5 Constructing northern Fennoscandia as a mining region

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Introduction

For several hundred years, actors within mining have taken an interest in the northern parts of Fennoscandia. This chapter aims to explain the historical development of this mining industry, with a focus on the period from 1880 to the present and a perspective on the future. Our main questions are: How was the mining industry in the region established, and why? How did the mining industry change over the period, and why? What path dependencies from the past linger on in the present? To what extent do we see differences and similarities in the development of the mining industry in Sweden, Norway, Finland and northwestern Russia, and why?

What is a mine? It is common to debate, when discussing the impacts of planned mining projects, what should be regarded as a mine or part of a mine. Is it the area where extraction takes place, or should it also include transport networks? Typically, mining companies and their critics will have different opinions on the matter. When explaining the historical development of the mining industry, however, regardless of what your opinion about mining may be, it is necessary to adopt a holistic definition of mining. For actors within mining, it has never been enough to be just a mineral body, explosives and machines for extraction. Mining operations are dependent on a much wider range of technical, societal and environmental components to function. Hence, it is motivated to think of them as large socio-technical systems made up of not only technical components but also environmental and social elements such as people, organizations and institutions. In order to do so we will use the conceptual framework of large technical systems (LTS) theory, developed within the field of history of technology (Hughes 1983; Hecht 2004; Kaijser 1999; Summerton 1998). LTS was introduced in order to move away from an artefact- and inventor-oriented research tradition within the history of technology and industry, which paid too little attention to the relation between technology and society when explaining the introduction of new technologies. Technology is made up of systems of interlinked artefacts and societal components which should be understood as socio-technical systems. The historian Staffan Hansson applied this approach to understand the establishment of the iron ore mines

in the county of Norrbotten in northernmost Sweden, calling them "megasystems" in order to capture their magnitude (Hansson 1998, 1994). Following in the footsteps of Hansson, we apply this approach to the entire Fennoscandinavian north in this chapter.

Thus the rationale for using LTS to explain the development of mining in northern Fennoscandia is because it allows for a holistic understanding of the industry, capturing both its technological and social components. Moreover, the LTS approach allow us to gain insights on the path dependencies the industry has generated over the centuries.

What, then, is a large socio-technological system for mining made of? To begin with, it consists of interconnected technological artefacts: mines with drilling machines, explosives, excavators, transport vehicles, conveyer belts and so forth. Down the production line there are ore crushers, concentration plants, pellets factories, waste rock piles, tailing ponds and on-site networks for transports. Mining operations consume large amounts of energy. Therefore, beyond the mines there will be systems for energy production: power plants (e.g. coal, hydro), transmission lines, transformers. There must also be transport infrastructures with the capacity to transport ore concentrates to global markets and for bringing supplies to the mines: railways, roads, harbour facilities, ships. The social components consist of a wide variety of actors: organizations such as prospecting and mining companies, contractor firms, and governing bodies involved in the permission-granting process for mining on different levels. There are also the employees working in the different parts of the system: workers, foremen, managers and researchers, to name a few. Such employees live in settlements (permanent or temporary) with housing, services and associated infrastructures. A crucial part of the systems are also the institutional frameworks for mining, consisting of formal rules (laws and regulations) and informal rules (norms and values) which steer the range of allowed actions, the ownership structures and organization forms.

When studying the history of large-scale socio-technical systems, a common methodology is to follow the system builders (i.e. leading state and corporate actors). Their development of the systems can be understood as divided into phases: an *innovation phase* involving, for instance, planning, prospecting and technology development; followed by an *expansion* phase of building the system; and finally a *momentum* phase. This last phase is reached when the sheer size of the systems makes them difficult to abandon because of the investments made in them, the amount of people working with them, the number of other systems linked to them and thereby the level of societal dependence on them. In this way the concept of *momentum* has similarities with the concepts of inertia or path dependence. Insightfully, Dodgshon (1998, xi) for example maintains that the "foundations for the strategic use of space by society derive from society's tendency to become inertial *through its use of space*" (emphasis in original). In this book, the notion of path dependence is used. In our chapter, we map the establishment, expansion and possible momentum of the northern Fennoscandia mining systems.

Sweden: the Norrbotten and Västerbotten mining systems

Mining systems in the Early Modern period

The first mining operations in the Swedish north started in the early 17th century. The financial needs of Swedish state actors were the main driver due to Swedish military involvement on the European continent – the Thirty Years' War. The state wanted precious metals and therefore facilitated the opening of a silver mine at Nasafjäll in 1635. During the same period, Swedish and Dutch entrepreneurs opened up copper and iron ore mining in Svappavaara and Masugnsbyn in the Torne River valley. These actors established the first mining systems in the north. They processed the ores in smelters and refined it in forges (Silbojokk, Kengis and Juvankaisenmaa), which they fuelled with charcoal produced from the forests (Nordin & Ojala 2015; Nordin 2015; RKY 2009; Puustinen 2003).

In the Torne River valley, the distance from the mines to steel works and shipping facilities were some 300–400 km. Therefore the companies contracted Sami and local farmers to transport ores and charcoal with reindeer- or horse-drawn sledges on snow and frozen water in the winter, and on boats in the summer. The mineworkers were a mix of soldiers, mine- and steelworkers from Bergslagen – the main Swedish mining and steel industry region in southern Sweden – and Sami. The institutional framework making the mining operations possible consisted, in the broadest sense, of the establishment and consolidation of Swedish state power in the north from the 16th century – a power that the Danish state challenged at Nasafjäll – as well as the mining laws, which during the 17th century stated that all underground mineral deposits belonged to the king. Thus the actors who established the first mining systems in the north faced no legal obstacles (Kjellberg 1909; Elenius et al. 2015, 98–100; Hansson 2015, 12–100).

In terms of the development phases described in LTS theory, the Early Modern mining systems in northern Sweden went through both innovation and expansion phases, but it is clear that they never entered a momentum phase. The mines, smelters and iron works were closed, reopened and closed again. Therefore they did not result in any permanently expanding settlements where other economies could have grown, nor did they generate much profit, as the production volumes were insignificant compared to the Bergslagen region. Moreover, the companies never established any permanent transport infrastructure which could have been utilized for other livelihoods.

It is nevertheless clear that the Early Modern mining industry in the north left two important legacies which helped to pave the way for the establishment of the much larger mining operations in Norrbotten's ore field from the late 19th century: the *understanding* of the Swedish north as an area that could be used for extracting minerals; and the *southern awareness* of the presence of very large iron mineralizations in the region – Malmberget, Svappavaara, Kirunavaara and Luossavaara were all discovered in the 17th century. Yet, the also mineral-rich Torne River valley still today appears "stuck" in-between the first and second phases of system development mining industries, as the boom and bust of the mines in Pajala and Kolari shows.

The construction of Norrbotten as a mining region

The second large wave of interest in minerals in the Swedish north took off during the second half of the 19th century with the establishment of the mining towns Malmberget in the 1880s and Kiruna in 1900. This was the beginning of a major transformation of the economic geography of mining and metal production in Sweden, from the Bergslagen region in the south to the northern counties of Norrbotten and Västerbotten.

One of the most important drivers of this development was industrialization, which created a growing demand for iron ore and steel. From 1830 to 1900, the Swedish iron and steel industry increased its production from 76,000 tons to 1 million tons (Isacson & Nisser 2011, 93). Another important driver, as Sörlin (1988a) has pointed out, was a growing understanding of the north as the key to the building of a new prosperous future for Sweden, as expressed in literature, art and public debates. This ideological context became an important component of the economization of minerals, forests and rivers of the north. Connected to these ideas was a growth of global resource–oriented colonialism in this period. While colonialist countries in Europe claimed possession of lands and resources overseas, actors from Sweden and Norway engaged in internal colonialism and took possession of resources and land within their own state borders.

Another driver of decisive importance was new technologies. Because of the high phosphorous content of the iron ore in Malmberget, Kirunavaara and Luossavaara, steel manufacturers had been reluctant to use it. In the 1850s, however, the steel industry developed the Bessemer process in order to increase productivity, and in 1879, inventors in the British steel sector created the Thomas process – a Bessemer converter coated with a layer of basic material – which reduced the phosphor content in melted iron (Nisser 2011, 102–103; Hansson 1998, 49). As a key component in a large socio-technical system in the making, the Thomas process contributed significantly to the economization of the Norrbotten iron ore deposits.

To establish a production of scale, however, it was necessary to construct a large socio-technical system for extraction. Numerous actors in late 19th-century Sweden and Europe took a leading role in the creation of such a system. These included British and Swedish private investors, whose interest was the potentially huge economic returns of mining, and the Swedish state, which intended to promote resource extraction in the region. To facilitate investments in the mining industry, the state introduced a new mining law in 1855, based more explicitly on the res nullius theory than previous legislation, meaning that ownership of the minerals is obtained through a claim system (Bäckström 2012, 29).

One of the main obstacles for large-scale mining in the region was the absence of infrastructure for transporting larger volumes of ore over significant distances. Therefore, in 1882, the state granted a concession to a British company to build a railway from Luleå by the Baltic Sea coast to Gällivare and Malmberget in the inland, and by 1888 the railway was in place. As shown by Hansson (2015) and Sörlin (1988b), this transport link was the key to the possibility of conducting large-scale mining operations for the export market. At the same time, in the vicinity of the mine, workers started to establish another system component: a settlement in the form of a shanty town, which the company soon replaced with the town of Malmberget (Hansson 2015, 54–112, 155–161; Sörlin 1988b, 36–37).

In the years that followed, the Swedish state and industry actors consolidated their roles as system builders. Fuelled by a growing protectionist and nationalist tendency in Sweden as well as across the rest of the industrialized world, the system builders argued that the northern iron ore deposits should be in the hands of Swedes. Therefore, in 1889 the state made an announcement[1] protecting its interests in the Norrbotten ore bodies (SOU 1924:32, 16), awaiting new legislation. In 1899 the state adopted a revised mining law which granted a land ownership share for mining on state lands and taxation rights (Bäckström 2012, 34). Also the new railway in the north was considered as something that should belong to the state. In 1891, the Swedish state bought the railway from the heavily criticized British company which had built it and soon started to implement the plan to extend it to Kiruna and across the mountains to Narvik at the Atlantic coast of northern Norway. The railway was finalized at Narvik in 1902, where yet another system component was established: an ice-free shipping harbour for iron ore. At the same time, LKAB opened up mining in Kirunavaara and commenced to build a second large mining settlement, Kiruna, which they turned into a high-profile project to make it an "ideal town". This strategy should be understood as a component of the system – a tool to create a workforce satisfied with their living conditions and therefore loyal to the company, working hard to produce economic returns for their owners. In the years that followed, the system builders added new components to the system. The company wanted to increase the output from the mine, which created energy needs that could not be sufficiently supplied by the coal-fired power plants and steam locomotives at hand. Hydropower-produced electricity was the desired solution, and in 1910 a Swedish state company established the first large hydropower station that dammed up the Lule River in Porjus, some 55 km from Malmberget. Another system component was the Boden fortress, which the Swedish state built from 1901 partly for the purpose of defending the railway and the mines (Fridlund 1999; Eriksson 1991, 39; Hansson 2015, 191–204).

At this point, the large-scale socio-technical system for mining entered its momentum phase. The existence of transport infrastructures, energy production, settlements and legislation favouring mining attracted industrialists to establish additional mines and link them to the system. Here can be mentioned AB Nautanens Kopparfält, which established the copper mining settlement Nautanen in 1903 and connected it with the system in nearby Malmberget/Gällivare. Another example is Svappavaara, located near the railway between Gällivare and Kiruna, where LKAB established an iron ore mine in 1965 as a part of a larger increase of the company's production capacity. This small agricultural settlement was (again) transformed into a mining community by building state-of-the-art workers' housing designed by Ralph Erskine. In 1968, the mining company Boliden established the copper mine Aitik near Gällivare and linked it to its smelter facilities in

Skellefteå through the nearby railway; workers were housed in Malmberget and Gällivare.

The construction of the Skellefteåfältet mining district

A second large-scale socio-technical system for mining in Sweden was established in Västerbotten in the 1920s. The system builder was the state and eventually the private mining company Boliden. They took the initiative because of disruptions in the production, export and import of metals during World War I, which caused shortages and high prices for a number of non-ferrous metals of great importance to Swedish industry. For this reason, the state encouraged domestic prospecting campaigns and deregulated mining, while prospectors developed new prospecting methods. The prospectors identified a large body of sulphide ores known today as the Skellefteå district. Boliden has produced mainly copper, zinc and gold from this district (Vikström 2016; Lundkvist 1980; Lundgren 2006; Lundqvist & Boliden Mineral 2016). Boliden built a settlement with the same name to facilitate a gold mining there. The company closed the mine in 1967, but the settlement is still a centre for the mining activities in the region with services and a concentration plant.

In total, more than 30 mines have been in operation in the region (Boliden 2017). Some were small and short-lived, while others lasted for decades. Kristineberg mine, for example, opened in the 1940s and is still operational. Boliden has also engaged in mines in a wider region, such as in Laver (1936–1947), Stekenjokk (1976–1988), Laisvall (1943–2001) and Aitik (1968–). Although the Skellefteå district is mainly perceived as "Boliden's territory", there are exceptions, for instance Björkdal mine is currently operated by the Canadian company Mandalay Resources (SGU 2017).

Just as in the case of Norrbotten, Boliden built a wide-ranging socio-technical system. In order to handle the complex ores, Boliden constructed a smelter at Rönnskär by the coast, east of Skellefteå, in the late 1920s. For the provision of electricity, the company built a hydropower station in the Skellefte River. Boliden also built transport infrastructures to move ore concentrates, supplies, machinery and people within their mines. In response to transport obstacles during World War II, the company constructed a 96 km ropeway from Kristineberg to its dressing plant that passed other mines on the way. The ropeway was used until 1987. Since then the company has moved the ores by road and railway. When necessary the company also established settlements for its workers, with housing and services, or expanded already existing ones.

Boliden's socio-technical system has gained momentum, facilitating further mining operations, and by promoting local entrepreneurship the company has contributed to various mining-related businesses (Wiberg 2009; Knobblock 2013; Tano et al. 2016). This momentum can be seen as a sign of path dependence, both institutional and technological. Features such as large fixed costs, coordination effects, and self-reinforcing or adaptive expectations (Hathaway 2001) make the costs for taking additional steps in the same direction lower, or the benefits higher, than changing direction, which in turn may also result in maintaining inefficient or undesirable system components.

Northern Swedish mining systems in a new historical context

In the 1970s there were signs that the growth generated by mining in northern Sweden during the previous decades could not be taken for granted. Rationalizations, increased global competition, environmental concerns and dramatic closures gave rise to pessimistic views on the role of mining in the future (Ministerrådet 1984; Liljenäs 1992; Karlsson & Nygren 1992; Jansson Myhr & Viklund 2015). For these reasons the state found it necessary to reform the institutional components of the system – the mining law. During the larger part of the 20th century, the laws had undergone relatively few changes. The 1884 mining law had been replaced by a new mining act in 1938 that was in force until 1974. This law was based on the claim system too, but with two important additions; it entitled the landowner to a share of the profit from the mining operations (*jordägaravgäld*) and it established a right for the state to participate in the mining operations (*kronoandel*). In 1969, an expert investigation found that the way in which the land-use rights were established hindered the rational utilization of mineral deposits (SOU 1969:10, 206). The proposed solution was to keep the claim system, but to complement it with features from a concession system, which resulted in two new laws (Gruvlag 1974:342; Gruvlag 1974:890).

In the early 1990s, with the purpose of bringing new life to the dwindling mining industry in Sweden, the Swedish government decided to deregulate mining in order to open it up to international companies (Knobblock & Pettersson 2010). The idea was to create a new legislation based on the concession principle, that is, that the right to explore and exploit deposits is granted upon approval from the state, although with some features of claim rights. With the technical and economic conditions for mineral exploration and extraction changed, it was no longer warranted to maintain the claim system as such, not least because the concession system allows for a stronger societal influence, which in turn was seen as an important part of the state's task of facilitating the efforts of the industry (Prop. 1988/89:92, 35). The current Mineral Act (1991:45) thus regulates the relationship between the landowner and the proprietor of the mining rights, which minerals are subject to the legislation and how the activities are to be conducted. The new act was also co-ordinated with other relevant legislation, such as the Natural Resources Act and the Environmental Protection Act, with the aim of ensuring that mining operations are carried out in a manner that is compatible with environmental protection requirements.

When most Swedish environmentally related laws were consolidated into the Environmental Code in 1999 under the umbrella of sustainable development, this did not imply any immediate changes for the mining industry as the mines were not new and operated under existing permits. However, from the early 2000s, as part of a global mining boom triggered by an increase in prices and a demand for metals (Bridge 2004; Humphreys 2010; Söderholm & Svahn 2015), international

companies and smaller domestic actors searched for and found exploitable minerals in the Swedish north. The new mining law was put to the test, with ambiguous results. On the one hand, the requirements for an integrated environmental assessment implied a major challenge for the mining industry, which became evident in the permit process for Gruvberget in Svappavaara. On the other hand, the limited scope of the environmental legislation in relation to mining activities was also revealed; environmental assessment only resulted in permit conditions and did not actually challenge the activity itself (Pettersson et al. 2015). The holistic and precautionary perspective on the environment that can be invoked under the Environmental Code is missing or can be avoided for mining operations (Pettersson et al. 2015). The design of the institutional framework for mining in Sweden thus implies "that the economic dimension of sustainable development is prioritized, partly at the expense of ecological and social sustainability aspects" (Bäckström 2012, 257).

With the early 21st-century metals price hike, the Swedish mining sector went from "doom" to "boom" (Nordregio 2009; Knobblock & Pettersson 2010; Tillväxtanalys 2010). Companies made large investments to speed up prospecting and to boost production in already running mines, and from 2003 employment figures in mining and related activities rose (Knobblock 2013; Tano et al. 2016; SGU 2016). Closed mines were reopened and entirely new sites were considered. Although only a few new mines opened during this period, expectations skyrocketed (Müller 2014). Mines shifted owners, such as Blaiken (Scan Mining, an international investment corporation), Storliden (Lundin Mining, Sweden) and Svartliden (Dragon Mining, Australia). Most were connected to the large technological systems established in Skellefteå and Norrbotten during the 20th century.

However, not all enterprises were successful (Müller 2014). The Blaiken zinc mine operated only during 2006–2008, ended in bankruptcy twice and left behind an environmental disaster. At Pajala, the company Northland invested heavily in a new mine, connecting it to the iron ore railway at Svappavaara. Production started in 2012, but when iron ore prices dropped dramatically in 2014, the company collapsed and production ceased (SGU 2015). Huge debts and unemployment for several hundred people proved that the mining boom was over. However, the momentum of the socio-technical system for mining – the national laws, the infrastructures in Norrbotten and the mine that was established at Pajala – provide the means for new actors to continue, as shown by the reopening of the mine in 2018 by yet another company: Kaunis Iron AB (Anselm & Haikola 2018). The large mining systems in the Swedish north are likely to benefit new actors also in the future, as signalled by increasing interests in various strategic minerals, for example, for producing electric batteries and related industries (Northvolt 2017).

Norway

Norway holds a considerable portion of the mineral-rich Fennoscandian geological shield within its land area, but in mining for metals it falls behind the Swedish, Finnish and Russian mining industries in the same geological formation on the

Kola Peninsula. It is the most mountainous of the countries with abundant access to bedrock, this being offset inland by the high costs to build transport infrastructure, and winter conditions with snowdrift and so forth causing frequent shutdowns of roads and railways. The European Commission has regarded Norway, along with Sweden and Finland in the EU near abroad, as one of its future providers of import security (COM 2008, 2013). Norwegian mining and quarrying has specialized in producing industrial minerals such as quartz and dolomite, and natural building stones such as marble and limestone rock. Deposits found along the coasts have been favoured, as this has eliminated the challenges of inland transport (NGU 2015).

There is a metallurgical industry specializing in high-energy-demand production of alloys, mainly for the steel industry. The latter resulted from a concerted state policy since the early 20th century of establishing such industry by public investments in hydropower in southern and middle Norway (Wicken 2009, 45–47). Norwegian aluminium production was initiated this way, based on imported raw materials, and has since developed and consolidated into the Norsk Hydro Corporation. Ferrosilicon production in the line of electrometallurgy is taking place, for example at Finnsnes in northwestern Norway (Perez 2017). Thorium, of global interest as a next-generation nuclear energy source, is found in many places in Norway, while graphite of commercial quality and quantity is found in the north, on Senja, Troms County, where mining is ongoing (Thorium 2008; Løvø 2018). These industries never needed to operate on a scale in terms of tonnage and volumes as the LTS for mining in Swedish Norrbotten, and thus did not affect developments in Norway in comparable ways.

One of the larger mining operations in the Norwegian north is the Sydvaranger iron mine, which provides an instructive example on how the technological systems for mining in the region have differed from those in Sweden because of the shorter distance between the ore bodies and the sea and the already existing settlements there. The Sydvaranger mine started operations in 1910 near the small parish of Kirkenes near the Russian border in the far northeast of Norway. The iron occurrence had been made part of Norwegian geological knowledge in 1866. Geopolitics in this borderland and international capital transfer became of crucial importance. The system of extraction consisted of a mine located inland, connected with an 8 km railway to a crushing mill, dressing plant and shipping facility in Kirkenes. Transfer of technology, especially that of magnetic separation, was a key component in the first layout of operations, and impulses from the south and from abroad have characterized the often dramatic ups and downs of this mine, including series of labour conflicts between its unions and management. It was devastated by Allied bombing and through the scorched earth policy at the end of World War II, when the German occupation power was ousted from Kirkenes by the Red Army (Kvammen 2013; Schröter 1988, 426; Wikan 2006).

In 1948, the Norwegian parliament decided to rebuild and restart the mine under the name A/S Sydvaranger. A total of USD 5 million in Marshall Plan funding was allocated, along with transfer of American technology suited for the hard taconite variety of iron ore on the site. The system was also supplemented with a new village with lodgings for miners and their families. Production began in 1952. The Norwegian state stepped in to replace pre-war German shareholders, since there was a lack of domestic industrial capital, as well as business interest for ownership. As before, the state's interest for subarctic mining was an amalgamation of concerns including that of securing Norwegian state presence, identity and language in a border region with major ethnic components of East and North Sami people, Kven people, many Finnish and a few Russian migrants (Lloyd 1955; Støyva Arvola 2004; Wråkberg 2015).

All output from the Sydvaranger mine was first exported as relatively low-priced iron fines, then locally processed with difficulty into iron oxide concentrate briquettes. It was only in the post–World War II era that local pellet production became successful, based on in-house technological innovation to handle the peculiarities of the local ore. Although the Sydvaranger LTS for mining has been far more limited in scale compared to the systems in northern Sweden, there are signs that it has gained a level of momentum. The company went bankrupt and closed the mine in 1996 (for the second time; the first occurred in 1925), but the existence of the system and the early 21st-century price hike on metals attracted new international capital that reopened the mine in 2007. When the boom turned into bust, the mine went out of business in 2015 for a third time. In a manner reminiscent of the case of Pajala in Sweden, the mine may be in the process of reopening once more, making use of previously established system components.

Given that Norwegian mines are (and have been) operated in many parts of the country, the future of this industry is deemed commercially and geologically most promising in the north (Vista Analyse & Sweco 2013; Finnmark fylkeskommune 2015). In recent decades, the Sydvaranger mine has been its most significant exponent. Other examples are plans for mining copper fines at Nussir and Ulveryggen in the west of Finnmark County. EIA and permissions are in place, but conflicts are unsettled with regional Sami reindeer herders. The Bidjovagge gold-copper deposit in the Kautokeino Greenstone Belt in the interior of Finnmark County was mined from 1985 to 1991, producing 6,200 kg of gold. Recent industry plans to reinvestigate the site have been revisited by the Kautokeino municipality, and it is unclear when and if this mine will re-open in the near future (Espiritu 2015).

In Norway, corporate and state actors have routinely viewed mineralizations close to the coast as logistically favourable and the ones to focus on commercially. This is also a main rationale for their design of technological systems for mining. An ore located near an operational or potential harbour is thus the benefit at Kirkenes, as well as at the Rana Gruber iron mines in Nordland. This circumstance is also regarded an asset of the prospective Nussir copper mines. However, this infrastructural benefit has also entailed the dumping of mine tailings of various composition on the seabed of a nearby fjord. This kind of tailing disposal has been shown to be environmentally reasonable in most cases by geoconsultants and in marine ecological field investigations and laboratory tests (Kvassnes & Iversen 2013; Sandvik & Larsen 2014). It has become increasingly unpopular with the public, local authorities and competing business interests, however, whose representatives are doubtful of the long-term environmental consequences of the practice. Severe clashes of interest can be noted with expanding fish farming and costal fishing (Bellona 2015, 83–84).

Only two mines are producing metal concentrates in Norway presently: the aforementioned Rana Gruber AS in Nordland County, and the Titania AS Corporation which mines ilmenite, a titanium-iron mineral, in southern Norway (Carstens 2017). The annual production values of these two mines are comparable to the average value of the output from one oil well in production on the Norwegian shelf. The life expectancy of most mines would often, but not always, be longer than that of any single hydrocarbon-producing well.

Political and legal conflicts over mining are found today on all levels of Norwegian society: national and regional and among different ethnic and socio-economic groups of local settlers, visitors and variously interested outside observers and decision makers. This involves the challenges from mining to reindeer herding, tourism, local recreation and nature conservation. Some say Finnmark County is today seen as a no-go zone by international investors; a growing percentage of the shares of the Nussir Company is held by Norwegian activists of the company themselves, which seems to indicate international reluctance to engage; time will tell if this is true (Aslaksen 2018; Kristoffersen 2018).

Finland

The LTS supporting mining in Finland mainly developed in the south and middle of the country. In comparison to Sweden, the Finnish north lay outside focus during the first period of expansion of mining in 1840–1860, which occurred during the period of autonomy under Russian rule since 1809 and was stimulated by Swedish-Russian commercial agreements. The number of base metal mines tripled and export to Russia increased during this period. In Lapland, the first mining operations were established during the latter part of the 19th century when the state entitled Finnish and Russian entrepreneurs to submit claims and pan for gold (Elenius et al. 2015, 178). Gold panning in Lapland has continued up until today, mostly machine assisted, with peak production years 1950 (50 kg) and 1997 (29 kg) (Puustinen 2003). The mining industry has seen periods of high and low activity, in reaction to either the discovery of deposits of value and exploitative potential or a disbelief in the existence of mineable reserves, such as during the 1840s and 1970s through to the 1990s. Since Finnish independence in 1917, the state has played a key role in building large technological systems for mining as a majority owner of companies, investing in exploration and driving technological and infrastructure development. Private actors have contributed to sustaining individual mining enterprises, some of which are still vital such as the Kalkkimaa dolomite-quartz mine in Tornio, founded in 1917 (Kemppainen Karoliina 2017; Puustinen 2003). This role of the state was eminent in Lapland, to where industrial mining spread in the late 1950s. Overall, within the sector equal importance has been assigned to minerals processing and development of mine machinery, mills and processing equipment (Hernesniemi et al. 2011). State programmes for regional employment and development in recent decades have contributed to an institutional framework working in favour of mining.

The system builders of Finnish mining in the north have been state and corporate actors cooperating closely. The prime example of the role of the state as system builder is the Outokumpu Company, founded as a joint state and private enterprise in 1914. Between 1924 and 1931, Outukumpu was completely controlled by the state, and from 1932 the state owned a minimum of 75% of its shares. Today, the state owns 27% of the shares, making it the largest owner in the company. Outukumpus production of copper concentrate from their Outokumpu mine (1910–1989) was a significant export commodity during the 1940s and 1950s (Puustinen 2003). The energy-efficient flash smelting of copper developed by Outokumpu, in response to the electric energy shortage in Finland after World War II, and further optimized by oxygen-enriched process air in 1971 are seen to be among the most important innovations in copper metallurgy (Kojo et al. 2000). This laid the foundation for the company's later development of mining industries in the northernmost part of the country, at Kemi Tornio. Another company that played a significant role in spreading mining systems to the north is Otanmäki – a state-owned company that originally had been founded to run an iron-vanadium mine in Otanmäki (1953–1985) – which in 1968 merged with Rautaruukki (originally a steel producing company).

The Finnish mining industry expanded significantly in the years following World War II, specializing on base metals, carbonate rocks and various industrial minerals. Its expansion in the north started in the 1960s. In Kemi, Outokumpu developed a metallurgy that economized an abundant but relatively poor chromium ore discovered in 1959 and could start commercial production in 1967. In 2011, Outukumpu's Kemi mine was the only producer of chrome in the EU and one of the largest mines in Finland (Rissanen 2011). The LTS of the Kemi mine consisted of ore crushers and concentrators, transport infrastructure (originally by rail, today by lorry) connecting the mine with ferrochrome and stainless steel plants in Tornio (35 km), with access to a shipping facility on the coast of the Baltic Sea. The placement of the industry in Tornio rather than further south in 1976 is an example of the state's regional-political interventions (Hernesniemi et al. 2011). Today, Outukumpu's system has contributed to making stainless steel and high-quality copper products lasting Finnish export commodities. Outokumpu-rooted companies are also important developers of mining technology and metallurgy. The industry has been kept in Finnish ownership (Rissanen 2011). This LTS in Kemi-Tornio dominates the employment statistics in mining and manufacturing in Lapland (RCL undated). In addition, the area hosts further quarries and mines (such as the aforementioned Kalkkimaa mine). Overall, the connected facilities for mining and metal production in the Kemi-Tornio region can be said to have gained momentum as an LTS.

The state took on an important role in the construction of the socio-technical systems for mining carbonates, aluminium minerals, iron, copper and gold in the north which began commercial production in the 1960s. The state did so by investing in infrastructure and mining settlements, for example, the railway to Kolari which opened in 1965 and also supported timber transports (similar to the case of Otanmäki and Kemi). The railroad facilitated mine construction and transports for what was often described as "the country's largest deposit of iron ore" (Pohjolan Sanomat 22 January 1958). Earlier, state investments in railways had linked the Tornio carbonate quarry to southern markets – after the CEO had telephoned the president. The rail construction also offered employment opportunity during the economic crisis of the 1930s (Kemppainen Karoliina 2017).

The mining systems developed or were brought to a standstill in response to booms bust phases. In Kolari, the construction of facilities for iron ore mining and processing were halted when the system builders experienced "Crisis on the Iron Ore Markets" (Pohjolan Sanomat 27 April 1967). Eventually, the Otanmäki-based Rautaruukki company operated the Kolari mine from 1975 to 1989, when the company deemed further mining inviable and the state (in the shape of the Outokumpu Company) stepped in to support continued operations in 1989–1990 and processed gold and copper ores from elsewhere in Lapland from 1989 to 1996. The first completely private industrial actor starting production in the area, however, was Nordkalk (as it is today called), which quarried carbonates at Äkäs River during the period 1968–1996; the limestone was mainly used by an adjacent concrete plant with three specialized variations of concrete and was closed in 1989 (PSAVI 2010).

In the 1990s, decreasing market prices brought mine closures and the industry turned to imported ores from Russian Kostamus and Swedish Kiruna (Hernesniemi et al. 2011). Yet industrial gold production expanded during the late 1990s and thereafter (Puustinen 2003; Finnish Mining Authority 2011, 2016). During the 2000s, just like in Sweden and Norway, the mining industry's interest in the Finnish north increased as a consequence of a global rise in metal prices (Hernesniemi et al. 2011). In 2008 Agnico-Eagle Mines Limited opened the Kittilä gold mine, and in 2012 First Quantum Minerals Limited opened the Kevitsa mine, producing copper, nickel, platinum, palladium and gold. Both mines are significant on the European scale (GTK 2014) and are in production as of 2018. Its commercial metals geology places northern Finland among the globally richest regions; accordingly, in coincidence with population decline and scarce employment opportunities in rural and northern areas, the role of mining is again seen as regionally and politically significant (Rissanen 2011; Laukkonen & Törmä 2014), just as it was during the industrial era that started in the 1960s. The different actors holding the rights to (remaining) mineral reserves in the Finnish north and elsewhere in the country are awaiting optimized market returns, for example in Otanmäki, in Sokli near the Russian border, in Rompas near Rovaniemi and in Kolari. Today, the Finnish state retains its role as a system builder but focuses on infrastructure investments, such as roads and bridges at the Kevitsa mine and the currently halted decision to fund the improvement and electrification of the Kolari railroad (Hernesniemi et al. 2011). The state also "rescued" the Talvivaara mine after bankruptcy (today named Terrafame under state ownership). The nested and networked structure of the modern mining sector is illustrated by the Tapojärvi

Company, which recently acquired (through its daughter company Hannukainen Mining) the rights to the remaining reserves in Kolari. Multinational companies are likewise important actors within the Finnish mining sector.

Technological solutions and greened, intelligent and minimum-impact mines and raw materials for high-tech metal compounds are flagged as the road ahead. It remains to be seen whether the current policy of responsible minerals economy will be in the position to bring long-term sustainable development in mining, as the sector also has suffered from instances of poor environmental management. Transport opportunities illustrate the weighing of economic and environmental interests, given the relative isolation of the country and changes in the environment, for example, the designation of the Baltic Sea as a Sulphur Emission Control Area (ECA) by the International Maritime Organization is mentioned as a threat to Baltic shipping and hence to the market access of the mining industry (Hernesniemi et al. 2011). Sweden, these actors argue, has better transport options because of the LTS for mining in Norrbotten – the railway to Narvik – and hope for state investment in a railroad to Russian Kovdor, with its processing industry and access to rail link to Murmansk which would support the realization of the large Sokli project (Hernesniemi et al. 2011). The Finnish mining industry is reported to have noted the test transports of nickel concentrate by Norilsk Nickel to China in 2010 and 2011 (at a fuel cost of only 30% of the cost of freight to the European mainland and ocean shipping) and the 40,140-ton transport from the Sydvaranger iron mine in northern Norway to China, which had been accompanied by a Russian nuclear icebreaker and had demonstrated significant fuel and time savings (Hernesniemi et al. 2011). In these visions of a new large expansion of the LTS for mining, Finnish icebreaker technology is not forgotten.

An important part of the socio-technical systems for mining in Finland was the institutional frameworks regulating this industry. Before 1809, Finland and Sweden formed a single state with the same mining law. After 1809, when Finland became an autonomous grand duchy within the Russian Empire, the mining law remained unaltered. At the time, mining and metal manufacturing only played a minor role in Finland and few viable mineral reserves were known/accessible. In the beginning of the 20th century the mining legislation was subject to review, in order to deal with perceived difficult exploration conditions in the country (Kaivoslakikomitea 1923, 43). In 1932 the Finnish state issued a new mining act which did not contain any fundamental changes to the former legislation, but it broadened the range of claimable minerals and contained provisions regarding state mining fields. A new mining act in 1943 (273/43) brought no major changes either – its key reforms were related to supervision and safety issues. In 1957, a new committee proposal aiming at modernizing the mining legislation reiterated the earlier perception on Finland's demanding geology; highlighting the systematic and ongoing geological research carried out by the state since the 1860s, the committee underlined that mining should not be hindered by high charges for claims or concessions (Kaivoslakikomitea 1957, 12, 17–18). A prolongation of the survey and exploration stages of the process was suggested in order to match factual time demands, alongside with limitations regarding the size of the reservation area, for example. These provisions were enacted in 1966 in a law based on the claim system, but with the authorities issuing the mining concessions (Mining Act 503/1965).

Thereafter, the mining law saw minor amendments until its reform in 2011, but laws on EIA, nature conservation and environmental protection started to affect mining operations and the administrative routines of the mine planning process. Essential to the reformed Mining Act (621/2011) is the strengthening of its character as a concession legislation; hence, a mining permit may not be granted if the mining proposed endangers public safety, causes environmental damage or weakens the local living conditions and established livelihoods – these changes have been deemed significant (Pölönen 2013; Finnish Environment Institute 2013, 24). Additionally, the role of the local government and its spatial planning has been subject to public debate and legal processes (Pölönen 2016). The enactment of the changed degree of investigation demanded from the mining administration is also likely to take time (cf. Solbär & Keskitalo 2017). At the same time, the mining companies active in Finland increasingly self-regulate and have recently subscribed to shared CSR-type of policies and reporting obligations – the detailed measures go clearly beyond the legislated requirements concerning mining operations (RMN 2015, 2017).

Fennoscandian mining systems in comparison – conclusions

The large-scale socio-technical systems for mining which were established in the northern parts of Fennoscandinavia from the second half of the 19th century played a significant role for the subsequent development in the region. The mining systems created a momentum working in favour of new mining projects. In Sweden, the transport infrastructures, energy production and settlements originally established to facilitate early mining projects such as Malmberget, Kiruna and Boliden provided a basic structure to which corporate and state actors could add. To use a term from Bridge (2004), the system contributed to an economization of additional mineral bodies in the north. The institutional framework (i.e. the mineral legislation from the late 19th century) also made a crucial contribution to this economization by privileging the state and mining companies over landowners and other land users. If these large-scale socio-technical systems had not been established, it is doubtful if any of the more recent mining projects would have made it beyond the planning stage. The same is true of Finland, where infrastructures built as part of mining projects in the inland worked in favour of additional mining projects when market prices were right. Also in Norway, older mining systems facilitated new mining projects – at least in the form of closed mines reopening in periods of high demand – but not to the same extent. Most mining projects there have tapped into mineralizations located closer to the sea. Although the Norwegian mining systems also included transport infrastructures and shipping harbours, they did not open up new geographies for mining to the same extent as in Finland and Sweden.

Another feature which stands out when considering the development of mining in the Fennoscandinavian north are its cross-border interconnections. On a general level, apart from the specific repercussions of World War II in northern Norway and Finland, the timing of many events in mining economic history were similar in the Fennoscandian north. On a project level, it is clear that knowledge travelled between mining projects through the transfer of ideas, technology and personnel. Last but not least, the mining LTS in Norrbotten in Sweden connected it with Norway through the ice-free export harbour of Narvik on the Atlantic. More recently, the innovation of the successful olivine pellets of LKAB have its source of the industrial mineral of olivine in Norway, brought to Kiruna by the railway.

It is also clear that the mining systems facilitated a diversification of the economy in the north. Other industries and land users have made use of the infrastructures and settlements established for mining, for other activities such as forestry and the tourism industry and also for the needs of reindeer herders. In Norway the new rapidly expanding offshore industry caused an opposite effect of "negative synergy", since its inception in the 1970s, by draining the mining industry of geological expertise. Such crowding-out of competence by oil and gas industry was limited roughly to the mining sector and to infrastructural geo-engineering, while Norway as a whole was successful in avoiding the "resource curse" and so-called Dutch disease of many suddenly expanding raw material–dependent economies (Vista Analyse & Sweco 2013, 47–49; Holden 2013).

LTS theory has been criticized for being deterministic by claiming that socio-technical systems can gain momentum and influence the future. Although it is clear that the historic mining systems in the north influenced subsequent development in different ways, it is important to point out that they did not determine the success or failure of new mining projects there. Other factors, most importantly world market prices but also state policies, available technologies and the character of ore bodies, have influenced the history of the northern mining industry. The companies running the early 20th-century mining towns of Nautanen and Laver in northern Sweden did not hesitate to close them down when the mines failed to deliver the expected returns, turning them into ghost towns despite the fact that the mines were connected with larger mining systems. In 2018 these ore bodies are the subject of new mining projects in the making, as are many other mineralizations in the Fennoscandinavian north. Whether these will become new mining sites will be dependent not only on the availability of systems to connect them to, but also broader ideological trends. Many mining projects today are facing increased scepticism due to environmental concerns (pollution and reshaped landscapes), which is fuelled by factual water management failures, land-use conflicts with nature conservation and reindeer husbandry, including issues of indigenous rights of the Sami people, and a general conception that the contribution to local development is marginal due to fly-in/fly-out labour management and that company tax often gets paid far away from the location of the raw material deposit. Regional development concerns and global markets will keep pushing for mining of strategic and commercial Arctic minerals. In contemporary Fennoscandia law makers, investors and state officials are joined in their governance of mining by an array of actors, including industry stakeholders, international lobbyists, consumers and local and national voters.

Note

1 1889 års kungörelse nr. 35 rörande inmutning å kronojord.

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6 Making "wilderness" in a northern natural resource periphery

On restructuring and the production of a pleasure periphery in northern Sweden

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Introduction

Historically, northern peripheries have been colonized in order to access northern resources. The use of these resources promised economic wealth and community development even in northern parts of the Scandinavian Peninsula (Sörlin 1988). However, already in the late 19th century the Swedish Tourist Association started promoting the area as also being worth a visit (Aldskogius 1993). Still, tourism has developed slowly, and as an industry it remained in the shadow of resource-extractive activities until the 1990s when automatization within resource industries, and a general transition of the Swedish economy towards a domination of service industries, caused a search for alternative development options (Müller 2011, 2013a). In this context, an abundant resource – a seemingly "pristine nature" or wilderness – is in focus and utilized as a resource for tourism development.

Today, a renewed focus on the north, because of climate change and new industrial opportunities, is creating a discursive environment where ideas of the region as pristine and important for a global environment compete with the idea of a resource periphery. This development is cutting across scales, creating new stakeholder constellations, and globalizing the issue of northern development far beyond what has been witnessed to date.

Against this background, the purpose of this chapter is to analyse tourism development in northern Sweden with regard to factors on different scales influencing the transition from a resource periphery to a pleasure periphery, and particularly the role of path dependence. This is achieved through a review of relevant literature and case studies conducted in the Swedish North.

From resource periphery to pleasure periphery

Due to the sub-arctic and arctic climate, circumpolar regions have never offered favourable conditions for settlement based on agriculture and thus, in most cases, have developed within a dependency on southern cores. Being located far from