вних прошарків угорського народу. Скоріше за все, коня ховали разом з багатими чи знатними людьми, членами їх родини (включаючи жінок та дітей), а також коня ховали разом з воїнами.

Про існування ієрархічних відмінностей між кочовою елітою та рядовим населенням свідчить і те, як вони були поховані. У Чомському могильнику спостерігається відокремлення місць поховань знаті, воїнів (з конем) та рядового населення. Між похованнями рядами пролягає смуга довжиною 8-10 м.

Чомський археологічний комплекс, який включає в собі поховання з конем, на сьогодні ще повністю не досліджений і тому потребує подальшого змістового вивчення.

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THE CEREMONY OF BURIAL HUNGARIAN PEOPLES WITH HORSE

(for example materials of Choma burial place)

Summary

The early medieval entombments with a horse are related to a specific group of entombments which were left by nomadic and seminomadic peoples. The tendency to use a horse in the ceremony of entombment was inherent to the Hungarian-nomads.

The ceremony of ceremony may be traced taking the sepulchral complex in the village of Choma (Berehovo district, Transcarpathian region) as an example. The exploration of an ancient burial place. Especially during a period of 1993-1997, gave a lot of archeological material. The study of which bears witness to certain Hungarian traditions of the ceremony of entombment which lasts some centuries without any notable changes. The given article the characteristics of the ceremony of entombment taking several entombments as an example.

The study of Choma sepulchar complex (which dates back to the end of IX – beginning of the Xth centuries) is being continued.

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METALLOGRAPHIC ANALYSIS OF IRON SWORD FROM ZÁVADA

The sword, submitted to metallographic analysis, was found in grave no. 23 at burying ground in Závada, west Slovakia. It was a part of 30 to 40 years old warrior graves inventory (Bialeková D., 1975; Bialeková D., 1982). By typology the sword is classed in Petersen type X or by next classifications to Ruttkay group VI (Ruttkay A., 1976) or Geibig group 12, variant I (Geibig A., 1991).

The parameters of the sword are as follows:

- total length: 93 cm
- length of blade: 80 cm
- width of blade near the cross-guard: 7 cm
- width of blade near the tip: 4 cm
- length of hilt: 9 cm
- length of cross-guard: 16 cm
- basis of pommel: 5,5 cm
- height of pommel: 3 cm
- weight of sword: 1430 g.

Sword´s blade with blood grooves in both sides was inserted in woodden sheat, its remnants were found on the blade surface. Together with the sword belt buckles were also found . In central Danube Slavs´territory these buckles are dated mostly to Blatnice-Mikulčice horizont (last decade of the 8th century to the first third of the 9th century A.D.) Based on vertical stratigraphy the grave no.23 from Závada should be dated to the first half of the 9th century. From this fact followed analyzed sword was made no later than in second third of the 9th century A.D. It is at least half of century earlier than the swords of this type are dated (Geibig A., 1991).

Accumulation of X-type swords on the territory of Slovakia and Nitra dukedoms and later on the territory of Great Morava Empire, mainly in Mikulčice and Pohansko near Břeclav (Poulík J., 1967; Klanica Z., 1985; Vignatiová J., 1993) and also on some other sites (Hrubý V., 1955; Dostál B., 1966; Měřínský Z, Unger J. 1990) led to prosupposition that at least a part of these swords was made in local smithy workshops. The fact followed from embargo imposed on weapons export to Slavs and Avars by Charlemagne (Bialeková D, 1975; Dostál B., 1966; Poulík J., 1957). Find of pommel from X-type sword in smithy workshop of Mikulčice fortified settlement would confirm this oppinion (Klíma B., 1985). Concerning to export of Frank weapons to Slav territory a supposition was made that only blades were exported and hilts and pommels were produced by local smiths (Arbam H., 1937). As described below, this supposition was not confirmed by analysis of sword from Závada.

The aim of the metallographic analysis was to find out the method of sword production. To to this, four samples were taken, Fig.1. As can be seen from the Figure, three parts of the sword were sampled: blade, pommel and cross-guard. The samples were taken with the help of diamond saw. Metallographic surfaces were prepared after mounting into mounting of samples resin by normal way: grinding and polishing. Metallographic surfaces were observed under metallographic light microscope in etched and non-etched states. 3% nital was used as etching agent. After observing the samples under microscope chemical composition was analysed by spectrographic method.

Results of metallographic analyses

Metallographic analysis of sample A, taken from the cross-guard, is in Fig.2. In the top left corner of the Figure there is a schematic representation of analyzed surface. By numbers at the sketch are indicated structures depicted on photographs in the Figure. A great amount of furnace slag inclusions was found in the sample. Such inclusion, partly deformed by hammering, is in photo in top right corner of the Figure. The inclusion is typical by wüstite and silicate structural components.

Places of welding were clearly observed on surface in non-etched state. One weld was indicated by corroded crack (1), the second one by light grey band in metal (2). In crack cavity particles of furnace slag were frequently observed (3).

Etching the sample by nital revealed only non-carburized or mildly carburized structures. Most part of the surface contained coarse grained ferritic structure (4). Not very large places under weld indicated by light grey band, had fine grained mildly carburized ferritic-pearlitic structure. Boundary between coarse grained and fine grained structures, formed by weld, is in Photo (5), fine grained ferritic-pearlitic structure is in Photo (6).

Metallographic analysis of sample B, taken from the pommel, is in Fig.3. Schematic representation of analyzed surface and distribution of structures, depicted in photographs in the Figure, is in top left corner. On the right side of this schematic representation there are two photographs of non-metallic inclusions observed in analyzed sample. Besides inclusions of furnace slag also inclusions of ferrous silicate were observed. These inclusions originated from silica sand used by blacksmiths to dissolve oxidic scale formed on surface of heated iron materials. Silica reacted with iron oxides and formed ferrous silicate, that was liquid in temperatures used by blacksmiths for welding and forming.

Three different structures were observed on metallographic surface of the sample after etching. In relative narrow band on top of analyzed surface fine grained ferritic-pearlitic structure was found. Such structure is depicted in photo (1), detail of this structure is in photo (2). Most of analyzed surface consisted of non-carburized medium-size grained ferritic iron (3). Spots of mildly carburized ferritic-pearlitic structures were also observed in this part of the surface (4). In the bottom part of analyzed surface carburized structures were found. Boundary of non-carburized centre and carburized bottom was formed by broken band of silicate inclusions, possibly indicating the place of weld (5). Highly carburized pearlitic structure with low content of ferrite is in photograph (6).

Metallographic analysis of sample C, taken from the sword's blade, is in Fig.4. The sample was typical by high content of smithy silicate inclusions, that are depicted on the right side of schematic representation of structures distribution on

analyzed surface. The inclusions proved intensive hammering of iron semiproducts during their assembly to final shape of sword and the use of smithy welding. The blade in analyzed place was made by welding of two bar-like semiproducts. Place of welding was indicated by crack, depicted in top right photograph. One of the bars, that didn't cover the sword's edge, was made of iron with fine grained ferritic-pearlitic structures. Carbon content in these structures slightly varied, as is depicted in photographs taken from places 1 and 2.

The second bar, that formed also the edge, had fine grained ferritic-pearlitic structure in places near the weld. Towards the edge carbon content increased to mostly pearlitic structures. Such distribution of structures is depicted in photograph taken from place 3. Edge and surface around edge were quenched. Quenching line pointing the position of sword during quenching was slant, is shown in sketch of analyzed surface in top left corner of the Figure. The fact that not all blade was quenched, was proved also by occurrence of troostitic structures (4), resulting from lower gradient of cooling. Martensitic structure, result of quenching, is depicted in photograph (5).

Metallographic analysis of sample D, taken from sword's blade, is in Fig.5. Also in this sample a high content of smithy silicate inclusions occurred, as depicted in photograph on top right side of the Figure. Besides them also inclusions of furnace slag were observed. In the centre of sword's cross-section non-carburized or low-carburized ferritic-pearlitic structures were found. Also in this place welding of sword from two iron bars was recognized. One of them had coarse grained ferritic structure (1), the second one had medium sized ferritic-pearlitic structure (2). Towards the edge carbon content increased with resulting pearlitic-ferritic structures (3). The blade itself and places around it were quenched, that resulted in martensistic and troostitic structures, photographs 4, 5 and 6.

Results of spectrographic analysis

Results of spectrographic analysis are in Table I. The analysis has qualitative character. The elements are divided into three groups:

- as major elements: those in concentration range of 1 to 100 wt%,
- as minor elements: those in concentration range of 0,01 to 1 wt%,
- as trace elements: those in concentration range of 0,0001 to 0,01 wt%.

Discussion of results

From metallographic analyses results follow ingenious and sophisticated blacksmiths method of sword production. Cross-guard was made of iron material that was not specialy processed. It had non-carburized low carbon ferritic structure, as most non-treated iron materials, products of smelting in small reduction furnace had. Such material had soft, and tough mechanic properties and for production of cross-guard was suitable.

Pommel was made from similar material, but it was carburized on surface of both shorter sides. Soft non-carburized iron was also suitable for production of pommel, but the aim of pommel's surface carburization was unclear.

As expected, the most elaborated part of the sword was blade. From metallographic analyses followed the method of blade production, also depicted in Fig.6. Rough shape of blade was made by welding of two iron semiproducts in form of bars. Both bars had very similar non-carburized and in places mildly carburized structures. Grain size of the structure was influenced by intensity of hammering prior to and during welding. After welding both edges were prepared by hammering. Then the iron material on edges and places around edges was processed by carburization followed by quenching.

Excellent properties of the blade resulted from above described method of treatment. Soft ferritic and ferritic-pearlitic iron material in the sword's core gave the sword tough properties. By carburizing and quenching very hard material on sword's edges was prepared. The sword was double-edged.

From spectrographic analysis followed very similar composition of all analyzed samples, only small differences were found. It is highly probable all iron semiproducts came from the same smelting workshop using iron ore from one source. The fact no other elements besides iron reduced into metal and the character of slag inclusions present in metal proved iron material used for sword production was smelted in primary small reduction furnace.

Conclusions

The contribution presents results of metallographic analysis of iron sword from Slav settlement in Závada. The results are as follows:

1. The analysis showed sophisticated production technology used by blacksmiths for production of iron sword.
2. The smiths produced the cross-guard a probably the hilt of the sword from soft and tough non-carburized iron material. The tough iron material was fully suitable for production of these parts of the sword.
3. The pommel was carburized on the surface. The purpose of pommel´s carburizaton is unclear.
4. The blade of the sword was made by welding of two non-carburized or mildly carburized iron bars. After welding the edges were made by hammering.
5. After preparing the final shape of the blade the edges were hardened by carburization and quenching.
6. Analyzed sword was double-edged.
7. Following the results of spectrographic analysis, all parts of the sword were made in the same site and from the same iron semiproducts.
8. Sword from Závada was of domestic production made in the first half of the 9 th century A.D.

Table I

Results of spectrographic analysis

Sample no	*Major elements*	*Minor elements*	*Trace elements*
A	Fe	Cu,Ni,Co,Ti,Mg,Si,Cr,Zn	Pb,Mn,Sn,Ag
B	Fe	Cu,Mn,Ni,Co,Ti,Mg,Si,Cr,Zn	Pb,Sn,Ag
C	Fe	Cu,Mn,Ti,Mg,Zn,Si,Cr	Pb,Sn,Ni,Ag
D	Fe	Cu,Mn,Ni,Co,Ti,Mg,Zn,Si,Cr	Pb,Sn,Ag

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МЕТАЛЛОГРАФИЧЕСКИЙ АНАЛИЗ ЖЕЛЕЗНОГО МЕЧА ИЗ ЗАВАДЫ

Резюме

В работе представлены следующие результаты анализа железного меча IX в. н.э. из славянского поселения в Заваде:

1. Анализом установлена софистицированная технология изготовления меча;
2. Кузнецы изготавливали перекрестье, а, возможно, и рукоять меча из мягкого ненауглерожнного металла. Состав железа соответствовал требованиям изготовления этих частей меча;
3. Набалдашник рукояти был науглерожен. Цель его науглероживанния неясна;
4. Лезвие меча изготовлено путём сварки двух ненауглероженных или средненауглероженных полос металла. После сварки лезвие меча было проковано;
5. Края клинка, после придания мечу окончательной формы, были науглерожены путём дополнительной ковки;
6. Анализируемый меч – обоюдоострый.
7. Результаты спектрографического анализа подтверждают вышесделанные выводы в отношении материала и первоначальной формы меча;
8. Меч из Завады местного производства и был изготовлен в первой половине IX в. н.э.

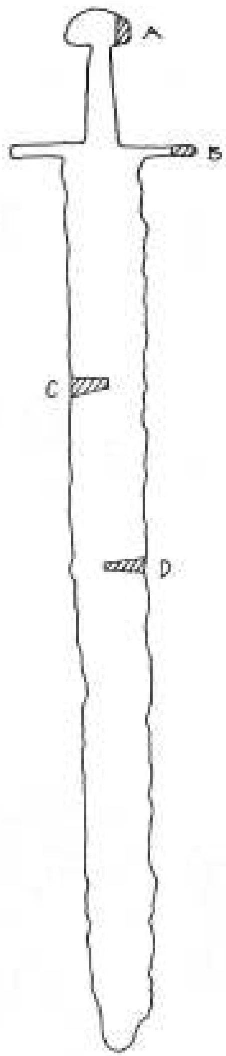

Fig.1. Schematic representation of sample taking.

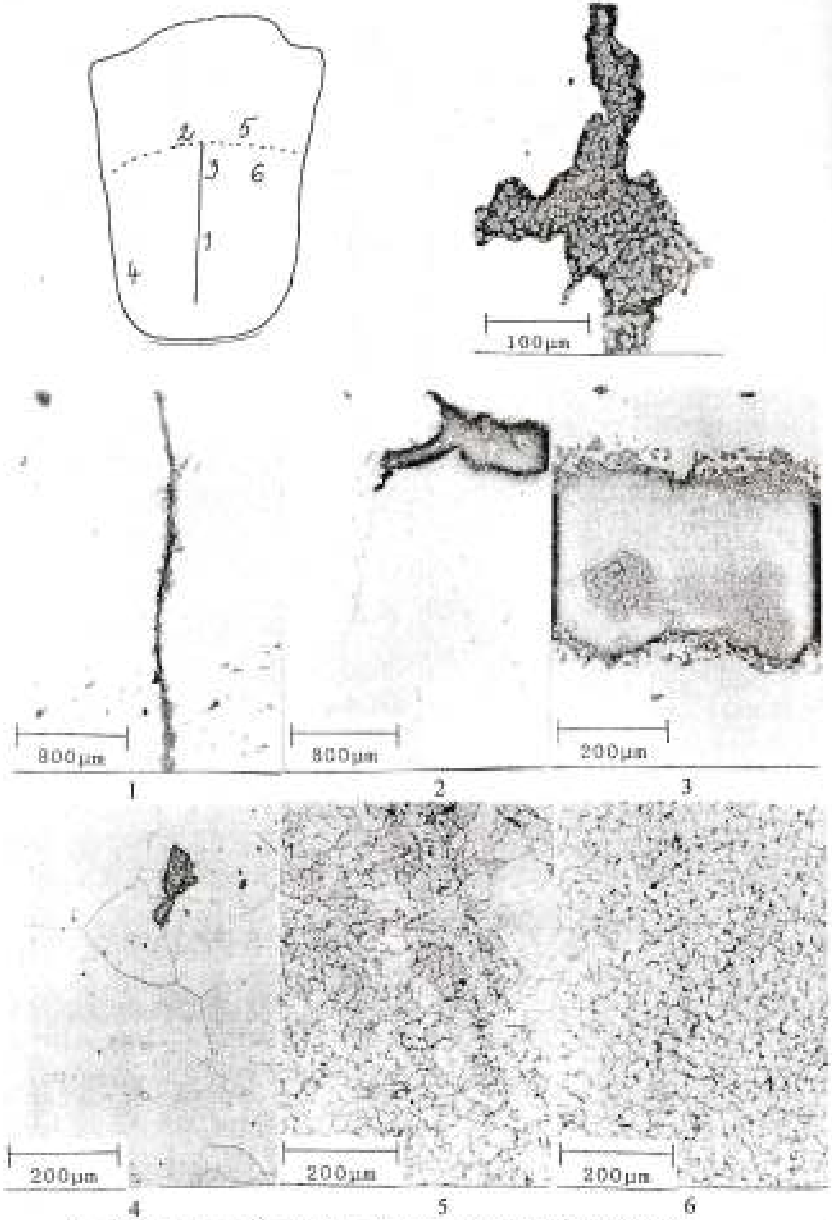

Fig.2. Metallographic analysis of sample A, taken from pommel.

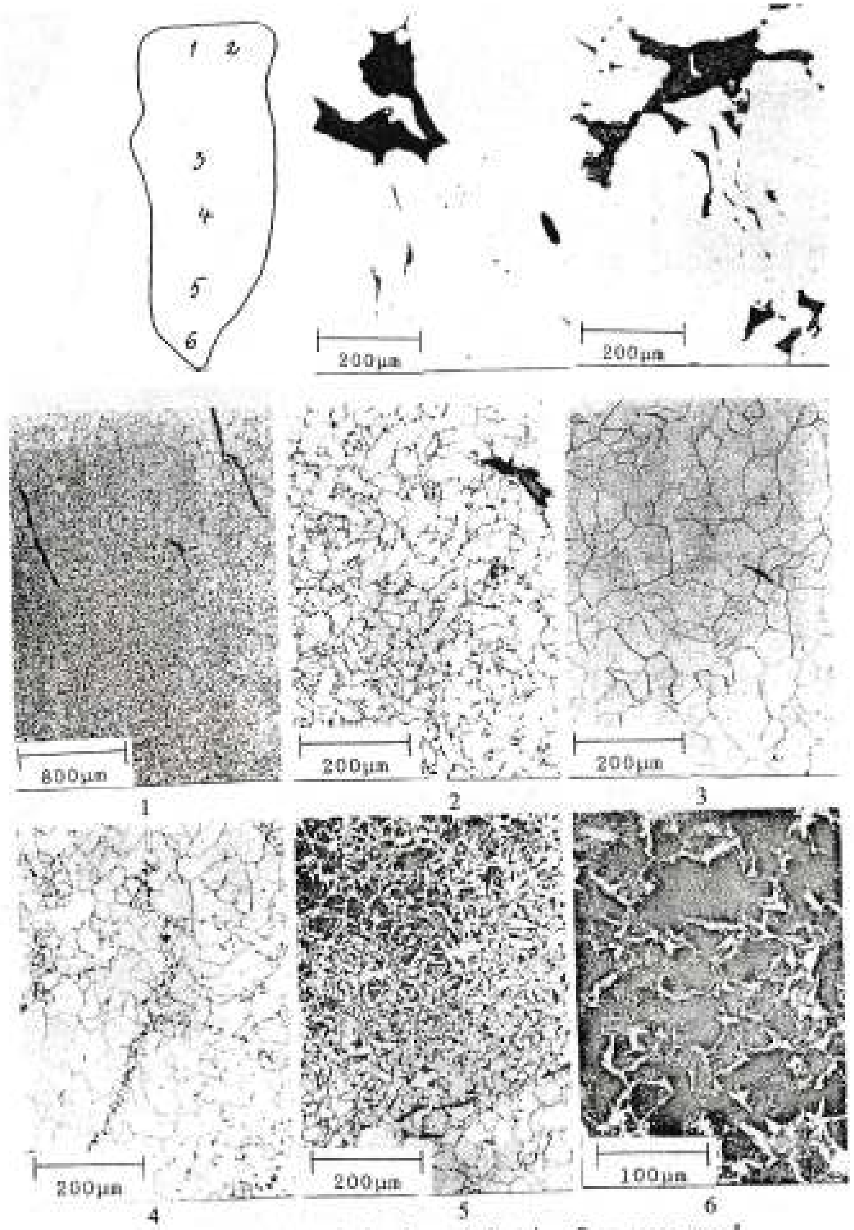

Fig.3. Metallographic analysis of sample B, taken from cross-guard.

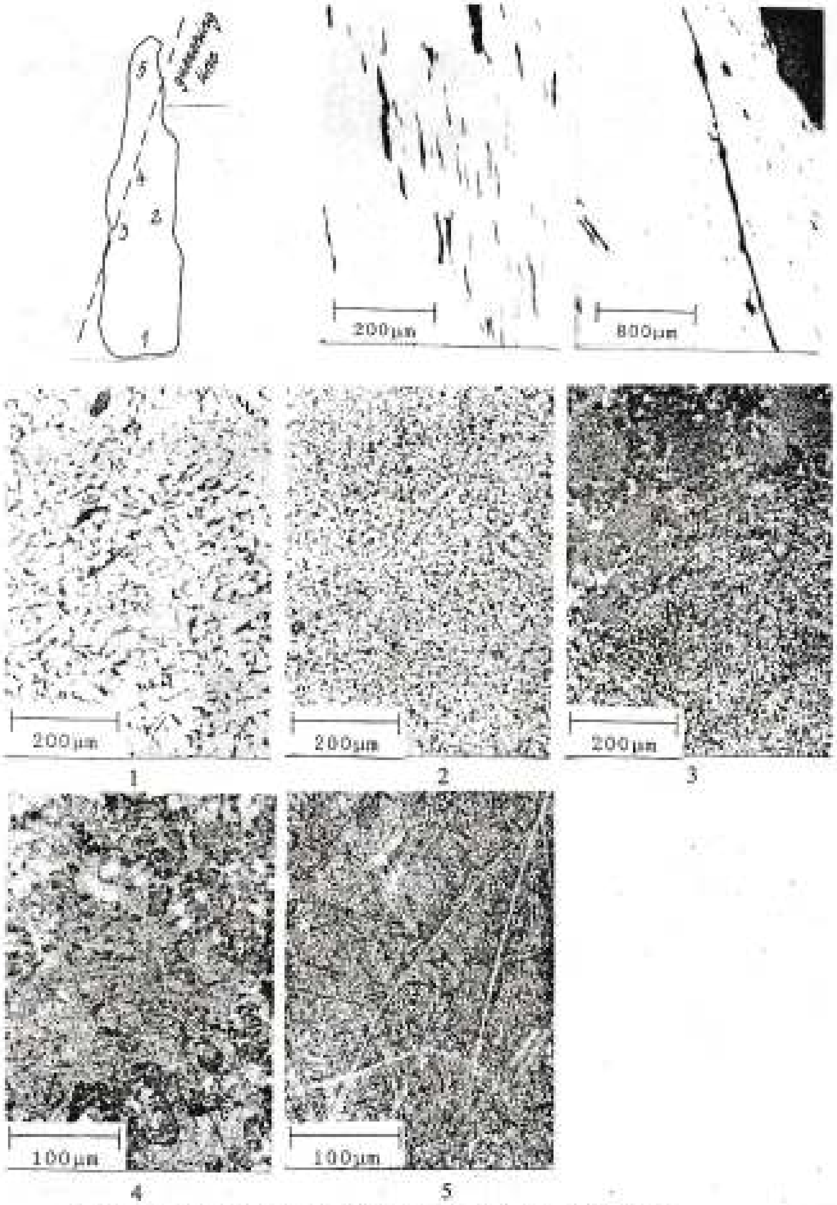

Fig.4. Metallographic analysis of sample C, taken from blade.

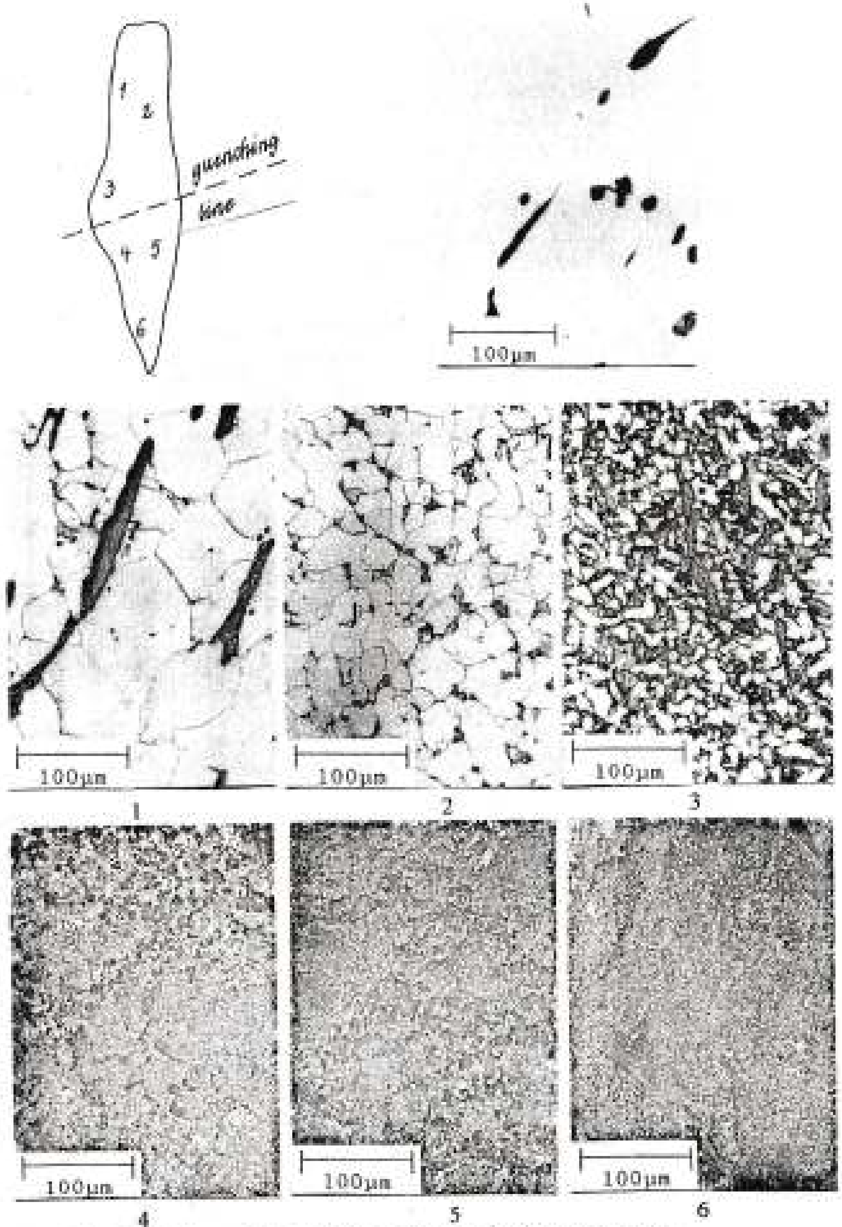

Fig.5. Metallographic analysis of sample D, taken from blade.

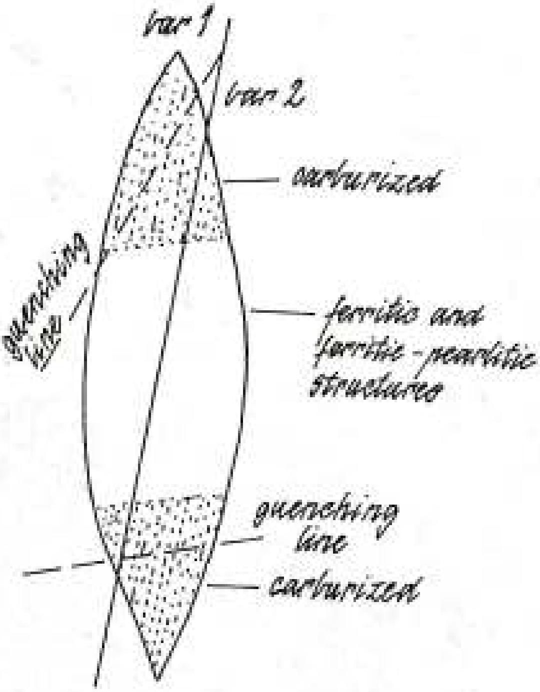

Fig.6. Schematic representation of blade production method.