SUPPLEMENTAL MATERIALS 04

STRUCTURAL EVOLUTION AND BASIN ARCHITECTURE OF THE TRAILL Ø REGION, NE GREENLAND: A RECORD OF POLYPHASE RIFTING OF THE EAST GREENLAND CONTINENTAL MARGIN

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Lithostratigraphic Framework

The mapped units are described below. With the exception of the Cretaceous stratigraphic subdivisions (*Section 4.6.*) all stratigraphic units have been previously defined. All information relating to depositional environment, macrofauna assemblages and age constraints are derived from previously published sources (listed under the headings titled '*Additional data sources*' below), unless otherwise specified with the exception of Jurassic and Cretaceous strata. A summary of the lithostratigraphic relationships is shown diagrammatically in Enclosure 3.

1. Devonian strata: Kap Kolthoff Group & Celsius Bjerg Group

Distribution & thickness. Devonian strata belonging to the Kap Kolthoff and Celsius Bjerg groups (defined by Olsen & Larsen, 1993) are exposed on the western parts of Traill Ø and Geographical Society Ø (Figure 2) and have a combined minimum thickness of 2700 m.

Lithology & sedimentology. Medium to coarse grained sandstones and subordinate conglomerates, siltstones, shales and acid and basic volcanics.

Basal contact. Not observed.

Palaeontology. Non-marine palynofloras, spores and pollen documented which define age.

Depositional environment. Fluvial with locally developed lacustrine and aeolian deposits.

Age. Latest Givetian–earliest Tournaisian.

Additional data sources. Surlyk, 1990; Olsen and Larsen, 1993; Clack and Neininger, 2000; Larsen *et al.*, 2008.

Mapping notes. The Kap Kolthoff & Celsius Bjerg groups are mapped as a single unit due to limited data coverage across the western edge of the region.

2. Carboniferous strata: Traill Ø Group

Distribution & thickness. Strata from the Traill Ø Group (defined by Vigran *et al.*, 1999) are found across the western margin of Traill Ø and Geographical Society Ø and have a minimum thickness of 3000 m thick (Figure 2).

Lithology & sedimentology. Coarse to medium grained sandstones, interbedded with minor mudstones and coals. Conglomerates and coarse grained sandstones dominate along basin margins.

Basal contact. Observed on Geographical Society Ø at Rudsbeck Bjerg. There is no evidence for a break in sedimentation across the contact and it is, therefore, assumed to be conformable.

Palaeontology. Non-marine palynofloras, spores and pollen documented which define age..

Depositional environment. Fluvial and lacustrine.

Age. Tournaisian–Westphalian

Additional data sources. Christiansen, 1990; Surlyk, 1990; Stemmerick *et al.*, 1991; Marshall *et al.*, 1999; Vigran *et al.*, 1999.

Mapping notes. The Traill Ø Group is mapped as a single unit.

3. Permian Strata: Foldvik Creek Group

Distribution & thickness. The Foldvik Creek Group (Group and formations defined by Surlyk *et al.,* 1986) is subdivided from bottom to top into the Huledal, Karstryggen, Wegener Halvø, Ravnefjeld and Schuchert Dal formations. The group is found on central Traill Ø around Rubjerg Knude, Rold Bjerge, Grønnebjerge, Månedal and on the Svinhufvud Bjerge and is 90-125 m thick (Figure 2).

Lithology & sedimentology. The Foldvik Creek Group is a fining upwards succession composed of conglomerates, sandstones, mudstones, carbonates and evaporites.

Basal contact. There is a measured angular unconformity with the underlying Traill Ø Group. A discordance of 4-12° is observed in the Svinhufvud Bjerge.

Palaeontology. A diverse marine macrofauna above the Karstryggen Formation includes brachiopods; *Streptorhynchus* cf. *kempei* Andersson, *Streptorhynchus* sp. and the bivalve *Schizodus obscurus* (J. Sowerby) (Surlyk *et al.*, 1986; Christiansen, 1990; Surlyk, 1990; Stemmerik *et al.*, 2001). Reworked material from the Foldvik Creek Group may occur in clasts in some of the coarse-grained Cretaceous units.

Depositional environment. Up-section transition from continental, through shallow marine, into offshore shelf environments.

Age. Wordian–Changhsingian.

Additional data sources. Surlyk *et al.*, 1986; Christiansen, 1990; Stemmerik *et al.*, 2001.

Mapping notes. The Foldvik Creek Group is mapped as a single unit due to the relatively small thickness of the sequence and as constituent formations have not been consistently recognised.

4. Triassic Strata: Scoresby Land Group

Distribution & thickness. The Scoresby Land Group (group and constituent formations defined by Clemmensen, 1980) is divided into the Wordie Creek, Pingo Dal, Gipsdalen and Fleming Fjord formations (listed bottom to top). Strata belonging to this group are found on Geographical Society Ø in Tværdal and around Laplace Bjerg. On Traill Ø these strata are found in Månedal, Vælddal, and around the Svinhufvud Bjerge and Mols Bjerge (Figure 2). These strata have a minimum thickness of 1800 m as a complete section through the entire succession is not observed.

Lithology & sedimentology. Grey-green mudstones and sandstones (Wordie Creek Fm) are overlain by locally reddened and gypsiferous mudstones and sandstones (Pingo Dal, Gipsdalen and Fleming Fjord formations).

Basal contact. In Månedal and around the Svinhufvud Bjerge, an erosive contact over Permian strata is observed. No angular discordance is recorded between the Triassic and Permian strata, despite reports of an Early Triassic rift event (cf. Seidler *et al.*, 2004).

Palaeontology. The Wordie Creek Formation contains a diverse marine macrofauna on Svinhufvud Bjerge, including well-dated ammonoids (Bjerager *et al*., 2006). In the upper part of the unit there are local dense monospecific accumulations of the bivalve *'Anodontophora'*. Macrofauna in the overlying formations are rarely reported (Clemmensen, 1980). Reworked material from the Wordie Creek Formation may occur in clasts in some of the coarse-grained Cretaceous units.

Depositional environment. The base of the Wordie Creek Formation was deposited in a marine setting largely below the fair weather wave base. Above this unit, there is an up-section transition from alluvial to lacustrine environments (Pingo Dal, Gipsdalen and Fleming Fjord formations.).

Age. The Wordie Creek Formation has an Early Triassic age (Bjerager *et al.*, 2006). The Pingo Dal, Gipsdalen and Fleming Fjord formations are Mid-Late Triassic in age, constrained by correlation with equivalent succession on Scoresby Land (cf. Andrews *et al.*, 2014).

Additional data source. Clemmensen, 1980; Christiansen, 1990; Seidler *et al.*, 2004; Bjerager *et al.*, 2006; Andrews *et al.*, 2014; Decou *et al.*, 2016.

Mapping notes. The Scoresby Land Group is mapped as a single unit.

5. Jurassic strata: Jameson Land Group & Hall Bredning Group

Pre-Volgian Jurassic strata in this region are divided from bottom to top into the Bristol Elv, Pelion and Olympen formations of the Jameson Land Group and the Bernbjerg Formation of the Hall Bredning Group (Surlyk, 1977; Engkilde & Surlyk, 2003; Therkelsen & Surlyk, 2004). Jurassic strata are most commonly found at the crests of tilted fault blocks (Figure 2).

5.1. *Bristol Elv and Pelion formations*

Distribution & thickness. Bristol Elv Formation (defined by Therkelsen & Surlyk, 2004) is found at Laplace Bjerg, in Bjørnedal, the Mols Bjerge, and the Svinhufvud Bjerge and has a thickness of 280-520 m. This thickness variation is thought to be due the fact the formation infills a relict topography similar to the Bastians Dal Formation on Kuhn Ø (Alsgaard *et al.*, 2003). The Pelion Formation (defined by Engkilde & Surlyk, 2003) is found in Tværdal, on Nordenskjøld Ø, Bjørnedal and in the Svinhufvud Bjerge. It varies in thickness between 290 and 1020 m and in Bjørnedal, it thins onto the crest of a tilted fault block (Vosgerau *et al.*, 2004). These thickness variations are thought to be due to contemporaneous faulting creating variable amounts of accommodation space. Cross section constructions of the two formations have a maximum combined thickness of ~900 m (Enclosure 2). This is less than the thickness of 1540 m for the two units reported by Price & Whitham (1997).

Lithology & sedimentology. The Bristol Elv Formation consists of lenticular bedded, medium to very coarse grained sandstones and pebbly sandstones with subordinate conglomerates, mudstones and coals. Wood and other plant fragments are locally abundant and rootlet horizons are also found. Calcareous macrofossils are absent. Cross bedding is common in the sandstones and within the units and indicates sediment transport direction towards the south. The Pelion Formation above consists largely of well sorted medium to coarse grained sandstone, which may be carbonate cemented. The sandstones show common cross bedding largely indicating southward sediment transport. Subordinate northward directed cross-bedding is also found. In places, coarsening-upwards cycles of mudstones, through bioturbated muddy sandstones to clean cross bedded sandstones are found.

Basal contact. The basal contact of the Bristol Elv Formation is erosive and cuts into the Scoresby Land Group sediments. The basal contact of the Pelion Formation in most places is conformable on the Bristol Elv Formation. In Tværdal, the Bristol Elv Formation is absent and the Pelion Formation rests on the Scoresby Land Group.

Palaeontology. Calcareous macrofauna are absent from the Bristol Elv Formation. Spores and pollen allow dating of the unit (Therkelsen & Surlyk, 2004). The Pelion Formation contains locally abundant and diverse assemblages of marine macrofauna: ammonites, belemnites and bivalves. The ammonites include biostratigraphically significant *Cranocephalites borealis* (Spath), *C. pompeckji* (Madsen), C*. tvaerdalensis* Alsen, *Cadoceras apertum* Callomon, *Kepplerites traillensis* Donovan (This study, plus Donovan, 1953, 1955, 1957; Callomon, 1993; Price & Whitham, 1997; Alsen *et al.*, 2004; Alsen, 2015; Callomon *et al.*, 2015; Kelly *et al.*, 2015).

Depositional environment. The Bristol Elv Formation was deposited in a terrestrial setting mainly by braided rivers some intervals were deposited in a lacustrine setting (Price & Whitham, 1997; Therkelsen & Surlyk, 2004). The Pelion Formation was deposited in a shallow marine environment in a tidal and/or storm wave base to shoreface setting (Price & Whitham, 1997; Vosgerau *et al*., 2004).

Age. The Bristol Elv Formation has an Aalenian–early Bajocian age (Therkelsen & Surlyk, 2004). The Pelion Formation has a late Bajocian–Callovian age, as determined from macrofauna assemblages (This study, plus Callomon, 1993; Engkilde & Surlyk, 2003; Callomon *et al.*, 2015).

Additional data sources. Donovan, 1953, 1955, 1957; Surlyk, 1973; Engkilde and Surlyk, 1993, 2003; Price and Whitham, 1997; Carr, 1998; Alsen *et al.*, 2004; Therkelsen and Surlyk, 2004; Vosgerau *et al.*, 2004; Alsen, 2005; Callomon *et al.*, 2015; Kelly *et al.*, 2015.

Mapping notes. The Bristol Elv and Pelion formations are mapped as a single unit because the contact between the two units is only identified on the southern coast of Traill Ø (Figure 2).

5.2. *Olympen Formation*

Distribution & thickness. The Olympen Formation (defined by Surlyk *et al.*, 1973 in Jameson Land) is found around Bjørnedal and in the Svinhufvud Bjerge and to the north of the Mols Bjerge (Figure 2). The formation is 90-250 m thick.

Lithology & sedimentology. The unit consists largely of medium to coarse grained sandstones, sandy mudstones and mudstones arranged as coarsening-upward cycles.

Sandstones are largely structureless, but may show cross bedded and parallel stratification. In the northern Svinhufvud Bjerge, sandstone units at the tops of cycles show fining upward sequences with a transition from cross bedding to parallel laminae to ripple cross laminae and contain abundant plant detritus. Rootlet horizons are developed in some units.

Basal contact. The Olympen Formation overlies the Pelion Formation conformably.

Palaeontology. Donovan (1953, p. 86) first used a cardioceratid ammonite to recognise a Late Oxfordian age on Traill Ø. A marine macrofauna of ammonites and belemnites with local bioturbation and fossilized wood contains *Quenstedtoceras woodhamense* Arkell (Early Oxfordian), *Cardioceras maltonense* (Young & Bird) and *C. vagum* (Ilovaisky) (Mid Oxfordian, Putallaz 1961) and *Amoeboceras regulare* Spath *and A. serratum* (Sowerby) (Late Oxfordian: This study, plus Price and Whitham, 1997).

Depositional environment. Coarsening up-wards cycles indicate up-section transitions from an offshore / outer shelf setting to shallow marine tidal and/or storm wave base settings and fluvial deltaic settings (determined from macrofauna and macroflora).

Age. An Early to Late Oxfordian age is determined from macrofossil assemblages which are the same as those on Jameson Land (Bruhn & Surlyk, 2004; Price & Whitham, 1997).

Additional data sources.; Surlyk *et al.*, 1973; Surlyk, 1991; Engkilde and Surlyk, 1993; Surlyk, 2003; Larsen and Surlyk, 2003; Vosgerau *et al.*, 2004; Kelly *et al.*, 2015.

Mapping notes. Variations in unit thickness may relate to syn-depositional faulting.

5.3. *Bernbjerg Formation*

Distribution & thickness. The Bernbjerg Formation (defined by Surlyk, 1977) is exposed on Nordenskjøld Ø, in the western Mols Bjerge and in Bjørnedal at the crests of tilted fault blocks (Figure 2). Exposed sections of the Bernbjerg Formation have a maximum thickness of ~300 m, however, the amount of footwall crest erosion is unconstrained. Map and cross section construction indicates that the formation has a minimum thickness of 450 m (Enclosure 2).

Lithology & sedimentology. Black, micaceous, organic-rich shales, containing thin sandstone laminae and rare ripple cross laminated / bedded sandstone beds.

Basal contact. There is a sharp conformable contact with the underlying Olympen Formation.

Palaeontology. Marine macrofauna are common throughout, dominated by ammonites and suspension feeding bivalves including *Amoeboceras* (*Euprionoceras*) *kochi* Spath, *Amoeboceras* (*Amoebites*) *pseudocanthophorum* Spath, cf. *Amoeboceras* (*Hoplocardioceras*) *decipens* Spath, *Rasenia* sp., *Buchia concentrica* (J. de C. Sowerby), *Buchia* cf. *tenuistriata* (Lahusen), *Pachyteuthis?* sp. (This study, plus Donovan, 1953, 1955, 1957; Surlyk & Zakharov, 1982; Birkelund and Callomon, 1985; Callomon, 1993; Kelly *et al.*, 2015).

Depositional environment. Anoxic, low energy, marine outer shelf setting (determined from sedimentology and macrofauna).

Age. The Bernbjerg Formation has a latest Oxfordian to Kimmeridgian age (Sykes & Surlyk, 1976; Surlyk, 1977).

Additional data sources. Donovan, 1953, 1955, 1957; Surlyk, 1977; Birkelund and Callomon, 1985; Marcussen *et al.*, 1987; Price and Whitham, 1997; Whitham *et al.*, 1999; Vosgerau *et al.*, 2004; Strogen *et al.*, 2005.

Mapping notes. The Bernbjerg Formation is not known to be exposed on Geographical Society Ø but it is predicted to lie in the subsurface on cross section A (Enclosure 2), acting as the source rock for the hydrocarbons found in Jurassic sandstones at Laplace Bjerg. Correlation with equivalent deposits in Wollaston Forland (Figure 1) suggests that the deposition of the Bernbjerg Formation continued into the Ryazanian at the crests of tilted fault blocks (Pauly *et al.*, 2012, 2013). Its absence in this region suggests it has been removed by erosion during Volgian-Valanginian rifting. As the unit has a Volgian- Ryazanian age at the crests of tilted fault blocks it is therefore part of the Volgian Valanginian syn-rift succession and will thicken and coarsen down the hanging wall slope towards the block-bounding normal fault.

6. Cretaceous strata (Ryazanian-Campanian): Wollaston Forland and Hold with Hope groups

Much of the Traill Ø region is composed of Cretaceous mudstones within which, sandstone and conglomerate units are a minor component. Here, we have subdivided this thick, lithologically homogeneous unit into seven different "Beds" (Figure 7), which are based on an earlier scheme devised by Donovan (1953, 1957) for subdivision of the Cretaceous mudstones.

Donovan (1957) subdivided these strata into four units: the Early Albian to Early Cenomanian Middle Cretaceous Shale Series, the Late Turonian *Inoceramus lamarcki* beds, the Late Santonian *Sphenoceramus* beds and the Late Campanian *Scaphites* beds. Nøhr-Hansen (1993) and Stemmerik *et al.* (1993) extended the base of the Middle Cretaceous Shale Series to include mudstones of Barremian and Aptian age and renamed them, the Middle Cretaceous Sandy Shale Sequence. Valanginian strata in the Mols Bjerge, containing the bivalve *Buchia,* along with a rich and diverse assemblage ammonites were first discovered by Donovan (1953), but remained unnamed. Alsen (2006) subsequently worked on these beds and assigned them to the Rødryggen and Albrechts Bugt Members of the Palnatokes Bjerg Formation which belongs to the Wollaston Forland Group (Surlyk, 1978). Immediately north of the Traill Ø region, in Hold with Hope (Figure 1), Kelly *et al.* (1998) defined the Home Forland Formation (part of the Hold with Hope Group), a unit that consists of deep marine mudstones and subordinate sandstones of Mid-Albian to Late Santonian age. Consequently, based on similarities in lithology, depositional environment and age, we consider it appropriate to extend the Home Forland Formation to cover most of Ryazanian–Campanian age mudstone succession in the Traill Ø region with the exception of strata already assigned to the Palnatokes Bjerg Formation of the Wollaston Forland Group (Surlyk, 1978) (Figure 7).

Whilst Donovan's 'beds' are by no means proper lithological divisions, given the general absence of lithological variation, the different macrofauna (Figures 8 & 9) provide the only means by which subdivision and therefore mapping of the monotonous Ryazanian–Campanian succession can be achieved (Enclosure 1). Thus, we subdivide this interval into seven mappable units ('Beds') based on the occurrence of specific macrofauna (Figures 8 & 9) in a manner similar to Donovan (1953,1957). We list the 'Beds' from oldest to youngest as follows (Figure 7): (*1*) *Buchia* Beds (new); (*2*) *Inoceramus aucella* Beds (new); (*3*) *Inoceramus anglicus* Beds (new); (*4*) *Inoceramus crippsi* Beds (new); (*5*) *Inoceramus lamarcki* Beds (Donovan, 1957); (*6*) *Sphenoceramus* Beds (Donovan, 1953); and (*7*) *Scaphites* Beds (Donovan, 1957). With the exception of the *Buchia* Beds (*1*), which are assigned to the Palnatokes Bjerg Formation (Wollaston Forland Group, Surlyk, 1978), all the other units (*2-7*) are assigned to the Home Forland Formation (Hold with Hope Group, Kelly *et al.*, 1998). These units are summarised in the sections below and described in detail the Supplemental Materials 04.

Implementation of these subdivisions reveals the geometry of different units and also provides an insight into Cretaceous sedimentation rates in the Traill Ø region. The Cretaceous mudstones contain up to 40% Cenozoic sills. The thicknesses of the individual Beds given below do not take into account the thickness of intrusions and are therefore overestimates. To acknowledge this, a minimum thickness assuming a 40% thickness attributed to of Cenozoic sills is also given. The actual stratigraphic thickness will fall somewhere between the measured structural thickness and the modified thickness, but the composite thickness of sills is generally greatest in the east and less in the west.

6.1. Buchia Beds

Definition. The *Buchia* Beds are recognised by the presence of the bivalves *Buchia terebratuloides* (Lahusen) (Figure 8a), *B. inflata* (Lahusen), and *B. keyserlingi* (Trautschold) (Zakharov, 1981; Surlyk and Zakharov, 1982). Earlier species of *Buchia* also occur in the underlying Bernbjerg Formation. Previously Donovan (1953) identified common belemnites as species of *Pachyteuthis*, giving rise to the *'Pachyteuthis* Beds'. However, the bulk of specimens can now be attributed to the genus *Acroteuthis* (Pinckney, 1975). The locally developed pink calcareous mudstones in southern Mols Bjerge were placed in the Rødryggen Member and the grey calcareous mudstones of northern Mols Bjerge were placed in the Albrechts Bugt Member by Alsen (2006). Both units form part of the Palnatokes Bjerg Formation of the Wollaston Forland Group (Surlyk, 1978).

There is a potential overlap between the *Buchia* Beds and the overlying *Inoceramus aucella* Beds. However, the presence of *Buchia* is most important and certainly goes no higher than Early Hauterivian. The presence of *Inoceramus aucella* without *Buchia* is most likely post-Early Hauterivian.

Distribution & thickness. The *Buchia* Beds are poorly exposed on Traill Ø in the Mols Bjerge, Vælddal, Forchhammer Bjerg and north of Rold Bjerge. Exposures at these localities are at the crests of tilted fault blocks with a thickness of ≤20 m (Figure 2). Extrapolation of mapped boundaries indicates that the surface geology of large areas of the Geographical Society Ø, southeast of Tværdal should also comprise the *Buchia* Beds, although there is no exposure to confirm this (Figure 2). In cross sections, the *Buchia* Beds thicken down the hanging wall slopes of tilted fault blocks and forms part of the sub-surface Volgian–Mid Albian syn-rift packages deposited in the hanging wall succession of the Månedal fault and possibly also the Mols Bjerge and Laplace Bjerg faults (cf. Surlyk, 1978; Whitham *et al.*, 1999). Sub-surface extrapolations of the *Buchia* Beds have a maximum thickness of 150-600 m (Enclosure 2).

Lithology & sedimentology. Grey (or red at the base of the unit) calcareous mudstones with calcareous concretions.

Basal contact. The basal contact of the *Buchia* Beds corresponds to the base-Cretaceous unconformity (BCU). In the Mols Bjerge and to the east of Bjørnedal, the *Buchia* Beds onlap the Jurassic Bernbjerg Formation and there is an angular unconformity of 4-8^{o}. This unconformity is erosive and related to footwall uplift associated with fault block rotation during Volgian–Valanginian rifting (Whitham *et al.*, 1999).

Palaeontology. The *Buchia* Beds on Traill Ø contain a locally abundant and diverse marine macrofauna. In the Mols Bjerge, Donovan (1953) discovered a rich ammonite fauna which was revised and monographed by Alsen (2006), including over 70 taxa, containing species of *Surites*, *Tollia*, *Polyptychites*, *Dichotomites*, *Simbirskites*, *Delphinites*, *Bochianites* and *Phylloceras*. Rhynchonellid brachiopods and a nautiloid were also described (This study, plus Spath, 1946; Donovan, 1953; Surlyk & Zakharov, 1982; Alsen & Rawson, 2005; Alsen, 2006).

Depositional environment. The unit was deposited in a deep marine, sub storm-wavebase setting particularly in the hanging walls of faults although not necessarily at the crests of tilted fault blocks. Evidence for this is provided by the deep marine setting of Volgian-Valanginian strata as seen in Wollaston Forland (Surlyk, 1978) and the deep marine of setting of similar facies in overlying Aptian-Campanian strata away from basin margins. The oxidised red colouration found at the base of the unit at the crest of Mols Bjerge tilted fault block indicates local sediment starvation, with deposition only from suspension and slow sedimentation rates. This is similar to the Rødryggen Member of the Palnatokes Bjerg Formation in Wollaston Forland (Surlyk, 1978; Alsen, 2006).

Age. A latest Ryazanian–Early Hauterivian age is determined from ammonite and bivalve evidence (Figure 7).

Additional data sources. Donovan, 1953, 1955, 1957; Surlyk, 1978; Whitham *et al.*, 1999; Alsen and Mutterlose, 2009.

Mapping notes. The *Buchia* Beds are extrapolated into the subsurface geology in the syn-rift hanging wall succession of the Månedal Fault (Cross Sections A to D, Enclosure 2) and other faults active during the Volgian–Valanginian rift event.

6.2. Inoceramus aucella Beds

Definition. The *Inoceramus aucella* Beds in the Traill Ø region are recognised by the presence of the named bivalve (Figure 8b) and the absence of *Buchia* spp. Elsewhere (NW

Europe, Russian Platform, Glazunova,1973) *I. aucella* Trautschold (1865) Is known to range from the Early Valanginian to the Late Hauterivian.

Distribution & thickness. The unit is well exposed south of Forchhammer Bjerg (Traill Ø) and poorly exposed to the north of Rold Bjerge and in Vælddal (Traill Ø) and to the south of Tørvestakken (Geographical Society Ø) (Figure 2). Sedimentological evidence for rifting between Barremian and Aptian times in Hold with Hope (Whitham *et al.*, 1999) suggests that the *Inoceramus aucella* Beds should thicken down the hanging wall slopes of fault blocks (westwards) which were active during Volgian–Valanginian rifting (e.g. the Månedal Fault and possibly the Mols Bjerge and Laplace Bjerg faults). Subsurface extrapolations of the *Inoceramus aucella* Beds indicate that it has a maximum thickness of 200-400 m. These figures do not take into account the presence of sills which may form up to 40% of the thickness of the unit.

Lithology & sedimentology. Poorly sorted, grey micaceous mudstones lacking sedimentary structures due to bioturbation.

Basal contact. Although the base is not observed, bedding orientations suggest that the *Inoceramus aucella* Beds are conformable with the underlying *Buchia* Beds. Regional geological evidence supports this relationship (e.g. Whitham *et al*., 1999 and Pauly *et al.,* 2016). Cross section construction indicates that the *Inoceramus aucella* Beds must also onlap Jurassic strata (the BCU) on the west dipping hanging wall slopes of east dipping normal faults (Enclosure 2).

Palaeontology. The lower part of the *Inoceramus aucella* Beds as mapped commonly contains the index fossil *Inoceramus aucella*, (Figure 8b) with belemnites (*Acroteuthis* sp. and *Pachyteuthis* sp.) and rare ammonites. These indicate a Hauterivian age (This study, plus Donovan, 1953, 1955, 1957; Kelly *et al.*, 1998; Alsen, 2006). Barremian-Aptian dinocysts are found within the upper part of this unit (Nøhr-Hansen, 1993).

Depositional environment. Deep, sub storm wave-base marine to outer shelf setting particularly in the hanging walls of faults although not necessarily at the crests of tilted fault blocks. Evidence for this is provided by the deep marine setting of Volgian-Valanginian strata as seen in Wollaston Forland (Surlyk, 1978) and the deep marine of setting of similar facies in overlying Aptian-Campanian strata away from basin margins.

Age. A mid Hauterivian–Aptian age is determined from molluscan assemblages and palynology (Figure 7).

Additional data sources. Donovan, 1953, 1955, 1957; Nøhr-Hansen, 1993; Stemmerik *et al.*, 1993; Kelly *et al.*, 1998; Whitham *et al.*, 1999.

Mapping notes. The *Inoceramus aucella* Beds are extrapolated into the subsurface geology, in the syn-rift hanging wall succession of the Månedal Fault (Cross Sections C and D, Enclosure 2).

6.3. Inoceramus anglicus Beds

Definition. The *Inoceramus anglicus* Beds in the Traill Ø region are recognised by the presence of the named bivalve *I. anglicus* Woods (1912) (Figure 8c) which is known to range from the Mid to the Late Albian in NW Europe. Outside of Greenland it is known to range just into the earliest Cenomanian (Tröger, 1996), but in Greenland there are no known associations with other Cenomanian fauna, so all occurrences can be treated as Albian. Also included within this unit on the geological map of Traill Ø are Early Albian strata which are recognised by the presence of ammonites including *Arcthoplites* cf. *jachromensis* (Nikitin) *Beudanticeras* cf. *hulenense* Anderson, *Leymeriella* aff. tardefurcata (D'Orbigny), and *"Puzosia" sigmoidalis* Donovan. (Spath, 1946; Donovan, 1955)

Distribution & thickness. The lower part of the *Inoceramus anglicus* Beds, (i.e. the Early Albian part), is found to the east of Tværdal and near Sverresborg, Geographical Society Ø. The upper portion (i.e. Mid-Late Albian) with *I. anglicus*, is exposed in Tværdal, the Mols Bjerge, to the east of Rold Bjerge, and in the Svinhufvud Bjerge (Figure 2). This unit is poorly exposed and a complete section has not been observed. Cross section construction indicates an estimated maximum thickness of 400-650 m (Enclosure 2). These figures do not take into account the presence of sills which may form up to 40% of the thickness of the unit.

Lithology & sedimentology. The unit is dominated by mudstone. Strata are largely parallel bedded. The mudstone is interbedded with thin sandstone beds and laminae showing ripple cross lamination and parallel lamination. Bedding is largely unaffected by bioturbation. Units of ripple cross laminated sandstone show mud drapes. Some thicker sandstone beds are graded. Locally, rare sandstone channels 100 m wide and up to 40 m deep are observed within the mudstones. Large matrix supported blocks of Jurassic and Triassic sandstone are found adjacent to the degraded footwall slopes of normal faults in the Svinhufvud Bjerge (Figures 10 & 11) and also at Kap Palander and in the Rold Bjerge. Rare lenticular bedded units of clast supported conglomerates, deposited by sediment gravity flows, are also found for example at Kap Palander. In Tværdal, at the basin margin, towards the base of the *Inoceramus anglicus* Beds, a 40 m thick fluvial sandstone unit is found with coal and rootlet horizons towards its top.

Basal contact. The contact between the *Inoceramus anglicus* Beds and the *Inoceramus aucella* Beds has not been observed, however, bedding orientations suggest that there is a conformable relationship between the two units. An angular unconformity is developed at the base of the unit on the submarine degraded footwall slopes of some tilted fault blocks such as the Mols Bjerge Fault Block. In these situations the *Inoceramus anglicus* Beds onlap Triassic and Jurassic strata (the BCU). Submarine valleys that are incised into these footwall slopes (Figure 12a) are infilled by this unit.

Palaeontology. A marine macrofauna of bivalves and ammonites is associated with *Inoceramus anglicus* Woods (1911) (Figure 8c), and is locally abundant in this unit. It includes other bivalves: *Aucellina*; the ammonites *Leymeriella*, *Arcthoplites*, *Beudanticeras*, *Puzosia*, a mortoniceratid and gastroplitinids; and belemnites of the *Neohibolites minimus* (Lister) group (This study, plus Spath, 1946; Donovan, 1949, 1953, 1955, 1957; Kelly *et al.*, 1998). At the basin margin, strata with rootlets and coals indicate that there was shallowing and emergence with climatic conditions that were capable of supporting a rich macroflora.

Depositional environment. The *Inoceramus anglicus* Beds were largely deposited in a deep marine sub-wave base setting by sediment gravity flows and hemipelagic processes under the influence of episodic bottom currents in places (*cf.* Pickering *et al*., 1986; Shanmugham *et al.*, 1994). The conglomeratic deposits at Kap Palander were deposited in the channel of a submarine fan (*cf.* Surlyk, 1978; Pickering *et al*., 1986). Thick mudstone beds containing large clasts are interpreted as debris flows caused by mass wastage of footwall slopes (*cf.* Pickering *et al*., 1986). The 40 m thick sandstone unit in Tværdal was deposited in a fluvio-deltaic environment and is thought to indicate the margin of the basin at this time. The onlapping nature of deep marine facies of the *Inoceramus anglicus* Beds onto degraded footwall slopes indicates that the geometry and distribution of tilted-fault blocks controlled bathymetry in the Traill Ø region at this time (Whitham *et al.*, 1999). This suggests that bathymetric relief confined the initial deposition of the *Inoceramus anglicus* Beds and older Cretaceous strata within rotated fault block intrabasins. At some locations, the upper part of the unit overfilled some of these basins.

Age. An Early Albian–Late Albian age is determined from ammonite and bivalve assemblages (Figure 7).

Additional data sources. Donovan, 1953, 1955, 1957; Nøhr-Hansen, 1993; Stemmerik *et al*., 1993; Kelly *et al*., 1998; Whitham *et al*., 1999.

Mapping notes. The *Inoceramus anglicus* Beds were deposited during a period of rifting that ended during the Mid Albian (Whitham *et al.*, 1999). As such, extrapolations of the *Inoceramus anglicus* Beds thicken downslope of fault block hanging walls.

6.4. Inoceramus crippsi Beds

Definition. The *Inoceramus crippsi* Beds on Traill Ø region are recognised by the presence of the named bivalve, *I. crippsi* Mantell (1822) (Figure 9a), which is known to range from the Early to early Mid Cenomanian in NW Europe (Tröger 1967). It is commonly associated with the ammonite *Schloenbachia varians* (J. Sowerby) which was a former zonal index for the Early Cenomanian in northwest Europe.

Distribution & thickness. The unit is found across large areas of Traill Ø and Geographical Society Ø. It has a thickness of between 600-1300 m (Figure 2) on cross sections. These figures do not take into account the presence of sills which may form up to 40% of the thickness of the unit.

Lithology & sedimentology. The unit is dominated by mudstone, with thin sandstone interbeds and sand laminae showing ripple cross lamination and parallel lamination. Strata are largely parallel bedded and mostly unaffected by bioturbation. Units of ripple cross laminated sandstone show mud drapes. Some thicker sandstone beds are graded. Rarely, units of cross bedded sandstone are found, for example in the Mols Bjerge. In the hanging walls adjacent to major normal faults units of folded and contorted interbedded mudstone and sandstone are common. Large matrix supported blocks of Jurassic and Triassic sandstone are found on the degraded footwall slopes of normal faults, for example around Laplace Bjerg.

Basal contact. A conformable basal contact with the underlying *Inoceramus anglicus* Beds is observed in Tværdal (Figure 2). An angular unconformity is developed at the base of the unit on the submarine degraded footwall slopes of some tilted fault blocks on Nordenskjøld Ø and in the Svinhufvud Bjerge (Figures 10 & 11). In these places the *Inoceramus crippsi* Beds onlap Triassic and Jurassic strata (the BCU). Submarine valleys that are incised into these footwall slopes (Figure 12b) are infilled by this unit.

Palaeontology. Marine macrofauna are commonly observed in sandier sediments and less commonly in the mudstones. The fauna is dominated by *Inoceramus crippsi* Mantell (Figure 9a) and the ammonite *Schloenbachia varians* (J. Sowerby); ammonites also present include species of *Gaudryceras*, *Parapuzosia*, and *Phylloceras*; small nuculoid tellinid and lucinacean bivalves may be locally common (This study, plus Donovan, 1949, 1953, 1954; Kelly *et al.*, 1998).

Depositional environment. The *Inoceramus crippsi* Beds were deposited in a deep marine sub-wave base setting by sediment gravity flows and hemipelagic processes under the influence of episodic bottom currents in places (*cf.* Pickering *et al*., 1986; Shanmugham *et al.*, 1994). Nuculoid bivalves indicate deposit feeding on a poorly oxygenated sea floor. Contorted units composed of intraformational strata are interpreted as slump deposits and indicate unstable slopes (*cf.* Pickering *et al*., 1986). Mudstone beds containing large Jurassic and Triassic clasts are interpreted as debris flows (*cf.* Pickering *et al*., 1986) caused by mass wastage of degrading submarine footwall slopes. Basal parts of the *Inoceramus crippsi* Beds onlap degraded footwall slopes and infill marine canyons (Figure 12b), which may account for some of the variation in thickness of the unit. By the end of the deposition of the *Inoceramus crippsi* Beds, all tilted fault block crests in the region were covered by sediment, indicating a change in basin architecture from smaller, localised tilted fault block intrabasins to a larger basin bound to the west by the shelf break.

Age. An Early to Mid-Cenomanian age is determined from inoceramid bivalves and ammonite assemblages (Figure 7). The Late Cenomanian is probably present but has not been formally recognised.

Additional data sources. Donovan, 1953, 1954, 1955, 1957; Tröger, 1967; Kelly *et al*., 1998; Whitham *et al*., 1999.

Mapping notes. *n/a*

6.5. Inoceramus lamarcki Beds

Definition. The *Inoceramus lamarcki* Beds are indicated by the presence of *Inoceramus* ex gr. *lamarcki* Parkinson (1819) (Figure 9b) and associated macrofauna. *Inoceramus lamarcki* is known to range from the Mid to the Late Turonian in NW Europe (Tröger, 1967). Included within these beds on the map of the Traill Ø region are later inoceramids including Coniacian *Cremnoceramus deformis erectus* (Meek), *I.* ex gr. *gibbosus* (Schlüter), and *Volviceramus koeneni* (Muller) (Det. I. Walaszczyk).

Distribution & thickness. The unit is poorly exposed. It is found widely across several areas of Geographical Society Ø and around Månedal on Traill Ø (Figure 2). The upper parts of the unit are known from southern Geographical Society Ø. The unit has an estimated minimum thickness of 400-450 m. These figures do not take into account the presence of sills which may form up to 40% of the thickness of the unit.

Lithology & sedimentology. The unit is dominated by mudstone. Strata are largely parallel bedded. The mudstone is interbedded with thin sandstone beds and laminae showing ripple cross lamination and parallel lamination. Bedding is largely unaffected by bioturbation. Units of ripple cross laminated sandstone show mud drapes. Some thicker sandstone beds are graded. In three areas, one to the north of Kap Hovgaard, one in Månedal and one to the west of Basaltø (Figure 2), units up to 40 m thick composed of interbedded conglomerate, pebbly sandstone, sandstone and subordinate mudstone are found. Bedding is lenticular and discontinuous. A reworked marine macrofauna of belemnites and inoceramid bivalves is found in the conglomerates.

Basal contact. The basal contact is conformable with the underlying *Inoceramus crippsi* Beds.

Palaeontology. The *Inoceramus lamarcki* Beds contain locally common marine macrofauna associated with the bivalve, *Inoceramus* ex gr. *lamarcki* Parkinson (Figure 9b). It includes the ammonites, *Scaphites* aff. *geinitzi* d'Orbigny, *Scaphites morrowi* Jeletzky and *Collignoniceras woollgari* (Mantell), the bivalves, *Inoceramus perplexus* Whitfield, *Inoceramus longealatus* Tröger, *Inoceramus pseudowanderi*, *Mytiloides mytiloidiformis* (Tröger), *Mytiloides scupini* (Heinz), *Cremnoceramus waltersdorfensis waltersdorfensis* (Andert), and *Lucina?* sp., plus the belemnites, *Actinocamax* cf. *manitobensis* (Whiteaves), *Actinocamax* cf. *plenus* (Blainville), echinoids and the caryophyllid coral *Discocyathus?* sp. (This study, plus Spath, 1946; Donovan, 1953, 1954, 1957; Tröger, 1967; Walaszczyk, 1992; Kelly *et al.*, 1998).

Depositional environment. The unit was deposited in a deep marine environment in sub-wave base setting by sediment gravity flows and hemipelagic processes under the influence of episodic bottom currents in places (*cf.* Pickering *et al*., 1986; Shanmugham *et al.*, 1994). The coarse grained sediments are interpreted as submarine fan channel deposits (*cf.* Surlyk, 1978; Pickering *et al*., 1986).

Age. A Turonian–Coniacian age is indicated by the ammonite and inoceramid bivalve assemblages (Figure 7).

Additional data sources. Donovan, 1953, 1954, 1955, 1957; Tröger, 1967; Kelly *et al*., 1998; Whitham *et al*., 1999; Surlyk and Noe-Nygaard, 2001.

Mapping notes. *n/a*

6.6. Sphenoceramus Beds

Definition. The *Sphenoceramus* Beds are indicated by the presence of *Sphenoceramus* spp; and associated macrofauna including *Hypoxytoma tenuistriata* (Römer) (Figure 9c). The lower part of the unit is characterised by *S. pinniformis* (Willet) -*martini* (Seitz) and *S.* ex gr. *cardissoides* sensu (Goldfuss)-*pachti* (Arkangelsky) and is Late Santonian in age. The upper part of the unit contains *Sphenoceramus cancellatus (*Goldfuss), *S*. cf. *lingua* (Goldfuss) and *S*. cf. *steenstrupi* (de Loriol), and is of Early Campanian age.

Distribution & thickness. The unit is found widely across Geographical Society Ø and around Månedal on Traill Ø (Figure 2). It has an estimated thickness of 500 m on Geographical Society Ø and 400 m on Traill Ø. These figures do not take into account the presence of sills which may form up to 40% of the thickness of the unit.

Lithology & sedimentology. The unit is dominated by mudstone. Strata are largely parallel bedded. The mudstone is interbedded with thin sandstone beds and laminae showing ripple cross lamination and parallel lamination. Units of ripple cross laminated sandstone show mud drapes. Some thicker sandstone beds are graded. Bedding is largely unaffected by bioturbation. Rarely, contorted units of interbedded sandstone and mudstone are found.

Basal contact. The basal contact is conformable with the underlying *Inoceramus lamarcki* Beds.

Palaeontology. The *Sphenoceramus* Beds contain a locally common marine fauna, dominated by sphenoceramid and oxytomid bivalves. Also present is the malacostracan arthropod *Linuparis duelmensis* (Geinitz) (This study, plus Donovan, 1953, 1954, 1957; Kelly *et al.*, 1998).

Depositional environment. The unit was deposited in a deep marine, sub-wave base setting by sediment gravity flows and hemipelagic processes under the influence of episodic bottom currents in places (*cf.* Pickering *et al*., 1986; Shanmugham *et al.*, 1994). Rarely, debris flows led to redeposition of sediment deposits (*cf.* Pickering *et al*., 1986).

Age. Santonian–Mid Campanian, as determined from macrofauna assemblages (Figure 7).

Additional data sources. Donovan, 1953, 1954, 1955, 1957; Kelly *et al*., 1998; Whitham *et al*., 1999; Surlyk and Noe-Nygaard, 2001.

Mapping notes. *n/a*

6.7. Scaphites Beds

Definition. The *Scaphites* Beds are recognised by the presence of ammonites *Hoploscaphites cobbani* (Birkelund) in the early Mid Campanian and *H. greenlandicus* (Donovan) (Figure 9d) in the latest Mid to early Late Campanian. These species are now known in Northeast and West Greenland (Donovan, 1953, 1954; Birkelund, 1965).

Distribution & thickness. The unit is found on Geographical Society Ø, to the south and east of Laplace Bjerg (Figure 2). It is very well exposed on the south side of Leitch Bjerg and very poorly exposed on Traill Ø around Månedal (Figure 2). A section 280 m thick without sills has been measured at Leitch Bjerg. The unit has an estimated *minimum* thickness of 400 m from cross sections. This figure does not take into account the presence of sills which may form up to 40% of the thickness of the unit. The top of the unit is not seen.

Lithology & sedimentology. The unit is dominated by mudstone. Strata are largely parallel bedded. The mudstone is interbedded with thin sandstone beds and laminae showing ripple cross lamination and parallel lamination. Bedding is largely unaffected by bioturbation although it is more common than in underlying units. Units of ripple cross laminated sandstone show mud drapes. Some thicker sandstone beds are graded. At one locality to the east of Laplace Bjerg, beds composed of contorted intraformational strata are common in a 90 m section. To the south of Leitch Bjerg (Figure 2), a lenticular unit of conglomerates, pebbly sandstones and sandstones of sediment gravity flow origin is found. This has a maximum thickness of 150 m and thins westward to 40 m over a distance of 3km.

Basal contact. The *Scaphites* Beds are conformable with the underlying *Sphenoceramus* Beds.

Palaeontology. In addition to the index taxa, the beds contain ammonites; *Baculites* sp., *Pseudophyllites latus* (Marshall), *Jeletzkytes compressus* (Römer), the bivalves; *Lucina laminosa* (Reuss), *Nucula cancellata* Meek & Hayden, *Tellina? steenstrupi* de Loriol, *Nuculana? panda* (Nilsson), *Corbula?* sp., plus, belemnites; *Belemnitella?* sp., gastropods; *turritellid?* and echinoids; indeterminate (*spatangoid?*) (This study, plus Donovan, 1953, 1954, 1955; Birkelund, 1965).

Depositional environment. The unit was deposited in a deep marine sub-wave base setting by sediment gravity flows and hemipelagic processes under the influence of episodic bottom currents in places (*cf.* Pickering *et al*., 1986; Shanmugham *et al.*, 1994). Locally steep slopes led to the redeposition of the thinly interbedded mudstones and sandstones by slumps and debris flows (*cf.* Pickering *et al.*, 1986). The thick lenticular unit of sandstones and conglomerates is interpreted as a submarine fan channel fill (*cf.* Surlyk, 1978; Pickering *et al.*, 1986). The localised carbonate bodies are probably associated with methane vents and are analogous to those described by Kelly *et al*. (2000).

Age. A Mid to Late Campanian age is determined from ammonite assemblages (Figure 7).

Additional data sources. Donovan, 1953, 1954, 1955, 1957; Whitham *et al*., 1999.

Mapping notes. Coarse grained lenticular channel fill deposits forming a mappable unit within the *Scaphites* Beds are defined as the '*Scaphites* Beds channel-fill'.

7. Cenozoic strata

7.1. Sub-basaltic Marine Beds

Distribution & thickness. The Sub-basaltic Marine Beds are a newly recognised unit found close to Leitch Bjerg, Geographical Society Ø (Figure 2). The unit has a minimum thickness of 65 m.

Lithology & sedimentology. The succession is poorly lithified and dominated by mudstones and sandy mudstones, interbedded with thin sandstone beds typically less than

10 cm thick. The sandstone beds are typically structureless. Parallel lamination is rarely seen and cross beds were observed in one bed. Foresets in the cross bedded interval have mudstone drapes. The succession contains plant fragments.

Basal contact. There is an angular discordance of ≤4^{o} with the underlying *Scaphites* Beds.

Palaeontology. Palynological analysis of mudstones reveals a marine flora including *Alisocysta margarita*, *Areoligera* cf *medusettiformis*, *Areoligera* cf. *senonensis* (C), *Cupuliferoipollenites cingulum* subsp. *fusus* (C), *Hystrichosphaeridium tubiferum*, *L. haardtii* (C), *Oligosphaeridium* cf *complex*, *Plicapollis pseudoexcelsus, Paraalnipollenites confusus/Triporopollenites coryloides complex* (C) and *Spiniferites ramosus* subp *ramosus*. Macrofauna were not observed.

Depositional environment. Sedimentological features and marine flora suggest a shallow marine to terrestrial environment. The presence of a cross beds with mudstone drapes on the foresets suggests a tidal influence on sedimentation. The presence of plant and wood fragments suggest proximity to the shoreline.

Age. A Thanetian age is determined by the presence of the dinocyst *Alisocysta margarita* (Figure S1, below) in association with frequent specimens of the dinocysts *Areoligera* cf *medusettiformis*, *Oligosphaeridium* cf *complex* and *Spiniferites ramosus* subp *ramosus*. All palyofloras from this interval are characterised by common to abundant reworked Late Cretaceous dinocysts.

Additional data sources. Jolley and Whitham, 2004; Nøhr-Hansen *et al.*, 2011.

Mapping notes. *n/a*

Figure S1. *Alisocysta margarita* (Harland) Harland 1979. Section W4600, sample W4898.

7.2. Plateau Basalts

Distribution & thickness. Plateau basalts are found on eastern Geographical Society Ø at Kap Mackenzie and on the summit of Leitch Bjerg (Figure 2). They have a maximum thickness of 150 m (Figure 2).

Lithology & sedimentology. The succession is dominated by basaltic lava flows with a tholeiitic composition. Individual flows are 1-5 m in thickness and are of Pahoehoe type (Hald, 1996). Rare tuffaceous layers are found between the flows.

Basal contact. Observations in southern East Greenland show that faulting occurred prior to and during the initial stages of flood basalt extrusion (Whitham *et al*., 2004; Larsen & Whitham 2005). Therefore, there may be an angular discordance at the base of the unit at its contact with the Sub-basaltic Marine Beds.

Palaeontology. No fossils are found in the succession.

Depositional environment. Extrusion of basaltic flows was subaerial. (Jolley & Whitham, 2004).

Age. There are no direct dates of the basaltic succession in the Traill Ø region. By analogy with other occurrences of plateau basalts elsewhere in East Greenland the basalts probably have a latest Paleocene to earliest Eocene age (Jolley & Whitham, 2004; Larson *et al.*, 2014).

Additional data sources. Hald, 1996; Jolley and Whitham, 2004; Larsen *et al.*, 2014

Mapping notes. *n/a*

8. Intrusive rocks

Cenozoic igneous intrusions are abundant in the region. Both basic and acidic intrusions are found, but basic intrusions are most common. Basic intrusions are present as dykes and sills particularly in the Cretaceous succession. The acidic intrusions are present as two large plutons and less commonly as sills in areas adjacent to the plutons.

8.1. Doleritic intrusions

Doleritic sills and dykes are present across the Traill Ø region. Most doleritic intrusions have a tholeiitic composition, but a minority of dykes have an alkaline composition (Brodie, 1995; Price *et al*., 1997). Lithology exerted a strong control on the type of intrusion with sills largely found in mudstones and dykes largely found in sandstones. The largest sills typically occur above the base Cretaceous unconformity (e.g. the Mols Bjerge, Traill Ø) with a maximum thickness of 300 m. The abundance of intrusions increases from west to east. Intrusions in Devonian strata are rare. In contrast, they may form up to 40% of the succession in the

Cretaceous mudstones found in the east of the region. The tholeiitic dolerites were emplaced at *ca.* 54 Ma and are related to the opening of the Norway-Greenland Sea in the Early Eocene (Price *et al*., 1997; Larsen *et al.*, 2014) forming the westernmost segment of the Traill-Vøring Igneous Complex (Olesen *et al.*, 2007). Alkaline intrusions were emplaced in the late Eocene-Early Oligocene coincident with the separation of the Jan Mayen microcontinent from East Greenland (Brodie, 1995; Price *et al*., 1997).

8.2. Acidic intrusions

The Kap Simpson and Kap Parry syenite plutons form the two eastern major promontories of Traill Ø (Figure 2) and have diameters of *ca*. 29 km and *ca.* 12 km, respectively (Koch and Haller 1971, Price *et al.*, 1997). A smaller syenite pluton is found in the Flakkebjerge area of Traill Ø. Thin felsite intrusions presumably with an alkaline acidic composition are found largely in the vicinity of the Kap Simpson syenite. K/Ar and apatite fission track age dates from the Kap Simpson and Kap Parry syenite plutons give approximate ages of *ca.* 35 Ma (Noble *et al.*, 1988; Thomson *et al.*, 1999). As with the alkaline doleritic intrusions, emplacement of alkaline acidic rocks was associated with the separation of the Jan Mayen micro-continent from the East Greenland continental margin (Price *et al*., 1997; Larsen *et al.*, 2014).