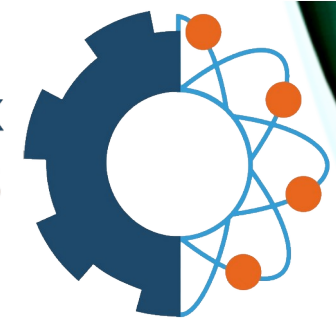




**Science Week**  
**Tirana 2023**



# STUDYING CULTURE HERITAGE WITH PHYSICAL ANALYTICAL METHODS

**DR. OLTA ÇAKAJ**

**Department of Physics**  
**Faculty of Natural Sciences**  
**University of Tirana**

**Science Week in Tirana, November 20-24,**  
**2023**



Science Week  
Tirana 2023



## Second Level Integrated Diploma

“Study of the elemental composition and microstructure of various ancient copper and copper alloy objects”

Supervisor:  
Prof. Dr. Teuta DILO

Faculty of Natural Sciences &  
Institute of Applied Nuclear  
Physics, UT

July 2009



# Second Level Integrated Master

“Synthesis, characterization and thermal analysis of  $\text{LiMn}_2\text{O}_4$  as cathode material for Li-ion batteries”

Supervisors:

Prof. Dr. rer. nat. habil H. J. Seifert

PhD D. M. Cupid

Prof. Dr. Teuta Dilo

Faculty of Natural Sciences, UT  
& Faculty of Materials Science  
and Materials Technology,  
Technische Universität  
Bergakademie Freiberg,  
Germany

(DAAD scholarship)

## »» Das DFG-Schwerpunktprogramm 1473: Werkstoffe mit neuem Design für verbesserte Lithium-Ionen-Batterien ««

*Das Schwerpunktprogramm „Werkstoffe mit neuem Design für verbesserte Lithium-Ionen-Batterien – WeNDeLIB“ wurde kürzlich von der Deutschen Forschungsgemeinschaft (DFG) eingerichtet.*

In diesem Programm werden in den nächsten sechs Jahren die Zusammenhänge zwischen dem strukturellen Aufbau und der Thermodynamik neuer Batterie-Werkstoffe und dem resultierenden elektrochemischen Systemverhalten erforscht. Mehr als 30 Forschergruppen an Universitäten und außer-universitären Einrichtungen in Deutschland und Österreich arbeiten hierzu koordiniert und interdisziplinär zusammen. Das gemeinsame übergreifende Ziel ist es, mit diesen Arbeiten einen grundlegenden Beitrag zum kommerziellen Erfolg von Fahrzeugen mit zunehmend elektrifiziertem Antriebsstrang (Hybrid-, Plug-in-Hybrid-, Elektro-Fahrzeuge)

zu leisten. Die Lithium-Ionen-Batterien sollen auf eine neue Leistungsstufe gehoben werden.

### Elektromobilität

Die Elektromobilität wird als eine wichtige Schlüsseltechnologie der nächsten Jahrzehnte für weltweit alle Volkswirtschaften angesehen deren Erfolg mit dem Angebot technisch innovativer und umweltfreundlicher Automobile verknüpft ist. Von zentraler Bedeutung für die Leistungsfähigkeit von modernen Elektro-Fahrzeugen sind die verwendeten Lithium-Ionen-Batterien. Diese

Batterien sind die derzeit mit Abstand leistungsfähigsten Systeme, um die technischen Anforderungen an die neuen mobilen Energiespeicher zu erfüllen. Sie bewähren sich bereits seit vielen Jahren in Laptops, Handys und Geräten der Unterhaltungselektronik. Für die moderne Elektro-Fahrzeugtechnologie sind jedoch sehr viel größer dimensionierte und leistungsfähigere Batteriesysteme erforderlich. Die jüngsten Fortschritte in der Erforschung, Entwicklung und beim kommerziellen Einsatz dieser Batterien für mobile Anwendungen sind höchst bemerkenswert. Die in Bild 1 gezeigten Nachwuchswissenschaftler der TU Bergakademie Freiberg (Institut für Werkstoffwissenschaft) halten eine solche Lithium-Ionen-Batteriezelle in Händen. Diese leistungsfähige Zelle besitzt eine Kapazität von 40 Amperestunden, liefert 3,6 Volt Spannung und wiegt nur ein Kilogramm. Rund einhundert dieser Zellen werden für die Konstruktion einer modernen Elektroauto-Batterie zusammengeschaltet.

Bekanntlich werden reine Elektro-Autos, die mit solchen oder ähnlichen Zellen betrieben werden, weltweit intensiv getestet und auch Serien-Elektro-Fahrzeuge werden bereits angeboten. Die Fahrberichte zeigen, dass der Fahrspaß beim Alltagseinsatz der Elektro-Autos durchaus nicht zu kurz kommt. Die sehr guten Beschleunigungswerte und das geräuscharme Dahingleiten werden als Pluspunkte der Elektrofahrzeuge vermerkt, auch wenn die Höchstgeschwindigkeiten alltagsstauhafter Automobile in der Regel noch auf ca. 130 Stundenkilometer begrenzt sind. Ein großer Vorteil der Elektromobilität ist auch



Abb. 1: Nachwuchswissenschaftler des DFG-Schwerpunktprogramms SPP 1473 begutachten eine Lithium-Ionen-Batteriezelle (Li-Tec Battery GmbH, Kamenz, Sachsen).



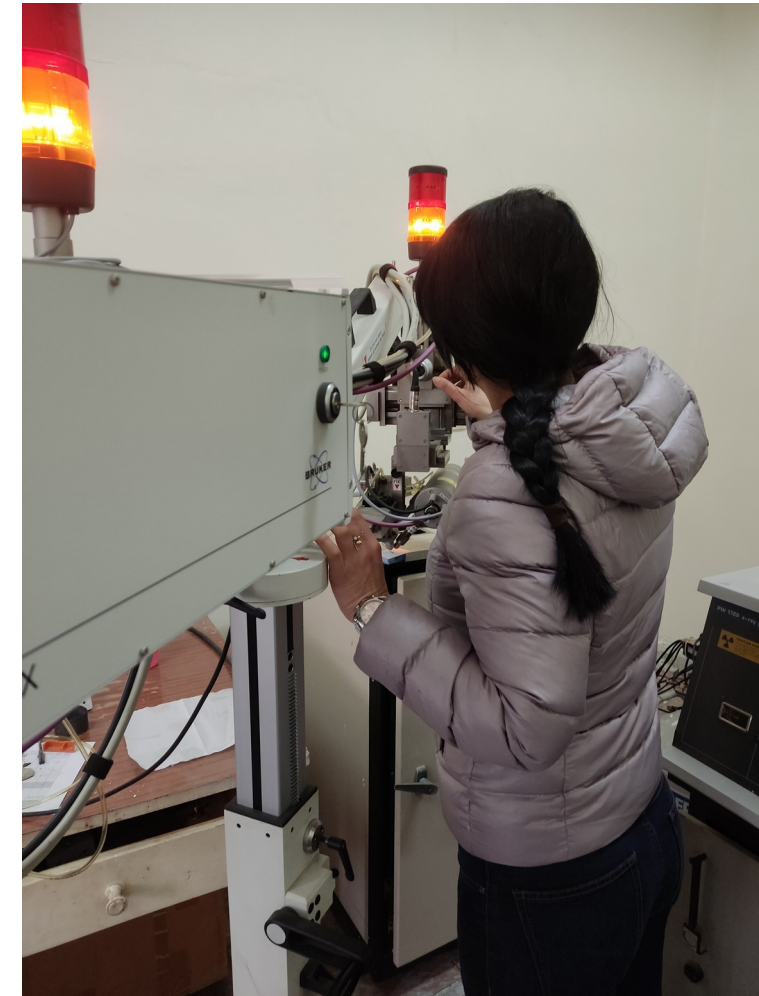
# Doctorate thesis

“Characterization and study of production technology of ancient copper and copper alloy objects excavated in Albania”

Supervisor:  
Prof. Dr. Teuta DILO

Faculty of Natural Sciences, UT  
Institute of Applied Nuclear Physics,  
Faculty of Mechanical Engineering,  
Process and Energy Engineering,  
Technische Universität Bergakademie  
Freiberg, Germany  
(DAAD scholarship)

June 2017



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# Doctorate thesis in archaeometry

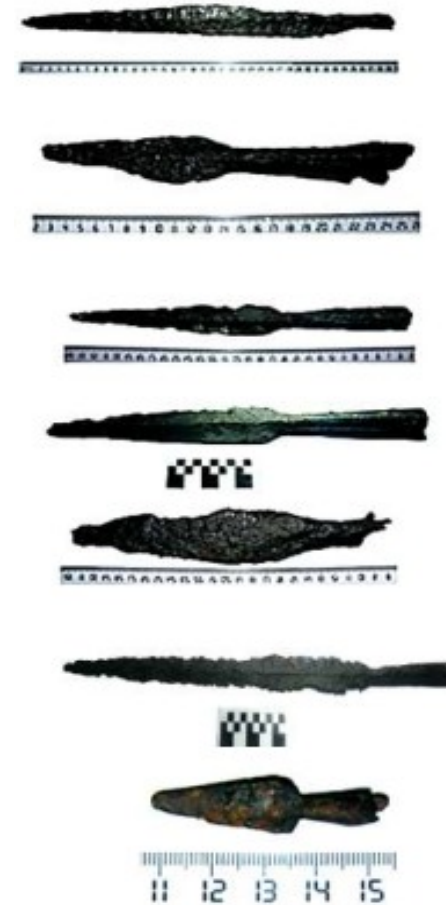
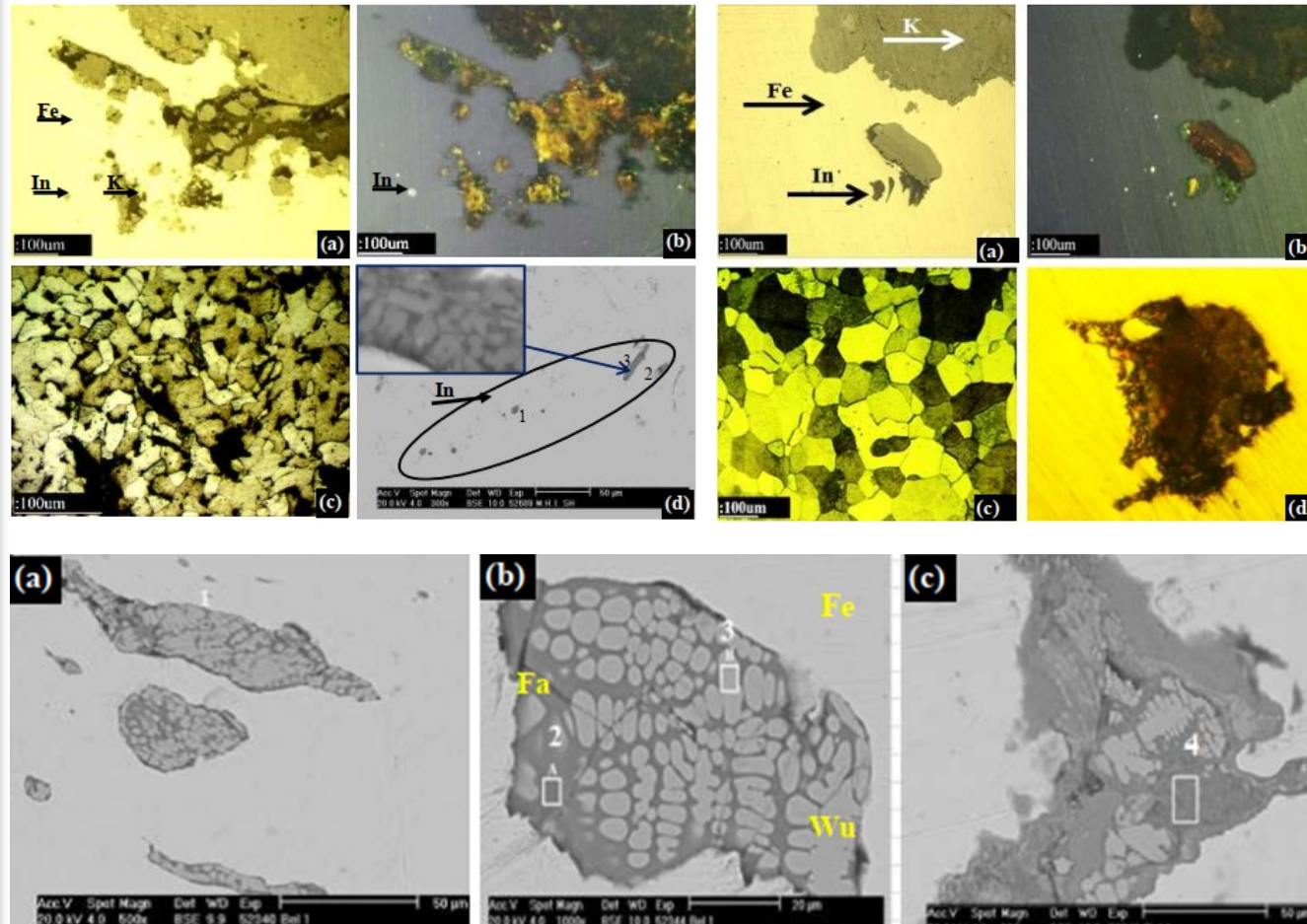
“Determination of structure and production technology of ancient iron objects excavated in Albania”

Dr. Edlira DUKA

Supervisor: Prof. Dr. Teuta DILO



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# Doctorate thesis in archaeometry

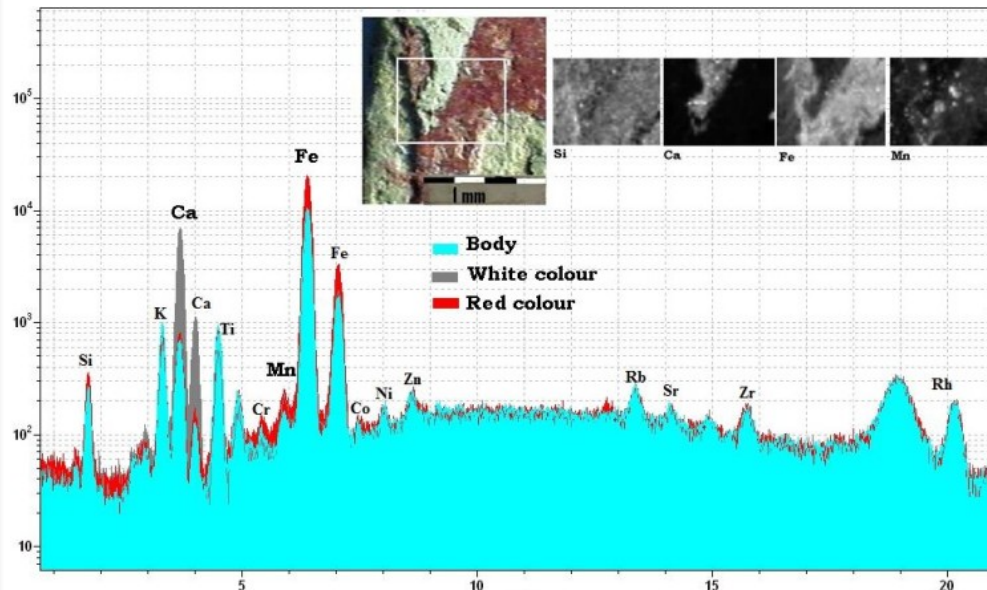
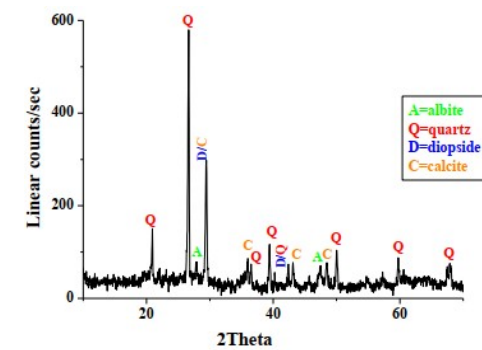
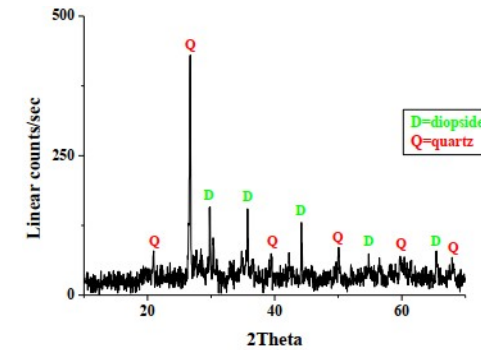
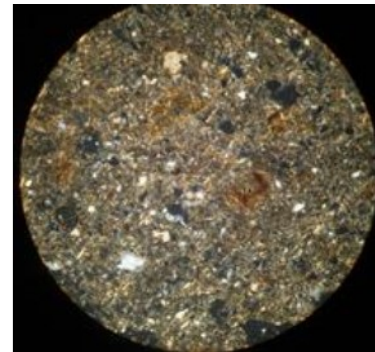
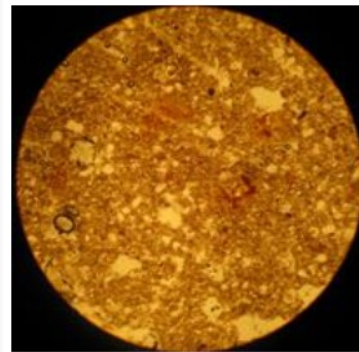
“Study of the ceramic objects’ composition excavated in the Neolithic period settlements in our country”

Dr. Erinda NDREÇKA

Supervisor: Prof. Dr. Nikolla Civici



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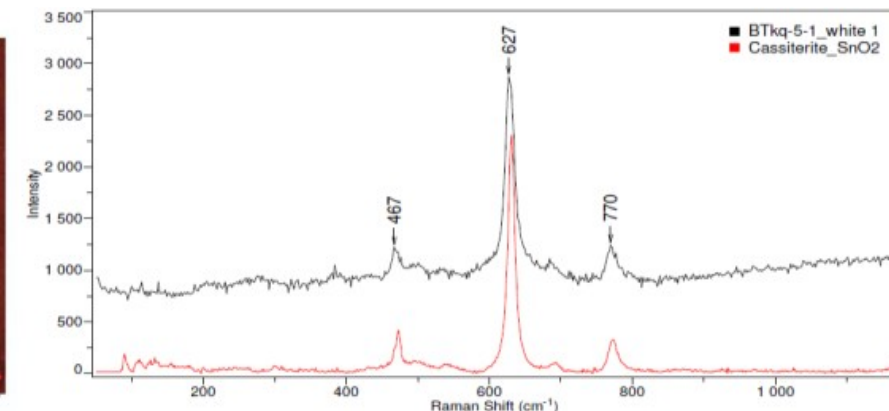
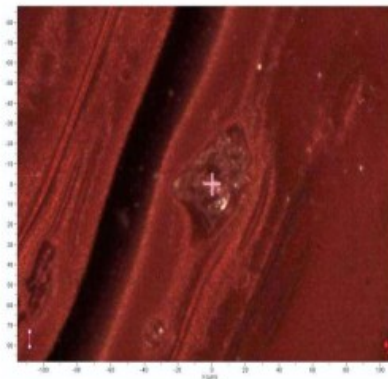
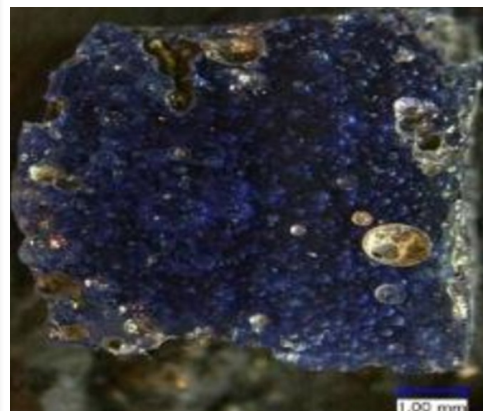
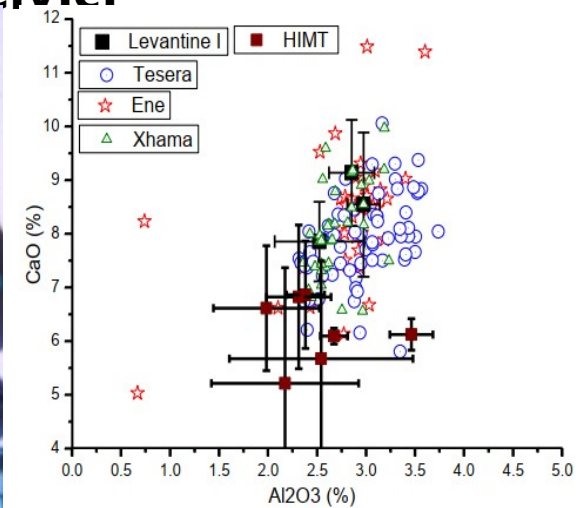
# Doctorate thesis in archaeometry

“Study of antique glassy objects excavated in our country

using non-destructive analytical methods”

Dr. Esmeralda VATAJ

Supervisor: Prof. Dr. Nikolla Çivici



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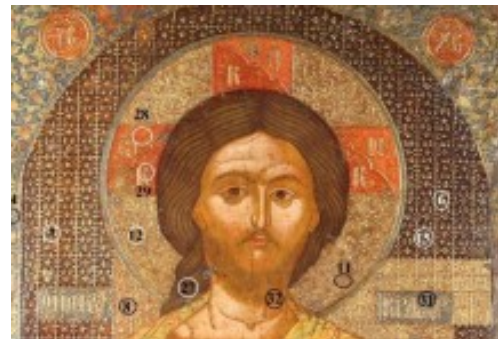
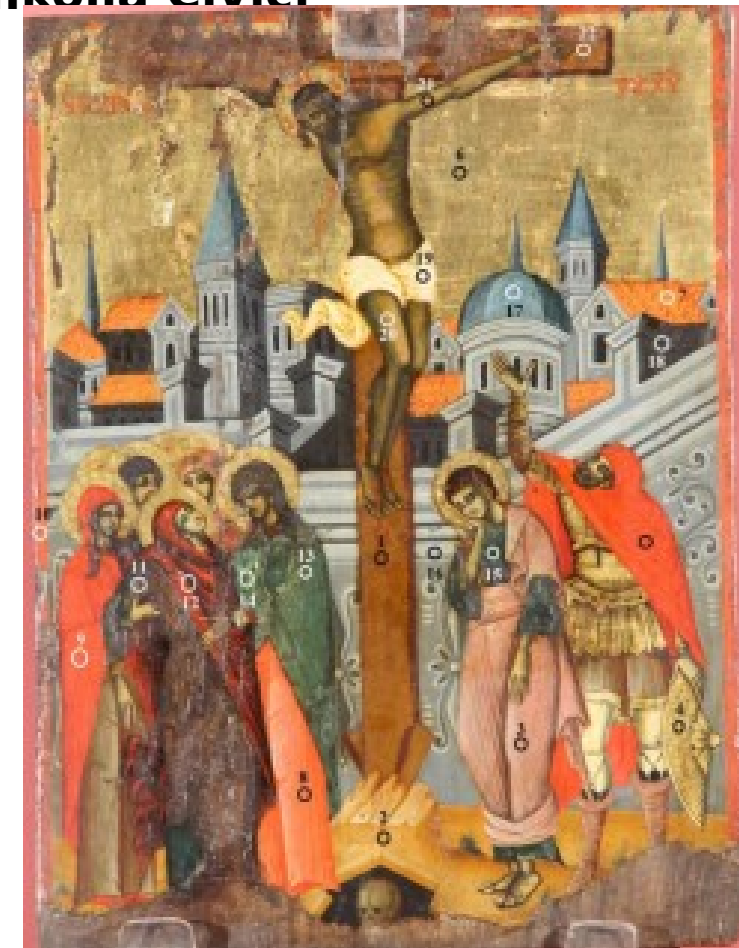
# Doctorate thesis in archaeometry

**“Study of materials used in early iconographic cult objects**

**with non-destructive analytical methods”**

**Dr. Eglantina MERKAJ**

**Supervisor: Prof. Dr. Nikolla Civici**



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# WORK EXPERIENCE

- **01 June 2014 - currently**

Physics lecturer – Department of Physics, Faculty of Natural Sciences, University of Tirana

- **01 August 2021 - currently**

Coordinator – National Institute of Physics (NIP), Academy of Sciences of Albania

- **01 January 2011 - 31 May 2014**

Physics lecturer – Department of Physics, FEM&EF, Polytechnic University of Tirana

- **01 October 2010 - 31 December 2010**

Physics lecturer – Department of Engineering Sciences, FPS, Aleksandër Moisiu University Durrës

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# PROJECTS

- **2023 - 2024**

Leader of the project "The study of Jani and Vasili workshop from Qestorati, within the iconography framework of the XVIII-XIX century", the program "UT - Research, Excellence and Innovation", in cooperation with the University of Tirana, the Institute of Applied Nuclear Physics and the Ministry of Culture.

- **2023 - 2024**

Member of the project "Effects of microplastics on water quality in Erzen River and Adriatic Sea", program "UT - Research, Excellence and Innovation", in cooperation with the University of Tirana and the Institute of Applied Nuclear Physics.

Nuclear Physics.

- **2021 - 2023**

Member of the project "Establishment of Raman Spectroscopy Laboratory for the study of microplastics in marine and freshwater ecosystems" of National Agency of Scientific Research and Innovation (AKKSHI) in collaboration with Institute of Applied Nuclear Physics, University of Tirana and Polytechnic University of Tirana.

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# ANALYTICAL METHODS USED SO FAR

Analytical methods used in Albania, Germany and Greece include:

- Optical microscopy
- Scanning electron microscopy
- X - ray fluorescence
- X - ray diffractometry
- Qualitative & quantitative image analysis
- Thermo differential & thermo gravimetric analysis
- Laser spectroscopy

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# RESEARCH AREAS

Research areas include:

- Materials science
- Characterization of materials
- Archaeometry
- Archaeometallurgy



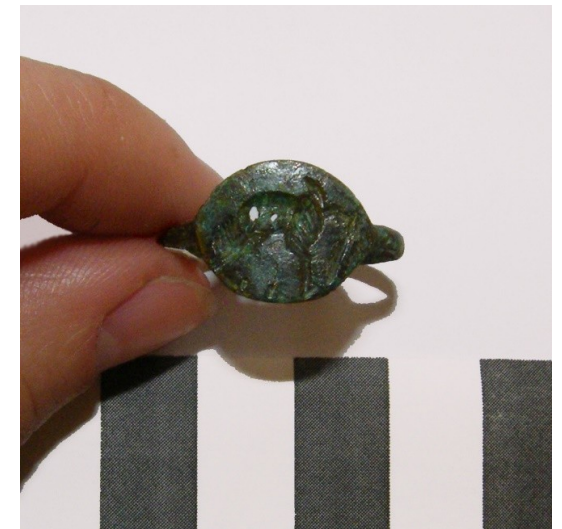
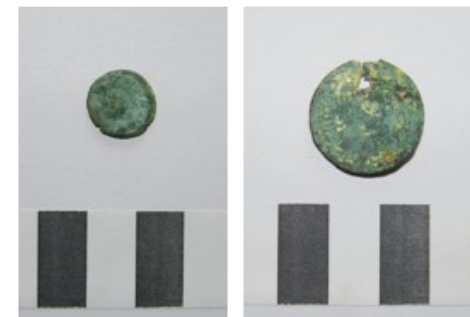
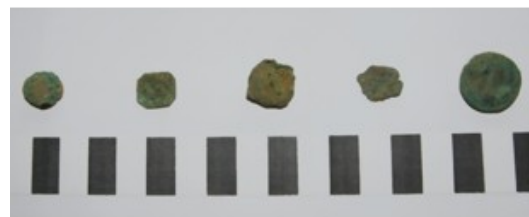
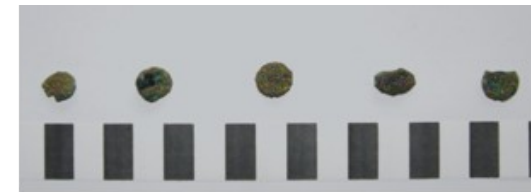
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# DURRËS ARCHAEOLOGICAL MUSEUM AND INSTITUTE OF CULTURAL MONUMENTS TIRANA



**From the XIV century B.C. to Middle Age**



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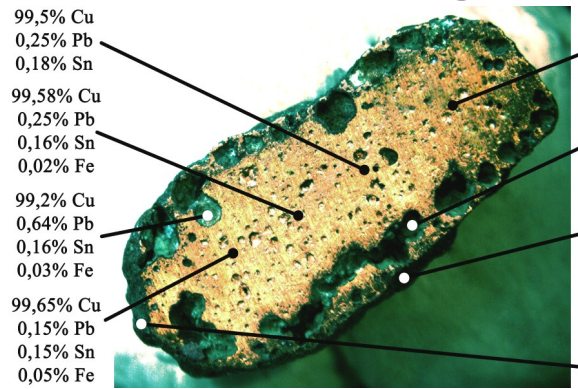
# SHKODRA MUSEUM



Science Week  
Tirana 2023



**From the XIV century B.C. to Middle Age**



# NATIONAL HISTORICAL MUSEUM, TIRANA



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Tirana 2023



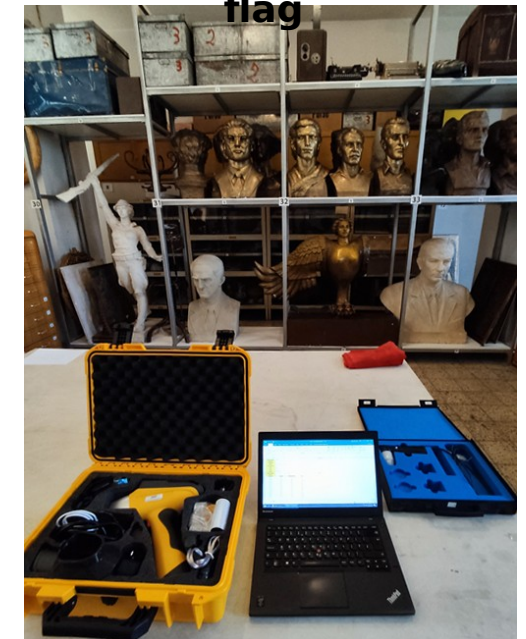
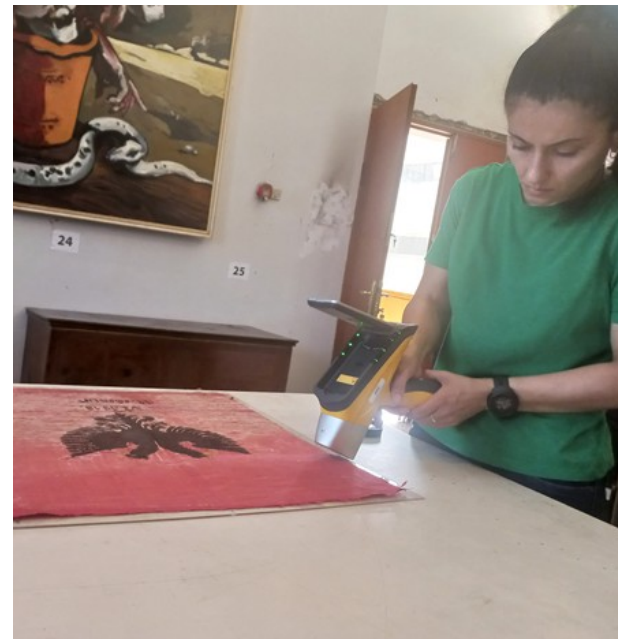
The renaissance çeta's flag



The one-year Independence's anniversary flag

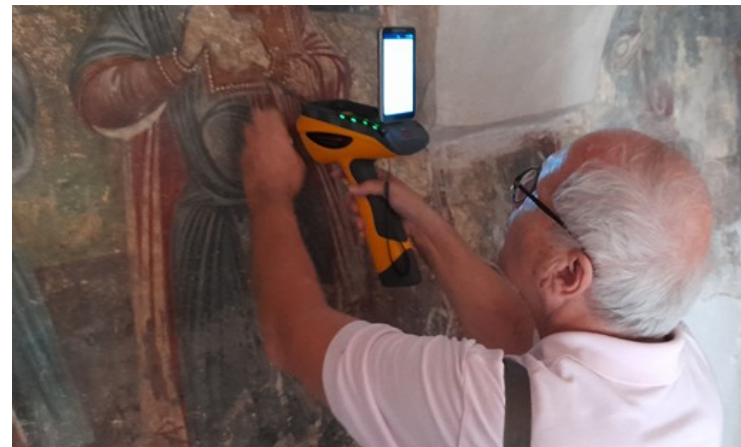


The "Dëshira" (desire) Albanian society in Sofia flag



# MONASTERY OF SAINT MARY ATHALI, HIMARË, VLORË

**Project:  
Jani and Vasili workshop  
XVIII-XIX century**



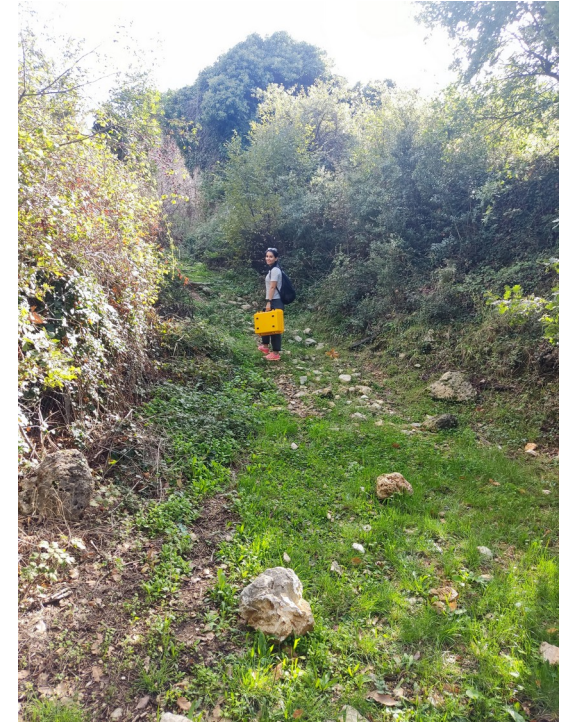
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# CHURCH OF SAINT KOLLI, DHROJAN, SARANDË

Project: Jani and Vasili workshop, XVIII-XIX century



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# MONASTERY OF EVANGELIZATION (STAIN MARY), VANISTËR, GJIROKASTË

**Project:  
Jani and Vasili  
workshop  
XVIII-XIX century**



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# STUDY OF MICROPLASTICS IN MARINE AND FRESHWATER ECOSYSTEMS



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**Sampling in  
Erzen river &  
the Adriatic  
ses**



# STUDY OF MICROPLASTICS IN MARINE AND FRESHWATER ECOSYSTEMS

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Tirana 2023



OM pictures  
with 40X &  
100X  
magnification

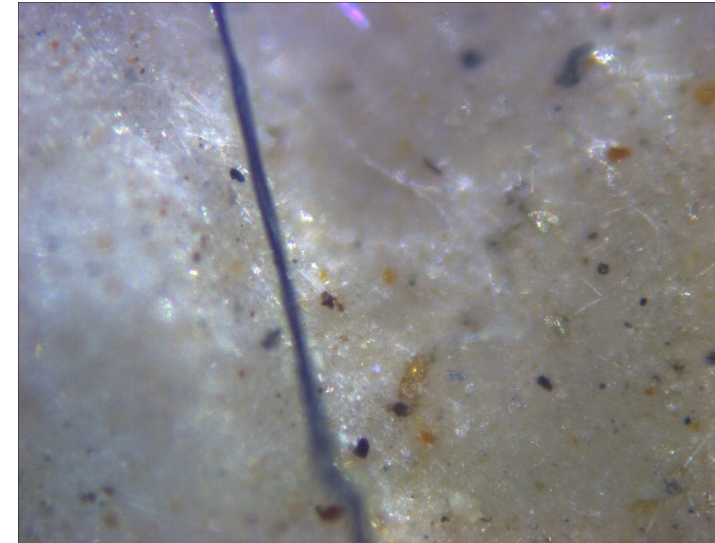


# STUDY OF MICROPLASTICS IN MARINE AND FRESHWATER ECOSYSTEMS

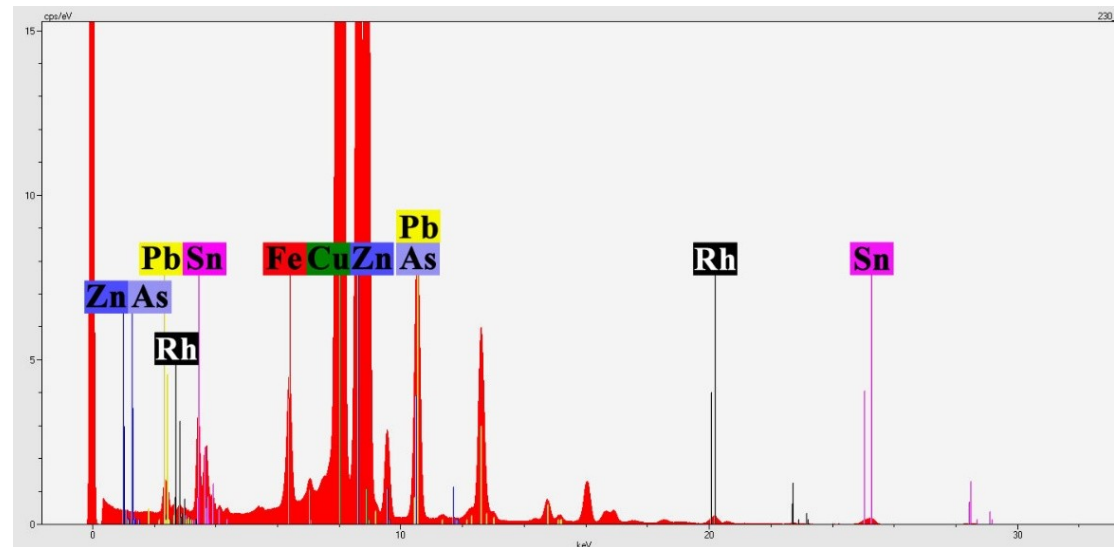
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Tirana 2023



OM pictures  
with 50X &  
100X  
magnification



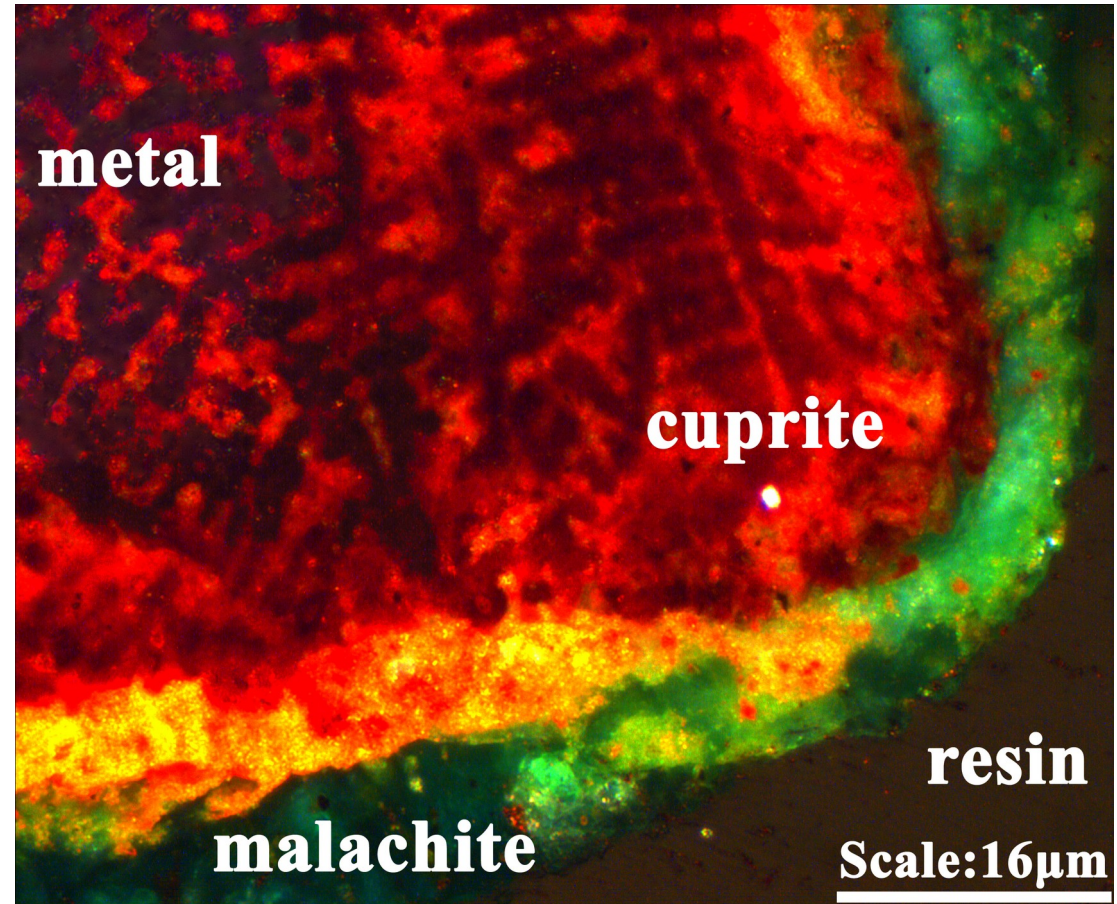
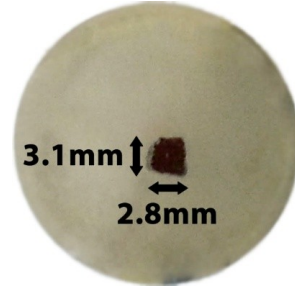
# IN-SITU XRF ANALYSIS



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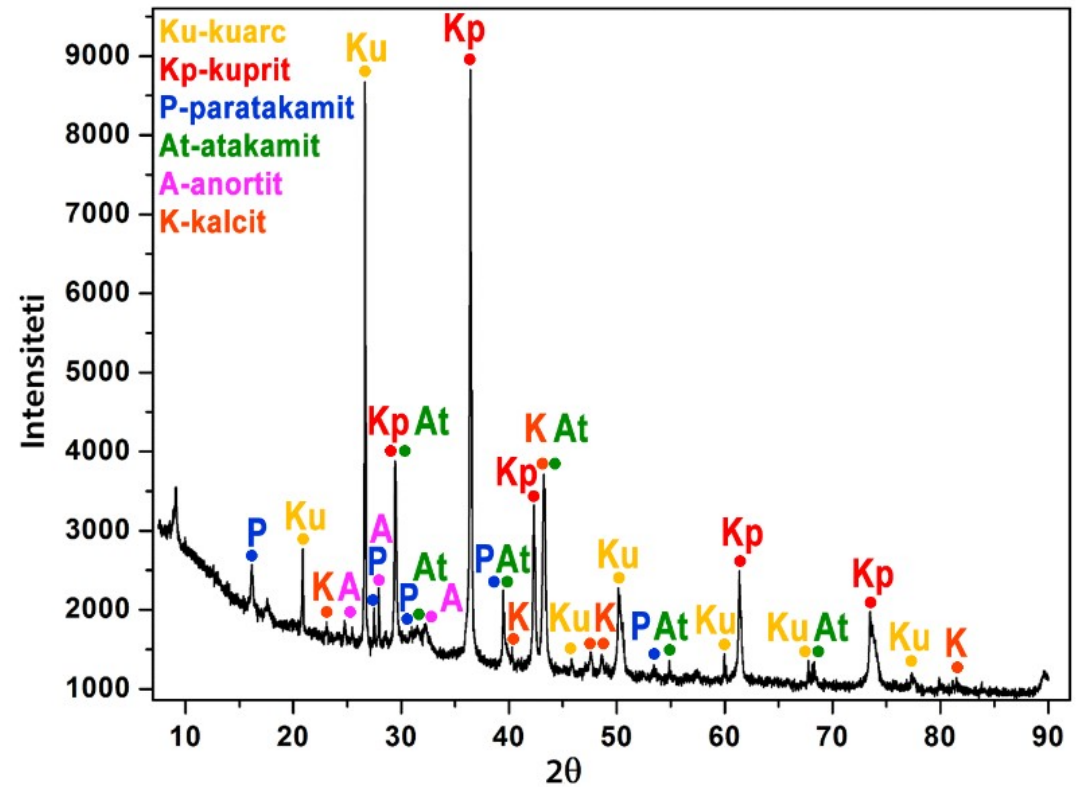
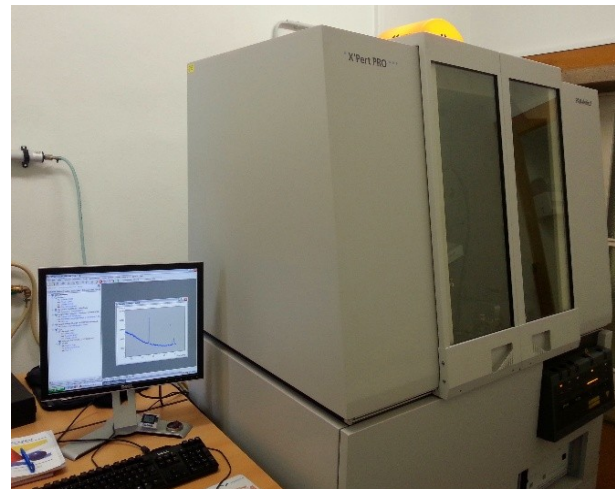
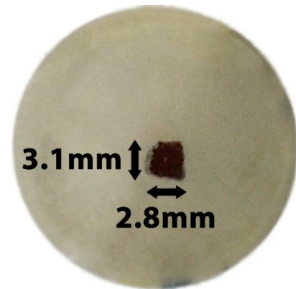
# OM ANALYSIS



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# XRD ANALYSIS

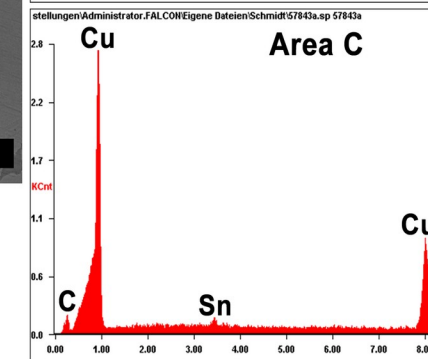
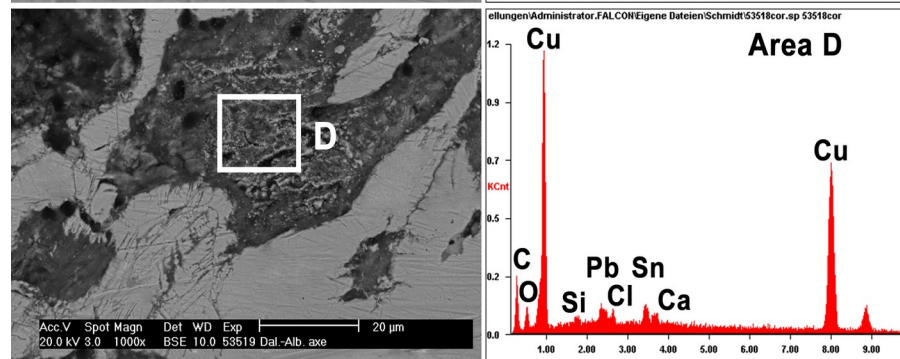
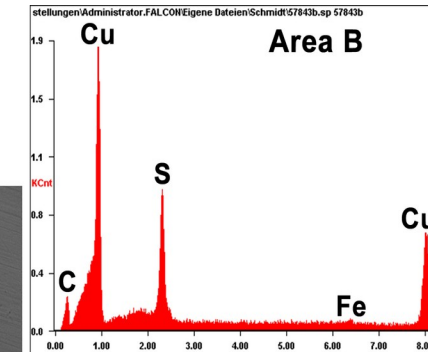
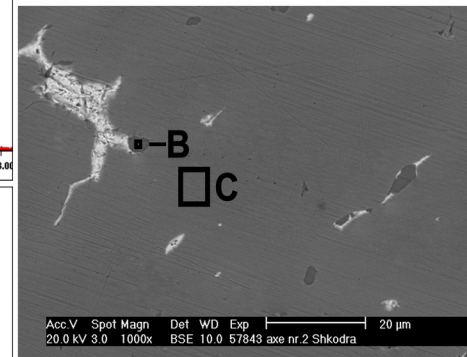
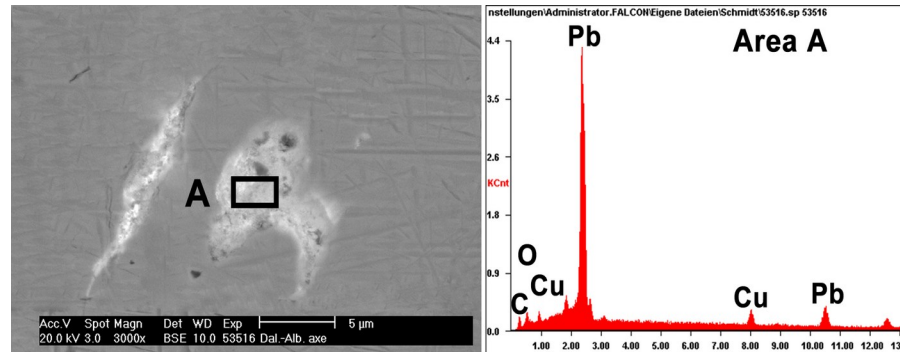
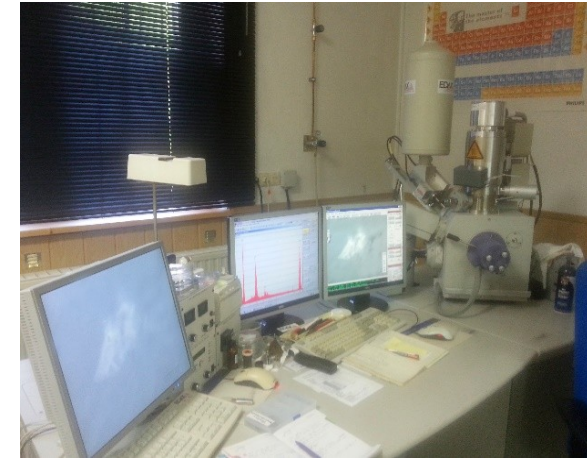
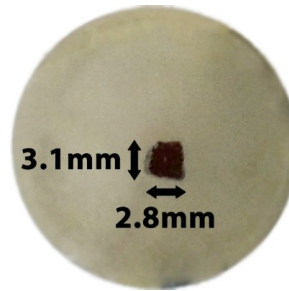


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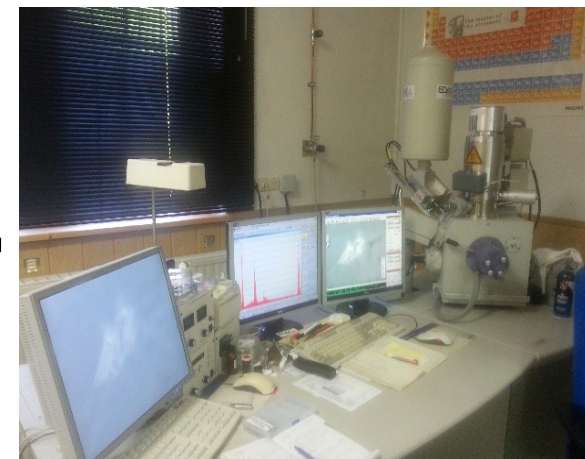
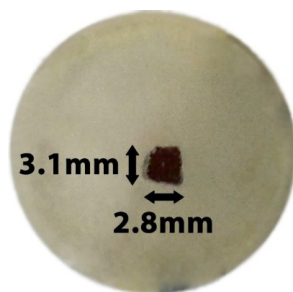
# SEM-EDS ANALYSIS



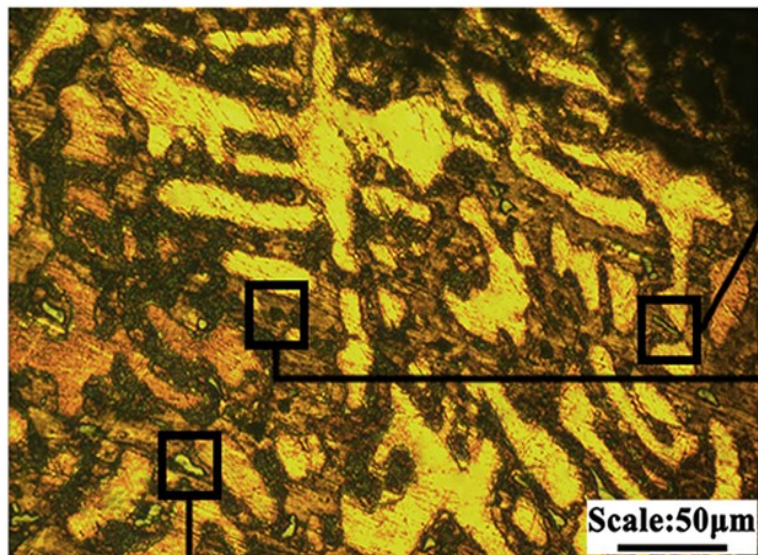
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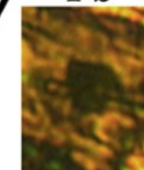
# OM & SEM ANALYSIS



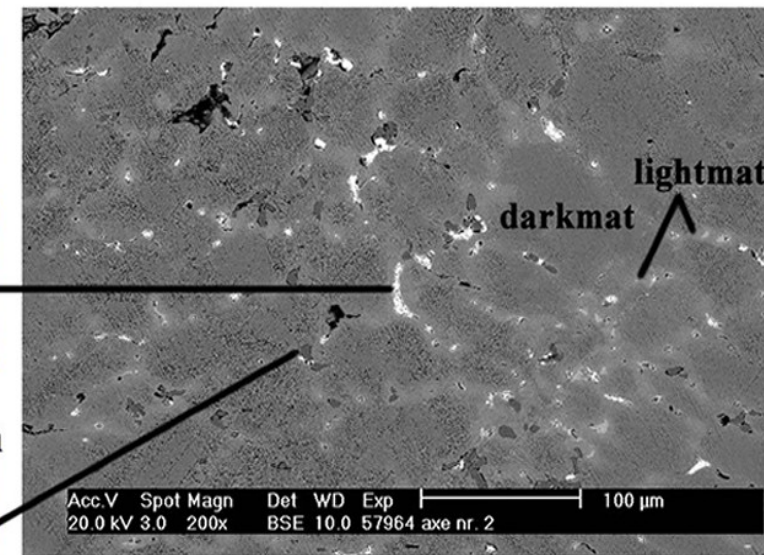
$\delta$  phase



Pb

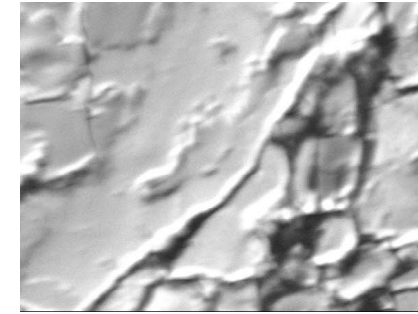
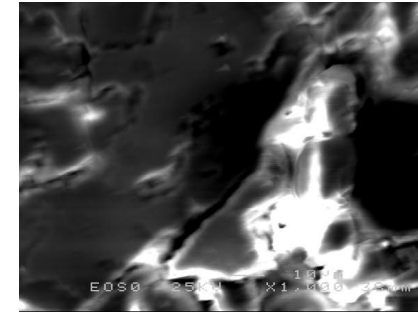
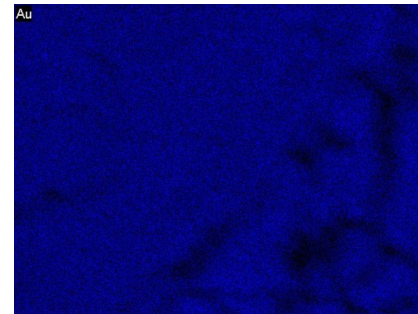
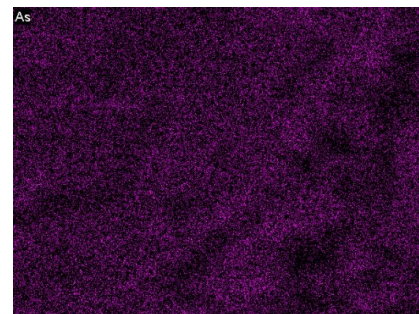
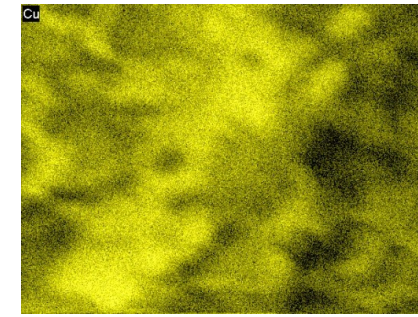
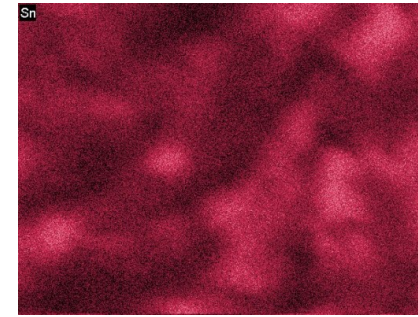
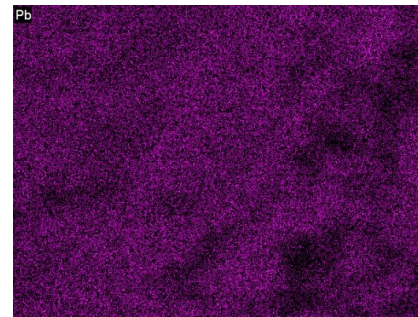
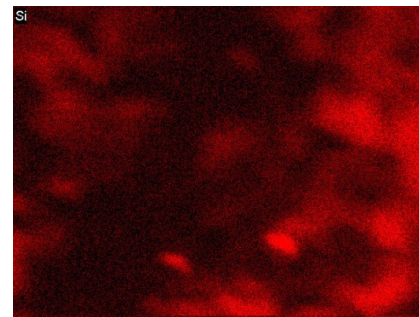
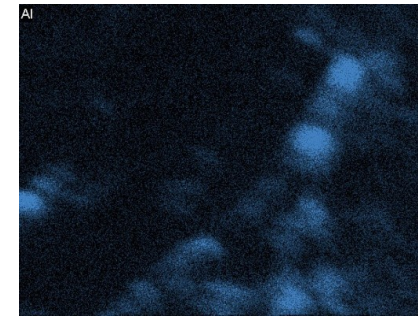
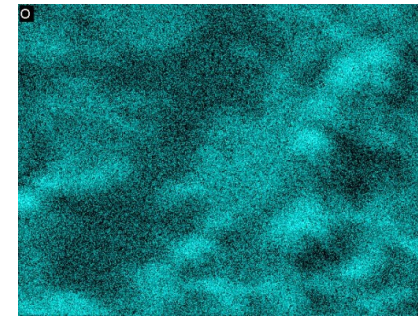
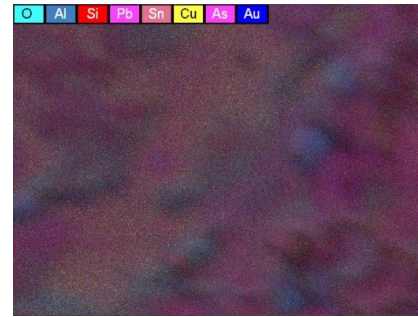


Cu-S  
inclusion



# SEM MAPPING ANALYSIS

**O, Al, Si, Pb,  
Sn, Cu, As, Au  
maps of a  
sword's sample  
from Erseka**

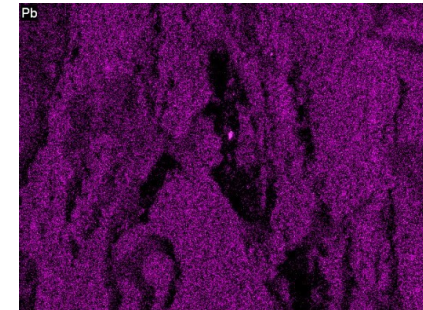
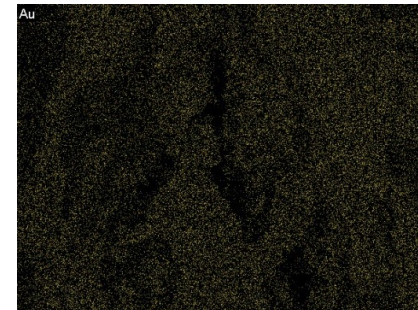
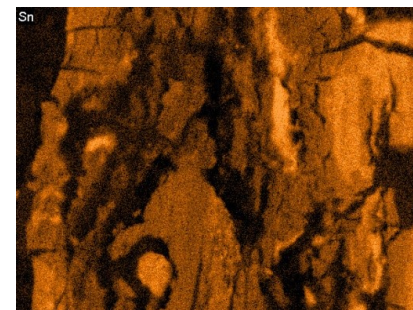
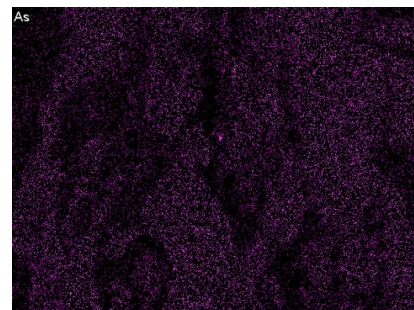
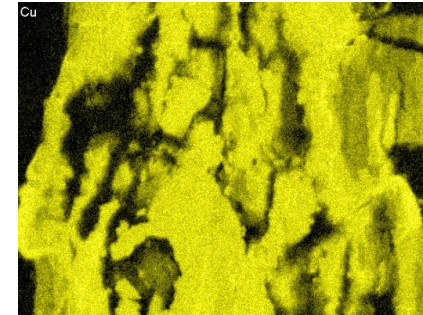
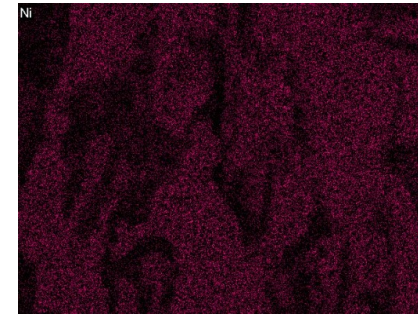
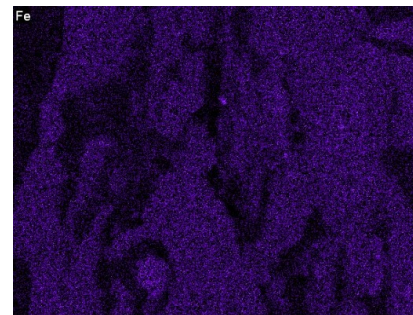
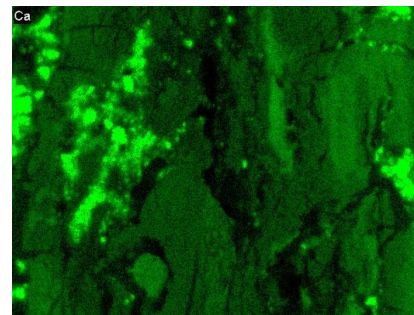
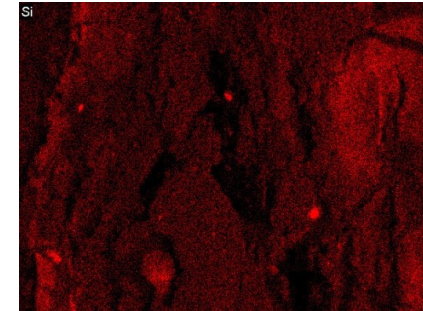
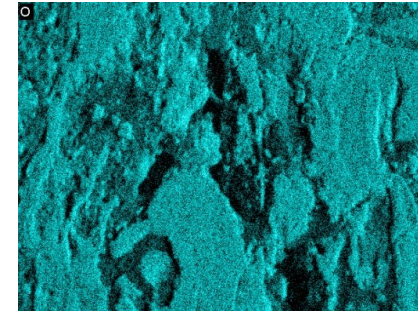
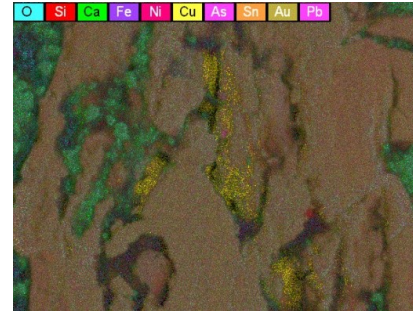


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# SEM MAPPING ANALYSIS

**O, Si, Ca, Fe,  
Ni, Cu, As, Sn,  
Au, Pb maps  
of a shield's  
sample  
from Apollonia**



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For further questions  
and information →

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**THANK YOU!**