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SMELTING AND TECHNICAL KNOWLEDGE IN NORTHERN ITALY BETWEEN THE 18TH AND 19TH CENTURIES

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RESUMEN

La región de los Alpes podría ser considerada, a partir de 1780, un área de transferencia tecnológica y desarrollo, especialmente en relación con la actividad minera y la gestión de los recursos naturales. A finales del siglo XVIII, un renovado interés hacia la explotación de yacimientos minerales, debido a la creciente demanda de metales en toda Europa, provocó la reapertura gradual de las excavaciones a lo largo de los flancos de los Alpes y los Prealpes. El redescubrimiento de los depósitos minerales de muchas montañas fue incluido en la formación científica y en la actividad social, tal es el caso de los viajes geo-mineralógicos. Esta especie de "turismo naturalista" fue apoyada a menudo por fondos del gobierno, como podemos ver en la región de Lombardía del siglo XVIII. A raíz de una serie de medidas adoptadas por algunos estados italianos con el fin de aumentar las actividades de la minería y hacer frente a la inminente escasez de leña a lo largo de las laderas de los Alpes, en el presente trabajo se examina la transferencia tecnológica que se produjo en el ámbito europeo, que permitió la introducción de las nuevas tecnologías de la fundición de metales y del laboreo de minas.

PALABRAS CLAVE: Historia ambiental, historia de la minería, historia de la tecnología, Italia, Lombardía.

ABSTRACT

The Alps, from the 1780s onward, might be considered an area of technological transfer and development, especially with relation to mining activity and management of natural resources. At the end of the eighteenth century, a renewed interest towards the exploitation of mineral deposits, due to a growing request of metals all over Europe, caused the gradual reopening of excavations along the flanks of the Alps and Prealps. The rediscovery of many deposits has been included in the scientific and social background of geo-mineralogical travels. These were often supported by government funding in eighteenth-century Lombardy. In the wake of several measures, undertaken by some Italian States in order to increase mining activities and cope with the imminent shortage of firewood along the sides of the Alps, the paper will examine the technological transfer, occurred in Europe, that allowed the introduction of new technologies of melting and mining.

KEY WORDS: Environmental history, history of technology, Italy, Lombardy, mining history.

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INTRODUCTION

Several historical studies have emphasized the relevance of alpine and pre-alpine valleys as places of communication and cultural exchange between Europe and the States of Italy in the eighteenth century, going beyond the traditional historical interpretation, which has mainly viewed this European 'environmental region' as a geographical barrier (Zanzi, 2004). It's no exaggeration, however, to argue that the Alps can be considered an area of technological transfer and development, and particularly so in relation to mining activity and management of natural resources, and especially from the 1780s onward. Indeed, at the end of the eighteenth century, a renewed interest in the exploitation of mineral deposits, due to a growing demand for metals all over Europe (Ritson, 1964; Frumento, 1985; 1991), caused the gradual reopening of various quarries and mines along the flanks of the Alps and Prealps. Also, it should not be overlooked that the rediscovery of many mountain ore deposits had been included in the scientific and social background of geo-mineralogical tours. This related to the territorial studies and the exploitation of natural resources, was often supported by government

funding in eighteenth-century Lombardy, where the Habsburg Government sometimes financed geological travels with considerable sums of money (Ferrazza, 2003; Candela, 2009).

At the same time, the need to increase energy supplies, in order to meet the growing demand for fuel in mining and manufacturing activities, brought the problem of forest depletion to the attention of several governmental authorities. The careless management of forestland, fires, the lack of rules and the massive use of woods for sheep grazing and cultivation, as stated by Bruno Vecchio (1974) and Agnese Visconti (2003; 2008), were the main causes of deforestation in the alpine regions. Moreover, it should not be overlooked that wood and iron were the most important economical resources in Europe until the mid-eighteenth century (Frumento, 1991).

Mines needed timber to secure galleries and other underground structures (Amoroso, 1985). According to some archive sources dating from the sixteenth century (Vergani, 2008), pine, larch and fir were the most frequently used materials to secure underground excavations. But metallurgical processes required fuel, firewood and above all charcoal to reduce minerals into metals. Wood from conifers (larch, fir, etc.) and holm oaks was heated slowly in charcoal piles to obtain so-called 'sweet coal', whereas the 'strong' one was produced from broad-leaved trees, such as beech (Vergani, 2008).

A brief examination of the eighteenth century scientific literature reveals the most immediate and serious implications of the gradual process of deforestation, such as landslides and floods; environmental problems also increased due to excessive agricultural tillage and grazing (Vecchio, 1974). Furthermore, some analysis in the history of technology (Giardino, 1998) have shown that shaft furnaces needed about 95 kilogrammes of coal to reach the right temperature for smelting iron ore (between 1200 and 1540 ºC). This quantity of charcoal, consumed during one melting only, was produced from 15 trees, which were between 14 and 16 centimetres in diameter. From these data, we can argue that metallurgical activities were undoubtedly among the causes of the broad-leaved forest depletion of several mountain areas. The soaring shortage of timber involved different European countries and the States of Northern Italy, influencing the economy and manufacturing systems of many regions.

For instance, in the second half of the eighteenth century, with a population of about 150,000 people, Venice was an important manufacturing centre counting a good number of industrial activities that required large wood supplies: timber for building and shipyards, firewood for domestic heating and cooking, charcoal for glass factories or forges (Lazzarini, 2008). But wood provisions encountered increasing difficulties. Therefore in the Republic of Venice, as in other European countries and Italian States, there were complaints and concerns about an imminent shortage of firewood, associated with the sudden reduction in woodlands; nevertheless despite the concerns of contemporaries, a real energy crisis did not occur. Shortages led to a rise of the price of wood, woodland did not disappear though trees were patently decreasing in number because of the growing population pressure, especially along the alpine rivers and on the lower slopes of the mountains (Lazzarini, 2008).

SEARCHING NEW TECHNOLOGIES OF SMELTING IN THE ALPS REGIONS

In such circumstances, the need to improve mining exploitation and metallurgical processes, together with the necessity to preserve woodlands, supported some actions involving alpine regions and, more generically, on all mountainsides.

Thus, in the Austrian Lombardy of the eighteenth century, various edicts and acts relating to the preservation of forests were drafted between 1784 and 1789. In relation to this matter, the Habsburg Monarchy supported an enquiry that started in 1781, which established an ambitious plan to take a census of all Lombardian woods. The survey, completed in 1785, noted the degradation of several wooded areas, particularly along the slopes of the pre-alpine valleys and in lowland provinces, where agriculture had brought large areas under cultivation. On the surrounding mountains of Lake Como, the forests made up about a sixth of the territory, while in the Dukedom of Milan, they covered approximately a seventh of the total surface area. The enquiry was focused on mining areas in particular (Amoroso, 1985; Visconti, 1995, 2003).

At the end of the eighteenth century, Europe was clearly divided in to two parts about the distribution and the use of steam engines in mining. They were spread in England, in the South of Netherlands and in some coal regions of Northern France; instead, the Central Europe, rich in rivers, remained faithful to the 'tradition' of hydraulic machines. Beyond a relative backwardness, Italy was undoubtedly closer to the central European technology (Vergani, 1998). In the Italian peninsula, the first steam-powered pump was introduced in mining during the second half of the nineteenth century. Therefore, the proven necessity to increase energy supplies, then still chiefly represented by timber, encouraged the circulation of early treaties on 'forest science' on a European-wide basis (Zanzi Sulli, 1997). Some significant contributions came from various Italian scholars, such as: Gottardo Canciani (1729–1793), Gianmaria Ortes (1713–1790), Girolamo Silvestri (1728–1788) (Vecchio, 1974), Alberto Fortis (1741–1803) (Ciancio, 1995) and Carlo Amoretti (1741–1816) (Amoretti, 1794; 1810). Several actions were suggested to cope with the gradual shrinkage of woodland, for example reforestation of the most ploughed lands, localization of given areas for intensive farming, grazing bans, regulations restricting the felling of trees, economic sanctions and, above all, the use of alternative fuels such as peat and mineral coal.

The list of several measures undertaken by some Italian States also included a real 'technological transfer', across Europe, that allowed the introduction of new technologies of smelting and mining (Brianta, 2007), particularly in the Lombardian Prealps. Indeed, if the efficiency of manufacturing processes could be improved sufficiently, the Lombardian woodland would have been enough for the requirements of the ironworks. This idea was quite widespread among different Italian scholars during the last decades of the eighteenth century.

Among them, the barnabite (a priest of the religious order named after the Church of St. Barnabas in Milan) Ermenegildo Pini (1739–1825) (Fig. 1), geologist and 'scientific officer to mines' for the Austrian Lombardy, should be remembered, whose analysis and empirical observations, carried out during his geological travels in Austria, Piedmont, Central Italy, Switzerland, Savoy and the Central Southern Alps from the end of the seventies, had supported this technological optimism (Pini, 1778, 1779, 1783, 1790; Visconti, 1995, 2004a, 2004b). Thus, in 1780, after an expedition undertaken in order to examine mining and the condition of the forests in parts of Northern Lombardy, Pini gave an account of his travel entitled *Memoria sulle miniere di ferro e sui boschi* (presently kept at the State Archives of Milan). The report focused on energy consumption and its decrease by various technological and structural improvements on blast-furnaces and he oriented his interests towards mining activity and the informed exploitation of natural resources, especially, after being given the position of Mining Delegate in 1782. Thus, Pini's mineralogical and metallurgical work directed efforts towards the study of energy saving, explaining the usefulness of improvements of this kind compared with reforestation alone. Indeed, funding of prospecting for new iron deposits and, at the same time, improving smelting methods and technical skills could have been less than that required to extend woodland (Visconti, 2008).

Technological matters were also occurring in the botanical and forestry field spreading in other European countries. By the way, the introduction of indigenous plant species, such as: *Robinia pseudoacacia*, *Pinus strobus*, *Abies balsamea* and *Tsuga canadensis*, was particularly important in order to encourage reforestation in different alpine and pre-alpine districts (Castiglioni, 2000).

There was also the problem of professional training and the Habsburg authorities arranged study trips to Styria and Carinthia in order to gain knowledge of different smelting techniques for Lombardian apprentices. For instance, between 1784 and 1785, several casters such as Francesco Guazzoni, Gioacchino Ruffinone, Mauro Mola, Agostino Parietti and Francesco Mornico, the owner of Dongo's factory, visited various Austrian manufacturing establishments with Pini and, in particular, they saw the blast-furnace of Treibach in Carinthia (Visconti, 2008), which had a circular cross-section instead of the square ones (Figure 2) used in the Lombardian furnaces known as *bergamaschi* (Cuomo di Caprio and Simoni, 1991; Piola Caselli and Piana Agostinetti, 1996).

Figure 1. Ermenegildo Pini (1739–1825).

The circular shape allowed a remarkable fuel saving –about one-third for the same quantity of end product. According to Pini's report *Viaggio in diverse parti della Germania*, the young apprentices lived in Treibach for more than a year to learn and practise the techniques of cast-iron.

Thus, by the end of the seventeen eighties, under the supervision of Pini and with Government funding, several furnaces circular cross-section were built, for instance in Valcavargna, in Valsassina and also near Lecco and Premana, so that a profitable period of metallurgical modernization began in Austrian Lombardy.

CONCLUSIONS

Following the Napoleonic period, improving smelting techniques did not attract much interest in the Department of Lario, despite the repeated efforts of the barnabite and some Italian scholars, such as the geologist Giambattista Brocchi (1772–1826) and the economist Melchiorre Gioia (1767–1829). However, it should not be ignored that the Mining Council of Napoleonic Kingdom of Italy, founded in Milan in 1808 with the supervision of Pini, Amoretti and Carlo Innocenzo Isimbardi (1767–1824), showed more sensitivity to this matter, explaining the unequivocal advantage of circular furnaces and, at the same time, asking for greater investment in order to encourage the spread of new technologies in different regions of Northern Italy (Frumento, 1991). By contrast, the French authorities chose to invest in the search for alternative fuels. But even if at

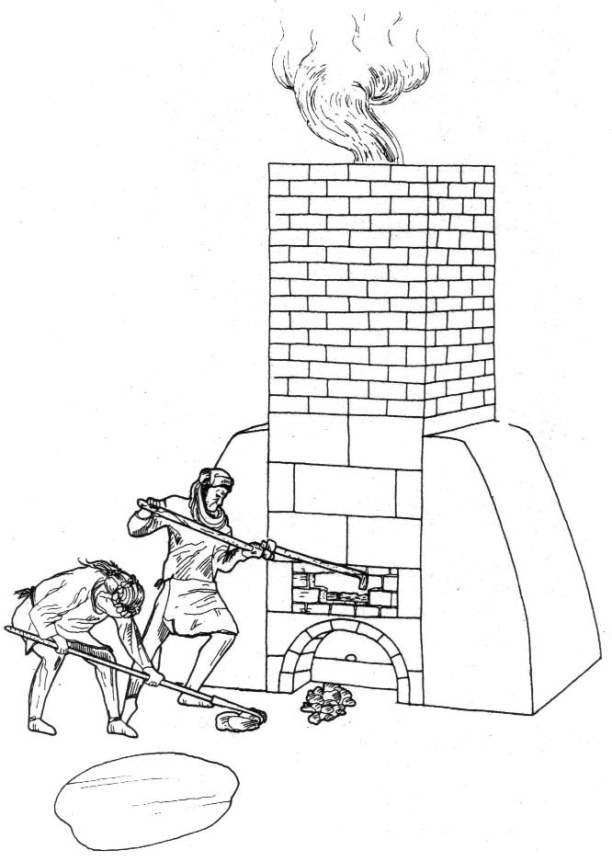

Figure 2. An example of a square cross-section furnace known as *bergamasco or alla bressana* (Cuomo di Caprio and Simoni, 1991)

Figure 3. Scipione Breislak (1750–1826)

the beginning of the nineteenth century, several printed works focused attention on the energy possibilities of peat and brown coals (Arena, 2011), after the Austrian Restoration, the Italian geologist Scipione Breislak (1750–1826) (Figure 3) still noticed a surprising resistance towards their use. This attitude was ascribed to transportation difficulties, the low prices of alpine timber and the awful smells caused by the combustion of the different fossil fuels (Breislak, 1838 and 1996). If in England and in France, coal was replacing wood and charcoal, beginning the 'era' of fossil fuels in energy supply, in Italy there was still resistance, despite continuous chemical and experimental investigations. In fact, smokes coming from peat and coal were considered dangerous to health, moreover their burning times were judged too long (Lazzarini, 2008).

Indeed the exploitation of fossil fuel allowed increased production and overall energy savings. Furthermore it supported the development of puddling furnaces and the improvement of the Huntsman furnace for cast iron production. Wood, which was still the basis of the Lombardy manufacturing processes, did not represent an interesting raw material anymore.

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ARCHIVES

Pini, E. 1778. *Memoria contenente il piano della descrizione fisico-mineralogica della Lombardia austriaca e dell'opera da pubblicarsi col titolo stesso, 1776-1778* held in: Autografi, envelope 180, State Archives of Milan (SAM).

Pini, E. 1779. *Relazione del viaggio mineralogico fatto nell'anno 1779 in diverse parti della Lombardia austriaca* held in: Commercio parte antica, envelope 203, SAM.

Pini, E. *Memoria sulle miniere di ferro e sui boschi* held in: Commercio parte antica, envelope 203 and 204, SAM.

Pini, E. *Viaggio in diverse parti della Germania* held in: Commercio parte antica, envelope 204, SAM.

REFERENCES

Amoretti, C. 1794. *Viaggio da Milano ai tre laghi Maggiore, di Lugano e di Como e ne' monti che li circondano*. Galeazzi, Milan, 143 pp.

Amoretti, C. 1810. *Della torba e della lignite, combustibili che possono sostituirsi alle legne nel Regno d'Italia*. Pirotta, Milan, 48 pp.

Amoroso, A. 1985. L'inchiesta sui boschi del 1781 e le origini della politica forestale nella Lombardia Austriaca. *Il Risorgimento*, 37, 9-27.

Arena, L.P. 2011. Finding and using peat and coal in Northern Italy between the eighteenth and the nineteenth century: fieldwork instructions in the writings of Carlo Amoretti. En: J. E. Ortiz, O. Puche, I. Rábano and L. F. Mazadiego (Eds.), *History of research in mineral resources*. Instituto Geológico y Minero de España, Madrid, 253-262.

Breislak, S. 1996. *Descrizione geologica della provincia di Milano*. Prometheus, Milan, 260 pp.

Breislak, S. 1838. Osservazioni sopra i terreni compresi tra il lago Maggiore e quello di Lugano alla base meridionale delle Alpi. *Memorie dell'Imperial Reale Istituto del Lombardo Veneto*, 5, 31-186.

Brianta, D. 2007. *Europa Mineraria. Circolazione delle élites e trasferimento tecnologico (secoli XVIII-XIX)*. FrancoAngeli, Milan, 447 pp.

Candela, A. 2009. *Alle origini della Terra. I vulcani , le Alpi e la Storia della Natura nell'età del viaggio scientifico*. IUP, Varese, 299 pp.

Castiglioni, L. 2000. *Viaggio negli Stati Uniti dell'America Settentrionale fatto negli anni 1785, 1786, 1787*. M. Sioli (Ed.). Selene, Milan, 2000, 556 pp.

Ciancio, L. 1995. *Autopsie della Terra. Illuminismo e geologia in Alberto Fortis (1741-1803)*. Olschki, Florence, 385 pp.

Cuomo di Caprio, N. and Simoni, C. (Eds.) 1991. *Dal basso fuoco all'altoforno*. Grafo, Brescia, 415 pp.

Ferrazza, M. 2003. *Il Grand Tour alla rovescia. Illuministi italiani alla scoperta delle Alpi*. CDA&Vivalda, Turin, 222 pp.

Frumento, A. 1985. *Le Repubbliche Cisalpina e Italiana con particolare riguardo a siderurgia, armamenti, economia ed agli antichi luoghi lombardi del ferro (1796-1805)*. Banca Commerciale Italiana, Milan, 608 pp.

Frumento, A. 1991. *Il Regno d'Italia Napoleonico: siderurgia, combustibili, armamenti ed economia (1805-1814)*. Banca Commerciale Italiana, Milan, 971 pp.

Giardino, C. 1998. *I metalli nel mondo antico. Introduzione all'archeometallurgia*. Laterza, Rome-Bari, 277 pp.

Lazzarini, A. 2008. Carbone e legna da fuoco per le manifatture veneziane nella seconda metà del Settecento. Una crisi energetica? En: A. Visconti (Ed.), *Il legno brucia: l'energia del fuoco nel mondo naturale e nella storia civile*. Società Italiana di Scienze Naturali, Milan, 98(1), 159-168.

Pini, E. 1783. *Memoria mineralogica sulla montagna e sui contorni del S. Gottardo*. Marelli, Milan, 128 pp.

Pini, E. 1790. *Di alcuni fossili singolari della Lombardia austriaca e di altre parti dell'Italia. Memoria nella quale trattasi anche di un vulcano supposto nella Lombardia medesima*. Marelli, Milan, 48 pp.

Piola Caselli, F. and Piana Agostinetti, P. (Eds.) 1996. *La miniera, l'uomo e l'ambiente. Fonti e metodi a confronto per la storia delle attività minerarie e metallurgiche in Italia*. All'Insegna del Giglio, Florence, 353 pp.

Ritson, J.A.S. 1964. Miniere metallifere e carbonifere dal 1750 al 1875. En: C. Singer, E. J. Holmyard, A. R. Hall, T. I. Williams (Eds.), *Storia della tecnologia. La rivoluzione industriale*. Bollati Boringhieri, Turin, 4(I), 64-99.

Vecchio, B. 1974. *Il bosco negli scrittori italiani del Settecento e dell'età napoleonica*. Einaudi, Turin, 283 pp.

Vergani, R. 1998. L'industria mineraria e metallurgica: tecniche, economie, società. En: E. Vaccari (Ed.), *Le scienze della Terra nel Veneto dell'Ottocento*. La Garangola, Venice–Padua, 231-302.

Vergani, R. 2008. Boschi, miniere e metallurgia nell'area veneta: norme, istituzioni, conflitti (secoli XIII-XVIII). En: A. Visconti (Ed.), *Il legno brucia: l'energia del fuoco nel mondo naturale e nella storia civile*. Società Italiana di Scienze Naturali, Milan, 98(1), 147-158.

Visconti, A. 1995. Il ruolo dei boschi della Lombardia austriaca per gli studi scientifici del naturalista milanese Ermenegildo Pini. *Natura. Rivista di Scienze Naturali*, 1, 21-32.

Visconti, A. 2003. Amministrare il sottosuolo per tutelare il suolo: la grande svolta energetica lombarda tra Settecento e Ottocento. En: L. Segre and M. Frey (Eds.), *Il sottosuolo lombardo e la gestione sostenibile delle sue risorse*. Bertieri Istituto Grafico, Milan, 59-79.

Visconti, A. 2004a. I viaggi compiuti da Ermenegildo Pini tra il 1777 e il 1782. Una breve stagione geografica. *Schede Umanistiche*, 1, 77-108.

Visconti, A. 2004b. Alcuni aspetti svelati dell'attività del naturalista milanese Ermenegildo Pini. En: M. T. Monti and M. J. Ratcliff (Eds.), *Figure dell'invisibilità. Le scienze della vita nell'Italia d'Antico Regime*. Olschki, Florence, 149-173.

Visconti, A. 2008. Ermenegildo Pini e la produzione siderurgica lombarda tra Sette e Ottocento: maestri fonditori, impianti e combustibili sulla via dell'efficienza energetica. En: A. Visconti (Ed.), *Il legno brucia: l'energia del fuoco nel mondo naturale e nella storia civile*. Società Italiana di Scienze Naturali, Milan, 98(1), 169-180.

Zanzi, L. 2004. *Le Alpi nella storia d'Europa. Ambienti, popoli, istituzioni e forme di civiltà del mondo "alpino" dal passato al futuro*. CDA&Vivalda,Turin, 447 pp.

Zanzi Sulli, A. 1997. La formazione del tecnico forestale tra Sette e Ottocento. En: M. L. Betri and A. Pastore (Eds.), *Avvocati, medici, ingegneri: alle origini delle professioni moderne (secoli XVI-XIX)*. Clueb, Bologna, 367-375.