Editor:
Christian Degrigny
cdegrigny@mcr.edu.mt
Assistant editor:
James Crawford
jamesbcrawford76@yahoo.com.au &
jcrawford@mcr.edu.mt
METALConsn-info

Metal working group

Bulletin of the Research On MEtal Conservation

November 2005

BROMEC16

Editorial

Normally, you should have downloaded this new issue of our bulletin from the Metal Working Group homepage, but the ICOM-CC website and the WGs homepage are not currently accessible. In fact, the 2nd level of accessibility to the website has been implemented, but none of the ICOM-CC "official" members (voting members, Friends and student-Friends) have been given their username and password. You will understand then that BROMEC 16 is exceptionally sent to you through the former distribution manner - via email as an attached document.

We cannot guarantee that in the future the BROMEC issues will remain freely accessible on the Metal homepage. There is some discussion at the moment at the Directory Board level on what will be fully accessible and what will be under restricted access. The new coordination team of the Metal WG has proposed to the Board to have all new issues of the BROMEC accessible during the first 3 months. That means then that if it is accepted all current Metal WG members would keep access to the most recent information in the domain. Only the "official" ICOM-CC members will have full access to all past BROMEC issues.

As regards this issue, some of the abstracts should draw the attention of all professionals involved in the conservation of archaeological iron artefacts. The two current ways of assuring the long-term conservation of these artefacts are presented in the two first papers: either by controlling the environment or through the extraction of active species (using the alkaline sulphite treatment which will be thoroughly reviewed through the completion of a PhD research project). A third abstract is essential since it presents a new corrosion product that might be responsible of active corrosion on iron artefacts from terrestrial sites and that is rarely mentioned in the conservation literature. The fourth abstract describes typical corrosion forms on large marine artefacts.

Two other abstracts deal with metals that deserve more research attention: aluminium and mercury. Aluminium alloys are commonly used in aircraft structures, but their precise composition and developed corrosion types require some investigation that will be carried out on the collection of the Air and Space Museum in Le Bourget (France). The project on mercury relates to the issue of the conservation of this dangerous metal in technical and scientific instruments. Such a topic cannot ignore the associated materials, the glass container in this case, and the ethical issues that will be examined.

Also, this issue marks the end of the first year of the EU PROMET project and reviews some of the major achievements up to now.

This bulletin is the first one of our new triennial period. It is hoped that it will remain an important tool of communication for the members. The coordination team of the Metal WG will do its best to maintain its quality, but it will depend too on you to maintain its activity. We are all conscious that without the voluntary, yet professional, contribution of the members and the active promotion of the national representatives of the Metal WG this bulletin would not exist.

As usual, we hope that you will find this issue as useful and as interesting as ever.

Editor
Christian DEGRIGNY
Assistant editor
James CRAWFORD

Contents

Ongoing research projects

PROMET - Developing new analytical techniques and materials for monitoring and protecting metal artefacts from the Mediterranean Region

Last November in BROMEC 12, the start of the three-year EU-INCO-MPC 1 PROMET (PROtection of METals) project was announced. The project aims to establish and promote a conservation strategy designed for the Mediterranean region by developing an approach to monitor and protect metal artefact collections using state of the art portable analytical techniques and new corrosion inhibitors and/or coatings that are safe and effective to use. The project will be exhibited at a stand during the conference: Communicating European Research (CER2005) to be held in Brussels between November 14 –15, 2005.

For the project, the portable hand-held Laser-Induced Breakdown Spectroscopy (LIBS) is now ready to use and will be demonstrated at CER2005. The portable micro X-Ray Fluorescence (μXRF) will soon be ready. Surveys of metals collections housed in 12 museums throughout the Mediterranean have been carried out using a systematic survey approach developed for the project, which involves using either a statistical approach in assessing the condition of a large sample of the objects or a data-mining technique to survey a random sample from the collection. Further scientific analyses will be applied, using in some cases the new innovative techniques LIBS and μ-XRF, to provide newer ways to accurately assess the condition of the collections. The survey approaches and the collections under study were presented at a workshop held in Jordan in June 2005.

The collections are as follows: Egypt (*Silver alloy collection of the Egyptian Museum of Cairo*); Greece (*Copper alloy and iron collection at the Archaeological Museum of Ancient Messene and Silver alloy collection at Museum of Technology of Athens*); Italy (*Silver alloy Coins from the National Roman Museum);* Jordan (*Copper alloy collection at the Museum of Umm Qais and Silver Abbasid coins from Museum of Jordanian Heritage);* Malta (*Steel Armour of the Knights of St. John, Palace Armoury, Valletta);* Morocco (*Copper alloy collection at the Rabat Archaeological Museum of Morocco);* Spain (*Iron alloy collection from the villages of Calatrava la Vieja and El Saucedo);* Syrian Arab Republic (*Copper and iron alloys collection from excavations in the Syrian Arab Republic)* and Turkey (*Copper alloy and iron collection of the Van Museum in Eastern Anatolia)*.

A second major part of the project involves developing and/or testing safe corrosion inhibitors (derived from vegetable oils, mature tobacco, and wood tannins), coatings (waxes and resins) with corrosion inhibitor additives, and barrier films (Physical Vapour Deposition (PVD), Plasma Enhanced Chemical Vapour Deposition (PECVD)). So far the work covered the preparation of coupons (steel, bronze and silver alloys) simulating real artefacts that will be used to test the protection systems chosen by the different project partners. In preparing these simulated artefact-coupons, artefacts from the collections under survey were thoroughly investigated in order to determine the composition of these test coupons. Three partners then had to produce for the consortium large quantities of coupons with the specific composition required. Some of these coupons were corroded under accelerated conditions for the partners to test a pre-selection of protection systems. Currently, the partners expose the remaining coupons to natural ageing on site during one year in order to produce corrosion layers formed over a natural timescale and environment. It is on these coupons and after selective corrosion product cleaning that the final selection of protection systems will be tested in these natural conditions during another year.

The partners are to discuss the standards used to assess the effectiveness of the protection systems at a workshop held in Malta on November 12 and 13, 2005.

Another major achievement is the assessment of the questionnaire results from respondents in museums etc. across the Mediterranean (so far 30 in total). The questionnaire dealt with the types of corrosion inhibitors and coatings used currently or in the past by conservators. The questionnaire can be found on the PROMET portal: www.promet.org.gr and results will be presented at the Malta workshop.

More information can be found on PROMET portal: www.promet.org.gr or in recent publications (see METAL 04 and ICOM-CC proceedings).

Contact: Dr Vasilike Argyropoulos, Co-ordinator (TEI of Athens)
Funding: EU STREP INCO-MPC 1, 6th Framework programme

Ongoing research projects

 The investigation of deterioration and stabilisation of archaeological iron in the British Museum and experiments on effects of RH on corrosion of iron (***DCDS-BM***)

Archaeological iron has proved to be problematic. Conservation treatments used in the past which involve the use of reducing agents in solutions are not considered to be acceptable by most British conservators, because they cause the uncontrolled removal of the evidence preserved in the corrosion products. Desalination of badly corroded metalwork often results in disintegration of the object, and incomplete removal of chlorides can result in further corrosion. Desalination cannot be taken as an alternative to current good practice in controlling environmental conditions and the implementation of dry storage regimes.

It was reported that 15% RH is the level above which α-FeOOH may convert to β-FeOOH to cause further deterioration if chloride ions are present on the object. However, keeping iron in storage at such a low level of RH is too expensive. The aim of the project is to identify the main causes of deterioration of archaeological iron in the British Museum and to identify a suitable storage environment. To achieve the aim, two approaches have been carried out for this project, including investigation of archaeological iron objects in the museum collection and experimental tests on effects of RH on corrosion of iron. Optical microscopy, XRF, Raman spectroscopy, XRD, SEM/EDS and FTIR has been used for the study.

Investigation has been carried out on Roman iron from Stonea Grange, Cambridgeshire and Uley, West Hill, Gloucestershire, and Anglo-Saxon iron from Garton Station, East Yorkshire and Dover Buckland, Kent. Surface corrosion products were identified. Detailed study on sections of unstratified iron nails from some of the sites and flakes from some objects were carried out to help understand development of corrosion. Effect of conservation treatment has also been investigated.

The experiment has been focused on formation of akaganeite, which has been recognised as the symbol of post excavation deterioration. It has been carried out in humidity chambers of five RH levels at ambient temperature. Powdery $FeCl_2.4H_2O$ alone and $FeCl_2.4H_2O$ on top of iron foil has been exposed to 25, 33, 44, 55 and 75%RH. Variation of each RH level is approximately ±5%. Changes in appearance and mass have been monitored with time and the reactant products were identified by Raman spectroscopy. Experiments have also been carried out on archaeological nails in the same humidity chambers. Sutton Hoo knives with different conservation treatments have been monitored in the Sturge basement, a British Museum on site store, with environmental data being simultaneously recorded with humbug data loggers.

The investigation of selected archaeological iron in the British Museum collection indicates that deterioration is so severe that some of the objects disintegrate. This is probably due to a poor environment in the stores, because no environmental control has been provided for the iron objects.

Exposure of powdery $FeCl_2.4H_2O$ to different RH levels results in formation of akaganeite within two days at 75%RH, one month at 55%RH, six months at 44%RH, and ten months at 33%RH. Other experiments are still in progress.

Contact: Quanyu Wang (DCDS-BM)
Funding: no external funds

Ongoing research projects

Corrosion study of aluminium artefacts in an aeronautic collection: analysis and identification of corrosion risks (***UHP-LCSM / LRMH***)

Because a large part of the elements of aeronautic heritage are made of aluminium alloys, the identification of the corrosion processes occurring on these materials is of particular interest to evaluate the risks of damage when these elements are conserved outdoor or in uncontrolled conservation conditions (sheltered from the rain).

A new research project involving laboratories from the CNRS, the French Ministry of Culture and the Air and Space Museum funded by the French Ministry of Culture was set up in July 2005.

The main objectives of this project are:

- the characterization of aluminium alloys in aeronautic collections,
- the analyses of the corrosion layer, especially the detection of contaminants (chlorides…)
- the determination of corrosion risks for the alloy/corrosion layer system

Samples will be collected from different aircraft at the Air and Space Museum of Le Bourget, France. Several characterisation techniques such as XRD, SEM, LIBS, Raman and IR spectroscopy will be used.

Using electrochemical measurements and climatic ageing, the reactivity of the alloy/corrosion layer system will be studied.

The different parameters collected should provide recommendations for the conservation of elements of aluminium Cultural Heritage.

Contacts: Emmanuel Rocca (UHP-LCSM) - François Mirambet (LRMH)
Funding: PNRC Ministère de la Culture et de la Communication (France)

Ongoing research projects

 Corrosion characterization and treatment evaluations of iron artefacts recovered from the USS *Monitor* (***TMM/ODU***)

The National Oceanic and Atmospheric Administration (NOAA) is in charge of conserving over 230 metric tons of metal artefacts recovered from the USS *Monitor*. These artefacts include the ship's iron gun turret, the engine and condenser, which were recovered between 1998 and 2002 (see BROMEC 5).

The *Monitor* conservation efforts are now expanding and will begin in earnest over the next year, with the completion of a dedicated conservation facility and the hiring of more support staff. Currently, the large metal artefacts, such as the engine, are stored in aqueous alkaline solutions or fresh water. The turret, which is in a mostly concreted state, has been stored in fresh water since recovery in 2002. It will be stored in this solution until archaeological excavation of its interior is completed. Scientists at Old Dominion University have been working with conservators on the project to study the corrosion characteristics of the turret and other iron artefacts. The focus of the work is to better understand the current preservation state of these artefacts and to determine treatment paths for the large *Monitor* artefacts.

Part of this work has involved the identification and characterization of corrosion products found underneath concretions covering the turret and corrosion products that form or are converted due to exposure to the fresh water storage solution and to air. Corrosion products on exterior surfaces that have been exposed to fresh water have been found to be composed mainly of siderite ($FeCO_3$), lepidocrocite (γ–FeOOH), and goethite (α–FeOOH). If this exterior surface rust is allowed to dry to any extent, akaganeite (β–FeOOH) will form due to the presence of the chloride ion.

The corrosion products that lie on the iron between the metal/concretion interface have been found to be comprised mainly of magnetite (Fe_3O_4) and fayalite ($FeSiO_4$). These corrosion products are deposited from the inclusions in the iron as it corrodes. High fractions of sulphur have been detected in the magnetite layer, owing to bacterial activity in a low oxygen environment.

The magnetite remains stable in its anaerobic environment, and is therefore somewhat protective of the iron, as long as the external corrosion products and concretions remain intact. Once the outer rust layer is ruptured, the magnetite can oxidize to maghemite, (γ–Fe_2O_3) and then to the iron oxyhydroxides mentioned above.

These results have shown that the conditions below the concretion are highly stable and have remained relatively unaffected by storage in freshwater over the past three years. The results have also shown the importance of keeping iron artefacts constantly wet during storage and treatment to prevent formation of akageneite. A final report of this work is, at the moment, underway and the results will soon be published.

Currently, the *Monitor* team is studying the microscopic corrosion patterns and distribution of free chlorides and chloride-bearing compounds in iron samples from the *Monitor*. Characterization of this type will aid in selecting and evaluating treatment methods for the iron *Monitor* artefacts. Concerning the latter, the *Monitor* project has teamed up with The Friends of the Hunley to further evaluate and refine the subcritical water treatment for marine archaeological iron. Members of both the *Monitor* and *Hunley* teams will present two papers on these topics at the 2005 Eastern Analytical Symposium in Sommerset, New Jersey.

Related Publications and Information:

Desmond C. Cook and Curtiss E. Peterson. 2005. Corrosion of Submerged Artifacts and the Conservation of the USS *Monitor.* Industrial Applications of the Mössbauer Effect, American Institute of Physics Proceedings Vol, CP765, pp. 91-96.

Other information on the *USS Monitor* can be found on the following website: www.monitorcenter.org and the scientific report: Investigation of the corrosion of *USS Monitor* artifacts (www.rustdr.com).

Contacts: Eric Schindelholz (TMM) and Desmond Cook (ODU)
Funding: The National Oceanic and Atmospheric Administration (NOAA), The Mariners' Museum, and Old Dominion University

Ongoing research projects

Chlorinated phases on archaeological iron artefacts from terrestrial sites: characterization and formation mechanisms (***LPS***)

The current conservation treatments of Cultural Heritage metal artefacts are intended to reduce corrosion processes but further optimisation is required. The limitations of treatments are mainly due to the fact that the corrosion products formed on archaeological artefacts and the mechanisms developed due to the presence of chlorides are not well known.

Within this PhD research project, the study of corrosion mechanisms of iron (carried out on fragments from the corpus considered) in terrestrial soils containing chlorides used analytical investigation consisting of local and structural characterization of chlorinated corrosion products. Different microstructural analytical techniques have been used such as SR-XRD and SR-XAFS. This work has provided fundamental results on chlorinated phases.

Two crystalline phases have been identified; the oxyhydroxide, akaganeite (β–FeOOH) that is commonly found in corrosion products of artefacts exposed to a chlorinated environment; furthermore the study revealed the presence of another phase rich in chlorides: the hydrochloride β–$Fe_2(OH)_3Cl$. This result is very important since this phase has only rarely been documented on archaeological artefacts although it seems to be present in a great amount. This research project proposed several formation mechanisms for these phases depending on the environmental conditions. This information will have then to be taken into consideration when treating similar artefacts.

The second part of the work was the study of the localization of chlorides in akaganeite β–FeOOH, a compound which can release chlorides and which is then considered as responsible for the active corrosion of archaeological artefacts. The clustering of micro-characterization techniques of chlorinated corrosion products on archaeological fragments, and their comparison with the ones obtained on synthetic phases, have permitted the understanding of the complexity of the long term corrosion of iron in soils containing chlorides.

Contact: Solenn Reguer (LPS)
Funding: Grant from the French Ministry of Research

New research projects

New French research program on very long term corrosion in concrete (***LPS***)

Within the framework of the PNRC (Programme National de Recherche en Conservation) of the French *Ministère de la Culture et de la Communication*, a new research programme on the very long term corrosion of iron in concrete began in September 2005. This two-year collaboration will involve several French laboratories : the Laboratoire Pierre Süe - CNRS, the CEA (Commissariat à l'Energie Atomique), the Laboratoire d'Etude du comportement des bétons et argiles (CEA), the Laboratoire de recherches des Monuments Historiques (LRMH) and the Laboratoire Dynamique, Interactions, Réactivité (CNRS). This programme is motivated by a common need of laboratories studying the degradation of ancient monuments, in which, often significant amounts of iron are used to reinforce the structure (cathedrals, modern churches...) and laboratories conducting research in the nuclear domain where reinforced concrete are used on the one hand to develop specific nuclear wastes over-containers and, on the other hand, to build buildings for the interim storage of these wastes. In both cases, concrete structures reinforced with steel or ferrous alloys embedded in hydraulic or aerial mortars are employed and must resist alteration during very long periods. It is therefore necessary to create a model and predict in a reliable way the influence of iron or steel corrosion on the mechanical behaviour of the structure. The research will combine fine characterisation of the corrosion system that forms in this medium (to obtain some important physico-chemical parameters for the modelling process) and also studies the influence of corrosion product growth on concrete cracking. For this purpose, a model developed in the CEA will be based on two historic buildings. The final aim will then be to test the model on these two buildings and to use the results of the comparison to improve it.

Contact: Philippe Dillmann (LPS)
Funding: PNRC Ministère de la Culture et de la Communication (France)

New research projects

 Investigations into the alkaline sulphite treatment for conservation of large quantities of archaeological iron objects (***SABK***)

Twenty-five years of examination and experience show that the alkaline-sulphite-reduction of North and Pearson is quite effective to stabilise excavated iron objects. Nevertheless, the method is not widely used and much of the unearthed ferrous heritage in Europe is simply rusting away over decades. The most important disadvantages in conserving large quantities of iron objects are the process' time and money consuming details. But preventive conservation and other conservation methods do not work as effectively. That is why further investigations into the alkaline-sulphite-method are needed for the conservation of all excavated iron objects.

This PhD project in the study programme 'Object Conservation' in Stuttgart will start with a survey of the practical experience with this treatment in conservation departments. Any comment on details of the practical handling and its problems and the overall experience is most welcome (contact address at the end of the bulletin).

The fundamental processes of the method are not fully understood yet. Therefore, alkaline sulphite solutions will be applied in various ways on synthesised iron corrosion products and finds, the resulting phases will be analysed. Based on this, ways to simplify the process will be explored to allow the increased application on large quantities of objects.

The period of efficacy of sulphite as an oxygen scavenger depends on bath construction. Alternative processes and designs, such as cold desalination and possibilities to shorten the desalination process will be investigated. Methods to protect non-ferrous materials associated with the object (e.g. organic remains) will be systematically compared.

Contact: Britta Schmutzler (SABK)
Funding: Land Baden-Württemberg

New research projects


Mercury in technical and industrial collections (***HE-ARC***)

Due to its specific physical properties, mercury has been largely employed in many technical and industrial applications since the 17th century (lighting, measuring instruments, high voltage apparatus…). Mercury belongs though to the category of heavy metals and comprises toxicological characteristics that make it a dangerous substance for human health and the environment. Technology and industry museums collecting apparatus containing such metals are faced with the health risks of the staff in charge of their handling and maintenance. The conservation of materials in contact with these dangerous substances is quite problematic too. Therefore these technical and industrial collections require a specific conservation strategy.

The study of three mercury arc rectifiers from the Museum of Science and Industry of Porto (Portugal) collection will be the occasion to review past and current conservation approaches for such delicate objects. These apparatus of English origin (Hackbridge & Hewittic C.° L TD - Walton-one-Thames) were used during fifty years by the department of public transport in Porto. This project will be carried out as a final year diploma of the High school of applied arts (conservation-restoration of the technical and industrial heritage) of La Chaux-de-Fonds, Switzerland.

The toxicity of mercury is a well-known subject in the public and industrial domain and regulations have been established in many countries (France, Germany, UK and Canada) for its handling and storage. As regards the museum field, existing and past studies on mercury concern mainly natural history collections where mercury is found as a residue of pesticides used in the past to treat the artefacts. Considering more specifically technical and industrial apparatus where mercury is playing an important role as a component, its conservation raises not only technical, but ethical issues. Regulations about mercury have changed with time to become much stricter, but still, it is important to keep it in place to maintain the apparatus as complete as possible.

Within this diploma project we will gather existing technical and safety information concerning mercury and see to which extent such regulations can be applied to technical and industrial artefacts. We will follow a multidisciplinary approach in order to cover the subject from all possible sides (reception, storage, maintenance, detection of mercury leakage, restoration, preventive conservation and ethical issues). Based on the acquired knowledge we will define a conservation strategy for our artefacts.

Contact: Antonin Tarchini (HE-ARC)
Funding: No external funding

Promotion of books

Buchwald, Vagn Fabritius (2005). Iron and steel in ancient times. Royal Academy of Sciences and Letters : Viborg, Denmark. 372 pp. illustrated

ISBN: 87-7304-308-7
E-mail for ordering: www.royalacademy.dk
Approximate price: 50 Euro

The history of iron and steel is presented from the earliest known examples and onwards until 1200 A.D., when new methods of production were introduced. In an introductory chapter the use of meteoritic iron for tools and weapons is discussed, and it is shown how the three iron types, meteoritic, telluric and man-made iron may be distinguished. The competition between the use of copper, bronze and iron in the Mediterranean area is followed, and the transition from Bronze Age to Iron Age explained. Early centres of iron production, such as Elba, are examined in some detail. In a chronological development, the Etruscan, Roman and Celtic handling of ores and metal is examined, and the success of Nordic steel explained. The North European scene is explored, with emphasis on Norway, Sweden and Denmark, and it is shown that there were two steel-producing centres in Scandinavia, Valdres, Norway, in the Iron and Viking Ages, and Småland, Sweden, in early mediaeval times. The material has been examined from a metallurgical standpoint. The metal phases are analysed and tested for their hardness, and it is shown that ancient iron was usually a complex alloy of three elements, iron, carbon and phosphorus, the last one being also an important component. The manufactured objects, whether nails, horseshoes or tools, were extremely heterogeneous, in the structure as well as in the hardness and the slag inclusions, but it is illustrated that there is a logical, metallurgical harmony between the heterogeneous zones.

The furnace slags have been characterized by their morphology and composition, and the slag inclusions have been analysed in great detail and used to discriminate between artefacts of Danish origin and those of foreign origin. It turns out that a significant fraction of Danish Viking Age and early mediaeval artefacts have been imported from Norway as well as Scania and Halland in Sweden. The special world of metallurgy is elucidated with discussions of furnace technology, forging, hardening, hammer- and pattern-welding. The war booty sacrifices of the 3rd to the 5th century (Roman and Germanic Iron Age) Denmark, which are rich in pattern-welded swords, are treated with examples from Vimose, Nydam and Illerup Ådal.

Vagn Fabritius Buchwald, Professor (emeritus), Department of Metallurgy, Danish Technical University, DK-2800 Lyngby.

Private address, Ingeborgvej 4, DK-2920 Charlottenlund.

General information

Websites

- ARTECH network: http://server.icvbc.cnr.it/progetti_futuri/progetto_artech.htm

- **BIGSTUFF (Care of Large Technology Objects) 2004:**
http://www.awm.gov.au/events/conference/bigstuff/index.asp

- **CAMEO**: website containing chemical, physical, visual, and analytical information on over 10,000 historic and contemporary materials used in the conservation, preservation, and production of artistic, architectural, and archaeological materials
http://www.mfa.org/_cameo/frontend/

- Cost Action G8: Non-destructive analysis and testing of museum objects. http://srs.dl.ac.uk/arch/cost-g8. Abstracts and booklets from previous workshops can be downloaded as well as announcements of future activities (Short Term Scientific Missions deadlines, training schools…).

- Cost Action G7: Artwork conservation by laser http://alpha1.infim.ro/cost

- **e-Preservation Science**: http://www.e-preservationscience.org

- **European Cultural Heritage Network**: http://www.echn.net/

- IR and Raman for cultural heritage http://www.irug.org/default.asp

- LabS-TECH network http://www.chm.unipg.it/chimgen/LabS-TECH.html

- **Laboratoire Pierre Sue**: LPS PhD thesis related to the alteration of archaeological artefacts can be downloaded from http://www-drecam.cea.fr/lps/ (in French) and go to "Archéomateriaux et prévision de l'altération."

- **M2ADL** - Microchemistry and Microscopy Art Diagnostic Laboratory is now available at the following website: http://www.tecore.unibo.it/html/Lab_Microscopia/M2ADL/

- **PROMET** website: http://www.promet.org.gr

- **RESTAURACION METAL SUR AMERICA**: www.restauraciondemetales.cl

- Working Group Metals ICOM Committee for Conservation
http://icom-cc.icom.museum/WG/Metals/

- Online publications of Surface Engineering Journal . Issue addressing specifically to Metal issues: **Surface Modification Issues in Art**, Volume 17, Issue 3, June 2001. Can be downloaded from:
(http://www.ingentaconnect.com/content/maney/se/2001/00000017/00000003;jsessionid=1xpmlw91522a3.victoria)

Future seminars and conference

- **EAS-NYCFCSAS 2005** (Eastern Analytical Symposium- New York Conservation Foundation Conservation Science Annual symposia) 2005 (14-16 November 2005, New York, USA), organized by the New York Conservation Foundation. Topics considered: deterioration of metal pipes in 16-18th Century European organs and diverse studies on Heritage in metal. For more information visit the following website: www.nycf.org/eas.html
- **The Conservation of Archaeological Materials—current trends and future directions** (13-17 November 2005, Williamsburg, USA), organized by The Archaeological Discussion group of the American Institute of Conservation and the Department of Conservation at the Colonial Williamsburg Foundation. For more information contact Emily Williams (ewilliams@cwf.org): program or Deb Chapman (dchapman@cwf.org): general
- **ACCESS AGLAE and MOLAB Users' Meeting** (*ARTECH, Access, Research and Technology for the conservation of the European Cultural Heritage* - Structuring the European Research Area - Research Infrastructures (23 November 2005, Paris, France) organized by the C2RMF-UMR 171 CNRS. Further details can be found at http://www.eu-artech.org. For more information contact Justine Simonot (justine.simonot@culture.fr)
- **BIGSTUFF 2005** (Assessment, conservation and maintenance of large technology objects (1-2 December 2005, Canberra, Australia), organized by the Australian War Memorial as a follow-up to the BigStuff workshop run last year once again in Canberra. For more information contact Alison Wain (alison.wain@awm.gov)
- **« Chimie, Art et Archéologie : bilan des recherches du GdR 2114 ChimArt »** (25-26 January 2006, Paris, France) organised by the CNRS and the Ministry of Culture and Communication. For more information contact Martine Regert (martine.regert@culture.fr)
- **Final workshop of COST Action G8 "Non-destructive analysis and testing of museum objects"** (18-20 May 2006, Nicosia, Cyprus). For more information contact Annemie Adriaens (annemie.adriaens@ugent.be)
- **IRON, STEEL AND STEAM 2006**: On site seminar (last week of June 2006) in response to Australia-wide and some initial overseas interest, the Western Australian Maritime Museum will be convening Australia's second on-site iron and steam ship archaeology seminar. For more information please contact the convenor m.mccarthy@museum.wa.gov.au
- **Archaeometallurgy in Europe** (May or June 2007, Grado and Aquileia, Italy) organized by the Associazione Italiana di Metallurgia. For more information visit the following website: www.aimnet.it/archaeometallurgy2.htm

Abbreviations and acronyms

CEA: Commissariat à l'Energie Atomique
DCDS-BM: Department of Conservation, Documentation and Science - British Museum, London
EDS: Energy Dispersive Spectroscopy
FTIR: Fourrier Transformed Infra Red
HE-AC: Haute école d'arts appliqués Arc
INP-DR: Institut National du Patrimoine – Département des restaurateurs
LIBS : Laser Induced Breakdown Spectroscopy
LRMH: Laboratoire de Recherche des Monuments Historiques
ODU : Old Dominium University
PNRC : Programme National de Recherche en Conservation
RBS: Rutherford Backscattering Spectrometry

RH: Relative Humidity
SABK: State Academy of Art and Design Stuttgart
SEM-EDS: Scanning Electron Microscopy – Energy Dispersive Spectroscopy
SR-XAFS: Synchrotron Radiation – X-Ray Absorption Spectroscopy
SR-XRF: Synchrotron Radiation – XRF
TEI: Technical Educational Institute
TMM: The Mariners' Museum
UHP – LCSM: Université Henri Poincaré - Laboratoire de Chimie du Solide Minéral
XRD: X-Ray Diffraction
XRF: X-Ray Fluorescence spectroscopy

Contacts

Vasilike Argyropoulos / TEI (bessie@teiath.gr)
Desmond Cook / ODU (DCook@physics.odu.edu)
Philippe Dillmann / LPS (Philippe.Dillmann@cea.fr)
François Mirambet / LRMH (francois.mirambet@culture.gouv.fr)
Solenn Reguer / LPS (REGUER@DRECAM.CEA.FR)
Emmanuel Rocca / UHP-LCSM (emmanuel.rocca@lcsm.uhp-nancy.fr)
Eric Schindelholz / TMM (eschindelholz@mariner.org)
Britta Schmutzler / SABK (Britta.Schmutzler@gmx.de)
Antonin Tarchini / HE-ARC (antonin.tarchini@he-arc.ch)
Quanyu Wang / DCDS-BM (qwang@thebritishmuseum.ac.uk)

National representatives of the Metal WG

- **Argentina**: Blanca Rosales, researcher, CIDEPINT, La Plata
- **Australia**: David Hallam, senior conservator of objects at the National Museum of Australia, Canberra
- **Belgium**: Annemie Adriaens, researcher and lecturer, head of the group "Electrochemistry and Surface Science", Ghent University, Gent and Gilberte Dewanckel, conservator at IRPA (Institut Royal du patrimoine artistique), Bruxelles
- **Bulgaria**: Petia Penkova, conservator, National Academy of Arts, Department of conservation-restoration, Sofia
- **Canada**: Judy Logan, senior conservator, Canadian Conservation Institute, Archaeology section, Ottawa
- **Chile**: Johanna Theile, conservator and lecturer, Facultad de Arte - Universidad de Chile Las Encinas, Santiago de Chile
- **Croatia**: Goran Budija, conservator, Museum of Arts and Crafts, Zagreb
- **Czech Republic**: Dusan Perlik, conservator, Museum of Central Bohemia, Roztoky
- **Denmark**: Karen Stemann Petersen, conservator, The National Museum of Denmark, Copenhagen
- **Egypt** : Wafaa Anwar Mohamed, conservator, Giza
- **Finland** : Eero Ehanti, conservator, Maritime Museum of Finland, Helsinki
- **France**: Marie-Anne Loeper-Attia, conservator and assistant-lecturer at the Conservation Department, Institut National du Patrimoine, St Denis, Paris and Christian Degrigny, conservation scientist
- **Germany**: Gerhard Eggert, head, study program "Object Conservation", Staatliche Akademie der Bildenden Künste, Stuttgart

- **Greece**: Vasilike Argyropoulos, assistant professor, Department of Conservation of Works of Art, Technological Educational Institution, Athens
- **Hungary**: Balazs Lencz, senior conservator, Conservation Department, Hungarian National Museum, Budapest
- **Italy**: Paola Letardi, scientist, Istituto per la corrosione marina dei metalli (ICMM), Genova
- **Malta**: Christian Degrigny, conservation scientist, Diagnostic Science Laboratories, Malta Centre for Restoration, Kalkara
- **The Netherlands**: Bart Ankersmit, conservation scientist, The Netherlands Institute of Cultural Heritage, Amsterdam
- **Norway**: Douwtje Van der Meulen, conservator, Conservation Department, University of Oslo, Oslo
- **Portugal**: Isabel Tissot, conservator, Portuguese conservation-restoration Institute, Lisbon
- **Romania**: Dorin Barbu, conservator, Brukenthal Museum, Sibiu
- **Russian Federation**: Andrey Chulin, conservator, the State Hermitage Museum, St Petersburg
- **South Africa**: Jaco Boshoff, maritime archaeologist, Iziko Museums of Cape Town, South Africa
- **Spain**: Emilio Cano, conservator, National Centre for Metallurgical Research (CENIM), Spanish Council for Scientific Research (CSIC), Madrid
- **Sweden**: Helena Strandberg, conservator and conservator scientist, freelancer, Göteborg
- **Switzerland**: Valentin Boissonnas, conservator and lecturer, Haute école d'arts appliqués Arc, La Chaux-de-Fonds
- **United Kingdom**: David Watkinson, Senior Lecturer, Conservation Section, School of History and Archaeology, Cardiff University, Cardiff
- **USA**: Paul Mardikian, senior conservator, Warren Lasch Conservation Centre, North Charleston & John Scott, New York Conservation Foundation, New York