

REALISATION OF THE PLANNED 'BLACK BOXES' IN THE HUNGARIAN NATIONAL MUSEUM

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Abstract

In the framework of the Ancient Charm Project (Analysis by Neutron resonant Capture Imaging and other Emerging Neutron Techniques: new Cultural Heritage and Archaeological Research Methods, <http://ancient-charm.neutron-eu.net/ach>), imaging potentials of non-destructive neutron analytical methods are evaluated for archaeological applications. Prior to working on real archaeological specimens, so-called 'black boxes' were constructed (and characterised) for tests of the various methods. This paper is about the construction of these test boxes as realised by the team of the Hungarian National Museum.

Kivonat

Az Ancient Charm Program keretében (Analysis by Neutron resonant Capture Imaging and other Emerging Neutron Techniques: new Cultural Heritage and Archaeological Research Methods, <http://ancient-charm.neutron-eu.net/ach>), különféle neutron analitikai vizsgálatok képalkotási lehetőségeit vizsgáljuk a kulturális örökség körébe tartozó tárgyakon. Mielőtt a régészeti műtárgyakat vizsgálnánk, a különféle vizsgálatok lehetőségeinek felmérésére kísérleti tárgyakat, úgynevezett "fekete dobozokat" készítettünk, amelyeken a módszereket kipróbálhattuk. Az alábbi cikk a Magyar Nemzeti Múzeum restaurátor műhelyében készült próbatestek előállítását mutatja be.

KEYWORDS: NEUTRON BASED IMAGING ANALYSIS, EXPERIMENTS

KULCSSZAVAK: NEUTRON ALAPÚ KÉPALKOTÁSI TECHNIKÁK, KÍSÉRLETEK

Introduction

In the framework of the Ancient Charm program, part of the responsibilities of the Hungarian National Museum was to prepare various test objects and copies (benchmark objects) before the specific methods covered by the project are to be applied on the archaeological specimens themselves. These test objects are important to learn about potentials of the various methods and find the 'best practice' solutions.

The 'black boxes'

Test objects of known geometry and contents were made after the plans of archaeologists (see Hajnal 2008, this volume). The task of constructing these 'black boxes' was shared between the Bonn University and the Hungarian National Museum (Kirfel 2008, volume). HNM produced boxes made of iron, 4 x 4 x 4 cm large. At BonnUni, 5 x 5 x 5 cm large aluminium boxes were made under the same principles and by the same basic ideas.

Planning the boxes was accomplished with an eye on existing archaeological situation foreseen, for example, in the case of composite objects like the round brooch from Kölked serving as an emblem for the Ancient Charm program (76.1.45, disc brooch with almandine inlays from Grave A 279) or belt-buckle from Környe (61.1.205, iron belt garniture with silver inlays, Grave 66), as well as

other composite objects in the Archaeological Collections of the HNM. They may contain various metal components (iron, bronze, gold, silver, lead etc. ...), ornamental stones, glass and a range of other materials as well.

In the conservator's workshops of the HNM, 9 different 'black boxes' were made, typically of raw materials generally used in our conservation practice. They were analysed, subsequently, by the Bonn University team: in the Appendix, the analytical results are presented directly after the data obtained from Armin Kirfel.

Box H-I.

In the first box, copper and brass rods of various diameter ($d=2, 5$ mm), copper wire ($d=1, 2, 5$ mm) as well as steel ($1 \times 36 \times 10$ mm) and zinc plates ($0,75 \times 36 \times 5$ mm) were placed (Figs. 1. and 2). The individual items were fixed into a 2 mm thick cast layer of gypsum. The cover plate of the box was glued to the walls by two-component epoxy resin (Araldite).

Box H-II.

The second box was supplied with copper and brass spirals made of bent plate (Fig. 3.). They were also fixed to the bottom in a thin gypsum layer and closed by a cover plate glued to the walls, same as the previous box. (Figs. 3. and 4).

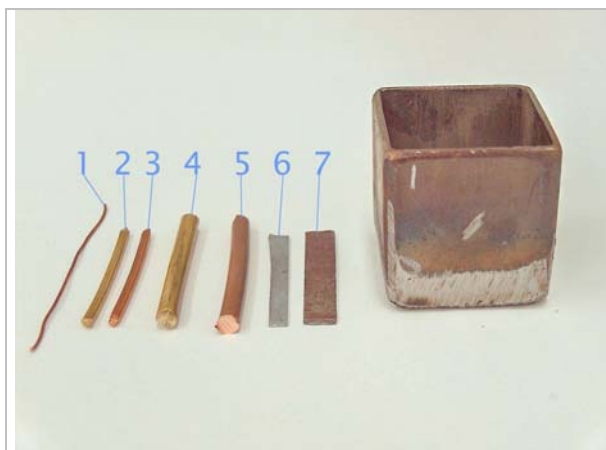


Fig. 1. Box H-I, contents



Fig. 2. Box H-I, mounted



Fig. 3. Box H-II, contents



Fig. 2. Box H-II, mounted



Fig. 5. Box H-III, contents



Fig. 6. Box H-III, mounted

Box H-III.

The third box was filled with metal plates of 3,8 x 3,8 cm size made of iron, steel, copper and brass. The thickness of the metal plates varies (see below). They were also fixed in a thin gypsum layer (~ 2 mm) and the cover plate glued on top (Figs. 5. and 6).

- 1: copper plate width: 1 mm
- 2: iron plate width: 3 mm
- 3: brass plate width: 0,5 mm
- 4: copper plate width: 1 mm
- 5: iron plate width: 3 mm
- 6: brass plate width: 1 mm
- 7: iron plate width: 3 mm
- 8: brass plate width: 1 mm
- 9: copper plate width: 0,5 mm

**Fig. 7.** Box H-IV, contents**Fig. 8.** Box H-IV, mounted**Fig. 9.** Box H-V, contents**Fig. 10.** Box H-V, mounted**Fig. 11.** Box H-VI, contents**Fig. 12.** Box H-VI, mounted**Box H-IV.**

There were three steel rods of different cross-section (3, 4, 6 mm, respectively) placed inside the box. Two different filling materials were used to fill the whole volume separated by a thin steel plate. On one side we used discarded chips of hammered iron while on the other side fine-grained quartz sand was used. Before closing this box, an

aluminium plate was glued under the cover to prevent the filling material from mixing and moving. (Figs. 7. and 8).

Box H-V.

Use of various metals in one object is one of the aspects for neutron imaging. We tried to simulate this situation here. A cylinder shaped from brass



Fig. 13. Box H-VII, contents

plate, a triangle bent from lead sheet, a copper ring and a tin rod in the middle were placed into this box, fixed into a layer of gypsum. The box was sealed with an iron plate, glued to the side of the box. (**Figs. 9. and 10.**)

1: brass plate width: 0,5 mm

2: lead plate width: 1 mm

3: copper ring width: 2 mm

4: soldering tin width: 8 mm, h=8 mm, m=36 mm

Box H-VI.

Box VI contained materials that are frequently met on the surface of weathered objects. The internal parts were divided into four, roughly equal parts.



Fig. 14. Box H-VIII, contents



Fig. 15. Box H-VIII, mounted



Fig. 16. Box H-IX, contents



Fig. 17. Box H-IX, mounted

The first quarter contained fine-grained quartz sand, the second iron scraps, the third rock salt (NaCl_2) and the last one contained silver scraps hidden in ground talcum powder (**Figs. 11. and 12.**).

Box H-VII

We were interested in testing the methodology, apart from metals, for objects made of ceramics as well. We have made two boxes using discarded

pieces of archaeological pottery with various temper and burnt on different temperatures. They were mixed in natural, unburned clay. (**Fig. 13.**)

Box H-VIII.

In Box Nr. H-VIII, archaeological pottery fragments were placed cast in gypsum (**Figs. 14. and 15.**)

Box H-IX.

Precious and ornamental stones frequently occur in composite archaeological objects. The last box, consequently, contained various minerals and ornamental stones, embedded into gypsum (**Figs. 16. and 17**) .

- 1: agate
- 2: agate
- 3: amethyst
- 4: cornean
- 5: blue glass
- 6: cornean
- 7: agate ball
- 8: turquoise
- 9: pyrite crystal
- 10: gypsum crystal
- 11: silver

The different raw materials used for the production of the boxes were sent to Bonn University where our colleagues could perform the same analyses on them as reported by Kirfel on UniBonn boxes. They are presented here as an (appendix App.Figs 1-19.)

Acknowledgements

The author and the HNM team is grateful for analytical results provided on the black box construction materials for A. Kirfel and Bonn University.

References

HAJNAL Zs. (2008): Developing non-destructive 3D material analysis of cultural heritage objects: plans for 'black boxes' as test objects to be analysed in the Ancient Charm project. *Archeometriai Műhely / Archaeometry Workshop, 2008/1* 3-6.

KIRFEL A. (2008): Construction and description of the UniBonn black boxes. *Archeometriai Műhely / Archaeometry Workshop 2008/1* 21-34.

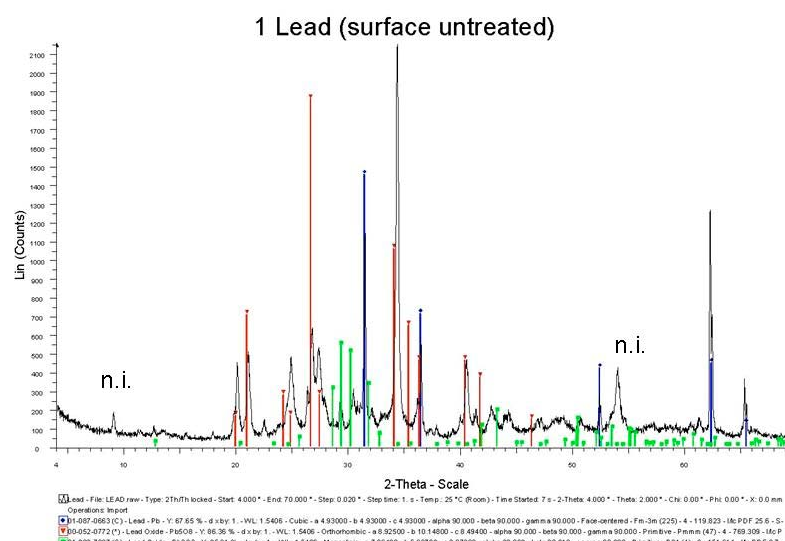
Ancient Charm object database, <http://www.ace.hu/acharmdb/index.html>

Appendix: X-ray Powder Diffraction Analyses of HNM 'Black Box' materials

Materials used for the production of the 'black boxes' at HNM. Analyses made at Bonn University by A. Kirfel and B. Barbier.

All measurements were carried out on a SIEMENS D5000 powder diffractometer using Cu-K α radiation and secondary monochromator. Cleaning of surfaces with fine emery paper. Qualitative analyses, where necessary, by Rietveld fitting.

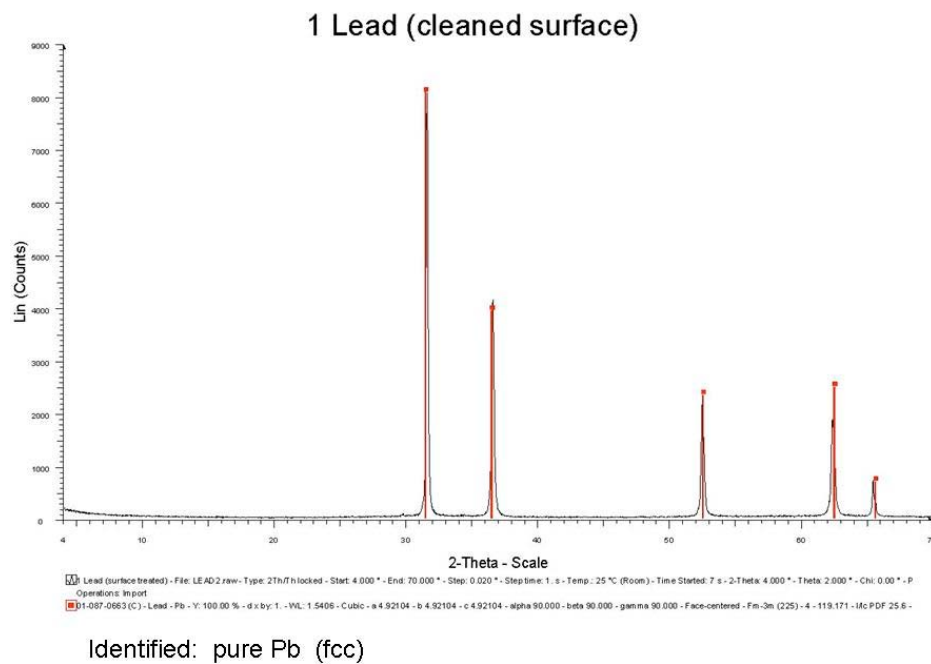
App.Fig. 1.



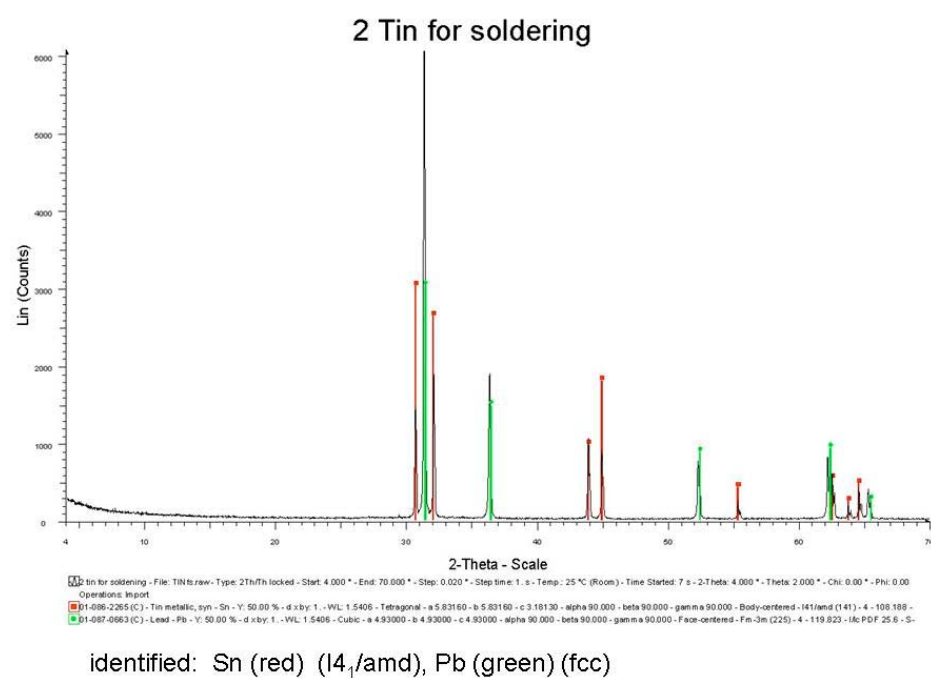
identified: Pb (fcc), Pb₂O₃ (P2₁), Pb₅O₈ (Pmmm)

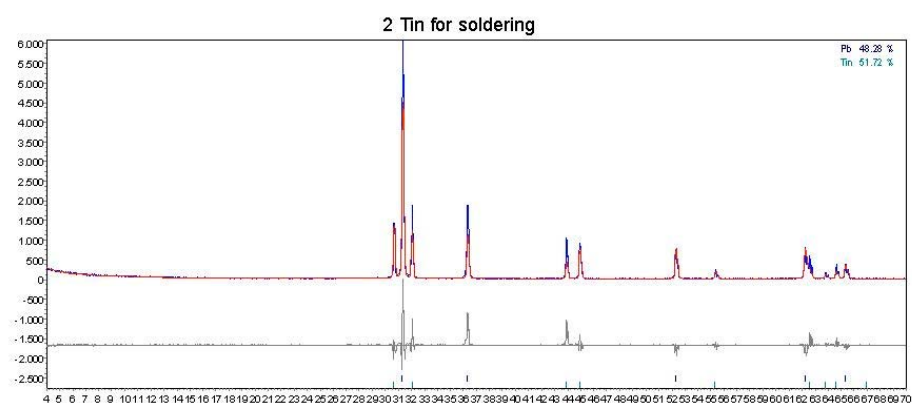
n.i. = not identified

App.Fig. 2.

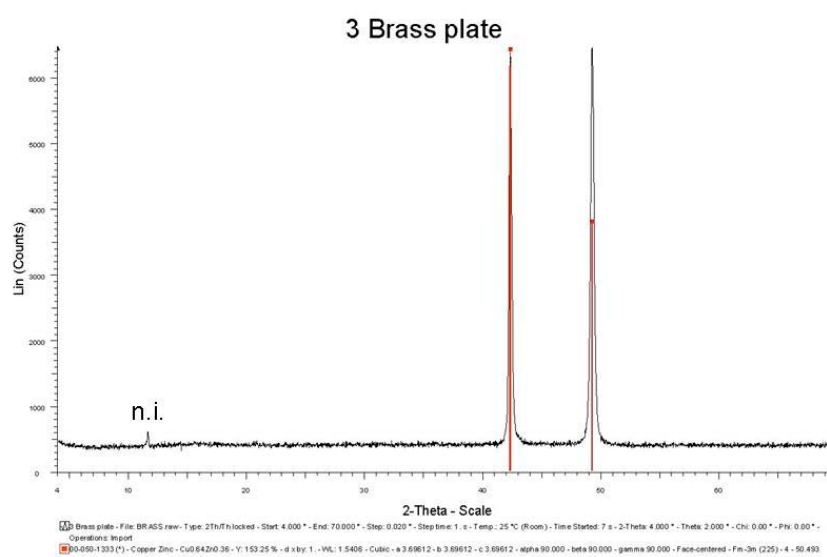


App.Fig. 3.



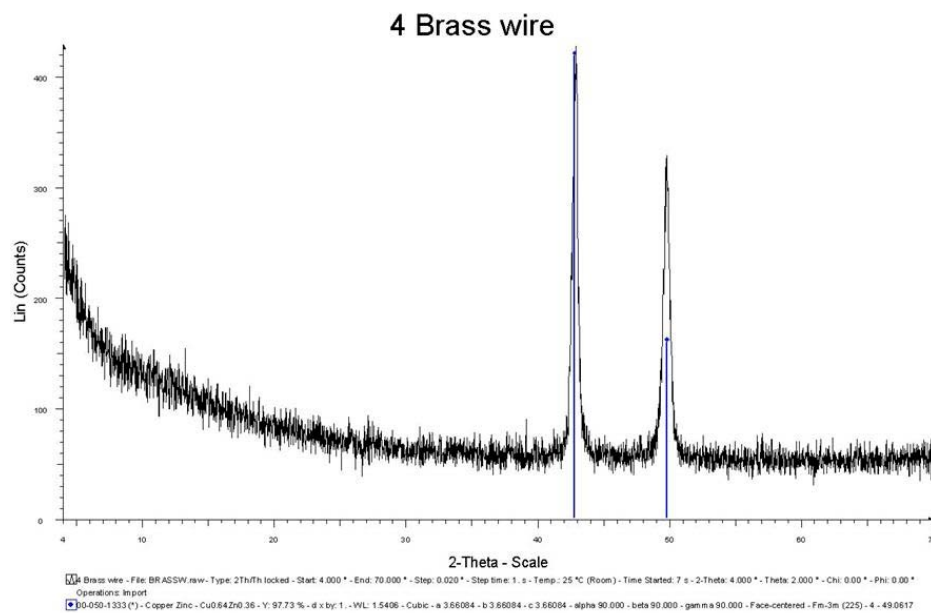
App.Fig. 4.

Rietveld refined: Sn (red) 52 %, Pb (green) 48 %

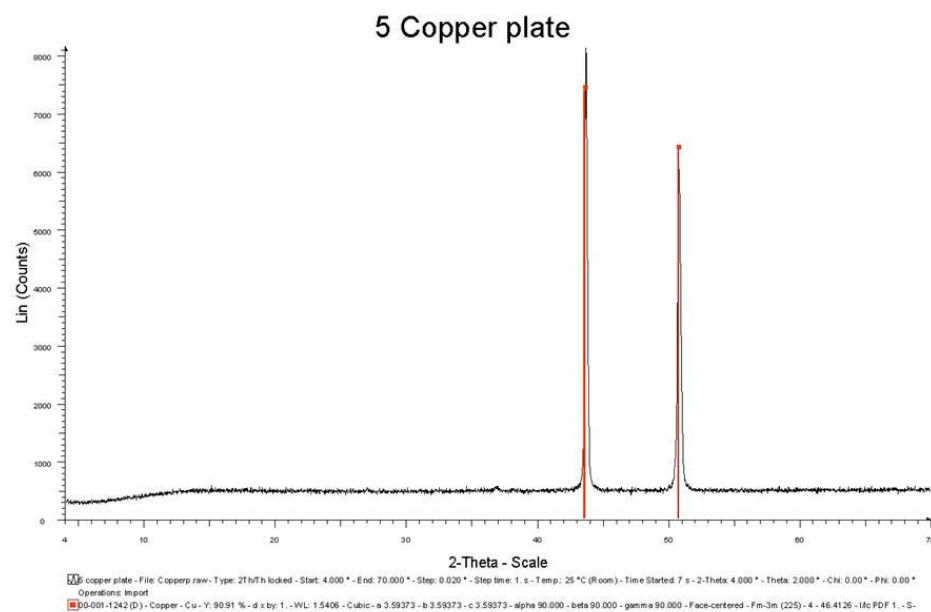
App.Fig. 5.

identified: Cu₆₄Zn₃₆ (fcc)

n.i. = not identified

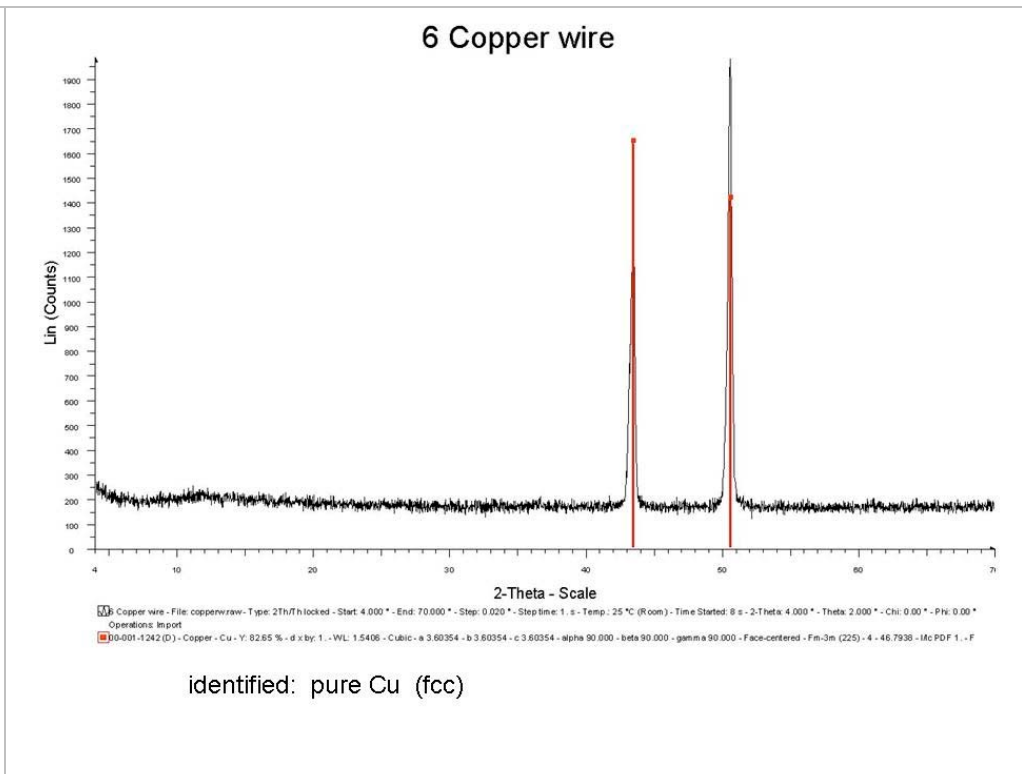
App.Fig. 6.

identified: Cu₆₄Zn₃₆ (fcc)

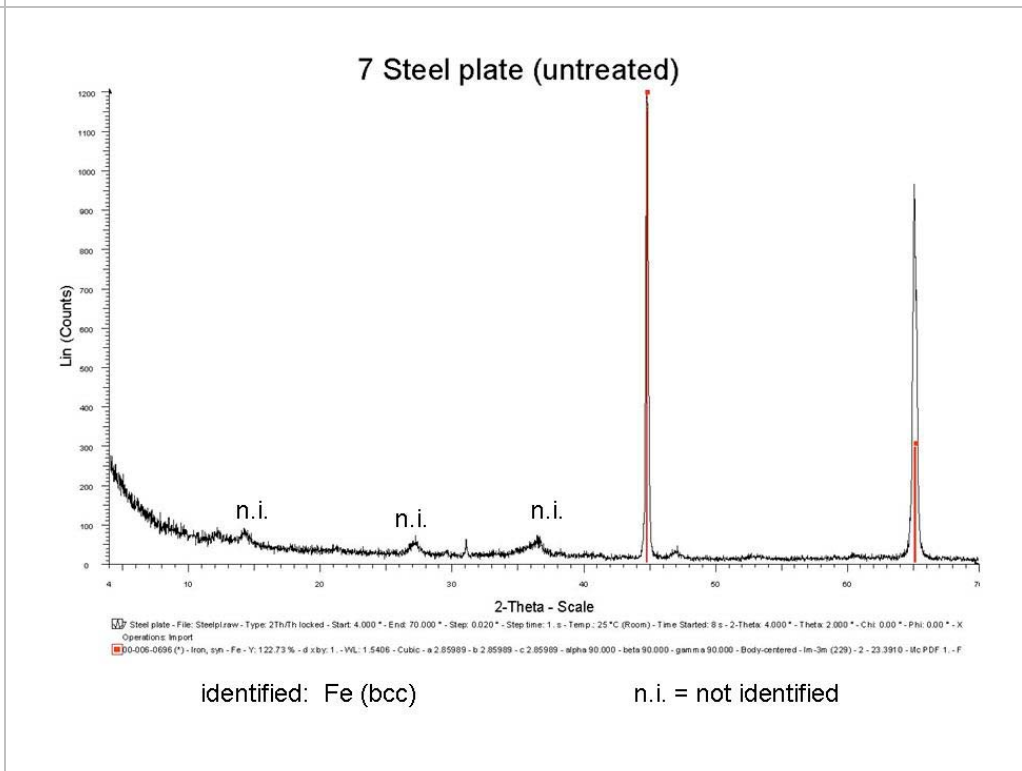
App.Fig. 7.

identified: pure Cu (fcc)

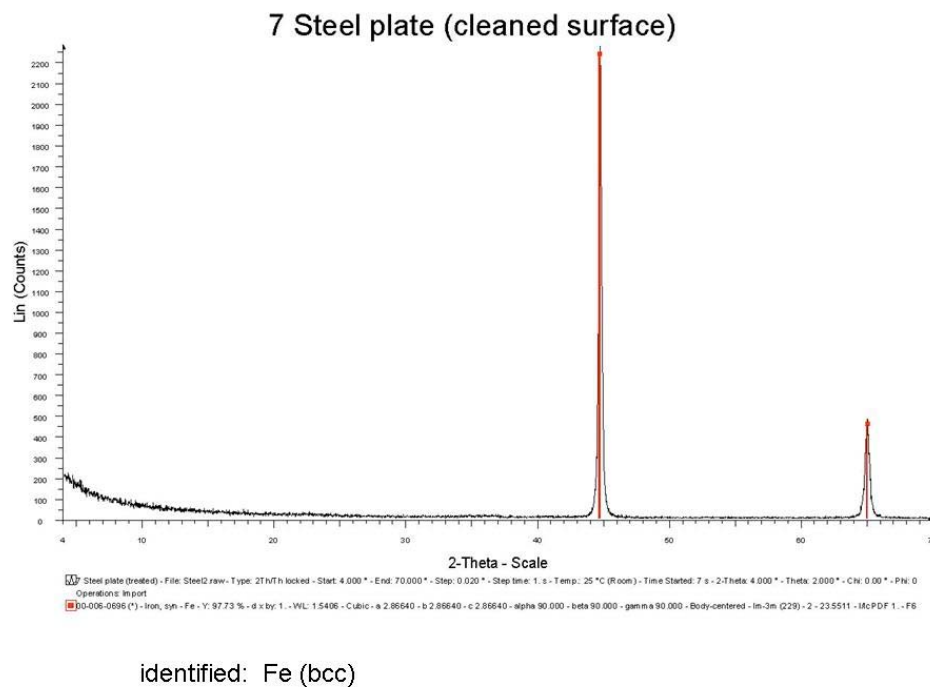
App.Fig. 8.



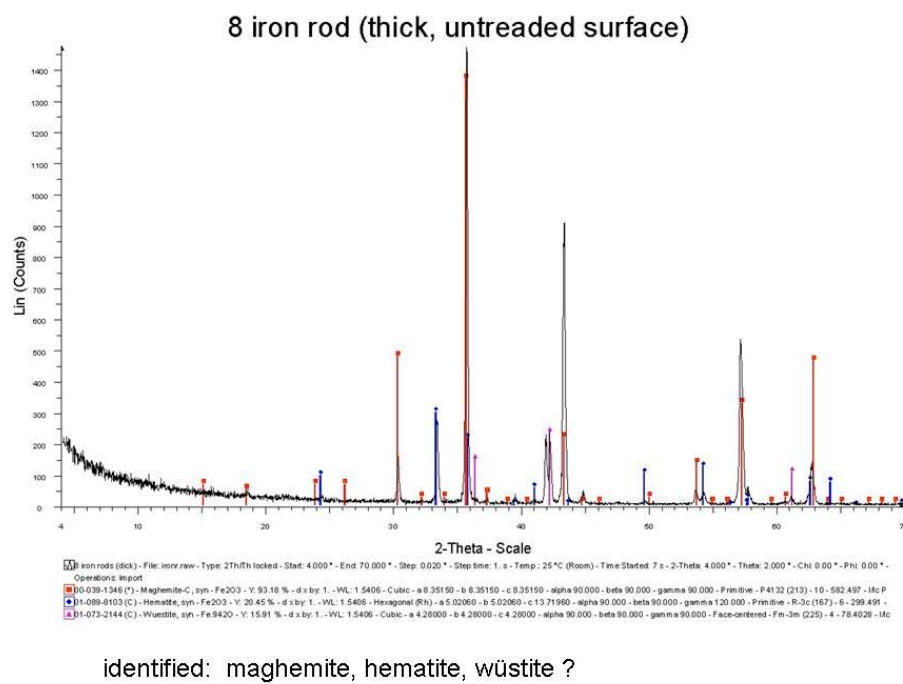
App.Fig. 9.

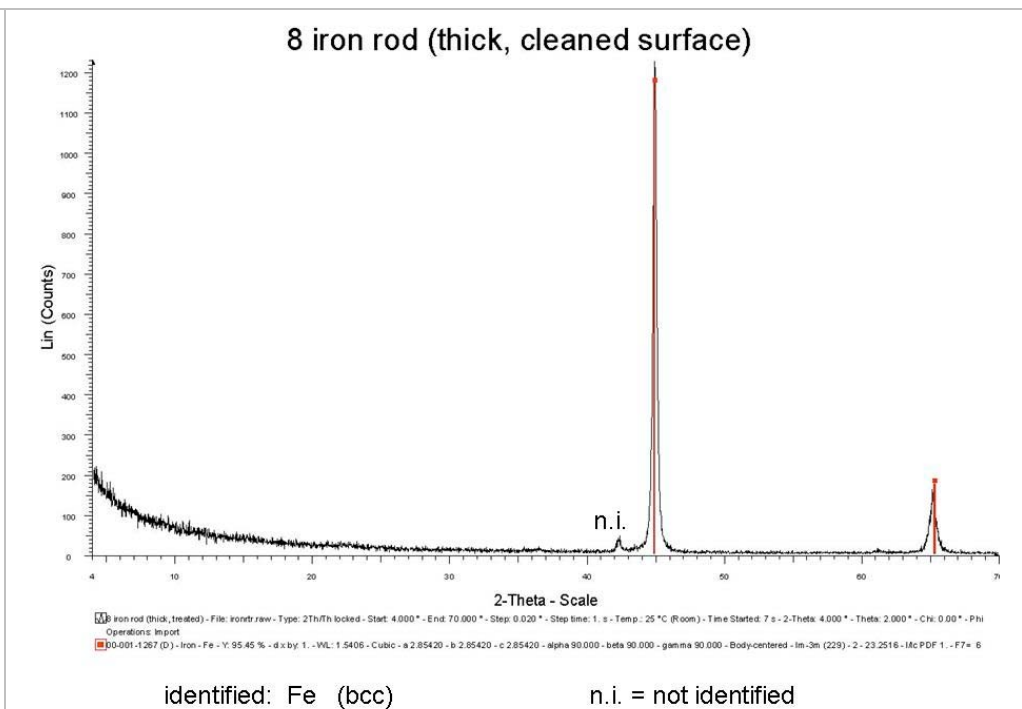
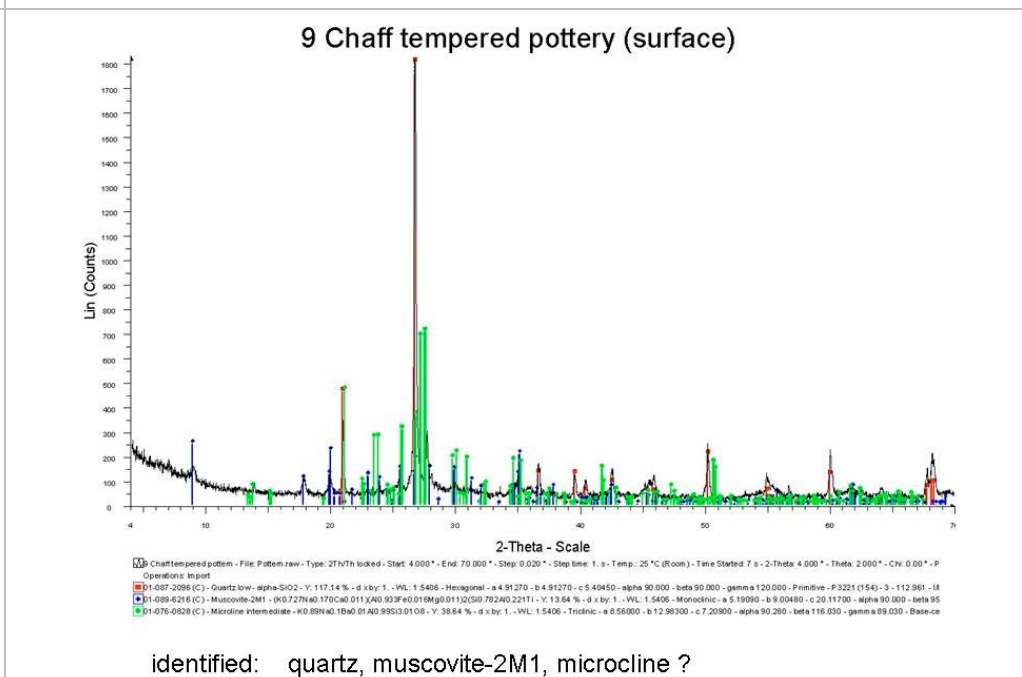


App.Fig. 10.

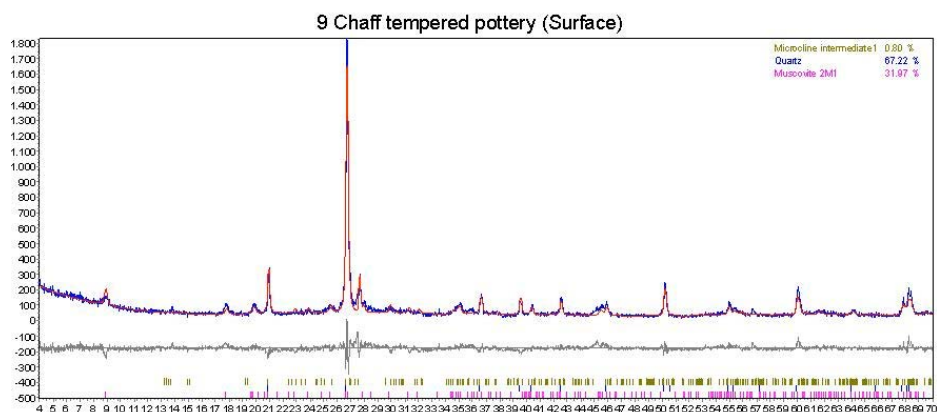


App.Fig. 11.



App.Fig. 12.**App.Fig. 13.**

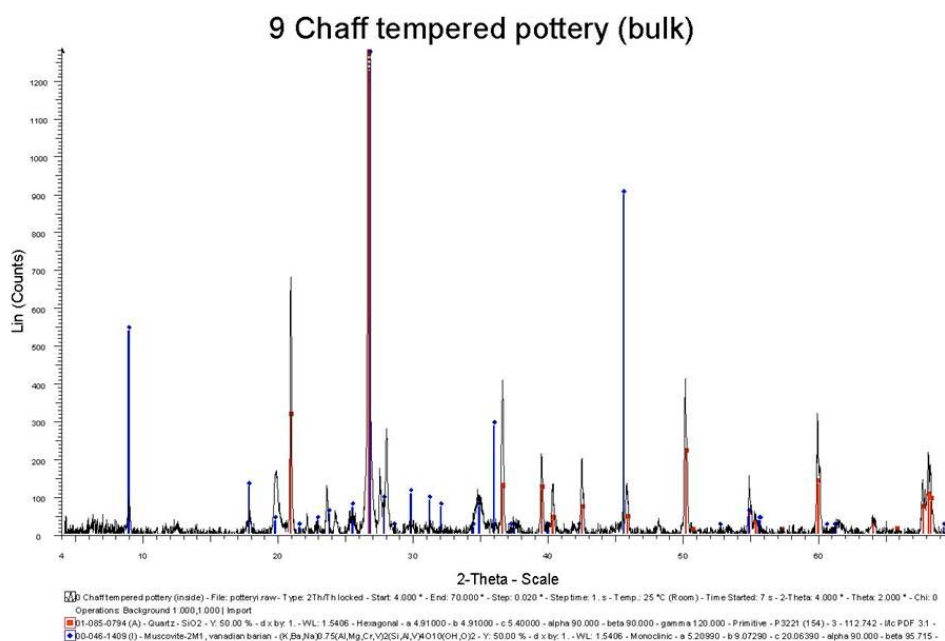
App.Fig. 14.



quartz 67 %, muscovite-2M1 32 %, microcline 1 % ?

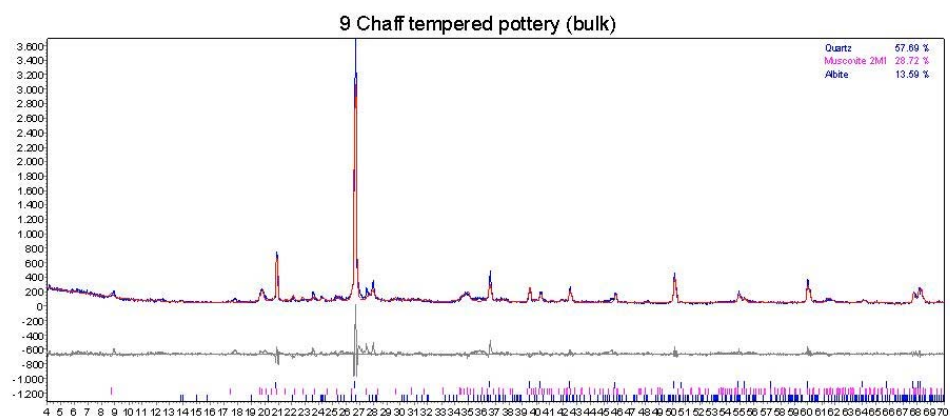
muscovite-2M1: contains K, Na, Al, Si, O and traces of Ca, Mg, Ti, Fe,

App.Fig. 15.



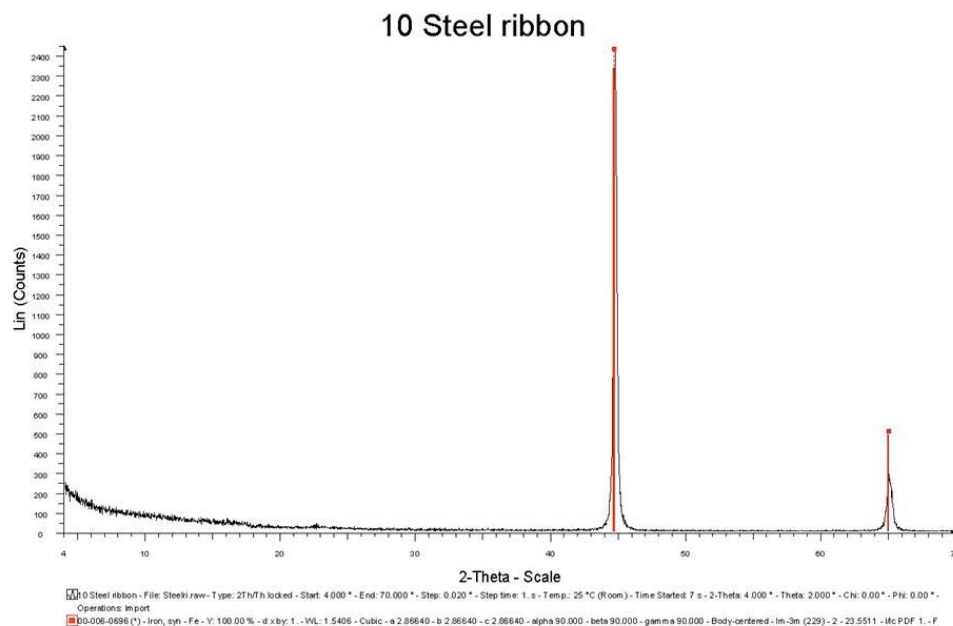
identified: quartz, muscovite-2M1, albite ?

App.Fig. 16.

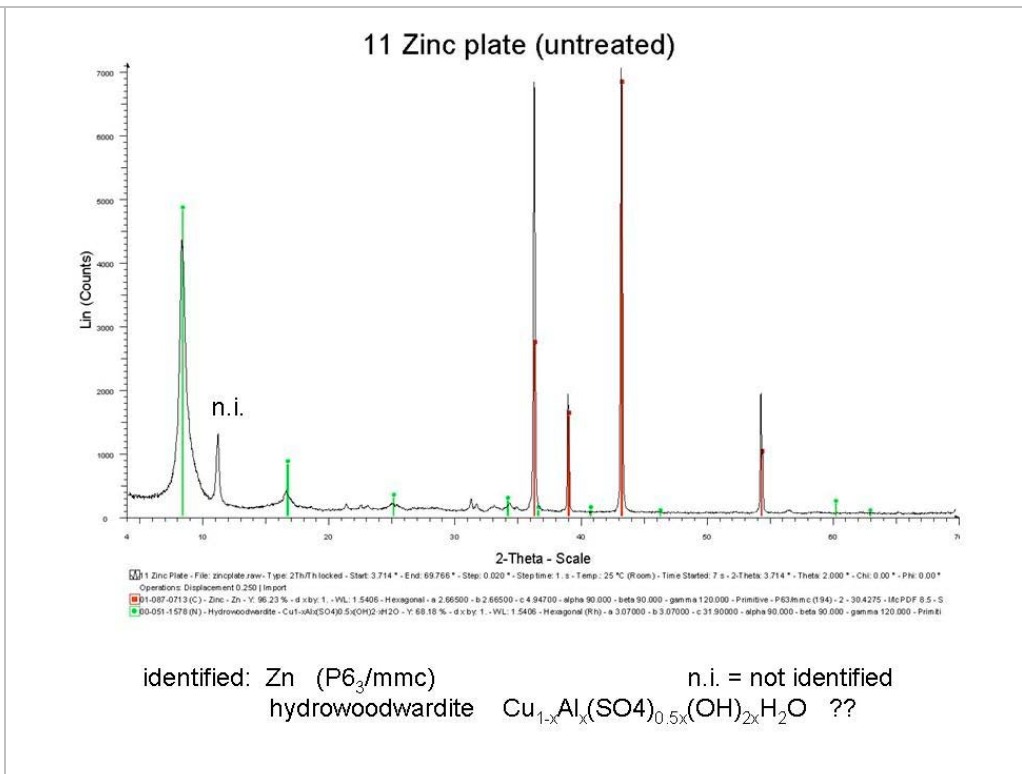


quartz 58 %, muscovite-2M1 29 %, albite 13 %

App.Fig. 17.



App.Fig. 18.



App.Fig. 19.

