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Irene Baug, Janicke Larsen and Sigrid Samset Mygland (Eds.)

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University of Bergen,
Faculty of Humanities,
Department of Archaeology, History, Cultural Studies and Religion
P.O. Box 7800
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Editors of this book
Irene Baug, Janicke Larsen and Sigrid Samset Mygland

Editors of the series UBAS
Nils Anfinset
Knut Andreas Bergsvik
Søren Diinhoff
Alf Tore Hommedal

Layout
Christian Bakke, Communication division, University of Bergen
Cover: Arkikon, www.arkikon.no

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Ole Tveiten

A Tale of Two Technologies – Late Medieval Iron Production in Oppland, Norway

Iron production from bog ore, often referred to as 'bloomery' or 'primitive' iron production, is a well-known and documented industry in Oppland as well as in other parts of the Norwegian outfield during the Middle Ages. As with most outfield activities during the Middle Ages, this industry is seldom mentioned in contemporary written sources (Olafsen 1916). On the other hand, the bloomery iron production in Norway has caught and kept the interest of archaeologists as well as amateur researchers for more than a century, and several surveys and excavation projects since the late 1960s have resulted in a large and diverse material. These projects have revealed that the iron industry sees a massive boom from the 10th century onwards, with the 11th, 12th and first half of the 13th centuries as a period of particularly intensive production (Martens 1988; Larsen 1991; 2009; Narmo 1996; 1997; Stenvik 1997; Rundberget 2007; Tveiten 2012). During the first half of the 14th century, the bloomery iron production in most of Norway seems almost to disappear. Some iron production is known to have taken place in northern parts of Østerdalen from the 16th to 18th centuries, but it does not match the the scale and economical importance of the earlier industry (Espelund 1997; 1999; Larsen 2009, 197-198). Why was there such a massive decline in iron production during the late medieval period? In this article, I will examine this question, using the two areas Gravfjellet and Grua where Oppland County Council recently has conducted surveys as examples (Fig. 1). But first, a few words about the decline of this medieval iron production technology.

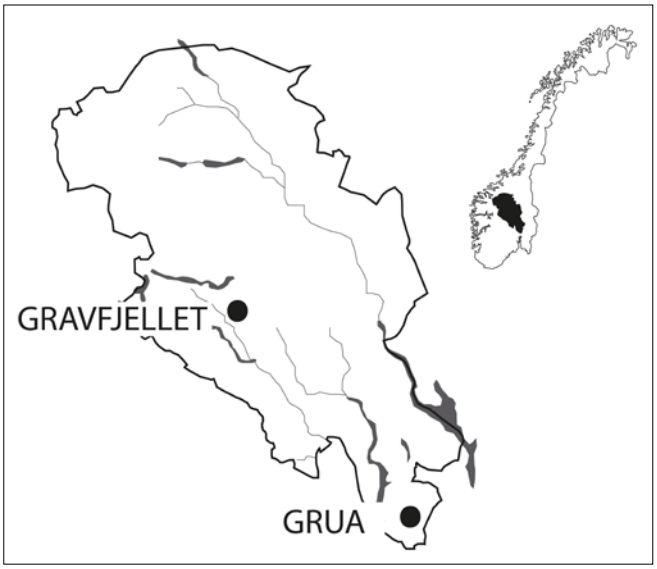

Figure 1. *Oppland County with the two areas of research marked.*

The decline of a technology

Medieval iron production through bloomery in the valley of Valdres is known through different written sources. *Valdresjern* – meaning 'iron from Valdres' – is mentioned in a royal regulation from 1282 (NgL III, 110). Iron is also documented as part of payment when farms in the area are sold (DN II, 186; DN II, 225; DN X, 27). We even know the names of some smiths working in the area during the early 14th century; *Olav*, *Sigurd*, *Isak* and *Kolbjørn* (DN II, 186; DN IV, 209; DN XIII, 12; DN II, 257). These written sources give no details concerning the actual iron production, but excavations have made it possible to reconstruct much of the technology used at the sites, recording extensive iron production during the Early Iron Age (0-AD 575). Shaft furnaces with slag pits is the preferred technology of the period, as in most of the Germanic areas (Pleiner 2000, 45). The 6th and 7th centuries AD are characterised by major changes in religion, language and social structure, which is also reflected in the iron technology. Furnaces with slag pits are gradually replaced by smaller furnaces with slag tapping, and by the end of the 8th century, most iron production using the earliest technology has ceased. The intensity of the new iron technology is visible not only by the slag heaps, but also by charcoal pits related to the production (Figs. 2 and 3). Separate pits used for charcoal production are introduced together with the new type of furnaces in the 8th century. These structures, easily recognized as 1-2 m deep circular or square pits dug into the ground, are frequently found in the areas of iron production from the 8th to the 14th centuries. Today, c. 25,000 pits and c. 3,000 slag heaps are recorded in Norway. While the slag heaps give an indication of the core areas of iron production in general (from c. BC 200 to c. AD 1800), the charcoal pits give more specific indications of the iron production in the period c. AD 700 to AD 1400 (Tveiten 2012, 237-242).

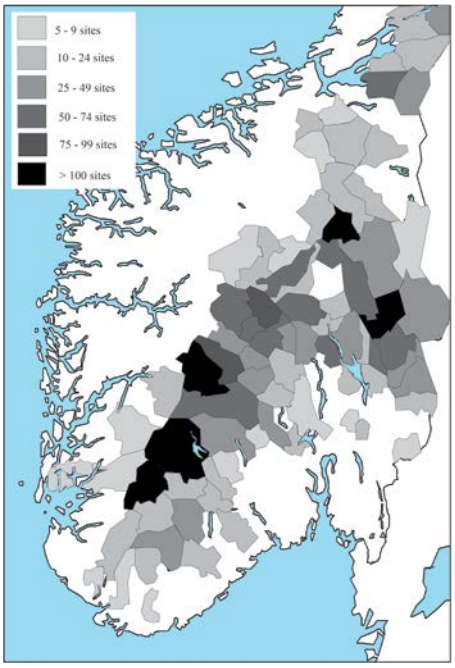

Figure 2. *Recorded iron production sites from the period c. 200 BC-AD 1800 (by 01/01/2010).*

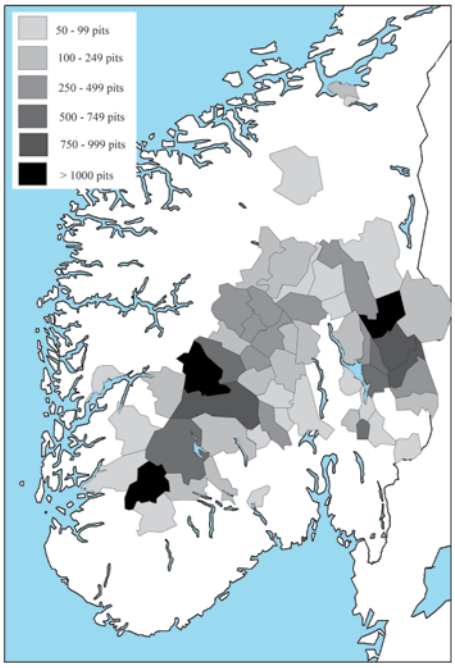

Figure 3. *Recorded charcoal pits, mainly from the period c. AD 700-1400 (by 01/01/2010).*

The iron production takes place over large areas of the outfield, and the maps above give a reasonably good picture of the general distribution. More detailed knowledge, which is necessary in the management of cultural heritage monuments, demands extensive and expensive surveys.

The -Opptakt Project

Oppland County Council has as a response to the general public demand of predictable planning processes established the -*Opptakt* project. Through this project, LIDAR technology ('LIght Detection And Ranging') is used to create detailed three-dimensional maps of the landscape, making it possible to track some of the cultural heritage monuments from the computer screen, particularly charcoal and hunting pits (Pilø et al. 2012; 2013; Pilø 2013). Through this project, a considerable number of iron production sites – mainly medieval, have been documented, giving new insight into this period of production.

The Gravfjellet area

Among the production sites investigated through the -Opptakt project is the mountain area *Gravfjellet*, a typical outfield area in Oppland, placed between 600 and 1,100 MASL. It is today covered by bogs and forest (spruce, birch and pine), with summer farms scattered in the landscape. Iron production is known to have taken place in the area, making it suitable as a test area for the LIDAR technology. In 2011, the area was scanned, and preliminary surveys were conducted. During the summer and autumn of 2012, more extensive surveys were conducted in c. 10 sq. km of Gravfjellet. After these surveys, c. 100 iron production sites and 450 charcoal pits are documented in the area of extensive surveys (Fig. 4). The distribution of iron production sites is much wider than this area, and based on the LIDAR scanning, some 700 iron production sites and 4,000 charcoal pits are estimated to be found in Øystre Slidre municipality, which Gravfjellet belong to (Pilø et al. 2012; Tveiten & Pettersson 2013).

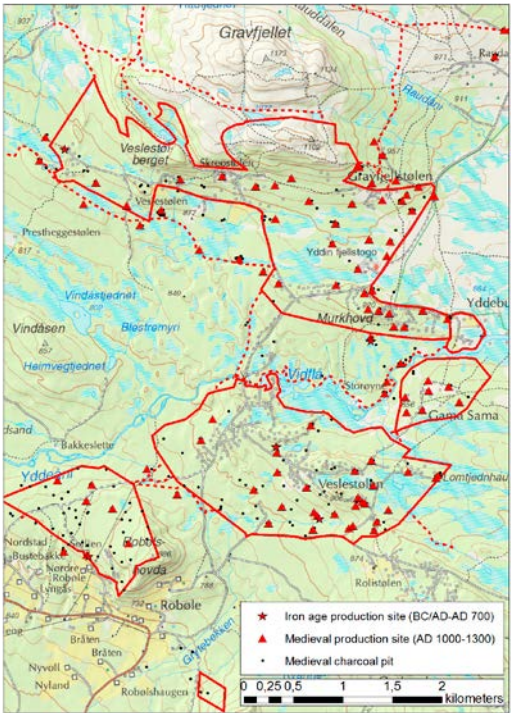

Figure 4. *Iron production sites and charcoal pits in the Gravfjellet area.*

Returning to the surveyed area, five of the c. 100 iron production sites are found to have shaft furnaces with slag pits, a type dated prior to the 8th century. The rest of the sites are found to have shaft furnaces with slag tapping, combined with charcoal pits, mainly dated from the 8th to 14th centuries. Radiocarbon dating from some of the sites in Gravfjellet, as well as from excavated sites nearby, indicates that the main period of iron production is the early 11th to mid-13th century, with a

rapid decline in the latter half of the 13th century (Narmo 1996, 186; Mjærum 2007, 185; Tveiten & Pettersson 2013, 40). Analyzes of pollen from bogs in Gravfjellet have shown that the intensive iron production is followed by a century of forest regrowth, before the use of the summer farms is intensified from the 16th century onwards (Tveiten & Pettersson 2013, 52).

Surveys and excavations in many parts of the Norwegian outfield have shown tendencies similar to the ones in Gravfjell, with a massive iron production from the 10th to the 13th centuries, followed by a massive decline. In some regions, the iron productions ceases in the first part of the 13th century, while others have some iron production until the mid-14th century. Some regions even have some iron production in the latter half of the 14th century, maybe also in the first part of the 15th century (Larsen 2009, 182-183). As far as it is known today, there is no continuity or geographical correlation between this production and the Norwegian bloomery iron production of the 16th to 18th centuries.

Why does the bloomery iron production decline?

A reasonable question is why this decline in iron production, which obviously must have been an important income in its time, occurred. Two factors have been put forward, often in combination. The late medieval crisis, made stronger by the declining population after the 1349-1350 plague, is a well-established fact in the historical agrarian research (Lunden 2002, 16). It is natural to relate the decline in iron production with this crisis, where not only the population is reduced, but where trade routes and market places are replaced, and a specialized market production in the outfield is replaced by a more closed home economy (Martens 1988, 126; Larsen 1991, 286-297; Narmo 1997, 191; Øye 2002, 393-394).

The agrarian crisis does not give a full explanation of the decline. Iron was still needed in society, and the bloomery production had to be replaced by some new form of supply. The 13th and 14th centuries do not only represent a period of decline in bloomery iron production. In this period, a new iron production technology based on rock ore is established. Particularly in Sweden, this technology is well documented. Excavations at *Lapphyttan* and several similar sites since the late 1970s have dated this activity as early as the 12th or 13th century. Here, blast furnaces are used to make pig iron, which in temporary written sources is called 'Osmund' iron (Magnusson 2011, 42). This has probably been a far more efficient technology, making more and cheaper iron than the bloomery process. The Norwegian bloomery iron production has probably not been able to compete with this new technology (Rundberget 2013, 320).

The agrarian crisis and cheaper Swedish iron are certainly important factors in the understanding of the decline in Norwegian iron production in the late medieval period. I still raise the question whether these are the only relevant factors in the understanding of this process. More particularly, I question whether the Norwegian iron production actually declined in this period. To do this, I will turn the focus to the second area where Oppland County Council recently has conducted surveys – Grua in Hadeland.

The rise of a new technology – iron production from rock ore in Grua, Hadeland

The village of Grua is situated in the southern part of Hadeland, a landscape of mainly wide farming fields. It is rich in different rock ores, and from the 16th to the 20th century, several ores are mined in the area; iron, lead, copper and tin. Lime and marble are also quarried in the area in the 19th and 20th century (Aasen & Günther 1995). The mining history of Grua is traced back to the 1540s, when the iron mine *Hadelandsgruven* is used by a new iron mill at Hakadal, some 20 km south of Grua. It is not clear whether this mine, which have given name to Grua – meaning 'the mine' – is totally new or an older mine that is reopened (Berg 2013, 53). In recent years, the question of earlier iron production in the Grua area has been raised (Asak 2006). Because of this, the Mining Museum at Grua and Oppland County Council have conducted surveys and excavations at some sites in the area, where late medieval iron production from rock ore may have taken place (Friis et al. 2014) (Fig. 5).

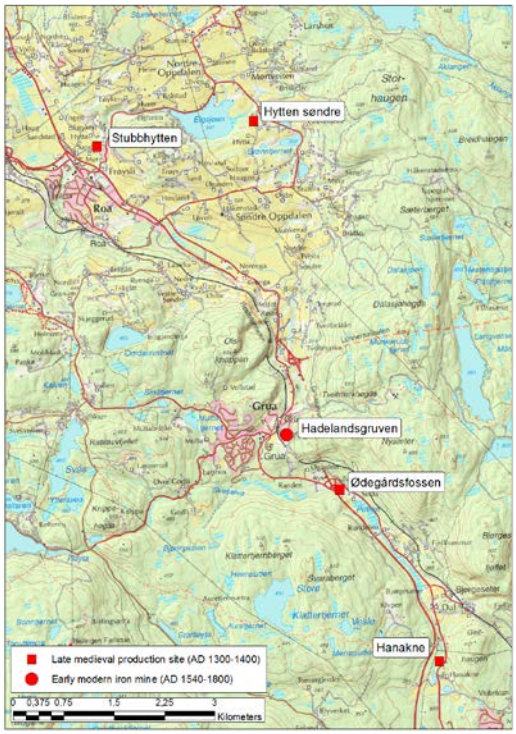

Figure 5. *The discussed sites in the Grua area.*

The site *Stubbhytten* is situated between a stream and a field, where slag, rock ore and charcoal have turned up during plowing. The farming, together with a 20th century grain mill, has damaged the site, and it is not possible to trace furnaces or other structures without further excavations. Still, some slag heaps between the field and the stream are reasonably intact, and three samples for radiocarbon dating are analyzed, giving the result AD 1290-1410, 1310-1425 and 1410-1450.

Hytten søndre is a site located c. 2 km east of Stubbhytten, by a small stream used by a mill in the 19th century. Slag and rock ore are found in this stream, together with the dam and parts of the millstone from the later mill. Unfortunately, the site is damaged by other recent activities, making it problematic to extract samples for dating of the site.

Ødegårdsfossen is situated a kilometer south of Hadelandsgruven, by a stream used by a saw mill in the late 19th century. The most visible structure at the site is a large heap of charcoal, while a slag heap is found between this structure and the stream. A sample from the charcoal heap is analyzed, giving the result AD 1290-1410.

Hanakne is situated by the same stream as Ødegårdsfossen, c. 3 km further to the south. While the other sites are all damaged by later use of the waterfalls or more recent activities, this site is almost intact. A corn mill is known to have existed close to the site, but on the other side

of the stream from the iron production. The remnants of the furnace, some 3 m high in its current state, are preserved, together with slag heaps and the site of a house used to store rock ore and charcoal (Fig. 6). Two samples of charcoal from the slag heaps have been analyzed, giving the result AD 1270-1380 and 1290-1410.

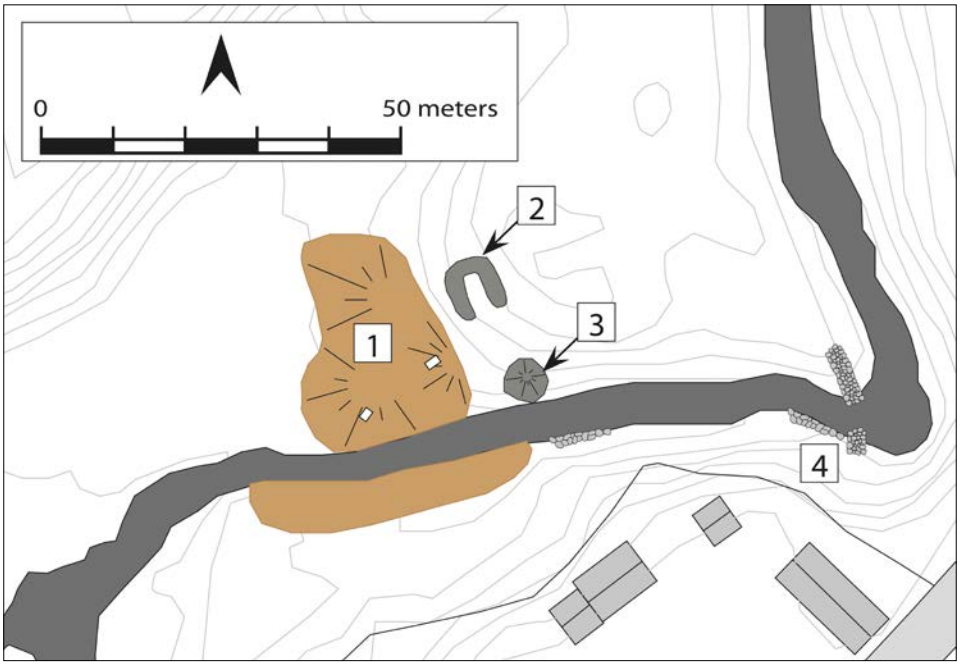

Figure 6. *The iron mill at Hanakne, Grua in Oppland. 1: Slag heaps. 2: House site, possibly a storage area for ore and charcoal. 3: Furnace. 4: Ruins of a mill and a dam, possibly from the 18th century.*

The radiocarbon dating results from the sites at Grua are all indicating activity in the area in the 14th century, possibly also the late 13th century. Of course, questions may be raised regarding the limited number of samples and the age of the wood in the analyzed samples, as when pine is used at the Hanakne site. An important factor is whether such old dating results from the activity may be supported by other sources.

Both the sites Stubbhytten and Hytten søndre are named by the nearby farms. 'Hytten' in these names is a German word (*hütten*), meaning smelting or extracting (Kirkeby 2004, 16). The name is first used at Grua in two documents from 1475 and 1476 (DN VI, 583; DN VI, 585; Alm 1975, 36-37), indicating that the activity was established in the area prior to 1475. These documents do not only tell about the situation in 1475, but also reveal that Hytten owned parts of the nearby outfield some 80 years prior to this. As the 'Hytten' name was established already back then, the iron production at these sites must go further back than the 1390s (Kirkeby 2004, 21-22). This corresponds well with the radiocarbon dating results from the sites. Together, the archaeological and historical material draws a picture of a well-established iron production from rock ore at Grua in the late 14th century. As we have seen, in Sweden, the technology may go as far back as the 12th century, and a similar early use of the

same technology is not impossible in Norway. The only historical evidence of the early iron production at Grua is the name 'Hytten', and archaeological excavations have been necessary to document the extent and time horizon of the activity. Excavation at other rock ore 'hot spots' may give further evidence of early iron production in Norway.

This study has only given preliminary results, but some thoughts concerning the technology and organizing of this iron production may be put through. Rock ore is found at the four sites, but it is not certain whether Hadelandsgruven is the source of this ore, or if smaller local mines close to the sites have been used. Further surveys and analyzes will have to answer this question.

In a paper from 1954, historian Gunnar Thuesen suggested 'rennherd' – small, open furnaces, as the only technology used to smelt rock ore prior to the 17th century (Thuesen 1954, 55). This hypothesis is based mainly on written sources, and also supported by excavations in Sweden since the late 1970s that have documented blast furnaces well prior to the activity at Grua (Magnusson 2011, 42). At Hanakne, an almost 3 meter high structure of slag and stone is preserved close to the stream. This structure is interpreted as a blast furnace, similar to the type found at Lapphyttan and similar Swedish sites. Of course, excavations and metallurgical analyzes will be necessary to confirm this hypothesis.

The organization of the iron production also needs to be investigated further. At the moment, I find it useful to draw parallels to Swedish sources, as found in a document concerning *Stora Kopparberg* in 1347. Here, the smelting process was led by master smelters, working in cooperation or in individual smelting huts. Charcoal production and mining were to some extend performed by specialists (charcoal producers and miners), where particularly the complex and expensive mining necessitated some kind of cooperation between the smelting huts (Berg 1998, 2-3). Further research into the ownership of farms and outfield resources is necessary to give a more complete picture of the relationship between the mining and smelting, and the farming society of the time.

Late medieval iron production – new perspectives

Even if the results from Grua in many ways open for more new questions than they answer, they also give new perspectives to the understanding of the late medieval iron production of Norway. We do not know who initiated the iron production at Grua. Also, did it occur as a result of a declining bloomery iron production, or as a competitor? The agrarian crisis has long been an important factor in explaining the decline in iron production, combined with the growth of an extensive Swedish mining industry. The surveys in Oppland show that late medieval iron production is more complex, involving entrepreneurs and new technologies. Even if some networks of iron production disappear, others – like the one Grua was part of – are established, based on new technology and new resources. The declining population, followed by destabilization of old trade routes and rights to outfield resources, may be important factors in the understanding of how these new networks could be established.

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