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# Exploring Natural Stone and Building a National Identity. The Geological Exploration of Natural Stone Deposits in the Nordic Countries and the Development of a National-Romantic Architecture

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**Abstract:** In the second half of the 19th century new methods for quarrying and processing natural stone are developed. In the Nordic countries Sweden, Norway and Finland this technological progress goes hand in hand with a systematic geological mapping and large-scale exploitation of natural stone deposits. As a result, new constructions are developed—changing the building practice in these countries. With the end of historicism a new architecture arises that particularly in Norway and Finland acquires a national-romantic character. This paper examines the interaction between geological exploration, commercial development, technical inventions and the development of a national-romantic architecture.

**Keywords:** architecture; 19th century; 20th century; Nordic countries; natural stone; national romanticism; geology

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## 1. Introduction

In the second half of the nineteenth century, the methods for quarrying and processing natural stone are developed further tremendously—parallel to the industrialization of brick production and later the advent of concrete construction. A number of technical innovations, such as the invention of the band saw or the use of power machines and explosives from the 1860s and 1880s onwards respectively, facilitate the hitherto laborious quarrying of natural stone, especially of hard rock varieties ([1], pp. 23–45).

In the Nordic countries Sweden, Norway and Finland this technological progress is accompanied by a systematic geological exploration and later by large-scale commercial exploitation of natural stone deposits. As a result, new constructions are developed that change the practice of building. From this enthusiasm for natural stone a new architectural language detached from historicism evolves. In Sweden it is neutrally labelled as “material realism”—a term coined by the Swedish architectural historian Elias Cornell (1916–2008) and used e.g. for the work of Ragnar Östberg (1866–1945) [2]. While in Norway and Finland it acquires a national-romantic character and is seen as a contribution to an independent cultural identity in the struggle for national independence [3].

This article traces the transition from geological exploration and commercial development of natural stone deposits in the Nordic countries to the application in a national-romantic architecture that emerges as a result. It examines the collaboration between geologists, entrepreneurs, and architects—including the role of the geological services—as well as the interplay between technical inventions and the changes in design and construction practices. This sheds not only a new light on the material origins of national-romantic architecture, but comparing the varying geological and commercial developments also helps to explain the differing architectural manifestations.

## 2. The geological exploration of the Nordic countries and the establishment of a natural stone industry

In the Nordic countries the systematic mapping and development of natural stone deposits begins in Sweden in the middle of the eighteenth century. Norway and Finland lag somewhat behind and Denmark remains sidelined, since it hardly possesses comparable natural stone deposits. In Sweden the range of easy-to-access and easy-to-use rock varieties is quite large, and traditional artisan mining, such as of Silurian limestone in Gotland and Öland, of marble in Kolmården or porphyry in Älvdalen, still exists at this time ([4], pp. 20–52). In addition, Sweden is the scientifically most advanced Nordic country. In 1739 the Royal Swedish Academy of Sciences ('Kungliga Vetenskapsakademien') is established and shortly thereafter the first publications on the country's geology appear. In 1758 the chemist and mineralogist Axel Fredrik Cronstedt (1722–1765) publishes a first comprehensive mineralogy. He approves of sandstone as a building material, but dismisses other types of stone, such as granite or porphyry, as exotic and useless [5]. However, natural stone plays a subordinate role in late 18th-century Swedish architecture. Carl Hårleman's (1700–1753) Övedskloster Manor (1768–1776) near Sjöbo, Skåne, is one of the few prominent examples with pilasters, gables and rusticated basement of red sandstone ([4], pp. 53–56). But Övedskloster comes to literary fame through Selma Lagerlöf's (1858–1940) novel *Nils Holgerssons underbara resa genom Sverige* ('The Wonderful Adventures of Nils', 1906/07).

The impetus for the establishment of a natural stone industry originates from the early 19th century large-scale infrastructure projects. For the construction of the Trollhättan lock (1796–1800) and for the Göta Canal (1810–1832)—part of the enormous waterway from the Swedish east coast to the west coast—a modern limestone quarry is established in Borghamn, east of Lake Vättern. This limestone is also used for two architectural projects: the fortress of Karlsborg (started in 1819), the largest fortification project in Sweden at that time, and the facade of the National Museum in Stockholm (1847–1866) designed by Friedrich August Stüler (1800–1865). In both cases the use of limestone can be attributed to the military engineer Johan af Kleen (1800–1884) ([6], pp. 45). A few years later, granite is quarried on the island of Malmö for the expansion of Carlsten fortress (1834–1851). This quarry is privately operated by the merchant Carl August Kullgren (1793–1851) who even presents the products of this first private quarry in the Crystal Palace at the First World Exhibition 1851 in London ([6], pp. 50–51).

Starting from these first pioneers a blossoming natural stone industry grows until the end of the 19th century. By the end of the century, the number of quarries has risen rapidly, from 18 quarries in 1881 to 229 quarries in 1901—the majority of them are located in the provinces Östergötland, Blekinge and Skåne; similarly, the number of employees rises from 1.319 to 11.646. A key role in this is played by the Geological Service of Sweden ('Sveriges Geologiska Undersökning')—a government agency founded in March 1858 and at the time headed by the Ministry of Trade, Industry and Maritime Affairs, the so-called Civil Department ('Civildepartementet'), today by the Ministry of Economy and Innovation ('Näringsdepartementet'). It systematically explores and maps the country's geology and frequently presents local natural stone suitable for building at trade fairs and exhibitions [4, pp. 60–61]. Machines are initially rather sparingly used for quarrying, and for a long time, traditional artisanal mining methods, i.e. sawing or splitting, are applied. Not least due to these rough and waste-intensive stone-quarrying techniques the stone is for a long time considered unsuitable for architecture. Primarily granite is mined in blocks and paving stones and used for domestic road construction as well as for export to Germany. In the early 1850s, the first steam-driven conveyor belts are installed in Borghamn, and in 1870 Kullgren's company in Malmö introduces the first steam-driven channelling machine invented in the United States in the 1860s. This early phase of the Swedish natural stone industry is summed up in 1871 by August Wilhelm Hoffstedt (1841–1907)—an engineer loosely associated with the Geological Service—in his article "Om svenska stenarters användning inom byggnadskonsten samt deras framställande i ett mera förarbetadt tillstånd" ('On the use of Swedish rock in architecture and the processing of stone') published in *Illustrerad Teknisk Tidning* ('Illustrated Technical News') [7]. And in 1877 he reports in another article in *Teknisk Tidskrift* ('Technical Journal') on the latest steam-powered machines for

natural stone processing, such as band saws, stone saws and stone planers, which he encounters at the 1876 World Exposition in Philadelphia and which are subsequently introduced in Sweden [8].

In Norway the Geological Service of Norway ('Norges geologiske undersøkelse') is established in February 1858—one month earlier than its Swedish counterpart; a government agency originally run by the Ministry of the Interior ('Departementet for det Indre'), today part of the Ministry for Trade, Industry and Fisheries ('Nærings- og fiskeridepartementet'). In Norway, however, the exploitation of natural stone resources starts considerably later than in Sweden, not least because in Norway there are—unlike in Sweden—few remnants left of a medieval natural stone tradition. In 1882 the country's first natural stone company—which still exists today—is founded ('Den Ankerske Marmorforretning'). It mainly quarries marble in the Iddefjord region, to a lesser extent syenite and granite in Drammensfjord; the main market is in both cases Germany ([9], pp. 104–111, 299–302, 330–332). It is not until the last decade of the 19th century that the Norwegian natural stone industry gains momentum—thanks mainly to the geologist Johan Herman Lie Vogt (1858–1932), who promotes the use of modern grinding and polishing machines [10].

The foundation of the natural stone industry in Finland differs in two aspects from that in Sweden and Norway: on the one hand it is limited to the very hard rock types of granite and gneiss—there is hardly any marble or sandstone; on the other hand, does the development originate from Russia. It is the clergyman and amateur mineralogist Samuel Alopæus (1721–1793)—from 1755 dean of the Karelian town Sortavala—, who explores the region's natural stone deposits and in 1765 brings them to attention of Mr. Pilugin, emissary of the Imperial Academy of Arts in St. Petersburg ([11], pp. 15–18; [12], pp. 39–40). As a result, Finnish natural stone deposits are increasingly made use of for buildings in St. Petersburg. Finnish granite is, for example, used for the construction of the Kazan Cathedral (1801–1811), and the typical porphyry-red Finnish granite becomes famous through its use at the Isaac Cathedral (1818–1858) and the Alexander column (1832–1838)—the latter a 47,5 metres high monolith weighing 600 tons, that is quarried in Virolahti near Viborg, transported to St. Petersburg and erected there in 1832 ([13], pp. 17–19). It is comparatively late that a systematic geological mapping of the country begins. In 1885 Tsar Alexander III. (1845–1894) establishes a Finnish Geological Service ('Suomen geologinen tutkimus') that is today part of the Ministry of Labour and Economy. Its work is modelled on the Swedish service and it tries with a series of exhibitions, events and publications to boost the sales of Finnish natural stone ([14]; [15]). The following year, a first private company is founded, which invests in modern stone saws and grinders and which quarries granite at various locations along the coast; the foremen are sent to Sweden, Denmark and later to Scotland for education. Up to the end of the 19th century this first exploitation of the Finnish natural stone deposits does not entail the development of an industry; quarrying and mining is mostly accomplished by simple means and without the use of machines ([12], pp. 39–42).

### 3. Natural stone in architecture

With the growth of a natural stone industry and thanks to the efforts of the Geological Services, natural stone is gradually picked up by architects. Once again, Sweden among the Nordic countries is leading the way.

One of the first architects to use natural stone is Adolf Kjellström (1834–1932), who from 1863 works on the restoration of the medieval Nicolai church in Örebro, a limestone building, and he consequently also builds his own house in 1879 in limestone ([16], p. 145). This house is highlighted by Isak Gustaf Clason (1856–1930)—one of the most prominent Swedish architects of the time—in an overview over contemporary Swedish architecture and it becomes a model for many other subsequent buildings [17].

The most important mediator between natural stone industry and architecture in Sweden is the engineer Hjalmar Lundbohm (1855–1926) who from 1879 onwards works for the Geological Service [18]. In the 1880s he systematically inspects quarries and natural stone companies in Sweden and later travels abroad: in 1888 to England, in 1891 to Scotland and in 1891/1892 to the United States. In numerous lectures and publications he not only reports on natural stone deposits and possibilities of development, but also vigorously promotes the use of natural stone in architecture ([19]; [20]; [21];

[22]; [23]; [24]). Alongside his travel impressions he publishes numerous suggestions for different types of cyclops-, polygonal- as well as ashlar-masonry and he explains how these constructions can be used in the Nordic countries ([25], pp. 109–111). He also engages in the architectural discourse and participates, for example, in the discussions of the Stockholm Group “De Byggande Bröderna” (‘The Building Brothers’), a circle of successful young architects that includes Gustaf Wickman (1858–1916), Ferdinand Boberg (1860–1946), Ludvig Peterson (1853–1931) and the already mentioned Isak Gustaf Clason [26]. Finally, Hjalmar Lundbohm also advises architects on individual projects, such as Herman Holmgren (1842–1914) with the Central Building of Uppsala University (1877–1887) or Ferdinand Boberg and Frans Gustaf Abraham Dahl (1835–1927) with the Central Post Office in Stockholm (1898–1903) ([12], p. 34). Towards the end of the 19th century natural stone, as Hjalmar Lundbohm notes, is firmly established as a facade material in Sweden. However, he regrets that Swedish architects prefer rather colorless native rock varieties and that they use natural stone only for the cladding of brick constructions [27].

In Norway similar things take place with a few years delay: In 1888, the young Norwegian geologist Hans Reusch (1852–1922) takes over the management of the Geological Service of Norway and bases his work on that of Lundbohm’s in Sweden. An important contribution to the breakthrough of natural stone is the 1896 conference “Om huggenstens anvendelse i vor husbyggningskunst” (‘On the use of carved stone in our art of building’) organized by The Norwegian Engineers and Architects Association (‘Den norske ingeniør- og arkitektforening’). On this occasion the Norwegian architect Adolf Schirmer (1850–1930) hopes that the use of sandstone, soapstone, granite, and marble will soon be just as widespread in Norway as in England or Scotland; as an example, he refers to the building of the Trondheim Savings Bank (1879–1882) that already shows signs of a newly emerging national-romanticism ([28]; [29]). After the 1896 meeting, natural stone becomes increasingly popular. In 1904 a commission is founded to promote it; the architect Andreas Bugge (1859–1945), who is appointed chairman, gives a much-lauded lecture published in *Teknisk Ugeblad* (‘Technical Weekly’), in which he not only refers to the experiences in Great Britain, but also to a number of Finnish examples [30]. This commission, led by Bugge, not only propagates natural stone masonry as an everyday way of building, but also actively promotes the development of new constructions; it publishes in *Teknisk Ugeblad* numerous articles on different aspects of natural stone masonry and advertises in particular three types of constructions that are later chosen by many architects and applied in their national-romantic architecture: irregular stonework, a combination of irregular and regular masonry as well as masonry with different layer heights [31].

In Finland, the transition from geological exploration to the breakthrough of natural stone in architecture takes place faster than in any other Nordic country. In 1893 the geologist Jakob Johannes Sederholm (1863–1934) takes over the Geological Service and he hires the engineer Hugo Blankett (1872–1949) to map the country’s granite deposits; he later also travels to Sweden to Lundbohm as well as to Germany, Austria, England and Scotland. Back in Finland, Blankett establishes in 1900 the company Finska Stenindustri (‘Finnish Stone Industry’), which rapidly grows into the country’s largest natural stone producer. To promote sales Blankett invites a number of architects, such as Onni Tarjanne (1864–1946) or Lars Sonck (1870–1956), to become shareholders. Subsequently the light gray granite quarried by Finska Stenindustri is used in a number of prominent new buildings, such as Onni Tarjanne’s Finnish National Theatre (1899–1902) or the Finnish National Museum (1904–1910) by Herman Gesellius (1874–1916), Armas Lindgren (1874–1929) and Eliel Saarinen (1873–1950) ([12], pp. 41–45).

#### 4. Natural stone and national romanticism

In the second half of the nineteenth century a wave of modernization, industrialization and urbanization starts in the Nordic countries, which catapults the backward and rural countries into the industrial age. However, these great upheavals topple the Nordic countries in a profound social and cultural crisis that results from a consciousness of backwardness compared to the countries on the European continent as well as from the insight that a nostalgic nationalism that draws on a mythical past has become obsolete in the industrial age and is no longer sufficient for the



establishment of a cultural identity. In response to this crisis, a national-romantic renewal movement arises, that is fuelled by the arts & crafts movement as well as different artistic and literary reform movements—and drawing on rural traditions as well as progressive social ideas—attempts to establish a new national everyday culture ([3], pp. 19–73).

In architecture this movement finds its expression in the search for a new national monumental architecture that differs decidedly from 19th century historicist styles and instead is derived from models that are regarded as particularly national, traditional or typical for the heyday of the respective country. Popular models are in Norway, for example the Håkons Hall in Bergen (1247–1261), or in Sweden the Vasa-era castles (15th–17th centuries), as well as the numerous medieval churches and cathedrals that are renovated in the late 19th century. The buildings of this national romantic monumental architecture vary considerably from country to country and in terms of historical references, but they are almost universally regarded as monumental sculptures to strengthen national identity. This can above all be seen in the building tasks; they can almost always be called national monuments, such as government buildings or town halls, museums, and churches dedicated to national heroes or national saints ([3], pp. 174–175). In many cases, the reference to national or traditional models finds a continuation in a material iconography, i.e. a building material that is regarded as correspondingly national—in many cases natural stone, in particular granite ([3], pp. 172–173). This refers to the discourse on the origin of historical architectural styles that emerges in the late 18th and early 19th century in the wake of the revival movements on the European continent and that establishes a reference to natural stone ([32], p. 38; cf. [33], pp. 334–336). Hjalmar Lundbohm, for example, refers in 1891 to the 1850 travel report by the German archaeologist Ludwig Ross (1806–1859), who describes how the different forms of cyclopean masonry can be traced back to the type of stone and stone splitting technique used ([25], p. 109). In addition, this ties to a material semantics that has its roots in antiquity and from 1790 onwards gains particular significance on the European continent ([34], pp. 114–120, 166–189). Important influences for equating stone and nation in the Nordic countries are the aforementioned renovations of medieval natural stone buildings ([3], p. 32–48), Julius Langbehn's (1851–1907) book *Rembrandt als Erzieher* (*Rembrandt as Teacher*, 1890) ([35], p. 221; cf. [3], pp. 172–175), in which he designates granite as a Nordic and Germanic stone, as well as the use of natural stone for monuments in contemporary Scottish and American architecture ([12], pp. 50–51).

In Sweden, the use of natural stone for a particular national architectural style is least pronounced, and the equivalency of natural stone and a specific national style most drawn in doubt. In 1886, at the Second Engineering Conference ('Andra Teknologmötet') in Stockholm, plaster architecture is unanimously condemned and natural stone propagated, but this does not imply a demand for a national style ([36], pp. 140–142). For example, Adolf Kjellström argues that material does not necessarily entail a style and he doubts that there can be a uniform Swedish national style: The different climatic conditions and varieties of stone would result in different styles, such as a Nordic sandstone style or a Nordic granite style—very similar to the difference between the sandstone Gothic and the brick Gothic in Germany ([36], pp. 142–143). This attitude can be attributed on the one hand to the great diversity of the regions in Sweden and to the many different types of stone and on the other hand to the fact that late 19th century Swedish historicism is characterized by a variety of different foreign influences. Significantly many Swedish architects aim for pluralistic, regional and material diversity. This can be seen, for instance, in the work of Gustaf Wickman (1858–1916), who uses sandstone from Skåne for the Skånebank building in Stockholm (1897–1900), but for the Örebro Enskilda Bank (1909–1912) marble from nearby Ekeberg—in both cases he chooses rock sorts that correspond to the regional origin of the respective banks and thus demonstrate this materially ([37] p. 53).

In contrast, the debates in Norway and Finland are much more nationally oriented, fostering nationalist cultural currents and actively working towards a Norwegian or Finnish national architecture. In both countries there is a passionate struggle for national rights and an independent cultural identity—in the case of Norway for freedom from the rule of the Swedish king and in the

case of Finland from the Russian Tsar. In Norway this struggle ends in 1905 with the dissolution of the Union with Sweden, in Finland with the fall of the Tsarist Empire in 1917.

In Norway numerous architects, above all the royal antiquarian Herman Major Schirmer (1845–1913), support a new national architecture ([12], pp. 47–50). Henrik Nissen (1848–1915) is one of the first to establish a link between national architecture and natural stone. In 1896 he demands that “every national architecture must of course be constructed from the respective country’s natural materials” ([38], p. 43). But there is no consensus on the question how this national stone architecture should look like, since there are hardly any suitable models for natural stone buildings, apart from a few exceptions such as the Håkons Hall in Bergen or the Cathedral in Trondheim. For this reason, many young Norwegian architects look towards contemporary natural stone architecture in the United Kingdom and the United States—most notably the buildings of Henry Hobson Richardson (1838–1886). In 1900 Hans Jacob Sparre (1861–1937) attempts to describe a Norwegian national architecture independently of historical or contemporary models. He rather prescribes four basic principles to it: First, that it lives up to the country’s harsh climate; second, that it takes the long dark winters and short bright summers into account and is therefore distinctively profiled; third, that it corresponds to the simple and poor cultural tradition, and fourth, that it corresponds to the country’s exceptionally hard and difficult-to-process types of stone [39]. In the years up to the dissolution of Norway’s union with Sweden in 1905 the urge for a national stone architecture continuously grows—there are very few voices that warn of excessive nationalization. Numerous architects like Andreas Bugge promote: “No imported stone on Norwegian soil” [40]. The Association of Young Architects (‘Yngre arkitektforening’) proclaims in 1901—on its ten-year anniversary—that it sees its task in “promoting a style of architecture on a national basis, that is [...] deeply and inextricably rooted in the character of our people and the nature of our country” [41]. Henrik Nissen’s Christiania Sparebank (1896–1901) and Henrik Bull’s (1864–1953) governmental buildings in Oslo (1898–1904) are considered the most prominent examples for this national spirit ([42]; cf. [3], pp. 198–199).

In Finland, the efforts to build a particular national architecture are—similar to Norway—heavily influenced by the building materials available, that is to say, the very hard stones gneiss and in particular granite that is regarded as *the* Finnish material par excellence. This equating of Finland and granite is repeatedly picked up and symbolically exaggerated by the country’s national independence movement; the Finnish-Swedish writer and rector of the University of Helsinki, Zacharias Topelius (1818–1898), for instance, compares the country’s hard stone with the sober and serious character of its people [43]. In the search for a national architecture that meets these requirements, Finnish architects—similar to their Norwegian colleagues—either draw on historical models or on contemporary natural stone architecture in Great Britain and the United States. The choice of models is often a generational question. For example Hugo Lindberg (1863–1932), as a representative of a somewhat older generation, still retains a conventional historicism in his design for the Historical Museum in Helsinki (1899) – despite the use of granite. The Finnish architects of the next generation, such as Lars Sonck (1870–1956) or Eliel Saarinen (1873–1950), build on earlier experiences, but after the turn of the century they invent their own anti-historical and proto-modern national-romanticism that causes quite a sensation ([3], pp. 96–102; [44], pp. 1–20).

Shortly after the turn of the century, it is foreseeable that this national-romantic granite architecture would remain a short episode and would be passé with the Finnish independence; after all, people in Finland hope that they will be able to break away from Russian rule within a few years. As early as 1906, Sigurd Frosterus (1876–1956) writes in his article “Framtidskonst” (“The art of the future”) that quite soon “the national question will be replaced by the social question. [...] National art will be ousted by an art of class struggle that will be characterized by cosmopolitanism” [45].

## 5. Conclusion

In the 19th century the geological exploration and commercial exploitation of natural stone deposits, combined with technological inventions and the changes in building and construction

practice lead to the emergence of a new natural stone architecture in the three Nordic countries of Sweden, Norway and Finland.

The transition from geological exploration and commercial development to architectural application arises from a close collaboration between geologists, entrepreneurs and architects. The development is carried out to a great extent by geologists and the geological services in the respective countries, who are familiar with one another and who maintain a lively exchange. The connections between architects are less significant and more difficult to trace. This is partly due to the different ways of application of natural stone in the respective countries. While Sweden is the leading Nordic country in terms of science and industry, and a thriving natural stone industry first emerges here, natural stone ultimately remains only a means to represent the pluralistic, regional and material diversity of late 19th-century Swedish historicism. In Norway and Finland, on the other hand, local natural stone, and granite in particular, becomes an important feature of national-romantic architecture and plays a significant role in breaking away from historicism.

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