DANMARKS OG GRØNLANDS GEOLOGISKE UNDERSØGELSE **RAPPORT 2021/4**

Geochemical database from East Greenland 70°–76°N

A compilation of data from rock, heavy mineral concentrate, stream sediment and soil samples

Simun Dalsenni Olsen & Bjørn Thomassen

GEOLOGICAL SURVEY OF DENMARK AND GREENLAND
DANISH MINISTRY OF CLIMATE, ENERGY AND UTILITIES

G E U S

DANMARKS OG GRØNLANDS GEOLOGISKE UNDERSØGELSE **RAPPORT 2021/4**

Geochemical database from East Greenland 70°–76°N

A compilation of data from rock, heavy mineral concentrate, stream sediment and soil samples

Simun Dalsenni Olsen & Bjørn Thomassen

GEOLOGICAL SURVEY OF DENMARK AND GREENLAND
DANISH MINISTRY OF CLIMATE, ENERGY AND UTILITIES

G E U S

Frontispiece. *The second author collecting a heavy mineral concentrate sample by panning.*

Abstract

The report describes a consolidated database of geochemical data from East Greenland compiled by the Geological Survey of Denmark and Greenland (GEUS) from data stored in its archives. The dataset comprises all rock, drainage and soil samples from the main part of the area between 70° and 76°N.

The original data in GEUS' archives are hosted in three databases viz. GEUS' own database, the database of Nordisk Mineselskab A/S (Nordmine) and the database of Avannaa Resources Ltd. Sample types registered in the databases are rock samples, stream sediment and soil samples, and heavy mineral concentrates of stream sediments. The three databases comprise geographical coordinates, chemical analyses and variable amounts of geological information, but the data are very heterogeneous.

Extraction of samples was different for the three involved databases, because they use different lithostratigraphic terms: GEUS samples have no lithostratigraphic coding; Nordmine samples are coded differently north and south of the 72° parallel, using two different sets of older nomenclature; and Avannaa rock samples are coded according to the most recent lithostratigraphy. In order to link the different codes, a common nomenclature is introduced and presented in three tables.

A total of 26,067 samples have been extracted: 16,356 rock samples, 3,773 heavy mineral concentrate samples and 5,938 stream sediment and soil samples. The extracted samples have been distributed among five geological units: Caledonian Crystalline Rocks (7,022 samples), Eleonore Bay Basin (3,909 samples), Devonian–Triassic Basin (10,091 samples), Jurassic–Cretaceous Basin (2,833 samples) and Palaeogene Igneous Province (2,212 samples). The distribution of the samples among the five geological units was based on existing geological coding and/or geological maps. Map polygons from the newest geological map, published by the Survey in 2007, were used for the extraction of some samples, and form the geological background on the 15 sample location maps presented in this report.

The samples extracted from the three databases are presented in 46 Excel tables of which three represent the final consolidation of all rock samples, heavy mineral concentrate samples, and stream sediment and soil samples, respectively, from the area of interest. This new database is available from the webshop on the Greenland Mineral Resource Portal: www.greenmin.gl

Contents

1. Introduction

In 2018, First Quantum Minerals Ltd., Toronto, commissioned the Geological Survey of Denmark and Greenland (GEUS) to compile a digital database of the Survey's geochemical data from specific sedimentary basins in East Greenland. The area of interest covered the main parts of the Neoproterozoic–Ordovician Eleonore Bay Basin and the Devonian, Carboniferous, Permian and Triassic basins between 70° and 76°N (Figure 1). The requested data were delivered by GEUS to First Quantum on March 15th. 2019, with a period of confidentiality of 12 months. After this date, GEUS decided to compile the data from the remaining geological units, in order to create a consolidated geochemical database for the area between 70° and 76°N (Figure 2). This subsequent project was supported financially by the Ministry of Mineral Resources of Greenland (MMR). The present report describes the two projects, which resulted in 46 Excel tables displayed on the Greenland Mineral Resource Portal: www.greenmin.gl

The geochemical data stored at GEUS and used in the two projects are hosted in three databases viz. GEUS' own database, the database of Nordisk Mineselskab A/S (Nordmine) and the database of Avannaa Resources Ltd. The two latter stem from now closed exploration companies. The physical samples are stored in the GEUS archives. All three databases comprise geographical coordinates, chemical analyses and variable amounts of geological information. Especially the chemical analyses are very heterogeneous; covering different elements, employed different methods of analysis, resulting in different detection limits, etc. These data have been merged without any calibration, and therefore they should be used with prudence. Nevertheless, we think they should constitute a useful tool for defining worthwhile geochemical anomalies.

Sample types registered in the databases are rock samples (RO), stream sediment (SS) and soil (SO) samples, and heavy mineral concentrates of stream sediments (HM). The latter were mainly produced by panning in the field (Frontispiece), rarely in the laboratory. In this study, stream sediment samples and soil samples are presented in the same tables.

The authors had various roles during the data compilation: while SOL was responsible for data handling and map presentations, BTH contributed with geological and historical information.

2. Project area

The area of interest (AOI) for this study comprises most of the ice-free land between 70° and 76°N in East Greenland. Only the most inaccessible tracts along the margin of the Inland Ice have been excluded. The bedrocks of the area have been divided into the five major geological units listed below. The original project generated by First Quantum comprised units 2 and 3, whereas units 1, 4 and 5 were dealt with in the subsequent project.

5. **Palaeogene Igneous Province (IP)**, see Figure 2 and Table C.

4. **Jurassic–Cretaceous Basin (JC)**, see Figure 2 and Table C.

3. **Devonian–Triassic Basin (DT)** comprising the sequential Devonian, Carboniferous, Permian and Triassic basins, see Figure 1 and Table B.

2. **Eleonore Bay Basin (EB)** comprising Eleonore Bay Supergroup, the Tillite Group and the Kong Oscar Fjord Group, see Figure 1 and Table A.

1. **Caledonian Crystalline Rocks (CC)** comprising Foreland Windows, Crystalline Complexes, and Granites, see Figure 2 and Table C.

Geological setting

The geology of central and North-East Greenland is dominated by the N–S-orientated Caledonian Fold Belt, formed by the collision between Laurentia and Baltica 465–400 million years ago. During and after the collapse of the Caledonides, coast-parallel Palaeozoic–Mesozoic sedimentary basins formed to the East, followed by extensive Palaeogene uplift and magmatic activity accompanying the opening of the North Atlantic (Henriksen 2009; Watt 2019).

1. Caledonian Crystalline Rocks, CC

Foreland Windows, CW. Three main Tectonic windows are situated along the eastern margin of the Greenland shield south of 76°N: Gåseland window, Charcot Land window and Eleonore Sø window. Parts of the two first are inside the AOI. They comprise both a Palaeoproterozoic gneissic basement overlain by younger supracrustals: in Charcot Land low-grade Palaeoproterozoic rocks, in Gåseland early Palaeozoic rocks (Higgins & Leslie 2008). Massive iron sulphides of possible volcanogenic origin with traces of Cu and Ni occur in Palaeoproterozoic supracrustals in the Charcot Land window (Harpøth *et al.* 1986).

Crystalline Complexes, CCC. Two main allochthonous thrust sheets, each comprising Archean–Palaeoproterozoic/Mesoproterozoic basement complexes of mainly granitoid orthogneisses overlain by the high-grade, Mesoproterozoic Krummedal supracrustal sequence: the lower Niggli Spids thrust sheet and the upper Hagar Bjerg thrust sheet (Leslie & Higgins 2008). The latter also hosts Neoproterozoic granitic rocks. The basement rocks host poorly known mineralisation of Cu, Au, PGE, Ni, Cr, Fe, Ti and U. The Krummedal supracrustal sequence have indications of Cu, Pb, Zn, W and U (Harpøth *et al.* 1986).

Caledonian granites, CG. During the Caledonian orogeny, widespread migmatisation took place in the crystalline complexes, and a suite of late to post-kinematic plutons was emplaced in the upper thrust sheet. These intrusions are mainly of granodioritic and granitic composition with ages in the range 440–425 Ma (Kalsbeek *et al.* 2008). *C*. 930 Ma old granites have been included in this unit in Table C. Abundant vein- and skarn-type W, Sb, Sn, Au, Cu, Pb and Zn mineralisation is associated with the Caledonian granites (Harpøth *et al.* 1986).

2. Eleonore Bay Basin, EB

Prior to the Caledonian deformation, an up to 18.5 km thick sequence of Neoproterozoic–Lower Palaeozoic sediments had been deposited in a 'Fjord Zone Basin' along the eastern margin of the Laurentian continent. The 900–600 Ma old basal part of the sequence constitutes the Eleonore Bay Supergroup (EBS); the upper parts consist of tillites and Cambro–Ordovician sediments. During the Caledonian orogeny, the sediments were transported several 100's km westwards as a Franz Joseph unit of weakly- to non-metamorphic sediments intruded by granites, riding on top of the Hagar Bjerg thrust sheet (Higgins *et al*. 2008).

Today, the EBS is exposed in four areas, of which the three easternmost form part of the present study (Figure 1). It is a 14–16 km thick sedimentary sequence, divided into four groups in the project area. These are, from base to top: Nathorst Land Group (*c.* 11 km thick), Lyell Land Group (2–3 km thick), Ymer Ø Group (*c.* 1 km thick) and Andrée Land Group (*c.* 1.5 km thick), see Table 1A. The EBS is separated from the underlying Mesoproterozoic, high-grade metasediments of the Hagar Bjerg thrust sheet by a detachment plane, and from the overlaying Neoproterozoic Tillite Group glacial deposits by an erosional unconformity (Sønderholm & Tirsgaard 1993; Sønderholm *et al*. 2008).

Stratiform and strata-bound copper mineralisation is known from eight stratigraphic levels in a 3 km thick part of the EBS sequence spanning from uppermost Nathorst Land Group to the lower part of Ymer Ø Group. Six of the levels occur over 1200 m in the upper part of the Lyell Land Group and the lower part of the Ymer Ø Group, a sequence characterized by a gradual shift from dominating siliciclastic sedimentation to dominating carbonate sedimentation and including abundant red bed intervals. The EBS sediments also host veins or skarns associated with Caledonian/Devonian intrusive granites. This type of mineralisation is enriched in elements such as W, Sb, As, Sn, Cu, Pb, Zn, Ag and Au. Especially scheelite-antimonite- and gold-bearing veins on Ymer Ø have been the target for previous exploration (Harpøth *et al.* 1986).

3. Devonian–Triassic Basin, DT

An up to 8 km thick pile of Devonian continental clastic sediments were deposited in N–S-orientated basins in central East Greenland during the extensional collapse of the Caledonian orogeny (Larsen *et al.* 2008). This was accompanied by minor felsic and mafic volcanic activity, with associated base/noble metal and uranium mineralisation (Harpøth *et al.* 1986).

After initial rifting during the earliest Carboniferous, a more than 3 km thick sequence of fluvial sandstone and shales were deposited in narrow N–S-trending half-grabens in central East Greenland. Deposition ceased in the earliest Permian, after which a new episode of regional uplift and erosion took place. Vein-type base metal mineralisation is widespread in the clastic sediments, as exemplified by the Blyklippen Pb-Zn deposit mined during 1956–62 (Harpøth *et al*. 1986).

The Upper Permian sediments represent the first marine transgression after the Caledonian orogenesis; they rest on older sediments with a distinct angular unconformity. The up to 300 m thick sequence, the Foldvik Creek Group, comprises five formations of interfingering shoreline-shallow marine lithofacies deposited in coast-parallel rift basins (Surlyk *et al.* 1986). Widespread strata-bound base metal mineralisation occurs in three of the five formations (Thomassen *et al.* 1982).

In the Triassic period, the sea retreated and an elongated inland basin formed in which *c.* 1400 m red-bed sediments were deposited in alluvial fans, in fluctuating rivers, in temporary lakes, and by the wind, under desert conditions (Clemmensen 1980 a, b). Thus, the Scoresby Land Group, divided in four formations, comprises conglomerates and sandstones along the basin margins while fine-grained lake sediments and dune sandstones with sporadic thin layers of limestone and gypsum dominate the centre. Widespread, stratiform and strata-bound, copper-dominated mineralisation occurs in the three uppermost formations (Thomassen *et al*. 1982).

4. Jurassic–Cretaceous Basin, JC

Renewed marine incursion took place during the Early Jurassic, and during the remaining part of the Jurassic and earliest Cretaceous shelf conditions persisted in the basin with deposition of fine- to coarse-grained clastic sediments (Ineson & Surlyk 2003). Fossil coastal placers rich in zirconium, titanium and rare-earth elements are associated with the Lower Jurassic transgression on Milne Land (Harpøth *et al.* 1986).

5. Palaeogene Igneous Province, IP

Palaeogene plateau basalts, linked to the continental break-up of the North Atlantic, cover an extensive area South of Scoresby Sund. North of Scoresby Sund, Palaeogene basic sills and dykes are widespread in the Mesozoic strata, and a further sequence of plateau basalts is found between latitudes 73° and 75°N. A number of alkaline felsic, intermediate and mafic intrusive complexes are exposed in the coastal regions of the area (Nielsen 2002; Brooks *et al.* 2004). Mineralisation includes a major porphyry-molybdenum deposit at Malmbjerg, as well as widespread base metal veins (Harpøth *et al.* 1986).

Geological maps

The area between 72° and 76°N was mapped topographically and geologically at 1:250,000 in 1926–1958 during the so-called Lauge Koch Expeditions (Koch & Haller 1971). The area 70°–72°N was mapped geologically at 1:100,000 in 1968–1972 by GGU (now GEUS). After fieldwork 1997–1998, GEUS issued revised maps at 1:500,000 covering the northern area. These three sets of maps used different lithostratigraphic nomenclature. Finally, the existing geology was transferred to revised topographic base maps at 1:250,000 and made available in digital format, the so-called Dancea maps, covering the whole area and with a fourth set of lithostratigraphic nomenclature (Mikkelsen *et al.* 2005, GEUS 2007).

The geological maps used in the present project were extracted from the 1: 250,000 Dancea maps. They comprise the geological Groups in the Eleonore Bay Basin in the form of 1,900 polygons, and the Groups or Formations in the Devonian–Triassic Basin in the form of 800 polygons, see Figure 1 and Tables A and B. For the Jurassic–Cretaceous Basin (530 polygons) and the Palaeogene Igneous Province (1,988 polygons), no geological subdivision has been used, whereas the Caledonian Crystalline Rocks (6,865 polygons) have been subdivided into Windows, Crystalline Complexes and Granites, see Figure 2 and Table C.

As to Table C: a further subdivision of the Caledonian Crystalline Complexes into basement/cover units or into Niggli Spids/Hagar Bjerg thrust sheets is not possible, because these units are not recognisable in the Nordmine codes. A desirable subdivision of not-geocoded samples between Caledonian Crystalline Complexes and Caledonian Granites has been abstained from, as it would be time-consuming and inaccurate.

3. Extraction and lithostratigraphic/tectonostratigraphic coding of samples

The dataset comprises all rock, drainage and soil samples from the AOI. Extraction of samples was different for the three used databases, because they use different lithostratigraphic/tectonostratigraphic terms: GEUS samples have no lithostratigraphic coding; Nordmine samples are coded differently north and south of the 72°N parallel, using older nomenclature; and Avannaa rock samples are coded according to the Dancea codes, as shown in Tables A, B and C. In order to link the different codes, the nomenclature shown in the column 'FirstQuantum2018' was used for the geological units 2 and 3 in the first part of this project, see Tables A and B. In the second part of the project, the unifying column is '2020 All samples' for units 1, 4 and 5, see Table C. The distribution of the extracted samples are shown on the maps in Figures 3–17.

Table A. *Lithostratigraphic codes, Eleonore Bay Basin.*

Code / Period	**70°–76°N FirstQuantum2018**	**70°–76°N** Dancea (GEUS 2007) Used by Avannaa	**70°–72°N** GGU 1:100,000 maps Used by Nordmine	**72°–76°N** Koch & Haller (1971) Used by Nordmine
Late Caledonian and older LC	LC Quartz vein		P (inside AOI)	P (inside AOI)
Ordovician Cambrian CO	CO Kong Oscar Fjord Gp.	CK, AW, NH	CA	11, 10
Neoproterozoic (Eleonore Bay Supergroup) NP	NP Tillite Gp.	TG	T, TF1	9
	NP Upper EBSG, undivided	AYL	-	-
	NP Andrée Land Gp.	AG1, AG2	L1, L2	8
	NP Ymer Ø Gp.	YG, YG1, YG2	M1, M2	7, 7M
	NP Lyell Land Gp.	KF, ST, LG1, BZ, KA, VS, SB, LG2	QZ	6, 6M, 5, 5M, 56
	NP Nathorst Land Gp.	NG, NG1, NG2	A, AF	4, 4A, 4M, 3, 3A, 3B, 3M, 2, 1

Table B. *Lithostratigraphic codes, Devonian–Triassic Basin.*

Code / Period	**70°–76°N FirstQuantum2018**	**70°–76°N** Dancea (GEUS 2007) Used by Avannaa	**70°–72°N** GGU 1:100,000 maps Used by Nordmine	**72°–76°N** Koch & Haller (1971) Used by Nordmine
Post Caledonian PC	PC Quartz vein		GAM (inside AOI)	QU (inside AOI)
Triassic T (Scoresby Land Group)	T Undivided Triassic (mainly WC)	TS	-	20, 19, 18, 1820
	T Fleming Fjord Fm.	FF	FF, F3, F2, F1, Pb, Sb	-
	T Gipsdalen Fm.	G	G, GF, G2, G1, GB, GK	-
	T Pingodal Fm.	P	PF, P4, P3, P2, P1	-
	T Wordie Creek Fm.	WC	WF	-
Upper Permian P	P Foldvik Creek Gp.	FC	FK, FK5, FK4, FK3, FK2, FK1, FK0	17
Carboniferous C	C Traill Ø Gp.	TOG	CP, CP4, CP3, CP2, CP1	16, 15, 1415
Devonian	Upper Devonian	Q, Pz, CG, KG, KKG	QF, Pz, VQ	13C, 13B, 13A
	Middle Devonian (Vilddal Gp.)	VIG	VI, VI3, VI2, VI1, WH, SH, BA	12, 12M, 1213
	Devonian Igneous rocks	db, rh, g7	VO, RH, GGI7 (inside AOI)	T, S, R, RS

Table C. *Lithostratigraphic/tectonostratigraphic codes, excluding EB and DT basins.*

70°–76°N **2020** **All samples**	**70°–76°N** **2020** **Geocoded samples**	**70°–76°N** Dancea (GEUS 2007) Used by Avannaa	**70°–72°N** GGU 1:100,000 maps Used by Nordmine	**72°–76°N** Koch & Haller (1971) Used by Nordmine
IP Palaeogene Igne-ous Province	IP Palaeogene Igne-ous Province	ψ, σ, ε, γ, gc, voc, vb, β2, β1, d2, b1, b2, ib, tu.	PS, AL, SI, EP, DE1, TA, BE, DE, DE5, OM, GAM (inside AOI).	U, V, M, W, X, Y, Z, YZ, RH, BX, QU (inside AOI).
JC Jurassic–Creta-ceous Basin	JC Jurassic–Creta-ceous Basin	Hz, RV, HBu, JK, Ha, KL, O, VK, Ch, Ju, N, KS, UCm, LCu, PT, LB, H.	HF, H2, H1, HZ, RF, R3, R2, R1, HA, OF, KR, KR4, KR3, KR2, KR1, CF, VF, V3, V2, V1, NF, N3, N2, N1, KF.	2123, 2223, 21, 22, 23, 2425, 24, 25, 26.
CC Caledonian Crys-talline Rocks (Archaean–Silu-rian)	CG Caledonian Granites *s.l.* (*c*. 930 and 430 Ma)	g4, g5, g6, mgi, agi, di, ω1.	GGI5, GGI6, GGI7, G3, G4, G5, G5A, G7, AG5, AG7, GI3, GI5, GI6, GI7, SGI5, SGI6, AGI5, AGI6, TGI5, TGI7, MGI6, MGI7, P (inside AOI)	O, N, NO, Q, P (inside AOI)
	CCC Caledonian Crystal-line Complexes (Archaean–Neopro-terozoic)	a1, a3, ms3, qg3, c2, c3, q2, md2, gn2, gn1g, gn1, gm3, mm3, agn, ub.	Q3, Q5, Q6, MS3, MS4, MS6, MS7, C3, C4, C5, C6, C7, VS4, MSQ3, MSQ6, QMS3, MGN3, A3, A4, A5, A7, AI4, MG5, MG6, DI5, UB3, UB4, UB5, UB7, QGN3, QGN4, QGN5, QGN7, GN4, GN5, GN7, AGN7, GGN4, GGN7, GNM5, GNM6, GNM7, GM5, GM6, BGN7	L, K, J, H, GA, GP, GAP, GS, GAS, F, E, D, C, JOP, JO
	CW Caledonian Windows (Palaeoproterozoic–Ordovician)	g2, qp, mg1, a1, vs1, vsz1, ms1, pg1, qms, c1, gn2, gn, Mf., MF, SF, TG (in-side AOI).	Q1, Q2, SP1, MS1 C1, C2, VS1, VS2, TF1, PE1, PE2, A1, A2, AE1, AI1, QGN2, GN1, GR1, GGI1	

4. GEUS samples

A total of 7,708 rock samples, heavy mineral concentrates, and stream sediment and soil samples from the AOI have been retrieved from the GEUS Database. The retrieved samples are shown on the maps in Figures 3–8, 13–16 and presented in the ten Excel tables 1–10 listed below. Analytical details for the GEUS samples are shown in Table 11. The GEUS samples have no lithostratigraphic code in the original database. For that reason, the samples have been retrieved and assigned to the five geological units according to where they plot on the Dancea map, as indicated in the columns 'Basin2018' and '2020_All_samples' introduced by us in the spreadsheets. A substantial part of the stream sediment samples plot in the Quaternary cover in the valley floors. These samples have been classed as the nearest outcrop on the geological map.

The SS-SO samples collected 1975–1977 were originally analysed for 11 elements at Risø National Laboratory. In 1992, 1,328 of these samples were reanalysed for 35 elements at Actlabs (Activation Laboratories Ltd.) (Steenfelt 1993).

- **Table_1_RO_CC_GEUS**. Rock samples belonging to the Caledonian Crystalline Rocks.
- **Table_2_RO_EB_GEUS**. Rock samples belonging to the Eleonore Bay Basin.
- **Table_3_RO_DT_GEUS**. Rock samples belonging to the Devonian–Triassic Basin.
- **Table_4_RO_JC_GEUS**. Rock samples belonging to the Jurassic–Cretaceous Basin.
- **Table_5_RO_IP_GEUS.** Rock samples belonging to the Palaeogene Igneous Province.
- **Table_6_HM_CC_GEUS.** Heavy mineral concentrates belonging to Caledonian Crystalline Rocks.
- **Table_7_SS-SO_CC_GEUS**. Stream sediment and soil samples belonging to the Caledonian Crystalline Rocks.
- **Table_8_SS-SO_EB_GEUS.** Stream sediment and soil samples belonging to the Eleonore Bay Basin.
- **Table_9_SS-SO_DT_GEUS.** Stream sediment and soil samples belonging to the Devonian–Triassic Basin.
- **Table_10_SS-SO_JC_GEUS**. Stream sediment and soil samples belonging to the Jurassic–Cretaceous Basin.
- **Table_11_GEUS_analytical_details.** Analytical details for GEUS samples.

5. Nordmine samples

The Nordmine database has been described by Thomassen & Tukiainen (2009). A total of 16,637 rock samples, heavy mineral concentrates, and stream sediment and soil samples have been retrieved from this database. These samples are shown on the maps in Figures 3–17 and presented in the 16 Excel tables 12–26 listed below.

Two sets of coordinates exist in the Nordmine database: the original coordinates based on old topographic maps, and newer coordinates marked T, better fitted to the Dancea map. The latter have been used in the present project. The UTM zone is 26N. The codes used in the spreadsheets are explained in the Nordmine Coding Manual (1981) which is included in Table 27, together with a Keycode List explaining the analytical methods.

The Nordmine samples all have geological codes, as shown in List 4 in the Nordmine Coding Manual (1981) and in Tables A, B and C. By only retrieving samples which plot on relevant geology on the Dancea Map, a large number of samples went amiss. The reason is, that many samples plot in the Quaternary or – because the coordinates were determined after old topographic maps – in the sea or on glaciers. Consequently, the samples had to be retrieved after their original coding, and detailed as shown in the columns 'FirstQuantum2018' or '2020_Geocoded_samples'. If a sample has Quaternary as the first priority in the Nordmine database, the second priority code has been used.

In 2011, 554 of the HM and SS-SO samples were reanalysed at Actlabs, courtesy of Avannaa Resources Ltd.

- **Table_12_RO_CC_Nordmine.** Rock samples belonging to the Caledonian Crystalline Rocks.
- **Table_13_RO_EB_Nordmine.** Rock samples belonging to the Eleonore Bay Basin.
- **Table_14_RO_DT_Nordmine.** Rock samples belonging to the Devonian–Triassic Basin.
- **Table_15_RO_JC_Nordmine.** Rock samples belonging to the Jurassic–Cretaceous Basin.
- **Table_16_RO_IP_Nordmine**. Rock samples belonging to the Palaeogene Igneous Province.
- **Table_17_HM_CC_Nordmine.** Heavy mineral concentrates belonging to the Caledonian Crystalline Rocks.
- **Table_18_HM_EB_Nordmine.** Heavy mineral concentrates belonging to the Eleonore Bay Basin.

- **Table_19_HM_DT_Nordmine.** Heavy mineral concentrates belonging to the Devonian–Triassic Basin.
- **Table_20_HM_JC_Nordmine**. Heavy mineral concentrates belonging to the Jurassic–Cretaceous Basin.
- **Table_21_HM_IP_Nordmine**. Heavy mineral concentrates belonging to the Palaeogene Igneous Province.
- **Table_22_SS-SO_CC_Nordmine.** Stream sediment and soil samples belonging to the Caledonian Crystalline Rocks.
- **Table_23_SS-SO_EB_Nordmine.** Stream sediment and soil samples belonging to the Eleonore Bay Basin.
- **Table_24_SS-SO_DT_Nordmine**. Stream sediment and soil samples belonging to the Devonian–Triassic Basin.
- **Table_25_SS-SO_JC_Nordmine.** Stream sediment and soil samples belonging to the Jurassic–Cretaceous Basin.
- **Table_26_SS-SO_IP_Nordmine.** Stream sediment and soil samples belonging to the Palaeogene Igneous Province.
- **Table_27_Nordmine_analytical_details.** Analytical details for Nordmine samples.

6. Avannaa samples

The Avannaa database hosts two types of samples, namely rock samples and stream sediment and soil samples. The 1,722 retrieved samples are shown on the maps in Figures 3–5, 13, 15, and presented in the five Excel tables 28–32 listed below, with analytical details shown in Table 33. For rock samples, the lithostratigraphic codes in the original database, stemming from the Dancea map, have been used, and homogenised into the 'FirstQuantum2018' or '2020_Geocoded_samples' columns, see Tables A, B and C. Stream sediment and soil samples have no lithostratigraphic codes, so they have only been classified into the five geological units, in the same way as the GEUS samples.

- **Table_28_RO_CC_Avannaa.** Rock samples belonging to the Caledonian Crystalline Rocks.
- **Table_29_RO_EB_Avannaa.** Rock samples belonging to the Eleonore Bay Basin.
- **Table_30_RO_DT_Avannaa.** Rock samples belonging to the Devonian–Triassic Basin.
- **Table_31_SS-SO_CC_Avannaa**. Stream sediment and soil samples belonging to the Caledonian Crystalline Rocks.
- **Table_ 32_SS-SO_DT_Avannaa.** Stream sediment and soil samples belonging to the Devonian–Triassic Basin.
- **Table_33_Avannaa_analytical_details.** Analytical details for Avannaa samples.

7. Consolidated database

The total number of samples extracted from the databases of GEUS, Nordmine and Avannaa amounts to 26,067, of which 16,356 are rock samples, 3,773 are heavy mineral concentrates, and 5,938 are stream sediment and soil samples, see Table 34.

As a first step in creating a consolidated database for all samples, the data from GEUS, Nordmine and Avannaa shown in Tables 1–10, 12–26 and 28–32 were amalgamated into the six new Excel tables 35–40 shown below.

- **Table_35_All_EB-DT_RO.** All EB-DT rock samples in two spreadsheets.
- **Table_36_All_CC-JC-IP_RO**. All CC-JC-IP rock samples in three spreadsheets.
- **Table_37_All_EB-DT_HM.** All EB-DT heavy mineral concentrates in two spreadsheets.
- **Table_38_All_CC-JC-IP_HM.** All CC-JC-IP heavy mineral concentrates in three spreadsheets.
- **Table_39_All_EB-DT_SS-SO.** All EB-DT stream sediment and soil samples in two spreadsheets.
- **Table_40_All_CC-JC-IP_SS-SO**. All CC-JC-IP stream sediment and soil samples in three spreadsheets.

The next step was to combine these six tables into three tables covering the three sample types, each with five spreadsheets:

- **Table_41_All_RO_5_sheets**. All rock samples inside the AOI in five spreadsheets.
- **Table_42_All_HM_5_sheets**. All heavy mineral concentrates inside the AOI in five spreadsheets
- **Table_43_All_SS-SO_5_sheets**. All stream sediment and soil samples inside the AOI in five spreadsheets.

Finally, the fifteen spreadsheets in Tables 41–43 were merged into three sheets presented as Tables 44–46. The lithostratigraphic codes are here presented in the two columns ‘Geocode_1’ and ‘Geocode_2’.

- **Table_44_All_RO_Final.** All rock samples inside the AOI in one spreadsheet.
- **Table_45_All_HM_Final**. All heavy mineral concentrates inside the AOI in one spreadsheet.

- **Table_46_All_SS-SO_Final**. All stream sediment and soil samples inside the AOI in one spreadsheet.

The guidelines for the homogenisation and merging of the tables are as follows:

- All coordinates are geographic and given as decimal degrees.
- Full stop is used before decimals.
- Major elements (Al, Ca, Fe, K, Mg, Na, P, S, Si, Ti + Zr for HM) are given in per cent (pct) with two decimals. Volatiles are given as VOL in pct.
- Noble elements (Au, Pt, Pd, Ir, Re, Rh, Ru) are given in parts per billion (ppb) without decimals.
- The remaining elements are given in parts per million (ppm) without decimals.
- Values below lower detection limits are indicated by 0 or 0.00.
- Values above upper detection limits are given as this value.
- 'Not analysed' is indicated by a blank space.
- Chemical values obtained by various analytical methods have not been calibrated.

Table 34. *Sample statistics.*

	Eleonore Bay Basin			Devonian–Triassic Basin			Caledonian Crystalline Rocks			Jurassic–Cretaceous Basin			Palaeogene Igneous Province			Institution Total
Type	*Rock*	*SS-SO*	*HM*	*Rock*	*SS-SO*	*HM*	*Rock*	*SS-SO*	*HM*	*Rock*	*SS-SO*	*HM*	*Rock*	*SS-SO*	*HM*	
GEUS	407	500	0	1,797	1,104	0	812	346	50	2,092	89	0	511	0	0	7,708
Nordmine	1,467	530	969	4,371	1,075	731	2,528	993	1,620	372	55	225	1,405	118	178	16,637
Avannaa	36	0	0	323	690	0	235	438	0	0	0	0	0	0	0	1,722
Total	1,910	1,030	969	6,491	2,869	731	3,575	1,777	1,670	2,464	144	225	1,916	118	178	
Total geol. unit	3,909			10,091			7,022			2,833			2,212			
Total HM	3,773															
Total SS-SO	5,938															
Total Rock	16,356															
Total samples	26,067															

8. Overview of Tables

Tables 1–46 described in this report are listed below. They are available from the webshop at Greenland Mineral Resource Portal: www.greenmin.gl

Actual link: https://frisbee.geus.dk/webshop/?customer=nanoq&lang=en, see 'Greenland Portal – Geochemistry' and 'East Greenland geochemistry data package (70-76°N)'.

Table_1_RO_CC_GEUS. Rock samples belonging to the Caledonian Crystalline Rocks.

Table_2_RO_EB_GEUS. Rock samples belonging to the Eleonore Bay Basin.

Table_3_RO_DT_GEUS. Rock samples belonging to the Devonian–Triassic Basin.

Table_4_RO_JC_GEUS. Rock samples belonging to the Jurassic–Cretaceous Basin.

Table_5_RO_IP_GEUS. Rock samples belonging to the Palaeogene Igneous Province.

Table_6_HM_CC_GEUS. Heavy mineral concentrates belonging to Caledonian Crystalline Rocks.

Table_7_SS-SO_CC_GEUS. Stream sediment and soil samples belonging to the Caledonian Crystalline Rocks.

Table_8_SS-SO_EB_GEUS. Stream sediment and soil samples belonging to the Eleonore Bay Basin.

Table_9_SS-SO_DT_GEUS. Stream sediment and soil samples belonging to the Devonian–Triassic Basin.

Table_10_SS-SO_JC_GEUS. Stream sediment and soil samples belonging to the Jurassic–Cretaceous Basin.

Table_11_GEUS_analytical_details. Analytical details for GEUS samples.

Table_12_RO_CC_Nordmine. Rock samples belonging to the Caledonian Crystalline Rocks.

Table_13_RO_EB_Nordmine. Rock samples belonging to the Eleonore Bay Basin.

Table_14_RO_DT_Nordmine. Rock samples belonging to the Devonian–Triassic Basin.

Table_15_RO_JC_Nordmine. Rock samples belonging to the Jurassic–Cretaceous Basin.

Table_16_RO_IP_Nordmine. Rock samples belonging to the Palaeogene Igneous Province.

Table_17_HM_CC_Nordmine. Heavy mineral concentrates belonging to the Caledonian Crystalline Rocks.

Table_18_HM_EB_Nordmine. Heavy mineral concentrates belonging to the Eleonore Bay Basin.

Table_19_HM_DT_Nordmine. Heavy mineral concentrates belonging to the Devonian–Triassic Basin.

Table_20_HM_JC_Nordmine. Heavy mineral concentrates belonging to the Jurassic–Cretaceous Basin.

Table_21_HM_IP_Nordmine. Heavy mineral concentrates belonging to the Palaeogene Igneous Province.

Table_22_SS-SO_CC_Nordmine. Stream sediment and soil samples belonging to the Caledonian Crystalline Rocks.

Table_23_SS-SO_EB_Nordmine. Stream sediment and soil samples belonging to the Eleonore Bay Basin.

Table_24_SS-SO_DT_Nordmine. Stream sediment and soil samples belonging to the Devonian–Triassic Basin.

Table_25_SS-SO_JC_Nordmine. Stream sediment and soil samples belonging to the Jurassic–Cretaceous Basin.

Table_26_SS-SO_IP_Nordmine. Stream sediment and soil samples belonging to the Palaeogene Igneous Province.

Table_27_Nordmine_analytical_details. Analytical details for Nordmine samples.

Table_28_RO_CC_Avannaa. Rock samples belonging to the Caledonian Crystalline Rocks.

Table_29_RO_EB_Avannaa. Rock samples belonging to the Eleonore Bay Basin.

Table_30_RO_DT_Avannaa. Rock samples belonging to the Devonian–Triassic Basin.

Table_31_SS-SO_CC_Avannaa. Stream sediment and soil samples belonging to the Caledonian Crystalline Rocks.

Table_ 32_SS-SO_DT_Avannaa. Stream sediment and soil samples belonging to the Devonian–Triassic Basin.

Table_33_Avannaa_analytical_details. Analytical details for Avannaa samples.

Table_34_Sample statistics.

Table_35_All_EB-DT_RO. All EB-DT rock samples in two spreadsheets.

Table_36_All_CC-JC-IP_RO. All CC-JC-IP rock samples in three spreadsheets.

Table_37_All_EB-DT_HM. All EB-DT heavy mineral concentrates in two spreadsheets.

Table_38_All_CC-JC-IP_HM. All CC-JC-IP heavy mineral concentrates in three spreadsheets.

Table_39_All_EB-DT_SS-SO. All EB-DT stream sediment and soil samples in two spreadsheets.

Table_40_All_CC-JC-IP_SS-SO. All CC-JC-IP stream sediment and soil samples in three spreadsheets.

Table_41_All_RO_5_sheets. All rock samples inside the AOI in five spreadsheets.

Table_42_All_HM_5_sheets. All heavy mineral concentrates inside the AOI in five spreadsheets.

Table_43_All_SS-SO_5_sheets. All stream sediment and soil samples inside the AOI in five spreadsheets.

Table_44_All_RO_Final. All rock samples inside the AOI in one spreadsheet.

Table_45_All_HM_Final. All heavy mineral concentrates inside the AOI in one spreadsheet.

Table_46_All_SS-SO_Final. All stream sediment and soil samples inside the AOI in one spreadsheet.

9. References

Brooks, C.K., Tegner, C., Stein, H. & Thomassen, B. 2004: Re-Os and $^{40}Ar/^{39}Ar$ ages of porphyry molybdenum deposits in the East Greenland volcanic-rifted margin. Economic Geology **99**, 1215–1222.

Clemmensen L.B. 1980a: Triassic rift sedimentation and paleogeography of central East Greenland. Bulletin Grønlands Geologiske Undersøgelse **136**, 72 pp.

Clemmensen L.B. 1980b: Triassic lithostratigraphy of East Greenland between Scoresby Sund and Kejser Franz Josephs Fjord. Bulletin Grønlands Geologiske Undersøgelse **139**, 56 pp.

GEUS 2007: Geological maps of North and North-East Greenland, 1:250 000. Geological Survey of Denmark and Greenland, Copenhagen.

Harpøth, O., Pedersen, J.L., Schønwandt, H.K. & Thomassen, B. 1986: The mineral occurrences of central East Greenland. Meddelelser om Grønland Geoscience **17**, 138 pp., 1 plate.

Henriksen, N. 2009: Greenland from Archaean to Quaternary. Geological Survey of Denmark and Greenland Bulletin **18**, 126 pp.

Higgins, A.K. & Leslie, A.G. 2008: Architecture and evolution of the East Greenland Caledonides – an introduction. In: Higgins, A.K., Gilotti, J.A. & Smith, M.P. (eds) 2008: The Greenland Caledonides: evolution of the northeast margin of Laurentia. Geological Society of America Memoir **202**, 29–53.

Higgins, A.K., Gilotti, J.A. & Smith, M.P. (eds) 2008: The Greenland Caledonides: evolution of the northeast margin of Laurentia. Geological Society of America Memoir **202**, 368 pp.

Ineson, J.R. & Surlyk, F. (eds) 2003: The Jurassic of Denmark and Greenland. Geological Survey of Denmark and Greenland Bulletin **1**, 948 pp.

Kalsbeek, F., Higgins, A.K., Jepsen, H.F., Frei, R. & Nutman, A.P. 2008: Granites and granites in the East Greenland Caledonides. In: Higgins, A.K., Gilotti, J.A. & Smith, M.P. (eds) 2008: The Greenland Caledonides: evolution of the northeast margin of Laurentia. Geological Society of America Memoir **202**, 227–249.

Koch, L. & Haller, J. 1971: Geological map of East Greenland 72°–76°N Lat. (1:250,000). Meddelelser om Grønland **183**, 26 pp., 13 map sheets.

Larsen, P.-H., Olsen, H. & Clack, J.A., 2008: The Devonian basin in East Greenland – review of basin evolution and vertebrate assemblages. In: Higgins, A.K., Gilotti, J.A. & Smith, M.P. (eds), The Greenland Caledonides: evolution of the Northeast Margin of Laurentia. Geological Society of America Memoir **202**, 273–292.

Leslie, A.G. & Higgins, A.K. 2008: Foreland-propagating Caledonian thrust systems in East Greenland. In: Higgins, A.K., Gilotti, J.A. & Smith, M.P. (eds) 2008: The Greenland Caledonides: evolution of the northeast margin of Laurentia. Geological Society of America Memoir **202**, 169–199.

Mikkelsen, N., Jepsen, H.F., Ineson, J.R., Piasecki, S., von Platen-Hallermund, F., Schjøth, F., Thomassen, B. & Weng, W.L. 2005: Thematic maps and data of North and Northeast Greenland: geology, mineral occurrences and hydrocarbons. Danmarks og Grønlands Geologiske Undersøgelse Rapport **2005/28**, 56 pp., 1 DVD included.

Nielsen, T.F.D. 2002: Palaeogene intrusions and magmatic complexes in East Greenland, 66 to 75°N. Danmarks og Grønlands Geologiske Undersøgelse Rapport **2002/113**, 249 pp.

Nordisk Mineselskab A/S 1981: Sample data sheet coding manual. Internal report, Nordisk Mineselskab A/S, 25 pp. In archives of Geological Survey of Denmark and Greenland, GEUS Report File 22101. – Also included in Table 27.

Steenfelt, A. 1993: Stream sediment geochemical evidence for gold mineralisation in Hudson Land (73°10' to 74°25'N, 21°30' to 24°45'W), North-East Greenland. Open File Series Grønlands Geologiske Undersøgelse **93/4**, 25 pp.

Surlyk, F., Hurst, J.M., Piasecki, S., Rolle, F., Scholle, P.A., Stemmerik, L. & Thomsen, E. 1986: The Permian of the western margin of the Greenland Sea – A future exploration target. In: Halbouty, M.T. (ed.) Future petroleum provinces of the world. American Association of Petroleum Geologists Memoir **40**, 629–659.

Sønderholm, M. & Tirsgaard, H. 1993: Lithostratigraphic framework of the Upper Proterozoic Eleonore Bay Supergroup of East and North-East Greenland. Bulletin Grønlands Geologiske Undersøgelse **167**, 38 pp.

Sønderholm, M., Frederiksen, K.S., Smith, M.P. & Tirsgaard, H. 2008: Neoproterozoic sedimentary basins with glacigenic deposits of the East Greenland Caledonides. In: Higgins, A.K., Gilotti, J.A. & Smith, M.P. (eds) 2008: The Greenland Caledonides: evolution of the Northeast margin of Laurentia. Geological Society of America Memoir **202**, 99–136.

Thomassen, B. & Tukiainen, T. 2009: Nordmine Archives: Part 1. Digital geological and geochemical data from Nordisk Mineselskab A/S' mineral exploration in central East Greenland 1968–83. Danmarks og Grønlands Geologiske Undersøgelse Rapport **2009/71**, 16 pp., 1 DVD.

Thomassen, B., Clemmensen, L.B. & Schønwandt, H.K. 1982: Stratabound copper-lead-zinc mineralisation in the Permo-Triassic of central East Greenland. Bulletin Grønlands Geologiske Undersøgelse **143**, 42 pp.

Watt, W.S. 2019: Stratigraphic lexicon for Greenland. Nomenclature of stratified successions in current use, 327 pp. Geological Survey of Denmark and Greenland, Copenhagen.

10. Figures

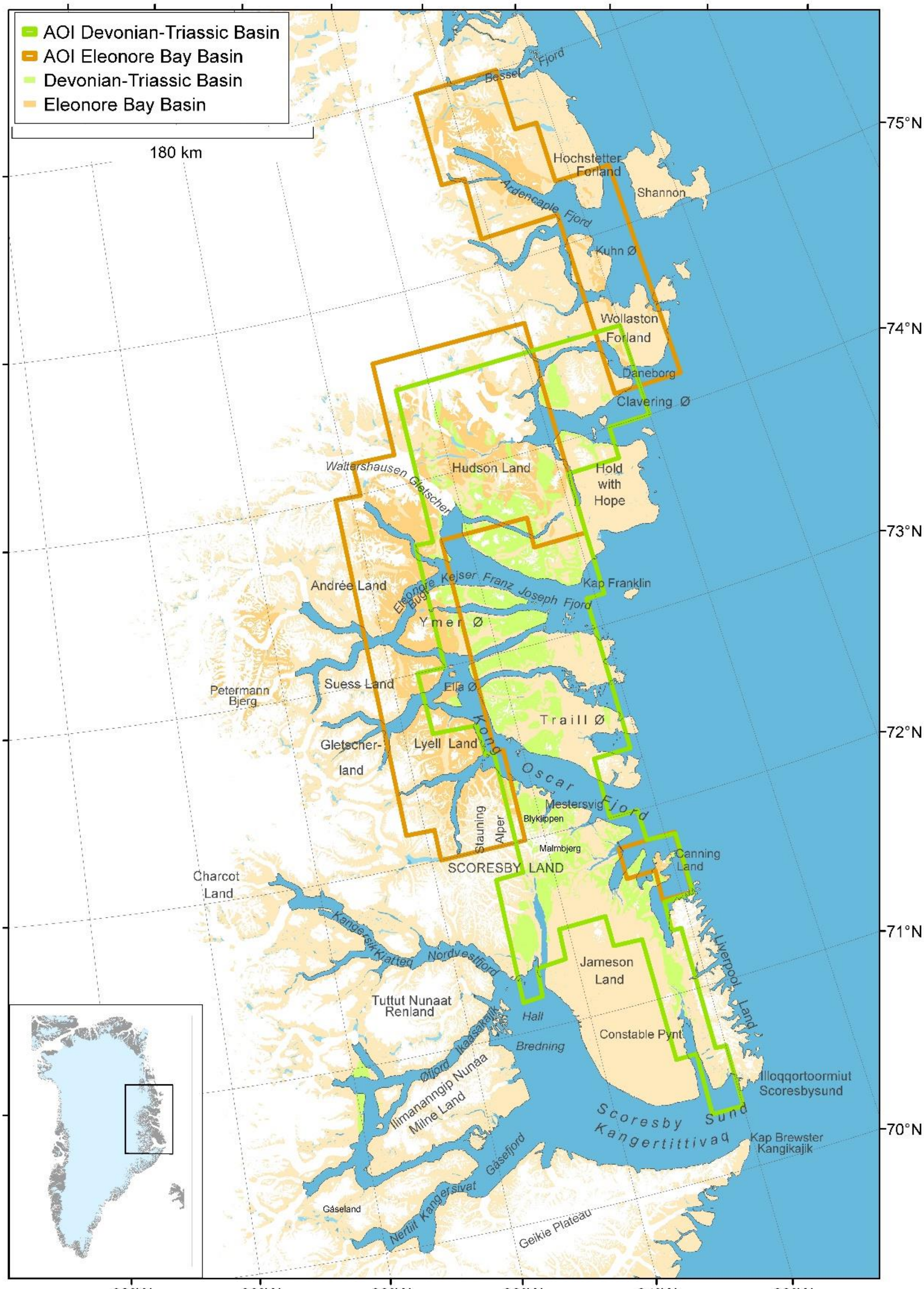

Figure 1. *Map of the Eleonore Bay and Devonian–Triassic basins. The frames indicate the parts of the basins included in the project (AOI).*

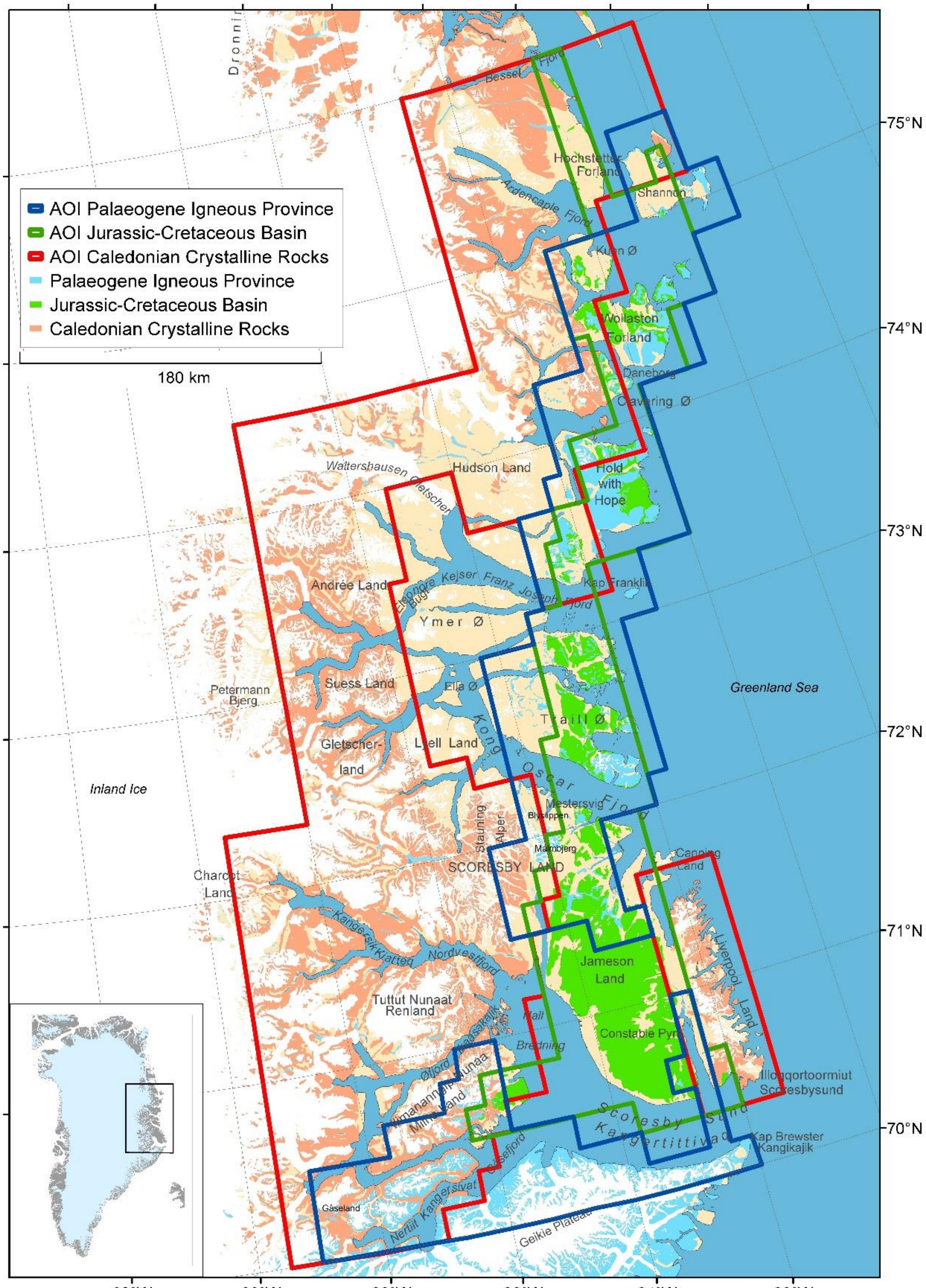

Figure 2. *Map of the Caledonian Crystalline Rocks, Jurassic–Cretaceous Basin and Palaeogene Igneous Province. The frames indicate the parts of the geological units included in the project (AOI).*

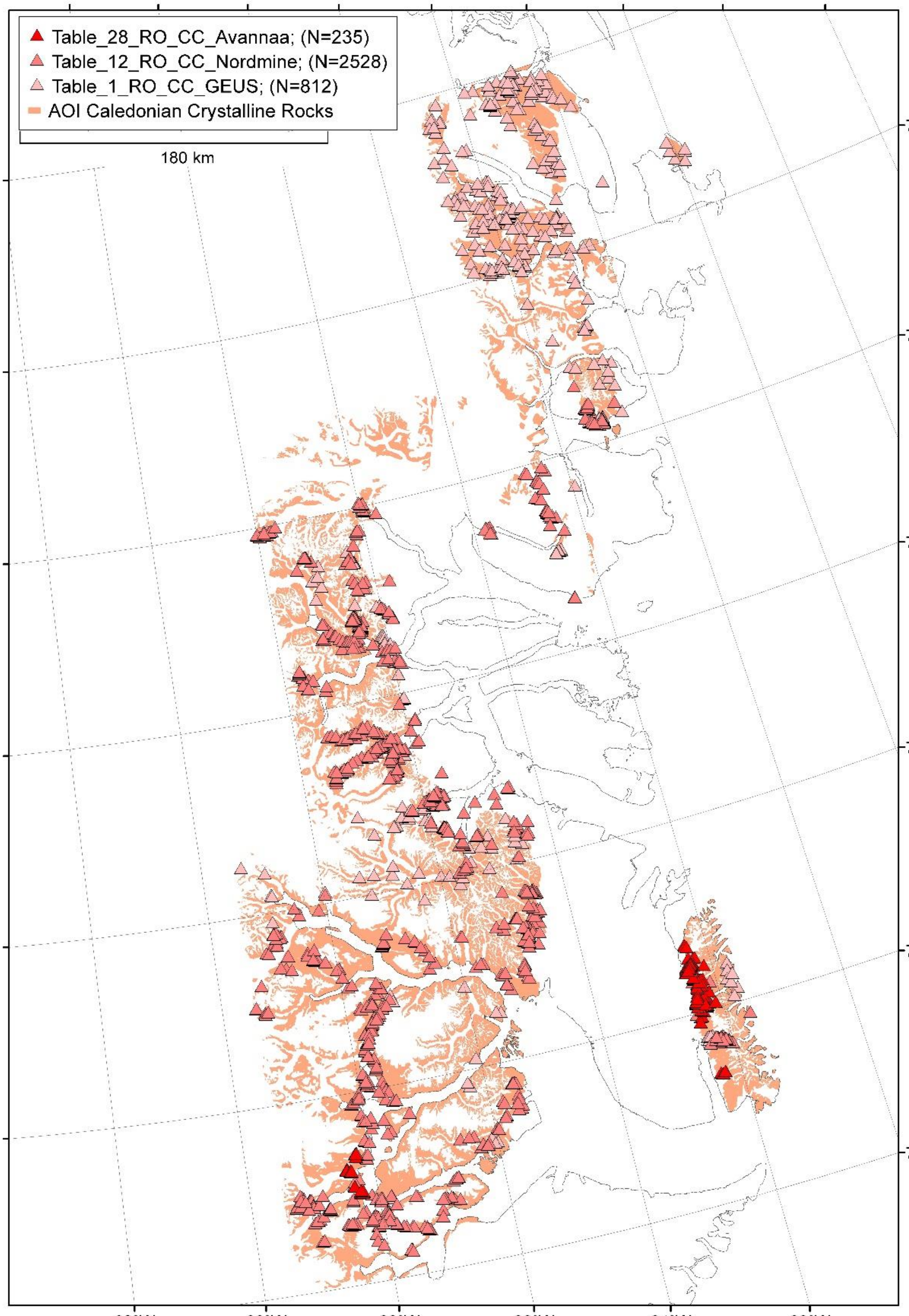

Figure 3. *Map of all rock samples from the Caledonian Crystalline Rocks.*

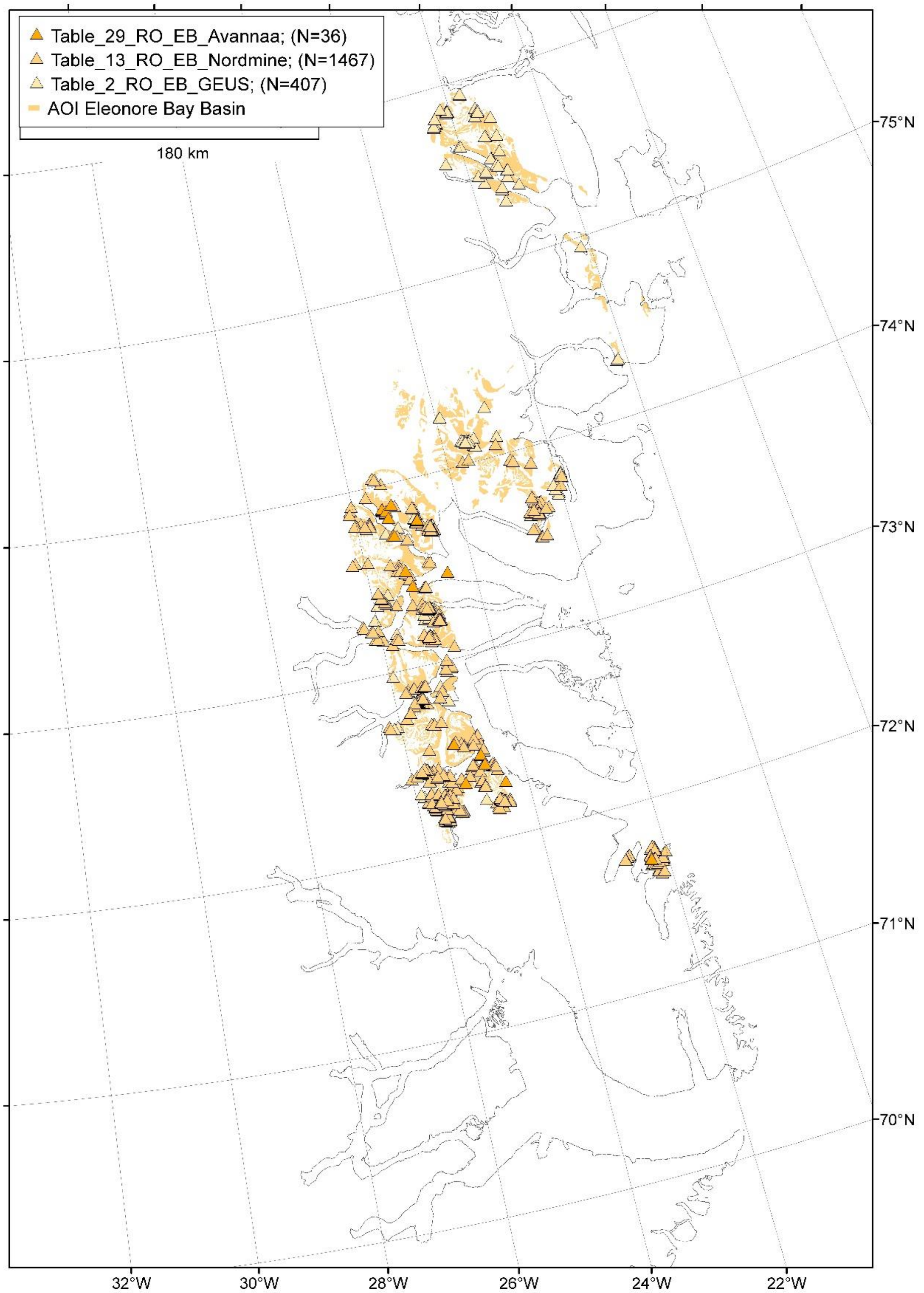

Figure 4. *Map of all rock samples from the Eleonore Bay Basin.*

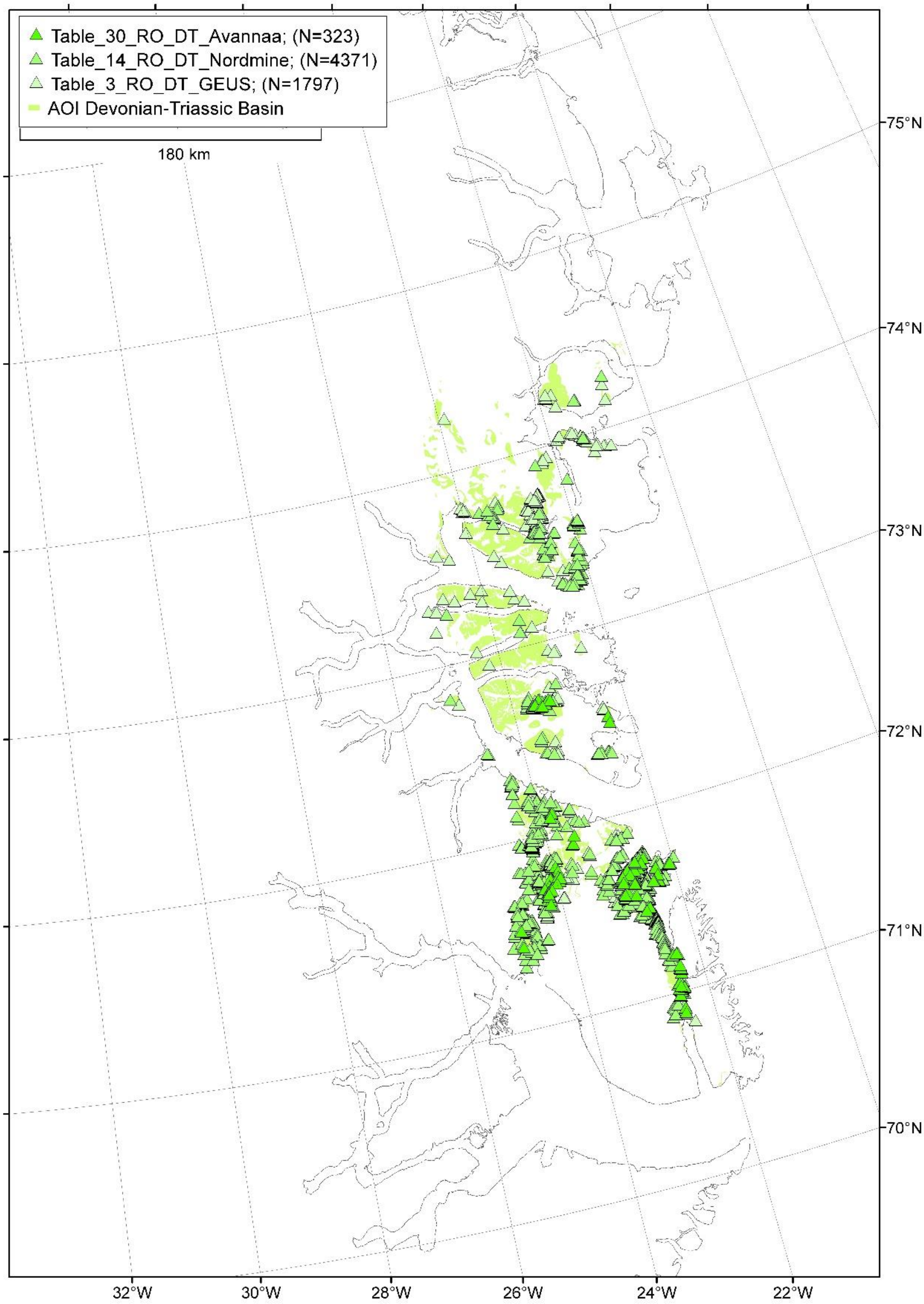

Figure 5. *Map of all rock samples from the Devonian–Triassic Basin.*

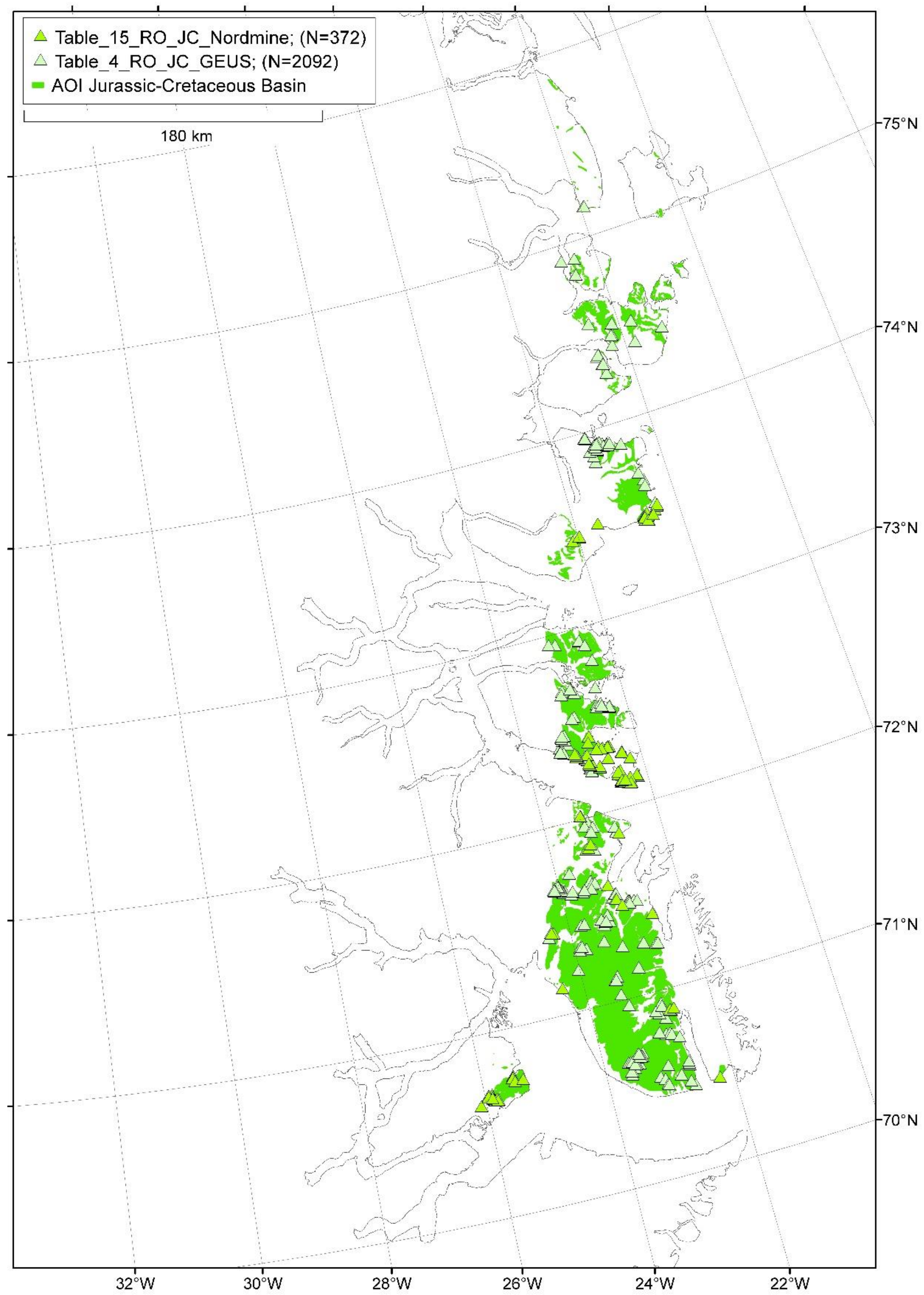

Figure 6. *Map of all rock samples from the Jurassic–Cretaceous Basin.*

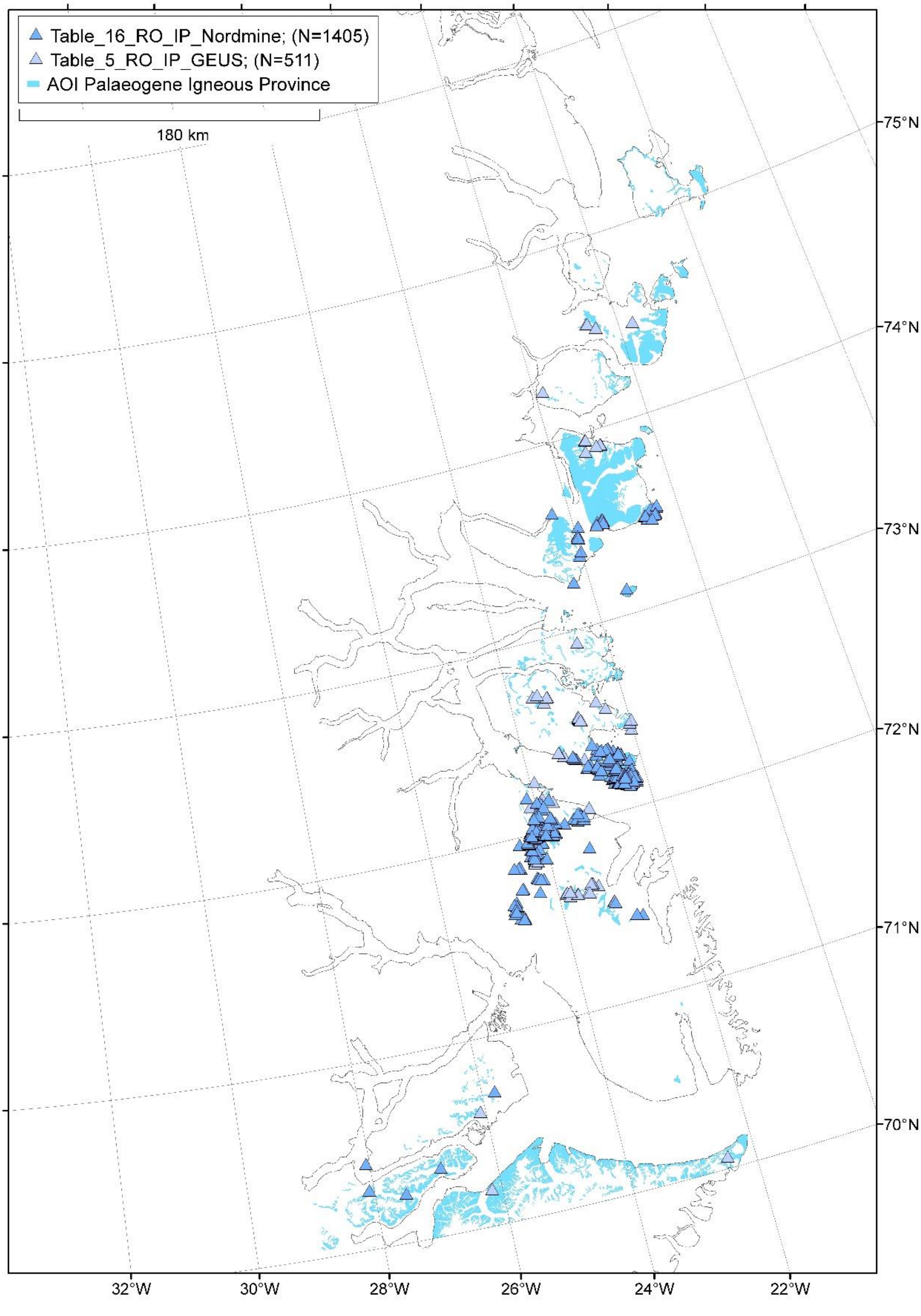

Figure 7. *Map of all rock samples from the Palaeogene Igneous Province.*

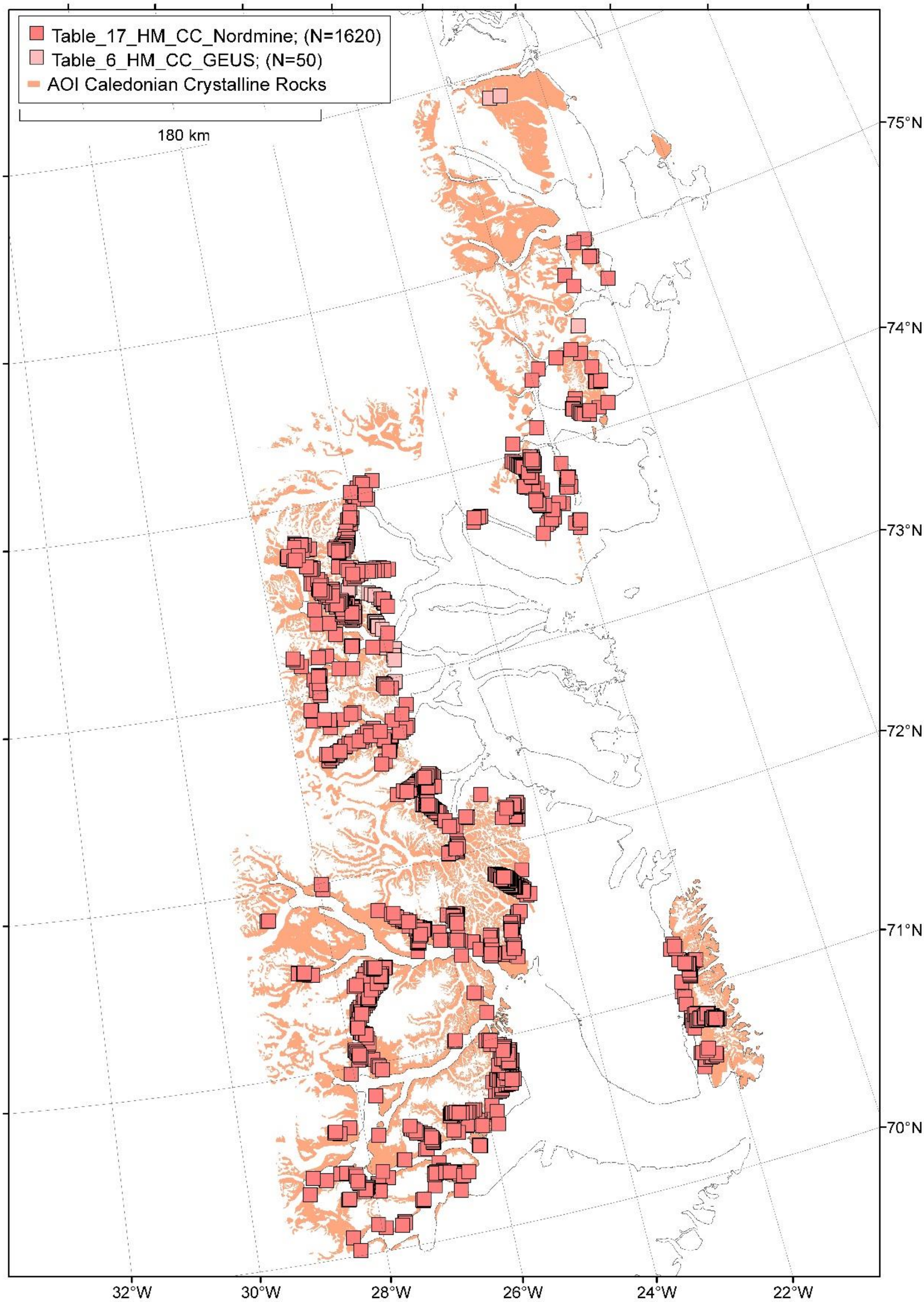

Figure 8. *Map of all heavy mineral concentrates from the Caledonian Crystalline Rocks.*

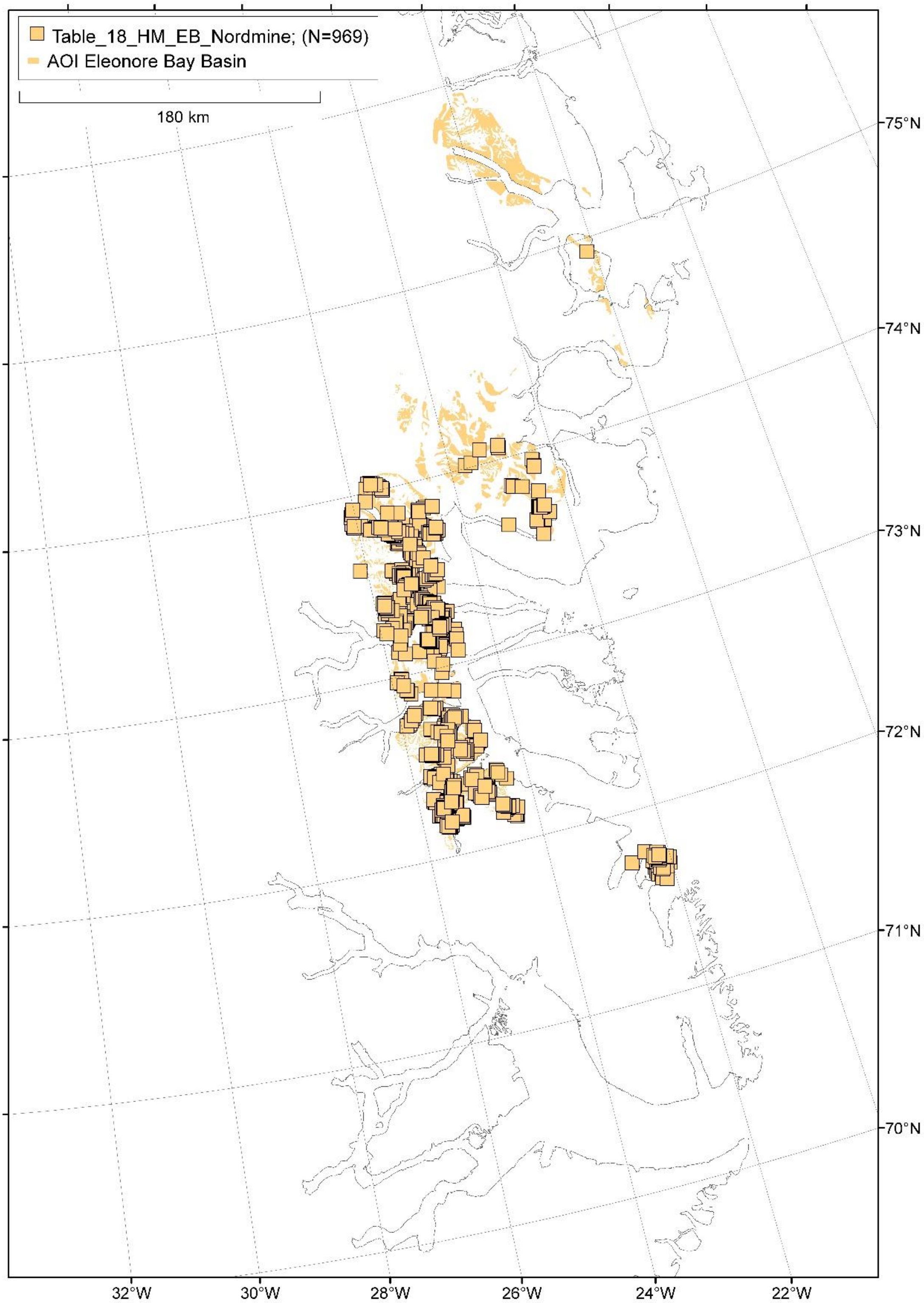

Figure 9. *Map of all heavy mineral concentrate samples from the Eleonore Bay Basin.*

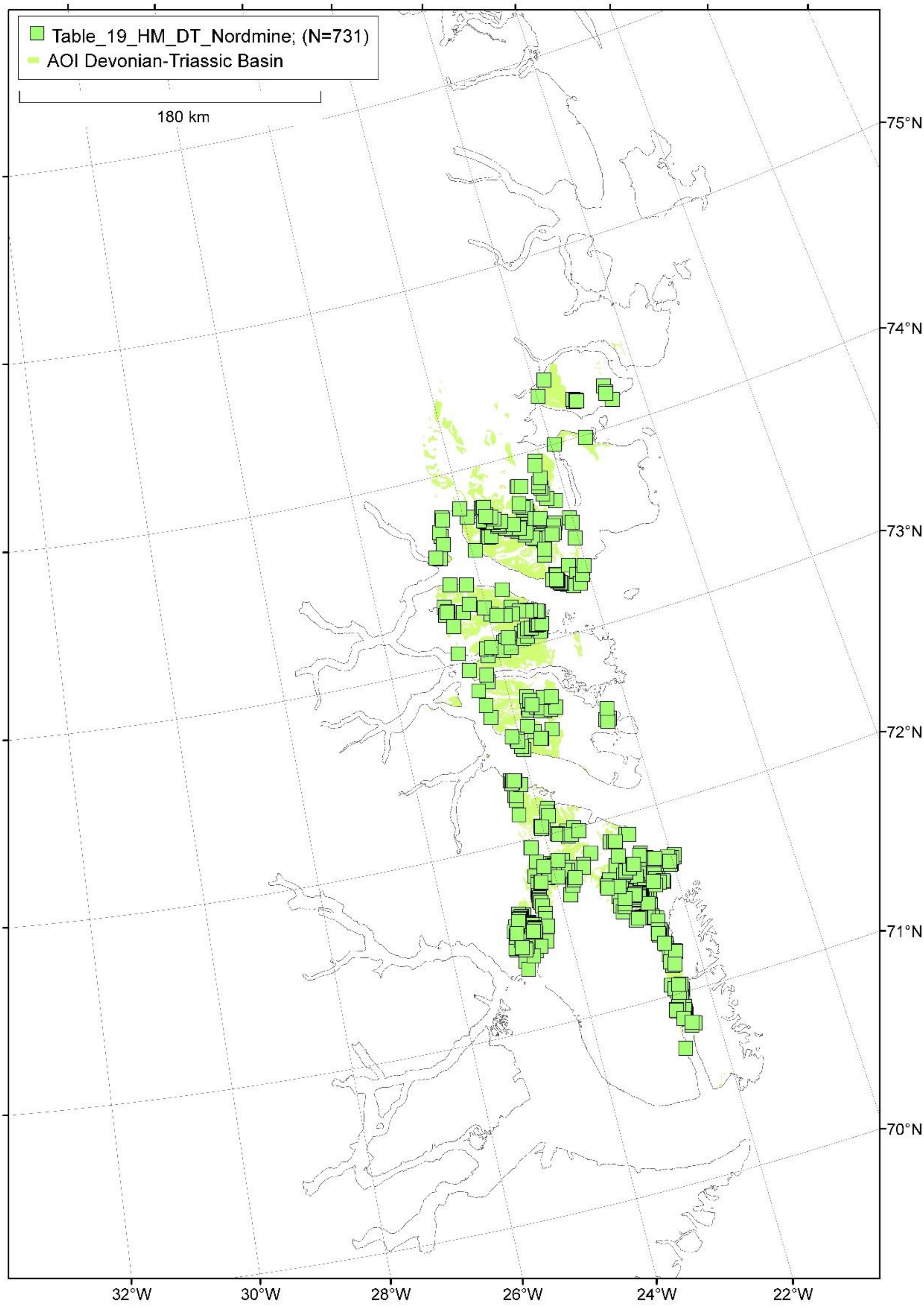

Figure 10. *Map of all heavy mineral concentrate samples from the Devonian–Triassic Basin.*

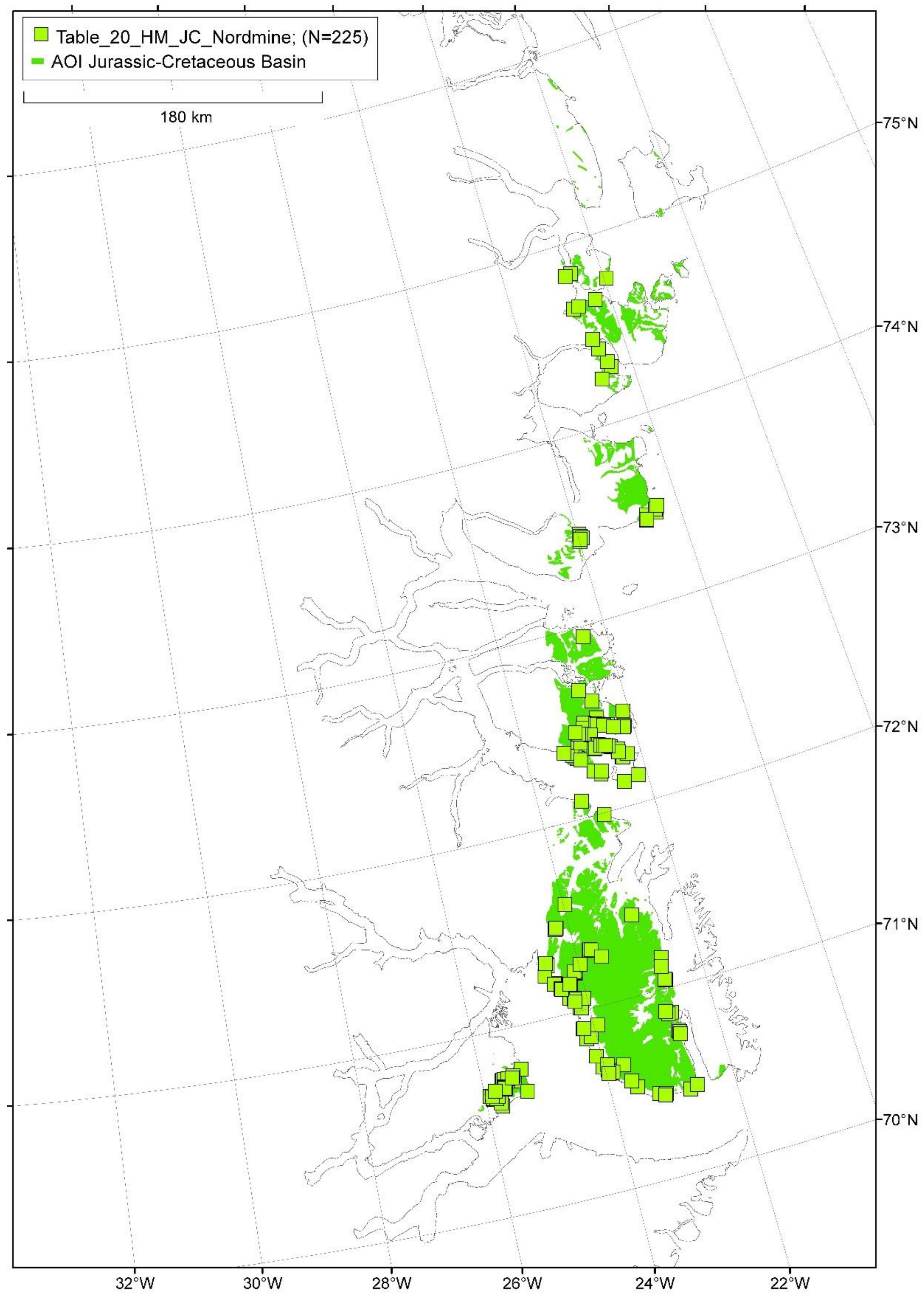

Figure 11. *Map of all heavy mineral concentrates from the Jurassic–Cretaceous Basin.*

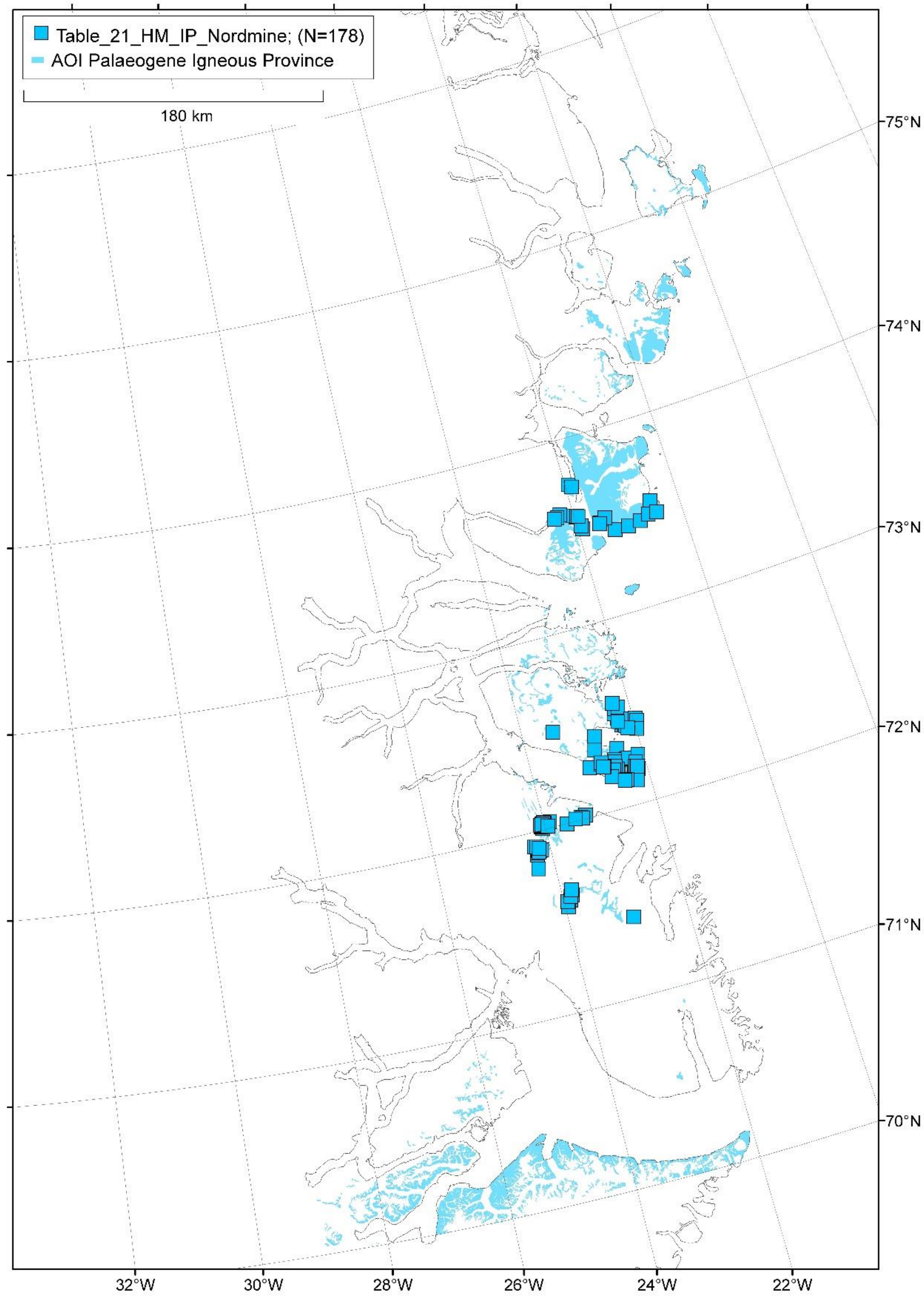

Figure 12. *Map of all heavy mineral concentrates from the Palaeogene Igneous Province.*

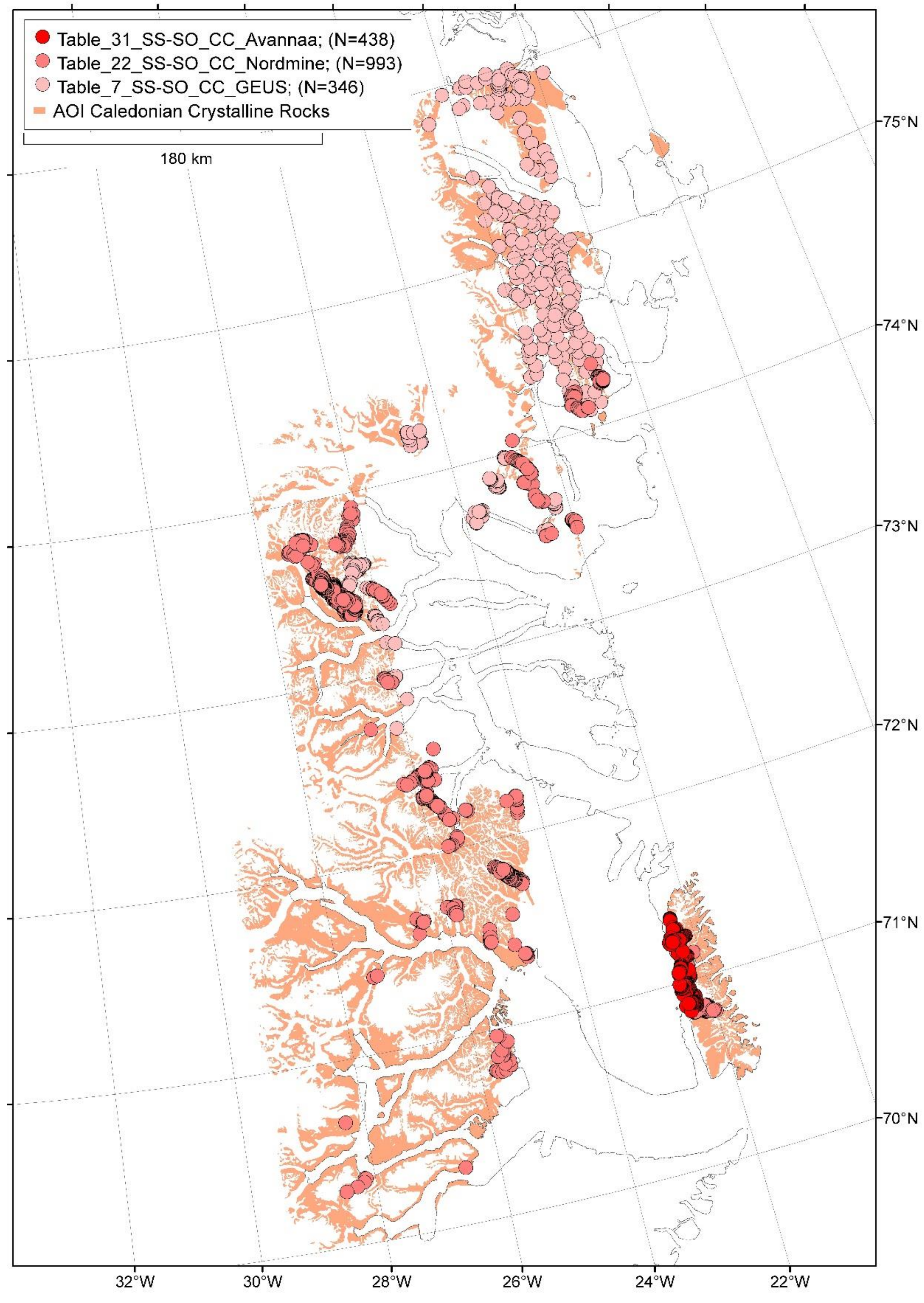

Figure 13. *Map of all stream sediment and soil samples from the Caledonian Crystalline Rocks.*

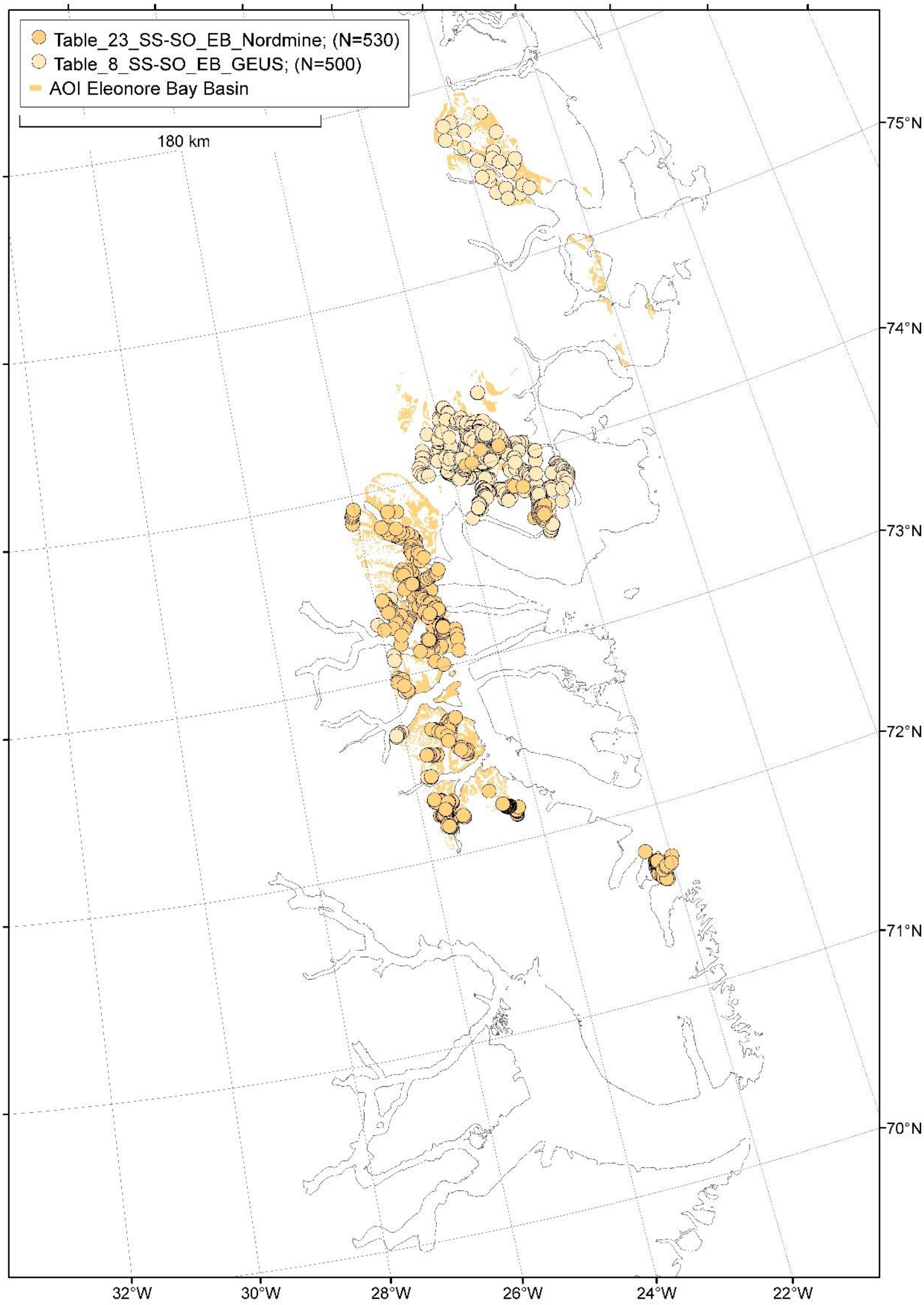

Figure 14. *Map of all stream sediment and soil samples from the Eleonore Bay Basin.*

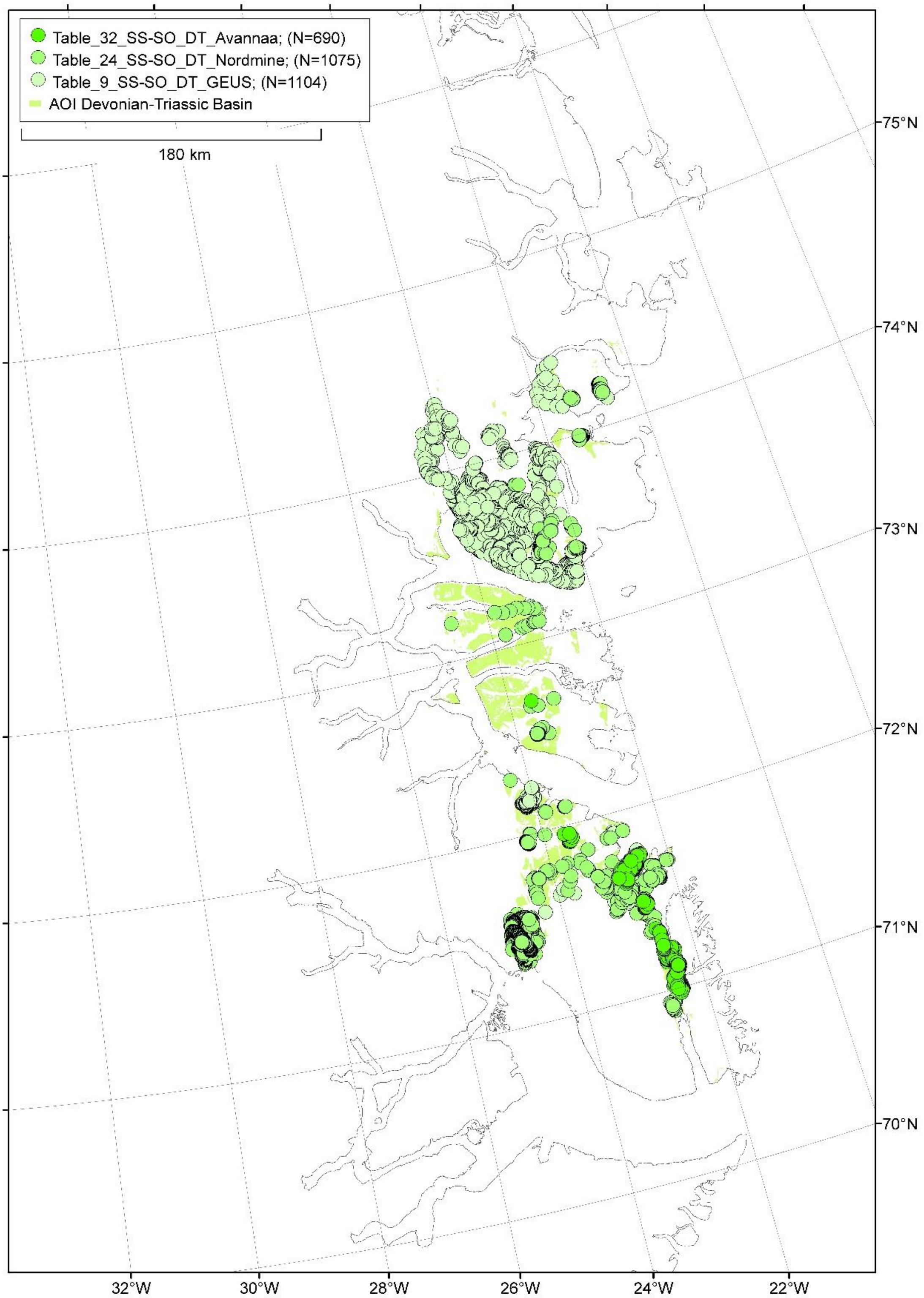

Figure 15. *Map of all stream sediment and soil samples from the Devonian–Triassic Basin.*

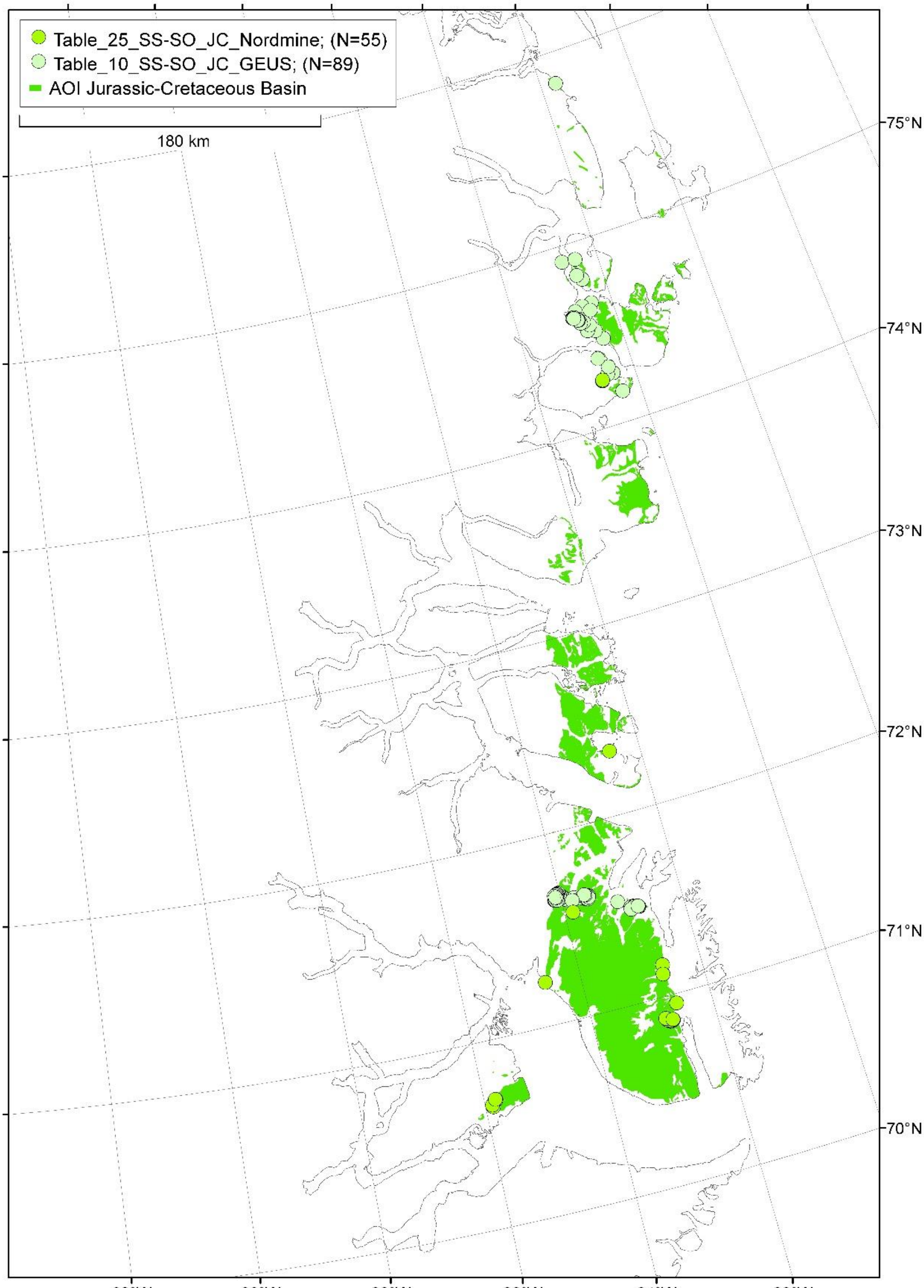

Figure 16. *Map of all stream sediment and soil samples from the Jurassic–Cretaceous Basin.*

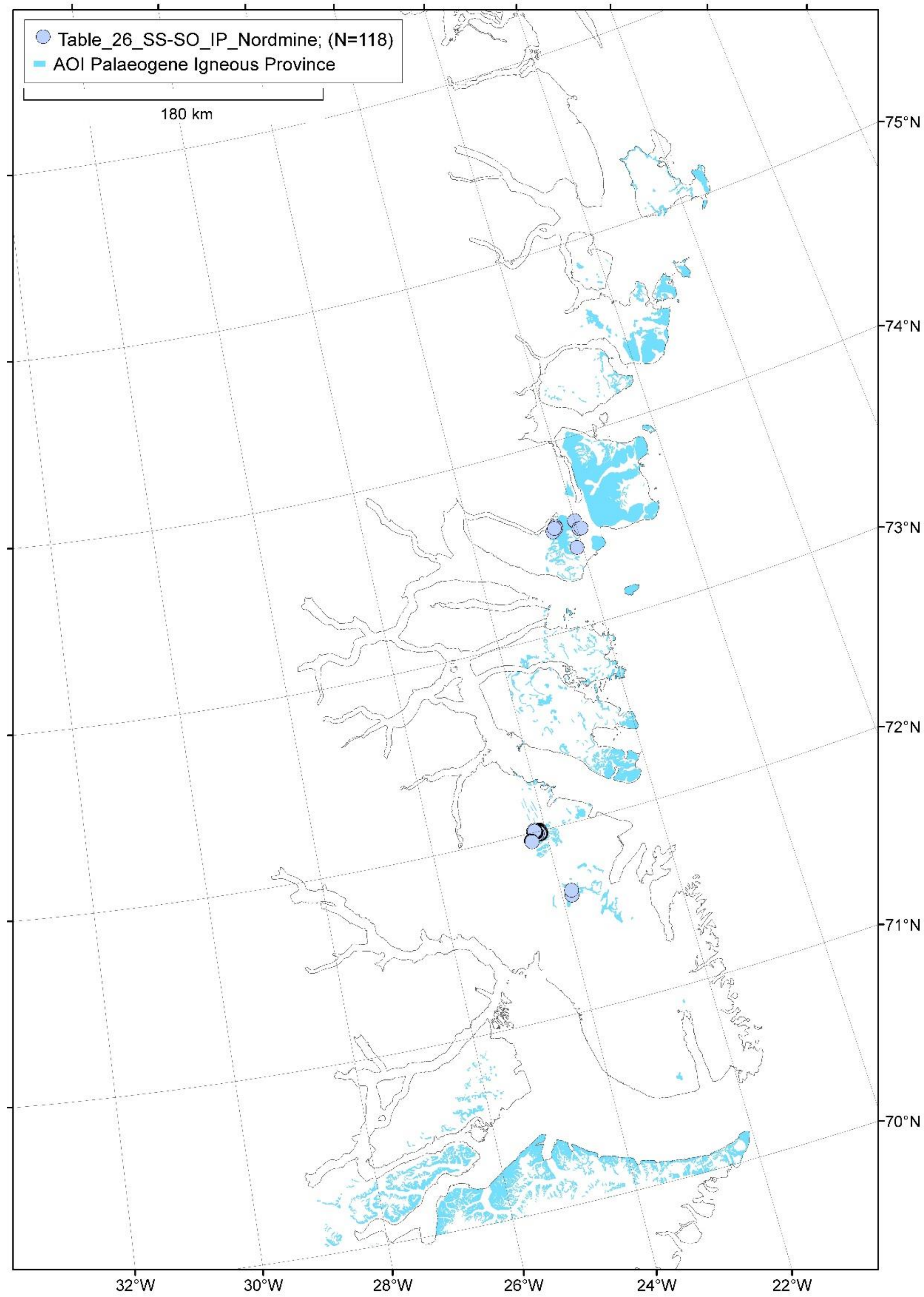

Figure 17. *Map of all stream sediment and soil samples from the Palaeogene Igneous Province.*