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# Central Norwegian Snow Patch Archaeology: Patterns Past and Present

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ABSTRACT. Over nearly a century, a large assemblage of archaeological artifacts has been collected from some high-lying snow patches in a number of mountain areas in central Norway. The regional collection now comprises 234 individual artifacts that include both organic and inorganic elements. Many of these are arrowheads, shafts, and other equipment from past hunting expeditions on alpine snow patches. This article outlines three different phases of artifact recovery in the region: Phase I (1914–43) began with the initial snow patch discovery and included large numbers of finds in the 1930s and early 1940s; Phase II (1944–2000) had relatively few discoveries; and Phase III (2001–11) included discovery of 17 new sites and a record number of 145 artifacts. Local reindeer hunters and hikers have recovered many of the artifacts. There are close links between reindeer hunting and snow patch surveying in the region. The majority of snow patch finds were recovered during the period from mid-August through mid-September. The collection can best be viewed as a cohesive long-term record of melting snow patches.

Key words: Scandinavia, snow patch, reindeer hunting, bow and arrow, alpine archaeology

RÉSUMÉ. Pendant près d'un siècle, un large assemblage d'artefacts archéologiques a été recueilli dans les névés en haute altitude de certaines régions montagneuses du centre de la Norvège. Cette collection comprend maintenant 234 artefacts individuels, composés d'éléments organiques et d'éléments inorganiques. Des pointes de flèches, des fûts de flèches et d'autre matériel provenant d'anciennes expéditions de chasse dans les névés alpins s'y trouvent en grand nombre. Cet article présente les trois phases de la récupération d'artefacts dans la région, soit la phase I (de 1914 à 1943) qui a commencé avec la découverte du névé et a donné lieu à de nombreuses découvertes dans les années 1930 et au début des années 1940, la phase II (de 1944 à 2000) qui s'est soldée par relativement peu de découvertes, et la phase III (de 2001 à 2011) qui a permis de découvrir 17 nouveaux sites et le nombre record de 145 artefacts. Grand nombre des artefacts ont été récupérés par les chasseurs de rennes et les randonneurs pédestres de la région. Il existe des liens étroits entre la chasse aux rennes et la couverture des névés de la région. La majorité des découvertes effectuées dans les névés a été faite de la mi-août à la mi-septembre. Cette collection représente un enregistrement cohésif et à long terme des névés en fusion.

Mots clés : Scandinavie, névé, chasse aux rennes, arc et flèche, archéologie alpine

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## INTRODUCTION

The large collection of snow patch artifacts housed at the Norwegian University of Science and Technology (NTNU) Museum of Natural History and Archaeology in Trondheim has been the subject of many years of research (Farbregd, 1972, 1983, 1991, 2009). Yet no detailed overview of the entire snow patch collection from central Norway exists at present. A collection of this kind, having been assembled over such a long time-frame (1914–2011), has great potential for both archaeology and other disciplines, especially in light of the current focus on melting alpine snow patches and their perceived relationship with shifting weather patterns and global climate change. A detailed presentation of the collection is an important first step towards more detailed archaeological and multidisciplinary research in the future. Some of the issues raised in this treatment may be relevant for similar collections from other regions as well.

This article presents in detail the snow patch sites and finds discovered in central Norway during the period 1914–2011, focusing on both the composition of the collection and the time when the artifacts were discovered. It seeks to uncover relevant patterns within the snow patch collection as a whole and to identify any methodological issues that may lie behind the patterns that emerge. The central question in this regard is the following: Can this collection can be viewed as a cohesive long-term record, or should it be seen as representative of a series of disjointed periods of discovery?

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## SNOW PATCH ARCHAEOLOGY IN NORWAY

At present, archaeological snow patch discoveries are known from four different regions of Norway. The most comprehensive finds come from two southern regions: the municipality of Oppdal in Sør-Trondelag County and the area centered on the municipality of Lom, in Oppland County. Oppdal is a municipality in the county of Sør Trøndelag, while Oppland is a large inland county that lies farther to the south (Fig. 1). A handful of individual finds have been recovered in inner mountain areas along the west coast (Shetelig, 1917; Åstveit, 2010). Two arrows discovered in 1999 at Seiland, Finnmark, are the northernmost finds in the country to date (Johansen, 2002).

Roughly 50 snow patch sites and find spots are known in Norway at present. Sites are usually found at elevations of 1400 m asl or above. However, the arrows from Seiland were recovered from sites lying at ca. 700 m asl, which underlines the possibility of making new snow patch discoveries at lower elevations in higher latitudes (Johansen, 2002).

On the basis of the current evidence, two types of sites are associated with archaeological snow patches in Norway: arrow sites and larger hybrid hunting/trapping sites. Both of these snow patch types have a number of particular characteristics, potentials, and challenges associated with them.


FIG. 1. Location of the four snow patch regions in Norway: 1) Oppdal, 2) Oppland County, 3) Vik, Sogn, and Fjordane, and 4) Seiland, Finnmark.

### *Arrow Sites*

Arrow sites are the most common type of snow patch site and are present in all four regions outlined in Figure 1 (e.g., Shetelig, 1917; Farbregd, 1972; Johansen, 2002; Finstad and Pilø, 2010). Materials recovered from arrow sites consist mainly of iron, bone, antler, and lithic arrowheads and wooden arrow shafts. Artifacts usually associated with hunting activities, such as bow fragments, knives, and snaresetters, are also occasionally recovered from arrow sites.

The state of preservation of the recovered artifacts varies from whole arrows with fletchings and adhesive to disassociated arrowheads and shaft fragments (Fig. 2). Artifacts found on arrow sites are interpreted as being largely the result of past reindeer hunting, although prey such as grouse and certain furred animals were trapped and possibly hunted too on these sites (Åstveit, 2007; Farbregd, 2009; Callanan, 2010).

Archaeological materials on arrow sites are found either on, around, or below melting snow patches (e.g., Farbregd, 1972). Earlier research has shown that artifacts were deposited on some arrow sites over long time periods of prehistory (Farbregd, 2009) and thus offer valuable insights into past technical traditions and hunting activities over long time spans. The arrow sites of central Norway form the main focus of this article.

### *Hybrid Hunting/Trapping Sites*

A number of discoveries made in Oppland County since 2006, including that of a well-preserved hunting/trapping system close to a snow patch at Juvfonna, have added a new dimension to Norwegian snow patch archaeology in recent years. The site at Juvfonna (1835 m asl) is likely the result of a hybrid form of hunting and trapping, in which reindeer were led or driven toward hunters hiding in carefully positioned blinds (Wammer, 2008). The archaeological remains

FIG. 2. This well-preserved arrow shaft and iron point were discovered lying directly on the ground close to Storbreen, Oppdal, on 21 August 2010. This kind of context is typical for the majority of finds in the central Norwegian collection. Photo: Martin Callanan.

recovered at Juvfonna consist of both organic finds and stone-set structures. Organic elements include large numbers of whole and fragmented sewels. A sewel is a thin branch or pole, with a light attachment of wood or bark fixed to the top (See Speiss, 1979:128). Lines of sewels were arranged in corridors that led reindeer to kill zones, where hunters were waiting behind stone-set hunting blinds.

Hybrid sites offer a different kind of information compared with arrow sites, producing a large number of organic finds that were probably deposited during single episodes. The organic elements recovered are the result of chronologically contiguous structures and activities and offer evidence of events restricted in time. That said, the indications are that hybrid systems were established and then reestablished on individual sites over considerable time spans. For example, elements of the hunting system at Juvfonna have been radiocarbon-dated to two distinct periods of the Iron Age (Finstad and Pilø, 2010). Since 2006, a number of additional sites of both arrow and hybrid types have been discovered in adjacent areas (Jotunheimen, Breheimen, and Reinheimen) (Finstad and Pilø, 2010). The artifacts recovered from snow patches in Oppland cover a broader range than those from the Oppdal area. Besides arrows and sewels, the Oppland finds include items such as wooden spades, textiles, and even a 3500-year-old shoe (Finstad and Vedeler, 2008; Finstad and Pilø, 2010).

### *Snow Patch Management in Norway*

Cultural heritage management in Norway is organized at county and regional levels, ostensibly under the administration of the Norwegian Directorate for Cultural Heritage. Approaches toward managing archaeological snow patches have evolved differently in counties where the snow patch phenomenon has been identified. Local conditions, available resources, traditions, and not least, the initiative of local curators and managers have all been important factors underlying the various local approaches to snow patch management. In the municipality of Oppdal, snow patch archaeology is based largely on the efforts of local collectors, who survey sites and recover finds in collaboration with the NTNU Museum of Natural History and Archaeology in Trondheim. In the county of Oppland, on the other hand, snow patch management and field surveys are the responsibility of county archaeologists, who also engage actively in public and political outreach activities that help to create an awareness of the significance and fragility of the archaeological heritage appearing from melting snow patches.

## SNOW PATCH ARCHAEOLOGY IN CENTRAL NORWAY

### *Arrow Sites in Central Norway*

The term "central Norway," as used in this article, refers to a large, mountainous, inland area that lies roughly between 62° and 63° N. The area includes a number of municipalities within Sør Trøndelag and Møre & Romsdal County Authorities. The landscape in the region is characterized by a generally east-west gradient with respect to glacial re-sculpturing of the pre-Quaternary land surface. The western areas have high relief from deeply scoured major glacial valleys and alpine topography between these valleys, whereas large parts of the eastern areas are still dominated by pre-Quaternary surfaces of low relief and gentle slopes. Some glaciers are present in the region, but the altitude of the equilibrium line rises above the topography east of the Snøhetta mountain massif (2268 m asl).

Wild mountain reindeer still populate portions of this region, and the hunting of reindeer and other prey is still practiced throughout the autumn.

At present, there are 27 archaeological snow patches in this region (Table 1). The majority are found in alpine areas to the south and east of the mountain town of Oppdal (Fig. 3). Find-bearing sites are located at elevations between ca. 1350 and 2000 m asl. Archaeological snow patches vary greatly in size, from large patches such as Storbreen and Evighetsfonna at Sandåfjellet, which measure up to 1500 m along the slope and several hundred meters downslope, to smaller patches such as that at Kaldvellkinn, which measures as little as 100 m by 50 m during the melting season. A map-based survey shows that most of the region's archaeological snow patches are oriented towards the northeast or east. As can been seen from Table 1, the snow patch collection is dominated by finds from five patches. These lie in two areas close to one another to the south and east of Oppdal (Fig. 3).

Snow patches often lie laterally along or under mountainsides, ridges, or tops. Some patches appear almost as if draped or wedged onto the underlying topography, and as a result, they can become very steep, particularly in a reduced state. Such is the case on the patches at Leirtjønnkollen and Løpesfonna, whereas on other larger patches, surfaces are more expansive and relatively flat. Measurable altitude differences on individual patches range from ca. 5 to 250 m.

Snow patches follow irregular annual cycles of accumulation in winter and ablation in summer. Archaeological finds are usually recovered during years of large negative mass balance, towards the end of the summer melt. Under such conditions, patches often appear as areas of snow or ice with dirty surfaces, at times surrounded by halos of lighter, lichen-free ground that outline the patches' previous extent. The archaeological season usually ends towards the end of autumn, once temperatures drop and snowfall returns.

Snow patches are dynamic contexts. Densification processes occur as new snow becomes compacted and transformed from snow through firn to ice, or as meltwater or water-soaked snow re-freezes (Nesje, 1995). During the course of these cycles, the horizontal and vertical form of snow patches varies considerably on an annual basis but especially over longer time scales. During summer months, layers of new snow retreat along the surface of the snow

TABLE 1. Overview of archaeological snow patches in central Norway.

| Snow patch | Latitude (N) | Longitude (E) | Elevation (m asl) | Orientation | No. of finds |
|---|---|---|---|---|---|
| Storbreen | 62° 21′51″ | 9° 24′48″ | 1810 | NE | 48 |
| Kringsollfonna | 62° 30′51″ | 9° 44′38″ | 1520 | NNE | 43 |
| Leirtjønnkollen | 62° 27′25″ | 9° 44′37″ | 1560 | NE | 35 |
| Brattfonna | 62° 28′38″ | 9° 46′25″ | 1470 | N-E | 32 |
| Løpesfonna | 62° 22′11″ | 9° 22′27″ | 1730 | NE | 18 |
| N. Knutshø | 62° 19′31″ | 9° 40′26″ | 1630 | NE | 8 |
| Vegskardet | 62° 21′56″ | 9° 19′35″ | 1500 | NE | 5 |
| Løftingfonnkollen | 62° 22′32″ | 9° 23′20″ | 1680 | NNE | 3 |
| Tverrfjellet | 62° 28′33″ | 9° 20′55″ | 1270 | NE | 3 |
| Bekkfonnhøa | 62° 32′09″ | 9° 41′34″ | 1360 | NNV | 3 |
| Kaldvellkinn | 62° 30′47″ | 9° 44′49″ | 1550 | ENE | 3 |
| Sandåfjellet/ Svorundfjellet | 62° 37′46″ | 9° 11′37″ | 1530 | E | 2 |
| Langfonnskarven | 62° 27′01″ | 9° 38′59″ | 1330 | E | 2 |
| Kinnin | 62° 21′24″ | 9° 26′40″ | 1720 | E | 2 |
| Kringsollfonna+ | 62° 30′52″ | 9° 45′33″ | 1400 | NNE | 1 |
| M. Knutshø | 62° 18′42″ | 9° 40′49″ | 1545 | E | 1 |
| Hesthågåhøa | 62° 23′59″ | 9° 35′18″ | 1530 | N | 1 |
| Snøhetta | 62° 19′61″ | 9° 17′29″ | 2000 | E | 1 |
| Skiråtangan, Sunndal | 62° 26′41″ | 9° 05′50″ | 1450 | NE | 1 |
| Råstu, Sunndal | 62° 31′18″ | 8° 47′24″ | 1547 | NE | 1 |
| N. Svarthammaren, Sunndal | 62° 26′55″ | 8° 44′59″ | 1700 | NE | 1 |
| Grovåbotn, Nesset | 62° 21′58″ | 8° 12′55″ | 1390 | N | 1 |
| Sissihøa | 62° 33′04″ | 9° 43′36″ | 1360 | N | 1 |
| Gravbekkfonna | 62° 27′08″ | 9° 30′09″ | 1300 | NNE | 1 |
| Namnlauskollen | 62° 22′25″ | 9° 25′19″ | 1750 | NE | 1 |
| Skirådalskardet | 62° 26′32″ | 9° 11′47″ | 1765 | E | 1 |
| Svartdalskardet | 62° 28′29″ | 9° 17′15″ | 1815 | NE | 1 |
| Sissihøa-Leirtjønnkollen (10 × 2 km) | – | – | > 1400 | – | 14 |
| | | | | | Total = 234 |

patch. Patches also contract inwards from the outer edges (Farbregd, 1983). At times, melting beneath the upper and lower edges, which is probably due to heat-transfer from meltwater, makes it possible to peer under the edges of the snow patch. Meltwater is frequently observed flowing out from under the lower edges of snow patches and may also flow internally along denser layers that formed earlier. On larger patches, meltwater gullies often form on the surface and at times cut deeply into the upper snow layer (Farbregd, 1983). The ground directly below snow patches is often severely waterlogged, as frozen ground conditions inhibit meltwater infiltration.

Much of the observable annual and multi-annual variation in the size of mountain snow patches is related to recent layers of new snow. These layers are renewable and shield the central ice core in some way. Changes in the relationship between the upper snow layer and the inner ice core probably play an important role with regard to the transportation of archaeological materials on both long and short time scales (Farbregd, 1983).

The "dirty" surfaces of exposed ice cores appear in years when melting is great. These dark grey, dark brown, and black surfaces are one of the key characteristics used to identify advanced melting on archaeological snow patches. The emergence of dirty surfaces on local snow patches has been documented over a number of years in the photographic and correspondence archive in Trondheim. Surface materials are often explicitly described by collectors as sludge (NOR. *slam*). The indications are that this material is a combination of reindeer feces, sediments carried downslope by meltwater, and wind-blown floral material (cf. Warren Wilson, 1958). From descriptions of snow patch surfaces in the 1930s, it appears that episodes of dense sludge cover were more common in the past than now (Farbregd, 2009: Fig. 6). However sludge layers have occasionally appeared on local snow patches in recent times (Fig. 4). Within a Norwegian context, surface sludge from melting snow patches has not been sampled, and it remains to be demonstrated whether this material is of minerogenic, faunal, or floral origin.

*Snow Patch Finds*

A total of 234 individual artifacts have been recovered from the 27 patches registered in the period 1914 – 2011. The central Norwegian snow patch collection comprises arrows, arrowheads, and arrow fragments in addition to a small number of related artifacts: bow fragments, knives, and other tools, such as a snare-setter. A number of unidentified but modified wood and bone fragments are also part of the collection. Until quite recently, unmodified faunal material had not been collected from sites in the region. As preservation of organic components is one of the main characteristics of the snow patch collection, the material composition of individual artifacts forms the basis for this presentation.

In Table 2 the collection is divided into two main groups; organic and inorganic finds. The organic group comprises artifacts made of wood, bone, antler, or with preserved accompanying organic adhesive or sinew lashings. This group also includes composite artifacts with both organic and inorganic elements, and in these cases, the organic

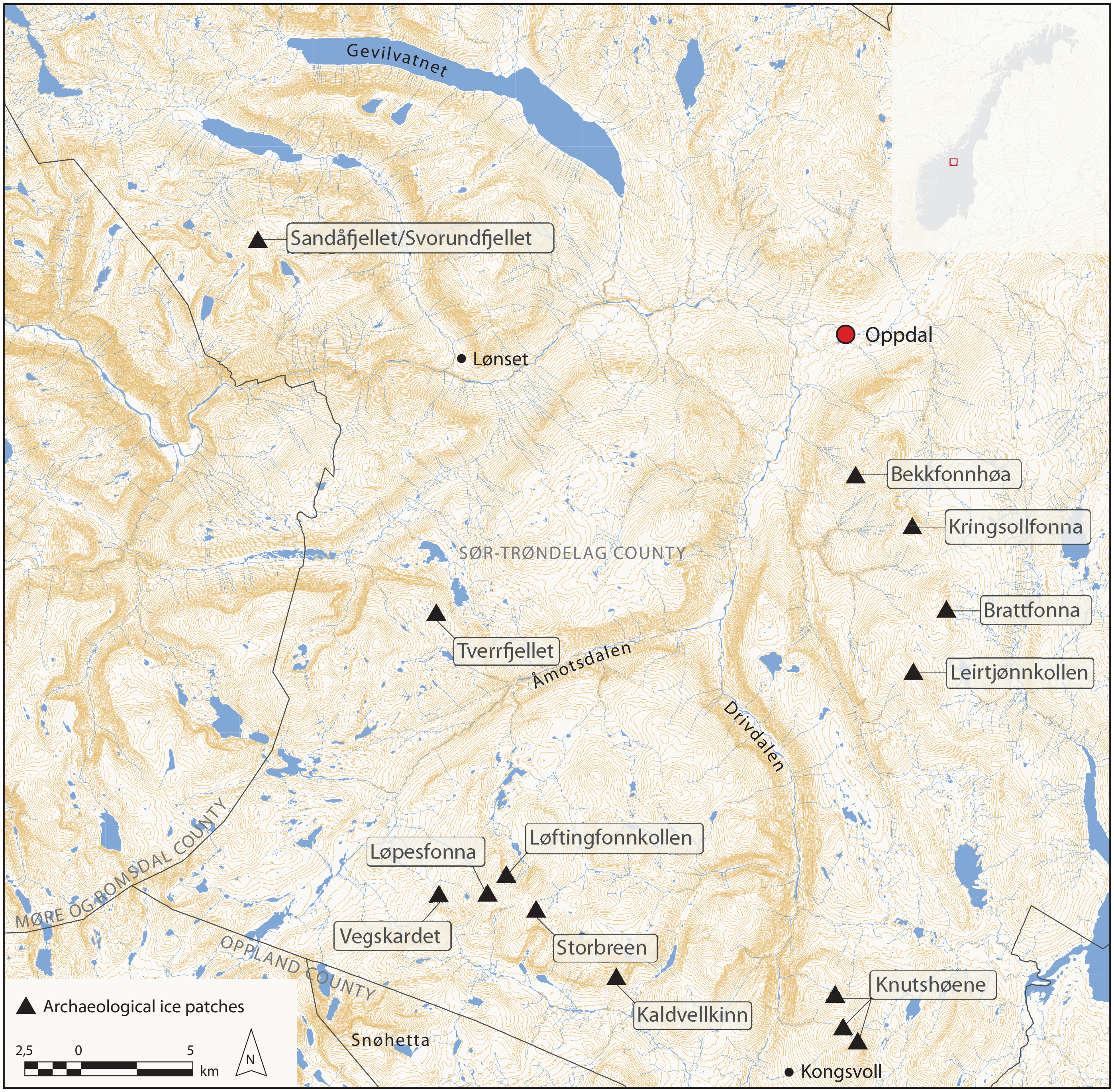


FIG. 3. Location of the principal snow patches of central Norway.

element has taken precedence for classification purposes. For example, a find comprising a complete wooden shaft and iron arrowhead is sorted under "organic finds" within the present system. The material composition of all arrowheads, such as iron, stone, bone, or antler, is also listed under "organic finds." All finds are counted only once in Table 2. For example, the collection contains a total of three bone arrowheads. Two of these are listed under different subgroups as shafts with points, while the third is listed as a loose point. Organic finds dominate the collection, representing 70% of recovered materials.

The group "inorganic finds" is dominated by disassociated iron arrowheads. Moreover, a slate arrowhead, a knife, and a disassociated metal fixture belonging to a club-headed arrow are included in this group. Inorganic elements represent 30% of the present collection.

Basic information regarding the condition of recovered artifacts is also presented in Table 2. As the majority of finds are prehistoric and historic arrows, the completeness of individual arrows forms the basis for organizing recovered shafts into three distinct groups: whole arrows, shaft sections, and shaft fragments. Artifacts are considered

FIG. 4. Sludge layer along the upper slope at Kringsollfonna, Oppdal, on 15 September 2003. Photo: Ingolf Røtvei.

whole arrows if the entire shaft, including both the distal and proximal ends, is present. Contiguous or refitted portions of shafts measuring more than 40 cm in length are classified as shaft sections. Contiguous, discontinuous, or refitted portions of shafts less than 40 cm long are classified as shaft fragments. Extant shaft fragments are grouped in this way because previous research has shown that whole shafts rarely exceed 75 cm in length (Farbregd, 2009: Fig. 9). Setting a metric border between sections and fragments at 40 cm allows us to highlight arrows of which more than half of the shaft is present.

The collection includes a total of 38 complete shafts and 43 arrow sections. The remaining 54 arrows are present as fragments. The general condition of the arrow group as a whole points in two different directions. First, the fact that so many whole arrows and arrow sections have been recovered appears to indicate that snow patches are relatively static environments that allow complex and delicate organic artifacts such as arrows to survive in relatively good condition. On the other hand, the large number of fragments also reminds us that some arrows are being exposed to destructive mechanical or environmental forces, or both.

### *Dating the Snow Patch Collection*

The age of the Trondheim collection of snow patch artifacts has been the subject of a number of studies (Farbregd, 1972, 1983, 1991, 2009; Åstveit, 2007). The chronological framework for snow patch finds has been developed typologically by comparing recovered iron arrowheads with well-established regional chronologies of finds from closed pagan graves. The result is a detailed regional chronology of arrow and crossbow projectile development for the approximate period AD 200 – 1700 (cf. Farbregd, 2009: Fig. 9). The large majority of snow patch finds can be assigned to two distinct periods: ca. AD 400 – 600 and ca. AD 1200 – 1700 (Farbregd, 2009). In recent years, the radiocarbon-dating of a number of atypical artifacts has considerably broadened the collection's chronological horizon. At present, the earliest radiocarbon-dated snow patch find from central Norway is dated to between 2480 and 2340 cal BC. The date is derived from organic adhesive remains recovered from the tang of a slate arrowhead (Åstveit, 2007: Fig. 5).

## PATTERNS IN ARTIFACT RECOVERY

### *Source Critical Issues*

The Trondheim snow patch collection has been collected over almost 100 years, between 1914 and 2011. A collection as old as this presents its own particular problems as research questions, perspectives, and especially equipment have changed over time. Today, many people carry mobile telephones with integrated GPS units and digital cameras that can record and send digital photos and accurate GPS positions instantaneously. These capabilities were unthinkable even a few years ago. As a result, one of the challenges in working with the Trondheim collection as it continues to grow lies in aligning contextual information from older finds with that from newer ones, so that the collection forms one cohesive unit.

Fortunately, most of the source-critical work has already been carried out by Farbregd in his 1972 publication. However, there are still some holes in the records. For example, precise geographical information on a group of 14 finds from the area between Sissihøa and Leirtjønnkollen in the eastern mountains has been lost (Table 1). For this reason, the sample numbers vary in the presentation that follows, as finds with incomplete contextual information have been omitted where appropriate.

## THREE PHASES OF SNOW PATCH ARTIFACT RECOVERY IN CENTRAL NORWAY

The year of discovery can be identified for 211 of the total 234 finds (Fig. 5). The distribution over time of these discoveries, separated into organic and inorganic elements, is presented in Figure 5. The history of snow patch artifact recovery in central Norway during the period 1914 – 2011 can be divided into three main phases, which are defined by the numbers of finds recovered and important developments in the way they were collected. Following an initial discovery in 1914, the first phase is marked by a large number of finds that were recovered during the late 1930s and early 1940s. There followed a second phase of almost 60 years with relatively few discoveries. The third phase, during which large numbers of finds are again being recovered, has lasted from 2001 until today.

### *Phase 1: 1914 – 1943*

Following an initial discovery in 1914, the vast majority of finds from this first phase were made during seven seasons between 1936 and 1943. This was a period of variable weather with a series of mild winters and extremely

TABLE 2. Inventory of the central Norwegian snow patch collection (n = 234).

| Artifact | Material | Number of Finds |
|---|---|---|
| **Organic Finds (n = 165)**: | | |
| Whole shaft with point | Iron | 19 |
| | Antler | 2 |
| | Shell | 1 |
| | Slate | 1 |
| Whole club-headed arrows | Wood | 2 |
| Club-headed arrow section | Wood | 1 |
| Shaft section with point | Iron | 12 |
| | Shell | 1 |
| Shaft fragment(s) with point etc. | Iron | 13 |
| | Bone | 1 |
| | Slate | 2 |
| Whole shaft | Wood | 13 |
| Shaft section | Wood | 29 |
| Shaft fragments | Wood | 38 |
| Bow fragments | Wood | 5 |
| Bone point | Bone | 1 |
| Wood fragments | Wood | 23 |
| Bone fragments | Bone | 1 |
| **Inorganic Finds (n = 69)**: | | |
| | Metal points | 66 |
| | Stone point | 1 |
| | Other | 2 |
| | | Total = 234 |

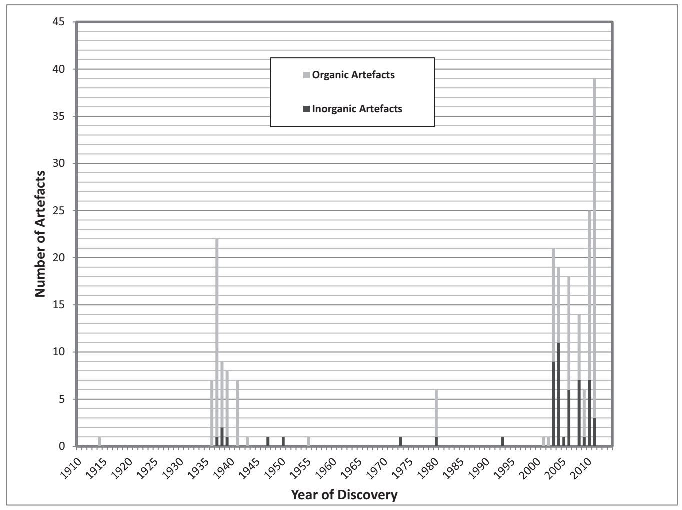


FIG. 5. Central Norwegian snow patch finds (n = 211) by year of discovery.

warm summers in quick succession, during which many of the large maritime and continental glaciers retreated (Fægri, 1938). It was during this phase that the tradition of snow patch surveying and collection first began in Oppdal, in cooperation with the Museum of Natural History and Archaeology in Trondheim (Farbregd, 1972, 1983; Callanan, 2010). A small number of local people began recovering arrows and other artifacts from snow patches in the mountain areas of Oppdal where they hunted and hiked.

During Phase 1 (1914 – 43), a total of 69 finds were collected from eight sites in the southern and eastern mountains, as well as at Sandåfjellet in Trollheimen (Fig. 3). Judging by the records in the archive at NTNU Museum of Natural History and Archaeology in Trondheim, the intensity of surveying activities varied during this phase. There is no evidence of surveys being carried out as a result of the initial discovery in 1914. However, starting in 1929, a small number of finds were recovered from mountain areas in and around some of the large snow patches, which seems to indicate a certain level of surveying. The main period of regular snow patch surveying in the mountains around Oppdal appears to have begun in the mid 1930s, with intense surveying carried out by a handful of local collectors. Artifacts recovered include iron and bone arrowheads, complete arrows and shafts, and shaft sections and fragments as small as 4 cm long (Farbregd, 1972). The collectors also provided detailed descriptions and observations of sites and contexts, which proved vital in helping archaeologists understand the prehistoric background for these discoveries and the connection between artifact and snow patch. Phase 1 ended with the last snow patch discovery made by a member of the pioneer group of collectors in 1943.

While it seems clear that there is a direct relationship between the discovery of large numbers of finds and the unusual weather patterns during 1914 – 1943, other factors may also have contributed to these numbers. It seems reasonable to suggest that a proportion of the finds recovered during Phase 1 had probably melted out of the snow patches for the first time at some date prior to their discovery. Under this scenario, the warm weather with mild winters during the 1930s not only caused alpine snow patches to melt and release artifacts for the first time (i.e., primary melt), but also allowed the recovery of artifacts that had accumulated around snow patches as a result of earlier melting events (i.e., secondary melt). At present, without specialist material studies, it is all but impossible to determine exactly which finds resulted from primary melts and which from secondary melts. But it is likely that the "discovery effect" of finding accumulations of artifacts during initial surveys is a general phenomenon associated with newly discovered archaeological snow patches.

*Phase 2: 1944 – 2000*

Phase 1 was followed by a 60-year period in which few new finds or sites were discovered. From 1944 to 2000, only 12 finds were recovered and two new snow patches added to the list of known sites. New finds included both organic and inorganic finds (Fig. 5, Table 3). The key question relating to this second phase is why so few finds were recovered. Did collectors stop surveying sites, or are there other factors that could explain the decline in the number of finds recovered?

Members of the pioneer group of collectors eventually retired or passed away, and new names began to appear on find lists. The general impression one gets from the records of Phase 2 is that surveying activities were not as intense as during the late 1930s. But there are signs of continuity too. The collectors of the second phase were younger associates of their predecessors. Some even hunted together with their

TABLE 3. Number of recovered finds[1] in the snow patch collection through three phases in the period 1914–2011.

| Period | Total | Organic (n) | Organic (%) | Inorganic (n) | Inorganic (%) |
|---|---|---|---|---|---|
| 1914–1943 | 69 | 60 | 87% | 9 | 13% |
| 1944–2000 | 12 | 6 | 50% | 6 | 50% |
| 2001–2011 | 145 | 97 | 67% | 48 | 33% |

[1] Eight artifacts for which the records are incomplete are excluded from the table.

older colleagues around classic snow patch sites (T. Bretten and I. Røtvei, pers. comm. 2010). It seems unlikely that local awareness of the region's snow patch tradition would be forgotten within such a short time. In support of this view, a search of the Museum's catalogue for this period reveals that of the 29 stray, non-snow patch finds recovered in Oppdal municipality during 1943 – 2001, a total of 17 were recovered in alpine locations or altitudes. The fact that hunters and hikers continued to make archaeological discoveries from time to time in relevant alpine areas lends further credence to the argument that snow patches were indeed being surveyed during this phase, but that the finds or the conditions suitable for their recovery were not present.

A key development during Phase 2 was Oddmunn Farbregd's engagement in snow patch archaeology in the region. Farbregd was based at the NTNU Museum of Natural History and Archaeology in Trondheim from the early 1970s, and his involvement has been central to both the continuation and the development of snow patch archaeology in the region.

From 1968 on, Farbregd carried out a number of small-scale surveys of central snow patches during the late summer melt season. In addition, by conferring with local hunters and other informants, he monitored annual developments on local snow patches during the melting season. Advanced melting is reported to have taken place in 1955, 1970, 1980, and 1986, and some finds were recovered as a result (O. Farbregd, pers. comm. 2011). In 1980, in response to reports of advanced melting, an extensive survey of the region's classic snow patches was mounted. This survey resulted in the recovery of a number of artifacts (Fig. 5, Table 3), the identification of a new site in the southern mountains, and the publication of survey results (Farbregd, 1983).

Farbregd's second important contribution during this phase was his role in continuing and renewing the local network of collectors based in Oppdal. A number of the pioneer collectors were interviewed in the late 1960s (Farbregd, 1972). Towards the end of Phase 2, new members joined the collector group. And thus an important continuity from the pioneer group of collectors was ensured through this second phase.

Other strands of evidence indicate that the paucity of finds during Phase 2 was probably more a result of the general conditions at the time, rather than a break in the snow patch surveying tradition. Regional meteorological records for 1944 – 2000 show generally colder temperatures compared to a high point in the 1930s, while precipitation levels remained relatively stable during the same period (Hanssen-Bauer, 2005: Figs. 2 and 9). In general, we should be wary of applying such regional data uncritically to local snow patches. But these data appear to suggest that the extreme conditions documented in the mid 1930s gave way to conditions more favorable to the maintenance of positive mass balances during the period 1944 – 2000.

*Phase 3: 2001 – 11*

The third phase of snow patch archaeology in central Norway is again a period of regular advanced melting, with large numbers of finds being recovered. The 2010 and 2011 seasons in particular have produced a record-breaking number of artifacts.

A total of 145 artifacts, both organic and inorganic, have been recovered from local snow patches during Phase 3, and 17 new sites have been identified, bringing the regional total to 27 sites (Fig. 4, Table 3). New sites have been identified both within the core areas around Oppdal and in the neighbouring municipalities of Sunndal and Nesset farther to the west.

The traditional network of local collectors has been renewed and expanded during this phase, building on efforts in the previous phase. Since 2003, site surveys have been more regular and systematic, with collectors spurred on by the increased numbers of finds and repeated advanced melting (T. Bretten, pers. comm. 2010). The period has been characterized by unstable weather conditions, with extreme melting taking place on certain sites in 2003, 2004, 2006, 2010, and 2011.

A new development during Phase 3 has been the regular use of metal detectors to recover iron arrowheads. One of the current collectors has specialized in surveying areas adjacent to snow patches with the aid of a metal detector. The widespread use of iron arrowheads throughout the late prehistoric period in Norway makes metal-detecting a very effective method for recovering artifacts buried in sediments and gravels at the base of snow patches. This approach has proved very successful and has produced significant results during Phase 3 (Table 4). The vast majority of the metal detector finds consist of disassociated arrowheads (See Åstveit, 2007: Fig. 2, for a notable exception).

Many important questions need to be asked about these finds and their contexts. When did they emerge from the snow patches? Are there any patterns in the age of metal detector finds? How and at what rate did they become

TABLE 4. Overview of metal detector finds recovered during Phase 3 (2001–11).

| | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2008 | 2009 | 2010 | 2011 |
|---|---|---|---|---|---|---|---|---|---|---|
| Total number of finds | 1 | 1 | 21 | 19 | 1 | 18 | 14 | 6 | 25 | 39 |
| Metal detector finds | 0 | 0 | 4 | 9 | 1 | 6 | 6 | 4 | 3 | 1 |

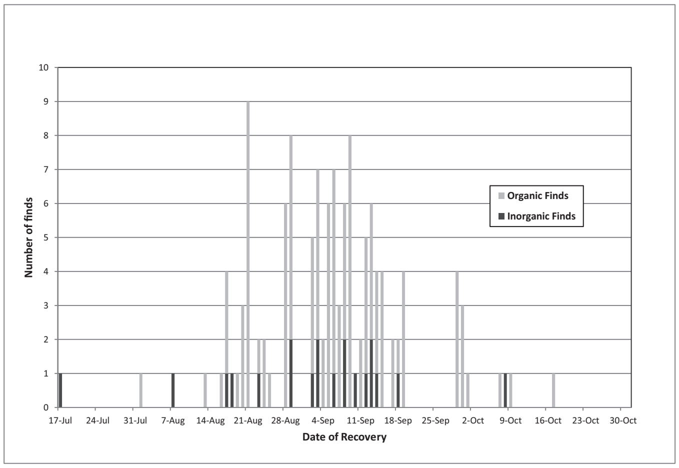


FIG. 6. Date of discovery of 128 artifacts found in the snow patches of central Norway.

buried? And what might the artifacts' locations tell us about the patches' previous extent and development? At present, the hypothesis is that some of these finds were released from snow patches during melting events that probably predate the initial 1914 discovery. The fact that some arrowheads have been recovered with metal detectors as far as 50 m from the edge of current snow patches lends support to this hypothesis. An overview of metal detector finds for the relevant years during Phase 3 is presented in Table 4.

## A COHESIVE LONG-TERM RECORD?

### *Continuity?*

The central question behind this review was whether the central Norwegian snow patch collection can be viewed as a cohesive long-term record, or whether it should be looked upon as representing a series of disjointed periods of discovery.

The review indicates that while there may have been some periodic variation in the level of surveying activity on and around snow patches, there was also a strong element of continuity between the three phases.

With regard to the 1944 – 2000 phase, the fact that from 1968 onward, sites were being visited and regularly monitored, and that focused surveys were carried out when suitable conditions presented themselves, indicates that the demonstrated find hiatus cannot be explained by lack of surveying. There is, however, one final piece of evidence in this regard.

### *Surveying and Reindeer Hunting?*

The dates of recovery for individual snow patch finds in the region are presented in Figure 6. The sample for this analysis is reduced (n = 128) as the precise date of recovery was not always recorded, especially during Phase 1. However, all three phases are represented, and the results are clear: the vast majority of snow patch finds in the region are recovered during a four-week period between the middle of August and the middle of September. This short window of opportunity for making discoveries is characteristic for snow patch archaeology. The period of maximal melting towards the end of the season is the time when one is most likely to recover artifacts. But it is also the time when bad weather and snow can cause problems for collectors in the field and ultimately bring an end to the surveying season (Farbregd, 2009). At first glance, one might easily conclude that it is this short window that is depicted in Figure 6—the period between the release of finds from patches, on the one hand, and the end of the season, as the first snow of winter falls, on the other. In reality, something else is also contributing to this distribution.

The vast majority of finds from central Norway are found by private collectors, many of whom are reindeer hunters. And many of the find-bearing patches lie in areas that are active hunting zones today. Reindeer hunting in Norway is heavily regulated, and there are restrictions on when, where, and how many animals may be felled each year. Although rules and practices have varied through the years, certain levels of regulation have been in place in the area in question since the early 1900s (Jordhøy, 2001). At present, reindeer hunting in central Norway is regulated to the period from the middle of August to the middle of September. This has long been the tradition. Thus it becomes clear that the pattern presented in Figure 6 is as much a record of hunters' activity in areas around snow patches as it is a record of the optimal find window. Reindeer hunting was the key factor drawing hunters up to the alpine zone, where they also made archaeological discoveries. From this perspective, Figure 6 is a clear illustration of the close link between reindeer hunting and snow patch discoveries in central Norway.

This link is highly relevant when trying to assess the changing levels of survey activity around alpine snow patches in Phase 2 (1944 – 2000), during which few finds were recovered. The history of local reindeer hunting shows that there was a large increase in the number of reindeer hunted in the region between 1950 and 1970 (Jordhøy, 2001). Increased hunting activity probably meant that more hunters were active in the mountains, close to find-bearing snow patches, during the melting season. Given the local awareness of the possibility for snow patch discoveries that existed at the time, it seems likely that more finds would have been recovered from snow patches if they had appeared, or if suitable conditions for find recovery had presented themselves during Phase 2.

## CONCLUSION

The question at hand has been whether the record of archaeological finds made around local snow patches is best viewed as a disjointed series of finds in similar locations, or whether the collection is rather a cohesive long-term record of melting alpine snow patches. An initial mapping of the temporal distribution of finds highlighted an uneven development, with two distinct phases characterized by large numbers of recovered artifacts. These phases were separated by nearly 60 years during which few new finds or sites were discovered. There is evidence of fluctuations in the intensity and regularity with which mountain snow patches were surveyed. But the analysis has also shown that there is much to indicate that the perceived pattern is in fact real. This evidence includes the continuity of the local collector tradition in Oppdal, important direct links between the pioneer group and today's collectors, records from local weather data, and evidence from the history of local reindeer hunting in the area. All these data lead to the conclusion that the pattern of temporal distribution demonstrated in Figure 4 is not a product of varying survey activity. And thus, the snow patch collection from central Norway can be confidently viewed as a cohesive, long-term product and record of melting alpine snow patches in the region in the period 1914–2011.

## OTHER SNOW PATCH ARCHAEOLOGY ISSUES

This review of aspects of the snow patch collection from central Norway raises a number of issues that might be relevant to similar collections or applied studies in the future. These issues include specific questions that have already been raised, such as the "discovery effect" and the role of surveying intensity in creating patterns of temporal distribution. Other issues are important to highlight because they seem fundamental to the nature of snow patch archaeology and to the kind of data we create. In the future, these and similar perspectives might temper and inform the demands we make of the data we possess, especially within the context of linking snow patch discoveries to climate variation and change.

Visual inspection, as commonly employed in snow patch surveys, is a method with obvious inherent weaknesses. Even when sites have been carefully surveyed, there is no guarantee that an artifact has not been overlooked or that finds will not appear later within the same melt season. Many anecdotes of finds being recovered in locations carefully surveyed just minutes before underline this weakness. In central Norway, we are fortunate that iron was used in the past to produce arrowheads. Metal detectors are therefore a great aid in increasing the reliability and effectiveness of visual surveys for recovering material from these periods. But the potential for error remains, and at present there appear to be no methodological parallels to traditional surveying techniques, such as test pitting and trenching, by which we can create reliable negative data from alpine snow patches.

A related issue is the importance of well-documented negative data. Until quite recently, it was not the norm in central Norway to record details of surveys that did not result in finds. And as we have seen, this omission can cause difficulties when trying to assess the validity of periods during which few finds were recovered. However, it is becoming increasingly clear that the ablation of many archaeological snow patches is a long-term, non-linear process, in which patches might often increase in size or melt in unexpected ways during any given season. In the future, it may be useful to be able to make year-to-year comparisons when trying to identify the causal factors behind long-term snow patch development. From this perspective, documenting the extent and conditions of surveys that do not produce finds may produce valuable data too. Obviously this perspective will have implications for how and over what time spans snow patch surveys might be designed.

Finally, more attention should be given to the proposed differentiation between primary and secondary melting events in relation to individual artifacts. As shown in Table 2, the degree to which artifacts are preserved on snow patches varies considerably, which may be partly explained by the effects of multiple melting episodes after the artifact's initial deposition. We should therefore probably be wary of presuming that the date of recovery for an individual artifact automatically marks the season or period during which it emerged from the snow and ice for the first time (primary melt). On the contrary, the release of artifacts from snow patches is probably more often than not a process that is repeated over time, rather than a singular event. With this in mind, if we wish to draw closer causal links between the appearance of ancient objects on alpine snow patches and developments in present-day weather and climate patterns, greater account needs to be taken of this issue.

Having such an old snow patch collection has its own particular possibilities and problems. Establishing the background and true nature of this collection is an important step forward with a view to future studies. Having confirmed the long-term nature of this snow patch collection, it is now possible to start looking for the long-term causal factors and drivers that lie behind these patterns. This is a complex and multidisciplinary challenge that will have to account not only for recent finds recovered since 2001, but also for the considerable number of finds recovered during the 1930s. Another challenge relates to finding a way to integrate the sizeable group of artifacts found by metal detectors with this larger group. And last but not least, there is the question of what the future will bring and how this archaeological record will continue to develop in the years and decades to come.

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