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Diabasodden and Its Suite – the High Arctic Large Igneous Province on Svalbard and Its Type Locality

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1. INTRODUCTION

During the Cretaceous, the circum-Arctic region was affected by widespread magmatism, known as the High Arctic Large Igneous Province (HALIP). These mainly mafic intrusives and extrusives are found throughout the Queen Elizabeth Islands, northern Greenland, the Alpha-Mendeleev Ridges, the New Siberian Islands, Franz Josef Land, and Svalbard (Senger et al. 2014; Maher 2001). There have been three proposed pulses, from 124 to 120 Ma, from 99 to 91 Ma, and from 85 to 77 Ma (Dockman et al. 2018). Generally, the oldest magmatism is tholeiitic, the middle pulse bimodal, and the youngest pulse alkaline (Tegner et al. 2011). The alkaline pulse is only found in northern Greenland and on the Queen Elizabeth Islands, while the tholeiitic magmatism is found throughout the circum-Arctic, with the exception of Greenland (Dockman et al. 2018; Thórarinsson et al. 2015). This large igneous province has been proposed to be related to a Cretaceous Arctic mantle plume, with a center located ca. 200 km west of Ellesmere Island (Buchan and Ernst 2018).

The HALIP rocks found throughout the Svalbard archipelago are regionally called the Diabasodden Suite, based on its type locality in central Spitsbergen, the main island of Svalbard. In this contribution, the focus will be on characterizing the Diabasodden Suite based on previously published data.

2. THE DIABASODDEN SUITE

The outcrops of the HALIP on Svalbard (Fig. 1) represent magmas that erupted on the surface in the far east, on Kong Karls Land, and that was intruded at various depths in the rest of the Svalbard archipelago. One of the shallowest sills, at Botneheia in central Spitsbergen, has an emplacement depth of ca. 0.5 km, based on the the thickness of the sedimentary units deposited above the intrusion until the early Cretaceous (Dallmann et al. 1999; Norwegian Polar Institute 2016). The emplacement depths cannot be estimated in all places, e.g. in Nordaustlandet, where

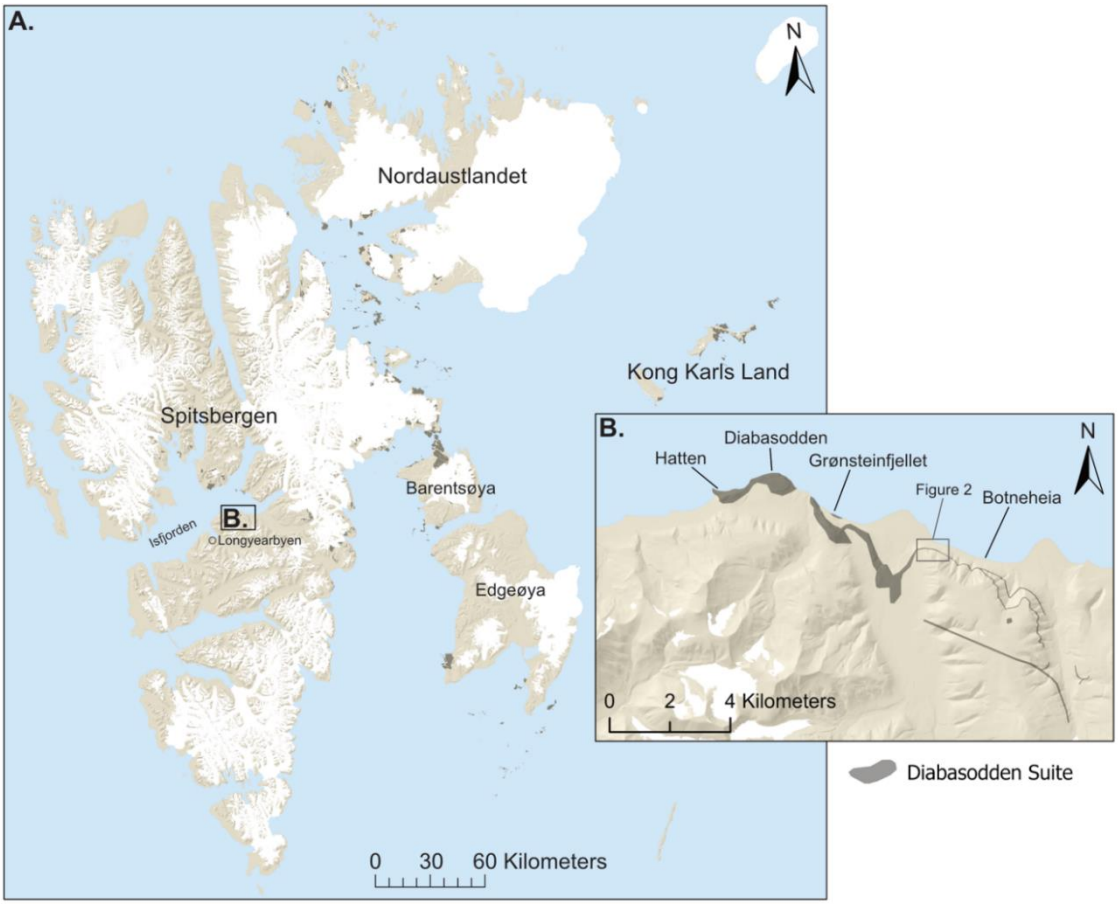

Fig. 1: A. Topographical map over Svalbard, illustrating the extent of the High Arctic Large Igneous Province, regionally called the Diabasodden Suite; B. Map over the type locality of the Diabasodden Suite, and surrounding intrusions. The area shown on the digital outcrop model in Fig. 2 is indicated on the map. The glacier extents, land area and digital elevation are from the Norwegian Polar Institute (2014a,b), and the extent of the Diabasodden Suite is a modified version of the Geological map of Svalbard (Norwegian Polar Institute 2016), based on field observations.

the magma was intruded into the crystalline basement. The thickness of the flood basalts and intrusions themselves vary from a few meters to more than 100 m, based on measurements from digital outcrop models (DOMs, Fig. 2). These are built on high-resolution UAV images acquired all around Svalbard, during various expeditions, e.g. SvalGeoBase II. These images and the resulting DOMs are openly available (Betlem et al. 2023). The Diabasodden Suite magmas were likely emplaced during a short time interval between 125 and 123 Ma, according to available U-Pb geochronology (Corfu et al. 2013; Midtkandal et al. 2016). This indicates that perhaps only the oldest pulse of the HALIP is present on Svalbard.

Petrographically, the Diabasodden Suite is commonly composed of plagioclase phenocrysts (up to 1 cm in size), surrounded by a groundmass of finer-grained feldspars, clinopyroxene, Fe-Ti oxides (up to 5 mm in size), and secondary alteration minerals (Nejbert et al. 2011). Occasionally, olivine is also present. Feldspars are mainly plagioclase, but minor amounts of alkali feldspars are also commonly found in the groundmass. Clinopyroxene is often augite. Fe-Ti oxides occur as needles or stubby crystals of Ti-magnetite and ilmenite. The texture of the Diabasodden Suite rocks is mainly doleritic, but ophitic textures also occur (Nejbert et al. 2011). Geochemically, the Diabasodden Suite is characterized as tholeiitic basalts, with SiO_2 contents ranging from ca. 43 to 49 wt%, FeO_{tot} from ca. 11 to 15 wt%, MgO from ca. 2.5–7.5 wt%, and TiO_2 from ca. 2 to 4 wt% (Nejbert et al. 2011).

Fig. 2. An example of a digital outcrop model from Botneheia, central Spitsbergen (Rodes et al. 2024; Betlem et al. 2023). This intrusion, belonging to the Diabasodden Suite, was emplaced into Triassic shales. The thickness of this particular sill is at A: 33 m, B: 38 m, and C: 23 m.

3. DIABASODDEN

Diabasodden, the type locality of the HALIP on Svalbard, is located in eastern Isfjorden, central Spitsbergen (Fig. 1). These dolerite cliffs tower over the water's edge, with an intrusion thickness of ca. 70 m (Norwegian Polar Institute 2014a). Near the Diabasodden intrusion, several other outcrops of the HALIP can be found, including Hatten, Grønsteinfjellet, and Botneheia (Fig. 1). While Diabasodden is an outcropping sill, both dikes and sills are found at these nearby localities. At Diabasodden, the magma intruded into Triassic strata, namely the shales, siltstones, and sandstones of the Late Triassic Kapp Toscana Group. The highest point of the Diabasodden sill is found at 69 m. a.s.l., while the coeval Early Cretaceous sedimentary units are found further inland on Wimanfjellet at ca. 700 m. a.s.l. Diabasodden has been visited and sampled many times in the past, with several publications as a result (e.g. Gayer et al. 1966; Nejbert et al. 2011; Corfu et al. 2013). One of the three (soon four; Sartell et al. in revision) published U-Pb ages on Svalbard is based on a sample collected at Diabasodden, yielding an age of 124.5 ± 0.2 Ma (Corfu et al. 2013). In addition to geochronology, geochemical data, and petrographic descriptions of dolerites from Diabasodden have also been published (Nejbert et al. 2011; Gayer et al. 1966). These suggest that the Diabasodden sill is characteristic for its Suite, with similar composition and petrography.

Acknowledgments. This contribution is dedicated to the scientists that have built up the knowledge we have today of the Diabasodden Suite, spending long days in the field, in the lab, and publishing data.

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