cuttlefishes and octopuses) are one of the major invertebrate fossil groups preserved in the fossil record. For example, the fossil group of ammonoids includes more than 20 000 species and the causes of their extinctions at the end of the Cretaceous are still debated. Knowledge on the anatomy and ecology is partial due to the rarity of soft tissue preservation in fossil cephalopods. A detailed 3D reconstruction of the feeding mechanisms provided for the first time clues that these animals were feeding on zooplankton suggesting a low position in the trophic web. Reassessment of collection material from an exceptional preservation sedimentary deposit of in the Jurassic of South-East of France also provides new exceptional data on preservation processes and the anatomy of a variety of groups including old octopod-relatives studied trough synchrotron microtomography (ESRF, ES 36). The data obtained on the limited collection material opens new scientific questions that can only be answered by the study of more material. More than ever, fieldwork remains therefore essential and decisive for the future of paleontology. Finally, these techniques go hand in hand with an ever-increasing quest for precision and resolution and generate large set of data, the storage and durability of which must be a concern for paleontologists community for their reuse.

Isabelle Kruta is an invertebrate palaeontologist researcher at the Centre de recherche sur la paleobiodiversité et les paléoenvironnements (CR2P, MNHN/SU/CNRS) and a lecturer at Sorbonne University in Paris since 2016. Prior to that, she completed her PhD in 2011 at the Muséum National d'Histoire Naturelle (Paris) and her postdoctoral activity included research at Yale University and the American Museum of Natural History (U.S.A.). Her work focuses on exceptional preservation in fossil cephalopods (the mollusc group including squids, octopuses and cuttlefishes) in order to reconstruct the paleobiology of these organisms and past trophic interactions, in particular in the Mesozoic. She applies a broad array of analytical methods from high-resolution 3D imaging to geochemical analyses based on field and collection resources.

Friday 15 February 2019 16:05 > 16:25

Ludovic Orlando

CNRS Research Director, Anthropobiologie Moléculaire et Imagerie de Synthèse (CNRS, Université Toulouse III Paul Sabatier), Toulouse, France, and Centre for GeoGenetics, Natural History Museum of Denmark, Copenhagen, Denmark

Ancient DNA: from ultrashort molecules to genomes, populations, species and communities

After more than three decades of research, ancient DNA has come of age and many thousands of ancient individuals have been sequenced at the genome-wide scale, both from human and non-human organisms. This wealth of genetic information allows the reconstruction of past population affinities at unprecedented detail, charting through space and time the history of population migration, contact, admixture and adaptation to novel environments. Beyond the sole genomes, epigenetic marks can also be reconstructed from subfossil material and tracked in the face of major cultural, social and environmental transitions. The recovery of DNA from microbes, especially pathogens, also opens for a deeper understanding of the origins of major infectious diseases, the genomic changes underlying virulence, and their impact on human history. Applied at the scale of communities, ancient DNA has started to reveal how our microbial self but also how plant and animal communities have responded to major environmental crises and other major evolutionary transitions. Even though a wealth of biochemical processes degrade DNA molecules post-mortem, its survival in ultrashort pieces offers a unique time travel machine into the last several hundred thousand years.

Ludovic Orlando is a former student from the Ecole Normale Supérieure of Lyon (ENS, 1996-2000), one of the top-5 French universities. First trained as a molecular biologist, he got increasingly interested in computational biology applied to DNA sequence data. He started his own research group in 2010 at the Centre for GeoGenetics, Univ. of Copenhagen, Denmark, where he has been appointed as a full Professor in Molecular Archaeology since 2016. He was appointed as a CNRS research director the same year. His group, the PALEOMIX group, develops integrative approaches in ancient DNA research, promoting the field of paleomics by the merger of biochemistry, molecular biology, genomics and computational biology. Ludovic is the Deputy Director of the Laboratory of Anthropo-Biology (CNRS UMR 5288), and the co-head of the CNRS AMADEUS LIA (International Associated Laboratory), which supports collaborative research programmes with the Centre for GeoGenetics, Univ. of Copenhagen, Denmark.

Friday 15 February 2019 16:25 > 16:45

Sophie Sanchez

Associate Senior Lecturer, Department of Organismal Biology, University of Uppsala, Sweden

Three-dimensional virtual bone histology: a new insight into the world of 370 million-year-old stem tetrapods

When did tetrapods move onto land? This evolutionary question has intrigued researchers for decades. To answer it, we need to dig into the fossil record dating from slightly less than 400 million years. Only a few remains of the earliest limbed stem tetrapods are present in museum collections worldwide. High-resolution synchrotron imaging therefore constitutes a unique tool for revealing the inner structure of this precious world heritage with no damage. Here I provide the first three-dimensional insight into the bone tissue of key taxa from the fish-to-tetrapod transition. In the framework of international collaborations, I could show the entire bone record of fins and limbs of stem tetrapods to reveal their life-history traits. Despite different ecologies and presumably distinct behaviours, the North-American lobe-finned fishes, *Eusthenopteron* and *Hyneria*, as well as the limbed stem tetrapod from the Devonian of Greenland, *Acanthostega*, exhibit a relatively late ossification onset of the appendicular skeleton and a long juvenile stage before reaching their sexual maturity. This seems to be a general character shared by the stem group of tetrapods. Such a developmental strategy has actual implications for the move of tetrapods onto land. The late ossification onset of *Acanthostega's* limb presumably prohibited the limb from sustaining the weight of the body out of the aquatic environment. The late onset of sexual maturity in *Acanthostega* suggests that no adult have been discovered so far. This implies for the first time that the environment in which the adults of *Acanthostega* were living was different from their offspring environment. In conclusion, three-dimensional virtual bone histology, based on propagation phase-contrast synchrotron microtomography, provides a first glimpse into the life-history traits of stem tetrapods and opens new directions for rethinking the move of tetrapods onto land.

Sophie Sanchez's research focuses on the application of innovative techniques to study fossil bone, including three-dimensional virtual bone palaeohistology, using synchrotron X-ray microtomography. These approaches not only allow the bone histology of rare and large fossils to be studied non-invasively, but virtual palaeohistology also provides the potential for studying hard tissues in three dimensions. She applied these techniques to her own investigations of the fish-tetrapod transition and muscular reconstructions in fossil vertebrates. By collaborations with her colleagues she also contributed to the development of new 3D models of hard-tissue arrangements among jawless, stem-jawed vertebrates and bony fishes.

Friday 15 February 2019 16:45 > 17:05

Emily Rayfield

Professor, Department of Earth Sciences, University of Bristol, The United Kingdom

Engineering analysis and the evolution of form and function in fossils

Animal form and function is dictated by the physical properties of the hard and soft tissues of the skeleton. In order to run at a certain speed, or bite with a particular force, the animal must be constructed in a particular fashion. We know from studies of living animals that form and function of the skeleton is intrinsically linked to the loads the skeleton experiences: increase or decrease loading and the skeleton changes shape accordingly. Because the laws of physics have not changed in deep time, we can apply these same physical principles to understanding the function of extinct animals, and in doing so construct testable hypotheses of function that allow us to better understand the behaviour and evolution of extinct animals. In this lecture I will discuss how a combination of computational methods such as computed tomography (CT) scanning and biomechanical principles and methods drawn from engineering structural analysis can be applied to understand the evolution of animals. I will discuss how these digital methods are reshaping how we conduct historical science, and I will focus on studies of feeding behaviour and skull evolution fossil animals. In particular, I will discuss how digital visualisation, reconstruction and biomechanical modelling allow us to test hypotheses of the evolution of the mammalian jaw joint. We find limited support for the idea that reorganisation of the jaw adductor muscles across the cynodont-mammaliaform transition limits loading at the jaw hinge. Previous theoretically derived hypotheses suggested relinquishing load at the jaw joint permitted the evolution of the unique mammalian quadrate-squamosal jaw hinge and the bones of the middle ear. Instead we find that miniaturisation plays an important role in the origin of mammals, with small mammals experiencing proportionately less stress at their jaw joint than larger mammals. This stress-reducing mechanism is proposed to be key to the origin of the mammalian jaw-joint and middle ear sound detection system.

Emily Rayfield is a Professor of Palaeobiology in the School of Earth Sciences at the University of Bristol, United Kingdom. She studies the function of living and extinct animals. In her lab, imaging methods such as X-ray CT are used to scan to digitise skeletons of fossils and living animals. Using biomechanical analysis, including the engineering technique finite element analysis (FEA) Emily Rayfield and her colleagues then work out how these skeletons function. From they can infer and estimate the function of living and extinct animals and explore the evolution of form and function, for example, in response to major environmental change and across evolutionary transitions.

Chairs' Conclusions

Dr. Philippe Janvier (born 1948) is currently emeritus Research Director at the CNRS and works in the Centre de Recherche en Paléontologie-Paris (CR2P) at the Muséum national d'Histoire naturelle, Paris. He is a specialist of the earliest known fishes and the evolutionary transition from jawless to jawed vertebrates, and he currently is particularly interested in exceptionally preserved soft tissues in early fishes. He notably described the first exceptionally preserved brain in a 310 million year-old shark relative. He also discovered the earliest complete vertebrate skeleton in 470 million year-old sediments of Bolivia. His book *Early Vertebrates* (1996) is a synthesis of the current knowledge on early vertebrate anatomy, interrelationships and evolution.

Isabelle Rouget is a palaeontologist, professor at Muséum National d'Histoire Naturelle at the Centre de Recherche sur la Paléobiodiversité de Paris. Her research focuses on macroevolutionary pattern and processes and uses fossils cephalopods as evolutionary model. Her earlier work, devoted to the reconstruction of the evolutionary relationship between ammonoids species, contributed to the renewal of phylogenetic analyses approaches in fossil cephalopods. She then explored anatomical characters with the objective of better understanding the biology of fossil species and participated to the first X-ray tomography of ammonites in collaboration with the ESRF (Grenoble). More recently, she has extended her studies to both modern and extinct cephalopods, with a comparative and integrative approach to analyse the functional morphology and adaptations of extinct species.

Jeremy Martin is a vertebrate palaeontologist recruited at CNRS in 2015 whose research activities range from systematics to paleoecology. His main research interests deal with the fossil record and the evolution of crocodylomorphs and involve fieldwork in France, Thailand and Senegal. Recently, he has focused his efforts on exploring the dietary preferences of extinct animals using non-traditional isotopes. Using the tooth or the bone object, Jeremy and collaborators extract and purify major constituents of bioapatite such as calcium or magnesium that may retain their initial isotopic composition through fossilization processes. Thanks to recent analytical developments in mass spectrometry, his team is now able to analyse small samples and report isotopic variability in precious fossil specimens. Their original approach offers perspectives to reconstructing modern and extinct trophic chains.

POSTER ABSTRACTS
RÉSUMÉS DES POSTERS

Sophie Cersoy[1], Ghizlène Daheur[1], Antoine Zazzo[2], Séverine Zirah[3], Michel Sablier[1]

[1] Centre de Recherche sur la Conservation (CRC), MNHN, Ministère de la Culture, CNRS, Paris, France
[2] Archéozoologie, archéobotanique : sociétés, pratiques et environnements (AASPE), MNHN, CNRS, Paris, France
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Using Py-GC×GC/MS as a new tool to assess the purity of ancient collagen prior to 14C dating

Exogenous carbonaceous contaminants coming from sediments significantly bias the radiocarbon date of collagen samples extracted from archaeological bone and teeth. We propose a new approach combining pyrolysis, comprehensive gas chromatography and mass spectrometry (Py-GC×GC/MS) to ensure their removal during the demineralization and collagen extraction. This method permitted to identify hydrocarbon contaminants for archaeological samples from the Neolithic period, in 30-40 kg of collagen. The use of GCxGC improved importantly the separation, selectivity and resolution compared to 1D GC thus permitting to detect organic contaminants within the complex chromatograms issued from collagen pyrolysis. Moreover, efficiency of the extraction steps in collagen sample preparation for radiocarbon dating (acid and alkali treatments, filtration steps) could be evaluated for four different protocols on the basis of organic contaminant removal. The extracted collagen of four of the tested protocols were radiocarbon dated on EchoMICADAS after graphitization with AGE 3 system. The significant shift obtained for one of protocol including a soft solubilization step and ultrafiltration, and corresponding to the lower level of detected contaminants in the chromatograms, corroborated the results of the Py GC×GC/MS data. These results open new perspectives for the use of comprehensive gas chromatography in the domain of archaeological sciences.

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Oxidation State Analysis and Phase Distribution in Ancient Chinese Ceramics using Full Field X-ray Absorption Spectroscopy

Since the 1950's, ancient ceramics are considered with particular interest among archeological materials. Changsha kiln is one of the pioneers to master the poly-color decoration technique at high temperature, which allowed the elaboration of lead-free colored glazes. Many studies involving synchrotron-based techniques were devoted to the blue color of ceramics from the Tang dynasty, but important questions on the chromogenic mechanisms are still unresolved. The elemental composition, the size of oxide particles and their spatial distribution are thought to influence the chromatic variation. Full-field XANES (FF-XANES) technique at Fe and Cu K-edge will be employed in parallel with μ-XRF at PUMA beamline to speedily determine the Fe and Cu speciation and the elemental distribution of large areas including glaze and body. A correlative imaging methodology will be developped to process data and uncover hidden information in the spatial and spectral space. This study will help to better understand the manufacturing processes of porcelains related to Changsha kiln and to gain a better idea about pigments provenance and trading contact across the world.

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Nanoscale investigation of body-glaze interface in ancient ceramics

Several interactions occur between glaze and body during the firing of glazed ceramics. These interactions lead to the formation of an *interface area* containing cristallines species whose morphology, chemistry and structure can give information on the firing parameters. By making replicas with different firing conditions and compare their interface to those of archaeological samples, we can approach the firing method used by the artist. Here we focus on Bernard Palissy glazed ceramics (16th century) which combine mechanical perfection (no cracking, remarkable interfacial cohesion) with aesthetic quality (wide range of colors). As the interface area presents nanoscale heterogeneities, scanning electron microscopy (SEM) and transmission electron microscopy (TEM) coupled to X-ray energy dispersive spectroscopy (EDX) and selection area electron diffraction (SAED) have been used to characterize the species properties at the sub-micron and nano-scales.

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Evaluation of ferrous alloys qualities by a diachronic and statistical approach: an original semi-automatic algorithm to estimate carbon content by image analysis

From Antiquity to Middle Age, ferrous alloy qualities have been constantly evolving and motivate a thorough study of archeo-metallurgical products. The variability of ferrous alloys semi-products qualities can be estimated by microhardness and tensile strength measurements and microscopic observations. Indeed, average carbon concentration (AC) has been proposed as a measure of quality in the literature (see, e.g., Leroy et al. 2017, Pagès 2008) to classify samples into groups of similar quality according to the nature of the metal.

Yet, to the best of our knowledge, AC estimation from microscope images relied on a manual procedure that was cumbersome and time-consuming. Thus, the study of the quality of a large corpus of ferrous alloy was nearly impossible. This paper proposes a semi-automatic image analysis algorithm to study ferrous alloy qualities in a reproducible and reliable way. Combining pre and post nital-etching images, the algorithm is not only able to estimate the AC but also a carbon and inclusions maps of distributions.

The algorithm guarantees a faster and more reproducible estimation of carbon concentration that allows us to study the quality of a large corpus of ferrous alloys samples among and inside three main sites in France.

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Kunsthistorisches Museum, Vienna, Austria

Application of neutron-based analytical techniques for studying the manufacturing technique and corrosion of high leaded antique bronze coins

Within a research project 1,200 selected ancient Greek bronze coins from the Coin Cabinet of the Kunsthistorisches Museum Vienna (KHM) were studied concerning their state of preservation and manufacturing technique. The coins had been minted during the Roman imperial time (50 to 280 AD) using alloys with high lead and/or tin contents. As a result of their burial followed by unfavourable storage conditions, a number of them show progressive whitish corrosion.

Different analytical techniques were used for the documentation and study of the corrosion phenomena. The bulk composition of a selected number of objects was investigated by non-destructive neutron diffraction (Rutherford Appleton Laboratory, ISIS, UK) and the presence of lead rich inclusions in a copper rich matrix within the bulk of the objects by applying neutron radiography and tomography studies (Paul Scherrer Institute, CH).

Continuative studies focused on the analysis of the corrosion phases as well as on the manufacturing techniques of the antique Greek coins. To enable the distinction between different manufacturing techniques – either cast only or cast and minted –, about 20 coins were analysed by bulk neutron texture analysis. Detected changes in the microcrystalline structure of the alloys were related to the mechanical minting processes.

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Recovering bone proteins in arid environments using palaeoproteomics

The timing and routes of diffusion of domestic caprines through the African continent are still poorly documented. This is partly due to the highly fragmented nature of the bone remains which often limits their determination on a morphological basis. Bone diagenesis also affects the preservation of biomolecules, especially DNA. Long term survival of proteins has previously been reported in fossil hominid sites from Tanzania highlighting the potential of paleoproteomics to reconstruct the scenario of diffusion of domestic caprines through the continent.

We report the use of palaeoproteomics on archaeological bones from the Later Stone Age sites of Toteng (Botswana) and Leopard Cave (Namibia). These sites were selected because they are considered as providing the first evidence of caprines in Austral Africa. Teeth and bones of small ungulates identified as caprines (*Ovis aries and Capra hircus*) as well as unidentified bone fragments were selected. Preservation of the organic phase was assessed using FT-IR. Different protocols were tested in order to extract structural proteins prior to their characterization. Sequences were identified with an UHPLC-ESI-MS/MS and assigned to the corresponding species thus allowing to ascertain the presence (or absence) of caprines in these sites.

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Domestication of South American Camelids: new Archaeological investigations

Archaeological evidence suggests that South American Camelids (SAC), llamas (Lama glama) and alpacas (Vicugna pacos), were domesticated from potential wild ancestors, guanacos (Lama guanacoe) and vicuñas (Vicugna vicugna), around 6000 years ago in the Andes. However, their domestication process is still poorly understood with two competing hypotheses. The first consider that both Llamas and Alpacas have been domesticated from guanacos while the second consider that llamas derived from guanacos an alpacas from vicuñas. We first investigated how much tooth morphology could contribute to identify the taxonomic diversity of SAC using 2D Geometric morphometrics (GMM) of teeth. This approach proved unable to distinguish current wild and domestic taxa. However, we found a great divergence between the archaeological and modern variation of SAC, suggesting that the camelids Prehispanic diversity could not be explored using modern SAC as comparatives.
To bring new insights into the SAC domestication process, my PhD research project will focus on the unique site of Telarmachay (Peru) where evidence of a domestication process, 2000 years before the rest of Andean area, has been proposed. We will use a multidisciplinary approach combining 3D geometrics morphometrics on post-cranial bones and isotopics geochesmistry analyses to test the two domestications hypotheses.

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Synchrotron-Based Phase Mapping in Corroded Metals: Insights from Early Copper-Base Artifacts

The detailed description of corrosion processes in ancient and historical metal artifacts currently relies on the in-depth study of prepared cross sections. The in-plane elemental and phase distributions can be established from a combination of light and electron microscopy characterization. Here, we show that high-resolution virtual sectioning through synchrotron X-ray microcomputed tomography allows a precise noninvasive 3D description of the distribution of both internal and external mineral phases in whole objects. In fragments of early copper artifacts (third–second millennium BC) from Southern Mesopotamia and the Indus valley, this approach provided essential clues on long-term corrosion processes. Major and minor phases were identified through semiquantitative evaluation of attenuation coefficients using polychromatic X-ray illumination. We found evidence for initially unidentified phases through statistical processing of images. We discuss interpretation of the distribution of these phases. A good correlation between the corrosion phases identified by CT and by invasive BSE-SEM is demonstrated. In addition to the stratigraphy of the copper corrosion compounds, we examine and discuss the variations observed in the attenuation coefficients of Cu(I) phases. Semiquantitative synchrotron X-ray microtomography phase mapping requires no specific sample preparation, in particular polishing or surface finishing, and any material tearing or displacement is avoided.

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Multi-analytical approach to the characterisation of mortars from Roman mosaics: a case-study from Conimbriga, Portugal

The *cubiculum's* mosaic in the House of Trident and Sword, excavated between 2008 and 2010, is a black and white mosaic, set on four *strata* of lime-based mortars with different features. The main panel underwent no intervention since that date, except mechanical cleaning of *tesselatum* and reburial with geotextile and excavated soil for protection. This enabled a multi-analytical study, resulting in the extensive characterisation of original, naturally aged, Roman mosaics components — mortars and tesserae. This work will focus on mosaic's mortars, analysed by X-ray diffraction (XRD), optical microscopy (OM), Ion Beam Analysis (IBA) and scanning electron microscopy with energy dispersive spectroscopy (SEM-EDS).

These mortars were typically produced by mixing lime, sand and crushed ceramics and XRD results indicate calcite and quartz as the main crystalline phases present in the samples, corroborated by OM results. Further results using IBA and SEM-EDS for chemical and morphological analysis of the different mortars components will be shown to ascertain the conditions of these materials in an attempt to better understand this historical legacy and to promote good practices in future conservation approaches of this historical site.

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Close to the bone object. Microscopy and imaging. Department Maison Archéologie & Ethnologie, René-Ginouvès (Nanterre – France)

In Europe, the golden age of stained glass windows was during medieval times, when religious buildings were built. Stained glass windows have passed through the centuries exposed to the atmosphere and have been altered over time. This presented PhD work aimed to study the alteration of these glasses to better understand the mechanisms and determine the associated kinetics to explain their aging taking into account the different phases of the atmosphere (rain and water vapor). Laboratory experiments were carried out on model glasses and on ancient stained-glass windows (14th century), in water-saturated and unsaturated environments. Isotopic tracers (D, 18O, 29Si) added to the altering medium allowed to trace these elements and determine the different involved processes. Long-term alteration experiments have shown that there was no protective character developed by the altered layer due to its fractured morphology. The mechanisms and their associated kinetic parameters determined from the experiments were implemented in a geochemical model (HYTEC software). Coupling the experimental and modelling results allowed simulating the evolution of the alteration depth of this type of glass.

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Light ageing of discoloured manganese stained glass from uppsala cathedral

During the conservation of Sweden's largest church window, questions were raised about the type of protective glass that should be installed. Some of the stained and painted glass pieces were noticeably discoloured and the concern was that the discolouration would continue if not appropriately protected from sunlight.

In the laboratory, the "browning" of the stained glass from Uppsala Cathedral was confirmed, by non-destructive μXRF, to be due to manganese dioxide. The discolouration process on one of the original glass pieces was followed spectrophotometrically on small areas exposed to accelerated light ageing including high UV. An area previously shielded by synthetic mastic and the lug bar (which secures the panel in the window), showed that the "original" colour changed from pink to the same brown as was seen all over the piece. Both the "original" and the "naturally aged" areas continued to change colour, but significantly slower and, although measurable, the additional colour change was not observable by eye.

Subsequently, it was decided to install one of the more aesthetic protective glasses, slumped float glass with a thin wash, rather than the more expensive option of a full UV protective glass.

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Investigation on the drying of oils used in paintings by LB monolayers and RMN-Mouse

In order to enhance the siccativity of their oils, painters used numerous additives. One of the most popular was litharge, of chemical composition PbO. The action of lead as drying agent is not fully understood yet. In this study, a multi-analytical approach is proposed to investigate the influence of lead on the drying of oils thanks to the analysis of model and real films.
To model the paint layer, we studied Langmuir-Blodgett monolayers of different C18 triglycerids at the air-water interface. Isotherms evolution, AFM observations and X-ray diffraction analysis at SOLEIL synchrotron, brought a better comprehension of saturated triglycerids organization. The pressure at the surface of unsaturated triglycerid monolayer showed an important increase when let at the air. It can find its explanation in the reaction between unsaturations and atmospheric oxygen that was checked by FTIR. Besides, the addition of Pb^{2+} in the sublayer induces an increase of the kinetic of reaction.
Besides, different 90um films of oils mixed with lead were prepared and their drying followed by NMR Mouse in parallel with infrared spectroscopy, in order to compare the influence on the film rheology. We evaluate the possibility to use relaxation time measurements to probe paint films ageing.

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Degradation of historical parchment and leather: a multi-analytical approach

A multi-analytical approach based on micro-destructive and non-destructive techniques was used to effectively assess degradation in parchment documents and leather artefacts. The evaluation of degradation in such materials is challenging due to the hierarchical structure of collagen. In addition, old parchments are constituted of various collagen populations with distinct thermal stability, from native collagen to gelatin, while leathers are even more complex materials constituted of tanned collagen, untanned collagen and gelatin [1]. As leather properties and damage behaviour highly depend on the interaction between collagen and tannins [2], tannin type identification is of great interest, too. This can be performed either by FTIR [3] or by 13C solid state NMR [4]. The multi-analytical protocol used for damage assessment includes complementary techniques for characterizing thermal stability of collagen (imageMHT method) [5], its heterogeneity (DSC) [6] and structural modifications (13C CP/MAS NMR and NMR MOUSE) [2,7] as well as alterations of secondary structure of collagen and presence of groups/compounds formed during degradation or added on manufacturing (FTIR) [8]. Evidences of different degradation patterns have been found and illustrated for various case studies. The results allowed us to further understand the degradation mechanism and structure of collagen in old parchment and leather.

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Claire Betelu, Aurélie Nicolaus, William Whitney

Université Panthéon-Sorbonne

Palette: A databased dedicated to the colour making process and material evolution

Palette, a free access database, has been created in order to valorise twenty years of research carried out by students registered in the conservation program of the University Paris 1 Panthéon-Sorbonne. Palette is dedicated to artistic painting technology with a focus on the colour making process and material evolution. The database is structured in three main categories: "One colour, one painting"; "One process, one painting", "One evolution, one painting". In the first category the user selects a colour and a painting. Information is shown considering the artists history, production context and scientific documentation available. A possible identification of the nature of the pigment is given as well as a recipe extracted from contemporary technical literature and a colour recipe reconstitution. Colour contemporary literature mentions are referenced in order to get familiar with the artistic context. The same is done for the two other categories; "One process, one painting", "One evolution, one painting". This initiative makes aware of art technology methodology research. Physics and chemistry analysis, macroscopy and microscopy observation and the study of historical written sources are used. Palette-database opens it up to a larger public.

Ilenia Cassan, Estelle Itié

Art in Lab, Paris, France

Scientific Imagery of Delacroix "Christ in the Garden of Olives"

The exhibition "Delacroix" held at the Louvre in 2018 was the opportunity to undertake a major campaign to restore the "Christ in the Garden of Olives" preserved in Saint Paul Saint Louis Church in Paris. This very large work has had a turbulent history. The experimental techniques used by Delacroix have had an impact on its conservation. Delacroix himself undertook a restoration of this painting in 1855. The "service de la Conservation des Oeuvres d'Art Religieuses et Civiles" of Paris (COARC) has set up an interdisciplinary committee of curators, historians, restorers and laboratories in order to carry out this restoration. Our intervention consisted in producing images including Infrared Reflectography, Ultraviolet Fluorescence photographs and oblique light photography. These images were used to answer the questions raised by the restorers and to evaluate the materiality and the state of this painting, but they were also useful to all to understand the technique used by the artist.

The outsized dimensions of this painting and the personality of the artist make this work an interesting case study that argues in favor of interdisciplinarity.

Alessia Coccato, Luciana Mantovani, Romano Ferrari, Danilo Bersani, Mario Tribaudino, Pier Paolo Lottici

Association Pour le Patrimoine d'Italie

A masterpiece of Romanesque sculpture in the Church of Saint-Germain-en-Laye (France)? Materials characterization to solve a 20th c. mystery

In the church of Saint-Germain-en-Laye, a mastic-incrustation *haut-relief* representing the Deposition from the Cross is exposed. This sculpture resembles closely the Deposition from the Cross in the transept of Parma Cathedral, dated 1178 and "signed" by Benedetto Antelami. However, the St-Germain Deposition appeared in 1994, when it was donated to the parish. The exact circumstances of the arrival of the sculpture in France are not known, neither are the context and reasons to duplicate a 12th c. masterpiece. Art historical considerations point to either a 12th-13th century manufacture, or a 19th-20th century one. Material characterisation was performed on samples. A multi-analytical approach based on molecular fingerprinting techniques (X-ray powder diffraction, micro-Raman spectroscopy, Fourier-transform infrared spectroscopy) allowed the characterisation of the rock, as well as the identification of traditional and synthetic pigments in the red and black mastics. The presence of a lithol red pigment, patented in 1899, in the red mastic, supports the 19th-20th century hypothesis, and better defines further researches on the genesis of this Deposition.

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Interdisciplinary and non-invasive approach to building pathology diagnosis in a historical masonry structure

This paper centres on the investigations carried out prior to the restoration of the 19th century St Paul's Anglican pro-Cathedral, Malta. Initial works focused around the 67m tall bell tower due to visible signs of advanced deterioration. The paper presents the methodology adopted to identify the possible causes of severe building pathology, and the results and possible limitations of this approach. Following initial historical research, a building survey was commissioned for an accurate recording of the building state of conservation. Architectural surfaces were mapped, and the processes of deterioration were recorded on drawings and photographs, documenting the structural condition of the historical fabric. Crack patterns were mapped out to assess the local and global cracking mechanisms. Further analysis of historical bills of quantities which indicated the possible presence of chain-bond, focused on structural and construction elements. Guided by this information and by the observed structural movement, a non-invasive method using ground penetrating radar at different frequencies and endoscopy was adopted to verify historical data and possibly identify and characterise the chains at the locations of visible movement. Correlation of both sets of data allowed for a more accurate understanding of the deterioration mechanisms and accordingly to chart remedial intervention.

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Macro and micro dynamics of tempera paint with green earth

The *tempera* technique consists of mixing egg yolk with pigments, was widespread during the Middle Ages. Although oil has been widely adopted during the Renaissance period, egg has been still used by some painters, The *tempera* painting method formulates fast-drying media with paste-like consistency which adds matte aspects to oil technique.
The present study focuses on the dynamic properties of model formulations based on ancient recipes in order to find out the motivation and the benefits of this painting technique for the artists. Rheology measurements give the macroscopic characteristics of the paint and the water dynamics is followed by proton NMR relaxometry on a much smaller scale.
The studied pigments are green earths mostly composed of micas dispersed either in water or egg yolk according to the artists' recipes. Preliminary results show that the material is viscoelastic. Its dynamic properties are correlated to the pigment volume fraction. The addition of egg yolk to the formulation leads to an increase of the viscoelastic properties of the material while the water dynamics evolve in the opposite trend with the increase of pigment content. These results suggest a high structuration of the binder and the pigment caused by the addition of egg yolk.

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A synchrotron photoluminescence microscopy study into the use and degradation of zinc white in 'The Woodcutters' by Bart van der Leck

Bart van der Leck (1876-1958) – member and co-founder of artistic movement De Stijl – was one of the pioneers of abstract art in The Netherlands. He is well-known for his color plane compositions on monochrome white backgrounds. The Woodcutters (1928, oil on canvas) is representative of his style as it had developed from 1919 onwards, when Van der Leck was moving away from highly abstracted forms to compositions in which the subject is more recognizable. In a recent technical study, it was noticed how the white background in The Woodcutters – when illuminated with ultraviolet light – displayed three distinctly different intensities of green luminescence. This observation raised the question whether photoluminescence could be used to gain insight into the painting process and paint degradation. In this study it is shown how deep-UV photoluminescence micro-imaging, combined with newly developed computational methodology, could be used to differentiate between zinc whites from different sources, hereby explaining the distinct luminescence behavior of The Woodcutters at the macroscale. Variations in the thickness of a degradative surface layer in paint regions comprising different types of zinc white suggests a correlation between crystal defects in zinc white and its reactivity towards atmospheric contaminants.

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Novel approach to restoration of paper cultural heritages

Damaged paper cultural heritages require reinforcement and restoration to prevent further damages. In addition, the missing parts of paper heritages need to be composited to sustain their original shape and structure. We propose cellulose nanofibers and 3D printing for the reliable and reproducible approach to restoration of damaged paper. The missing part of paper was scanned and converted to 3D printable digital data files. Then, the 3D molds were printed with several polymeric materials including polycarbonate, poly(lactic acid), acrylonitrile butadiene styrene and polystyrene using fused deposition modeling mode. The reproduction of missing paper part was performed by filling the molds with the suspension of pulp fibers. The nanofibrillation of pulp cellulose was controlled by the pass number through the mechanical grinder and the prepared cellulose nanofibers showed a high aspect ratio of ultrafine structures. The morphological properties of cellulose nanofibers were observed with electron microscopy and the rheological properties were characterized with viscometry. The cellulose nanofibers functioned as a reinforcing and adhesive material during the restoration process and enabled the effective restoration of damaged paper minimizing the deformation or contamination of original paper.

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Spectroscopic Studies of a Cellulose-Based Nanoparticle Treatment for Organic-Based Artefacts of the Mary Rose

The *Mary Rose* is a Tudor warship, which sank in 1545 off the south coast of England. It was raised in 1982 with over 19,000 artefacts. In marine archaeological wood, the major degradation pathway is through sulfur species, where reduced sulfur compounds oxidise upon raising the ship to form sulfate salts and sulfuric acid. This hydrolyses cellulose and iron from ship fixtures can catalyse this process.

A conservation treatment that neutralises sulfuric acid and removes iron sulfate is essential to prevent degradation of the organic-based artefacts from the ship. In this work, SrCO3 cellulose patches were applied to iron sulfate soaked oak cubes. After removal, the patches and the wood were analysed by S and Fe K-edge X-ray Absorption Near Edge Structure (XANES), FTIR, Raman, and XRF spectroscopy. The results-reveal that these SrCO3 cellulose patches have the potential as a spot conservation treatment for marine archaeological wood.

This project further encompasses the characterisation of rope, wool, leather, and sail cloth from the *Mary Rose* as well as reference fibres. The materials are characterised using optical microscopy, portable XRF, and polarised ATR-FTIR. This will influence the development of future conservation treatments for marine archaeological organic artefacts.

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Synthesis and characterization of an historical hybrid gel used by oil painters

For centuries painters have been experimenting with paint formulae and adjusting consistencies according to the effects they expected. During the 19th century, British painters prepared a particular medium composed of siccative oil, mastic resin and lead acetate. The so-called "gumtions" form gel-like materials in a relatively short time.

The thorough study of the chemical interactions occurring during the formation of "gumtion" improves the knowledge of the gel behaviour, and in particular the chemical processes involved in its formation, drying and ageing. Its characterisation is therefore crucial for the conservation of works of art.

As a first step, reconstructions of various recipes were made and their rheological properties have been highlighted, as well as their lamellar organisation at the mesoscopic scale. The second approach has consisted in the synthesis of simplified formulations to deepen the understanding of the chemical interactions between the gel components. These new formulae termed as "model systems" contain oleanolic acid (commercial triterpenoid) and a lead compound (acetate or oxide). They are investigated at different scales by spectroscopic (FTIR, MAS-NMR) and structural analyses (Cryo-TEM, SAXS). The use of these complementary techniques gives an overview of the gel's structure and formation.

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Talens Oil paints - use of synthetic organic pigments before 1950 according to recipes and non-destructive analysis

The introduction of synthetic organic pigments around 1900 led to new applications as imitations of traditional pigments, or for new bright hues in artists' paint. Therefore, investigation and identification of these pigments is an important subject within the field of heritage science, to answer questions of authenticity and advance conservation of art from this era. The Dutch paint manufacturer *Talens & Co* (now *Royal Talens*) started the production of Rembrandt Olieverven in 1904 in Apeldoorn, and much of the company's historical archive still remains. *Talens* is a world-wide distributer of artist material, and artists such as Karel Appel and Ernst Ludwig Kirchner are known to have used *Talens* oil paint. This poster will present the production history of a selection of synthetic organic pigments, their application by *Talens* and the instrumental analysis results. This is based on the research of more than 3000 of *Talens*' original production recipes for artist oil paint from 1922-1950, in combination with non-destructive analysis of original oil paint samples with micro-Raman spectroscopy and X-Ray Fluorescence Spectroscopy. In this way, the pigments are set into time periods of use and visualise *Talens*' application of synthetic organic pigments.

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Alteration mechanisms and kinetics of stained glass windows in atmospheric medium

In Europe, the golden age of stained glass windows was during medieval times, when religious buildings were built. Stained glass windows have passed through the centuries exposed to the atmosphere and have been altered over time. This presented PhD work aimed to study the alteration of these glasses to better understand the mechanisms and determine the associated kinetics to explain their aging taking into account the different phases of the atmosphere (rain and water vapor). Laboratory experiments were carried out on model glasses and on ancient stained-glass windows (14th century), in water-saturated and unsaturated environments. Isotopic tracers (D, ^{18}O, ^{29}Si) added to the altering medium allowed to trace these elements and determine the different involved processes. Long-term alteration experiments have shown that there was no protective character developed by the altered layer due to its fractured morphology. The mechanisms and their associated kinetic parameters determined from the experiments were implemented in a geochemical model (HYTEC software). Coupling the experimental and modelling results allowed simulating the evolution of the alteration depth of this type of glass.

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Evaluation of analytical approaches for the characterization synthetic organic pigments

The rapid advances made In the field of color chemistry during the late 19th and early 20th centuries produced countless synthetic organic pigments (SOPs) to be incorporated into artists' materials. Thus, the development of the pigment industry—its innovations and successes, as well as its experiments and failures—are contained within paintings produced during this era. Identification of the SOPs within these paint samples has consequences for art history, conservation, and preservation. Of the several technologies employed by today's scientists for SOP identification, microRaman spectroscopy, pyrolysis gas chromatography/mass spectrometry (PyGC-MS), and ultra-high pressure liquid chromatography/diode array detection (UPLC-DAD) are especially well-suited. However, depending on the technique implemented, one's analysis could lead to considerably different answers, depending on variables such as sample complexity, pigment class and functionalities, means of detection, and other instrumentation biases. This study takes an in-depth look at the discrepancies in SOP detection and identification by applying all three analytical approaches to a range of SOPs from 1920-1950, several of which have not yet been characterized in the literature. The shortcomings and advantages of each method are addressed, and suggestions are made for selecting micro-destructive techniques for SOP analysis.

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Understanding the browning phenomenon of medieval stained-glass windows: impact of bacteria and bacterial exudates on the dissolution of a Mn-bearing glass

While the browning of stained-glass windows is a well-known pathology, the mechanisms responsible for this phenomenon are not understood yet. Previous studies revealed enrichment in Mn in the browned areas and some of them have suggested that manganese migration to the surface, oxidation and/or precipitation might be linked to biological activity. In order to improve our understanding of this phenomenon and investigate the direct and indirect implication of microorganisms, weathering experiments of a model glass representative of medieval stained glasses were designed. Dissolution experiments in presence of bacterial exudates (oxalic acid, siderophore DFOB) and/or bacteria (model strains) were conducted in biotic and abiotic reactors in different experimental conditions. The leachates were periodically sampled and the release of elements from the glass was quantified by ICP-OES. The results show that the presence of bacteria and bacterial exudates modifies the dissolution mechanisms and kinetics, increasing dissolution rates and changing dissolution stoichiometry. This highlights that a biological activity could be involved in the solubilisation of Mn in a Mn-bearing glass, which is the first step of the appearance of the browning phenomenon.

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When Van Gogh meets Mandelbrot: Multifractal classification of painting's texture

Recently, a growing interest has emerged for examining the potential of Image Processing tools to assist Art Investigation. Simultaneously, several research works showed the interest of using multifractal analysis for the description of homogeneous textures in images. In this context, the goal of the present contribution is to study the benefits of using the wavelet leader based multifractal formalism to characterize paintings. After a brief review of the underlying key theoretical concepts, methods and tools, two sets of digitized paintings are analyzed. The first one, the Princeton Experiment, consists of a set of seven paintings and their replicas, made by the same artist. It enables examination of the potential of multifractal analysis in forgery detection. The second one is composed of paintings by Van Gogh and contemporaries, made available by the Van Gogh and Kröller-Müller Museums (Netherlands) in the frame work of the Image processing for Art Investigation research program. It enables us to show various differences in the regularity of textures of Van Gogh's paintings from different periods, or between Van Gogh's and contemporaries' paintings. These preliminary results plead for the constitution of inter-disciplinary research teams consisting of experts in art, image processing, mathematics and computer sciences

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Multiscale Anisotropic Texture Analysis and Classification of Photographic Prints

Texture characterization of photographic prints can provide scholars with valuable information regarding photographers' aesthetic intentions and working practices. Texture assessment is strictly based on the visual acuity of a range of scholars associated with collecting institutions, such as museum curators and conservators. Natural inter-individual discrepancies, intra-individual variability, and the large size of collections present a pressing need for computerized and automated solutions for the texture characterization and classification of photographic prints.

In the present contribution, this challenging image processing task is addressed using an anisotropic multiscale representation of texture, the Hyperbolic Wavelet Transform, from which robust multiscale features are constructed. Cepstral distances aimed at ensuring balanced multiscale contributions are computed between pairs of images. The resulting large-size affinity matrix is then clustered using spectral clustering, followed by a ward-linkage procedure.

For proof of concept, these procedures are first applied to a reference dataset of historic photographic papers that combine several levels of similarity, and second to a large dataset of culturally valuable photographic prints held by the Museum of Modern Art in New York. The characterization and clustering results are interpreted in collaboration with art scholars with an aim toward developing new modes of art historical research and humanities-based collaboration.

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Archeology research databases : how are the user communities articulated?

As open science develops, the acceptability of databases in archeology is problematic. Using the methods of socio-anthropology, the purpose of this study is to understand the structuring of research communities, in terms of discipline, profession, designer and user that revolve around these databases and the acceptability factors that flow from it. These interactions generate frictions, which results in conflicts, negotiations, and collaborations between the different actors, thus allowing the production of new knowledge. The ethnographic study focuses on the design of four database projects on ancient materials in a unit of specialists. Interviews and observations are conducted in the different communities, and grapho-numeric objects, understood as intermediate objects, are also collected. At this point, we found that interdisciplinary collaborations were less important after the creation of the database. If the database delimits the action of its users, the sharing of data depends on individual wishes. We observed that the dialogue between engineers and researchers is considered a key element and that the transmission of skills is partial. There is no simple reproducibility when creating a search database. It is therefore difficult to predict its acceptability. Financing remains, however, the crucial point for ensuring the sustainability and development of a database.

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Ab initio study of Silver chloride: Becquerel's photochromatic photography

Silver chloride has been widely used in photographic process, thanks to its sensitivity to visible light and its capacity to form latent images. It was at the heart of the works of Edmond Becquerel for the photovoltaic effect and the first color photographic process. This photographic process is still mysterious as no clear explanation for how this process work is available. More recently, this material gained interest also as a photocatalyst.

In the present work, we have calculated and analyzed the optical and dielectric properties of bulk silver chloride from first principles.

We report here the calculated absorption and Electron Energy Loss spectra for a perfect crystal of silver chloride. The calculations have been carried out within Time Dependent Density Functional Theory using the Adiabatic Local Density Approximation, as implemented in the DP code and in the framework of the GW approximation and the Bethe-Salpeter equation using Ab initio code for spectroscopy. We compare our results with recent experimental spectra obtained by the Centre de Recherche sur la Conservation with which we collaborate on elucidating the mechanisms that might explain the color photochromatic images of Edmond Becquerel.

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Toward perennial archival media: the legacy of GIS-SPADON

Created in 2004 at the request of the French Ministry of Culture, the Scientific Interest Grouping GIS-DON, which became GIS-SPADON in 2012, has until 2017 devoted its activity to develop a perennial medium for archiving data that could take over the role of paper for the "Archive and Forget" process. Composed of scientists from some of the leading French laboratories in Chemistry, Optics, Electronics and Signal Processing, it has organized regular meetings, published specific reports, and issued recommendations, all of which are available at https://www.lne.fr/fr/projets/gis-spadon Most notably, under the leadership of the former chairperson of its Scientific Committee, GIS-DON captured the attention of the French Academies of Sciences and Technology that issued a warning in 2010, "Longevity of Digital Information", that recommended the development of new media for perennial preservation of digital data. The poster focuses on the realizations of GIS-(SPA)DON in the decade 2005-2015 concerning the longevity of CD and DVD, including studies of the mechanisms responsible for their decay, and on some technological watch concerning possible media for the future.

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Neutrons for Heritage Science at the Budapest Neutron Centre

The application of various analytical methods based on neutrons for investigating archaeological artefacts has long tradition at the Budapest Neutron Centre. Dating back to the 1990's our cooperation network has been gradually built by participating in national and international heritage projects. Nuclear reactions initiated by high penetrating neutrons are used to explore the composition and structure of the heritage objects without destruction. Typical research tasks are aimed to answer questions regarding the identification of workshops or manufacturing techniques, provenance or authenticity of an object.

In this study we introduce our neutron based instruments which contribute to heritage science, i.e. Prompt Gamma Activation Analysis, Small Angle Neutron Scattering, Time-Of-Flight Neutron Diffraction, Neutron Radiography and Tomography and Instrumental Neutron Activation Analysis. In addition, we present four of our latest success stories that were performed at the BNC. We show the studies of the famous small bronze, the "Budapest Horse and Rider", attributed to Leonardo da Vinci, and also the investigation of a 17th century articulated iron lobster from Japan – both were studied using combined neutron methods. In another study, water uptake of limestone-based building stones was investigated by neutrons. Finally, a successful determination of obsidian artefacts excavated in Romania is presented.

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Radiocarbon dating of lead white: a new tool for tracing pigment origin and authenticating painting

The absolute dating of paintings is central for tackling fake art. We report here a method to date the major white pigment used in the European paintings from Antiquity to the beginning of the 20th century. This pigment is composed of two synthesized lead carbonates: cerussite ($PbCO_3$) and hydrocerussite ($2PbCO_3Pb(OH)_2$). As we recently demonstrated that organic carbon dioxide was incorporated in its production up to the 18th century, we propose to date lead white pigment in cosmetics and paintings by the radiocarbon method. We developed an innovative protocol for the carbon extraction based on a selective thermal decomposition of the carbonates. Radiocarbon and the other carbon isotopes were measured by accelerator mass spectrometry using the ARTEMIS facility (LMC14-LSCE, Saclay, France). We successfully dated Greek and Egyptian ancient lead-based cosmetics as well as mural paintings of castles and church. These results demonstrate the capacity of the radiocarbon method to date lead white. Direct pigment dating provides a more reliable age and a stronger evidence for painting authentication than the dating of the canvas or support which may have been reused. We provide a new tool for the detection of forgery and the authentication of paintings.

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A New Large-Range Rapid-Scan X-ray Fluorescence Imaging Station at SSRL beam line 6-2

Synchrotron-rapid-scan X-ray fluorescence (SRS-XRF) imaging is a powerful technique to create elemental maps of large ancient objects. Here we describe a new SRS-XRF instrument that is now in the final commissioning phase at SSRL beamline 6-2. This new instrument provides unique capabilities, including the ability to image a wide range scales up to 1 meter horizontally at a wide range of spatial resolutions, as well as a wide range of elements, from high Z materials such as lead to light elements, such as phosphorous and sulfur.
While specifically designed for the SRS-XRF imaging of large ancient objects in paleontology and cultural heritage, the station provides analysis capabilities for a wide range of other materials and research fields including biological, chemical, geological, environmental, and materials science. It also provides the community with a user-friendly and flexible instrument based on state-of-the-art detection, scanning, alignment, and data acquisition/processing instrumentation. One of the first application at this instrument was the SRS-XRF imaging of the famous Syriac Galen Palimpsest, which contains the Syriac translation of work by the Greek physician, surgeon and philosopher Galen of Pergamon. Arguably the most accomplished of all medical researchers of antiquity, Galen influenced the development of various scientific disciplines, including anatomy, physiology, pathology, pharmacology, and neurology, as well as philosophy and logic. This Syriac translation is the only known link between the original Greek and the very popular Arabic translations. Using the SRS-XRF imaging combined with advanced machine learning algorithms, we were able to identify and read several previously non-legible pages in the palimpsest.

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Layered double hydroxide and zirconium phosphate as ion exchangers for the cleaning of gypsum efflorescences in fresco paintings

A new system has been explored to remove calcium sulphate efflorescences grown on frescoes by using a mixture of ion exchangers and polymers. The active role of gypsum dissolution is played by the chloride form of layered double hydroxide (LDHCl) and the semisodic form of α-zirconium phosphate (ZrPNaH), used respectively as anion and cation exchanger, through the Na^+, H^+/Ca^{2+} and the Cl^-/SO_4^{2-} exchange reactions. The efficiency of the ion exchangers was tested over gypsum encrustations reproduced on five fresco mock-ups painted with different pigments. In order to simplify the paste removal and avoid undesired residuals on the surface, sodium alginate (SA) was added to the ion exchangers mixture. The interaction between the chains of SA and the Ca^{2+} ions not captured by ZrPNaH induce gelation in the area of the mixture in contact with the salt deposits allowing the peeling of the cleaning pack and its reuse on the opposite side. Preliminary studies have also been conducted employing hydrogels composed by LDHCl and ZrPNaH mixed together with polyvinyl alcohol (PVA), SA and borax that can be applied on more delicate surfaces. The efficacy of the cleaning techniques was evaluated by XRD analysis, XRF, IR and Raman spectroscopy.

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Emissions from unplaticized PVC and their implications for heritage preservation

Unplasticized polyvinyl chloride (uPVC) sheets are gaining popularity in display case manufacture as replacements for wood products like medium density fiberboard (MDF). Both materials are commonly used as base platforms inside display cases. MDF produces acetic acid gas, which is known to deteriorate many cultural heritage materials. Conversely, emissions from uPVC sheets under typical display case conditions are not well researched. This study intends to elucidate the off-gassing properties of uPVC products, providing museums with the knowledge to make informed display choices.

Forex®, a popular brand of uPVC, was investigated through material characterization, emissions testing, and in-situ air quality analysis. X-ray fluorescence, scanning electron microscopy, and evolved gas analysis – gas chromatography – mass spectrometry (EGA-GC-MS) were used to determine the presence of additives like sulfur-containing heat stabilizers. Volatile organic compounds and organic acid emissions were quantified using GC-MS and ion chromatography. As a case study, air quality measurements were performed with a local museum that used Forex® inside new display cases. Passive air sampling devices were placed inside select display cases to collect volatile compounds, followed by quantitative analysis. Complementary data from this investigation will facilitate a stronger understanding of uPVC materials and their role in heritage preservation.

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SCIBEC: the Italian laboratory looking at macromolecules to discover art secrets in the present and past times

The Group of Analytical Chemistry for the Conservation of Cultural Heritage (SCIBEC) carries out scientific researches for gaining knowledge and safeguarding the cultural heritage. SCIBEC develops and implements analytical methods based on chromatography, analytical pyrolysis, spectroscopy and mass spectrometry for the characterization of organic materials collected from archaeological objects and artworks. The numerous international co-operations permit SCIBEC to face complex problems crossing information with complementary non-invasive techniques. Thus, SCIBEC, exploiting integrated trans-disciplinary approaches based on both *in situ* non-invasive and *micro-invasive* techniques, is able to give a complete picture of the composition of an artwork . Such a knowledge enables us to assess the state of conservation and on-going degradation processes, to set up exhibition and storage conditions, and to plan sustainable conservation strategies. Examples of material identification and degradation studies are presented, including: the meaning of ergot lipids in archaeology, investigation of lignin degradation in wet environments, fading of organic dyes in textiles and paintings, elucidation of pigment/protein/lipid interactions in paintings, thermal effects induced by laser cleaning, and inspection of binders and colors in modern and contemporary art. In addition, the problem of assessing the authenticity of paintings is addressed.

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New frontiers in the characterization of synthetic polymers: from the analysis of the volatile compounds to the characterization of the polymeric network

In the last years, the Group of Analytical Chemistry for the Conservation of Cultural Heritage (SCIBEC) has carried out several works dedicated to the characterization and evaluation of the degradation processes of synthetic polymers, implementing methods to face several challenges in conservation.
In particular, Py-GC/MS, which allows us to direct analyze high molecular weight molecules in a solid micro sample without any pretreatment, is emerging as a fundamental tool. Thanks to the new instrumental developments represented by double shot and multi-shot , we show its use in conservation. The analytical asset of evolved gas analysis – mass spectrometry (EGA-MS) permits to have information on alteration processes of polymers linked to depolymerization or cross-linking phenomena, evaluating the relative amounts of evolved compounds during thermal degradation at increasing temperature. Select Ion Flow Tube - Mass Spectrometry (SIFT-MS) is a direct MS technique, recently introduced as a portable device, which achieves quantitative analysis of VOCs at trace levels in real time, by applying precisely controlled ultra-soft chemical ionization using eight different chemical ionization agents, and, above all, avoiding any sampling step.
Here we present the new developments of analytical pyrolysis in the study of synthetic polymers through a selection of case studies.

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Ionizing Radiation for Preservation of Cultural Heritage

Heritage conservation science acknowledges the biodegradation that leads to serious irreversible damage in cultural collections, especially to organic materials of natural origin. In the fight against infestation from insect or fungi, many processes are proposed, but few are actually suitable.

By comparison with classical treatments based on the diffusion of a toxin as liquid or gas, gamma irradiation technology offers a high level of efficiency and reliability. It is safe for the professional, the public and the environment. Even though harmlessness cannot be retained as absolute, as it cannot with any process that is required to be active (included anoxia), it is almost innocuous for a broad range of materials.

Gamma irradiation has been used for 50 years on a massive scale for medical sterilization, and has been used for decades in the field of cultural heritage conservation. It has already demonstrated the extent of its possibilities and limits. The reluctance of curators and conservators has been compounded by insufficient knowledge of irradiation side effects, which is now outdated. A recent free publication from the International Atomic Energy Agency (IAEA) has brought together the basic principles, protocols and trends with various applications from many countries around the world.

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Cultural Heritage at the ID21 beamline, ESRF: recent applications and on-going refurbishment

Cultural heritage has represented an important research activity at the ID21 beamline, ESRF, for more than 15 years. The X-ray and infrared microscopes are regularly used to study various ancient and artistic materials, such as fragments from paintings, glasses, ceramics, wood, papyrus. μXRF, μXRD, μXANES and μFTIR can be combined to obtain elemental, phase, speciation and molecular maps. These complementary pieces of information can be used to reveal manufacturing processes or to understand degradation phenomena. Recent applications will be presented.

The ESRF is currently benefiting from a major upgrade, with the coming implementation of an "extremely brilliant source" (EBS). This upgrade will significantly increase the brilliance and coherence of the X-rays beam. In this context, the ID21 instruments are being deeply refurbished. The modification of X-ray optics is on-going with the objectives to extend the energy range (to ~2-11 keV) and to obtain a smaller (~100 nm) and more stable beam. The X-ray microscopes will be completely re-designed to make their use more efficient and reduce set-up time. Software developments are also planned to improve data acquisition, data processing, data analysis and data archiving. The project and its benefits to the cultural heritage community will be presented as well.

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Radiocarbon dating of iron and the chronology of ancient monumental architecture

The time scale covered by the Radiocarbon dating method is particularly well suited to study the development of the human cultures through the dating of artefacts discovered in archaeological sites or monuments. For years, organic remains like charcoal, wood, seeds or bones were chosen mainly because of their rich carbon content. With the development of Accelerator Mass Spectrometers that reduced dramatically the quantity of sample needed (1 mg to 10 µg of carbon), radiocarbon laboratories could consider more complex materials. It is the case of iron that constitutes an important witness of ancient societies for 3000 years.

At least until the 19th century, the charcoal was used to reduce iron ore into metal. During the reduction process, the carbon present in the charcoal diffuses into the metal of the ferrous alloys. It is therefore possible by radiocarbon dating to date the ferrous archaeological objects.

We present here the original methodology developed by the LMC14 and the LAPA to reliably radiocarbon date ferrous alloys. Through two studies carried on architectural iron objects sampled in French gothic cathedrals and Angkorian monuments, we show the effectiveness of radiocarbon dating of iron when it is combined with a full archaeometric study of the objects.

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Study of the interactions and reactions in naturally aged newsprint papers strenghtened with polysiloxane copolymer networks

Natural ageing of paper is responsible for its slow decay. Late 19th and early 20th century lignocellulosic paper collections of mediocre quality, especially newsprint papers, are often in poorer conservation state than medieval handmade rag papers. In order to find a conservation solution for Libraries and Archives collection keepers, CRC and LPPI have developed novel one-pot treatments based on the use of copolymerized aminoalkylalkoxysilanes (AAAS) that allow the simultaneous deacidification and strengthening of cellulosic objects of the cultural heritage.
Several paper constituents are thought to affect the efficiency of the copolymer treatment under study, including papermaking additives. In particular, alum-rosin sizing, and the presence of mechanical pulp, which contains copious amount of lignin, a biopolymer largely responsible for the acidity of early industrial paper, are thought to play an adverse role. Nuclear Magnetic Resonance (NMR) and Fourier-transform infrared (FTIR) spectroscopies were used to investigate the interactions and the reactions occurring between the AAAS and the paper at room temperature, by focusing on key characteristic functional groups. A study with molecular models of cellulose and lignin was thus undertaken. In complement, the study included naturally aged newsprint papers from the early 20th century treated with AAAS.

Didier Geffard-Kuriyama, Marta Bellato

Outils et Méthodes de la Systématique Intégrative (OMSI), CNRS, MNHN, Paris, France

The TRIPHON 3D project – Technique de Réplication Informatisée de Portoirs HOrs-Normes – Computerised replication technique for nonstandard supports

3D imaging, chemical or structural analyses require sample preparation protocols that can be very restrictive when analyzing Heritage materials. MultiJet Printing (MJP) is an advanced high-resolution polymer 3D printing technology that offers a new way of securing and optimising analyses in heritage sciences. *A 3D Systems ProJet MJP 2500 Plus* printer has been recently acquired at the MNHN of Paris thanks to *Île-de-France* DIM-MAP grants.

Our workflow focuses on the conception, design and printing 3D supports or moulds to fit closely with the shape of objects of interest. A 3D digital scanning and/or computerised 3D modelling is used to replicate unique fixtures perfectly adapting to support and to secure any item or object of natural and heritage sciences. We focus on the potential of this technique for the MNHN AST-RX platform to optimise CT-scan acquisitions. By designing different supports adapted to our tube/rotate-plate systems and specimens together, we can assist in positioning and firmly fixing objects, and in the analyses setting of a R.O.I.

Extended possibilities will be soon offered to the full *Île-de-France* DIM-Matériaux anciens et patrimoniaux community in order to benefit from preferred access to TRIPHON services, including to packaging solutions for transportation or to answer specific exhibition needs.

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Limestone weathering in the urban environment: tracing the alteration to construct a geochemical model

In France, limestone was used abundantly in stone buildings and monuments. On ancient monuments, built in mostly urban areas, it is exposed to urban-borne pollutants (gas - SO_2, NO_x - and particulate - soot) that can modify the alteration mechanisms and weathering kinetics. Calcite is the main phase of the limestone, and its alteration encompasses two main chemical processes: dissolution and new phase precipitation. These processes affect the limestone pore's network and can modify its capillary properties. Dissolution can open the pores and new-phases tend to precipitate inside the pore's network leading in some cases to partial obstruction of the pores.

To study the alteration processes occurring on this complex system, a multidisciplinary approach is developed based on field analyses, laboratory experiments and numerical modeling. Firstly, one needs to identify the alteration patterns of limestone from monuments at a fine scale. Secondly, alteration experiments are performed to identify the reactive zones in controlled environments. Oxygen and hydrogen isotopes are used to trace the transfer of water and identify the location of the reactive area. And lastly, a model based on a description of the mechanisms is developed, using HYTEC reactive transport code, to assess the impact of urban atmospheric parameters.

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X-ray Raman scattering discriminates carbon-based compounds in art and fossil materials

Deciphering the chemical nature of carbon-based compounds in ancient materials although challenging is an essential source of information in many archaeological and paleontological studies. Difficulties in the characterization and identification of organic carbon compounds are common both due to specificities of the material (e.g., alteration during time, fine scale association with inorganic phases, turbostraticity) and to experimental constraints. X-ray Raman scattering (XRS) recently proved very promising to probe carbon speciation in complex heterogeneous solid ancient samples. In the XRS process, an incident photon is inelastically scattered by a core electron, and part of its energy is transferred to excite the inner shell electron into an empty state. XRS is analogous of Raman scattering widely used in optical spectroscopy, with primary differences the wavelength of the exciting photons which fall in the hard x-ray regime, and the excitation of core electrons.

This hard X-ray inelastic technique enables the measurement to be done in a nondestructive way, in air and provides information from the bulk of the probed material avoiding surface contamination. Here, we demonstrate the potential of XRS through the analysis of a range of materials from carbon-based artists' pigments to paleontological specimens.

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Separative and Spectroscopic Monitoring of the Degradation of Historical Paper after Synchrotron X-ray Exposure

X-ray techniques are increasingly used to study cultural heritage (CH) artefacts, including paper-based artworks and manuscripts, yet little is known about the potential damage of X-rays to cellulosic materials. This research was therefore conducted to assess how cellulosic paper behaves under synchrotron X-ray examination, mostly by studying depolymerization and oxidation. Paper is mainly composed of cellulose, a homopolysaccharide made of β-D-glucopyranosyl(1→4)D-glucopyranose units. Size-Exclusion Chromatography (SEC-MALS-DRI) was used to measure the molar masses and molar mass distributions of cellulose in model and ancient papers made of cotton linters and linen rags after exposure to X-rays (PUMA beamline, SOLEIL). Liquid Chromatography (RPLC-FLD-UV) was used to evaluate the formation of hydroxyl radicals. The onset of UV fluorescence and yellowing of the irradiated samples was monitored non-invasively. The impact of various parameters inherent to ancient papers, such as moisture content and the presence of papermaking additives (calcium carbonate, ink and sizing), was assessed. This multi-analytical approach allowed calculating the dose-damage response at the macroscopic and macromolecular level for the first time, within a low dose range (0-4 kGy). Assessing the Low Observed Adverse Effect Level and the No Observed Adverse Effect Level will allow developing safer protocols for the X-ray examination of cellulosic artefacts.

David Giovannacci, Stéphanie Duchêne, Didier Brissaud, Tiphaine Fabris, Witold Nowik

Centre de Recherche sur la Conservation (CRC LRMH), MNHN, Ministère de la Culture, CNRS, Champs-sur-Marne, France

Terahertz Time-Domain Reflectometrometry System

This study aims to evaluate the capabilities of THz-TDI for characterizing immovable cultural heritage materials, understanding decay processes, as well as improving conservation of heritage objects. Specifically for conservation science, the capacity of the THz to image the internal structure of such materials with non-ionizing effect is a great benefit, compare to X-Ray which require skilled personnel and specific facilities such as radiation-shielded rooms. Moreover this technique is contact free and gives information for a wide variety of optically opaque and non-conducting materials.

THz-TDI can be carried out in reflection, in that respect there is no need to access to both sides. THz imaging can provide information in depth and THz data contains spectral information which can potentially be used to identify different materials. The versatility of THz-TDI is one of the key points for the success because it finds application in a broad range of fields of archeometry and conservation science. Case studies were carried out to illustrate structural and material information to conservators.

Archismita Misra, Isabel Franco Castillo, Jesús Martínez De La Fuente, Stéphanie Eyssautier, Carsten Streb, Scott Mitchell

Consejo Superior de Investigaciones Científicas (CSIC), Madrid, Spain

Modular molecular and hybrid nanomaterials to prevent biodeterioration of heritage objects

Microorganisms are highly proficient at inhabiting and decaying paper, leather and stone objects, generating serious problems for the conservation of paintings, textiles and sculptures. The associated health risks coupled with the cost of decontaminating infected artifacts, exhibition rooms and depots make this a pertinent topic for museums, local authorities and private collectors alike. Moreover, our shared cultural heritage is a social, economic and environmental resource for Europe. The overall aim of our current research efforts is to engineer a range of molecular and hybrid materials with enhanced antimicrobial properties, which act to help prevent the biodeterioration of cultural heritage objects. For example, modular and tunable polyoxometalate ionic liquid materials (POM-ILs) can act as precision biocides that meet the specific needs of cultural heritage conservation (e.g highly applicable colourless gels, waxes, sols etc.) [1, 2]. Our research also demonstrates how comprehensive antimicrobial activity programs can be used to assess the activity of nanomaterials against bacterial and fungal strains commonly found infecting real heritage objects [2, 3].

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[3] I. Franco Castillo, et al, Int. Biodeterior. Biodegradation, 2018, DOI: 10.1016/j.ibiod.2018.04.004

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PUMA, a new animal for tackling historic samples

PUMA is a new beamline at Synchrotron Soleil, built with support from IPANEMA, dedicated to the analysis of artistic, historical and ancient materials. PUMA is a hard x-ray beamline, from 4-60 keV, optimized for experiments utilizing X-ray fluorescence spectroscopy (XRF), absorption spectroscopy (XAS) and powder diffraction (XRD) type techniques. The experimental station consists a Kirkpatrick-Baez mirror system with a micro-focus of 3 µm (horizontal) * 3 µm (vertical) and a luminescence microscope for in situ sample observation. The first expert users will arrive February 2019 and the beamline will open to all users in Spring 2019. A sample of first data acquired from the commissioning of PUMA will be presented.

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LumStimAge project: TL/OSL imaging for heritage materials

The LumStimAge project funding by the Île-de-France heritage and ancient materials research network (DIM-MAP) proposes the acquisition of a thermally stimulated (TL) and optically (OSL) luminescence imaging system focused on heritage. It will complete the new TL / OSL reader acquired a year ago by the Research and Restoration Center of the French Museums (C2RMF). The main objective of this device is to study the phenomena of stimulated luminescence within materials of heritage interest, for the purpose of dating, characterization, and study provenance of the materials. The use of TL / OSL imaging is still limited because of the low light intensity and the rapid kinetics of the phenomena observed, but also because of phenomena of optical aberration due to the proximity between luminescent grains. In-depth research into image processing and development of algorithms is therefore necessary. A first application will focus on the study of unfired material and in particular on mortars. Imaging should identify the grains that have undergone the most efficient resetting during mortar manufacturing while taking into account the effects produced at local scale by microdosimetry.

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PictOu database : a project dedicated to Jean-Baptiste Oudry's painting technique

PictOu is a collaborative project between the University Paris 1 Panthéon-Sorbonne and the C2RMF, supported by the DIM-MAP Ile-de-France. In February 2019, PictOu-database, dedicated to J.-B. Oudry's painting technique will be online. Oudry is a well-known French painter, active in the first half of the 18th century. Member of the Académie Royale de Peinture et de Sculpture since 1717, and the only member to give conferences showing technical data in 1749 and 1752. PictOu project consists of studying the material characteristics of his productions and comparing with the date from his conferences

Thanks to Physics, Chemistry, Art History and Conservation Restoration methodologies, seventy of Oudry's paintings, restored at the C2RMF, are studied in order to get a precise idea on Oudry's technique. That includes material nature identification, traces left by tools and execution process interpretation. Attention is paid to painting conservation state. It is a preamble to technical investigation in order that visitors, students, scientists, art historians or curators, understand that the scope of the information depends on it.

Our database gives public access to organised and scientific information. Order context, conservation history, technical and conservation description as well as important photographic documentation are available online.

Mouna Chambon[1], Edmond Roger[2], Miadama Faramalala[2], Joro Rakotoarinivo[3], Solofo Rakotondraompiana[3], Camelias Rasoamanantenaniaina[2], Tony Arison[3], Bernard Riera[1]

[1] Mécanismes adaptatifs : des organismes aux communautés (MECADEV), CNRS, MNHN, Paris, France
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Bridging cultural conservation and community development: case study of the use of *Bismarckia nobilis* Hildebr. & H.Wendl. for ancestral handicraft activities in the New Protected Area of Antrema, North-Western Madagascar.

Biodiversity and natural heritage provide significant benefits to people throughout the world. Grounding this study in the New Protected Area (NPA) of Antrema, North-Western Madagascar, we addressed the potential win-wins of biodiversity conservation and community development through a focus on the local uses of the endemic palm species *Bismarckia nobilis* Hildebr. & H.Wendl. The NPA was established in view to showcase local knowledge and practices as an effective tool for conservation, hence its name of "bio-cultural" project. The goal of the study was to assess the sustainability of the management of *B. nobilis* populations in the NPA. The species is mainly harvested for its leaves by local people, especially women for handicraft activities. These ancestral practices are transmitted from mother to daughter within communities. To estimate the leaf harvesting rates of women, we applied an ethnobotanical approach by using questionnaires. The data allowed us to build a model of change in *B. nobilis* population dynamics for the next 50 years. Our findings demonstrate that anthropogenic activities do not have a negative impact on the population size of the species in the NPA. However, we recommend a long-term monitoring of *B. nobilis* to prevent its over-exploitation in the future.

Ana Claro, Teresa Ferreira, Scott Mitchell, Carla Lobo, Rita Marquilhas, David Martín

Centre for the Humanities, FCSH, Universidade Nova de Lisboa (CHAM, UNL), Lisbon, Portugal

IRONIC - Iron Gall Ink Challenges: History and Conservation of a disapearing Cultural Heritage

In this poster we will present a new financed project. Is an interdisciplinary project, combining Conservation Science, Nanotechnology, Restoration and Written Culture History, it aims to solve the iron gall ink corrosion problem.
Being the main ink used in Europe since the 5th century, its study is crucial to avoid the continuous loss of documents. IRONIC will allow gathering and studying the information about archiving conservation issues since the 14th century, as a proof of a long-term concern of European societies, associated to State formation processes.

IRONIC will identify and characterize the ink alterations in different dated manuscripts from the archives. This project will be using, in manuscripts, the advantages that nanotechology has brought to other fields last years, developing polyoxometalates that could be applied as a treatment for the corrosion ink issue. Therefore, IRONIC will also develop an IRONIC kit which will be an important tool made available to the worldwide Conservators to better preserve of our cultural heritage.

Pauline Martinetto, Laurence Rivière, Emilie Chalmin, Pierre Bordet, Catherine Dejoie, Danielle Ziebelin, Karine Froment, Nicolas Holzschuch, Mélanie Duval

Institut Néel, Grenoble, France

Patrimalp: Development of an Integrated Interdisciplinary Cultural Heritage Science

The main objective and challenge of the Patrimalp project is to develop a cross-disciplinary approach in order to get a better knowledge of the material cultural heritage in order to ensure its sustainability, valorization and diffusion in society.
Carried out by members of Université Grenoble Alpes laboratories (Institut Néel, LUHCIE, EDYTEM, LIG, Arc Nucléart, LJK and ESRF), combining skills in human sciences, geosciences, digital engineering, material sciences, in close connection with stakeholders of heritage and cultural life, curators and restorers, Patrimalp intends to federate and structure an interdisciplinary scientific community focused on Cultural Heritage Science within the UGA.

The scientific approach consists in a cross-discipline study of heritage objects dated from the Neolithic period to the pre-industrial period, which are preserved in the West Alps and the Rhone Corridor. These objects, regarded as "Boundary objects" will be analyzed following a tripartite approach:
- An intrinsic analysis to understand their manufacture as well as their transformation.
- A study of the historical and environmental context of creation.
- A restitution of the heritage object in its ancient and physical appearance to serve as a support for the conservation-restoration process and promote its accessibility to the general public.

Nicolas Ruffini-Ronzani

Laboratoire Dynamiques patrimoniales et culturelles (DYPAC), Université de Versailles Saint-Quentin-en-Yvelines, Versailles, France

Iron-Gall Inks in Fourteenth-Century Chartres: The EVAS Project

Thanks to new non-invasive processes, it is now possible to "enter" the medieval writing materials and to determine their physicochemical properties. In 2018, the EVAS project ("Évaluer l'activité d'un scriptorium", funded by the DIM "Matériaux anciens et Patrimoniaux") aimed at developing some non-invasive analysis techniques of the iron-gall inks (or "black inks") which were used in medieval manuscripts. A corpus of fourteenth-century registers and rolls from the city of Chartres (France) was examined through XRF-analysis by researchers from the Centre de recherche sur la Conservation, the Institut de recherche et d'histoire des textes, and the University of Versailles – Saint-Quentin. The project was a success. By revealing which metallic sulphates were used to make iron-gall inks and in which proportions, XRF analysis has made it possible to distinguish between different inks that look similar. This is a new way for understanding the writing process of documents, and thus the organization of the medieval chanceries. The objective of the poster is to present the methods and the results of the research.

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Multiplying observation methods to better document exceptionally preserved fossil fishes

Past life forms are of great interest in understanding the evolutionary history of a taxon or an ecosystem. Fossil organisms show features or combination of features unknown to extant representatives, enlarging our knowledge on the morpho-anatomy. In these respects, Konservat-Lagerstätten play a key role by providing exceptionally preserved specimens with structures usually absent from the fossil record. The access and description of these structures largely depend on the relevance and precision of the employed observation methods.

As a case study, new species of ray-finned fishes (actinopterygians), coming from the Moroccan locality of OT1 and dated as early Late Cretaceous (ca. 95 Ma), are described. The specimens are very well-preserved but, owing to the nature of the sediment, no mechanical or chemical preparations were attempted. The low thickness of the specimens and the presence of iron oxides limit microtomography reconstructions. Microtomography was therefore coupled with classical observations with binocular lens, under natural and UV lights, and with macrophotography, SEM imaging, and X-ray fluorescence. The combination of the resulting observations revealed mineralized soft tissues and very peculiar bone structures. This study illustrates that, far from being redundant, these observation methods are complementary by providing a wide variety of data that can be combinable.

Pierre Linchamps[1], Christiane Denys[2], Raphaël Hanon[1], Thalassa Matthews[3], Christine Steininger[4], Emmanuelle Stoetzel[1]

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MiCoTaph Project: Fossil Micromammals from Cooper's Cave (Lower Pleistocene, South Africa) - contribution to a better knowledge of the taphonomic and environmental context of Paranthropus robustus occupations

The simultaneous presence of several hominin species in South Africa during the Plio-Pleistocene, especially the first representatives of the genus Homo, Paranthropus and possibly late surviving Australopithecines, makes it difficult to understand the evolutionary history of these lineages, as well as their technical and subsistence behaviors. It then appears necessary to better characterize the occupations related to each species, and in particular the environment in which each of them has evolved. Small mammals such as rodents are good palaeoecological markers, but remain poorly studied in early hominin sites in South Africa. In order to understand the evolutionary dynamics of this time, the MiCoTaph project aims to reconstruct the taphonomic and palaeoenvironmental context of the Paranthropus robustus occupations of Cooper's D (Bloubank Valley, South Africa, < 1.4 Ma). An interdisciplinary approach is applied using taxonomic, taphonomic and palaeoecological methods to analysis the micromammal remains.

Romain Pintore[1], Arnaud Delapré[2], Rémi Lefebvre[1], Léo Botton-Divet[3], Alexandra Houssaye[1], Raphaël Cornette[2]

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Accessing the lost biological shape of fossils: How to study altered natural heritage?

Fossils are generally discovered with post-mortem deformations that unavoidably alter their biological information. It appears essential to estimate as accurately as possible the original morphology of an extinct organism before its study. This is particularly true for quantitative shape analysis. 3D deformations offer a wide range of possibilities in order to retrodeform a distorted fossil. Geometric morphometrics and thin-plate splines (TPS) interpolation are already used as retrodeformation tools but only for symmetrical objects such as skulls. In this study, we propose to: 1) Quantify the effectiveness of the TPS interpolation as a retrodeformation method for asymmetrical bones; 2) Apply this method on a sample of 31 fossilized femora of basal sauropodomorph dinosaurs. To do so, taphonomical degradations were computed in 3D on a modern horse femur. Results show that affine deformations – flattening and stretching of the whole bone - are the best corrected deformations. Then, retrodeformations were performed on the sample of dinosaur femora. Best handled deformations were consistent with the previous simulation part. The resort to 3D anatomical optimizations for retrodeformed fossils could generate new possibilities in qualitative analysis for comparative anatomy but notably also for advanced computational analysis technics such as biomechanical modelling and morphometrics.

Jean-Christophe Viennet[1,2], Sylvain Bernard[1], Pierre Jacquemot[1,2], Maguy Jaber[2]

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[2] Laboratoire d'Archéologie Moléculaire et Structurale (LAMS), CNRS, Sorbonne Université, Paris, France

Searching for organic biosignatures on Mars: Experimental perspectives

Upcoming exploration of Mars officially aims at identifying potential organic biosignatures in the subsurface. Despite the continuous UV irradiation of the surface, Mars subsurface has mostly acted as a giant freezer, thereby preserving potential remains of Martian life dating back from the Noachian (~4.1-3.7 Ga). Yet, volcanic events or crater-forming impacts generated hydrothermal systems, altering ancient rocks and their (possibly biogenic) organic content. It thus appears crucial to constrain the impact of hydrothermal processes on organic biogeochemical signals, especially in the presence of clay minerals which are targeted by the future rovers. Here, we submitted RNA (i.e., the most emblematic biogenic molecule) to hydrothermal conditions in the presence of Mg-smectites (i.e., a widespread clay mineral on Mars). Results show highly heterogeneous organo-mineral residues, with nano-phosphates and nano-carbonates associated to submicrometric amorphous silica particles and Mg-smectites with interlayer spaces saturated by N-rich organic compounds. Even though the chemical structure of RNA did not sustain hydrothermal conditions, the present study demonstrates that clay minerals can efficiently trap organic carbon under hydrothermal conditions typical of Martian subsurface, confirming the relevance of digging for organic carbon on Mars.

Satellite events
Événements satellites

Tuesday 12 February 2019

Third users' meeting of the IPERION CH European network, C2RMF
IPERION CH, C2RMF

14h00 > 17h00

X-ray fluorescence mapping and musical instruments:
Visit of the laboratory and of the collections of the Musée de la musique, Cité de la musique - Philharmonie de Paris, 221 rue Jean Jaurès, 75019 Paris
Contact and registration: Stéphane Vaiedelich

14h30

« Datable, pas datable »,
LMC14, CEA-Saclay
Contact and registration: Valérie Setti et Lucile Beck

Thirsday 13 February 2019

Press conference Google Arts & Culture,
Institut de France
(invitation only)

E-RIHS Scientific Strategy meeting,
Institut de France
(invitation only)

Tuesday 19 February 2019

14h00 > 16h30

PictOu : étude de la technique picturale de Jean Baptiste Oudry, INHA, salle Jullian 1er étage, 2-4 rue des Petits Champs
Contact and registration: Claire Betelu

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