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THE METALLURGY IN SPIŠ COUNTY

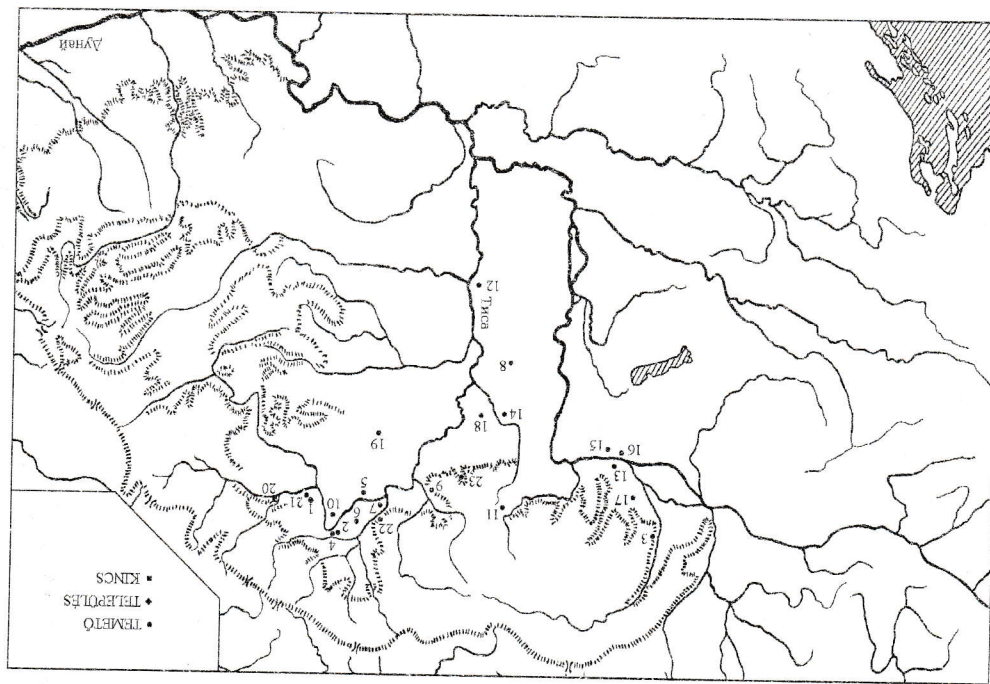
Spíš (Szepesség) county (župa, megye) is mountainous country with harsh conditions of the nature. The worse conditions for agriculture are offset by sources of minerals, water power and the woodland. The county was ranked among the most important sources of the iron (and since the end of the 17th century also copper) in Hungary in former times. The production of metals became the base for metal-working industry. Manufacturing of the metals into high-grade products was the field of craft guilds. They were concentrated in free royal cities in Spíš (Levoča, Kežmarok, Gelnica) or in surrounding counties (Košice, Prešov, Sabinov) as well as in privileged "Spíš towns" (Spišská Nová Ves, Spišské Podhradie, Stará Ľubovňa). The "Spíš towns" (24 towns in common) had complicated history because some of them (13 towns and the earldom of Stará Ľubovňa) were between the 15th and 18th centuries under double Polish and Ugrian administration. Their legal status was as the status of royal towns in essence. Other important group of the consumers of metals were the smiths in small towns and villages, in feudal tenures as a rule, manufacturing ordinary products for agriculture. Important group of consumers group were manufactories (hammer-mills) producing on a large scale nails and chains (Gelnica) and hoes, spades, axes... (Hrabušice and Medzev, lying alongside of Spíš) since the 18th to the first half of the 20th centuries. A rest of iron and copper was exported to other parts of Hungary or to Poland (Galicia).

After disintegration of the Great Moravia in the 10th century was the territory of contemporary Slovakia gradually incorporated into Hungarian kingdom, whose northern boundary became constant in the 12th century. Until then the territory of Spíš was part of Nitra principality, the buffer border region of the head of member of Hungarian royal family. The Spíš county was established in the second half of the 12th century, but the name of the first count (župan, főispán) was mentioned only in 1216. Since the end of the 12th century the population was completed by immigrants. The most of them were miners, metallurgists and metals processing craftsmen from Germany. They brought now technologies and on large scale helped the growth of metallurgy and manufacturing of metals in this region.

The wars with Turks and uprisings against the regnant Habsburg house (the 16th and 17th centuries) were the cause of regress in metallurgy. The creation of compact forest properties in state ownership (as a result of seizure of the unsuccessful risers) was the only positive factor. The problem of the fuel shortage was solved thereby and the base of copper production was removed from central Slovakia (Banská Bystrica and surroundings) into Smolník and surroundings. The silver, gold, mercury and antimony were smelted the first of all as a coo-product in metallurgy of copper.

The important enterpriser in this region was Oberungarische Waldbürgerschaft (the association mining businessmen of Upper Hungary). The association was

1 КРР. Arab dirhemek a Karpatok vonulatán belül (10 sz.). 1. Beregszász (Bücsü); 2. Bodrogvécs; 3. Galgóc; 4. Kisodbra; 5. Ibtány; 6. Karos; 7. Kenézlő; 8. Kecskemet; 9. Kiskaj; 10. Páp; 11. Perse; 12. Szeged; 13. Szilas; 14. Szolnok; 15. Szomód; 16. Tata; 17. Tardosked; 18. Tiszasuly; 19. Hajdudorog; 20. Huszi környéke; 21. Tiszasoma; 22. Sárospatak; 23. Eger.



founded in 1784 in Spišská Nová Ves, extincted in 1895.

The sources of ore and power. The iron ore in Spiš occurs in form of magnetite (Fe_3O_4), hematite (Fe_2O_3), limonite ($Fe_2O_3 \cdot nH_2O$) and siderite ($FeCO_3$), the first of all in the south part of county (Spišsko - gemerské Rudohorie). The hydrothermal deposits with vein structure are dominant. The exploitation of limonite witness the finds of Roman period. It was opencast mined from gossans (the upper and weather part of an ore deposit or mineral vein) or as a bog ore. The hematite was mined in south - west parts of Spiš adjacent to Dobsiná, in mountain chain Galmus, in surroundings of Rudňany, Veľký Folkmar and Mlynsky. The ore deposits from south Poland extend to Spiš (favorina). The siderite was mined since the 16th century. The copper ore was mined in form of fahl-ore (tetrahedrite) in surroundings of Rudňany (with high mercury content) Slovinky and Gelnica (high silver content).

The steam-power for blowing was exploited belatedly (Smizany since 1840). The rivers (Hornád, Poprad, Hnilec) and the brooks with sufficient flow were used as the source of blowing power.

The charcoal was dominant fuel in iron and non-iron metallurgy till the end of the 19th century. The first coke blast furnace were blowed-in in Krompachy (Crecula et al., 1995).

The development of metallurgy. The oldest iron artifact found in region (Gánovce) was knife (dagger) dated to the 15th century BC. Likely it was imported. Region had become a base of well-developed metallurgy and craftsman's processing of metals, dated at the test from the Celtic period and culminated in the period between the 16th and 17th centuries and slowly extinct in the 20th century.

The contribution of Celts to the field of metallurgy was iron smelting in little shaft furnace with the slag pit and development of the forging technologies.

The remains of the shaft furnace with the slag pit (AD 0 - 400, Roman period, Púchovská Culture) have been excavated at Spišské Tomášovce. The shaft height was about 800 mm and diameter of the hearth diameter was about 300 mm. The shaft had two-layer construction, typical for Spiš. The inner liner of the shaft (thick 30 - 40 mm) contained about 70 % of SiO_2 . The clay and stones were used for construction of external shaft layer (thick 60 - 70 mm) (Mihok, Javorský, 1988; Mihok, 1995, s.14).

The Slavs used little shaft furnaces with two-layer construction (Spišské Vlachy, Vlková - Levkovce, Spišský Hrušov, Nemešany, Spišská Nová Ves, AD 500 - 1000). The hearth diameter was between 250 and 300 mm. The effectivity of smelting increased in comparison with the past period. Olivine slag practically without wüstite confirms high temperature of the smelting. The result was more efficient process of the reduction (Mihok, Javorský, 1988).

The embanked furnace with thin breast wall, partly dug into the earth (Imola type) frequently used by Slavs in Great Moravian (the 9th - 10th century) and Arpad period (the 10th - 13th century) was not found in Spiš until now.

The written sources regard to iron metallurgy are random and fragmentary in the documents dated between AD 1000 - 1400. The iron metallurgy was

concentrated in Spiš in the valley of the river Hnilec with the centre in Gelnica. The Slavic metallurgical toponyms (Ruda, Rudnik, Rudnick - ore, metallurgist) can be found in the all territory of Spiš. The committee staked out the frontier in the region of Smolník in 1278 mentioned the valley, where "domus seu edificia, in quibus ferrum flari et purgari" (houses or buildings where iron is smelted and refined). The townsmen of Spišská Nová Ves made charcoal in lliášovce in 1399 "pro conflatione seu purgatione ferri" (for smelting, refining or forging of iron). The "old" hammer was mentioned in the valley of Hnilec in 1402 (Pleiner, Vozár, Šarudyová, 1976, s.14; Pleiner et al., 1984, s.63).

The invasion of Mongols (1241) results in the change of iron smelting technology. New waves of immigrants from Western Europe replaced population, decimated by invaders. The smelting in manually-blown little shaft furnaces died away practically. New technology was higher shaft furnace blown with water power. The overspreading of this furnace since the 14th century began the period of the furnaces and hammers fixed to rivers. The blowing of furnace and hammer (and processing of their products, a bigger bloom) needed water power. The furnaces were built in Spišská Nová Ves in the first half of the 14th century, in Gelnica in 1435, in Krompachy and Veľký Folkmar in 1574. Its height was 2.2 - 3,8 m, the diameter near bottom was 670 - 740 mm. The furnace was blown through one clay tuéyre. The bloom was taken out together with the slag through the open, pierced in the front wall. The slag was expulsed from the bloom by a water powered hammer, than it was quarry forged and cut into two pieces. Charcoal was used as fuel, the limonite was especially used as ore. Two furnaces were always built together, lined with common masonry. The building material was stone, the front wall was from clay, the furnace was lined by the mixing of the charcoal and clay (Hapák, 1962, s.9-21; Vozár, 1974, s.13; Pleiner, Vozár, Šarudyová, 1976, s.20-26).

The higher shaft furnace with water blowing (bloomeries, Stückerfen, Blaaofen) was in the German and Hungarian (Magyar) literature, dated to the 18th - 19th centuries titled as Slovak furnace (Windischer Ofen, Slowakisches Feuer, tókevence, H.I.Bieder mann: das Eisenhütten - Gewerbe in Ungarn... 1857: "die slawischen, oder wie sie auch hiessen - slowakischen Feuer" (Slavonic, but as it is also called, Slovak furnace") (Pleiner et al., 1984, s.211). Slovak furnace was dominant iron smelting device till the 30s of the 19th century.

The document of the count Mariássy supports the existence of infrequent hearth furnace, typical for the north Europe or Mediterranean in the 13th - 16th centuries in Nálepkovo (Pleiner, Vozár, Šarudyová, 1976, s.15).

Slovak furnace and Blaaofen were probably very similar. Blaaofen produced besides the bloom also cast iron ("casting furnace"). The Blaaofens were used in Košické Háme, Veľký Folkmar, Gelnica and Krompachy still in 1842 (Hapák, 1962, s.29).

The first blast furnace in Slovakia was built in Lubietová in 1692 (1594 in Bohemia and 1674 in Poland). The blast furnaces in Dobsiná, Revúca, Rejdová and Poniky were blow - in in the first half of the 18th century. There were 5 blast furnaces and 124 bloomeries in 1776 in Slovakia. The cast iron, which

was smelted in charcoal fuelled blast furnaces exceeded the iron, smelted in bloomeries about 1830. The first coke fuelled blast furnace in Slovakia was blow-in in Likier in 1885 (Pleiner, Vozár, Šarudyová, 1976, s.12-60; Pleiner et al., 1984, s.92-122).

The refinery (the hammer where pig iron was transformed into forgeable iron, "skujňovač hámor") used in the 18th and 19th centuries in Slovakia consisted of the charcoal fuelled hearth, the bellows powered by water and water powered hammer. The hearth had rectangular, later quadratic shape, was built from natural stones with gaps filled out with sand. The air was blown through tuyère, the walls of the hearth were usually jacketed with cast-iron plates covered with refractory clay or stamped charcoal dust with the slag layer. The burden was 150 - 200 kg of pig iron, the process lasted 4 - 5 hours, the loss by burning was 28 - 30 %. The first puddling furnace in Slovakia was built in Chvatimech in 1839 (Hapák, 1962, s.36; Vozár, 1974, s.23; Pleiner, Vozár, Šarudyová, 1976, s.56, 114).

The samples of slags (tab.1) were obtained by archaeological research or by surface collection on the places of former smelting plants. The mineralogical surface was prepared by standard way by dry grinding and polishing by diamond, moisture with petroleum. The presence of sulphide inclusions was evaluated by Baumann test. The wet chemical analysis was used for the assessment.

The valley of Hornád:

Margeeany (Margiffalu). Little ironwork owned by count Csaky family with Slovak furnace and hammer was in the valley of creek Bystrá between 1782 and 1815. The locality of copper and antimony (about 1867 also cobalt and nickel) smelting plant "Phönix" (Rhollova huta, Fönixshuta) is partly flooded by Ružin dam. The plant was founded by noble family Rholl in the 18th century. The next owner was noble family (Brezoi) Prihradny (1826 - 1865) and Waldbürgerschaft (1865 - 1888). The smeltery was equipped by the reverberatory and finery furnaces, furnace for cupellation and hammer (Magula, 1994, s.97; Petrik, Mihok, Soláriková, 2002, s.44-47; Petrik, Mihok, 2005, s.13-22; Mihok, Moravčíková, Petrik, 2006, s.59-60).

Jaklovce (Jekelfalu, Jekelsdorf). The slag typical for smelting in Slovak furnaces was found on two probably secondary places (near church and in the valley of creek Kojšovský potok). The original place of the smeltery on the bank of river Hmliec (according to map, dated to the end of the 18th century) is today flooded by Ružin dam. The smeltery with Slovak furnace was founded by noble family Jakelfalussy at the beginning of the 19th century (or in 1782) and closed in 1867. The metallurgical activity of Jakelfalussy family is older, A. Jekelfalussy founded ironwork in Rimavské Brezovo (Gemser county) in 1767 (Zhiák, 1990, s.177).

Veľký Folkmar (Nagyfolkmar, Nagysolymár, Volkmar). The first evidence of iron smelting in the village is in 1435. The local lord of a manor Csaky and noble family Gundelfinger were the owners of iron smeltery with Slovak furnaces and Paoofen (noticed 1840) and hammers until the half of the 19th century.

Kluknava (Kluknó, Klaknau). The owner of local ironwork was family Csaky. The hammer was built in 1583. Two hammers and two indefinite furnaces were here according the inventory in 1691. The two Slovak furnaces were in operation in 1841. The plant extinct about 1850. The village was one of centers of peasants rebellion in 1831. Waldbürgerschaft established the copper smeltery Štefanska Huta (1849 - 1897). The tetrahydrate ore was utilized in completion. The mercury obtained by roasting of the ore was applied for amalgamation of copper to acquirement the silver. The roasted ore was smelted to copper and antimony matte. The roasted copper matte was smelted into "black" copper. Granulated copper was amalgamated, melted, and fire refined. The electrolytic cells were used for refining to obtain the silver or the gold since 1891. The antimony matte was smelted in Ružomberok (Huta Leopold). The silver amalgam was distilled, and excessive mercury was sold. The slag was used for production of the bricks (Šimko, 1987).

Krompachy (Korompá, Krompach). The privileged mining town (since 1246) Krompachy was in dependence on Csaky family. The owner of ironwork with Slovak furnaces and hammers (1557) was family Gundelfinger. Two "Blauofen" owned by Csakys and two Slovak furnaces, owned by Gundelfingers were recorded in 1804. New blast furnace with refinery built: Gundelfingers in locality "Maša" in 1831. Hernádtóhaler Eisenindustrie a. g. (Pohornádska) association bought the furnace in 1841. The second blast furnace was blow-in in 1880. The plant was rebuilt between 1896 - 1911. Rima - murányi Társaság (Rimavsko - muraňská) association became the new owner in 1899. The plant after reconstruction consisted of three coke blast furnaces, Siemens - Martin and puddle steel works, rolling mills. The factory was closed down after rebellion of (unpaid) employees in 1922.

The copper smeltery "Kovohuty" (1937 - 1998) was built in place of the former ironwork. The copper ore mined above all in near Slovinky was smelted in reverberatory furnace Maerz Zurich, four converters and refining furnaces. The plant produced zinc and manganese (Chalupecký, Rak, 1981; Očvár, 1987). **Slovinky (Felsőszlovinka, Felsőszalánk).** The iron was smelted in Slovak furnace between 1782 and 1815. The copper smeltery "Nicolaus" (1820 - 1890) owned the Waldbürgerschaft.

Levoča (Lőcse, Leutschau). Royal free town Levoča was administrative and manufacturing centre of Spiš. The slag dated between the 13th and 14th centuries was the waste material from iron smelting process in the small shaft furnace, blown by hand-powered bellows or the smutthy slag. The slag No. P110 is the product of relatively effective smelting. The process could have been realized probably in the Slovak furnace (Petrik et al., 2001, p.66-79).

Spišská Nová Ves (Igló, Zipser Neudorf). "Privileged" town Spišská Nová Ves took over the role of Levoča as center of Spiš since the end of the 19th century. The slag of iron smelting process in the small shaft furnace blown by hand-powered bellows and smutthy slag dated between the 13th and 16th centuries were found in various localities of the town.

The slag, found in locality Feröckovec (P116) was (probably incorrectly)

dated to the 18th - 19th centuries. The SiO_2/FeO has relatively low value, similar as the slag from small shaft reduction furnaces. Typical for this smelting technology is also high content of wüstite in the slag. But in Spiš the iron was smelted in Slovak furnaces or in the blast furnaces in period of dating of analyzed slag. The small shaft furnaces were not used in this region at this period. The analyzed slag could be older, or the smelting technology in higher shaft furnace in this case was not mastered. Because lack of information about metallurgical equipment in Ferčokovce, it is difficult to find unequivocal conclusion (Petřík et al., 2001, p.66-79). The smelting plant in local part Spišskonovoveská Huta (Jánova huta) between 1839 - 1888, produced copper and antimony. It was founded by Waldbürgerschaft.

Saizany (Smizsán, Szépešsüveg, Schmögen). Count Csaky established the ironwork with two blast furnaces (1803 - 1886). The steam-powered air blower was put into service in 1840s. The plant produced about 4500 t of pig iron per year. The content of sulfur in the slag (P70A, B) suggests the experiments with mineral fuel (Vozár, 1974; Petřík et al., 2000, s.74-83).

Hrabušice (Kaposztafalu, Kabsdorf). The medieval iron slag was found in locality "Zelená hora". The hammer is documented in 1583. There were two or three hammers and finery between 1707 and 1838. The duchy Coburg family had there between 1842 - 1886 finery and the smithy manufacture. Black finery slag with more than 50 % of FeO can be found in surrounding (samples 4.2 and 4.4) (Fečková, 2007; Petřík, 2008, s.64-71).

Rudňany (Koterbachy, Órtósbánya, Kotterbach). Vítkovice ironwork built there a big roasting kilns for iron ores in the 19th century. Local siderite with mercury content was roasted in the stack (Čermak) furnace since 1899 and in the rotary kiln since 1908. The plant was reconstructed in 1928. The siderite was roasted in three shaft furnaces, the mercury containing fume condensed in wooden condensing towers. The mixture of mercury, lime and smoke particles ("šupa") was roasted in rotary kilns. The mercury (by 37,5 kg) was transported in steel bottles. The last smeltery (1970 - 1993) with stack furnace and condensing unit produced 99,99 % mercury (Butkovič, 1968, s.163).

The valley of Hnilce:

Žakarovce (Zsakaróc). Žakarovce was established on the territory of Gelnica as settlement of the miners. Big roasting kiln was built there in the 19th century (Kropilák et al., 1977, III, s.370).

Gelnica (Gölnichánya, Gölnitz). The oldest written reference related to Gelnica is dated to 1246, in 1276 it became a town. It's coat of arms with miner's symbols (hammer, miner's irons and the double-arm cross) was dated to the end of the 13th century. The town became the property of the Casile of Spiš (Spišský hrad) in 1465, it became the free royal town in 1844 (Kropilák et al., 1977, I, s.385).

The slag from iron smelting and forging, dated to the 13th, 16th and 17th centuries was found in the town (Javorský, 1982, s.12). The first reference about Slovak furnace is dated to 1435. Two water powered hammers worked here in 1707 (Vozár, 1974, s.13; Pleiner et al., 1984, s.171, 211).

The ironwork with blast furnace, finery and hammer established A.Patz in local part Maria Huta in 1810. Mansdorfer family acquired this plant in 1850. The rolling mill was built in 1870. The plant was extinct in 1880.

Baron O Jacobs was the owner of the ironwork with finery, hammer, rolling mill and wire drawing mill in local part Maria Huta since 1850. The plant was destroyed by the floods in 1878 (Vozár, 1974, s.87).

The smiths of Gelnica had their guild's statute probable from the Middle Ages. There were 11 smiths in Gelnica in 1715 and 102 (with locksmiths) in 1828. They produced the tools for miners, tools for woodcutters, shoes for horses and oxen working in mines, smelteries and ore transport (Spiesz, 1972, s.97, 214).

The beginnings of hammer-mills (manufacture) production in Gelnica and surroundings are dated to the half of the 19th century. The nails, chains and tools of everyday use were characteristic products of the hammer-mills. The smiths formed different kinds of nail heads: square, flat, pyramid, cone, arrow-like. Usual types of produced nails were for ships (carpenters), pales, locks, shoemakers and the shingle-nails. Some kind were tin plated (Cennik..., 1928; Adamuš, 1978, s.119-141).

The highest number of smiths-nail producers in Gelnica and surroundings, was in 1870: 303 foremen, 90 helpers and 95 apprentices. The production of nails and number of nails producing workshops slowly decreased thenceforward. Only one nails producing workshop with five employees worked prior to the World War I (Vozár, 1974; Csizmazia).

The smiths were supplied with local produced iron, smelted in Slovak furnaces. New sources of the iron became the ironworks in Gelnica and Prakovce since the beginnings of the 19th century. The rolling mill in Matilda ironwork was specialized to production of "nail iron" (Vozár, 1974; Pleiner, 1986). The nails production was supplied from Coburg ironwork in Pohorelá since the 1850s. Soft iron from Pohorelá was suitable for production of horse-shoe nails. The iron wire made in Tešín was increasingly used for nails production in Gelnica between 1880 - 1903. Its advantage was low price and high quality. The iron wire (drawn from the steel made in Krompachy) in Salgótarján ironwork was supplied to Gelnica workshops since 1901 in addition (Csizmazia; Vozár, 1974; Chalupecký, Rak, 1981; Pleiner, 1986).

The Gólniczbányai Allami Vasipari Szakiskola - Státna odborná škola železiarska (The State Iron Industry Technical School) was established in Gelnica 1893 as a result of development of local metallurgy and iron processing. After united with Technical school in Košice in 1919 it was extinct (Adamuš, 1978, s.119-141).

Production of mercury in Gelnica is mentioned in 1574. The mercury was produced since 1903 in "primitive device". The retort furnace was used between 1941 - 1943 (Butkovič, 1968, s.162).

Prakovce (Prakfalu, Prakendorf). There were iron hammers in the 16th and 17th centuries. The ironwork (Huta Ludmila) was established by count Csaky in 1808. It consisted of the blast furnace, three fineries and hammer. The

rolling mill was built in 1843. The bronze guns were cast here in the period of the revolution in 1848. The cupola furnaces, new rolling-mill and crucible steel work were built in the 1880s. The blast furnace was blown-out in time of the World War I. The foundry is the continuator of local metallurgical traditions (Vozár, 1974; Kropiák et al., 1977, II, s.435; Pleiner et al., 1984).

Múšek nad Huilcom (Remete, Szepesremete, Einsiedel an der Gölnitz). The production of the iron and hammer were mentioned in 1583. J.G.Parl founded the plant (1851 - 1882?) with puddled furnace, heated with wood gas, hammer and rolling mill.

Smolník (Szomolnok, Schmölnitz). The production of the iron was mentioned as early as in 1255. There were iron hammers in the 16th - 18th centuries and iron workings in the 16th century. The blast furnace (1863 - 1918), smelting about 1000 t of the pig iron per year was a part of copper smeltery (local part Smolnícka Huta, Szomolnokhuta, Schmölntzer Hütte). The high content of iron in found slag (M28.2) suggests low effectivity of smelting process.

The copper was smelted in Smolník since 14th century at least. Count Thurzo had here the liqation furnaces for extracting the silver from silver rich copper between 1497 - 1528. The copper was smelted in 8 furnaces in the 17th century. The problem of the fuel shortage for smelting in region of Banská Bystrica was solved by aforementioned movement of copper metallurgy into Smolník and some plants in the valleys of Huilec and Hornád rivers (the 18th century). The plants "Horná huta" ("the upper smeltery" with 7 shaft furnaces, the furnace for brass, refinery furnace in 1740), "Stredná huta" ("the middle smeltery" with a liqation furnace, 2 melting furnaces, refinery furnace, cupellation furnace and furnace for burning of exhausted liqation cakes (kynátek) in 1787) and "Dolná huta" ("the lower smeltery" with the blast and half-blast copper smelting furnaces, reverberatory furnace, 6 roasting stalls, refinery furnace and copper hammer in 1812) together with hydrometallurgy and amalgamation smeltery (1787 - 1792) were extinct between 1856 and 1918. The auriferous (crudum) was smelted in Smolník in 1870s by crucible metallurgy in reverberatory furnace (Vozár, 1988, s.120; Bernáth, 1976).

Štós (Stósz). Production of local craftsmen - sabres and swords became the base of industrial production of the knives (Wlaszowitz, Komporday, Schreiber and Sandrik after socialization). The copper was smelted since the 16th century. The copper slags with various content of matte were found (P176, P179) (Petrik, 2005, s.5-12).

Svedlár - Stará Voda (Svedlár, Schwedler - Óvíz, Altvasser). The iron was worked in hammers, mentioned in the 16th century and in 1707. The ironwork with two blast furnaces (1870 - 1903), produced 1680 t of the pig iron per year, and 1817 produced copper for monetization of low-values coins) was equipped with shaft furnaces. The mercury smeltery in ownership of Waldbürgerschaft and (since the 1850s) the state. The ores (tetraedrite) were roasted since 1810 in structure with "frequent emissions of mercury vapors through the crack in the walls". The Alberty's reverberatory furnace and distilled equipment, made

in Prakovce, were used since 1842. The roasting stalls (13 x 6 x 1,4 m) were used in the second half of the 19th century (Bukovič, 1968, s.152). Only old stock of the row materials were sporadically roasted after 1856. It is difficult to distinguish the slag from iron (probably M30.2 with ultra high content of the iron) and copper (P177) or mercury smelting.

Nálepkovo (Vondřísel, Merény, Vagendrüssel). The hammer was mentioned in 1352; another hammer and Slovak furnace were here between 1782 and 1815. The municipal ironwork with two Slovak furnaces was built here in 1804. Those were replaced by the blast furnace, producing about 1300 t of the pig iron per year, in 1854. The furnace blown-out in 1910. The family Plander had here pans producing hammer and foundry between 1785 and 1927. The smelting process was cost-effective, only about 1,7 % of the iron remained in the slag (M31.1.1).

Huilík (Kishyilec, Eisenbach). The smelting plant (Jurajova huta), produced copper in the 19th century, was founded by Waldbürgerschaft.

Mlynsky - Dobšinská Maša. The base of this ironwork was the blast furnace, built by Lányi (about 1712) in the time of F.Rakoczi II uprising. The town Dobšiná (situated outside of Spiš) purchased works later. The average year production was about 1120 t of the pig iron. The plant was extinct between 1906 - 1919. The slag (M59) with high iron content was found in the secondary location (the original place of the work is today flooded by Palcmanová Maša dam).

Mlynsky - Palcmanová Maša. The Peltzmann family founded the ironwork with the blast furnace, three finery hearts, hammer and hammer for the pans production in the 18th century (without exact date of building-up). The Coburg family was the owner since 1834 to the extinction in 1880s. The average year production was 1300 t of the pig iron. The iron content in the slag varied between 2,2 - 14,8 % (M50).

Stratená (Sztracena). The ironwork plant was founded by count A.Csaky in 1820s on the place of extinct copper smeltery when duke F.Coburg bought the plant in 1842, the production of the pig iron was about 1120 t per year. After the reconstruction of the blast furnace in 1854 and set-up of the second one in 1861 was the production about 4612 t. The puddling furnace, heated by the wood and later by gas was built in 1842. The pig iron was refined also in the Comite - hearts (1843 - 1846) and in Hrabušice.

The valley of Poprad:

The villages of the "lancers" were firstly mentioned in the 14th century (Machalovec even in the 13th century). They were prerogative territory (Stolica X spišských kopijníkov, Sedes X lanceatorum; Roman numeral X match with fen villages of the "lancers" in Spiš) probably settled by Slav population before the German settlement on Spiš in the 13th century as border-men at the Hungarian - Polish borders. The status of the "lancers" match with the status of gentry. They partly were subject to count of Spiš and partly had self-government. They became a part of the Spiš county since 1802. The slag (P117), dated to the 9th - 10th centuries (Great Moravian period) in Kišovce, one of their villages. The

smelting was carried out in low shaft furnace blown by hand power (Petrik et al., 2000, s.31).

Spíšská Belá (Szépesbélia, Waltendorf). There was the undated slag (P62A) of very effective iron smelting process, probably done in Slovak furnace.

Bušovce (Busoc, Bausehendorf). The finery with four hearts (owner S.Pozewitz, 1850 - 1868) refined pig iron from Stratená, Smižany, Kroupachy and Pohorelá.

Javorina (Urgarten). The village Javorina was property of counts Horváth-Palocsy. They founded ironwork with blast furnace and hammers in 1759. The plant smelted local hematite. The rolling and wire-drawing mills were built in 1837. The finery with hearths and puddling furnaces was since 1842. The blast furnace and finery were extinct between 1856 - 1861, the rest of the plant in 1875. The automatic target for firing club in Kežmarok was cast here in the end of 18th century. The value of the hit was distinguished by shot of on-line mortars (little guns). The results of analysis confirmed indifferent quality of smelting process (sample P155). The charcoal was dominant fuel, the sulphur from pyrite in the burden was balanced out by addition of CaO or MgO (Petrik, Mihok, Pavlarčík, 2003, s.9-12; Lungs, 1973).

Stará Ľubovňa (Oublo, Allubiau). The rest of the copper melting (or smelting) furnace dated to the 16th or the 17th centuries was found.

Jakubany (Jakubján, Szépesjakobfalva, Jakobsau). The noble family Probstner (one member of family was founder of copper smeltery "Nicolaus" in Slovinky) leased and after bought the state-owned enterprise with Slovak furnace (since 1760) and blast furnace (since 1776) in 1820s. The average production was about 560 t of pig iron per year. The iron was refined in three hearts. The part of the plant was hammer in near Nová Ľubovňa and the rolling mill since 1825. The work became extinct in the 1860s. The blast furnace (inaccessible in consequence of irregular ownerships between state and restitutors at the present time) is in fairish condition (Moravčíková, Mihok, Petrik, 2003, s.27-32; Cengel, 2009).

Múšček nad Popradom (Paprádremete, Einsiedel). The little ironwork with Slovak furnace and hammer bought by K.Heysel in 1840. The blast furnace was built in 1856. The year production of pig iron was between 392 and 840 t. The blast furnace had not long life, it was blown-out in 1860s.

Table 1: The composition of the slags found on the localities with extinct metallurgy.

No.	Locality	SiO ₂ (%)	Fe ^{tot} (%)	FeO (%)	CaO (%)	MgO (%)	S (%)	P ₂ O ₅ (%)	B	Cu	Ag	Sb	Pb
M61.1	Múšček n. Popradom	42.2	5.3	-	6.2	14.0	0.41	N	0.1	0.47			
M61.2		48.5	6.1	-	5.0	7.2	0.83	N	0.09	0.25			
M61.4		20.4	1.4	-	20.2	37.2	4.8	N	0.11	2.03			
M72.2	Jakubany	34.3	2.2	1.0	27.4	22.0	0.25	N	0.17	1.36			
P155	Javorina	46.1	2.2	0.18	22.2	0.8	18.8	N	0.076	0.5			
P70A	Smižany	45.5	3.9	-	15.6	8.0	5.3	P	0.13	0.52			
P70B		54.2	1.2	-	16.2	3.0	11.2	N	0.11	0.35			

4.2	Hrabušice	22.78	37.97	46.71	5.04	4.0	1.02	N	0.053	0.40			
4.4		22.26	32.39	41.52	4.48	4.0	0.78	N	0.058	0.38			
P117	Kišovce	27.68	44.68	48.3	5.6	0.0	0.02	N	0.25	0.2			
P62A	Spíšská Belá	30.5	43.6	50.0	4.5	0.0	6.6	N	-	0.15			
P169.1	Margecany-Bušovce	35.8	20.1	26.3	5.0	14.0	0.86	N	0.14	0.53			
P169.2		36.5	33.5	38.1	5.0	9.6	1.13	N	0.005	0.4			
P182.1	Margecany-Pbónik	38.3	22.6	7.9	7.6	2.3	0.3	N	-	0.26	0.31	0.023	0.09
P182.2		44.0	13.6	1.4	1.0	2.2	0.32	N	-	0.07	0.25	0.019	0.09
P182.3		40.3	13.4	2.1	11.9	4.8	0.28	N	-	0.41	0.12	0.005	0.08
P170.1	Jakovec-Košický potok	52.7	13.9	28.7	7.84	10.0	1.3	N	0.06	0.33			
P170.2		27.2	40.3	53.9	7.3	5.6	3.6	N	0.13	0.47			
P62.1	Jakovec - šurc	51.66	16.75	16.23	12.83	14.0	0.36	N	-	0.31			
P62.2		48.48	21.89	20.11	11.2	10.0	1.13	N	-	0.44			
P17	Veľký Fokmar	23.0	49.7	55.9	5.6	2.0	3.0	N	0.07	0.33			
P167	Klukava	68.4	5.6	10.2	5.0	7.2	0.69	N	0.15	0.18			
P180A	Sčifárska Ľúta	33.1	26.2	19.9	5.5	3.9	1.1	N	-	0.28	0.34	0.013	0.054
P91	Gréňa - Matúša Ľúta	28.2	48.6	54.8	3.4	0	0.05	P	0.19	0.12			
M 23.2.1	Gréňa - Mária Ľúta	25.7	5.9	-	29.1	28.5	1.16	N	0.053	2.23			
M 23.2.5		25.8	10.6	-	12.3	30.1	0.33	N	0.069	1.6			
P91.1	Prakovce	25.2	1.12	-	27.43	22.4	1.55	N/P	0.114	1.98			
P91A	Kroupachy locality of iron plant 1896-1922)	28.5	13.9	11.1	21.8	20.8	1.5	N	0.09	1.49			
P91B		25.3	10.9	6.2	26.9	7.2	2.9	P	0.09	1.34			
P93.1	Kroupachy - Mäsa	31.2	5.9	-	16.8	24.0	2.56	N-P	0.15	1.3			
P93.2		35.8	5.6	-	14.6	23.2	1.9	P	0.13	1.06			
P93.4		30.4	6.7	-	19.0	30.4	2.99	P	0.06	1.6			
P181A	Slovaky	40.4	18.8	1.8	13.0	1.3	0.3	N	-	0.35	0.83	0.025	0.07
P181B		39.3	17.1	18.2	12.6	1.9	0.26	N	-	0.36	0.41	0.009	0.09
P181C		44.5	15.1	3.2	16.9	1.5	0.28	N-P	-	0.41	0.09	0.019	0.09
M 55.1	Stratená	31.3	18.7	-	12.3	17.6	3.4	P	0.1	1.0			
M 55.3		29.6	14.8	-	14.0	12.4	7.3	N	0.12	0.9			
M 50.2	Petromanská	22.7	14.8	-	15.7	17.2	6.5	N-P	0.03	1.4			
M 50.3	Mäsa	23.1	2.2	-	21.3	16.0	6.5	N	0.05	2.0			
M 59.1	Dobšinská Ľúta	46.5	10.3	-	9.0	6.0	1.1	N	0.12	0.32			
M 59.1		21.5	12.0	-	25.2	14.0	3.6	N	0.16	1.25			
M 30.2	Svedlar - Stará Voda	27.5	22.1	-	16.2	11.2	0.8	N	0.1	1.0			
P177	Svedlar - village	31.1	37.6	35.7	2.1	6.7	0.2	N	-	0.34	0.016	0.074	0.081
M 26.5	Stročník	31.5	10.6	-	13.4	19.6	3.5	N	0.13	1.04			
M 28.2	Smútnická Ľúta	46.2	7.0	-	18.5	12.4	3.7	N	0.04	0.66			
P176	Stes - Čierna Beňa	37.0	34.5	31.8	2.1	5.1	0.15	0.83	-	0.19	0.29	0.08	0.1
P179	Stes - Šišový potok	26.7	45.5	52.9	2.0	1.3	0.15	0.77	-	0.12	1.0	0.07	0.09
M 29.1.1	Prakovce	25.2	1.1	-	27.4	22.4	1.55	N-P	0.11	1.98			
M 31.1.1	Nálekovo	39.8	1.7	-	4.4	28.8	0.04	N	0.15	0.8			
P170	Levoča	28.6	53.6	32.9	4.5	1.2	1.2	N	0.09	0.2			
P175.1	Spíšskomorovská Ľúta	47.1	19.7	1.8	18.3	5.1	0.5	0.24	-	0.50	0.23	0.016	0.097
P175.2	Spíšská Nová Ves - Ľubekovec	49.7	18.5	2.5	16.0	3.4	0.4	0.41	-	0.39	0.26	0.016	0.082
P116	Spíšská Nová Ves - Ľubekovec	15.8	53.61	61.5	4.48	1.2	1.9	0.025	-	0.36			

N - negative Baumann test, P - positive Baumann test, basicity B = CaO+MgO/SiO₂+P₂O₅

Keywords: Spiš, metallurgy, iron, copper, slag.
Ключевые слова: Спиш, металлургия, железо, медь, руда.

Петрик Ю. (м.Кошице, Словакия)
Металлургия на Спиши
 (Резюме)

Спишская жупа, размещена в горской местности, богатами родовыми руд, с возможностью использования энергии воды та лесов, стала одним из важнейших центров металлургии в Угорщине. Наибольшая интенсивность производства железа фиксируется в 19 столетии. До 30 років вказаного сторіччя виплавка заліза в високих шахтових печах з використанням води для поступлення повітря (словацькі печі) переважала виготовлення кричного заліза у високих печах.

Проблема нестачі палива в майстернях з виплавки міді в середньословацькій області була вирішена переносом виробництва міді до Смолянська і його округи. Також виплавлялися інші кольорові метали, рахуючи срібло та золото.

Петрик Ю. (м.Кошице, Словакия)
Металлургия на Спише
 (Резюме)

Спишская жупа, расположенная в горной местности, с богатыми месторождениями руд, с возможностью использования энергии воды и лесов, стала одним из важнейших центров металлургии в Венгрии. Наибольшая интенсивность производства железа фиксируется в 19 веке. До 30 годов указанного столетия выплавка железа в высоких шахтовых печах с использованием воды для подачи воздуха (словацкие печи) превосходила изготовление кричного железа в высоких печах.

Проблема нехватки топлива в мастерских по выплавке меди в среднесловацкой области была решена переносом производства меди в Смолянск и его округу. Также выплавлялись другие цветные металлы, в том числе серебро и золото.

Petrík J. (Košice, Slovakia)
The Metallurgy in Spiš County
 (Summary)

The mountainous Spiš county with rich sources of minerals, water power and the woodland became one of important centers of metallurgy in Hungary. The iron production culminated in the 19th century. The production of the bloom iron

in higher shaft furnace blown with water power (Slovak furnace) predominate over the production of the pig iron in the blast furnaces till the 1830s.

The problem of the fuel shortage in copper metallurgy was by removing of the production base from central Slovakia into Smolník and surroundings. The silver, gold, mercury and antimony were smelted the first of all as a coo-product in metallurgy of copper.

Petrík J. (Košice, Slovakia)
 Hutnictvo na Spiši
 (Abstrakt)

Hornatá spišská župa s bohatými zdrojmi rúd, vodnej energie a lesov sa stala jedným z najdôležitejších centier hutníctva v Uhorsku. Produkcia železa kulminovala v 19. storočí. Až do 30. rokov 19. storočia výroba železa vo vyšších šachtových pečiach s vodným dúchaním (slovenské pece) bola vyššia ako výroba surového železa vo vysokých pečiach.

Problém s nedostatkom paliva v medených hutách v stredoslovenskej oblasti bol riešený presunom základne hutníctva medi do Smolníka a okolia. Zhutňovalo sa aj striebro, zlato, ortuť a antimón, najčastejšie v návaznosti na metalurgiu medi.

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ПОВІДОМЛЕННЯ

Мойжес В.В., Щербей К.І. (м. Ужгород, Україна)

РОЗВІДКИ В С.АРДАНОВО

У червні 2010 р. експедицією Ужгородського національного університету обстежувались околиці с.Арданово Ірнавського р-ну Закарпатської обл. України. Основна мета - виявлення поховань некрополя шеворської культури, частина якого досліджена в ур.Рокитне Т.Легоцьким ще наприкінці XIX ст. (рис.1) (Легоцький, 1997, с.21; Koval', 1994, s.32-34). Приводом для проведення додаткових пошуків стала інформація про випадкові знахідки наконечників списів в ур.Каміння (1,5 км від ур.Рокитне) у 80-х рр. XX ст. Сліди перебування зброї в поховальному вогніщі дозволили припустити існування в с.Арданово ще однієї групи крематійних поховань.

Опитування осіб, якими були виявлені наконечники, дозволило локалізувати місце знахідки в центральній частині урочища (рис.1). Як результати плантажної оранки, земля на вказаній території перегортула, а на поверхні місцями фіксуються виходи материкової глини жовтого кольору і значна кількість каміння. Археологічний матеріал на обстеженій ділянці не виявлений.

Не прініс результату і огляд території ур.Костий, яке знаходиться південніше від ур.Каміння, на північному схилі сусіднього пагорба (рис.1). За інформацією місцевих мешканців тут під час оранки часто знаходили кістки, що і визначило назву урочища.

Більш конкретні дані отримані в ході огляду території городища, розміщеного на верхівці гори Богуслав (північно-східна окраїна села) (рис.1). У науковій літературі з кінця XIX ст. воно відоме як пам'ятка епохи гальштату. Досліджувалося в 1954 р. експедицією Закарпатського краєзнавчого музею, 1958 і 1962 рр. - Західноукраїнською експедицією Державного Ермітажу (Смирнова, 1966, с.397; Балагурі, 1972, с.11) і в 1991 р. - експедицією Ужгородського державного університету (Дзембас, 1991, с.9-12).

Городище має форму неправильного овалу, довжиною 700 м, шириною 200 м, витягнуте в напрямку південний схід - північний захід (Смирнова, 1966, с.397).

У ході обстеження урочища Богуслав, переважно у північно-західній його частині, в колях ґрунтової дороги, утвореної лісовозами та в коріннях вивернутих буревіями дерев, зібрано 242 фрагменти кераміки гальштатського взірця. В залежності від техніки виготовлення вона поділяється на дві групи: кухонна та столова.

Перша група представлена уламками горщиків, сформованих з глиняної маси з домішками крупного шамоту, рідше жорстви. Колір посуду світло-