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The Relational Geography of Post-Staples Development—a Case in Malå, north Sweden

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Abstract

Mitigating the cycles of ‘boom and bust’ associated with natural resource led economic development in northern peripheries requires economic diversification through post-extractive ‘mature staples’ or ‘post-staples’ activities. The dominant thinking is that resource peripheries are subject to processes of exogenous development, with limited capacity for local agency—endogenous development. This paper argues that it is possible to achieve neoendogenous development that mobilises local resources and incorporates extra-local factors. The paper examines the case of *Malå Geoscience*, a small ground penetrating radar company based in a very small community in northern Sweden which has nonetheless achieved global niche positioning through innovation and product diversification. By using the ARTE framework—agglomeration, regionalisation, translocalisation, Europeanisation—the paper demonstrates how the company was able to pursue new development paths even as the local mining sector was closing down. There is a particular emphasis on how the maintenance of local and regional knowledge and supply networks enabled the company to remain locally based but globally relevant.

Keywords: northern development; resource peripheries; post-staples economies; small manufacturing; niche market; neoendogenous development

1.0 Introduction

‘Northern development’ in Europe, North America and Australia has, over the past century at least, been primarily based on exploitation of natural resources in the form of mining, forestry, fishing, and fur trading (Lloyd & Metzger, 2013). This approach to development has been criticised at the national level, with a broad acceptance emerging that over-reliance on export of minimally processed resources leads to slower long term economic growth, exposure to the ‘booms and busts’ of resource cycles, and unfavourable social conditions arising from unbalanced demography and marginalisation of Indigenous and other populations (Parlee, 2015). The presumed key to mitigating some of these negative impacts is to diversify economic activity. This can occur through engagement in post-extractive or ‘mature staples’ activities—refining, basic manufacturing—or in ‘post-staples’ activities which can involve the technological and service aspects of the resource industry (Mitchell & O'Neill, 2015). Post-staples economies can also incorporate alternative forms of resource exploitation such as tourism and energy generation, although these have been

criticised as subject to similar risks of economic ‘curse’ that applies to primary resource extraction (Carson, Carson, Nordin, & Sköld, 2016; Schmallegger & Carson, 2010).

The processes and challenges of evolving post-staples economies have been examined primarily at the national level, and, typically, northern regions have continued to be viewed as ‘resource peripheries’ at the margins of these nationally resituating economies (Dubé & Polèse, 2015). Economic development at a broad level is difficult in these peripheries because they tend to be isolated from product and labour markets, they tend to have infrastructure and investment resources which are ‘locked in’ to the extractive activities, and they have few independent local actors. There are some case examples, however, of individual ‘northern’ businesses which have had success in accessing markets and engaging in sectors beyond resource extraction, such as in the emerging cleantech sector that strives for a more environmentally friendly exploitation of natural resources (Teräs, Dubois, Sörvick, & Pertoldi, 2015). Such case studies tend to focus on the business as an independent entity. This does not sit well with contemporary theories of economic geography which emphasise the role of networks and clusters in facilitating territorial systems of innovation (Parrilli, Nadvi, & Yeung, 2013). Such systems are thought to require some of the attributes—spatial proximity of firms, critical mass of actors—that are notably absent from resource peripheries. There is a question, therefore, of how ‘northern’ firms might overcome the limitations and harness the potentials inherent to their geography.

This paper aims to investigate this issue through the case example of *Malå Geoscience*, a ground penetrating radar research, development and production enterprise which, between 1994 and 2008 was privately owned by a grouping of local investors and operated from a small town (c. 2000 residents) in the sparsely populated northern inland of Sweden. Malå Geoscience had its roots in servicing the local mining industry, but evolved during this period into an internationally important company whose Ground Penetrating Radar technologies are still used in a variety of industries and applications. The research investigates whether the increasingly accepted view that non-urban local economies can be innovative and adaptive (Esparcia, 2014; Virkkala, 2007) could be legitimate in the context of resource peripheries which apparently lack at least some critical inputs.

2.0 Introducing Malå Geoscience

The municipality of Malå is located in the county of Västerbotten, mid-way between the coast of the Gulf of Bothnia and the Norwegian border. The colonisation of areas within what is now the municipality of Malå was undertaken in the late 18th century. The Malå Parish—conforming to the contemporary municipal borders—was separated from Arvidsjaur Parish in 1880. At that time, agriculture and forestry were the dominant industries. Malå is located in one of Sweden’s two main mining areas, the Skelleftefältet extending from the town of Skellefteå on the coast to Malå in the inland. Mining exploration began in earnest in the 1920s and by the early 1940s there were mining operations in three broad clusters—around Adak in the North West; Lainejaur 10km to the north of Malå town, and Aspliden in the south, with mines in both Malå and Lycksele municipalities (see Figure 1). The largest mines—mostly copper, zinc and sulphide—were at Adak and Kristineberg (located in the Lycksele municipality, but adjacent to Aspliden).

Figure 1: Map of the Settlements and Mines of the Municipality of Malå



Source: Authors.

The peak mining era extended from the 1940s through to the late 1980s, but small-scale activity continued near Lainejaur until 2008, and continues to this day at Kristineberg. During the bulk of this period (up until 1993), mining was a State-owned activity in Sweden, and many resources—including labour—were shared between the various mines. With the exception of the Storliden mine, all mines in the *Skelleftefältet* area were operated by the state-owned company, Boliden.

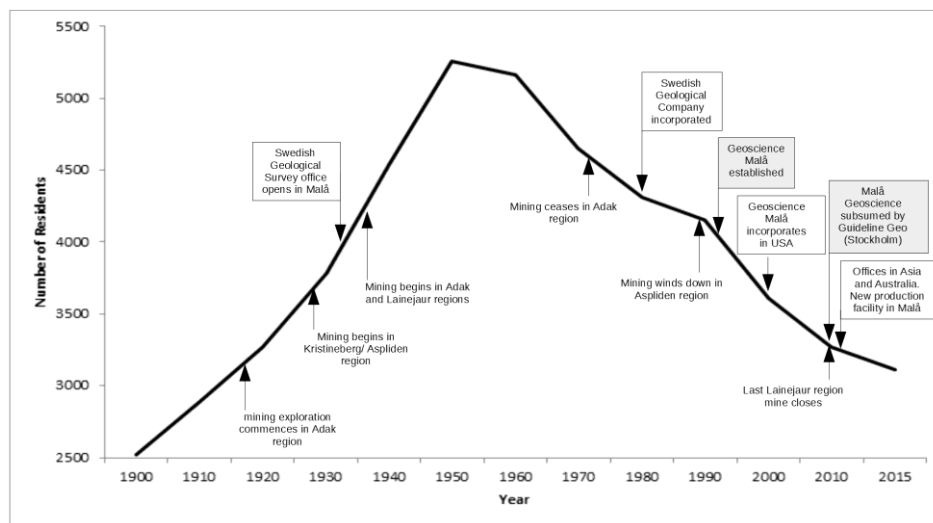
The origins of *Malå Geoscience* can be traced back to the early 1930s with the opening of a Malå office of the public institute Geological Survey of Sweden (*Sveriges Geologiska Undersökning* [SGU]) with a focus on developing geophysical instruments for mining exploration. In 1982, the separation of SGU into two entities led to the creation of *Sveriges Geologiska AB* (SGAB), which was set up as a publicly owned company to commercialise products and services developed for the purpose of underground exploration. At the time, SGAB had about 500 employees distributed over several sites across Sweden in Luleå, Uppsala, Gothenburg, Lund and Malå (Riksdagen, 1984). In 1988, SGAB acquired ABEM, a Swedish manufacturer of geophysical instruments. At the same time, the operations of SGAB were divided into three separate companies including SGAB Borr based in Malå—50 employees in 1988—and specialising in borehole operations. In 1992, in the aftermath of a severe nation-wide financial crisis, the Swedish government began to privatise public companies including SGAB. In 1994, twelve SGAB employees in Malå bought the Malå SGAB operation and created *Malå Geoscience*. The rest of SGAB was subsequently liquidated by 1996 (Holmgren, 2009). From that point forward, *Malå Geoscience* focused on the development of advanced systems for underground exploration (Guideline, 2012). In 2008, *Malå Geoscience* was bought out by the group Guideline Technology, whose corporate headquarters

are in Stockholm County. By this time, *Malå Geoscience* was one of the biggest private employers in the Malå municipality with around 40 employees (Norrstyre, 2009).

Major product milestones for the company included the development of borehole radars in the 1980s and the Ground Penetrating Radar system launched in 1994. These devices have been used in many different countries for mining prospection along with other activities such as water prospection, construction, and even archaeology. The company opened offices in the United States in 1997. *Malå Geoscience* achieved international visibility when its Ground Penetrating Radar technology was used for underground searches on Ground Zero in New York. Since the takeover by Guideline Technology, sales offices have also been opened in Australia and Malaysia.

Figure 2 summarises the relationship between Malå mining activity (below the line), development of *Malå Geoscience* (above the line), and demographic development in Malå municipality. Like many inland northern communities in Sweden, there has been dramatic population loss since the 1960s (Nilsson & Lundgren, 2015), and in Malå this loss coincided with the winding down of mining activity. Nevertheless, *Malå Geoscience* continued to develop its product offerings and technical competence after the mining boom. In fact, the period of local ownership (1994–2008) represented one in which this small local enterprise became a major international player in surveying technology. This paper examines how it was able to do this while remaining firmly situated in a resource periphery.

Figure 2: Gross Population Development Tracks against the Mining and SGS Development



Source: Authors.

3.0 Understanding Contemporary Processes of Northern Development

The significance of the mining lifecycle in the demographic story of Malå emphasises its position as a resource periphery. As mining—and, to a lesser extent, forestry—activity has wound down since the 1970s, gross population loss has been accompanied by population ageing, increased youth outmigration, and increasingly difficult local economic conditions including reduced employment opportunities. Public and private services—schools, shops, health care facilities—have been closed or downgraded, particularly outside of the main

town. Resource peripheries like Malå are particularly susceptible to the ‘resource curse’ or ‘staples trap’ because generally very few advanced services—administration and finance, marketing, research and development—are located at the site of extraction (Ryser, Markey, Manson, & Halseth, 2014). While the literature suggests that economic diversification, particularly into mature and post-staples activities can reduce the negative impacts of the staples trap, the geographical scale at which the processes of diversification have been studied have been primarily national or at least regional (Dubé & Polèse, 2015).

Malå Geoscience presents an interesting case in this context, demonstrating a long history of mature staples, and ultimately post-staples development at least at the firm level. The siting in Malå of a branch of SGU right at the start of the mining life cycle was a rare case of a deliberate attempt—in this case by the State—to co-locate extractive and ‘mature’ activities. The diversification of the company’s business operations into construction, archaeology and other non-mining fields during the 1990s is representative of post-staples development. That *Malå Geoscience* was able to maintain a strong local presence after the mining boom ended, and subsequently became the target of a takeover, is a sign of the capacity for small firms in resource peripheries to succeed despite the limitations of staples economies.

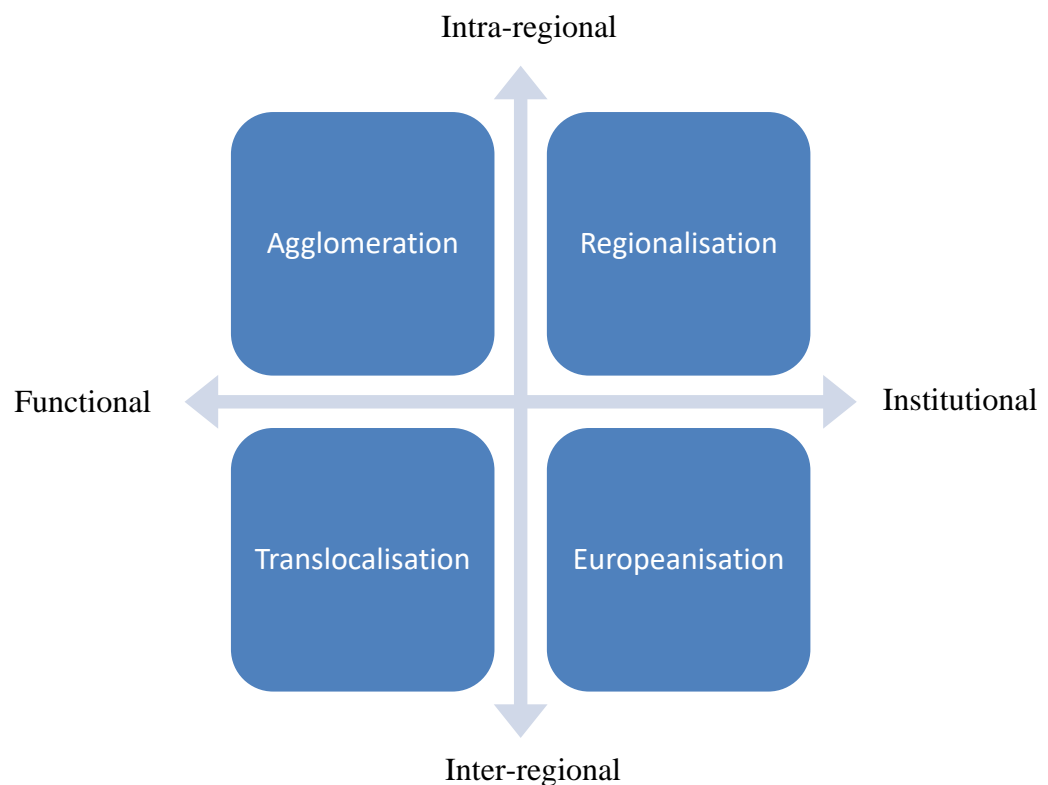
There is a sense in which at least some of the limitations of staples-led economies in resource peripheries may actually provide a foundation for post-staples development. Resource peripheries are seen as inherently dependent on external agents who control economic activity and markets for resource commodities (Watkins, 2009). In theory at least, the dependence on external—and often international—actors to invest in and manage resource extraction can also be seen as a process which brings local actors into contact with global economic networks. Likewise, the labour demands of resource industries encourage new forms of migration and mobility which expose local communities to new skills and social as well as economic networks that need to be sourced from elsewhere. Typically, small resource peripheries are seen as being unable to take advantage of these ephemeral connections because their local businesses are too small and too isolated from industrial networks (Schmallegger, Carson, & Tremblay, 2010).

Staples development can be equated with exogenous development. Exogenous development corresponds to attempts by external agents, either public or private, to promote economic development by investing in a large-scale venture. Such forms of development are often centralised (Bosworth & Atterton, 2012) and remotely controlled, i.e. the decision-makers are located outside the locality. Key principles of exogenous development are economies of scale and concentration of productive means (Bosworth & Atterton, 2012). In contrast, the endogenous development paradigm reinstates the importance of local resources and adaptive capacity for promoting the sustainable exploitation of local resources (Bosworth & Atterton, 2012; Dinis, 2006). The endogenous and exogenous development paradigms are usually opposed in the literature for analytical purposes, but they are often found as co-occurrent, albeit implemented through disconnected parallel processes. *Neoendogenous* development considers that the mobilization of local resources and the need to incorporate extra-local factors requires community actors to share a common identity and the capability of working together (Bosworth & Atterton, 2012). The neoendogenous development approach emphasizes the importance of both external knowledge acquisition and localized learning through networking (Virkkala, 2007) as a precondition for rural entrepreneurship.

A critical factor for the applicability of the neoendogenous development paradigm in resource peripheries is the ability for local actors to partake in processes of knowledge acquisition, production and application. Nonetheless, recent works showed how innovative clusters (Virkkala, 2007), niche specialisation (Dubois, 2016) or creative outposts (Brouder, 2012) come about and thrive in peripheral regions. Recent empirical studies about the networking behavior of peripheral small firms pinpointed that geographical remoteness seemed to bolster rather than restrain the need for developing external connections (Dubois, 2015; Jakobsen & Lorentzen, 2015; Sæther, 2015). However, these accounts have tended to examine businesses that are not specifically originating from the resource exploitation industry. What needs to be better understood is how innovation processes are able to transcend the expected lock-in effects resulting from remoteness and northern development legacy by incorporating local and external actors to create new configurations for knowledge exchanges.

Dubois and Carson (2016) have argued that neoendogenous development in resource peripheries can be characterised as the interplay between multiple relational processes that are either functional or institutional in nature, and that take place mostly at intra-regional or inter-regional scales. The ARTE framework (Figure 3) positions development within the context of agglomeration (processes engaging local economic actors collectively), regionalisation (processes that define the 'region' as a development space), translocalisation (opportunities that emerge beyond the region) and Europeanisation. The ARTE framework is used in this paper to examine the 'relational routes' (Young, 2010) by which *Malå Geoscience* was able to innovate and establish a global niche for its products and services while remaining firmly embedded in a small local economy.

Figure 3: The A.R.T.E. Framework



Source: Dubois and Carson, 2016.

4.0 Methods

This research uses a ‘critical case’ design which aims to illustrate aspects of a general problem based on the experience of a specific entity (Flyvbjerg, 2006, p. 224). In our case, the general problem is the transition of resource periphery economies from staples to mature or post-staples states. The key features making our case study a ‘critical case’ are:

- *Peripheral location*: the firm investigated is situated in a locality that is remote from the main national and regional urban centres and geographically remote from resource market consumers;
- *Resource industry legacy*: the firm is located in an area which has a strong legacy in mining activities, but limited contemporary economic dependence on this industry; and
- *Niche market positioning*: the firm is a recognized player in its field of activity, providing the market with major innovations in ground exploration techniques with applications in many different sectors, that is, beyond mining prospection alone.

Data were drawn from a range of sources. Historical data came from the company web-site—formerly www.malags.se—and company publications. Data about research activities and research networks came from academic papers where *Malå Geoscience* staff were listed authors, and the citation records relating to those publications—drawn from Google Scholar. Information about research project involvement was gathered from the *Malå Geoscience* homepage and complemented and cross-checked with the CORDIS European Union research and development project database (cordis.europe.eu). Patent descriptions relating to *Malå Geoscience* technologies (www.uspto.gov) were analysed to identify the country and sector—university, corporate, government—of collaborators—co-authors and co-applicants. Finally, eleven interviews were conducted with key informants. The first interview was with the production site manager in Malå who, during the course of the interview, referred to five key regional suppliers. The suppliers were subsequently contacted by mail: three agreed to be interviewed, which were performed some weeks later at the suppliers’ premises, one declined and one did not respond. Finally, two meetings with executive and commercial staff were held at the Guideline Geo headquarters in Sundbyberg (Stockholm) giving more contextual understanding of the company’s historical development trajectory. These semi-structured interviews focused on the development of local, regional, national and international networks and collaborations for research, development, organisational management, and product sales and distribution. Our investigation spans until the integration in 2008 of Malå Geoscience in the Guideline Group.

5.0 Results

5.1 Agglomeration

On their homepage, in the section about local economic development, the municipality of Malå makes the following statement:

Malå has historically been a centre, as well regionally, nationally as internationally, for mining and mineral exploration activities. Geological Survey of Sweden (SGU) has a long history in Malå. The mineral information offices of SGU, with among other things the world's largest collection of drill cores, makes it a leading international knowledge centre. In addition to a number of companies in the branch that have Malå as a site for their activities, a number of geo-related companies with worldwide operations have been established. (Authors' translation, Malå kommun, 2016).

Malå uses this historical clustering of actors, both public and private, in underground exploration competences in order to promote itself as a knowledge centre that is both regionally and globally important. This local achievement in sustaining knowledge based activities beyond the lifespan of the mining activities has enabled the local economy of Malå to differentiate itself from neighbouring municipalities, and sustain a local cluster of competences and skills in manufacturing activities (Dubois & Roto, 2012, p. 54).

The underground exploration sector in Malå benefited from major long-term investments made by the Swedish State as it recognized mineral prospection as being of national interest. It was national government policy to decentralise Geological Survey of Sweden (SGU) offices and to develop areas of speciality for each office. For example, Malå was selected as the site for Sweden's national archives of drill cores. By the late 1980s, the Mineral Centre in Malå was being recognised in the national parliament as a knowledge centre about Sweden's geology (Tillväxtverket, 2009, p. 31). State support of knowledge based activities was considered an important regional policy initiative that was deemed to strengthen the local labour-market (http://www.riksdagen.se/sv/dokument-lagar/dokument/motion/statliga-insatser-for-gruvnaringen_GC02N308). The importance of Malå as the centre of knowledge and competences about mineral prospection could be assessed by the increase in visits made by prospection companies to the Mineral Centre in the midst of the boom in prospective activities in the north of Sweden in the early 2000s (*Sveriges Geologiska Undersökning*, 2008, p. 44). The SGU office, a national public actor, in Malå still remained a central piece in the localized knowledge system related to underground exploration and anchoring it in the community.

The national Growth Agency, *Tillväxtverket*, identified two private actors based in Malå that have played a significant role in the development of this knowledge system, one being *Malå Geoscience* and the other being the Önnerlöv Group AB, specialized in drillhole products and services (Tillväxtverket, 2009, p. 29). The *Tillväxtverket* report specifically emphasized the global outreach of the company and its engagement in varied research and development activities (Tillväxtverket, 2009, p. 29). While the activities of SGU and *Malå Geoscience* in Malå have become less directly entwined as the latter expanded its activities beyond mining and beyond Sweden, their offices are located at the same street address in Malå, and the close physical proximity and shared scientific interests could lead to informal, tacit knowledge exchanges.

The importance of Malå as a place, that is, as a geographical arena providing meaning to relationships, could be perceived in the accounts of some interviewees that referred to a certain 'Malå spirit'. This 'spirit' acted as a glue

to strengthen the relationship both within the firm, but also between the firm and its suppliers and customers. Humility and authenticity were perceived as the key elements of this ‘Malå spirit’. The idea of a shared ‘sprit’ constitutes a palpable form of relational capital that the firm could draw upon both for intra- and inter-organizational network development, based on its belonging to the Malå community. The ‘Malå spirit’ thus created a shared experience between the firm and key partner organizations that transcended the mere financial aspects of the transaction—with either suppliers and clients—and created a level of trust that could lead to sustained exchanges and collaborations. This confirms the importance of processes of place-making (Woods, 2007) in creating new conditions for mobilizing local resources in a wider socio-economic context.

5.2 Regionalisation

Malå Geoscience was one of the founding organizations of the GEORANGE network in 1999. The network was initially financed through a European Union Structural Funds initiative aiming at strengthening the relations between regional actors engaged in the mining and related industries in the northern Sweden counties of Västerbotten and Norrbotten. At its start, it included 16 municipalities from the two counties, regional authorities from both counties, universities (Luleå and Umeå), private firms, the state-owned mining company (Boliden), a Swedish branch of a large international conglomerate of mining operations (North Atlantic Natural Resources), and small technical firms such as Malå Geoscience and Geovista, as well as trade associations and unions (SveMin and Metall) (VINNOVA, 2006). This network constitutes a highly heterogeneous grouping of regional actors with seemingly different interests. A stated mission for GEORANGE is the realising of ‘sustainable development’ in the mining and minerals industry (GEORANGE, 2016).

The GEORANGE project was showcased in an Organisation for Economic Co-operation and Development (OECD) study about new forms of governance for local economic development. It was characterised as a geo-scientific mining initiative aiming at utilizing “an existing business activity to achieve a structural transformation of the labour market” (OECD, 2004, p. 65). Regional integration processes of actors sharing an interest in the development of mining and prospective activities was undertaken by using GEORANGE as a “knowledge broker with science-based knowledge in focus” and through “multidisciplinary initiatives” (OECD, 2004, p. 65). Clearly, the ability of regional actors not only to share their existing knowledge-bases, but also to co-create new knowledge, is central to the continuing success of the GEORANGE initiative. The first coordinator of GEORANGE—from 1999 to 2003—has been a director of *Malå Geoscience* from 1994 to 1998.

The engagement of *Malå Geoscience* in regional integration processes was also demonstrated through its supply chain and production system. Although Malå Geoscience had a diversified pool of regional and international suppliers, interviewees stressed the strong relationships between the firm and a handful of suppliers from the surrounding region. These strong relations were developed both for operational and strategic reasons. They represented a hybrid between a classic transactional buyer-seller relation and a more informal process of knowledge exchange. The strength of these relations was not based on large financial ties, as the transactions between the firm and these regional suppliers did not correspond to large order volumes. The relations were rather direct and personal and revolved around knowledge exchanges. The relations survived personnel changes within both *Malå Geoscience* and the suppliers. The benefits induced by these embedded relations were multiple. They ensured flexibility and

continuity in the supply chain and production of *Malå Geoscience*'s high-quality products. The maintenance of relations over the long term also allowed *Malå Geoscience* to mobilise partners to help respond to short term crises in production and distribution. Interviewees perceived that proximity, both in geographical and cognitive terms, was a key factor in making these relations work, and were therefore motivated to ensure that key state-of-the-art manufacturing techniques and competences were developed and maintained in the region. For the suppliers, the relations with *Malå Geoscience* have enabled them to be on the front line of technical developments, and to more easily access up-to-date market intelligence—what is happening in global demand—and technical innovations—what types of products are in demand. The regional relations were celebrated at annual *Malå Geoscience* gatherings to which regional suppliers were invited.

5.3 Europeanisation

A benefit of the accession of Sweden to the European Union has been for regional actors, and especially the ones in the northern periphery (Dubois & Carson, 2016), to anchor their claims in a much wider institutional context. The GEORANGE network was used by its regional stakeholders as a springboard to federate other European actors engaged in the mining prospection sector. The GEORANGE network took the leading role in initiating a European Network of Mining Regions (ENMR) funded through the INTERREG IVC programme for the period 2005–2007. The ENMR project consisted of a highly heterogeneous grouping of different actors—universities, regional authorities or local associations—from Portugal, Spain, Greece, Finland, Poland, Italy, Germany and the United Kingdom, in addition to Sweden. The explicit aim of the network was “to raise the regional awareness and the profile of being a mining region, to support the exchange of experience on regional and European policies, and to develop an innovative model for regional development” (ENMR, 2009, p. 1). Hence, the ENMR initiative enabled not only to connect the regional processes related to the future sustainable development in the mining industry to the ones taking place in other regions of Europe, but also to anchor these issues in the European regional policy debates and practices.

In addition to its role and prominence in the GEORANGE network, *Malå Geoscience* was also engaged in several transnational EU-funded *research* projects. Such transnational research projects are often highly heterogeneous as participants originate from different countries, have varied disciplinary competences and are of different types, such as research institutes, public authorities or firms, large and small. The breadth of knowledge and level of expertise in such collaborative arrangements can thus be deemed as large, from hands-on practices to theoretical knowledge. Besides the obvious benefits with respect to knowledge creation, the participation in transnational projects is a means, especially for small firms like *Malå Geoscience*, to mobilize external funding to finance their research and development activities.

The CORDIS database lists five EU-funded transnational projects involving *Malå Geoscience* between 1997 and 2008. The first project came just two years after Sweden's accession to the EU, demonstrating that *Malå Geoscience* was rather swift in utilising this new opportunity to support the growth of its research and development activities. The main characteristics of the five projects are compiled in Table 1.

There are three main findings that can be drawn from Table 1. First, in all projects, *Malå Geoscience* was the sole Swedish partner. Second, there were some foreign organizations that were key research and development partners as

they engaged in several consecutive projects—identified in **bold** in second and subsequent projects. For instance, a single Italian firm participated in the Eurothen, SmartRad and Saferail projects spanning 1997 to 2008. Furthermore, the SmartRad partnership was fully reconvened—along with a new Italian partner—in the subsequent Saferail project. The final point that we can draw from the analysis of these collaborative arrangements is the shift of focus from mining and extractive industries to broader applications of *Malå Geoscience* technology. The two initial projects, BoraTec and Eurothen from the 1997–2000/01 period, were strongly related to technical knowledge of geological and mining prospection. However, the subsequent projects focused more on novel applications for these technologies in other fields such as cultural heritage investigation or infrastructure development. The first period corresponded to a phase of technical consolidation and geographical widening of the historical market, while the later ones corresponded to a diversification into multiple growth sectors for the Ground Penetrating Radar technology.

5.4 Translocalisation

Besides these European transnational ventures, *Malå Geoscience* developed cooperative relationships with Swedish research institutions. The company did not have formal partnerships outside of GEORANGE with the relatively proximate Universities of Umeå and Luleå, despite the latter being recognised for its competence in knowledge relevant to underground exploration (Tillväxtverket, 2009, p. 32). It was, however, involved with other national universities, such as the Faculty of Engineering at Lund University (*Lund Tekniska Högskola*) for the development of imagery geophysical prospection techniques.

The success of the Ground Penetrating Radar technology led to an enhanced internationalization of *Malå Geoscience*'s customer base. In order to support this internationalization process, *Malå Geoscience* established ventures in the USA, Malaysia and China (Tillväxtverket, 2009, p. 29). The set-up of the US venture is especially interesting in relation to the positioning of *Malå Geoscience* in global knowledge flows. This is also reflected in the activities of *Malå Geoscience*'s United States based subsidiary which was established in 1997. The United States office was not located in one of the traditional American big markets (e.g. New York, Chicago, California), nor in a traditional mining region of the US (e.g. Mid-West or Appalachia). It was located in close vicinity of the North Carolina Research Triangle. Being located in close geographical proximity to such a global scientific knowledge hub provided an entry-point for the firm into wider networks of researchers. The strategic location of the US subsidiary was selected to facilitate not so much the selling of products, but rather the demonstrating of the capabilities of the devices and the obtaining of direct feedback from demanding and critical users such as the academic community. Such information becomes instrumental in improving the products and technologies for more mainstream uses.

Table 1. *Transnational EU-funded Projects with Malå Geoscience as a Partner.*

Period	Project	Stated Objectives	Partner structure (MG in all)
1997–2000/01	BoraTec	Development and utilisation of a complete directional borehole radar system with a maximum operating depth of 2500 metres.	<i>Lead Partner: Malå Geoscience;</i> R (DE); F (BE); F (DE); F (DE); R (BE)
	EUROTHEN	Provide a European forum for the development, dissemination and exchange of scientific and technological knowledge on all aspects of the extractive industries; Accelerate dissemination and exploitation of results; Improve the coordination of research programmes and priorities in Europe; Interact between industry and regulatory authorities with respect to sustainable development.	LP: R (GR); SO (ES); F (FR); F (UK); R (FR); F (IT); R (IT); F (IT) ; F (BE); F (GR); F (BE); F (IT); F (DE); R (UK); R (FR); R (GR); F (FR); R (GR); F (GR); F (ES); R (UK); F (DE); R (UK); F (FR); F (FI); F (IT); F (ES); F (GR); F (FR); F (GR); F (FR); R (FI), R (DE); R (DE); R (UK); R (IT); F (AT)
2001-04	ON SITE FOR MASONRY	Develop and improve methodologies for the evaluation of the structure of historic masonry cultural heritages.	LP: R (DE) ; R (IT); F (ES); R (IT); R (IT); P (IT); R (ES); R (SI); SO (DE); P (ES); F (SI); R (IT); R (CZ)
	SmartRad	Develop innovative ground penetrating radar for recognition and identification of subsurface buried objects.	LP: F (IT) ; F (UK) ; R (DE) ; F (CZ) ; F (UK) ; R (IT)
2004-08	SAFERAIL	Development of an Innovative Ground Penetrating Radar System for Fast and Efficient Monitoring of Rail Track Substructure Conditions	LP: F (IT) ; F (UK) ; R (DE) ; F (CZ) ; F (UK) ; R (IT) ; F (IT)

* R= Research and educational organization; F=Firm; P=Public authority; SO=Sectoral organization

Country acronyms: AT: Austria; BE: Belgium; CZ: Czech Republic; DE: Germany; ES: Spain; FI: Finland; FR: France; GR: Greece; IT: Italy; SI: Slovenia; UK: United Kingdom

Bold marking identifies partners belonging to two or more of the listed project consortia.

One instance by which the diffusion of the internal science-based knowledge of the firm may be assessed is by examining the participation of its staff in scientific publications. Five of such publications could be retrieved (see Table 2). The first paper, published in 1982, addressed the results of a geological survey situated in north Sweden. This paper can be said to be directly related to the regional legacy of underground prospection. In the four later publications, the focus is on applications of the Ground Penetrating Radar device in diverse scientific endeavours. The device is explicitly referred to in the title or abstract of the publications which indicates the important role that the device played for the achievement of the reported research outcomes. These applications were in the field of geology, but also in archaeology and engineering. This integration of *Malå Geoscience* technology in multiple fields of scientific investigation indicates the increasing importance of applications outside local geological prospection. The papers have been collectively cited in the academic literature over 80 times, with the first paper and the most recent paper—focussing on archaeological applications of the technology—most heavily cited. Citations have come from authors based in twenty-three different countries.

Table 2. *Citations of Scientific Publications by Malå Geoscience Staff.*

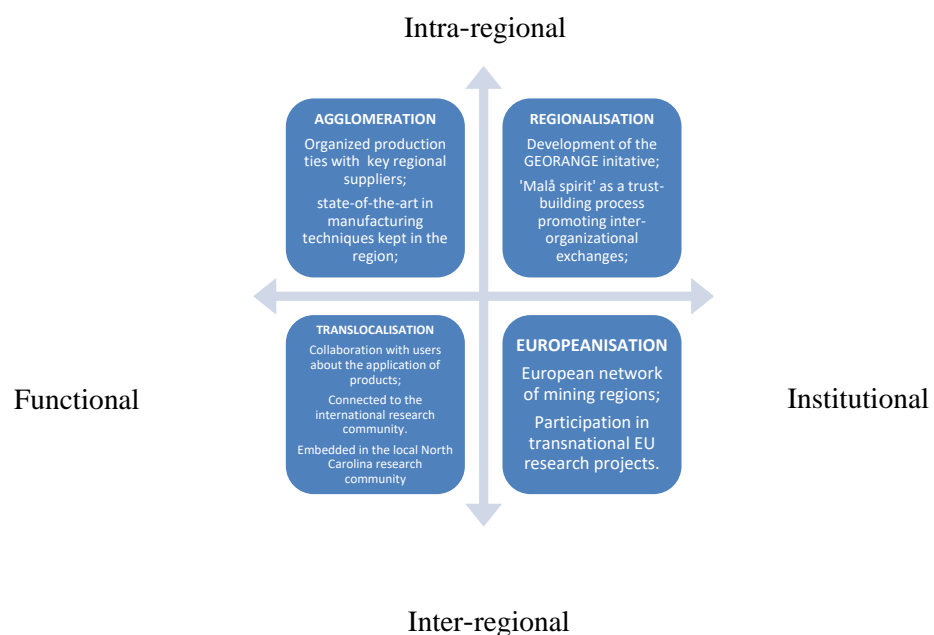
Paper	Number of citations	Number of countries of citing authors
Walser, G., & Einarsson, Ö. (1982). <i>The geological context of molybdenum occurrences in the southern Norrbotten region, northern Sweden</i> . <i>Geologische Rundschau</i> , 71(1), 213–229.	32	7
Emilsson, J., Englund, P., & Friborg, J. (2002, April). <i>Simple method for estimation of water content of roadbeds using multi-offset GPR</i> . In <i>Ninth International Conference on Ground Penetrating Radar (GPR2002)</i> (pp. 422–426). International Society for Optics and Photonics	5	5
Gustafsson, J., & Alkarp, M. (2007). <i>Array GPR investigation of the cathedral of Uppsala</i> . <i>Near surface geophysics</i> , 5(3), 203–207.	9	7
Gustafsson, J. (2008). <i>Borehole radar investigations for subsurface characterization</i> . <i>First Break</i> , 26(11).	0	0
Trinks, I., Johansson, B., Gustafsson, J., Emilsson, J., Friborg, J., Gustafsson, C., ... & Hinterleitner, A. (2010). <i>Efficient, large-scale archaeological prospection using a true three-dimensional ground-penetrating Radar Array system</i> . <i>Archaeological Prospection</i> , 17(3), 175–186.	39	19

In addition to scientific publications, *Malå Geoscience* was listed as an assignee on four US patents active between 1994 and 2008. The patents all concerned advanced in design of Ground Penetrating Radar equipment, and each has been cited in at least 20 further patent applications, including by companies based in the United States, Great Britain and Japan.

6.0 Concluding Discussion

During its period of local ownership (1994–2008) *Malå Geoscience* successfully mobilised both local and extra local resources to position itself as a globally important ground penetrating radar business. It emerged as a knowledge based enterprise first within the mining and mineral exploration sectors—mature staples development—and later within a broad range of industries including archaeology, engineering and construction—post-staples development. It was able to do this by sustaining a complex network of relationships which were focused not just on direct financial transactions, but on knowledge generation and diffusion. The activities of *Malå Geoscience* in Malå actually involved a clustering of public and private companies, suppliers and distributors who formed the core of the supply chain, and of the ultimately global knowledge networks. The clustering was important functionally—allowing the company to respond to urgent product orders, for example—and institutionally—creating the nucleus for a shared vision for the future of the sector in Sweden and, later on, Europe. Figure 4 also shows how *Malå Geoscience* contributed to and benefited from the regionalisation of the geology sector—principally through the GEORANGE network, but also through its valuing of the place as an important part of its business success (the ‘Malå spirit’). Europeanisation is reflected most profoundly in the participation in European Union research and development projects, which supported a transnational network of collaborators providing expertise and access that could not be gained locally. In fact, *Malå Geoscience* occasionally overlooked local actors—such as the proximate universities—which were seen to have less to offer than more distant ones. This is demonstrated in the strategic siting of the United States subsidiary, which created a second locus of activity for the firm.

Figure 4: Four Main Relational Realms in the ‘Post-Staples’ Development of Malå Geoscience



Malå Geoscience skilfully mobilized external science-based resources in order to complement and transcend its internal research and development capabilities. The participation in EU-funded transnational research projects not only provided *Malå Geoscience* with some important opportunities for co-financing its own research and development activities, that is, at the design and production phases, but also provided a platform for connecting with end-users, that is, at the application phase. These networks are highly heterogeneous in terms of types of actors—educational, public or private—, country of origin or field of competence, which means that the participation in such initiatives, enabled the firm to establish and maintain relations with actors from other communities of practice in more or less distant places.

Firms traditionally use patent applications in order to protect their intellectual property and demonstrate their scientific expertise. *Malå Geoscience* also used scientific publication as a way of participating in the creation of scientific knowledge about its core competencies. Scientific research also showcased the use of its devices and services to advance the state-of-the-art in multiple fields of investigation, often far from its original competence—mining prospecting. The benefit of such codified knowledge exchanges is that it can be mobilized effortlessly by the research community globally. The mapping of the citations of *Malå Geoscience's* scientific publications reveals this global outreach.

The *Malå Geoscience* story is important because it provides a critical example of how location within a resource periphery can at least in some cases advantage the transition from staples to post-staples economies. The geology of the Skelleftefältet and the mining activities it has supported over the years formed a core part of the *Malå Geoscience* local, regional, and international identity. As the business model progressed beyond mining, the attention to this identity remained in the engagement with SGU, GEORANGE, and the assistance provided to local partner organisations to also develop their businesses. Rather than be limited by the geography, the company used it to stimulate functional and institutional networks.

Malå Geoscience progressed from being relatively proximate to its markets—dominated by the Swedish mining sector—to being relatively distant. It moved from a limited market to a very diverse one. It did this in large part because of its ability to stimulate some form of local critical mass which was not so much about the number of businesses sharing an interest in these markets, but the core role of those businesses in developing and sustaining the 'Malå spirit'. Spatial proximity therefore turned out to be important for some functions, but not for others.

Sweden's northern resource periphery, while 'remote' in the European context, is still relatively close to large population centres when compared with the norths of Canada and Australia, for example. While most settlements in the north of Sweden are small in population, they are not as isolated from one another as are settlements in the Australian desert or the Canadian tundra. Ground and air transport is relatively accessible and reliable. Whether the *Malå Geoscience* experience could be replicated in an even more isolated geographical context is unclear, but warrants further investigation. Nevertheless, this research shows that there is no prima facie reason that resource peripheries cannot be home to local systems of innovation and innovative enterprise development that not just moves beyond resource extraction, but benefits from the history of resource extraction.

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