

ABOUT THE SIGNIFICATION OF WOOTZ AND OTHER NAMES GIVEN TO STEEL

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Taking into account the fact that the names given to steel in different languages have always a technical content (hardness, resistance, etc.), a signification of *wootz*, an Indian crucible steel, is researched through Arab texts of the 9-12th centuries AD describing the preparation of the crucible steel named *fulad*. An Indian origin of the word as transformed by Arab travellers and a technical content are proposed.

Key words : Bulat, Crucible steel, Damascene steel, Etymology, History, Indian steel, Wootz

INTRODUCTION

Wootz is the name given to a *crucible steel* prepared in India. It first occurred in printed form in the 1795 Pearson's report. This steel was abundantly studied in Western Europe during the 19th century AD (Bronson 1986) because of its special characteristics: high hardness, difficulty for forging, unknown preparation, etc. However, the origin of the name itself is unclear even if it has been proposed by Yule and Burnell (1886) in the Hobson-Jobson Dictionary that the word *wootz* could come from *ukku* in Canarese language. Such a possibility does not give any technical content to the word, and there lays the center of the problem because, in the etymology of the different names given to *steel* in different countries and times, it appears that, contrary to *iron* which is a general name, *steel* represents a property qualifying a particular iron product. This point can be understood, because steel is never a primary product extracted from the ore: in ancient metallurgy, it was obtained by

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cementation of wrought iron (malleable iron) or in recent process, by fining cast iron, whereas iron - either wrought or cast - has always been a primary product. In the present paper, the names given to steel in different languages will be analysed and the question of the property possibly represented by the word *wootz* will be asked.

EXAMPLES OF PROPERTIES INCLUDED IN WORDS DESIGNATING STEEL

The English word *steel* and the German *Stahl* are coming from *Stahal* in Old High German (~11th century AD) and contain the reconstituted indo-european root **sta* which can be found in the German verb "*stehen/stand*" (Wahrig 1980) or in English "to stand", and related to the Sanskrit *stakati* the signification of which is: "it resists" (Longman-Webster 1985). The same root is used in Nordic languages and in modern Russian, Polish, etc. In Celtic languages the same root is generally used, e.g., *stailin* but other words meaning force or hardness are also found, e.g., *dir* in Breton (MacBain 1982).

In French, *acier* is coming from the Latin *acies* which means *cutting edge* or point of an arrow. The same root is used in all Latin base languages: Spanish, Italian, etc. Diderot (1751) explained that Pliny used *acies* to represent the word *chalybs*, i.e., steel in ancient Greek (see below).

It can be noticed that the Latin word *acieris* close to *acies*, represents a bronze axe used for religious sacrifices (Gaffiot). The main point here is not the nature of the metal, but the property of the tool. The same remark applies to the names of metal in the ancient Vedic hymns (15th-11th centuries BC) analysed by Pleiner: *ayas* and *loha* could represent indistinctly iron or other metals. *Ayas* would signify "strength and solidity" of a metal. In the Pali Canon (5th-3th BC), *ayo-*(in composition words) often means iron, and *loha* is copper but in many cases there is a possible confusion. For instance, *ayas* has given *aes* (bronze) in Latin but, about the 1st BC, *ayo-* is generally related to iron. Such imprecise situation is also found in ancient Greek texts (Halleux). It means simply that the chemical definition given today to metals and alloys must be let aside in order to try and understand the concepts of ancient metallurgists.

In ancient Greek, three names were attributed to steel : *στομωμα* (*stomoma*), *αδαμας* (*adamas*) and *χαλυβς* (*chalybs*). *Stomoma*, used by Aristoteles (4th BC), means *cutting* (edge). Since Hesiod (~8th BC), *adamas* signifies inflexible or hard, speaking of gods but not necessarily of a metal, except in special cases where it represents a hard material not clearly identified, may be a stone. It was systematically translated into "hard as steel" (Bailly) but there is no necessary reference to a metal in Hesiod texts or even in Virgil, eight centuries later. However, *adamas* has been the origin of the adjective for diamond (adamantine) and the English *adamant* which means inflexible (Longman). The different possible meanings of *adamas* have been discussed by Halleux. Following Herodote (5th BC), *Chalybs* is the name of a people living in Asia Minor. They were known to prepare *chalybdikos* (*sideros*) (Bailly) i.e., *hard (iron)*. This name is not directly a qualification of a technical property but of the geographical origin of the product. The name *Chalybs* can be found until the 18th AD, e.g., in the "Encyclopedie" (Diderot) where, surprisingly, *Chalybs* is said to be the name of a Spanish river. The error is due to Justinus 2nd AD (Gaffiot).

In China, (Needham) *iron* is represented by *thieh* which could mean *grey* and *steel* by *kang*, from *kang thieh* (hard iron).

In the Muslim world of the 9th-12th AD, the production of *fuladh*, a Persian word, has been described by Al-Kindī, Al-Bīrūnī and Al-Tarsūsī, from *narm-ahan* and *shaburqan*, two other Persian words representing iron products obtained by direct reduction of the ore. *Ahan* means iron (Pigott). *Narm-ahan* is a soft iron and *shaburqan* a harder one or able to be quench hardened. Old nails and horse-shoes were also used as base for *fuladh* preparation. It must be noticed that, according to Hammer-Purgstall, there was no Arab word for steel, which explain the use of Persian words. *Fuladh* prepared by melting in small crucibles (~2kg or less) can be considered as a steel in our modern classification, due to its properties (hardness, quench hardenability, etc.). The word *fuladh* means "the purified" as explained by Al-Kindī. This word can be found as *puladh*, for instance in Chardin (1711 AD) who called this product; *poulad jauherder*, *acier ondé* which means "watering steel", a characteristic of what was

called Damascene steel in Europe. A description of the small ingots (compared to small cakes) is given by Tavernier.

In Russian the corresponding word is *bulat* (Belaiew) and in Mongol *bolot* (Pigott). In the 19th AD, it was accepted as evident by European metallurgists that the ancient word *bulat/fuladh* and the newly introduced one *wootz* (Pearson 1795) represented the same kind of high carbon crucible steel (1-2wt%C) which should have been used by Muslim blacksmiths to forge the so called Damascene blades, the secret of which had been lost as was said by Russian and European metallurgists of that time. Anosof in mid-19th claimed to have rediscovered the secret and proposed that it could be reactivated for making tools and swords, but *wootz* steel found no development, it was soon replaced by new tool steels containing alloying elements such as tungsten, chromium, vanadium, etc. which are easier to forge and present more reproducible properties. Such alloyed tool steels are those used today.

It is not the aim of the present paper to discuss on a technical point of view the identification of the ancient steels named *fuladh* and the *wootz* specimens observed in the 19th AD, which were all of recent production (Zschokke, Bronson, Verhoeven). Ancient pieces of metals have not been analysed, up to now. However, even if differences can be found between the Indian and Muslim processes (Ragib 1997), the essential character of melting in crucibles is present in both products (compare al-Tarsūsi 12thAD and Buchanan 1807). More precisely, following the preceding analysis of the names given to steel, all of which have a technical content, it is proposed just below to find a possible signification of the word *wootz* as a technical qualification of this particular steel obtained by melting in crucible, more than 10 centuries before the 1st European crucible steel in Sheffield.

POSSIBLE ORIGIN AND SIGNIFICATION OF THE WORD WOOTZ

Names used for steel in India

In India, different names were given to crucible steel in different languages. Following Yule and Burnell (1886), *wootz* would seem to have

originated in some clerical error, or misreading, very possibly for *wook*, representing the Canarese *ukku* (pron. *wukku*) "steel" or *uchcha*, "of superior quality". The first suggestion was preferred by Yule and Burnell. They add : "the *Madras Glossary* gives as local names of steel, Can. *ukku*, Tel. *ukku*, Tam. and Malayal. *urukku*, and derives *wootz* from Skt. *ucca*, whence comes H. *uncha*".

Hadfield (1912) reported: "Mr. Heath says this term *wootz* or *oots* is probably the name for steel in the Guzeratte language in use at Bombay". Mr. Heath had been a director of the Indian Iron and Steel Company before 1837. This opinion is considered as "highly improbable" in the written discussion of the Hadfield's paper by V. Smith, making reference to Yule and Burnell.

In his important *History of Chemistry in Ancient and Medieval India*, Ray (1956) mentioned only that *wootz* was the name given to Indian crucible steel in Europe, showing no interest in the origin of this word.

Zaky (1979) proposed that *wootz* belongs to the Telanga language of south-eastern Hyderabad state, without any reference.

Biswas (1994) wrote that *vr̥tta* means steel in Kauṭilya's *Arthasāstra*: "*vr̥tta* means circle or disc and could denote crucible-molten steel". Steel is also represented by *ukku* in Telugu or Kannada, *wuz* in Gujarati, or *wootz* which was the term used and spread all over the world by the traders from the Middle East. Unfortunately there is no reference on this point.

As a partial conclusion, it can be seen that, except *uchcha* which was rejected by Yule and Burnell, in the proposed origin for *wootz* no technical content is given. It must be remarked that Yule and Burnell gave no reference in Gujarati, contrarily to Hadfield and Biswas.

Signification of *dōṣ*

In the description of the *fuladh* preparation, it appears a substance called *duç*, *dōṣ* or *dwṣ* as a function of the transliteration from Arab to Latin characters. In Al-Bīrūnī (Al-Hassan), it can be found : "*Nirmahan* is

divided...into two types. One is (*nirmahan*) itself, and the other is its water which flows from it when it is melted and extracted from stones, and it is called *dōṣ*; in Persian it is called *astah* and in the area of Zabilstan, *rō*, because of its speed of flow and because it overtakes iron when it is flowing. It is solid, white and tends to be silvery". The translation by Allan is quite similar: "...This is called *dūḥ*...because of the speed with which it comes out of the iron and precedes the iron in reaching a fluid state...". Mazahéri (1958) uses the transcription *al-dwṣ*

It is important to remark that the origin of *dōṣ* is unknown. Contrarily to *fulah*, *nirmahan* and *shaburqan*, which are persian words, *dōṣ* is not. Its Persian equivalent was *astah* and in Zabulistan—between Afghanistan and Pakistan—its name was *rō*. It is not more Arab, and the Arab word for water is different.

This substance could be identified either with liquid metal or liquid slag. The discussion of this point by Bronson (p. 44) leads to: if the "water" is slag, the description is unintelligible but if it is cast iron the description can be understood. However, it must be remembered that the signification of the word can have changed from the 9th to the 12th AD, and that it could represent quite different products as compared with our present definitions of iron and steel, because the products were identified from their fabrication process, not from a chemical composition as of today. Without discussing the details, it is clear that the substance represented by *dōṣ* has the property of "flowing like water".

Following Mazahéri (1958), the word *dwṣ* in oriental Arab can be transformed into *wdṣ* in occidental Arab, due to an ordinary confusion between the sounds represented by *d* and *w*. Mazahéri proposed that *dwṣ* after transformation into *wdṣ* during its travels from East to West, is the origin of the *wootz* name.

DISCUSSION

Even if the Mazahéri's proposition may not give the 1st origin of the European *wootz*, it shows how it could have been transmitted from India

to Europe. More important, such interpretation presents the interest of giving a technical content to *wootz* as a material prepared in the liquid state and shows the historical continuity between the 9thAD products named *fuladh* by Muslim writers and the 19thAD *wootz*, name given in Europe.

The Arab transmission of the word *wootz* seems logical because Muslim traders were very active between India, Persia and western Muslim countries (Biswas). But this is not sufficient to give an absolute demonstration. Written sources should be found to make a decisive link. Concerning the origin of *dwṣ* itself, it could be thought that it was a local name, completely different from Persian and Arab, as observed above, and the Gujarati *oots* proposed by Heath (Hadfield) or *wus* by Biswas are strong possibilities, the transfer by *dōṣ/wdṣ* giving a technical content to this word, thanks to ancient Muslim written sources. However, it could also be objected that the Gujarati word would come from *dōṣ/wdṣ*. An answer should be found by questioning the relation between *oots/wdṣ* and the possible notion of "flowing liquid" in Gujarati, today and if possible 1000 years ago.

A second possibility, the simplest of all, would be that *wus* (Gujarati) was existing independently of Arab travellers and that Al-Bīrūnī, who seems to be the first to write the word *dōṣ*, would also have been the author who transformed *wus* into *dūṣ*. This explanation can be supported by the fact that Al-Bīrūnī, after visiting India, lived in Ghazni about 100 km south from Kaboul, at a time when the Ghaznevid Empire extended as far as the Sindh at the border of Gudiarat (Larousse). Al-Bīrūnī was then living in eastern Muslim countries where he might have transformed the *w* sound of *wus* into the *d* sound of *dūṣ*, in the same way as the reverse was possible from eastern to western Arab (Mazahéri).

CONCLUSION

Combining the idea that *wootz* (name of a steel) had necessarily a technical content as the other names given to steel in many languages,

with the proposal by Mazahéri of the relation $d\bar{o}s/wd\bar{s}$ which contains the idea of "flowing like water" found in the preparation of *fuladh*, it becomes possible (i) to understand the transmission of $wd\bar{s}$ from India to Europe by Arab travellers, (ii) to show the continuity *fuladh/wootz* from the 9th AD to 19th AD, and (iii) to give a technical content to *wootz* as $d\bar{o}s$, i.e., *melted* steel. The 1st origin of the word *wootz*, transmitted by Muslim travellers, is not Persian. It could be attributed to Gujarati but this point must be precised by questioning the possible relation of *wus* with the notion of *flowing liquid* in this language or an other one of the same family.

The main result of the present paper is to propose a technical sense to the European word *wootz* but more specialised studies are necessary in co-operation between linguists and metallurgist on technical and commercial documents about this problem.

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