Skaergaard Pluton Introduction

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Introduction

The Skaergaard Intrusion is an Eocene layered intrusion on the east Greenland coast. It is roughly 10 by 7.5 km in exposed size and is 3 to 4 km thick. It has an original volume of perhaps 250 km^3, though this has been a hotly debated point over the years. The pluton parental magma was relatively evolved, with the first exposed crystallization products being troctolite with relatively iron-rich olivine and Na-rich plagioclase. In contrast, primitive magmas from the mantle should first crystallize abundant Mg-rich olivine and chromite.

The pluton was emplaced into Archean gneisses, Cretaceous sediments, and Paleogene basaltic lavas. Igneous activity was related to opening of the North Atlantic Ocean (separation of Greenland and Scandinavia), and passage of a hot spot that started in northeastern Canada, and crossed under Greenland and into the North Atlantic as the ocean widened. That is now the Iceland hot spot. After emplacement, the magma convected and crystallized as it lost heat to its surroundings. Complex processes during convection produced layering, including modally graded layers on the roof and floor, and other layered structures on the walls. There are scour and fill structures, foundered autolith and xenolith blocks from the roof (ranging up to hundreds of meters across), and spectacular trough and ridge structures.

The Skaergaard magma was a little on the alkaline side, so there is no magmatic Opx in any of these samples. All Opx is present as inverted pigeonite and exsolution lamellae in augite. In general, the amount of rock alteration increases upwards from the base, as H_2O was concentrated with progressive fractional crystallization of anhydrous phases. Iron is also progressively concentrated upwards, and magnesium depleted. Na was concentrated upward and Ca depleted also, but not to such an extreme extent.

This sample set was collected during an IGC conference field trip in 2001, led byT. Neil Irvine, Jens Christian Andersen, and C. Kent Brooks. Most samples were collected from layered cumulates that formed on the magma chamber floor. These layers record more or less continuous deposition that shows step changes in cumulus mineralogy, resulting from changing magmatic phase relations. Initially, troctolite cumulates formed, having had just olivine and plagioclase on the liquidus. This progressed so that, ultimately, the very iron-rich last bit of magma finally crystallized in a narrow space between the roof and floor cumulates (the sandwich horizon). The figures below show the physical and mineralogical layering.

Descriptions of the facies collected

Layered series: Lower, middle, and upper zone (LZa, b, c, MZ, UZa, b, c) samples were collected from cumulates that formed on the magma chamber floor. Due to time constraints and terrain, no samples were collected from the upper border zone (UBZ) that crystallized onto the magma chamber roof, except as autolith blocks that fell to the floor.

Marginal border series (MBS) rocks crystallized onto the magma chamber walls. These partly crystallized in place and are partly cumulates. The MBS layers grade into the floor cumulates at a surprisingly sharp break in slope at the base of the walls.

Autolith blocks formed originally as cumulates on the magma chamber roof (UBZ). They then detached as blocks and sank to hit the floor cumulates below. Roof cumulate layers grade into mineralogically identical marginal border series layers, which in turn grade into the layered series on the floor.

Dikes, in several generations, abundantly crosscut the Skaergaard pluton. Because the pluton was necessarily solid at the time of dike emplacement, none of the dikes sampled can actually be the parental Skaergaard magma. However, some of the dikes are thought to be similar to what the parental Skaergaard magma was.

References

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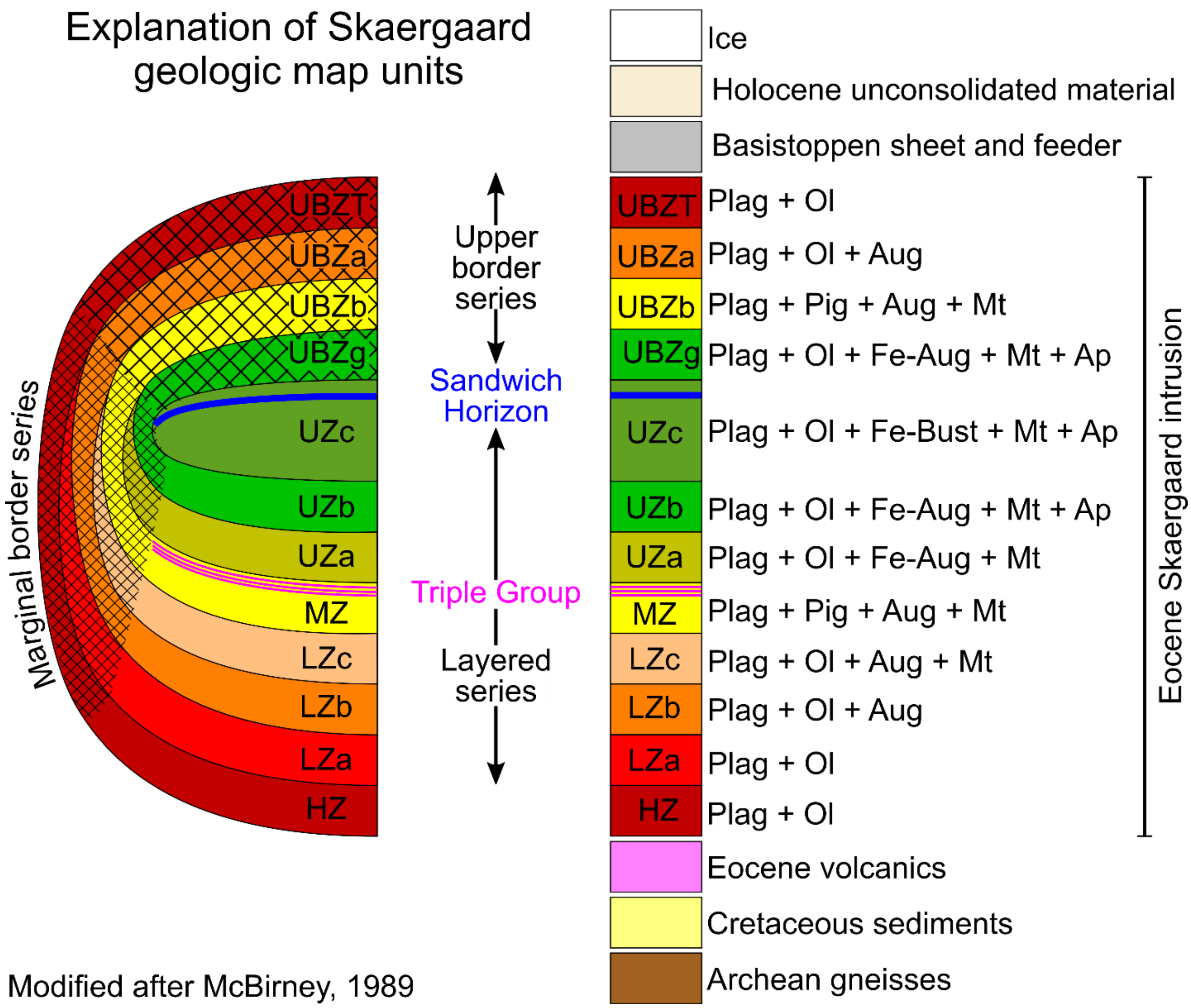
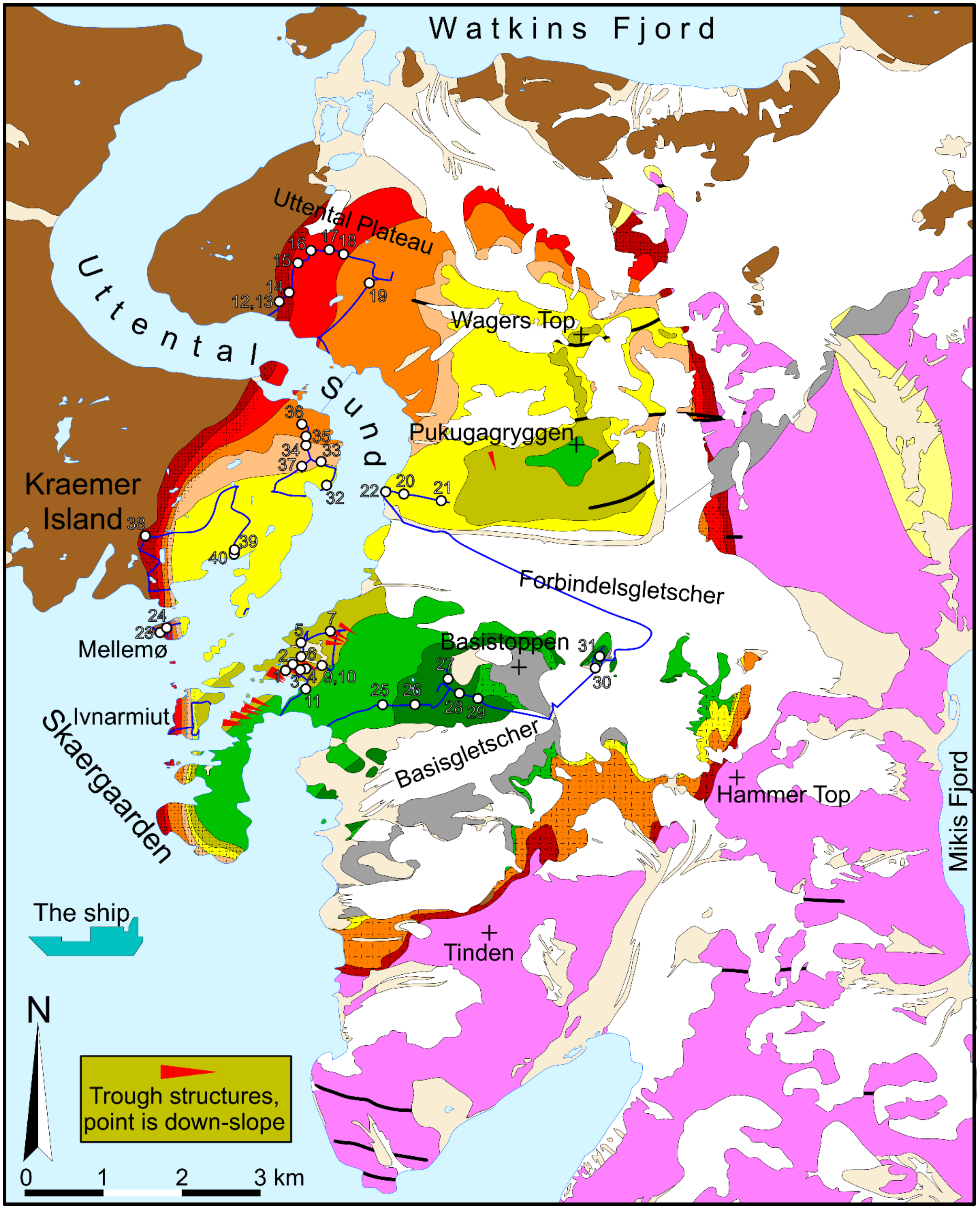
Table 1. List of samples. Layered series unit designations are based on statements by the field trip leaders, and may not exactly represent rock cumulus mineralogy.

Sample #	Unit	Series
Green-1	UZa	Floor layered series
Green-2	UZa	Floor layered series
Green-3	UZa	Floor layered series
Green-4	Autolith block	Roof layered series
Green-5	Dike	Late crosscutting dike
Green-6	UZb	Floor layered series
Green-7	Autolith block	Roof layered series
Green-8	Granophyre	Late crosscutting dike
Green-9	Dike	Late crosscutting dike
Green-10	Xenolith in a dike	Country rock from below pluton
Green-11	UZb	Floor layered series
Green-12	Wherelite xenolith	Wall or roof country rocks
Green-13	MBS	Marginal border series
Green-14	MBS	Marginal border series
Green-15	LZa	Floor layered series
Green-16	Replacement anorthosite	Metasomatic replacement rock
Green-17	LZa	Floor layered series
Green-18	LZa	Floor layered series
Green-19	LZb	Floor layered series
Green-20	MZ	Floor layered series
Green-21	MZ	Floor layered series
Green-22	MZ	Floor layered series
Green-23	CZ	Contact zone
Green-24	MBS	Marginal border series
Green-25	UZb	Floor layered series
Green-26	UZc	Floor layered series
Green-27	UZc	Floor layered series
Green-28	UZc	Floor layered series
Green-29	Sandwich horizon	Most evolved magma
Green-30	Basistoppen sheet	Sill and dike of different magma
Green-31	Sandwich horizon	Most evolved magma
Green-32	Autolith block	Roof layered series
Green-33	LZc	Floor layered series
Green-34	LZc	Floor layered series
Green-35	LZb	Floor layered series
Green-36	LZb	Floor layered series
Green-37	LZc	Floor layered series
Green-38	Sedimentary xenolith	Roof country rock
Green-39	Basalt xenolith	Roof country rock
Green-40	Basalt xenolith	Roof country rock



Explanation of the geologic map units, showing cumulus phases typical for each layer. Unit names largely follow McBirney (1989). The Hidden Zone is now thought to be of small volume, and similar to upper border series T.

UBZT: Upper Border Series T
UBZα: Upper Border Series alpha
UBZβ: Upper Border Series beta
UBZγ: Upper Border Series gamma
UZc: Upper Zone c
UZb: Upper Zone b
UZa: Upper Zone a
MZ: Middle Zone
LZc: Lower Zone c
LZb: Lower Zone b
LZa: Lower Zone a
HZ: Hidden Zone



Geologic map of the Skaergaard intrusion with sample locations, modified after McBirney (1989). The map unit explanation is shown above. The dark blue lines are the field trip excursions on land.