



# Some aspects of iron production on the territory of Colchis (Western Georgia)

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## **Abstract.**

*This article presents data and addresses the main issues of the development sites of iron paleometallurgy on the territory of ancient Colchis (Western Georgia, Caucasus). It has been proven that iron metallurgy was widely developed throughout the entire given territory starting from the end of the 2nd and beginning of the 1st millennium BC. It is quite obvious that even in those time, craftsmen mined, processed, smelted and forged high-quality iron products from the mined ore material. These items were not only for household purposes, but most often represented very high-quality bladed weapons, which they achieved by alloying of ore. One of the ways to achieve ore smelting, apparently, was by using ordinary magnetic sands located on the eastern shore of the Black Sea. The article also examines the possibilities and methods of achieving forging iron bladed weapons by modern Georgian craftsmen from these Ureki sands (magnetite sands).*

## **Introduction**

Based on the history of research concerning the issue of iron processing, it is known that even during the time of the pyramids in Egypt (which were built before the advent of the art of iron smelting), the Egyptians already knew about iron from meteorites. At that time, iron was used mainly in cult objects by forging material from meteorites. Iron was probably very expensive in those time, more expensive than gold. An artifact, the presence of which was already present during the time of Tutankhamun, is enough for proof. There, the sword was made by gold and the handle was made by iron. At a time when weapons were made by bronze, the winner was awarded an iron object. At the time of the "Iliad", weapons were made primarily of bronze, yet, Homer (in Book 23 of the "Iliad") tells us that Achilles awarded a discus made from an iron ball to the winner of the discus throwing competition.

As is known, iron from meteorites that fell to Earth was used very rarely until the 12th century BC. Later, in Mesopotamia, Anatolia, Egypt and the Caucasus, the first objects made from smelted iron (determined by the absence of nickel in the composition) appeared. Between the 12th and 10th centuries BC, the Middle East saw a dramatic shift in the production of tools and weapons, moving from bronze to iron. The period of time following the start of mass iron processing is commonly referred as the Iron Age. The "Iron Revolution" in the world began at the turn of the 1st and 2nd millennia BC.

As early as the 8th century BC, ties between Greece and Colchis are documented. This is evidenced by the objects found in the Tsaishi tomb. Along with the bones, unique artifacts made of gold, silver, copper, iron, and clay were found in the tomb, including spears, axes, various vessels, belt buckles, clasps, and statues, the analogues of which have been discovered in Greece. Iron has been known in Georgia (Fig.1) since from prehistoric times. It is believed that iron was first obtained from ores in western Asia in the 2nd millennium BC. The territory of Georgia is considered as the oldest center of iron production. The Bible mentions that the tribes living here have been engaged in the production of metals, including iron, since time immemorial. This is also reported by ancient Greek and other written sources. Archaeological excavations have confirmed that iron production began in the territory of ancient Georgia at the beginning of the 2nd millennium BC, and was especially developed at the end of the 1st millennium BC.; for example, iron making and forging has been known in Western Georgia since time immemorial. Iron furnaces have been discovered in the same area, which also indicate the ancient production of iron in Georgia. For many centuries, iron ore was extracted from ore by a cold-pressing process, from which iron was extracted, then it was reheated with charcoal in a furnace set in a pit, into which air was blown by a blower; The recovered product was stripped of slag and various items were made from it by stamping.



From this point of view, the territory of Racha and Lechkhumi, adjacent to Svaneti, also remains interesting. There, in the village of Uravi (high-mountain Racha), a copper-lead-zinc ore occurrence and an ancient beneficiation bath with stone hammers and pieces of ore found in it were discovered (Mujiri T., 1987). An iron ploughshare was also found in the excavation materials of the Brill burial ground (high-mountain Racha) of the 4th century BC. [Gobedzhishvili G. F., 1952]. A similar ploughshare from approximately the same era was discovered by M.M. Tranche in Abkhazia. Large quantities of iron slag were found in the adjacent region of Racha – in Lechkhumi. This circumstance confirmed the presence of an iron plow both in the mountainous and in the lowland, more developed part of ancient Colchis. Iron agricultural tools are also frequently found in burials. Particularly noteworthy are the iron hoes and, most importantly, the iron ploughshares or ploughshare-like tools (Mikeladze T.K., Baramidze M.B., 1977; Mikeladze T.K., 1982) from the burials of Nigvziani and Ureki (7th-6th centuries BC).

Some researchers of Colchis [Bgazhba O. et.al., 1989] studied the technological characteristics of some iron products, including those from Abkhazia (see Fig. 2). All technological schemes from these regions ultimately provided products with a steel working surface, which, in some cases, was subjected to an additional operation - heat treatment. The technological characteristics of iron products from the settlements and burial grounds of the coastal part of northern Colchis (Guad-ihu, Sukhumi Mountain, Eshera settlement) with the richest finds are generally similar. However, heat-treated items were found outside, mainly during excavations of Guad-ihu and Sukhumi Mountain. Among the iron inventory of the Escher settlement, only one item was heat-treated.

For the ancient iron metallurgy within Colchis, the frequent contamination of the territory with hematite and manganese-hematite mineralization was certainly especially valuable. It is quite possible that ancient metallurgists also used manganese when smelting high-quality steel. However, they could have achieved the same result by simply smelting manganese-hematite ores from local deposits. Smaller-scale manganese deposits are recorded in the western part of the zone, for example, in the village of Shemokmedi (Ozurgeti district). However, the number of ore points here is very limited, and the ore in most cases is earthy pyrolusite (up to 1.2 mm in diameter). Here we note that in the gorge of the modern Rioni River (Phasis) there is a large deposit of manganese and when it is washed out of the rocks, this element is deposited in the sands on the shores of the Black Sea, within Colchis.



Fig.3. Map of ancient Georgia at the end of the first millennium B.C.

Analyzing archaeological data, in the southwestern part of the Lesser Caucasus (southern part of Colchis), the magnetic sands of the Chorokhi River basin and the Black Sea magnetic sands were of great interest to ancient metallurgists. Information about their use in ancient times can be found in Aristotle: "They tell of a very special origin of the Chalybian and Amisian iron: It is formed, according to stories, from sand brought by rivers; This sand, according to some stories, is washed and melted over a fire; according to others, it is washed several times and then melted with the addition of so-called fire-resistant stone (most likely referring to manganese. Author's note), of which there is a lot in their country and which is melted in furnaces of a special design." ("Bulletin of Ancient History", 1947). The metal obtained in this way had a silver color and was considered stainless. In describing the Chalyb traditions of iron mining, Aristotle reports on an ancient common Colchian method, widespread throughout the Black Sea region inhabited by the "Kartvelian" (Georgian) tribes. The process of enrichment of magnetite sands was most likely associated with the discovery of large bath-shaped vessels with a drain, made of coarse-grained clay, in the areas of ancient sites on the coastal strip of the Colchis Lowland (Ramishvili A.).

The largest deposit of magnetite sands on the Black Sea coast of the Caucasus is located between the mouths of the Supsa and Natanebi, Choloki rivers. It was here, in the Supsa-Choloki interfluvium, that the remains of numerous settlements and a large metallurgical center, numbering hundreds of iron smelting workshops (first half of the 1st millennium BC), were discovered. This complex has not yet been sufficiently studied archaeologically (only a few iron smelting workshops with thirteen smelting furnaces have been excavated in different areas). Ancient Colchian iron smelting workshops were usually located on hills and slopes, as well as in gorges and ravines. But the most interesting thing is that the cluster of these iron smelting industries is often cut off from the raw material base and tied to an inland zone rich in refractory clays and hardwoods. Perhaps ancient metallurgists considered it

economically more profitable or physically easier to transport raw materials than to bring clay and charcoal to the area of magnetite sand deposits. [Khakhutaishvili D.A., 1973]. It is possible, of course, that such a removal of the raw material base from production was caused by other reasons that are not yet entirely clear to us. A high concentration of iron smelting workshops has been noted in the area of the middle reaches of the Choloki River, near the mouth of which (the northern outskirts of Kobuleti), a large group of pre-Colchian settlements, settlement sites on a coastal dune, and a large settlement from the 6th-2nd centuries BC have been discovered. Concentrations of ironworks have also been discovered in the Khobi and Ochkhauri river basins, the oldest of which dates back to the 9th century BC.

Based on the above, the most accessible raw materials for the ancient artisans of Colchis, in our opinion, were the Black Sea magnetic sands and the sands of the Chorokhi River basin (Ajaria), which lay on the surface, both literally and figuratively. The important role of the region in the development of iron metallurgy was due to favorable natural and mining-geological conditions, large reserves and the specific mineralogical composition of sands. Of the four main ore-forming iron minerals, three have been noted in the territory of Colchis: hematite, magnetite and limonite. The iron content is 10-15%, occasionally 20%. Table 1 shows the average data of chemical analyses of Black Sea sands from the samples we collected (beach strip of Kobuleti, Grigoleti, Ureki, Supsa and Poti).

Table 1. Average data of chemical analyses of Black Sea sands, in %

SiO <sub>2</sub>	TiO	Al <sub>2</sub> O	Fe <sub>2</sub> O	Feo	P <sub>2</sub> O <sub>5</sub>	MnO	CaO	MgO	SO <sub>3</sub>	Na <sub>2</sub> O	K <sub>2</sub> O	Ni	Co	Zn	As
50.6	0.10	11.5	6.5	4.2	0.26	0.24	11.1	6.1	0.03	3.1	1.7	0.018	0.015	0.02	0.02

The main alloying element in the steel samples studied by us was manganese (Kuparadze D., Pataridze D., 2013). Its presence in iron has been recorded by us in ancient products. We also examined the ores of the Black Sea coast of Georgia, the so-called magnetite sands, for the presence of manganese. The MnO content in them is: in the area of the village of Gonio - 0.2%; Kobuleti - 0.3%; the village of Grigoleti - 0.6%; and near the city of Poti - 0.4%. Thus, the iron ore (which was most likely processed by the Khalibs) was initially already slightly "naturally alloyed" with manganese. Moreover, on the outskirts of the city of Poti (ancient Greek Phasis), in the delta of the Rioni River, in the basin of which the Chiatura manganese deposit is located, a significant accumulation of this element is still observed today, which could have been added to the charge by ancient metallurgists.

We attempted to identify the reasons for the exceptional properties of the metal smelted from these sands. Chemical analysis results (Table 1) indicate that these sands are so-called "poor" iron ores. According to the results of our research, in certain areas there are increased contents of vanadium (the average content of vanadium oxide [V<sub>2</sub>O<sub>5</sub>] reaches 0.08-0.1%) and zircon. Magnetite sands are products of the destruction of igneous rocks, which, in small quantities, contain vanadium, molybdenum and chromium. Their presence can also affect the quality of the metal. For example, the content of chromium oxide in such rocks (Cr<sub>2</sub>O<sub>3</sub>) is about 0.5% (Onuma K., Tohara T. 1984). Thus, the steel smelted by the Chalibs was, in fact, initially alloyed by nature, due to which it possessed outstanding properties. The method of making iron products by craftsmen, of course, was not universal and could not be applied everywhere, but it served as an impetus for the further development of iron metallurgy.

### Metalworking

In this article will not limit itself to listing and describing the exact locations and methods of processing gold, copper, bronze, silver, zinc, and other metals, which have been processed throughout Georgia (Sakartvelo = Colchis + Iberia) since time immemorial. Such deposits and ore occurrences abound throughout Georgia, in both the south and north, western and central regions.

Here we will only touch upon the clarification of possible locations of iron ores, methods of mining ore on site, smelting iron blooms (or even high-quality steel) from ore and, accordingly, obtaining mainly cold weapons from it, as well as household utensils in the territory of Ancient Colchis. However, without touching only on Colchis, we must immediately state that at all the discovered and known deposits and ore occurrences of iron throughout the territory of Georgia (see Fig. 2), at all sites, numerous ancient iron-smelting workshops have been officially described, and at some of them we have discovered numerous ancient iron-smelting workshops. Here we will also note that we will, in parallel, try to recreate the technology for producing Colchis steel with the help of modern craftsmen. Written sources have preserved noteworthy information about the high level of iron processing among the "Georgian" (Kartvelian) tribes of southwestern Georgia, and modern archaeological discoveries clearly indicate a significant level of metal production in Kartli too (Southern and Central Georgia).

The high level of development of crafts in one of the regions of Georgia - the Black Sea region (Western Georgia) can be judged by the quantity and quality of the available archaeological materials [Khakhutaishvili D.A., 1973.; G.Inanishvili, 2007; Gilmour B. et.al, 2014; Kuparadze D. et.al, 2008]. Factual data leaves no doubt that in Colchis at the beginning of the 1st millennium BC, there also existed a highly developed iron metallurgy. However, to clarify these questions, we need to identify and characterize the inhabitants (tribes) who originally lived and produced metal in the territory of ancient Colchis. We will attempt to do this very briefly.

According to written sources, in the Hellenistic era and even earlier, one of the ancestors of the Georgians (Colchians) - the Chalybes - mined and even exported iron ore, and this ore and products were so highly valued that each of them tried to make weapons from it. According to Strabo (66 BC), these experienced miners and metallurgists began with the development of silver mines, and then became the first of those who serviced the full cycle of metal production - from the extraction of raw materials to the production of iron products (Georgica ..., 1961).

In numerous descriptions, the Greeks note the eastern part of Asia Minor (the southeastern coast of the Black Sea) as the area where the tribes of the Chalibs or Chaliph lived. In their opinion, this region can be considered as one of the centers of the emergence of ferrous metallurgy. It is quite possible that it was from them (from Chalibs) the Greeks received information about iron. Thus, in Latin the common name of steel (Chalib) comes from and is the name of the tribe of Chalib who lived on the southern coast of the Black Sea.

Assyrian inscriptions confirm that the Muscian tribe lived in the areas adjacent to the Chalibs (in the 11th century BC), who were known mainly for viticulture and metal production. Nennius calls the Iberians as the descendants of Tubal. The descendants of Tubal also included the Tibareni (Greek: Τιβαρηνοί), who lived together with the Moschians (Meskhi) on the southeastern coast of the Black Sea, on the territory of which, according to Herodotus, the 19th satrapy of the empire of Darius was located. (<http://wap.nyhas.borda.ru/?1-10-20-00000040-000-40-0>). According to academician Ivane Javakhishvili, the Tubals are the oldest Georgian tribes. (Javakhishvili I.A. 1951).

It should also be noted that during the same period, the Tubal tribe seems to have been more advanced than other tribes in metallurgy, as they were famous not only for the processing of iron, but also for other metals. It was their silver mines that were captured in 837 BC by Shalmaneser II. Also mentioned in the Bible is Tubal-Cain (Cain means blacksmith in Semitic), who "was a carpenter with a hammer, a forger of brass and iron".

According to the Bible, these tribes traded their metal products over a fairly wide area. Pseudo-Aristotle, describing the technological process of the Chalibs, adds - "As they say, only this iron does not rust." If this is true, it is interesting in itself, and if not, then we must assume that the metallurgical knowledge of the Chalibs was so superior to anyone else's that even contemporaries of that time wrote legends about it.

Here we should also note another proto-Kartvelian tribe, the "Mossiniki", who were mainly engaged in agriculture, including viticulture, and they had a widely developed fishing industry. They were also engaged in metal processing. Xenophon noted that the Mossinians were armed with iron axes, and in the far west of their territory the Greeks encountered people engaged in iron processing. These were a small number of Chalybes, subject to the Mossiniks, who lived mainly by mining and processing iron. The Mossiniks apparently had quite good trade relations with the Greek cities. They were famous for their techniques of producing copper, bronze and brass. Their bronze, according to Aristotle, had a special shine and was distinguished by its whiteness. (Kuparadze D., Pataridze D., 2009).

Narrow specialization in the process of historical development developed production traditions, dexterity, technical skills and improved methods of metal production among individual tribes. In his commentary on the "Prophecies of Tire" (Prophet Ezekiel – 6th century BC), academician Javakhishvili (Javakhishvili I.A., 1951) writes: "Georgian" tribes produced metal products not only for their own consumption, but also exported them to such distant places as the city of Tire." The widespread sale of iron in foreign markets, and in particular in the Middle East, testified to the high quality of its products.

In such a situation, no matter how the questions of the identity of the Chalybes and Muscians, as well as their relationships with the tribes that inhabited the territory of Georgia in a later period, are resolved, it is still clear that the eastern, southwestern and southern coasts of the Black Sea were not cut off from each other either in ancient times or earlier, and what Pseudo-Aristotle said about the iron of the Chalybes can also be extended to the Georgian tribes; Especially since Georgian ethnographic materials seem to preserve the rules for making Chalibian iron.

A specific feature of ancient Georgian (ancient Kartvelian) metallurgy is the wide division and specialization of social labor. Even Apollonios Rhodios (ancient Greek: Ἀπολλώνιος Ῥόδιος; 200-250 BC) noted that the Chalybes "do not cultivate the land, nor grow sweet fruits, do not graze flocks on dewy pastures," but, instead, "they dig up the iron-rich hard earth and exchange iron for food supplies. The only occupation of the Chalibs is the production of iron, which they do day after day, from dawn until late at night." He also adds: "The dawn never rises for them without new labors. Amidst the black soot and smoke they carry out their hard work". (Antipenko A.L., 2005). That iron smelting was a common practice among the majority of the ancient Chalybes is also confirmed by Xenophon (ancient Greek: Ξενοφῶν; 4th century BC) - "The common conquest of life for the majority of the Chalybes living in mountainous areas is the processing of technological ore." (Xenophon. 1994).

It is quite obvious that the specialization of individual tribes was the result of a firmly established division of social labor. This specialization, in the process of historical development, developed production traditions, dexterity, technical skills, and improved methods of metal production among individual tribes.

Thus, the highly developed production of metals, and in particular iron, served not only as a source of livelihood for many ancient Georgian tribes, but also connected ancient Georgia with the outside world. Metallurgy became the basis for intensive trade with the highly developed states of the ancient era. This is a very important historical fact, which clearly indicates the relatively large scale of iron production in this region.

It should be added to the above that, when describing the Chalyb traditions of iron mining, Aristotle reports on the ancient common Colchian method, widespread throughout the entire Black Sea region of the settlement of the Colchian tribes. The process of enrichment of magnetite sands was most likely associated with the discovery of large bath-shaped vessels with a drain, made of coarse-grained clay, in the areas of ancient sites on the coastal strip of the Colchis Lowland (Ramishvili A.).

Since the temperature regime of the metallurgical cycle (800-1300°C) did not allow obtaining iron in molten form, the process of direct reduction led to the production of metallurgical iron in a dough-like state as a sponge iron (G.Inanishvili, 2001; Khakhutaishvili D.A., 1987). All elements contained in hematite and magnetite iron ores were slagged and separated from the reduced metal.

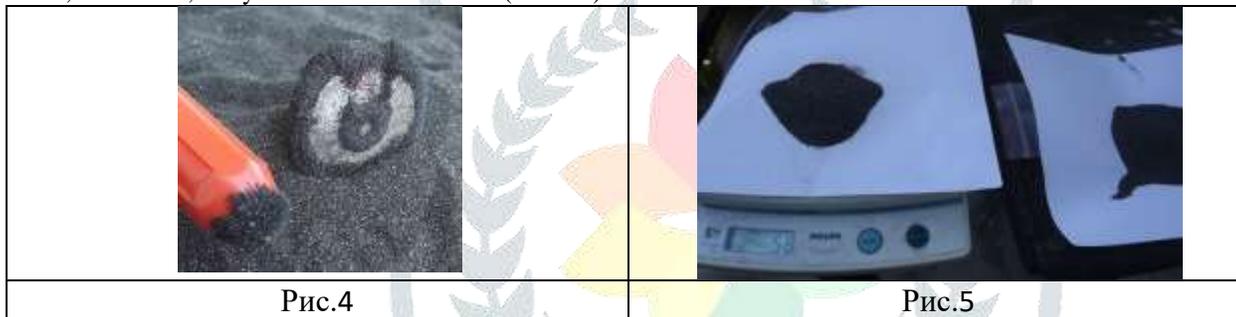
From this era onwards, high-quality iron and steel were continuously smelted in the territories of Colchis and Iberia (in Georgia as a whole) throughout the following centuries, which were mainly used to create bladed weapons (Kuparadze D., Pataridze D., 2023), and also for household utensils. In the Middle Ages, the development of so-called "Damascus steel," from which excellent sabers and daggers were forged, became highly significant. It became especially important in the late 17th and early 19th centuries. This happened after a short break in Georgian metalworking. The traditions of making Damascus steel in Georgia were directly linked to the production of weapons in the Middle East. It is an indisputable fact that even in the century before last, Georgians remembered the technology of manufacturing and produced high-quality steel. There is information that one of the masters of this craft, Karaman Eliazaroshvili, revealed the recipe for making Georgian saber steel in 1828. Researcher K.K. Cholokashvili found this recipe in the old "Acts of the Caucasian Archival Company". Let us quote it in full (Gurevich Iu.G., 1985). From this description, even a non-specialist can see how difficult the method was: "For one saber or shashka, take 5 pounds of strip iron, put it in a forge, in which bring it to such a degree (i.e. heat it up) that it can be cut into three parts along the length of the strip, after which cut each part into two

pieces, from which 6 equal parts are formed, each a quarter of an arshin (One arshin equals 71.12 centimeters. This old Russian unit of length, officially established in the 19th century, is equal to 16 vershoks or 28 inches. Author's note) long. Then take two pounds of steel, boiled and raw, and put it in the ladle, heating it so that it can be cut into three parts along the length of the strip, equal in size to the iron parts. Then, taking two pieces of the above-mentioned iron, inserting one piece of the prescribed steel into them, weld with sand and in the usual manner also with the other iron parts and steel. When iron and steel are welded in this manner, a welded piece must be forged that is twice as long, i.e. half an arshin, three-quarters of a vershok wide (1 vershok = 4.445 cm or 44.45 mm) and one-eighth of a vershok thick. Then, after heating each piece in a furnace, sprinkle it from above and below using an iron spatula with crushed cast iron (which should be prepared in advance like sand). In total, you will need cast iron from 6 pieces of the above-mentioned iron, one pound (about 450 grams). After this, forge each piece again in half, i.e. one arshin long and half an inch wide. When finished, bend each piece 5 times, taking them in pliers, weld together in a forge with sand; then, using leather to pull out a rod half an arshin long from this material, cut it into two parts, weld them with sand and, pulling out half an arshin from it again, cut it in half. After this, insert into their middle a half-pound strip of steel, the length and width of which are similar to these pieces of chopped iron, weld it together with sand, and forge a strip similar to a saber, but, however, shorter by two inches. This strip must be notched with a chisel on both sides, like a large file, then this notch must be ground down or filed off, and then the saber must be drawn out at will, then put it in the blade, and after a quarter of an hour, take it out and clean out the dust in some place, observe if the stream on it seems good or, if desired, then for hours clean out the same thing from the dust with powder."

Eliazarshvili's recipe is very similar to surviving descriptions of the production of swords in Northern India with an artificially carbonized surface. A strip of ordinary bloomery iron was repeatedly sprinkled with cast iron filings, and then, by subsequent repeated forging in the "welding heat", a cemented surface was created on it. Such blades had a sharp edge and had some longitudinal elasticity and toughness.

Over the past year, we have again attempted to examine the quality of magnetic sand from the village of Ureki to determine its potential for producing high-quality steel.

For this reason, we selected several kilograms of these sands from the above-mentioned place. Using a conventional magnet, 100 grams of magnetic fraction was isolated (Fig. 4) and transferred to the laboratory of the Caucasian Institute of Mineral Resources at Tbilisi State University. A complete silicate analysis of this fraction was carried out there, in addition to determining the percentage of silver, chromium, molybdenum and vanadium (Table 2).



To determine the percentage of magnetic fraction in sand, we determined the percentage of waste rock to the magnetic fraction from 100 grams of this sand and obtained the result that the magnetic fraction in sand corresponds to 53-58% (Fig. 5).

Table 2. Weight %

SiO <sub>2</sub>	TiO	Al <sub>2</sub> O	Fe <sub>2</sub> O	Feo	P <sub>2</sub> O <sub>5</sub>	MnO	CaO	MgO	SO <sub>3</sub>	Na <sub>2</sub> O	K <sub>2</sub> O	Ni	Cr	Mo	Ag	V
35.5	2.9	7.4	20.1	9.7	0.08	0.3	12.8	9.3	1.13	0.7	0.6	0.05	0.015	0.02	0.02	0.035

Over the past 35-40 years, a whole host of artisans and researchers have emerged in Georgia with a keen desire to recreate lost methods of producing high-quality steel and reproduce the old Georgian (Kartvelian) high-quality techniques. It should be noted that they are experimenting with a variety of raw materials from different regions of Georgia.

Одним из таких мастеров мы должны отметить Захария (Закро) Ноникашвили, который достиг очень хороших результатов выплавляя и создавая холодное оружия из разного сырья. Последние годы он получил «Дамасскую сталь» из песков Черноморского побережья Грузии очень высокого качества для сабель и клинков (рис.6) и продолжает изыскания в этой области по сей день.



Fig.6. Wootz steel by Zaqro Nonikashvili, melted from Ureki sand

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