MetalPAT

The MetalPAT project brings together a large group of professionals spread over the Interreg France-Switzerland region. The numerous collaborations set up between the project partners and the end-users involved contribute to the success of the project through the exchange of knowledge and experience.

The project partners

MetalPAT project activities started at the time of the 1st Covid-19 lockdown in March 2020. The year 2020 was conducted with periods of deconfinement and re-confinement. Faced with these unmanageable hazards, we have adapted and this third letter shows that the project is progressing as expected.

- **COLLABORATION BETWEEN METALPAT'S PARTNERS**

The development of the tool for identifying heritage metals based on their macroscopic description, as requested by collections managers and initiated in 2020 with the support of the *Communauté du Savoir* (CdS - (http://www.communautedusavoir.org/), continues. The prototype has been submitted to the Haute Ecole Gestion Arc (HEG Arc). Since its integration into the MiCorr+ application requires its translation into computer language, the preparatory work was entrusted to a student currently doing his bachelor's degree at the HEG Arc, Yann Hackel.

The current prototype does not take into account certain special cases: archaeological, modern, surface-treated metals and metals combined to organic materials. As this gap needs to be filled, we submitted a second application for support to the CdS. This application was again successful. For the first application, the meetings were plenary; for the second, we will work in workshops to deal with the problem posed between participants (the same as for the first application) motivated by it. However, a plenary meeting at the end of the project will present the progress made in the four workshops to all project participants.

While the tool developed is highly praised by collections managers, it has also been tested with master students from the HE-Arc CR and the conservation department of the University of Oslo. All of them consider it as user-friendly and appreciate the information provided on the summary sheets of the metal families.
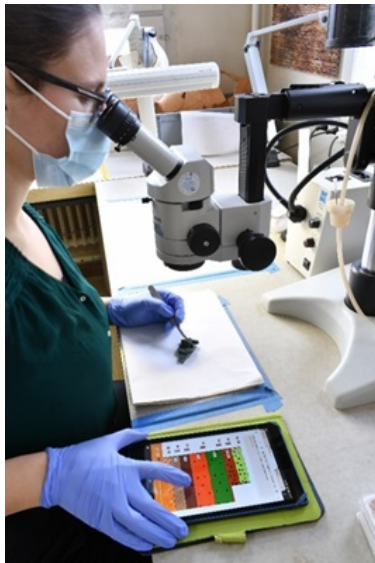
The project partners have also made good progress on another front, that of the new search engine by building digital stratigraphies reflecting the corrosion structures observed on the heritage metals studied.

On the left, observation in binocular mode, © N. Gutknecht, on the right, observation in cross-section mode, © UTBM.

As a reminder, the search engine had to be subdivided according to two observation modes in order to better meet the needs of future MiCorr+ users: the "binocular" mode adapted to the tactile approach of the material followed by conservators and the "cross-section" mode used by conservation and corrosion scientists, as well as archaeometallurgists, having techniques for studying the physical chemistry of materials and working rather on cross-sections. The sub-characteristics to be filled in according to the two modes of observation were compiled by the experts of the HE-Arc CR, the LMC-IRAMAT (UTBM) and the LAPA (CEA) and transmitted to the experts of the HEG Arc, who rearranged them in order to be able to integrate them into the new fields created. We give below an example of data acquired with the new search engine during the study of the corrosion structure of a lake patina. The corrosion structure is first studied in a micro-invasive way on the object itself, based on spot scalpel probes or here on the observation of existing lacuna (non-invasive approach in this case) revealing the stratigraphy in place.

Detail of a needle with lake patina showing lacuna, Laténium collections, © S. Ramseyer.

Digital stratigraphy of the corrosion structure observed under binocular.

After sampling, this same stratigraphy is examined in cross-section using multiple observation techniques (optical and electron microscopies) and analyses (energy dispersive and Raman spectroscopies, etc.).
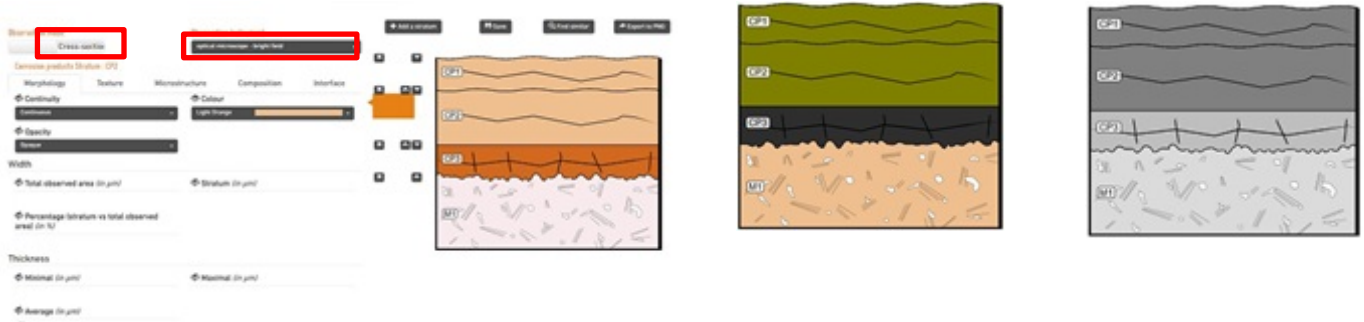
Digital stratigraphies of the same corrosion structure observed under optical (bright field, left, and dark field, centre) and electronic (secondary and backscattered electrons, right) microscopes.

Each observation mode has its own sub-characteristics that the user must fill in.

The two modes of observation, "binocular" and "cross-section", are naturally complementary. The next step will therefore be to find correspondences between them so that a MiCorr+ user constructing a digital stratigraphy in "binocular" mode can benefit, via comparison with the stratigraphies in the database, from in-depth information on objects showing similar corrosion patterns (development of corrosion in the core of the material, influence of its composition and microstructure, etc.), accessible only by cross-section examination.

For the time being, the whole database built from the previous search engine is being reviewed in order to adapt it to the new engine in place. A parallel work aims at giving a specific weight to each sub-characteristic so that the comparison between a digital stratigraphy of an unknown corrosion structure and those of corrosion structures in the database is relevant.

- ## COLLABORATION WITH END-USERS – CONSERVATORS

The collaboration with the end-users - collection managers - is more related to the demands of the *Communauté du Savoir*. As the workshops are planned for June 2021, we will present the results in the fourth newsletter in November 2021. In the following, we develop the collaboration with end-users - conservators, even if some collection managers may be involved.

Valentina Valbi (VVA), post-doc at the LMC-IRAMAT of UTBM, started her contract in January 2021. Her main task is to enrich the MiCorr+ database with cross-section examination of corrosion structures, previously observed macroscopically by Naïma Gutknecht (NGU) from HE-Arc CR. As VVA uses the search engines and the different functions of the MiCorr+ application, she also contributes to its optimisation.

Material	Research theme	Canton / department	End-user[1] and corpus	2021		2022	
				Semester1	Semester2	Semester3	Semester4
Iron	Atmospheric corrosion of cast iron	Territoire Belfort	UTBM / factory poles	In progress			
	Crevice corrosion	Canton de Vaud	SMRA / ring				
		Département du Jura	CCE-LS / buckle plate		Planned		
		Département du Doubs	MBAA / buckle plate		Planned		
	Corrosion of composite objects	Canton du Jura	SAP / knifes		Planned		
		Département du Doubs	MBAA / knifes		Planned		
	Metallurgic studies	UTBM / LAPA	Inrap	In progress			
			MCAH / semi-finished objects		Planned		
	Filiform corrosion	Canton de Neuchâtel	HE-Arc CR				
Copper	Crumbling of corrosion products	Canton de Berne	SACB / pin		Planned		
		Canton de Vaud	SMRA / ear pick & fibula	In progress			
		Département du Jura	CCE LS / axe		Planned		
		Département de Saône-et-Loire	Inrap (Autun) / craft		Planned		
	Lake corrosion	Canton de Neuchâtel	Laténium / pins	In progress			
		Canton de Berne	SACB / bracelet		Planned		
	Metallurgic studies	Canton de Vaud	MCAH / situla and other containers	In progress			
		Etat de Fribourg	SAEF / bracelets	In progress			
		Canton de Genève	MAHG / coins	In progress			
	Metal soaps	Canton de Genève	MEG / composites		Planned		
		Canton de Berne	Foundation HAM / composites		Planned		
		Département du Haut-Rhin	MNAM / car parts		Planned		
Silver	Horn silver	Canton de Berne	SACB / coin	In progress			
		Canton de Vaud	SMRA / coin	In progress			
	Technological study	Canton du Valais	ABSM / shrine	In progress			
Zinc	Localised corrosion	Canton de Neuchâtel	HE-Arc CR / engraving plates				
	Zinc pest	Département du Haut-Rhin	MNAM / car parts		Planned		
Modern metals	Unusual form of corrosion	Canton de Berne	Foundation HAM / military objects		Planned		

Legend: ▮ Technology ▮ Corrosion mechanisms ▮ Conservation ▮ In progress ▮ Planned

[1] ABSM : Abbaye de Saint-Maurice ; CCE-LS : Centre de conservation et d'étude des Musées de Lons-le-Saunier ; Fondation HAM : Fondation matériel historique de l'armée suisse à Thun ; Inrap : Institut national de recherches archéologiques préventives ; Laténium : Parc et musée d'archéologie de Neuchâtel ; MAHG : Musée d'art et d'histoire de Genève ; MBAA : Musée des Beaux-Arts et d'archéologie de Besançon ; MCAH : Musée cantonal d'archéologie et d'histoire de Lausanne ; MEG : Musée d'ethnographie de Genève ; MNAM : Musée national de l'automobile de Mulhouse ; SACB : Service d'archéologie du Canton de Berne ; SAEF : Service archéologique de l'Etat de Fribourg ; SAP : Section d'archéologie et paléontologie du Jura ; SMRA : Site et musée romains d'Avenches.
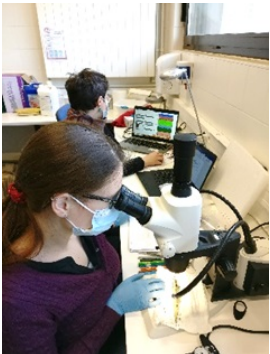
Research themes have been defined by the MetalPAT partners on the basis of the corpus of objects proposed by the various end-users. These are technological and/or corrosion mechanisms and/or conservation questions related to the forms of corrosion developed.

The table above summarises, by type of material, the collaborations set up around the different research themes. Current and future work is given as an indication. Indeed, although some collaborations have been established, the actual work requires access to the objects in question and/or the possibility of taking samples, which could not always be carried out because of Covid-19.

However, some of the work is well advanced, as the following illustrations show.

Iron		
Study of cast iron poles of Japy factory, © V. Valbi	Crevice corrosion on a ring, SMRA, © SMRA	Corrosion of knifes with wooden or horn handles from St Ursanne site, SAP, Jura, © SAP Corrosion of a knife from Saint-Vit site, MBAA, © MBAA
Copper		
© C. Degrigny	© SACB © SMRA	Pin with lake patina, Laténium, © C. Cevey
	Objects with crumbling corrosion products: on the left, point observed under binocular at CCE-LS, on the right above pin, SACB and below fibula, SMRA	

Metallurgical study of draft bracelets from Bussy site, SAEF, © SAEF |

Examination of the artefacts from the Mormont site at MCAH for further metallurgical study, © N. Gutknecht |
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Metal soaps: above on rivets of a belt, MNAM and below on the rivet of a bag, Foundation HAM, © C. Degrigny |

Metallurgical study of a hoard of coins from Peney site, MAHG, © C. Degrigny | |
| **Silver** |

Technological study based on detached fragments of the Shrine of Saint Maurice, © ABSM | | |
| **Zinc and light metals** |

Observation of a set of Zamak parts suffering from zinc pest, MNAM, © N. Gutknecht |

Observation of a set of light alloy soldier medals, HAM Foundation, © N. Gutknecht | |

- **COMMUNICATIONS**

Publications
Article from the talk « Outils numériques en libre accès et participatifs comme supports pour l'analyse et le diagnostic des métaux du patrimoine : possibilités et limites » in the proceedings of the conference DigiArch2020 - Cultural Heritage in the Digital Age held on 24 March 2021.

Talks
- Talk by C. Degrigny "MiCorr a user-friendly platform to assist in the diagnosis of metal corrosion" at the Swiss Corrosion Science Day seminar held on 26 April 2021 at Metrohm premises in Zofingen.

- Talk by C. Degrigny " Développement de Micorr comme outil participatif d'aide au diagnostic des métaux patrimoniaux " at the Journées Etude, Recherche et Innovation en Conservation-restauration 2021 to be held in Toulouse on 4 June 2021.