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METALLOGRAPHIC ANALYSIS OF DACIAN AND LATÉNE IRON OBJECTS FOUND IN MALAYA KOPAN ARCHAEOLOGICAL COMPLEX

Introduction. Iron metal appeared in the human history in the IIIrd millennium B.C. up to half of the IInd millennium B.C. iron existed in shade of copper and copper bronzes as a new, special, but scarcely utilized metal. Hittites in the half of the IInd millennium B.C. started extensive use of iron, mostly in production of swords. This fact supported their dominance in Asia Minor.

Similar situation existed in Hallstat and Laténe continental Europe, where poor Hallstat iron metallurgy Celtic tribes changed to very extensive and efficient metallurgy, realised predominantly in production of weapons. The masterpiece of Celtic blacksmiths - Celtic sword, enabled them to occupy about half of the European territory (Pleiner, 2006). The sword was the object, where ancient blacksmiths realised their skills and knowledge in full scale.

Excavations in Malaya Kopan archaeological complex, dated to the Ist century B.C. - Ist century A.D., connected with Dacian inhabitation, discovered beside other iron objects also swords (Котигорошко, 1989). Some of them have already been analysed and published (Kotigoroshko, Mihok, 2005, p.73-77; Mihok, Kotigoroshko, 2008, p.60-72). No other similarly dated swords from close Central European regions were analysed. Two iron swords from Laténe site in Zemplin (Budinský-Krička, Lamiová-Schmiedlová, 1990, p.245-344) were not analysed by metallography methods. Only analyses of Avaric iron swords from Šebastovce cemetery (Mihok, Pribulová, Mačala, 1995, p.145-188), dated to the VIIth century A.D., Avaric iron sabres from Želovce cemetery (Mihok, Soláriková, Hollý, Čilinská, 1991, p.67-101; Hollý, Mihok, Cengel, Čilinská, 1989, p.907-912), similarly dated, and Slavic iron sword from Varín (Mihok, Pieta, 2004, p.16-20) are in disposition for comparison purposes.

New finds of three Dacian iron fighting sicas, five Laténe iron swords and one fighting axe in Tschellenica site of Malaya Kopan complex are welcome and precious opportunity to extend not very large knowledge about production methods of iron swords dated to Laténe time and to the beginnings of the Ist millennium A.D.

Archaeological situation. In 2007 - 2008 archaeological expedition of the Uzhgorod National University made excavations in the site Tschellenica. The site is situated on the top of the hill 200 m north-west from the Malaya Kopan Dacian settlement, Vinogradovo district, Transcarpathian Ukraine. In course of excavations on the square more than 2000 m^2 twelve cremation graves were discovered. Rich material was found in the graves. Basically, the material consisted of adornments and objects persistent to clothes-fibulae, buckles and clasps, bracelets, little chains. Special group of finds consisted of weapons (swords, fighting sicas, spearheads, darts, fighting axe, etc.). Big amount of chronoindicators enabled to relate the graves with Dacian necropolis of the first half of the Ist century B.C. and to the first years of the Ist millennium A.D.

In 2007 one sword was excavated and in 2008 ten swords followed. It formed very broad collection of attacking weapons used by inhabitants of the Malaya Kopan complex. Next, the swords were classified and submitted for metallographic analysis.

Methods of metallographic analysis. Nine iron objects found in the Ochellenica site of the Malaya Kopan complex were selected for metallographic analysis. The objects represented swords, only object no.4 represented a fighting axe. The objects were in preserved state, only swords no.8 and no.9 were represented by fragments. The samples from the objects were taken with the help of a saw. Next the samples were mounted in mounting resin and metallographic surfaces were prepared by grinding and polishing. The surfaces were observed under metallographic optic microscope first in non-etched, next in etched states. As an etching agent nital (solution of nitrid acid in alcohol) was used. Interesting features observed on metallographic surfaces both in non-etched and etched states were photographically documented. As the samples were taken only from one spot on each blade, they could not characterize all construction features of the whole weapon.

Results of metallographic analysis. *Sample 1. Dacian fighting sica.* The object 1, Dacian sica, is in Fig.1. The method of sample taking is in Fig.2. As can be seen from the Figure, the sample was taken from one edge and body of the sica blade. The sketch of analysed metallographic surface is in Fig.3. The numbers in the sketch show spots where different structures were observed.

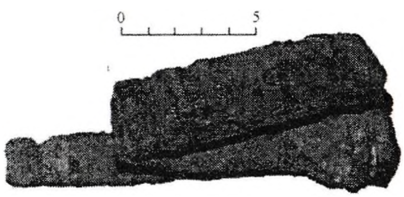

Fig.1. Object 1. Dacian fighting sica.

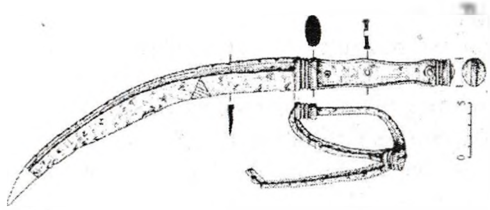

Fig.2. Object 1. Dacian fighting sica. Method of sample taking.

Fig.3. Object 1. Dacian fighting sica. Analysed metallographic surface.

Bands of smithy inclusions and scales (Fig.4) were observed on the metallographic surface of the sample prior to etching. Etching by nital revealed only coarse grained ferritic structure of non-carburised iron in the body of the fighting sica (Fig.5, spot 1). Down to the edge not very deep (about 0,2% C) carburisation, documented by ferritic-pearlitic structure, appeared only on one side of the metallographic surface. It is shown in Fig.6, taken from the spot 2. Fig.7 shows situation near the edge (spot 3). The situation is very similar to the one in the spot 2. The band of not very deep carburised iron stretches through the centre down to the very edge. Carburised iron is surrounded by non-carburised iron with coarse grained ferritic structure. Very sharp boundary between carburised part and non-carburised ones evidences of intentional welding of carburised and non-carburised iron semi-products in form of plates or bars, when the carburised one was positioned on and near the edge.

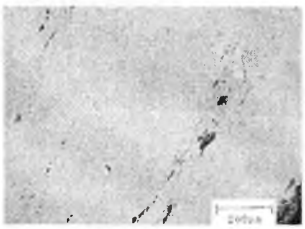

Fig.4. Bands of smithy inclusions and scales. Sample 1.

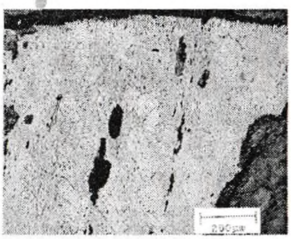

Fig.5. Ferritic structure of non-carburised iron. Spot 1. Sample 1.

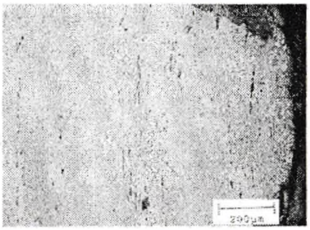

Fig.6. Carburisation on one side of the metallographic surface. Spot 2. Sample 1.

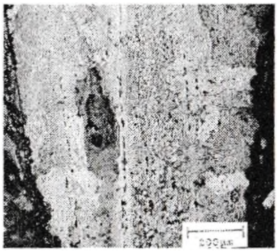

Fig.7. Distribution of structures near the edge. Spot 3. Sample 1.

The fighting sica no.1 had satisfactory quality. Because of non-carburised iron in the body it gained sufficient toughness. The edge was carburised, not too much, but enough for sufficient hardness of this part. No special construction features were found by the analysis.

Sample 2. Dacian fighting sica. The object 2, Dacian fighting sica, is in Fig.8, the method of sample taking is shown in Fig.9. Also in this case the sample covered the edge and part of the body of the sica. The sketch of metallographic surface is in Fig.10.

Fig.8. Object 2. Dacian fighting sica.

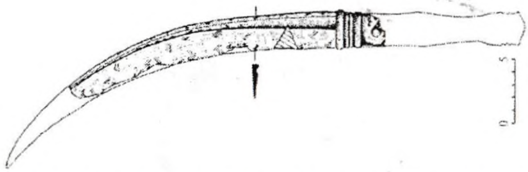

Fig.9. Object 2. Dacian fighting sica. Method of sample taking.

Fig.10. Object 2. Dacian fighting sica. Analysed metallographic surface.

A lot of smithy inclusions, mostly in form of bands, were found on the metallographic surface in non-etched state. A band of big smithy inclusions is depicted in Fig.11.

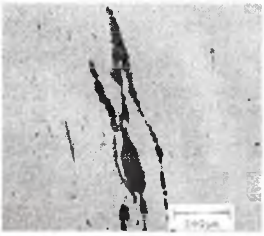

Fig.11. Band of smithy inclusions in sample 2.

Etching revealed ferritic-pearlitic structure of carburised iron with about 0,3% C in the spot 1 in the body of the sword (Fig.12). Down to the edge, the spot 2, ferritic-pearlitic structure of carburised iron with lower carbon content about 0,25% was found (Fig.13). In parts near the edge carbon content in iron decreased to about 0,1% (Fig.14, spot 3). It is the opposite situation as should be. Low carbon content on the edge and higher carbon content in the body? Probably not the edge, but the back of the fighting sica was sampled. There is no sharp edge around the spot 3 on the sketch of metallographic surface (Fig.10). Probably the body is around the spot 3 and the spot 1 is in position towards the edge.

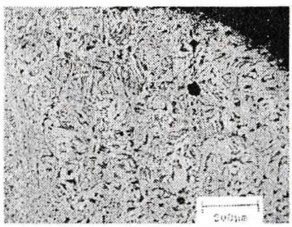

Fig.12. Ferritic-pearlitic structure of carburised iron. Spot 1. Sample 2.

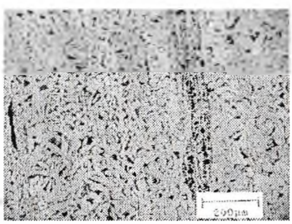

Fig.13. Ferritic-pearlitic structure of carburised iron. Spot 2. Sample 2.

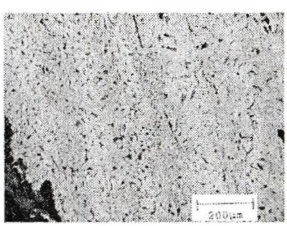

Fig.14. Low carburised iron near the edge. Spot 3. Sample 2.

When taking into account the situation described above, the fighting sica was prepared with proper method, with low carbon tough iron in the body and carburised iron on the edge.

Sample 3. Dacian fighting sica. The object 3, Dacian fighting sica, is in Fig.15, the method of sample taking is in Fig.16. The sample, that was taken, covers the edge and a part of the sica body. Fig.17 presents the sketch of the metallographic surface prepared on the sample.

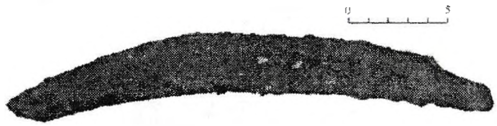

Fig.15. Object 3. Dacian fighting sica.

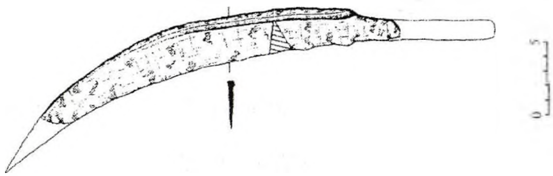

Fig. 16. Object 3. Dacian fighting sica. Method of sample taking.

Fig.17. Object 3. Dacian fighting sica. Analysed metallographic surface.

A lot of smithy inclusions and particles of scales were observed on the metallographic surface in non-etched state. Etching visualised following distribution of structures. In the body of the fighting sica, spot 1, fine grained ferritic-pearlitic structure of not very deep carburised iron was found (Fig.18). Down to the edge, spot 2, feritic-pearlitic structure with carbon content similar to spot 1 was found only by one side of the surface, the other iron material in this spot had lower carbon content (Fig.19). On the very edge, spot 3, fine grained ferritic-pearlitic structure of iron with very low carbon content (about 0,1%) was observed (Fig.20).

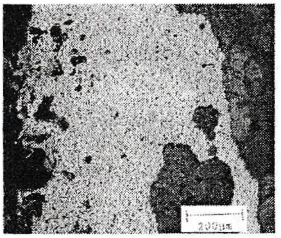

Fig.18. Ferritic-pearlitic structure of low carburised iron. Spot 1. Sample 3.

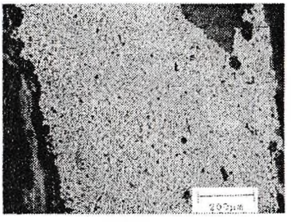

Fig.19. Ferritic-pearlitic structure of low carburised iron. Spot 2. Sample 3.

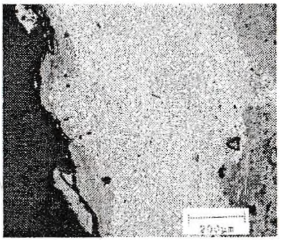

Fig.20. Very low carburised iron on the very edge. Spot 3. Sample 3.

It is probably the same situation as in analysis of the sample 2, back and body of the sword were sampled, not the edge. From this point of view analysis of spot 1 in the body proves growing content of carbon towards the edge that was in opposite position. Taking this fact into account, the way of the sword manufacturing was proper.

Sample 4. Fighting axe. The object 4, fighting axe, is in Fig.21, the method of sample taking is in Fig.22. As can be seen from the Fig.22, the sample covered the edge and the body of the axe. The sketch of metallographic surface prepared on the sample is in Fig.23.

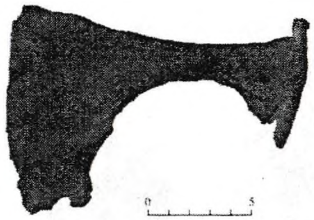

Fig.21. Object 4. Fighting axe.

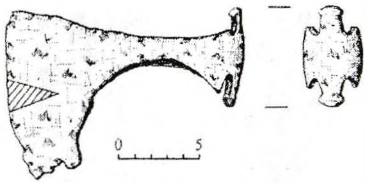

Fig.22. Object 4. Fighting axe. Method of sample taking.

Fig.23. Object 4. Fighting axe. Analysed metallographic surface.

Bands and clusters of big particles of smithy inclusions were observed on the metallographic surface prior to etching (Fig.24). Etching revealed two kinds of structures in spot 1 in the body of the axe. One of them was coarse grained ferritic structure of non-carburised iron, the second one was fine grained ferritic-pearlitic structure of mildly carburised iron. Both structures are depicted in Fig. 25. Boundary between both structures is formed by the band of smithy inclusions. All other parts of the metallographic surface are characteristic by structures of carburised iron. In spot 2 down to the edge two different carburised structures were observed, one was deep carburised, the second one mild carburised, both were fine grained as a result of intensive hammering (Fig.26). Sharp boundary between the two structures is very interesting. Special situation is depicted in Fig.27, spot 3. Here also two bands of differently carburised iron are visible, but, moreover, the structure by one side of the metallographic surface (one surface of the axe) has ferritic character of non-carburised iron. Probably it resulted from secondary decarburisation in a flame. Structure on the very edge, spot 4, is in Fig.28. The structure represents deep carburised and quenched iron.

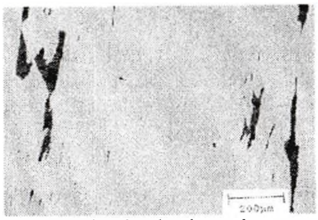

Fig.24. Smithy inclusions in sample 4.

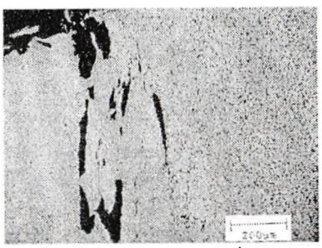

Fig.25. Distribution of structures in spot 1. Sample 4.

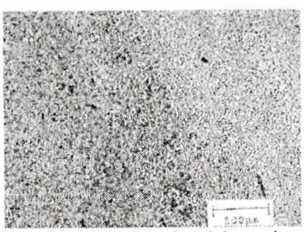

Fig.26. Two structures of carburised iron in spot 2. Sample 4.

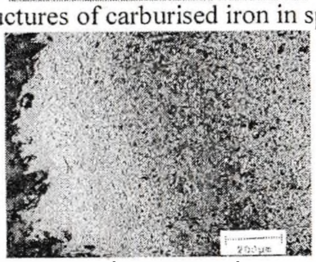

Fig.27. Distribution of structures in spot 3. Sample 4.

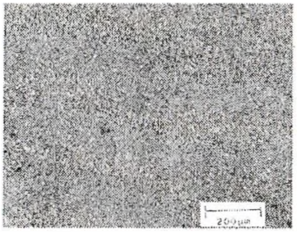

Fig.28. Structure of deep carburised and quenched iron on the edge. Spot 4. Sample 4.

From results of metallographic analysis followed the body of the fighting axe was made from non-carburised tough iron. Broad part of the axe near the edge was carburised, or, probably, prepared by welding of carburised iron semi-products, as documented by sharp boundaries between the structures. The edge itself was deep carburised and quenched. By described way of manufacturing local smiths prepared high quality weapon - the fighting axe.

Sample 5. Latène sword. The object 5, Latène sword, is in Fig.29, the method of sample taking is in Fig.30. The sample covered the edge and part of the body of the sword. The sketch of metallographic surface of the sample taken from the sword, is presented in Fig.31.

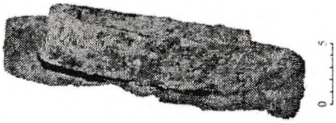

Fig.29. Object 5. Latène sword.

Fig.30. Object 5. Latène sword. Method of sample taking.

Fig.31. Object 5. Latène sword. Analysed metallographic surface.

Observation of the metallographic surface in non-etched state showed enormous quantity of smithy inclusions and scales particles (Fig.32). Structures in spot 1, visualized by etching, are in Fig.33. In this spot coarse grained ferritic structure of non-carburised iron prevailed, only in some places coarse grained ferritic-pearlitic structure of mildly carburised iron was observed. Similar situation was found in spot 2, coarse grained ferritic-pearlitic structure of mildly carburised iron was situated in both sides of the metallographic surface, i.e. on the sword surface (Fig.34). The same situation was observed is spot 3 near the edge (Fig.35).

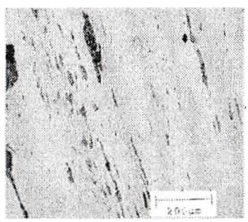

Fig.32. Particles of smithy inclusions and scales in sample 5.

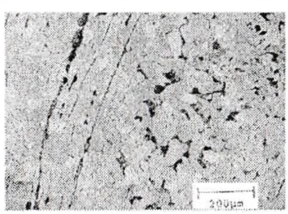

Fig.33. Structures of non-carburised and low-carburised iron in spot 1. Sample 5.

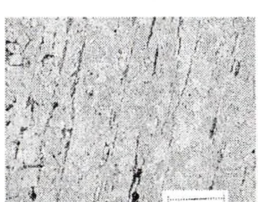

Fig.34. Structures of non-carburised and low-carburised iron in spot 2. Sample 5.

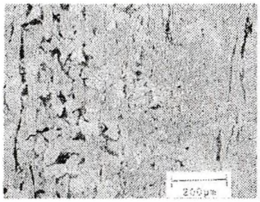

Fig.35. Structures of non-carburised and low-carburised iron in spot 3. Sample 5.

Results of metallographic analysis prove low quality of the sword. Soft and tough iron on the very edge is not a good solution. Are we sure the sword was double-edged? If it was single edged, are we sure the edge was sampled?

Sample 6. Laténe sword. The object 6, Laténe sword, is in Fig.36, the method of sample taking is in Fig.37. The sketch of metallographic surface is in Fig.38.

Fig.36. Object 6. Laténe sword.

Fig.37. Object 6. Laténe sword. Method of sample taking.

Fig.38. Object 6. Laténe sword. Analysed metallographic surface.

Observation of the metallographic surface prior to etching showed very clean iron material with only one band of scales and smithy inclusions. After etching, fine grained ferritic-pearlitic structure of low carburised iron was found in the body of the sword (Fig.39, spot 1). Lower down to the edge deep carburised iron, represented by ferritic-pearlitic and pearlitic-ferritic structures, appeared along one side of the metallographic surface (Fig.40, spot 2). Low carburised ferritic-pearlitic iron was observed along the other side and in the centre of the metallographic surface. Structures in spot 3 are nearly similar, but carburised iron with pearlitic-ferritic structure is not situated along the one side of the metallographic surface, but near it. Iron along the other side was very low carburised. The structures in spot 3 are depicted in Fig.41. Similar situation was found in spot 4 near the edge. Only one side of the metallographic surface, i.e. sword surface was deep carburised. The other part contained low-carburised iron (Fig.42).

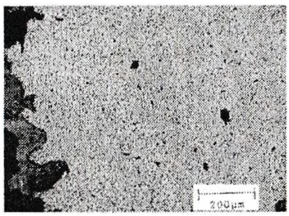

Fig.39. Ferritic-pearlitic structure of low-carburised iron in spot 1. Sample 6.

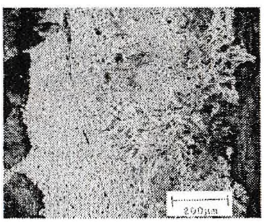

Fig.40. Deep carburised iron by the surface. Spot 2. Sample 6.

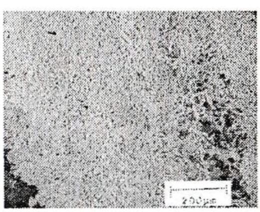

Fig.41. Deep carburised iron near one surface. Spot 3. Sample 6.

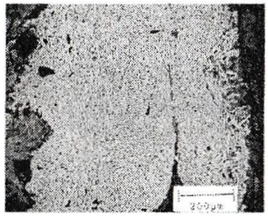

Fig.42. Distribution of structures near the edge. Spot 4. Sample 6.

The way of sword construction was not very positive for its properties. Deep carburised surface of the sword around and on the edge was needed.

Sample 7. Laténe sword. The object 7, Laténe sword, is in Fig.43. The object was found in two fragments, the sample was taken from the smaller one (Fig.44). The sketch of metallographic surface is in Fig.45.

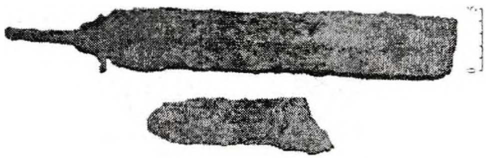

Fig.43. Object 7. Laténe sword.

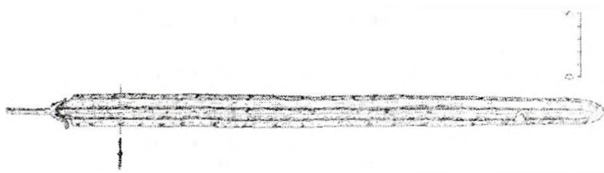

Fig.44. Object 7. Laténe sword. Method of sample taking.

Fig.45. Object 7. Laténe sword. Analysed metallographic surface.

Observation of the metallographic surface prior to etching showed bands of smithy inclusions and scales particles. Etching visualised in spot 1 coarse grained ferritic-pearlitic structure of mildly carburised iron, but carbon content, i.e. intensity of carburisation, was much higher along one side of the metallographic surface (Fig.46). Down to the edge more intensive carburisation of the whole iron material appeared, spot 2, moreover, one side of the metallographic surface, the same as in spot 1, was deep carburised with resulting pearlitic-ferritic structures (Fig.47). Similar situation was observed in spot 3, but broad band of deep carburisation up to 0,8% C stretching from the surface was observed (Fig.48). Similar situation was found in spot 4, where band of deep carburised iron material finished on the very edge (Fig.49).

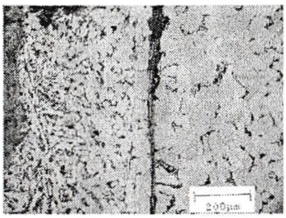

Fig.46. Distribution of structures in spot 1. Sample 7.

Fig.47. Deep carburisation by one side of the surface. Spot 2. Sample 7.

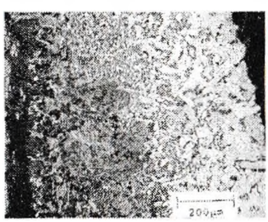

Fig.48. Deep carburisation by one side of the surface. Spot 3. Sample 7.

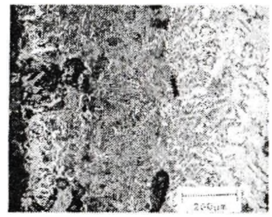

Fig.49. Distribution of structures near the edge. Spot 4. Sample 7.

It was very interesting that the sword was carburised only from one surface. Carburisation covered the edge(s). Nevertheless, high quality of the sword resulted from above described way of construction.

Sample 8. Laténe sword. The object 8, Laténe sword, is in Fig.50. As can be seen from the Figure, fragment of the sword was found and sampled, Fig.51. The sketch of metallographic surface is in Fig.52.

Fig.50. Object 8. Fragment of Laténe sword.

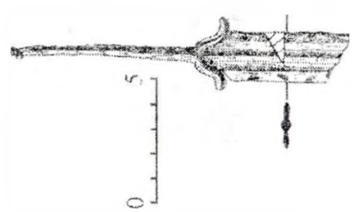

Fig.51. Object 8. Fragment of Laténe sword. Method of sample taking.

Fig.52. Object 8. Fragment of Laténe sword. Analysed metallographic surface.

Observation of the metallographic surface prior to etching showed a lot of smithy inclusions particles. Cluster of smithy inclusions is depicted in Fig.53. Etching by nital visualised following distribution of structures. In the body of the sword, spot 1, only ferritic structure of non-carburised iron, in some places coarse grained, was observed (Fig.54). In spot 2 still in the body very little carburisation appeared by one side of the metallographic surface, represented by fine grained ferritic-pearlitic structure (Fig.55). Down to the edge, spot 3, deep carburisation started by the same side of the metallographic surface (Fig.56). The second side was carburised only in small extent. Lower down to the edge, spot 4, deep carburisation by the one side was replaced by small carburisation, represented by fine grained ferritic-pearlitic structure, similar to spot 2 (Fig.57). Rest of the metallographic surface towards the other side in spot 4 was formed by coarse grained ferritic structure of non-carburised iron. The same situation was found near the very edge (Fig.58, spot 5).

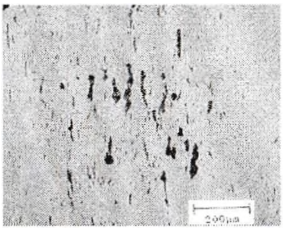

Fig.53. Particles of smithy inclusions and scales in sample 8.

Fig.54. Non-carburised iron in spot 1. Sample 8.

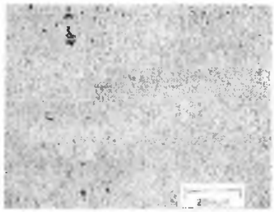

Fig.55. Low-carburised iron in spot 2. Sample 8.

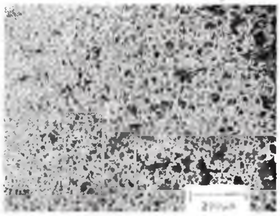

Fig.56. Deep carburisation by one side of the surface. Spot 3. Sample 8.

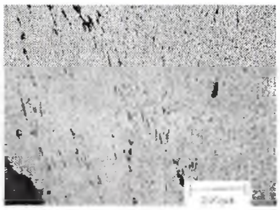

Fig.57. Low-carburised iron by one side of the surface. Spot 4. Sample 8.

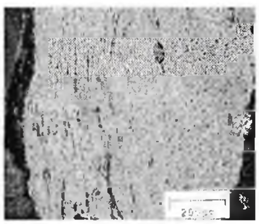

Fig.58. Distribution of structures near the edge. Spot 5. Sample 8.

The sword no.8 was constructed by the similar way as the swords no.6 and no.7. Carburisation of the sword was performed only on one surface and covered also the edge(s). Carburisation was not even, the edge and surface by the edge were carburised only in small extent. It is the reason why utility value of the sword was not very high.

Sample 9. Laténe sword. The object 9, Laténe sword, is in Fig.59. Also in this case the fragment of the sword was sampled (Fig.60). The sketch of metallographic surface is in Fig.61.

Fig.59. Object 9. Fragment of Laténe sword.

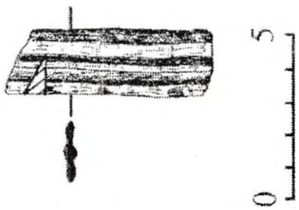

Fig.60. Object 9. Fragment of Laténe sword. Method of sample taking.

Fig.61. Object 9. Fragment of Laténe sword. Analysed metallographic surface.

The metallographic surface, observed prior to etching, contained high amount of scales particles and a few particles of smithy inclusions (Fig.62). Etching revealed ferritic structure of non-carburised iron in the body of the sword (Fig.63, spot 1). Down to the edge, spot 2, the structure on the whole surface was mildly carburised with resulting ferritic-pearlitic structure (Fig.64). Character of the structure was not changed up to the edge (Fig.65, spot 3). High deformation of structure in the very edge is visible from the Figure.

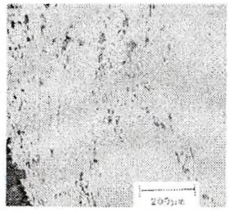

Fig.62. Particles of scales in sample 9.

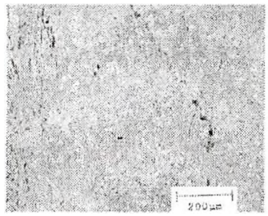

Fig.63. Non-carburised iron in spot 1. Sample 9.

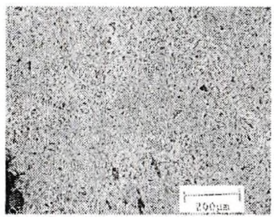

Fig.64. Low-carburised iron in spot 2. Sample 9.

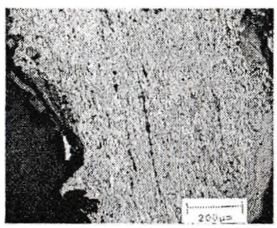

Fig.65. Structure of low-carburised iron on the edge. Spot 3. Sample 9.

Construction method of the sword no.9 was different from the ones described above. The body of the sword contained only non-carburised tough iron, but whole iron material in the edge(s) and around it was mildly carburised, not only the surface of the sword. Owing to low carburisation of the edge utility properties of the sword were not very high.

Discussion. Three Dacian fighting sicas were analysed by metallography method and nearly the same situation was found in analysis of sicas no.2 and no.3. Higher carbon contents were found in the bodies of the sicas and they gradually decreased towards the edge. Probably the back and body of the sica were analysed owing to improper sample taking. An assumption can be done higher carbon content in the body of the sica increased towards the edge, that was not analysed. Such production method would be proper. The sica no.1 had the edge carburised, not very deep, but carburised. The extent of carburisation was sufficient for hard edge of the sica, production way was proper.

The fighting axe, also of Dacian origin, had tough body from non-carburised iron and very hard edge, resulting from its deep carburisation and subsequent quenching. This excellent production method was also found in analysis of some other contemporary collections (Mihok, Pribulová, 2002, p.83-112).

Five Laténe (Celtic?) swords were analysed by metallography method. Three of the swords, nos.6,7 and 8, were produced by the same method. Only one surface of the sword was carburised, the carburisation covered also the edge. Carburisation of the edge was not very deep. Production method was proper, but not excellent, high utility properties of the swords were not attained. Whole iron material of the sword no.9 near the edge was carburised, but not very deep. Also this production method was proper. On the other side, the edge of the sword no.5 was not carburised, only tough non-carburised iron was found on the very edge. Owing to probably mistake of the blacksmiths, the sword had very poor properties. The same situation was found in analysis of German sword from Avaric cemetery in Želovce (Mihok, Soláriková, Hollý, Čilinská, 1991, p.67-101).

Analysis of four iron swords from the Malaya Kopan complex, described in (Kotigoroshko, Mihok, 2005, p.73-77; Mihok, Kotigoroshko, 2008, p.60-72), resulted in different production methods, from low-carburised edge to deep carburised and deep carburised / quenched ones. This situation proves there was not one common method for production of iron swords utilized by local blacksmiths.

Conclusions. The paper presents metallographic analysis of three Dacian fighting sicas, five Laténe iron swords and one fighting axe, excavated in the Malaya Kopan archaeological complex, site Tschellenica. The results of analysis are as follow.

1. Two of the Dacian fighting sicas were probably sampled from wrong side, i.e. back and body of the fighting sicas were covered by the samples. The supposition was made the edges of the sicas were carburised and carbon

contents decreased towards the backs of the sicas. Such way of construction was proper.

2. The third of the Dacian fighting sicas had edge and body covered by sampling. Analysis showed the edge was not very deep carburised, non carburised tough iron was found in the body.

3. From five Latene swords three of them were made by similar way, when only one surface of the sword was carburised. Carburisation covered also the edge. The fourth sword had edge and whole iron material near the edge carburised. All four swords were produced by proper technology, producing swords with convenient properties.

4. The fifth Latene sword had analysed edge made of non-carburised iron. The properties of the sword were bad.

5. The fighting axe was produced by method providing tough body from non-carburised iron and very hard edge as a result of deep carburisation and quenching of this part. Excellent properties of the fighting axe resulted from the production method.

Ключові слова: даки, латен, могильник, археометалургійний аналіз, меч, сіка, сокира.

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Металографічний аналіз дакійських і латенських залізних предметів з Малокопанського археологічного комплексу
(Резюме)

У публікації подані результати металографічного аналізу наступальної зброї (дакійські мечі типу сіки, двосічні мечі, бойова сокира), виявленого в 2008 р. на Малокопанському могильнику (ур.Челлениця). Відзначається різноманітність технологічних методів, застосованих при виготовленні даної зброї, разом з тим три меча, за своїми археометалургійними параметрами, можливо були виготовлені в одній майстерні.

Особливо відзначається висока техніка виготовлення бойової сокири, відомої в одиничному екземплярі, у зв'язку з чим він не підлягає порівнянню.

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Металлографический анализ дакийских и латенских железных предметов с Малокопаньского археологического комплекса

(Резюме)

В публикации поданы результаты металлографического анализа наступательного оружия (дакийские боевые серпы типа сики, боюдоостые мечи, боевой топор), обнаруженного в 2008 г. на Малокопаньском могильнике (ур.Челленица). Отмечается разнообразие технологических методов, применённых при изготовлении данного оружия, вместе с тем три меча, по своим археометаллургическим параметрам, возможно были изготовлены в одной мастерской.

Особо отмечается высокая техника изготовления боевого топора, известного в единичном экземпляре, в связи с чем он не подлежит сравнению.

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