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The Dimna Ash — a 12.8 ^{14}C ka-old volcanic ash in Western Norway

J.H. Koren[a], J.I. Svendsen[a,b,*], J. Mangerud[a,b], H. Furnes[a]

[a]*Department of Earth Science, University of Bergen, Allégaten 41, N-5007 Bergen, Norway*
[b]*Bjerknes Centre for Climate Research, Allégaten 55, N-5007 Bergen, Norway*

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Abstract

A new volcanic ash, named the Dimna Ash, geochemically similar to the rhyolitic component of the Vedde Ash, is described in a core from a palaeo-lake in Western Norway. The Dimna Ash occurs more than a metre below the Vedde Ash and radiocarbon datings indicate a minimum age of 15,100 calendar years BP (12,800 ^{14}C years BP). In comparison the age of the Vedde Ash is 12,120 calendar (NGRIP) years BP (10,300 ^{14}C years BP). The Dimna Ash is invisible to the naked eye in the core and was detected by applying a density separation technique. It comprises, however, up to 12,900 ash shards per cm^3 sediment. We conclude that the Dimna Ash is wind-blown from Iceland and should therefore be found also in marine cores between Iceland and Norway and thus has the potential to become an important marker horizon. The core also contains scattered ash shards, geochemically similar to the Borrobol Ash, that are spread over a 50 cm thick zone deposited between 13,400 and 12,700 calendar years BP. This is the first discovery of Borrobol-like ash in Norway.

1. Introduction

The discovery of the 10,300 ^{14}C ka Vedde Ash in Western Norway (Mangerud et al., 1984) and its correlation with the North Atlantic Ash Zone 1 by means of single-shard microprobe geochemistry (Mangerud et al., 1984; Kvamme et al., 1989) triggered a wave of search for volcanic ashes in northern Europe. Few ash zones are visible to the naked eye on the British Isles and mainland N-Europe. However, the development of an enrichment method for rhyolitic glass shards in sediments (Lowe and Turney, 1997; Turney et al., 1997; Turney, 1998a) has made it possible to map the Vedde Ash across much of N-Europe (Wastegard et al., 2000; Davies et al., 2001, 2005; Pilcher et al., 2005; Wastegard, 2005) and to the discovery of new ashes, such as the Borrobol Ash (Turney et al., 1997). At present a number of Icelandic volcanic ashes are known from the last deglaciation period (Hafliðason et al., 2000; Lowe, 2001).

In this paper, a slightly modified version of the enrichment method has been applied to a sediment sequence close to the type area for the Vedde Ash in Western Norway. The area was chosen in the region where the Vedde Ash has shown to be at its thickest; i.e., in the sector of strong winds from Iceland (Fig. 1). This is also an area along the Norwegian coast that was early deglaciated (Svendsen and Mangerud, 1987). We discovered a new rhyolitic ash bed stratigraphically well below the Vedde Ash. This has been given the formal name the Dimna Ash.

2. Methods

2.1. Field work

We first explored several basins before selecting the one presented here. The basin (Fig. 2), a peat bog called Dimnamyra (The Dimna Bog), was chosen due to the good resolution of the pre-Vedde sediments and the occurrence of exceptionally thick Vedde Ash here. The thickness of the Vedde Ash indicates that the basin was an efficient trap for ash shards washed in from the drainage area of the palaeo-lake. The basin was mapped by coring profiles with a Russian corer (Jowsey, 1966). The core locations and their internal correlation are shown in Figs. 2 and 3, respectively. Based on this mapping we selected the site with the best resolution for the pre-Vedde sediments for coring with an 11-cm-diameter piston corer. This has 2-m-long PVC

*Corresponding author at: Department of Earth Science, University of Bergen, Allégaten 41, N-5007 Bergen, Norway. Tel.: +47 55 58 35 10; fax: +47 55 58 36 60.
E-mail address: John.Svendsen@geo.uib.no (J.I. Svendsen).

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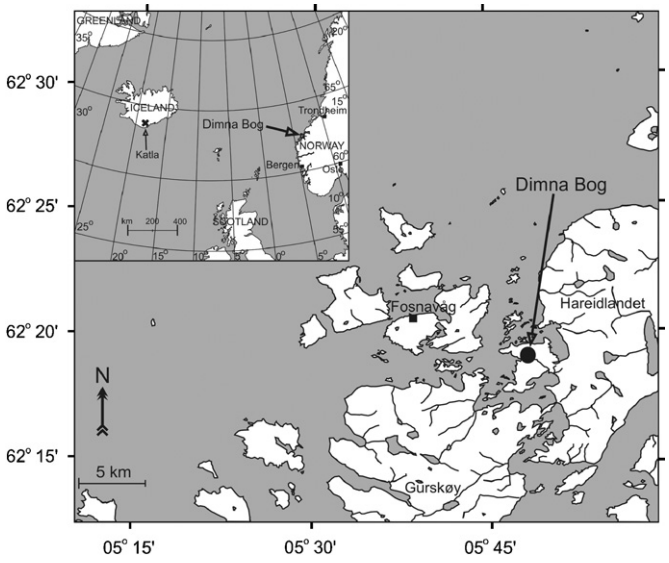

Fig. 1. Map of study area with Dimnamyra marked with a black dot. Inset map shows location.

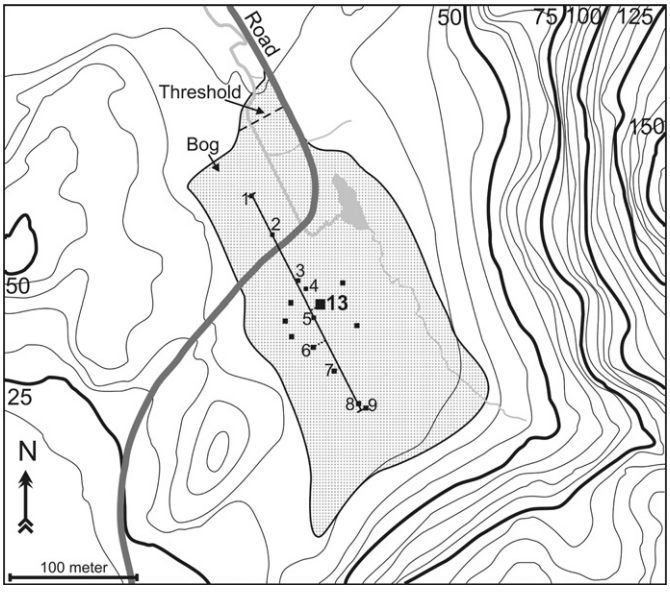

Fig. 2. Map of Dimnamyra: contour interval 5 m. Black dots show sites cored with a Russian corer. A profile through the numbered locations 1–9 and 13 is shown in Fig. 3. The UTM coordinates for core 13 is 32 V334286 6913946.

tubes that, after coring, were brought back to the laboratory, split laterally, described and sub-sampled.

2.2. Radiocarbon dating

The sediments were sieved through a 0.5 mm mesh and terrestrial plant fragments hand picked following the procedure of Birks and Lotter (2000). These were ^{14}C accelerator mass spectrometry (AMS) dated at the Poznań Radiocarbon Laboratory in Poland. The dates have been calibrated with the computer program OxCal 3.10 (Bronk Ramsey, 2001) based on the IntCal04 database (Reimer et al., 2004). The dates (Table 1) are consistent with earlier published dates from basins with similar lithostratigraphy in this area (Kristiansen et al., 1988; Birks et al., 1994). The lowermost dates, yielding an age of ca 12,800 ^{14}C years BP, were obtained some 60 cm above the base of the core. Below this level we did not find sufficient plant material for AMS dating (Fig. 4).

2.3. Ash shard enrichment and preparation

Density separation, using heavy liquids, makes it possible to enrich rhyolitic ash grains. The method follows Turney et al. (1997) and Turney (1998a) with minor modifications. Details are given in Koren (2005). Simplified, the procedure was to remove organic matter from the sample, sieve it and collect the fraction in the size range 25–80 μm. Rhyolitic glass has a density between 2.3 and 2.5 g/cm^3 and after centrifuging in sodium polytungstate with a density of 2.3 g/cm^3 lighter grains were decanted away. After a subsequent centrifuging with a density of 2.5 g/cm^3 floating particles were transferred to a microscope slide and mixed with Canada balsam. Five-cm-thick sediment slices were first collected continuously throughout the core and treated as described. Ash shards were detected in all intervals, but only the 5-cm intervals with high ash shard concentrations and a few others were further investigated. These intervals were re-sampled for each 1 cm and the new samples similarly treated.

Rhyolitic ash shards were identified with an optical microscope and counted. The ash shard concentration for the 5-cm-interval samples (4 cm^3) was estimated by counting the number of ash shards per 100 grains. Thus, the concentrations of these samples are given as % glass shards relative to the total number of mineral grains (Fig. 4). The much smaller 1-cm-interval samples (1 cm^3) made it possible to prepare the whole sample in one microscope slide. Here the ash shards within a known area of the slides (normally 6–10% of the total area) were counted and then the total number in the sample calculated. Hence, for these samples the concentration is given as the number of shards per cm^3 sediment (left panel in Fig. 5).

New samples were collected from the core at 1 cm intervals showing maximum ash concentration (marked with arrows in Fig. 4). Removing organic material by ashing has proven to alter the alkali content of glass shards (Pilcher and Hall, 1992; Dugmore et al., 1995). Therefore, the organic material was here removed by H_2O_2 treatment. The samples were sieved and concentrated as described above. Individual ash shards were collected, embedded in epoxy, wet rubbed and polished for electron microprobe analysis. We assume that the peroxide treatment does not affect the glass geochemistry. Anyhow, the surface presented to the analytical beam is freshly exposed and the risk for chemical alteration is probably not greater than by