Medieval Smithy Production in Spiš Castle

Introduction

Production of iron weapons, agricultural tools and objects of everyday use was driving force of medieval human society developments. Every town, village, castle had its own smithy workshop producing a broad variety of iron tools. In many towns smithy workshops specialised on production of certain kinds of iron objects existed. Though common manufacturing methods for production of different tools were spread among blacksmiths on the whole territory of Central Carpathians, individual workshop or blacksmiths communities developed specific alterations as a response to quality of used iron metal, to specific use of produced tools and also to traditions. Metallographic investigation of iron tools from medieval Spiš Castle, found in archaeological excavations during restoration works at the Castle, created important opportunity to study very rich collection, that was probably produced in one closed inhabitation object or in settlement that belonged to it.

The Spiš Castle. The oldest written record on the Spiš region in general dates back to 1209, considering the lands sales excluded from jurisdiction of the centre of region - the castle. The castle remained royal property until 1465 when it became the personal property of the Zápoľský family line, though not for long, as already in 1531 it was owned by the Thurzo family, while from 1638 the castle was owned by the Csaky family.

Limestone tuff of the castle hill, reaching 634 m above sea level forms an impressive dominant of the basin, lowering some 200 m above the surrounding country level.

Sporadic remnants from the neolithic age documented that the messengers of bukovsky and bodrogkertszturskу cultures settled the massif. The castle hill and its surrounding country came to be settled more considerably toward end of the Neolithic age by carriers of Baden culture. Both in number and in density was the castle hill massif most intensively settled by bearers ofpuchovskv culture during an era from 1st century BC to 1st century AD. The tribe built fortified stronghold internally articulated with accordance taken to not only terrain factor but also to social differentiation. The most elevated part of the hill was dwelled upon by most stratum of the puchovian population, and for these also special silver coins were minted, as documented by several coins discovered under the medieval castle.

The oldest rock masonry of the medieval castle is presented by a huge habitable tower dating back to 13th century. During the first third of the 13th century the upper platform of the castle hill had been fortified and later an originally three-floor palace was built. This upper castle was protected by a smaller courtyard accesible only through a narrow part cut into the rock.

The chapel, discovered beneath the 15th century castle foundation presents another unique architectural feature of the castle. The whole complexity of the roman castle remained untouched, until the second half of the 15th century, when the castle was quite rebuilt into the late-gothic appearance. Soldiers of Jiskra around the middle 15th century modified the castle. Nevertheless, individual reconstruction of the castle took place, successively in 16th, first third of 17th and beginning of 18th centuries almost always coupled with the original conception of a romanesque castle.

Description of analysed objects. Collection of finds, submitted for metallographic analysis, contained 24 iron objects. They were selected from large amount of finds, related to production of iron objects at the Spiš Castle that were in deposits of Spiš Museum in Levoča. Selected finds represented iron objects of both military and economic character. Metallographic analysis of twelve of them is presented in this contribution.

Results of metallographic analysis. One or two samples were taken from each analysed iron object. The samples were cut with diamond saw. Next the samples were mounted into mounting resin and metallographic surfaces were prepared by grinding and polishing.

Polished surfaces in non-etched state were observed under metallographic microscope. Non-metalic inclusions and discontinuities in iron matrix, like cracks, holes etc. were observed and photographically documented. Three types of inclusions were found on most of analysed surfaces:

1. Inclusions of scales, remnants of surface oxidation of iron in course of heating.
2. Smithy inclusions, products of reactions between iron oxides in scales and silica from silica sand - deliberately performed process to remove particles of scales from heated surface.
3. Inclusions of furnace slag - that remained in the iron semiproducts used in manufacturing of iron objects.

Next metallographic surfaces were etched in reagent nital to minimalize structures in iron metal. The structures were observed under microscope and documented.

SH2 - Sickle. The sample was taken from the end of the sickle fragment. Etching revealed nearly on the whole surface martensitic and bainitic structures. In some small places also ferritic structure of non-carburised iron was found. From analysis follows after finishing of shape whole sickle was carburised and, after reheating, quenched. Though carburisation was not perfect, the smiths used very sophisticated manufacturing technology, leading to high quality of the sickle.

SH5 - Nail with lentil-like head. Two samples were taken from the nail, the first one from the nail's head, the second one from trunk above nail's tip. Metallographic surface of the sample taken from nail's head showed after etching mostly non-carburised ferritic structure, only on some places by the surface carburised pearlitic structures were found. Metallographic surface of the sample taken from nail's trunk showed carburised pearlitic and pearlitic-ferritic structures, content of carbon on the surface was very variable.

From metallographic analysis followed the head and the tip of analysed nail

were carburised with the goal to increase hardness of both parts. Such manufacturing method is frequently found by analysis of medieval iron nails with resulting superstandard quality of these common goods.

SH6 - Nail T. Two samples were taken from the nail's trunk, the first below the head, the second one above the tip. On metallographic surface of the sample, taken from trunk below nail's head mostly ferritic structure of non-carburised iron was found, only in two places ferritic-pearlitic structures with somewhat increased carbon content were observed. Only non-carburised ferritic structures were found on metallographic surface of sample taken above the nail's tip. It is necessary to note, that the very tip of the nail was not sampled.

Analysis suggested that at least surface of nail's head was carburised. Method of sampling didn't allow making conclusions concerning nail's tip. Nevertheless, superstandard production technique with carburisation of both nail's head and nail's tip can be expected also in this case.

SH8 – Knife. This distorted iron fragment was described by archaeologists as knife. The sample was taken by cross section cut. Only ferritic structures of non-carburised iron were found, on part by the surface slightly increased carbon content was observed. No typical features of knife structure were found. Probably the object was described as knife by mistake.

SH9 - Fragment of gun ball. The fragment is in fig.1. The sample was taken from one of the fragment corners. Etching of the metallographic surface revealed the ball was made of cast iron (fig.2). In place by the surface martensitic structure in original austenitic grains was observed (fig.3). One small place with ferritic structure was also observed on the very rim of the surface (fig.4).

As in time of the castle inhabitation blast furnace didn't exist on the territory of Slovakia, the gun ball was probably produced from iron smelted in so called „massa", predecessor of blast furnaces, able to produce both pig and wrought iron. It can explain two different iron materials in gun ball. The ball was quenched in process of its production. Local decarburization had secondary character.

SH10 - Fragment of horseshoe. The sample was taken by cross section cut through the horseshoe. Only non-carburised iron material, represented by coarse-grained ferritic structure, was found on the metallographic surface. Production of horseshoe from non-carburised soft and tough Iron was common.

SH12 - Knife. The sample was taken by cross section cut. Etching of metallographic surface revealed martensitic, bainitic and troostitic structures on whole surface, only on one place in the narrowest part of the surface ferritic structure of non-carburised iron was observed. From metallographic analysis follows, the knife was very inhomogeneously carburised, then, after reheating, quenched. Manufacturing technology was proper, but imperfectly done.

SH14 - Spearhead with eye. Spearhead is in fig.5. Two samples were taken from the objects, the one by cross section below the tip, the second one by cross section through eye. Etching of metallographic surface of sample taken below the tip, revealed ferritic-pearlitic structures on most of the surface (fig.6), pearlitic structure in the surface centre around the crack (fig.7) and non-carburised ferritic structure in one small place in the corner.

Observing of metallographic surface of the second sample, taken from the eye, showed band of carburised iron in the surface centre and non-carburised ferritic material at both sides (fig.8).

From metallographic analysis follows, the tip of spearhead was deeply carburised, penetration of carburised structures was observed on metallographic surface. Band of carburised structure in centre of sample, taken from eye, had no special sense. Probably scrap material was used for production of eye part of the spearhead.

SH15 – Point. Point, object SH15, is in fig. 9. Two samples were taken from the point, the first one by cross section below the tip, the second one by cross section through eye. Metallographic analysis of the sample, taken below the tip showed the same technology, as found in analysis of spearhead, SH14, carburisation of the tip. Analysis of the sample taken from eye showed, the eye was covered by thin layer of copper. Iron material itself was carburised with resulting pearlitic-ferritic structures. Two layers of copper with iron material between them, are depicted in fig.10.

Though the tip of the object was carburised, it can be expected, the point had decoration purposes.

SH19 - Spearhead with pin. The sample was taken below spearhead tip by cross section cut. Etching of metallographic surface revealed most of the surface bore ferritic structure, structure of non-carburised iron. There was a band of scales on the surface and pearlitic structure, representing deeply carburised iron around it. It is suggested this pearlitic structure come from penetration of pearlitic structure from the very tip of spearhead. It means tip of spearhead was hardened by deep carburisation. Production technique was proper.

SH20 – Axe. The object was in highly corroded state. Two samples were taken, the first one from edge, the second one from remnants of eye. Melallographic analysis of the sample taken from edge showed increasing content of carbon from one side of the surface to the other, i.e. towards to the axe edge. It means the axe edge was carburised, though it was not directly observed on the sample owing to deep corrosion of the edge. Different kinds of structures from ferrite to pearlite were observed on metallographic surface of the sample taken from axe's eye.

From metallographic analysis follows, the axe was produced from non-carburised tough iron material, next the blade was carburised. The smiths didn't pay attention lo manufacturing of axe's eye, they used for its manufacturing either the scrap iron material, or not used iron material, that remained in the smithy. Production technique was proper.

SH23 – Horseshoe. Analysed horseshoe, object SH23, is in fig.11. One sample was taken from cross section cut through the horseshoe. Etching of the metallographic surface revealed non-carburised ferritic structure prevailed, but in some places carburised pearlitic-ferritic structures were observed (fig.12; 13). Because variability of carbon contents is typical for iron bloom, probably not treated iron was used for manufacturing of horseshoe.

Conclusions

Analysed set of iron objects found in excavation at medieval Spiš Castle showed local blacksmiths produced various kinds of iron objects, most of then was produced by very sophisticated manufacturing technique. The most important features of their methods are:

1. Methods of hardness increasing by carburisation and in some cases by quenching were very frequently used. The smiths carburised either whole objects, especially when of smaller dimensions, or the parts that were the most important to meet needed utility value.

2. Special attention was paid to production of common goods, nails. The smiths' carburised both heads and tips of the nails. Though superstandard, such production technique was recognised by the author at some other sites in Spiš (Mihok, Petrik, 2000, p.271-274).

3. The parts of the objects, that were not highly strained, e.g. eyes, were produced from non-selected iron material, probably from scrap or from iron remnants in smithy.

4. Surprisingly little attention was paid to production of horseshoes. The author found in his previous researches very sophisticated production of horse shoes, when they were produced from two iron bars of different properties (Mihok, Caplovič, 1996, p.61-77; Mihok, Pribulová, Hollý, 1998, p.471-474). On the other side, production of horse shoe from iron scrap material was also found (Mihok, Pribulová, Linger, 1999, p.125-131).

5. Analysis of gun ball proved the ability of called „massa" furnaces, utilised on the territory of Slovakia prior to blast furnace production, smelt both pig iron and wrought iron.

6. Only part of the research of iron objects from the Spiš Castle is presented in this contribution, the paper, comprising whole research will be published in the near future.

Literature

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Mihok Ľ., Petrik J., Demková D. 19th Century Production of Iron Nails in Spiš, Slovakia // Metalurgija 39. – 2000. - 4. - P.271-274.

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Summary

The paper presents metallographic analysis of twelve iron objects from collection of finds from excavation at the Spiš Castle. All of them are dated to Middle Ages. Metallographic analysis enabled to determine which smithy methods were used for manufacturing of the objects that had both military and economic character. Local smiths utilized sophistical techniques to enhance quality of produced iron objects. They frequently used techniques ofcarburisation and quenching, either whole objects, or the parts that were the most important to meet needed utility value. They paid surprisingly little attention to production of horseshoes, that were produced from non-treated or scrap iron material.

Fig. 2 – Structure of cast iron in sample of gun ball.

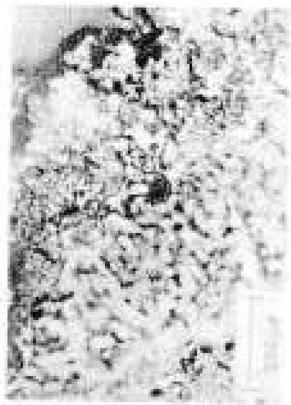

Fig. 1 – Fragment of gun ball, object SH9

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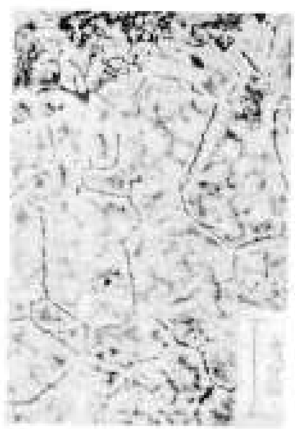

Fig. 3 – Martensitic structure in sample of gun ball.

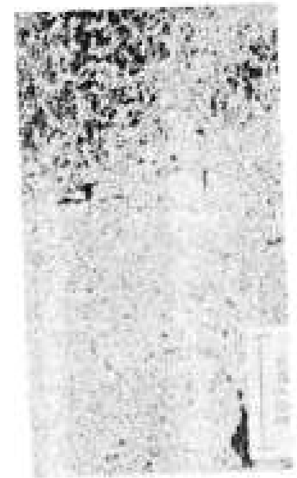

Fig. 6 – Ferritic-pearlitic structure in sample taken below the tip.

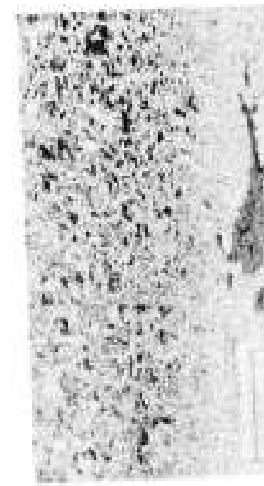

Fig. 8 – Structure of sample taken from spearhead eye.

Fig. 5 – Spearhead with eye, object SH14

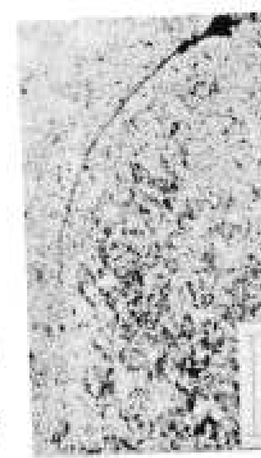

Fig. 7 – Pearlitic structure around the crack in the centre of the surface in sample taken below spearhead tip.

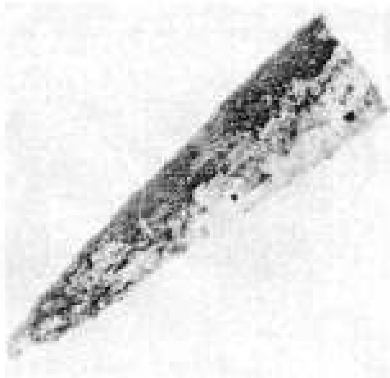

Fig. 9 – Point, object SH15

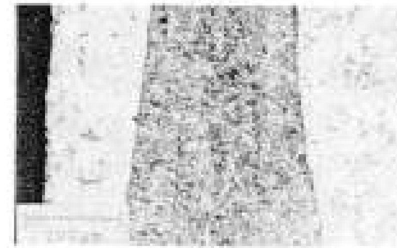

Fig. 10 – Copper layers in sample taken from eye of the point, object SH15

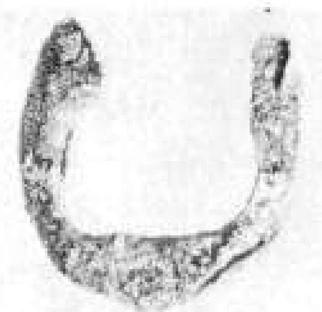

Fig. 11 – Horse shoe, object SH23

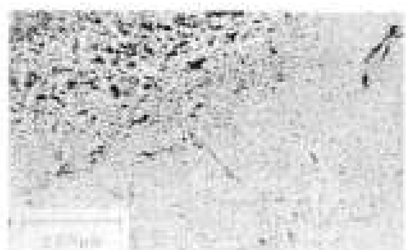

Fig. 12 – Carburised iron in sample taken from the horse shoe, object SH23

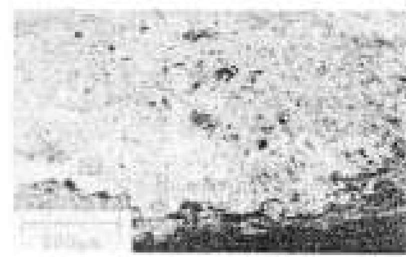

Fig. 13 – Carburised iron in sample taken from horse shoe, object SH23