Geoheritage in Ardennes (France and Belgium): geology, cultural heritage and landscapes

Gilles Fronteau
GEGENAA (EA3795) Université de Reims Champagne-Ardenne,
2 Esplanade Roland Garros, F-51100 Reims (France) *gilles.fronteau@univ-reims.fr*

Yans Johan
Université de Namur, rue de Bruxelles 61, 5000 Namur (Belgique)
johan.yans@unamur.be

Frédéric Boulvain
Pétrologie sédimentaire, B20, Géologie,
Université de Liège, Sart Tilman, B-4000 Liège (Belgique) *fboulvain@ulg.ac.be*

Eric Goemaere
Geological Survey of Belgium, OD Earth and History of Life,
Royal Belgian Institute of Natural Sciences, 13, Rue Jenner, B-1000 Bruxelles (Belgique)
eric.goemaere@naturalsciences.be

ABSTRACT

The geology of the western part of the Ardenne Massif is renowned by various stratotypical outcrops. But the Ardennes, highlighted with the geoheritage point of view, can show other specific topics. Some of these topics are based on geomaterials: the slates from the Cambrian formations, the ancient mill-stones quarries in lower Devonian sandstones, the red “marbles” and blue or black ornamental limestones from middle and upper Devonian, the fluorine deposits... Others are focused on geomorphological specific sites, linked to local legends. These sites, sometimes already include in the touristic promotion of the Ardennes, can be an excellent entry point to encourage the emergence of a transnational Geopark project in this area.

Introduction

Involving two countries (France and Belgium), the Ardenne Massif shows numerous and famous outcrops from the Paleozoic era (Boulvain and Pingot, 2011), with massive sedimentary rocks (limestones, red and black “marbles”) and low-grade metamorphic rocks (slates and quartzites).

These stones were affected by the Caledonian and/or Variscan orogenies and they outcrop in various steep-sided valleys formed after a recent low uplift. The Ardenne Massif and the Meuse valley were largely described and used in early geological dissertations (Guettard, 1780; d’Omalius d’Halloy, 1809, 1831; Lyell, 1832 etc.]. This massif is also worldwide renowned in the geological community for his Devonian stratotypes: Givetian (Préat *et al.,* 2006), Frasnien (Coen-Aubert and Boulvain, 2006], Famennien (Thorez *et al.,* 2006), and the now obsolete: Gedinian, Burnotian, Couvinian, Waulsortian, Dinantian, Namurian, or for Cambrian period, the local chronostratigraphical units: Devillian, Revinian…).

Lithological changes, tectonic features and hydrography control the landscape and the accessibility to the various materials, extracted from the prehistoric times to current days, giving very specific identities to numerous areas of the Massif.

1. Ardennes: a country of slates

A wide range of coloured slates have been mined in the Ardennes in numerous places (Rimogne, Fumay, Haybes, Deville, Oignies in France, Alle-sur-Semois, Herbeumont, Neufchâteau in Belgium; Martelange and Asselborn in the GreatDuchy of Luxembourg). These underground roofing slate quarries mined from black to blue (Lower Devonian and Middle Cambrian, formerly known as Revinian after the French city of Revin), greyish blue or greyish green, green (Lower Cambrian formerly called Devillian after the French city of Deville) or red, wine-coloured or violet slates from the Fumay-Haybes area (Devillian). Red-purplish slates are due to the occurrence of finely disseminated grains of hematite, the organic carbonaceous matter stains the slate in black, until green colours are due to chlorite/pyrite/magnetite crystals, linked to a metamorphism in the greenschist facies in the southern part of the Rocroi Inlier.

Beside building stones and roofing slates, slates from the Ardennes were used to make funeral crosses, tombstones and more later used as writing plates,

blackboards, billiard tables... The « Maison de l'Ardoise de Rimogne » in France, the « Domaine de la Morepire » (Bertix, Belgium) and the Slate Museum Haut-Martelange (GDLux) allow the visitors to discover the world of slate (extraction, transformation, quarrymen working conditions...).

The last slate quarry which is still in operation is located in Warnifontaine (Belgium), while the « Ardoisière d'Alle » (Vresse-sur-Semois, Belgium) reuses the old heaps for building stones.

2. Ancient millstones quarries in sandstones and conglomerates

The first Lower Devonian sediments deposited on the Caledonian substrate are conglomerates, interpreted as continental alluvial fans (Meilliez, 2006]. The first marine sediments are littoral sandstones/quartzites or shales/slates (Goemaere and Dejonghe, 2005]. They are younger along the northern border of the Dinant Syncline (Praguian) than along its southern border, reflecting the progression of the Lower Devonian marine transgression. The Emsian shows a marked regressive trend: alluvio-littoral environments prograded southward at the expense of marine facies. The most spectacular unit is the deltaic Burnot formation (Upper Emsian-Eifelian), which includes several hundreds of meters of red conglomerates, sandstones and siltstones.

These various detrital formations were locally quarried for building stones and also for millstones. Huge protohistorical and roman millstone quarries in Lochkovian conglomerates and sandstones from Macquenoise, near the French-Belgian border, are quite well known, even if no recent archeological excavations allow to precise the datation of the quarrying. Antique and modern millstones quarries are also observed near Vielsalm (Belgium) and Haybes (France). Some others gallic and roman quarries are suspected near Namur, in the Burnot formation.

3. The grey, blue and black limestones

The black limestones are mined for more than two thousand years in Wallonia (Belgium) and France, for building and furniture materials. These are named "marbles" although they are not geologically true marbles. The black marbles have been used during the Roman times, the Middle Ages, the XIXth and XXth centuries. The high quality of this stone is related to the purity and homogeneity of its matrix. The black color is associated to the relatively high

content of organic matter. We should consider dealing with various black marbles, mined in several localities of the Northern part of the Ardennes: e.g., Salet and Denée in the Dinant area, Theux (Liège area), Golzinne – Mazy (Gembloux area), Basècles (Tournai area) in Belgium, and in the Bavay area (France). The geological, rheological and visual characteristics of the various marbles are different and do justify the appellation of marbles. Some of them have original names, such as "Poil d'herbe", "Fleuri", "Noirs à Amandes" in French, or "coperlagerstenen" in Flemish (Groessens 1997), suggesting various forms and petrofabrics. Frasnian (Devonian) or Visean (Carboniferous) in age, the black marbles are recognized in many places, such as the Bavay Forum, the graves of Dinant, the grave of Philippe le Hardy in Dijon, the castle of Versailles, and in numerous churches in Belgium and France (Groessens, 1997; 2002).

4. The red-"marbles"

During the Frasnian, the southern border of the Dinant Syncline shows three stratigraphic levels bearing carbonate mounds. In the Philippeville Anticline, only the upper level contains mounds (from Petit-Mont Member) which were quarried for ornamental stones since Romans time. Among the various Palaeozoic carbonate mounds known throughout the world, the Frasnian Petit-Mont carbonate mounds of Belgium are probably the earliest studied. This remarkable interest carried by generations of geologists derives from the number and quality of outcrop: 69 carbonate mounds are known and the majority was actively quarried.

The Petit-Mont mounds are 30 to 80 m thick and 100 to 150 m in diameter. They are embedded in shale and nodular shale. Five facies were recognized in the buildups, each characterized by a specific range of textures and assemblage of organisms (Boulvain, 2007). Sedimentological evidence suggests that the deepest facies correspond to iron bacteria-sponge-dominated communities, developing in a quiet aphotic and hypoxic environment (this facies corresponds to the commercial names "griotte fleurie", "Impérial"). Next facies, rich in corals and crinoids developed between the storm wave base and the fairweather wave base, in an oligophotic environment ("Royal rosé", "Byzantin"). The shallower facies, with stromatolitic coatings and thrombolitic bushes developed close to the fair-weather wave base ("Gris", "Gris des Ardennes"). The red pigment is derived from microaerophilic iron bacteria (Boulvain *et al.,* 2001).

5. The fluorine deposits

In rare places in both the French and the Belgian Ardennes, significant amounts of fluorite are associated with silicified Devonian limestones and Dinantian limestones belonging to different structural and geographical units. Veins and pockets of massive fluorite occur in Givetian-Frasnian carbonates from the natural region called 'La Calestienne'. Topographically, this forms a 'narrow' hilly limestone band, which occurs between the shally FagneFamenne depression to the north and the siliciclastic Lower Devonian terrains to the south. Massive fluorite is restricted to the Givet area (Doische, Foisches, Gimnée, Rancennes) and the Rochefort area (Han-sur-Lesse, Ave-et-Auffe). In the Givet area, on both sides of the Franco-Belgian border, fluorite occurs in the partly silicified fossiliferous limestones of the Fromelennes Formation (Givetian). Purple fluorite dominates over white, green and blue colors. Fluorite was mined in small, open pits and short galleries for a short time during the 20th century but only limited volumes of these minerals (hundreds of tons) were extracted. In these places, Givetian limestone of the Fromelennes Formation forms topographic highs and fluorite can still be sampled from the outcropping limestones and old waste heaps. Worked (polished, cleaved or bored) and fragments of violet, purple and greenish fluorites have been found at several archaeological sites in Belgium dating to both the Upper Paleolithic (e.g. Spy, Chaleux and Trou Magrite Belgian caves) and Neolithic (e.g. Spienne, Thieusies, Spiere Belgian sites and Carvin, Lauwin-Planque… in the North France sites) as well as one bead at the Bronze Age site of Mol. An archaeometric study conducted by Goemaere *et al.* (2013) shows a single geological and geographical origin for the Magdalenian archaeological material: the silicified Givetian limestones of the Calestian Band near Givet (France). The research regarding the fluorite found in the Neolithic sites is always in progress but another source will be proposed.

6. Geomorphological or anthropical specific forms linked to local legends

The quartzitic sandstones of the Deville Group characterize the Lower Cambrian. These light-colored, massive sandstones are interbedded with soft schists. Overlooking the Meuse Valley near Bogny-sur-Meuse and Monthermé (France), they form indentation in the plateau ridge and in the crest between the Meuse meanders. The more famous geomorphological form induced is called the "4 Fils Aymon" – the 4 Aymon's sons - from a medieval epic tradition.

Near Monthermé, in the Semois valley, quartzite formed a ruins-like landscape, called "Roc-la-Tour", which correspond, again from a local legend, to the ruins of a castle, built by devil minions, but collapsed before his completion.

Some other places, in the Ardenne Massif and its borders, are called "PasBayard" and were supposed to be big horseshoe marks or breaches opened by the horse himself. Bayard was the name of the magical horse, which allow to the four Aymon's sons to escape to the Charlemagne soldiers all along the Ardennes. Near Hirson, the Pas-Bayard site is a part of a large quarry in Lower Devonian sandstones near Macquenoise and Milourd millstone quarries. Near Hargnies, the Pas-Bayard is more reduced and corresponds to an unfinished medieval -or modern- millstone, with a horseshoe shape broken eye.

Numerous other legends of the Ardennes are strongly linked to geological or geomorphological features: Devil's stones, Meuse ladies, bloody springs… and they are a practical and effective means for promoting the local geoheritage to the public.

Conclusion

The French Ardennes were focused on social and industrial problems, but nowadays local communities and regional natural reserves look toward a better understanding and promotion of their rich cultural and natural heritages. The Belgian valorization of the Ardenne geoheritage is far more developed (see for example Verheyden *et al*., this volume and Dupuis *et al*, this volume) and they will be precious for further transnational synergic projects.

With a rich internationally renowned geoheritage, strongly linked to cultural or industrial heritages, local myths and legends, the Ardenne massif plateaus and valleys hold important and attractive geosites.

The objective is now to federate the various local initiatives and/or projects and to promote the geoheritage theme in one or some places in the Ardenne Massif, in order to encourage the emergence of a common, and if possible, transnational project.

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