

THE FORMER LEAD AND ZINC DISTRICT OF EASTERN BELGIUM AND THE CALAMINARIAN GRASSLANDS AFTER THE END OF EXPLOITATIONS

L'ancien district plombo-zincifère de l'Est de la Belgique et les pelouses calaminaires après la fin des exploitations

by Léon DEJONGHE

Belgian Institute of Natural Sciences, Geological Survey of Belgium, 13 Jenner street, B 1000 Brussels, Belgium ;
email: leon.dejonghe@naturalsciences.be

Abstract

In Eastern Belgium, lead and zinc deposits have been intensively exploited in the past, mainly in the XIXth century. It was one of the most important European mining areas during the Middle Ages up to the onset of the Industrial Revolution, as illustrated by paintings of Bastiné and Maugendre. This region was also the object of political tensions at the origin of the creation of the neutral territory of Moresnet. However, in spite of this importance, no attention has been provided to its geological and mining heritage after closure of the metal mines. Today, traces of the former mining exploitations nearly completely disappeared from the landscape. Calaminarian grasslands are the most visible remnants of past mining operations, sheltering an anomalous metallophyte flora. They constitute remarkable ecosystems which are now the subject of particular protection.

Résumé

Dans l'Est de la Belgique, les gisements plombo-zincifères ont été intensivement exploités, principalement au cours du XIX^e siècle. Ils constituaient un des plus importants districts miniers européens pendant le Moyen-Âge jusqu'à l'aube de la révolution industrielle comme en témoignent les peintures de Bastiné et Maugendre. Cette région fut également l'objet de tensions politiques à l'origine de la création du territoire neutre de Moresnet. Cependant, en dépit de cette importance, aucune attention particulière n'a été dévolue à son héritage géologique et minier après la fermeture des mines métalliques. Aujourd'hui, les traces des anciennes exploitations ont presque complètement disparu du paysage. Les pelouses calaminaires abritant une flore métallophyte singulière sont les vestiges les plus visibles de ces anciennes activités minières. Elles constituent des écosystèmes remarquables qui sont l'objet d'une protection particulière.

INTRODUCTION - THE MINING DISTRICT

In Belgium, there are three areas where lead-zinc deposits were exploited, the most important district being that of the Verviers Synclinorium located in Eastern Belgium. (Dejonghe, 1998). In this area, lead and zinc deposits have indeed been intensively exploited in the past, since prehistoric times and the Middle Age, but mainly during the XIXth century. Its apogee was between 1850 and 1870. The last mine (Roer) was closed in 1936. Their main geological and mining features are described by Dejonghe & Jans (1983). Shortly, most of the ore deposits are vein-type deposits located in fractures transverse to the folding and the faulting. These fractures are related to the Rhine graben tectonics. Most of them are crossing the sedimentary carbonate Devonian and Dinantian formations. Some also cross the Famennian and Namurian detrital rocks. In many cases, irregular bodies (the so-called "amas" in French) were connected to the lodes and were located at lithostratigraphic and tectonic contacts between various lithological formations. Some deposits are linked to the Palaeozoic-Mesozoic unconformity and would originate from the reworking on short distance of pre-existing

ore-deposits, likely in karstic traps. An extensive and detailed description of each of the ore deposits existing between Liège and Aachen is given by Dejonghe *et al.* (1993). Petrographical, mineralogical, geochemical data, stable isotopes (C and O) and fluid inclusions characterizing the "calamine" non-sulfide Zn-Pb deposits of Belgium are specified by Boni *et al.* (2007) and Coppola *et al.* (2008).

LA CALAMINE (MORESNET) ORE DEPOSIT

The region situated between Liège and Aachen produced about 1 260 000 tons of zinc (metal) and 133 000 tons of lead (metal). The largest deposit, that of La Calamine (Kelmis in German), yielded about a total of 760 000 tons of zinc (metal) during all its mining activity (Dejonghe *et al.*, 1993, p. 443). Its zinc production topped that of all other Belgian deposits altogether. The ore body was exhausted in 1879 (small activities lasted up to 1884). It was one of the most important European mining areas during the Middle Ages up to the onset of the industrial revolution. Its importance is illustrated by paintings of Bastiné and Maugendre, respectively dating back to 1843 and 1850 (Figs. 1 & 2).



Fig. 1. — Painting of the La Calamine (Moresnet) open-pit by Jean-Baptiste Bastiné (1843) kept in the Vieille Montagne Museum (formerly Göhlthal Museum), La Calamine. Reproduced from Ladeuze *et al.* (1991).
Fig. 1. — Tableau de l'exploitation à ciel ouvert du gisement de La Calamine (Moresnet) dû à Jean-Baptiste Bastiné (1843), conservé au Musée de la Vieille Montagne (anciennement, Musée de la Gueule) à La Calamine. Reproduit de Ladeuze *et al.* (1991).

La Calamine deposit was a huge lenticular body of 450 to 500 m in length and 65 to 100 m in width which was exploited down to 110 m at depth. The ore body is genetically related to the Palaeozoic-Mesozoic unconformity through karstic process of concentration. Main features are:

- ✧ The ore deposit has produced only zinc while most of other Belgian deposits delivered a mixed production of zinc and lead;
- ✧ The ore was completely oxidized down to the depth of 110 m (base of the ore deposit), while most of other deposits presented a dominant sulphide nature below the current water-table. The ore was named “calamine” by the miners. It is a mixture of several minerals: Zn carbonate (smithsonite, ZnCO_3) and Zn silicate {hemimorphite, $\text{Zn}_4\text{Si}_2\text{O}_7(\text{OH})_2 \cdot \text{H}_2\text{O}$ } or the assemblage of smithsonite, hemimorphite, hydrozincite $\{\text{Zn}_5(\text{CO}_3)_2(\text{OH})_6\}$ and (willemite, Zn_2SiO_4), locally associated with Fe-oxyhydroxydes and clays;
- ✧ The mineralized body rested on the detrital Famennian formations by means of an irregular intermediary layer of silicified dolomite of Tournaisian age.

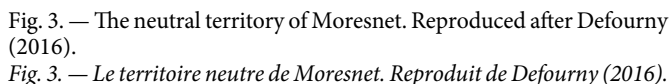
La Calamine ore deposit, also known by other names (Altenberg-, Vieille-Montagne-, Grande-Montagne- or Moresnet-ore deposit), was also the object of political tensions. After the defeat of Napoleon I, the Vienna Congress created in 1815 the kingdom of The Netherlands including current Holland and Belgium. But a part of the border between this new country and Prussia was disputed, more particularly where the ore deposit of La Calamine was situated. The

problem was solved in 1816 by the Treaty of Limits creating the neutral territory of Moresnet (Fig. 3). The history of this small territory of 350 hectares, which lasted from 1816 to 1919 with a lot of privileges, is described by Defourny (2016). There, the Vieille-Montagne society, which exploited the La Calamine deposit, had a very important social role (see also Ladeuze *et al.*, 1991 for an historical account of the role of the Vieille-Montagne in Eastern Belgium).



Fig. 2. — Engravings from Adolphe Maugendre, around 1850. La Calamine (Moresnet) deposit. General view of the processing plant (above) and of the north side of the open-pit exploitation (below). Source : Museum Vieille-Montagne (formerly Göhlthal Museum), La Calamine, photo Léon Dejonghe. Reproduced from Ladeuze *et al.* (1991).

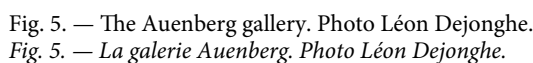
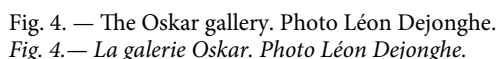
Fig. 2. — Gravures dues à Adolphe Maugendre, vers 1850. Gisement de La Calamine (Moresnet). Partie supérieure : vue générale de l'usine de traitement. Partie inférieure : Gîte nord de la mine à ciel-ouvert. Source : Musée de la Vieille Montagne (anciennement, Musée de la Gueule) à La Calamine, photo Léon Dejonghe. Reproduit de Ladeuze *et al.* (1991).



Dates of closure and productions of the three main ore deposits are shown in Table 1. More details on the periods of exploitation of the various Pb-Zn deposit of Eastern Belgium are given by Dejonghe & Jans (1983, fig. 1) and by Dejonghe *et al.* (1993).

Table 1. — Features of the main ore deposits (figures of Zn and Pb productions are in tons of metals).
 Tableau 1. — Caractéristiques des principaux gisements (les chiffres des productions de Zn et de Pb sont exprimés en tonnes de métaux).

former mining exploitations have nearly completely disappeared from the landscape in this area. Some vestiges (ruins) of the former mining surface buildings still exist at Schmalgraf, the deepest metal mine in Belgium (290 m) employing up to 120 miners. The ore extracted from Schmalgraf was sent by railway to the processing plant of La Calamine. This railway situated in the Hohn valley following the river Hohn (Hohnbach also named Lontzenerbach, a tributary of the Gueule river) is at present a touristic path. The Oskar gallery, of 500 m long, connected the Schmalgraf underground mine to the Hohn valley to evacuate waters pumped in the mine. This gallery, also known under various names (e.g., Max Stollen gallery), was dug between 1862 and 1867 starting from the mine level of -42 m. Today, the exit of this gallery is still visible (Fig. 4) and preserved to facilitate access to the bats. The exit of another gallery, the Auenberg gallery (Fig. 5), is also kept for the same purposes.



Calaminarian grasslands are environments where the process of seral succession has been halted due to the toxicity

of soils containing high levels of toxic metal ions. They can have three origins: (1) Natural primary sites directly above iron caps deposits; (2) Secondary sites where mining, ore processing, storage, manufacture of finished products and landfill of waste lead to the formation of calaminar waste dumps; (3) Tertiary sites related to the emission and atmospheric dispersion of metallic particles and acid fumes.

In Belgium, calaminarian grasslands are the most visible remnants of past Pb-Zn mining operations, sheltering an anomalous metallophyte flora (Fig. 6). These are plants which need zinc to grow and are only found where soils contain a high zinc content (e.g. above zinciferous gossans or in polluted soils by storage of extracted ore and by residues around processing plants). Pseudometallophytes are plants which grow as well on metalliferous soils than elsewhere. For more details on these plants appearing in Eastern Belgium, see Rosengarten (2010) and Hermanns (2014).



Fig. 6. — Calaminarian grassland with *Viola calaminaria*. Photo Léon Dejonghe.

Fig. 6. — Pelouses calaminaires à *Viola Calaminaria*. Photo Léon Dejonghe.

Six metallophytes and several pseudometallophytes are identified in Eastern Belgium (Table 2).

The literature provides information on the presence of calaminarian grasslands in Belgian areas characterized by former lead-zinc exploitations in the Meuse, Vesdre, Ourthe and Gueule valleys. An inventory of calaminarian sites in the Walloon region was carried out by Graitson (2006). Thirty-seven sites were studied in the field. For each site, Graitson (2006), lists the detected metallophytes. But he remarks that, within their ranges, the distribution of metallophytes is increasingly fragmented by the destruction of their habitats. One can observe the typical and complete assembly of metallophytes in Wallonia no more than on 3 sites. That is why he advocates that measures allow the maintenance of these environments in a state of conservation favourable to long term.

The calaminarian grasslands already existed before any human activity because Zn-Pb veins capped by zinciferous gossans already outcropped in the Pleistocene. But the level of pollution by Pb and Zn dramatically increased during the industrial period around the surface mine sites and the ore processing plants, creating new calaminarian grasslands. Since, most of these have disappeared because they were removed to recover the ground for other purposes. Those which still exist constitute remarkable ecosystems which are now the subject of particular protection through the actions listed below (after Rosengarten, 2010, p. 8).

✧ CORINE: Inventory of major important sites for the conservation of nature in the European community;

✧ ISIWAL: Inventory of Walloon sites of great biological concern;

✧ SGIB: Sites of great biological concern;

Latin name	English name	French name
Metallophytes		
<i>Viola calaminaria</i> (Fig. 6)	Zinc violet	Pensée calaminaire
<i>Armeria maritima</i> subsp. <i>Halleri</i>	Thrift	Gazon d'Olympe calaminaire
<i>Thlaspi caerulescens</i> subsp. <i>Calaminare</i>	Alpine pennycress	Tabouret calaminaire
<i>Silene vulgaris</i> subsp. <i>humilis</i> var. <i>humilis</i>	Bladder campion	Silène calaminaire
<i>Minuartia verna</i> var. <i>hercynia</i>	Spring sandwort or "Leadwort" locally used in Derbyshire	Alsine calaminaire
<i>Festuca ovina</i> subsp. <i>Guestfalcia</i>	Sheep's fescue	Fétuque de Westphalie
Pseudometallophytes		
<i>Rumex acetosa</i>	Sorrel	Oseille sauvage
<i>Campanula rotundifolia</i>	Harebell	Campanule à feuilles rondes
etc.		

Table 2. — Metallophytes and pseudometallophytes identified in Eastern Belgium.

Tableau 2. — Métallophytes et pseudométallophytes identifiés dans l'Est de la Belgique.

- ✧ ZHIB: Humid zones of biological concern;
- ✧ Natura 2000;
- ✧ Natural reserves under the impetus of the ASBL (non-profit organisation) Ardenne & Gaume.

Since 1995, the Koul calaminarian grassland at La Calamine has enjoyed official protection status to preserve its exceptional historical significance. See also the issue published by Ardenne & Gaume in 2011 and devoted exclusively to the calaminarian grasslands. In the Netherlands, close to the Belgian border, in the Gueule valley, calaminarian grasslands also occur. They are due to an ancient pollution of the soils related to the Belgian mining activities of lead-zinc deposits. But according to Willems (2004), calaminarian grassland with *Viola calaminaria*, which undergoes a sharp decline, occupies less than half a hectare.

BIBLIOGRAPHIE

- ARDENNE & GAUME (2011). – Les pelouse calaminaires. *Parcs & Réserves*, **66** (3) : 31 p.
- BONI M., DEJONGHE L., BALASSONE G., COPPOLA V. & GIL A.H. (2007). – State of the art on the “calamine”-type zinc deposits of Belgium. *Geologica Belgica*, **10** (3-4) : 141-144.
- COPPOLA V., BONI M., GILG H.A., BALASSONE G. & DEJONGHE L. (2008). – The “calamine” nonsulfide Zn-Pb deposits of Belgium: Petrographical, mineralogical and geochemical characterization. *Ore Geology Reviews*, **33** : 187-210.
- DEFOURNY O. (2016). – Moresnet neutre, deux cents ans plus tard. *Contrepoints, Histoire*. World Wide Web : www.contrepoints.org/2016/06/26/258204-moresnet-neutre-deux-cents-ans-plus-tard.
- DEJONGHE L. (1998). – Zinc-lead deposits of Belgium. *Ore Geology Reviews*, **12** : 329-354.
- DEJONGHE L. & JANS D. (1983). – Les gisements plombo-zincifères de l'Est de la Belgique. *Chronique de la Recherche minière, BRGM, Orléans*, **470** : 3-24.
- DEJONGHE L., LADEUZE F. & JANS D. (1993). – Atlas des gisements plombo-zincifères du Synclinorium de Verviers (Est de la Belgique). *Mémoire pour servir à l'Explication des Cartes géologiques et minières de la Belgique*, **33** : 483 p.

CONCLUSION

This paper illustrates one aspect of the post-mine context in the case of lead-zinc mines in Eastern Belgium. With the exception of calaminarian grasslands, the trace of these former mining exploitations has almost completely disappeared. These calaminarian grasslands are remarkable ecosystems regarded as of principal importance for biodiversity conservation. Therefore, they deserve special attention and protection measures due to their unique historical significance.

Acknowledgements

I am grateful to Prof. Nathalie Verbruggen (Free University Brussels) for assisting with the English translation of the metallophytes and pseudometallophytes and to Michiel Duser (Geological Survey of Belgium) and Didier Torz (Editor-in-chief, Société géologique du Nord) for constructive comments about the manuscript.

- GRAITSON, E. (2006). Inventaire et caractérisation des sites calaminaires en région wallonne. *Natura Mosa*, **58** [2005] : 83-124.
- HERMANN J.-F. (2014). – Chapitre 3 : Le site calaminier de Plombières, un écosystème dans un environnement. In : SIMONS M. éd., Plom'hier a bonnes mines. *ASBL Espace Culture-Plombières* : 67-82.
- LADEUZE F., DEJONGHE L. & PAUQUET F. (1991). – La Vieille-Montagne, l'exploitation minière et la métallurgie du zinc dans l'ancien duché de Limbourg. *Bulletin trimestriel du Crédit communal*, **178** : 15-34.
- POLROT F. (2014). – Chapitre 2 : Le Bleyberg : extraction et transformation des minerais de plomb et de zinc à Plombières. In : SIMONS M. éd., Plom'hier a bonnes mines. *ASBL Espace Culture-Plombières* : 21-65.
- ROSENGARTEN D. (2010). – Les milieux calaminaires, la biodiversité au service du patrimoine. *L'étable, revue trimestrielle de la Société royale Cercles des Naturalistes de Belgique*, **2^e trimestre 2010** : 2-13.
- WILLEMS, J.H. (2004). – Hoe is het eigenlijk met onze zinkflora gesteld ? *Natuurhist. Maandblad*, **93** : 21-25.

RÉSUMÉ TOUT PUBLIC

L'ANCIEN DISTRICT PLOMBO-ZINCIFÈRE DE L'EST DE LA BELGIQUE ET LES PELOUSES CALAMINAIRES APRÈS LA FIN DES EXPLOITATIONS

Dans l'Est de la Belgique, les gisements plombo-zincifères ont été intensivement exploités, principalement au cours du XIX^e siècle, avec une apogée entre 1850 et 1870. La dernière mine métallique (Roer) a été fermée en 1936. La plus grande partie des gisements consistait en filons localisés dans des fractures transversales aux plissements et aux failles. Ces fractures, en relation avec la tectonique du graben du Rhin, recoupaient généralement les formations sédimentaires carbonatées du Dévonien et du Dinantien et, par endroits, également les formations détritiques du Famennien et du Namurien. En outre, dans beaucoup de cas, des amas étaient localisés à des contacts lithostratigraphiques et tectoniques entre des roches (formations) de natures différentes. Certains amas étaient localisés à la discordance entre le Paléozoïque et le Mésozoïque et résultaient du remaniement à courte distance de gisements préexistants, probablement dans des pièges karstiques. La région située entre Liège et Aix-la-Chapelle a produit environ 1 260 000 tonnes de zinc-métal et 133 000 tonnes de plomb-métal. Le plus grand gisement, celui de La Calamine, a livré un total d'environ 760 000 tonnes de zinc-métal sur toute la durée de son exploitation, sa production dépassant celle de tous les autres gisements réunis. Il présentait la forme d'un énorme corps lenticulaire de 450 à 500 m de long, 65 à 100 m de large et fut exploité jusqu'à 110 m de profondeur. Sa genèse est conditionnée par des processus de concentrations karstiques. Épuisé en 1879, il a contribué à faire de cette région un des districts miniers les plus importants au Moyen-Âge jusqu'à l'aube de la révolution industrielle. Cette conjoncture est illustrée par des peintures de Bastiné de 1841 (Fig. 1) et de Maugendre vers 1850 (Fig. 2). Le gisement de La Calamine, aussi connu sous d'autres noms (gisement de la Vieille-Montagne, de l'Altenberg, de la Grande-Montagne ou de Moresnet) a suscité des tensions politiques. En effet, en 1815, le Congrès de Vienne a instauré le royaume des Pays-Bas qui regroupait les territoires actuels de la Hollande et de la Belgique. Mais une partie de la frontière de ce nouvel état avec la Prusse a engendré un conflit car cette région où était situé le gisement de La Calamine était revendiquée par les deux états. Le problème a été résolu en 1816 par le Traité des Limites qui instaura le territoire neutre de Moresnet (Fig. 3). Ce petit territoire de 350 hectares subsista de 1816 à 1919, soit pendant plus de cent ans, en bénéficiant de toute une série de privilèges. La société Vieille-Montagne qui exploitait le gisement de La Calamine y a joué un rôle social d'avant-garde. Après la fermeture des mines métalliques, aucune attention particulière n'a été accordée à leur héritage géologique et minier. Aujourd'hui, toute trace de cette ancienne activité industrielle a presque complètement disparu si on excepte quelques ruines sur l'ancien site de Schmalgraf, la mine métallique la plus profonde (290 m) de Belgique qui employa jusqu'à 120 mineurs et les orifices d'anciennes galeries d'exhaure (galerie Oskar, Fig. 4 et galerie Auenberg, Fig. 5). Les pelouses calaminaires sont les témoins les plus visibles des anciennes exploitations. Elles hébergent une flore métallophyte particulière (Fig. 6). Il s'agit de plantes qui ont besoin du zinc pour se développer et qui ne sont connues que là où les sols possèdent de hautes teneurs en zinc. Ces pelouses calaminaires existaient déjà avant toute activité humaine puisque des chapeaux d'oxydation affleuraient au Pléistocène au-dessus des filons plombo-zincifères. Mais le niveau de pollution par le plomb et le zinc a considérablement augmenté pendant la période d'exploitation autour des sites miniers et de traitement des minerais et a engendré de nouvelles pelouses calaminaires. Étant donné les remarquables écosystèmes qu'elles représentent et leur signification historique, elles sont l'objet d'une protection particulière.