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The Dala (Älvdalen) porphyries from Sweden

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(Received September 1, 2014; Revised accepted October 22, 2014)

The commercial stone industry in Älvdalen, northwest of Stockholm, started in the second half of the 18th century as a social need. The region had been plagued by severe famine and there was an urgent need for additional wealth-generating industry. At that time it was already known that the porphyry in the area was similar to the "porfido rosso antico" from Egypt which had played an important role in the Roman culture. Many ups and downs followed. During one period in the 19th century, the Swedish Royal family owned the industry. At the same time, several "porphyry" objects were presented to different courts around Europe (e.g. a 4 metre tall vase to the Russian czar, although of a more granitic variety). Otherwise most products have been smaller objects like urns, vases, candelabras, etc. The very hard Stone (with variable red or black colours) can be highly polished.

Many of the porphyry varieties were sourced from glacial boulders. These had been "mechanically tested" by nature and were free from joints which otherwise was a problem in the associated quarries.

Comagmatic granites also occur. The porphyries and granites have an age around 1700 Ma, and the former are amazingly well preserved with magnificent volcanic textures.

The porphyries and granites occupy a vast area and are in part covered with red, continental sandstones, which are quarried to-day.

In the middle of the 20th century, the ignimbritic character of the porphyry was discovered. Previously, the flattened "fiamme" (collapsed pumice) had been interpreted as some kind of flow structure in lava. The porphyry manufacturing plants in Älvdalen are a part of the Swedish industrial history. Over a significant historical period the porphyry-works produced good

handicrafts that catered for the poor as well as providing items of extravagant luxury.

Today a porphyry museum exists in Älvdalen. A few handicraft workers are active, and the abandoned old porphyry plants are open to visitors.

Introduction

The commercial stone industry in Älvdalen, about 350 km northwest of Stockholm, commenced in the second half of the 18th century as a consequence of social need. A severe climate, in addition to an increasing population, produced great strain on society. The region had been plagued by severe famine. When crops failed, people were starving and many died. There was an urgent need for additional wealth-generating industry.

At that time it was already known that the porphyry in the area was similar to the "porfido rosso antico" from Egypt that had played an important role in the culture of ancient Rome where porphyry was a symbol of power. Later, during the Renaissance, a renewed interest in the material took place and many old objects were reused. The shortage of good quality porphyry led to the idea that the porphyries in the region of Älvdalen were a valuable natural resource. Some Swedish 18th century scientists like Linneus, Cronstedt and Gahn, honoured later with the mineral names linnaeite, cronstedtite and gahnite, were involved in the investigations prior to establishment of the industry. Private entrepreneurs, with support from the King, ultimately launched an industry in 1788. King Gustaf III made a journey to Italy in 1783 where he visited the stone industry in Florence. Most likely this visit inspired him to support the establishment of porphyry manufacturing operations.

History of porphyry

The word "porphyry" derives from the Greek πορφύρεος and means "purple". In ancient times the stone was much sought after. The oldest porphyry quarries were to be found in Egypt near the Red Sea (Maxfield and Peacock, 2001). Cleopatra of Egypt, the Emperor of Rome, the Popes of the Middle Ages, the Medici of Florence, Cardinals Richelieu and Mazarin, Napoleon and many more famous figures surrounded themselves with beautiful objects made of porphyry, where the colour of the material, purple, would give an extra stress to mark the importance of the owner. The traditional royal

colour used to be blue, but Cleopatra changed the symbolic colour to red and had the walls of her banqueting hall in Alexandria adorned in porphyry. Roman Emperors continued the use of the red stone. Bathtubs of porphyry were popular. In the Eastern Roman (Byzantine) Empire the material was especially used to mark the importance of the Emperor. In the palace of Constantinople a special childbirth delivery-room was designed for the Empress where the walls and floors were covered in porphyry. A prince born in this room was bestowed with the extra title "born to the purple".

The ancient mining of porphyry was concentrated on the Egyptian quarries, active from 20AD to 400AD. During the Middle Ages, the importation of porphyry to Europe was discontinued and alternatives had to be found leading to reuse of the existing material. Since the fashion was to bury ecclesiastical princes in sarcophagi of porphyry, a great number of Roman bathtubs were rebuilt and elevated to the new status of papal sarcophagi. The King of the Ostrogoths, Theodoric

the Great, was also entombed in a porphyry bathtub. There are occurrences of porphyry in several places in Western Europe, but in the Älvdalen area in Sweden the porphyries display an unusually great variation in colour, texture, phenocryst size and content, which makes them favourable for use as ornamental stone.

The Swedish porphyry occurrences were discovered in the 1730s by a vicar in Älvdalen, but half a century was to pass before the working of porphyry objects was in progress. The Swedish counsellor of the realm formed, together with ten other men, a company for the working of porphyry. A huge grinding house (Figure 1), driven by water power, was constructed in 1796-97. It greatly facilitated the subsequent production. The first foreign agent was established in Hamburg, Germany, but it was soon followed by representatives in London, Paris and Vienna. A catalogue from Paris, 1805, (Sundblom et al, 1985) shows a variety of objects for sale. In France, there was also cooperation with skilful workers for bronze decorations. In

Figure 1. Sketch of the porphyry grinding house, built 1796-97, driven by water power. Destroyed by fire in 1867 (Lagerqvist and Åberg, 1984).

general, France was a good market, and Swedish porphyry objects can still be seen in French museums and homes.

Economic fluctuations were a feature of the porphyry enterprise. At the beginning of the 19th century, Napoleon's general Bernadotte became King of Sweden under the name Karl XIV Johan. The Swedish Royal family owned the porphyry-works between 1818 and 1856 and it used porphyry items as gifts to various international luminaries. During this period, Sweden was economically poor and roads, bridges etc., were of inferior quality. Thus transportation of the larger manufactured porphyry objects created major challenges (see below).

Even though the Napoleonic wars curtailed activities between Sweden and France, the porphyry business soon recommenced after the wars. Much later in 1867, a severe fire destroyed the major grinding house and resulted in closure of the initial industrial enterprise. Soon after, it was reopened but never recovered its initial capacity.

Today a porphyry museum has been established in Älvdalen. A few handicraft workers are active, and the abandoned porphyry manufacturing plants are open to visitors. (<http://www.geonord.org/shows/porph.html>)

Geology

Figure 2 shows the location of Dala porphyry production area, where Dala volcanites occupy an area approximately 5000–6000 km² in size (Figure 3). These rocks are also present below a cover of continental sandstone (Dala Sandstone) to an unknown extent. They were subdivided into porphyries and porphyrites by Hjelmqvist (1966) where the former are mainly ignimbrites and the latter mainly lavas ranging from basalt to dacite in composition (Nyström 2004). The lavas have had limited interest for the stone industry. The continuation in Norway is known as the "Trysil porphyries" (Wolff *et al.*, 1995).

Figure 2. Map showing the location of Dala Porphyry production area.

Figure 3. Bedrock map (Bergman *et al.* 2014). The porphyries are shown with dark yellow colour, the covering continental sandstones in pale violet colour, dolerites in dark violet, and granites in red.

In Sweden "porphyry" is the traditional rock name for well preserved (very low or low grade) felsic, porphyritic volcanic rocks and some dike rocks occurring at Älvdalen and other parts of the country. This name has earlier been widely used by geologists, but it is now often replaced by "rhyolite", "trachyte" etc., according to modern international rules. However, since the name "porphyry" (*porfyr* in Swedish) is deeply rooted in common language in Sweden, largely because of the famous objects made at the porphyry works of Älvdalen, we think it is appropriate to use it in the context of this paper.

The ignimbritic character (Figure 4) of the porphyries was described by Hjelmqvist (1956, 1966, 1982) and Lundqvist (1968), and a general overview was given by Nyström (2004). Some of the porphyries (see for instance the Kåtilla porphyries, Figure 5) are closely associated to high-level granite intrusions and display textural similarities with a porphyritic granite called the Garberg granite. This

Figure 4: Microphoto of ignimbritic, rhyolitic Dala Porphyry (Rännås Porphyry) showing well preserved glass-shard texture and more coarse-grained ignimbrite flames. Rännåsarna, 12 km north-northeast of Älvdalen. Photo by Thomas Lundqvist.

has been manufactured under the name "granitell". The Garberg granite has many chemical similarities with rapakivi granites, including its high content of fluorine (Lundqvist and Persson 1999). Radiometric dating (U–Pb on zircon) of both porphyries and granites (e.g. Garberg granite) results in dates of around 1700 Ma (Lundqvist and Persson (1999). The metamorphic grade decreases from greenschistfacies at the base of the porphyry complex to prehnite-pumpellyite facies near the top. The burial metamorphic pattern indicates that the original thickness of the deposit was several thousand meters (Lundqvist, 1968; Nyström, 2004).

Boulders and blocks of porphyry from this part of Sweden have been glacially transported for long distances due to their hardness. Both in Sweden and Central Europe, they have acted as tracers for ice movements (Hesemann 1936). Glacial boulders of a green tinguaita, with nepheline, cancrinite and aegirine phenocrysts, also attracted the stone workers early and were sometimes considered as

"porphyry". This tinguaita is considerably younger, 280 Ma, than the true porphyries and have been further described by Lundqvist (1997).

Manufactured objects

The Älvdalen porphyries can take a high polish with a special lustre, but to attain this finish there is a need for time consuming handicraft work. As a result, prices have been very high over the years and the objects have been rated in the luxury category.

Although most of the raw materials have been extracted in bedrock quarries, much porphyry was also sourced from glacial boulders. These had been "mechanically tested" by nature and were free from joints, which otherwise caused problems in the quarries.

Large objects, like the 4 meter tall vase presented by the Swedish King Karl XIV Johan to the Russian Czar and the large sarcophagus for this king, were manufactured from the Garberg granite. This granite is more suitable for large objects because it has a lower frequency of fissures than the porphyries.

Special products included mosaic tables, often with many different porphyry varieties.

As mentioned above, the Swedish king Karl XIV Johan commenced giving porphyry gifts to prominent persons. The Royal Court continued with this custom, at least until the 1920s when the King of Siam (modern Thailand) was presented with a porphyry vase.

A list of known porphyry gifts noted from published sources, mainly Lagerqvist and Åberg (1989) follows. Large objects, manufactured from "granitell", are listed:

- 1838. Four meters tall vase presented to the Russian Czar Nikolaus I, installed in in the garden of the Summer Palace in St. Petersburg.
- Large urn installed outside the small pavilion of Rosendal in Djurgarden in Stockholm (Figure 6).
- Sarcophagus of Karl XIV Johan.
- 1822: two large vases presented to King George IV of the United Kingdom.
- 1837: a large vase presented to King Maximilian of Bavaria.

Figure 5: Different varieties of Swedish porphyries used in industry. From left to right and from top to bottom: Garberg granite, Blyberg porphyry with ignimbritic "flames", the most commonly used variety, Rännås porphyry, Kåtilla porphyry, Dysberg porphyry, Kåtilla porphyry, Rämna porphyry and Bredvad porphyry. Photos by J.-O. Svedlund.

Figures 6-8. (6) Large vase made from “granitell” between 1815 and 1825, Rosendal Castle, Stockholm. Photo from Bukowskis auctions. (7) Gilded bronze ornamented Dala Porphyry urn. Photo from Bukowskis auctions. (8) Porphyry memorial in honour to Linneus, inside Uppsala Cathedral. Photo by Björn Schouenborg.

- 1851: a large vase presented to Queen Victoria of the United Kingdom from King Oscar I.
- Unspecified porphyry gift presented to the French monarch.
- A number of urns and memorials (Figures 7 and 8).

Conclusion

Sweden's Dala or Älvdalen porphyries have had major decorative and ornamental significance at an international scale for more than 200 years.

They have been utilised in the most prestigious vases, urns, sarcophagi, mosaic tables and other ornamental works especially as gifts from the Swedish monarchy during the early nineteenth century.

Their historic importance continues to be recognised in Sweden today with the establishment of a porphyry museum in the village of Älvdalen, about 350 km northwest of Stockholm and the maintenance of handicraft manufacture.

Dala or Älvdalen porphyries deserve to be considered as a potential “Global Heritage Stone Resource” from Sweden.

Acknowledgements

We thank Jan-Olov Svedlund for supplying us with photos of different porphyry varieties. We also thank the Bukowskis auction firm in Stockholm for the permission to use two photos from their catalogues. Tom Hendal and Benno Kathol provided useful reviews and comments to improve the manuscript. Björn Schouenborg provided the picture from inside Uppsala cathedral. Project 18KBGZ/463AC01, from the University of Salamanca, and ERASMUS Intensive Programme 2012-1-ES1-ERA10-54375 are acknowledged for financial support. This is a contribution of the HSTG.

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