THEMATIC MAP SERIES

Regional Geoscience Compilations

Thematic Map Series No. 96/1

Regional compilations of geoscience data from Inglefield Land, North-West Greenland

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GEOLOGICAL SURVEY OF GREENLAND

Regional compilations of geoscience data from Inglefield Land, North-West Greenland

edited by

F. Schjøth, A. Steenfelt and L. Thorning

1996

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Scale:	1:500 000
Permission No:	KMS A.200/87

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Fig. 1. Index map showing the position of this series of thematic maps.

Introduction

The present set of maps displaying regional geoscience data from Inglefield Land, North-West Greenland (Fig. 1), is the fourth issue of the Thematic Map Series published by the Geological Survey of Greenland (since mid-1995 incorporated into Geological Survey of Denmark and Greenland - GEUS). The main aim of the map compilations is to encourage mineral exploration and mineral deposit modelling using integrated datasets. Another aim is to encourage the use of regional geophysical and geochemical data in the geological interpretation of this poorly known area.

The majority of the results compiled in the present thematic maps is obtained during field activities in 1994 and 1995. The investigations were funded by the Government of Greenland, Minerals Office and carried out by GEUS with the objective of providing data for a mineral resource evaluation of Inglefield Land. The work comprised geological photointerpretation, aeromagnetic and electromagnetic mapping, geochemical mapping and geological reconnaissance. The geophysical measurements were conducted in 1994 using Pituffik (Thule Air Base) as a base while field work for the two latter activities were undertaken in 1995 from Hiawatha Base Camp (78°50.60'N, 67°18.03'W) on the south shore of the lake in front of Hiawatha Gletscher, see map 96/1-001). Preliminary results of this work are reported in Bengaard (1995), Stemp & Thorning (1995a, b), Appel (1996), Appel *et al* (1995), Steenfelt & Dam (1996), Thomassen & Dawes (1996).

In addition to this recent data, observations from previous geological work in Inglefield Land are used in the map (96/1-011) and description of the geology (see list of references), and data obtained by RTZ Mining and Exploration Ltd. (Sharp, 1991; Coppard, 1996) are included into the mineral occurrence map (96/1-401).

This present map series comprises 51 maps (see Table 1). The accompanying text has a descriptive part in which the methods for data acquisition and presentation are documented, and a discussion part with comments on the distribution patterns for the various parameters and their implications for the tectonic setting and mineral potential of Inglefield Land.

Location and topography

Inglefield Land occupies the area between the Inland Ice and the Kane Basin of the Nares Strait between Greenland and Canada. To the north-east and south-west the area is bounded by large glaciers from the Inland Ice (see map 96/1-001 and 002). The 7000 km^ large area is uninhabited and the nearest settlement, Qaanaq, is about 100 km to the south, while the nearest air field, Pituffik (Thule Air Base), is 200 km to the south. From Pituffik there are regular connections to Kangerlussuaq (Søndre Strømflord) Air Port in southern West

Greenland. A number of Twin Otter landing sites have been identified within Inglefield Land. Administratively, Inglefield Land belongs to the municipality of Avanersuaq (Thule).

Morphologically, the central part of the land forms a gently seawards inclined plateau elevated 550 - 600 metres above sea level at the margin of the Inland Ice and forming 300 m high cliffs along the coast (map 96/1-001). Large areas of the plateau surface are covered by stony till vsath spectacular development of patterned ground. The large number of small lakes also illustrates the flat landscapes (see map 96/1-001). Melt water flows over the plain in front of the ice margin and then gradually drains through major stream systems which have created impressive gorges across the outer part of the plateau. Additional drainage systems have developed in the coastal parts of the area and are particularly pronounced where the underlying rock consists of limestone and dolomite (map 96/1-011). To the north-east and south-west the terrain is lower with moderate relief and altitudes less than 400 m.

The climate of Inglefield Land is high arctic with low precipitation and low ice melting rates. Permafrost prevails and solifluction is common on all slopes. The vegetation is scarce.

Map production methods

Since the publication of the first issue of the Thematic Map Series in 1994, the main emphasis has been on the digital data behind the maps. The maps have been considered as a selection and presentation of the basic data. The first issues were prepared with graphical software intended mainly for lay-out (Steenfelt *et al*, 1990; Thorning *et. al*, 1994), since then, the spatial aspect of the data and the maps have gradually become more important (Ady & Tukiainen, 1995). The digital versions of the maps in this volume now include topology and links to databases and are prepared entirely from digital data using ARC/INFO (Unix ver. 7.0.4) and Arcview (Unix and PC ver. 2.1a) geographical information system (GIS), both ESRJ-products. The move to a combination of ARC/INFO and Ingres relational database management system (RDBMS) was initiated for the preceding issue of the Thematic Map Series (Ady, 1995; Ady & Tukiainen, 1995). The present map production has become an important part of the development of an integrated system for Geoscience Information Management for Mineral Exploration in Greenland (GIMMEX) using ARC/INFO and ArcView with a linked Ingres RDBMS, and other third party software (PCI, Geosoft, CA-OpenRoad).

In continuation of this development GEUS is now considering the introduction of digital versions of future thematic maps, on-line or on CD-ROM with appropriate viewing and printing software. The collection of thematic maps from Inglefield Land may well be the last in the present form of paper prints.

All maps have been designed to fit A3 sized paper. The limited areal extent of the area has made it possible to use a scale of 1:500 000 rather than 1:1 000 000 which was used in previous issues of the Thematic Map Series. Also, legends have been included on the same sheets as the maps themselves, thus avoiding the separate sheets with map legends.

The topographical data for the spatial basemaps used with the various types of thematic maps in this volume were prepared entirely from digital data using the ARC/INFO GIS. The digital data have been produced in scale 1:100 000 in GEUS' photogrammetric laboratory using datum WGS84 and UTM zone 20.

The geological map (96/1-011) was prepared from a digital photogeological interpretation of Inglefield Land (Bengaard, 1995) revised by P.R. Dawes after the 1995 field season. The revisions, made at 1:250 000 scale, were scanned and used as a basis for the digitizing of new or changed elements on screen in ARC/INFO. The south-westernmost part of the map south of Foulke Fjord, not part of Bengaard's map, was scanned from material compiled from Dawes (in press).

The original grids of the geophysical maps (Geoterrex, 1994) were translated from archived files in Geosoft GXF-format to ARC/INFO's ascii grid-format using third party software, and then prepared in ARC/INFO GRID-module, remapped and combined with a colour scale generated to match the original colour scale for the grid.

The geochemical maps (96/1-131 and 96/1-201 to 240) in the form of 'dot maps' were produced in ArcView using an interactive Avenue-script to calculate the size of the dots. The chemical analyses were extracted from the Ingres database and the histogram and statistical parameters calculated. Dot plot presentations were made as coloured circles with haloes (similar to SPOTSIZE in ARC/INFO).

The mineral occurrences maps (96/1-401 to 402) are based on data extracted from the GREENMIN database (Lind *et al.,* 1994) and processed in a Avenue-script to make the different symbols represent various types of mineral occurrences by different combinations of colours and symbols.

(Frands Schjøth & Leif Thorning)

Landsat TM

The Landsat TM image map (96/1-002) is a colour composite of the Landsat TM bands 4 (red), 3 (green) and 2 (blue).

The map was prepared from a mosaic of the geometrically corrected subscenes from two nominal, system corrected Landsat TM scenes: 035-004/1994-07-02 and 035-003/1992-06-26, respectively.

The ground control points (GCP) were interactively selected from the georeferenced vectors of the topographic data.

A second order polynomial was used to perform the image registration warping. The resampling was done by using an 8pt sin(x)/x method. Although this resampling method alters the original grey level values, it produces a sharper image than other standard resampling methods such as bilinear interpolation, cubic convolution or nearest neighbour.

The georeferenced image mosaic was enhanced by histogram equalization stretch which preferentially enhanced the contrast of the land area. Finally, the edge sharpening filter (subtractive smoothing) was applied to the image to enhance the overall readability.

In order not to decrease the contrast of the image, the cyclic striping due to the satellites' different detector signal response, visible as faint diagonal bands, was not filtered away. Features such as sea and lake water, rivers and ice have been overlain on the image map.

(Tapani Tukiainen)

Precambrian and Lower Palaeozoic geology

The geological map (96/1-011) is a *simplified* depiction of the bedrock geology of Inglefield Land and the adjoining area between Kap Alexander and Sonntag Bugt. Hie map was compiled in 1995 after the summer field season specifically for this thematic series and it has been reproduced at reduced scale in Steenfelt & Dam (1996) and Thomassen & Dawes (1996). It should be noted that the area south of Kap Alexander is not Inglefield Land but part of northern Prudhoe Land: for simplicity however, in the following description the entire area shown on the map is referred to as Inglefield Land.

The map shows the main geological provinces and their predominant lithologies, as well as main structural trends. Although lithological and stratigraphical detail is available from many areas, no attempt has been made to differentiate each geological province into main rock types or formations. Similarly, the Quaternary deposits are left undivided. This approach allows for the straightforward comparison with the geophysical maps in this thematic map volume. Compilation of a geological map based on an interpretation of all available data is planned.

Unlike the other three regions of western Greenland so far covered by the thematic map series, Inglefield Land is not covered by published maps of the national map coverage, i.e. map sheets at scales of 100 000 or 1:500 000. The geological map is therefore based on previous geological and photogeological maps (Dawes, 1976; Peel & Christie, 1982; Bengaard, 1995), that have been revised by preliminary treatment of field data collected in 1995 during helicopter reconnaissance (Thomassen & Dawes, 1996). The south-westernmost comer of the map, covering the northern margin of the Proterozoic Thule Basin and bordering at 78°N onto the published 1:500 000 map (map sheet 5, Thule), is taken from maps in Dawes (in press).

Geological outline

A glance at the geological map shows that Inglefield Land is composed of a Precambrian crystalline shield unconformably overlain by homoclinal Proterozoic-Cambrian cover strata, and that in inland areas, large areas are covered by Quaternary deposits. This homoclinal cover is composed of undeformed and unmetamorphic sediments with, in the lower Proterozoic part, conspicuous basaltic sills. These rocks form outliers along coastal areas and make up about 40% of the bedrock exposure. The cover strata were deposited on a well-developed Precambrian peneplain.

The distinction between crystalline shield and cover rocks is generally well seen on aerial photographs and, as might be expected, on the other aerial maps in this thematic map volume, for example, the satellite image, total magnetic intensity, and calculated conductivity maps (96/1-002, 96/1-101 & 96/1-104). In the region south of Rensselaer Bugt towards the Inland Ice, where Quaternary deposits form a more-or-less continuous blanket, the precise limits of the cover succession are in doubt. On the satellite map (96/1-002) this particular region has a signature similar to the main outcrops of cover rocks farther north. This similarity, plus the field observations that the surficial deposits in the region contain abundant unmetamorphosed sediment fragments (e.g. Steenfelt & Dam, 1996), could indicate that some thin cover strata, or rubble after them, are preserved within this region.

The homoclinal cover comprises strata of two overlapping sedimentary basins: the Proterozoic Thule Basin in the south-west and the Lower Palaeozoic Franklinian Basin to the north-east (Fig. 2). The hiatus between these basins, that is well documented in the area between Force Bugt and Rensselaer Bugt, represents a time lapse of around 500 Ma. The unconformity between the crystalline shield and the Thule Basin represents a similar time break.

On map 96/1-011 the bedrock is referred to three main geological provinces, all of which have their main extent in Greenland outside Inglefield Land, and all of which continue in Ellesmere Island on the Canadian side of Kane Basin.

1) Precambrian Shield comprising rocks of the Ellesmere-Inglefield mobile belt of Early Proterozoic age (?with reworked Archaean elements). The shield represents the northernmost outcrops of Early Proterozoic (Aphebian) rocks in western Greenland.
2) Middle to Late Proterozoic Thule Basin represented in Inglefield Land mainly by Neohelikian sediments and basaltic rocks of the northern basin margin, with in the extreme south-west (south of Sonntag Bugt) possible Hadrynian deposits.

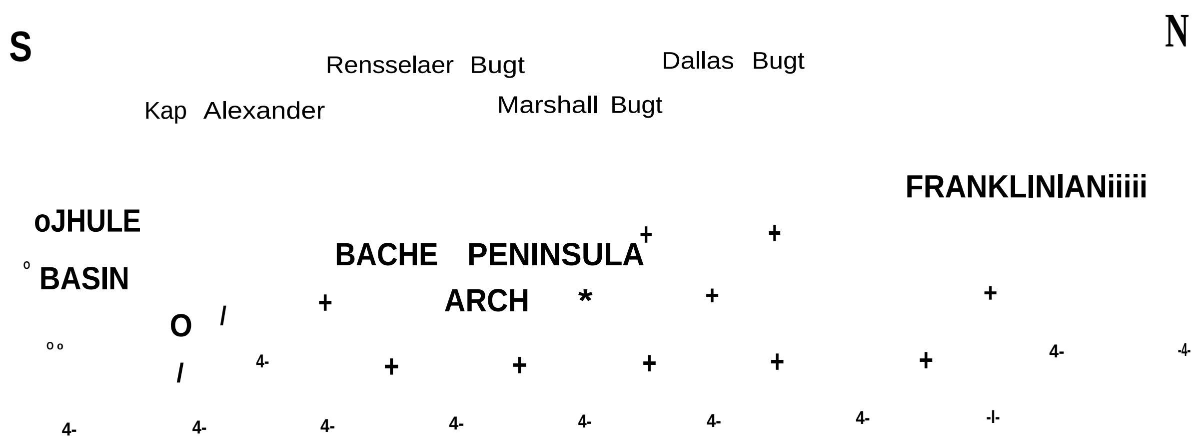

Fig. 2. Schematic section across Inglefield Land and area to the south showing the relationship between the Proterozoic Thule Basin and the Lower Palaeozoic Franklinian Basin. From Peel *ef al.* (1982).

3) Lower Palaeozoic Franklinian Basin represented in Inglefield Land by Cambrian platform sediments.

Geological data base

Present knowledge of the Precambrian and Lower Palaeozoic geology of Inglefield Land and northern Prudhoe Land is an accumulation of data spanning 80 years from the first regional appraisal (e.g. Koch, 1920, 1929, 1933) and biostratigraphical studies (e.g. Poulsen, 1927), to the most recent helicopter reconnaissance carried out in 1995 (Appel *et al*, 1995; Appel, 1996; Coppard, 1996; Steenfelt & Dam, 1996; Thomassen & Dawes, 1996). Pre- and post-war expeditions enabled work by Danish and foreign geologists (e.g. Troelsen, 1950; Clebsch, 1956, Cowie, 1961; Poulsen, 1964) and in the 1970s the Geological Survey of Greenland undertook limited field work on both the Precambrian shield and cover sequence and the first isotopic dating was carried out (e.g. Dawes, 1972,1979; Larsen & Dawes, 1974). Commercial activities were also carried out in the 70s, regional studies that included photogeological mapping (Stuart-Smith & Campbell 1971; Gray, 1975). The most recent summary of the pre-Quatemary geology of Inglefield Land is given as five papers in the 'Nares Strait volume' (Dawes & Kerr, 1982), where relationships to Canada are focused on. A summary of the evidence for Early Proterozoic regional magmatism and deformation throughout Inglefield Land is given by Dawes (1988); a paper that defines the region as the easternmost part of the Early Proterozoic Ellesmere-Inglefield mobile belt that has its main development in Canada. Rb-Sr whole-rock data confirming the presence of conspicuous Early Proterozoic magmatism were reported on by Dawes *et al.* (1988). The 90s have seen renewed commercial activity in Inglefield Land (e.g. Sharp, 1991; Coppard, 1996; Gowen & Kelly, 1996), in part stimulated by the airborne magnetic and electromagnetic survey carried out in 1994 (Stemp & Thorning 1995b). The helicopter-supported field work carried out in 1995 as a follow-up to the airborne survey has been referenced above.

The above chronological history serves as a background to this present description and thus in the following references are kept to a minimum.

Geological province 1: Ellesmere-Inglefield mobile belt

The crystalline rocks of the Precambrian Shield of Inglefield Land, composing the Greenland portion of the Ellesmere-Inglefield mobile belt, are highly-deformed, high-grade suites of metasedimentary and meta-igneous rocks, with associated gneisses. Post-tectonic rocks include minor intrusions of granite, pegmatite and quartz. The youngest rocks are undeformed basic dykes. The sample maps of Steenfelt & Dam (1996) suggest that metasediments and paragneisses dominate over meta-igneous rocks and orthogneisses. Gneisses older than the metasediments and meta-ignoeus rocks have not been identified and the role of Archaean crust (if any) in the region is unknown. Candidates for possible reworked 'older' rocks occur in the southernmost area of gneisses and granitoids close to the Inland Ice between the headwaters of the Tuff Elv and Mintum Elv in an area initially investigated by Clebsch (1956). In the absence of absolute dating, these rocks are not differentiated as such on the geological map.

The rocks of the mobile belt are divided on the geological map into three units. Supracrustal sequences of variable lithology but in which marble forms a dominant part (map unit la; see Fig. 3), and a distinctive porphyritic granite in the north-east (map unit Ic), are distinguished out from the bulk of the rocks of the shield that are grouped together as a single unit - map unit lb. This comprises a mixed complex of meta-igneous rocks and gneisses, including the Etah meta-igneous complex and derived orthogneisses, as well as widespread paragneisses. As illustrated by the Sunrise Pynt section (Fig. 2), the rocks of map units la and lb are intimately associated.

Chronology and age

A fixed point in the chronology is the Early Proterozoic (late Aphebian) intrusive ages of the Etah meta-igneous complex. Dating of material from Ellesmere Island (conventional zircon U-Pb; Frisch & Hunt, 1988), suggests that the main period of magmatism in the mobile belt occurred between 1.97 Ga and 1.91 Ga; a supposition confirmed by recent zircon U-Pb reconnaissance SHRIMP work from Inglefield Land with the five dated samples all falling within this range (F. Kalsbeek, personal communication 1996). Rb-Sr whole-rock data from south-western Inglefield Land (Larsen & Dawes, 1974; Dawes *et al.* 1988) show severe isotopic disturbance which is attributed to regional metamorphism, possibly around 1.8 Ga; this is in agreement with the new SHRIMP data referred to above that suggests a metamorphic overprint at 1.75 Ga. Most rocks - apart from the post-tectonic minor intrusions - appear to have been metamorphosed in the granulite facies; lower grade rocks in shear zones and in other areas, for example in the southernmost gneiss area studied by Clebsch (1956) mentioned above, are interpreted as retrogressed granulites.

The metasediments of the Etah Group pre-date the late Aphebian Etah meta-igneous complex and both units have been folded and metamorphosed together. The Etah Group and associated paragneisses are thus of Aphebian and/or Archaean age. In areas of low

Mainly red granite
Mainly pale granite | Etah meta-igneous complex
Mainly quartz diorite

pyy-i Metabasic rock, including ampNbofite
Pelitic schist, gametiterous
K-LiLI Marble and calc-silicate rocks, including siliceous schist
fEtah Group

Cover

Fig. 3. Photograph and field sketch through the east-west linear straight belt of south-western Inglefield Land illustrating the intricate relationship between map unit la (Etah Group supracrustals) and map unit lb (represented in these outcrops solely by intrusives of the Etah meta-igneous complex). Metasedimentary rocks dominate so that on the geological map (Map 96/1-011) the outcrop is shown as map unit la. The same relationships - meta-igneous rocks of varying composition invading supracrustal sequences rich in calcacreous rocks - occur throughout Inglefield Land and in different structural settings, for example in north-eastern Inglefield Land in open-style multiple folds. The view is east over Sunrise Pynt; height of the cliff above the fjord is around 300 m. Photograph showing the southern part of the cliff is reproduced from Dawes (1976), M = meta-igneous rocks, E =Etah Group supracustals. Sketch is reproduced from Dawes (1988).

deformation the igneous rocks cut across the main structure of the metasediments; with increase in deformation there is a gradation from such discordances to a concordant and intimate interleaving of metasediments and igneous rocks in which the relationships between lithological units are obscure.

Regional structure

A prominent feature of the mobile belt is its varying structural style; for example, the contrast between south-westem/south-central parts of Inglefield Land characterised by a regular and consistent, approximately east-west strike, and north-eastem/north-central parts, that show variable regional foliation trends. The south-western style, accentuated by steeply dipping, linear intercalated tracts of metasediments, meta-igneous rocks, granitoids and gneisses, is characterised by internal recumbent folding with axial planes parallel to regional foliation and banding (Fig. 3). This steep straight belt style has been likened to the linear structural pattern of the Nagssugtoqidian mobile belt of West Greenland (Dawes, 1988) while in contrast, the north-eastern structural style, that is characterised by large-scale multiple fold patterns, of which the horseshoe-shaped Wulff structure east of Dallas Bugt is a conspicuous example, is similar to the dome and basin pattern of the Rinkian mobile belt described by Grocott & Pulvertaft (1990) and to the inner §ord zone of the Nagssugtoqidian belt of West Greenland (most recent paper on the Nagssugtoqidian mobile belt is van Gool *et ai,* 1996). The Etah meta-igneous complex is involved in both these Proterozoic structural patterns (Fig. 3).

Map unit la: Etah Group, marble-rich supracrustal strata

This map unit is dominated by pale-weathering marbles and calc-silicate rocks, associated with a variety of psammitic and quartzo-felspathic schists and paragneisses, as well as subordinate pelitic lithologies. In places metabasic rocks, including amphibolites are associated lithologies (Fig. 3). Garnet is a common mineral. Where paragneisses are intimately associated with calcareous rocks, for example the gamet-biotite (-sillimanite-cordierite) gneisses in south-western Inglefield Land, they are included in this map unit. On the other hand the large expanses of quartzo-feldspathic gamet-sillimanite paragneissses in central and eastern Inglefield Land are included in unit lb (see below). The map unit can be picked out in the airborne geophysical data; on the total field magnetic map (map 96/1-101) for example, the marble-rich supracrustal rocks are portrayed as blue-coloured units of uniform, low magnetic intensity.

The metasediments are invaded by magmatic rocks of map unit lb on all scales and intensities (Fig. 3). Thus metasediments form both coherent supracrustal tracts, as in the east-west straight belt of south-westem/south-central areas, and fragmented tracts and isolated inclusions within magmatic terrain - an exposure form characteristic of the north/central and north-eastern parts of the map. Mobilisation and flow deformation features, as well as contact metamorphic minerals, are common in the marble and calc-silicate rocks. Where mobility has been severe, the meta-igneous rocks can occur as fragments and enclaves within the incompetent calcareous rocks, often in train patterns that depict initially-continuous bodies.

Map unit lb: Etah meta-igneous complex, para- and orthogneisses

This map unit contains a wide variety of rock lithologies and ages, including meta-igneous rocks and derived orthogneisses, as well as a diverse suite of paragneisses that, at least in part, includes gneisses derived from the Etah Group. The map unit includes the variable gneisses of Dawes (1976, 1988) and the garnet granulites of Sharp (1991).

The Etah meta-igneous complex has a compositional range from ultramafic and mafic rocks through tonalites, diorites, monzonites, syenites, granodiorites to granites. Intermediate to felsic compositions dominate. Hypersthene is a common mafic mineral; magnetite is also locally abimdant. Magnetite segregations have been found in amphibolite in the eastern end of the straight belt (Appel *et al.,* 1995; see this volume, section ‘Mineral occurrences’). The bulk of the rocks of the Etah meta-igneous complex are high-grade - upper amphibolite to granulite facies - and where highly-deformed, the rocks have a strong planar fabric, commonly with intimate interleaving of lithologies. Passages from such rocks into orthogneiss are common. Other rocks, from areas that have been subjected to polyphase deformation, for example from some units of the Wulff structure, have non-directional textures. Metabasite rocks commonly with both pyroxene and amphibole, form tabular bodies and dykes of probably more than one generation (Frisch 1980; Frisch & Dawes, 1982).

A dominant rock type present throughout Inglefield Land is a dark-weathering, hypersthene-bearing quartzo-feldspathic dioritic rock, first described by Bugge (1910) from the Foulke Fjord area. For example, one major tract of this rock type occurs north-east of Hiawatha Gletscher. Also present throughout Inglefield Land but prominent in some areas, for example along the coast from Cairn Pynt eastwards, are large masses of syn- to post-tectonic, reddish coloured granites and leucogranites of various types. Some of these were intruded into deformed meta-igneous rocks and are themselves deformed.

The rocks of the Etah meta-igneous complex are clearly reflected in the aeromagnetic data, for example on the total magnetic map (map 96/1-101) the rocks are depicted as units of relatively high magnetic intensity. One area of meta-igneous rocks in central/south Inglefield Land to the east of the headwaters of Mintum Elv and reaching the Inland Ice is, in this respect, worthy of special note since it is outlined by a large, irregular aeromagnetic high covering about 400 km . Unfortimately, overall field correlation with bedrock is hampered by profuse surficial deposits, particularly on the eastern side of the anomaly. This conspicuous magnetic high area, initially remarked on by Stemp & Thorning (1995b) for its complex form, and situation at the eastern end of the east-west straight belt, was interpreted by these authors and Bengaard (1995) to represent, at least in part, basic igneous rocks. Meta-igneous rocks containing basic to acid compositions and including large areas of syenitic rocks, as well as variable gneisses and syn- to post-tectonic granitic rocks, are now known from the region. Steenfelt & Dam (1996), stressing a correlation to high phosphorous values in stream sediment and soil (see map 96/1-210), as well as to other elements (Mn, Mg, Na and Sr; see Maps 205, 206, 208 & 227) designate syenitic and monzonitic intrusions as the cause of this large anomaly. On the other hand, Appel (1996) recognises syenitic rocks over a much more restricted area and locates the syenitic complex to the west of the anomaly. The magnetic signature of this large anomaly (maps 96/1-101 and 102) and the variable geology mentioned above known from the exposed bedrock, suggest to this author that this large complex-shaped anomalous area has a multiple source.

The conspicuous syenitic rocks from the area of the magnetic high anomaly (as well as those outside) vary, like other rocks of the Etah meta-igneous complex, from having non-directional textures to a strong planar fabric but, unlike other main units, many of the syenitic rocks are readily conspicuous by having a dark appearance that is mainly due to profuse black lichens (Appel, 1996; Steenfelt & Dam, 1996). An estimated intrusion age of 1.92Ga has been obtained for one syenite sample by reconnaissance SHRIMP zircon dating (F. Kalsbeek, personal communication, 1996).

Paragneisses. Large areas of central and eastern Inglefield Land are composed of pale-weathering, gametiferous quartzo-feldspathic gneisses, in places characterised by sillimanite and graphite, and with disseminated iron suphides. These rocks - that correspond in part to the granitic biotite-gamet gneisses or garnet granulites of Sharp (1991) - are regarded primarily as a paragneiss suite, representing, at least in part, deformed and migmatised psammitic rocks of the Etah Group. Many of the rocks lack strong foliation, are rather homogeneous and there is common gradation to leucocratic garnet granitic gneisses. Various syn- to post-tectonic granitic and pegmatitic rocks cut and vein these paragneisses. The quartzo-feldspathic paragneisses host widespread yellow and orange gossans and rust zones up to several kilometres in length, elongated generally along rock strike (Sharp, 1991; see this volume, section ‘Mineral occurrences’).

Map unit Ic: Late granite

Certain syn- to post-tectonic granitic and pegmatitic rocks are mentioned under the previous unit. Post-tectonic granitic rocks are widespread, mainly forming small irregular masses, dykes and veins. One sizeable pluton shown on the map is in the north-east, south of

Kap Agassiz. It is a brown-weathering, medium- to coarse-grained biotite granite to quartz syenite with a megacrystic texture that shows little signs of deformation. Its presence was predicted by R.W. Stemp (personal communication, 1995) as a cause of a medium to high intensity recorded in the aeromagnetic data (map 96/1-101). SHRIMP reconnaissance dating of the granite gave an age estimate of 1.94 Ga (F. Kalsbeek, personal communication, 1996), implying that the granite is coeval vrith the igneous rocks of the Etah meta-igneous complex described in unit lb above.

Geological province 2: Thule Basin

The outcrops of the Thule Supergroup in south-western Inglefield Land (i.e. north of Kap Alexander) represent thin deposits at the northern margin of the Thule Basin (Dawes *et al*, 1982a). The zero-edge of the basin is shown on the map to the east of Rensselaer Bugt. However, the precise position of the pinching-out of the Thule Supergroup is hampered by poor inland exposure and coastal scree slopes. Major basin margin faults, with downthrow to the west and south-west, shown on the map east and south of Kap Alexander, coincide with the abrupt thickening of the main succession (map unit 2a) into the depocentre (Fig. 1). The south-westernmost outcrops on the map represent the youngest strata exposed (map unit 2c).

The succession varies in thickness from a feather-edge in the north-east to 150-250 m over much of its outcrop in the map area, to a much greater thickness south-west of the marginal faults.

Map unit 2a: Neohelikian sediments

All Thule Basin deposits in the map area, except a small outcrop on the south-western extremity (map unit 2c), are of Neohelikian age. The main outcrops are referred to the Smith Sound Group; minor outcrops south-east of Sonntag Bugt belong to the Nares Strait Group (Dawes, in press). The map unit represents a varicoloured sequence of sandstones and shales, including red bed and clean quartz arenite units, with subordinate stromatolitic carbonates. The strata were laid down in a stable overall shallow shelf environment ensuring long-lasting conditions for shallow-water to subaerial deposition. Five formations have been defined.

Map unit 2b: Neohelikian basaltic sills

Tholeiitic basalt sills, intrusive into sediments, are prominent in the Smith Sound Group; correlatable effusive rocks occur south-east of Sonntag Bugt in the Nares Strait Group. Two of the thickest sills (up 60 m) can be traced over much of south-west Inglefield Land. K/Ar whole-rock ages around 1100 Ma suggest a late Neohelikian age; an age confirmed by the dating of basaltic material from south of the map area and in neighbouring Ellesmere Island.

Map unit 2c: Hadrynian sediments

Dark-weathering, interbedded quartz arenites, siltsones and shales, with some dolostones form the south-westernmost outcrop of the map; these represent the northern exposures of the basinal Dundas Group. Microfossil data and isotopic ages of basaltic intrusions from outcrops south of the map area, suggest that the strata are Hadrynian in age.

Geological province 3: Franklinian Basin

The Cambrian deposits of Inglefield Land represent the basal part of the Franklinian succession that on the northern side of the Humboldt Gletscher in Washington Land contains important Ordovician and Silurian sections. The succession in Inglefield Land is limited upwards by Quaternary deposits and the present erosion surface.

The homoclinal strata are flat-lying to generally north-westerly dipping up to 3°. Directly resting on the crystalline shield in the north-east, the Cambrian strata overlap onto the Proterozoic strata of the Thule Basin in the south-west (Fig. 1). The succession is dominated by carbonates of the Ryder Gletscher Group that represent Cambrian to Ordovician shallow-water interior platform deposits (Ineson & Peel, 1987; Higgins *et al.*, 1991). In Inglefield Land these overlie basal fluviatile and shoreline siliciclastic deposits of the Dallas Bugt Formation (Peel *et al.*, 1982).

Map unit 3a: Lower to Middle Cambrian

This map unit, about 350 m thick, comprises the main part of the Franklinian succession in Inglefield Land. The Lower Cambrian Dallas Bugt Formation (up to 150 m thick), is composed of basal feldspathic red beds and clean quartz sandstones, that pass upwards into the dolomites of the Cape Leiper and Cape Ingersoll Formations. The upper part of the section is composed of Lower to Middle Cambrian limestones of the Wulff River, Cape Kent and Cape Wood Formations.

Map unit 3b: Middle to Upper Cambrian

The youngest rocks in Inglefield Land are limestones and flat-pebble conglomerates of the Middle Cambrian to Early Ordovician Cass Fjord Formation. Only the basal part of the formation is preserved; a thickness, according to Bengaard (1995), of about 100 m. In Washington Land to the north, the formation is up to 470 m thick (Peel & Christie, 1982). The precise stratigraphic intervals preserved in Inglefield Land are uncertain and the presence of Ordovician strata on the relatively unexplored inland plateau cannot be discounted.

Basic dykes

A number of WNW-trending basaltic dykes cut the Precambrian shield in south-^vestem Inglefield Land. Very sporadic NW-trending dykes are also known. Both these trends are clearly seen in the magnetic data of Stemp & Thorning (1995), who suggest additional dyke trends of NE and ENE (see maps 96/1-101 and 102). The WNW-trending dykes cut the Thule Supergroup but not the Franklinian Basin succession, an age relationship confirmed by isotopic dates. These dykes represent the northern components of a regional swarm of Late Proterozoic (late Hadrynian) dykes that are present throughout the Thule district at least as far south as 76° N. The one age date available fi*om Inglefield Land is from a dyke at Kap Leiper that has given a K/Ar whole-rock age of 627±25 Ma (Dawes *et al*, 1982b).

(Peter R. Dawes)

Magnetic and electromagnetic data

The source of the data is an airborne electromagnetic and magnetic survey flown in 1994 as the first survey of project AEM Greenland 1994-1998 (Stemp & Thorning, 1995a, b), a project financed by the Government of Greenland to promote mineral exploration in Greenland. In the first year of the project 17,365 line kilometres were acquired over Inglefield Land at a line spacing of 400 metres (4000 metres for tie-lines). The thematic maps of magnetic and electromagnetic anomalies are based on grids with a cell dimension of 100 by 100 metres produced by Geoterrex Ltd. from the original high sensitivity line data as part of the contract for the data acquisition of project AEM Greenland 1994 (Geoterrex, 1994).

Total magnetic intensity and calculated magnetic vertical gradient

The total intensity is shown as a colour contour map (96/1-101) with superimposed shaded relief (light from the north-west). The magnetic sensor altitude is approximately 65 metres over the ground. The International Geomagnetic Reference Field 90 (IGRF90) calculated to the time of surveying has been subtracted from the data.

The total magnetic intensity map exhibits a well defined regional variation which is closely related to the underlying geology. A comparison with the preliminary geological map (96/1-011) shows that the magnetic data provides much more detail on the geology than it has so far been possible to map by aerial photographs. Although there is practically no vegetation in the area, large areas are covered by glacial drift or boulder fields.

Many linear and folded structures mentioned in the section on bedrock geology are visible in the magnetic data, e.g. the NNW, WNW, NE and ENE linear features related to basic dykes and faults and the folded structures in the north-eastern part of the area. Similar structures are revealed by the magnetic data in the basement where it is covered by strata of the Thule and Franklinian basins. The E-W trending magnetic features across southern Inglefield Land very clearly display the structure of the straight belt.

The strongest magnetic anomaly with a peak value of some 15,000 nT relative to the IGRF is situated in the central part of Inglefield Land near Mintum Elv. The anomaly has been interpreted to reflect a large deposit of magnetite hosted in mafic to ultramafic intrusive rocks (Appel *et* a/., 1995; see section on ‘Mineral occurrences’). Stemp & Thorning (1995b) give a more detailed account of the results of the airborne geophysical survey in general.

The calculation of the vertical gradient, or first vertical derivative, was carried out using the grid values of the total magnetic intensity. The map (96/1-102), presented as a shaded relief map with light from north-west, enhances the structural patterns and emphasises features near the surface.

Calculated apparent conductivity

From the electromagnetic data (all channels) values of broadband apparent conductivity have been calculated assuming a homogeneous half-space model. The method resolves conductivity values in the range 0.05 to 5000 mS/m (Geoterrex, 1994). The result is shown in map 96/1-104. This geophysical parameter also clearly distinguishes the geological units and structures. Regionally, large parts of the Proterozoic basement is seen to be highly resistive, providing a good background for the detected EM anomalies. Areas of very weak conductivity clearly reflect the rocks of the unmetamorphosed cover sequences, and the very

Strong bedrock conductors forming linear or semi-linear trends correlate with the regional structural trends. The isolated single anomaly targets seen on the map of GEOTEM anomalies are also visible in the calculated apparent conductivity.

GEOTEM anomalies

GEOTEM operated by Geoterrex Ltd. is an asymmetrical transient electromagnetic EM system with the transmitter in the aircraft at an altitude of approximately 120 metres and the receiver in a bird trailing 120 metres after and 65 metres below the aircraft. The system has a good ground penetration. In optimal conditions conductive targets in a resistive environment can be detected down to perhaps 3-400 metres below the surface.

Some 4600 individual GEOTEM anomalies of various types were identified in the survey area in Inglefield Land. Map 96/1-103 shows the position of automatically identified GEOTEM anomalies, subsequently evaluated and accepted. Assuming a source in the shape of a vertical plate, 600 metres long and 300 metres deep, the conductivity-thickness product and the depth to the top of the plate has been calculated for each anomaly. The calculation can be significantly in error if the model does not accurately portray the real situation, but in order to provide a general impression of the variation in depth, the calculated depths have been used to classify the anomalies by assigning a specific colour to four different depths ranges. The first class (depths < 0) contains all the anomalies, where the assumed model produces clearly invalid depths, probably because the model assumptions do not hold. However, these anomalies are still real and interesting for further investigation and analysis.

The distribution of depths do not show any clear regional pattern. The depth estimates indicate that the sources of the anomalies may occur at depths down to 200 metres. This means that in most cases ground geophysics and drilling will be necessary to identify and investigate the many potentially interesting targets. In general, most of the conductors revealed by the anomalies can be classified as ‘formational EM conductors’ (Stemp & Thorning, 1995b) related to formations within the supercrustal sedimentary sequences, where they form multiple conductor zones. Their most probable causes are graphite, massive sulphides, or a combination of the two. There are also many short, localised conductors present in a variety of geological settings. Stemp and Thorning (1995b) discusses a selection of these. Both types of conductors may be economically interesting.

{LeifThorning)

Gravimetry

The data source for the Bouguer anomaly map (96/1-111) is a regional gravity survey carried out by the Geodetic Division, Kort- og Matrikelstyrelsen (KMS, Copenhagen) with financial support from the Defence Mapping Agency (US) as a part of a two year joint Danish-Canadian-US gravity project in the Nares Strait region (Forsberg *et al.,* 1994, 1995). Forsberg *et al.* (1994) compiled the gravity data relative to ISGN71 and calculated the terrain corrected Bouguer anomalies using a density of 2.67 g/cm for rocks and 1.0 g/cm for water.

Approximately 100 of the gravity observations are situated in Inglefield Land and form the basis for the calculation of the terrain corrected Bouguer anomaly map (500 by 500 metres grid). Although regional in character, the map shows two interesting features. Firstly, the very strong gradient from values in the range -^-20 to h-30 mGal near the Inland Ice to values around ^50 mGal just off the coast, is aligned with the linear mobile belt, and may reflect deeper features related to the position of the linear belt. Secondly, this pattern is broken by a north-south trending high in a region Avith generally higher gravity values of unknown origin.

{LeifThorning)

Ground scintillometry

Measurements of total gamma-radiation were made using a Saphymo Srat SPP2 scintillometer at the sites sampled for the geochemical survey. At each locality five to ten scintillometer readings were made on representative rock surfaces or boulder assemblages. The average or typical radiation level was noted and the results are presented as dot maps showing readings in counts per second (cps). A calibration test of the instrument has shown that approximately 9 counts per second correspond to a radiation of 1 Ur.

Map 96/1-131 shows a considerable range in measured gamma-radiation. The hypersthene orthogneisses, the mafic igneous rocks, the marbles and also the carbonates of the cover successions have the lowest radiation, less than 30 cps, while the gametiferous metasediments of the mobile belt typically give 50 to 80 cps. The basal red beds of the Franklinian succession commonly gave readings around 80 to 100 cps. The granites showed very variable radiation reflecting their different origins. Many gave around 50 cps whereas some pegmatite veins and small granite bodies had ‘hot spots’ up to 1500 cps. The distribution pattern of the readings is fairly irregular and there are no obvious regional trends. The high readings south of Force Bugt and Rensselaer Bugt are not matched by high U or Th in the overburden (map 231 and 230, respectively). This is due to the predominance of granite and granite boulders at sampling sites in streams which are otherwise draining and carrying material derived from the carbonates and sandstones of the cover successions.

(Agnete Steenfelt)

Overburden geochemistry

The geochemical maps (96/1-201 to 239) are based on multi-element analysis of the < 0.1 mm fraction of 293 samples of stream sediment or soil collected at a density of 1 sample per 30 km . The geochemical survey forms part of the Greenland Reconnaissance Geochemical Mapping Programme (Steenfelt, 1993, 1994). The original intention was to use stream sediment only, but the topographical conditions appeared unfavourable for stream sediment sampling at many localities: Close to the ice margin the water flows over the till with insignificant gradient and proper stream sediment is not deposited. Many of the drainage channels throughout Inglefield Land are guided by existing fault and fracture systems and as the drainage patterns changed with time a number of the ravines and gullies were left dry. The bottoms of the dry ravines were covered by 'fist-sized' or larger boulders and fine grained stream sediment was missing. It was decided to keep as close as possible to the predesigned sampling layout to ensure even coverage, and then sample what appeared the most reasonable substitute of a stream sediment, i.e. some kind of 'soil' preferably derived from the surrounding rocks. On the plains, the thin till was sampled, whereas in ravines regolithic soil from the slopes was sampled. The large till-covered area in the south-eastern part of Inglefield Land is without drainage and there soil samples were collected in a square grid. Details of the sampling procedures are given in Steenfelt & Dam (1996).

All samples were sieved and the < 0.1 mm fraction submitted for analysis. Major elements were determined by X-ray fluorescence (XRF) using fused glass discs at GEUS, and trace elements by instrumental neutron activation analysis (INAA), as well as inductively coupled plasma emission spectrometry (ICP-ES) at Activation Laboratories Ltd., Canada. The analysis method is shown on each geochemical map. The quality of the analysis is discussed in Steenfelt & Dam (1996). Major element oxide concentrations are calculated as volatile-free values.

The geochemical maps comprise results from all samples collected at a regional scale whether categorised as stream sediment or soil. Both media consist of mechanically weathered bedrock material which has suffered only minor changes. However, it is expected that the proportion of weathering to resistant minerals is higher in stream sediment than in the surrounding bedrock or regolith derived from that bedrock, hence stream sediment are likely to be enhanced in elements such as Zr, Hf, Th, P, Y, and Yb relative to soil. This is confirmed by the composition of samples, one stream sediment and one soil, collected at the same locality (Steenfelt & Dam, 1996). However, for the purpose of distinguishing and displaying regional geochemical trends these differences are not significant. In the geochemical maps the two sample types are shown in different colours, but the two colours are deliberately chosen so closely in shade that the total impression of the regional distribution pattern is not disturbed.

The element distribution patterns displayed by the geochemical maps are related to lithology and mineralisation and they help to outline lithological units and mineralised structures otherwise only known from scattered ground inspection (Steenfelt & Dam, 1996). The main lithostratigraphical units, the basement and the cover successions, are most clearly distinguished from each other by the distribution of Sc, V and also to some extent by Ni and Zn, the platform cover being characterised by low values of these elements. In addition, the basement has higher values of Ti, Al, Fe, Na, Co, Cr, Sr, although boundaries are less distinctly seen in maps of these elements.

Within the basement some element distribution patterns reflect lithological differences (see discussion) and high values of Au (map 96/l>213), Cu (map 96/1-219) and Zn (map 96/1-233) indicate gold and base metal mineralisation. Three samples yielded concentrations of above 50 ppb Au which is strongly anomalous by Greenland measures (Steenfelt, 1996).

The medium high and high Au values (map 96/1-213) appear to be spatially associated with the distribution of high As (map 96/1-212) although high Au does not always coincide with high As. A small group of samples with high As occur in the southern comer of the area, other high values form a N-S elongated cluster in central Inglefield Land. Medium high As (and Au) values extend along a north-eastern trend and are scattered in the north-eastern part of Inglefield Land. The central cluster of Au and As anomalies occurs in an area with poor exposure. Scattered outcrops comprise felsic and mafic supracmstal rocks with mst coloration. Elsewhere, the As and Au anomalies occur in metapsammites and metapelites enriched in graphite and pyrite.

The N-S alignment of high values of the metals Co, Cu, Ni, Pb and Zn across north-eastern Inglefield Land would suggest a stmcturally controlled mineralisation. However, no such lineament is indicated by the topographical, geological or geophysical maps. High Al and Fe, and slightly elevated As follow the same trends which suggests that the host rock of the high metal values are supracmstal rocks, and high U in the same samples may be taken to indicate the additional presence of granite in this zone. The aeromagnetic maps show an intricate fold pattern in this area and it may be just fortuitous that the anomalies are aligned. Copper sulphide mineralisation was discovered near amphibolitic rocks close to multi-metal anomaly at latitude 79° N (locality No. 524/4 in map 96/1-402, see section on ‘Mineral occurrences’), which support the suggestion that the geochemical base metal anomalies may be considered indicative of mineralisation.

The elements Hf, Th, U, REE, and Y are anomalously high in samples just south of Dallas Bugt and around Marshall Bugt, in areas where the dark red, siliciclastic beds of the Dallas Bugt Formation (the basal part of the Franklinian succession) outcrop. The element association suggests that the sediments contain horizons of concentrated heavy minerals (zircon, monazite, ?gamet) possibly derived from the erosion of a granitoid terrain.

(Agnete Steenfelt)

Mineral occurrences

The mineral occurrence maps (96/1-401 and 402) show the location and type of iron, base and noble metal mineralisation encountered in Inglefield Land. The numbers next to the symbols refer to entry numbers in the Greenland mineral occurrence data base (GREENMIN) maintained at the Department of Economic Geology of the Geological Survey of Denmark and Greenland. All mineral occurrences recorded so far are classified as showings.

Fe-sulphides associated with rust zones

The most widespread visual expression of mineralisation in Inglefield Land is a large number of enormous rust zones which may be hundreds of metres wide and traceable for kilometres along strike. They are typically formed by oxidation of sulphides and vary in colour from deep red to bright yellow. Locally a well developed gossan is seen. The rust zones commonly contain disseminated pyrrhotite and pyrite, but semi-massive to massive sulphide lenses of metre size also occur. The rust zones are most abundant in north-eastern Inglefield Land where they are hosted by the paragneisses of assumed Early Proterozoic age (see section on geology). Thus host rocks of the major rust zones are commonly garnet-rich quartzites with varying amounts of biotite, feldspar, sillimanite, graphite and magnetite. Preliminary speculations concerning the genesis of the iron sulphide mineralisation are based mainly on field evidence. Two models have been considered (Thomassen & Dawes, 1996): 1) the sulphur and iron were deposited together with organic matter during sedimentation (see also Steenfelt & Dam, 1996), 2) magnetite was the dominant iron mineral during sedimentation and was later transformed into sulphides.

The rust zones attracted the attention of mining companies in the period 1969-1973 (Greenarctic Consortium and Internationalt Mineselskab A/S) and again two decades later in 1991 and 1995 (Rio Tinto Zinc (RTZ) Mining and Exploration Limited; Sharp, 1991; Coppard, 1996). The helicopter-supported mineral exploration by RTZ over the whole of Inglefield Land resulted in the identification of 59 rust zones (some with gossanous

development) from the air, 25 of which were checked on the ground. The rust zones checked on the groimd vary in scale from 5 x 5 m up to 4 x 1.5 km . The highest concentration of rust zones, including most of the larger ones, occur in the basement rocks of north-eastern Inglefield Land (e.i. east of 69°30'W and north of 78°30'N). Data on the 20 largest of the visited rust zones are extracted from an RTZ Mining and Exploration Ltd. report (Sharp, 1991) and included in the GREENMIN data base. The locations are shown on map 401, which then illustrates the distribution of major rust zones in Inglefield Land. The best surface samples showed elevated trace amounts of gold and some base metals: max. 207 ppb Au at 522/1, 3767 ppm Cu at 521/2, 2565 ppm Zn and 960 ppm Ni both at 521/4.

Base metals, noble metals and magnetite

Data in map 96/1-402 stem from the 1995 field work in Inglefield Land (Appel *et al,* 1995; Thomassen & Dawes, 1996). The 11 GREENMIN localities indicate the most promising mineralisation encountered during the field work. They include the ten sulphide mineralisation localities which returned the highest analytical values for gold or some base metals in rock samples, and one magnetite occurrence.

Minor sulphide mineralisation, revealed by malachite staining, occurs in gneisses at gneiss/marble contacts. At the best investigated locality (No. 524/5 in map 96/1-402), such mineralisation has been followed over 300 m along strike. Two chip samples average 36 ppb Au and 2382 ppm Cu over 0.8 m, whereas four grab samples contain up to 1188 ppb Au and 1.3% Cu. The ore minerals are chalcopyrite, bomite and magnetite along with minor pyrrhotite and pyrite.

A poorly outcropping, half a metre wide lens of semi-massive sulphides occurs at the south-west coast of Inglefield Land (No. 524/1). A grab sample consisting of pyrrhotite with minor chalcopyrite and a single grain of gold returned 1134 ppb Au and 1014 ppm Cu. The lateral extent of the lens is not known.

Quartz veins of decimetre thickness with traces of chalcopyrite have also been observed in a number of settings (No. 524/2).

Close to Marshall Bugt a rust zone consisting of massive to semi-massive pyrrhotite is situated in a small ridge in the Precambrian basement (No. 523/1). This rust zone is discordantly overlain by about one metre of unexposed rocks which in turn are overlain by 1.5 m sandstone followed by dark schists. Further uphill a sequence of conglomerates and sandstones is seen. These sediments are probably of basal Cambrian age. The lower sandstone unit contains small amounts of chalcopyrite and exhibits frequent malachite staining. A few samples were analysed and the highest grade found was 0.56% Cu. One sample had 160 ppm

As. The dark schists contain small amounts of disseminated pyrrhotite. This mineralisation was discovered by RTZ (Coppard, 1996).

Magnetite associated with mafic and ultramafic intrusive complexes

A field check of a strong positive magnetic anomaly south-east of Marshall Bugt (No. 523/3 in map 96/1-402) revealed a medium-grained massive gabbro containing abimdant magnetite as small disseminated grains and chalcopyrite and malachite on joint surfaces. The gabbro is cut by several generations of pegmatites, quartz veins and metre-wide granite sheets. Late non-deformed sheeted quartz veins up to 0.5 m wide and several tens of metres long transect the gabbro. One sample of malachite stained gabbro analysed by INAA at Activation Laboratories Ltd. yielded 0.16 % Cu.

Field checks at the eastern end of the strong E-W trending linear positive magnetic anomaly within the straight belt (see map 96/1-101) resulted in the discovery of outcrops of magnetite mineralised mafic-ultramafic rocks in the upper Mintum Elv area. The occurrence (No. 525/1 on map 96/1-402) is described in Appel *et al* (1995). An up to 20 cm thick band of massive magnetite with minor spinel and olivine is hosted by amphibolite. A nearby outcrop of ultramafic rocks have a peculiar mineral assemblage of forsterite, phlogopite, spinel, tourmaline, and warwickite. The two latter boron-rich minerals constitute up to 10 % of the rock. The forsterite has been altered to an assemblage of serpentine and magnetite. The warwickite has been altered to an assemblage of unknown boron-rich minerals and magnetite. Five samples of the ultramafic rock have been analysed by fire assay at Activation Laboratories Ltd. The Pt contents were below the detection limit of 5 ppb.

Where the strongest magnetic anomaly is recorded there are no bedrock exposures. However, abundant magnetite float in the overburden indicates the existence of magnetite mineralisation at depth. The magnetite occurs as angular to weakly rounded up to 10 cm sized blocks of pure magnetite without any silicates. Some blocks have a high proportion of hematite which is clearly secondary after magnetite. Tiny exsolutions of spinel are seen in the magnetite. Samples of magnetite float were analysed for major and selected trace elements by X-ray fluorescence at the GEUS laboratory. The most interesting results were up to 0.14 % V and 0.1 % Ni (Appel *etal.,* 1995).

(P. W. U Appel & B. Thomassen)

Discussion

Implications for geological mapping and interpretation

Large areas of the basement have not been mapped in detail and although the major tectonic framework was established by the studies prior to the recent GEUS activities (see section on geology), the new geophysical and geochemical data combined with geological reconnaissance provide substantial additional information on the extent and character of lithological units and structure. This information is very valuable for future geological investigations.

In general terms, the aeromagnetic map depicts the majority of the igneous intrusive units as magnetic highs, the apparent conductivity map shows them as lows, while the geochemical data or the geological fieldwork has identified the character of a number of these units as granitoid orthogneisses, syenitic or amphibolitic to ultramafic rocks. Thus, the large intrusive complex at upper Mintum Elv is monzonitic to syenitic, the E-W trending positive anomaly following the northern edge of straight belt is underlain by magnetite bearing orthogneiss (B. Thomassen and P. R. Dawes, pers. comm. 1996), and a meta-gabbro (locality 523/3 in map 96/1-402) causes the magnetic high east of Marshall Bugt. The late granite (unit Ic in map 96/1-011) is also magnetic, whereas most other granite bodies give low response in magnetic field and conductivity. The geochemical maps have indicated the distribution of granitic magmatism characterised by Be and U. The conductivity and the geochemical maps show where sedimentary sequences are enriched in aluminium, arsenic or base metals. The marble units are displayed as magnetic lows and poor conductors and their whitish colour make them recognisable on aerial photographs and in the satellite image (map 96/1-002).

The regional structure is clearly illustrated by the geophysical maps, showing how the intrusive and sedimentary units are folded together in open folds in the north-east and in a narrow E-W straight belt in the south.

The Ellesmere-Inglefield mobile belt comprises pre-1.97 Ga supracrustal rocks which have been intruded by felsic and mafic plutons in the period 1.97 to 1.9 Ga. A heating event resulting in granulite facies metamorphism and minor granite veining appears to have taken place at *c.* 1.75 Ga. In Inglefield Land the sedimentary succession of the mobile belt comprises metamorphosed carbonates and psammitic to pelitic rocks. Amphibolites north-west of Septembersøeme are regarded as possible metavolcanic rocks (B. Thomassen, pers. comm., 1996) and the sedimentary packages may also include layers of felsic volcanic origin although such rocks have not been recognised in the field. The high grade metamorphism has destroyed original textures thereby making a distinction between felsic sedimentary and volcanic rocks very difficult. There are no detailed sedimentological studies to provide evidence for the sedimentary environment, but the predominance of carbonates and quartz-feldspar dominated facies suggest a continental or near-continental setting, i.e. marginal platform or cratonic basin-type environment. The lack of precise age dating of the sediments and their complex tectonic reworking make it impossible to decide whether there are one or more sedimentary basins involved. A continental setting of the early Proterozoic sediments would imply that a basement (of ?Archaean age) for the sediments is to be found in the area although this has not been recognised with certainty during field and isotope work.

The Mintum intrusive complex: The aeromagnetic map outlines the intrusive complex which is partly buried under glacial overburden in its eastern part and partly overlain by the gametiferous metasediments in its northern part. A buried satellite intrusion is indicated in the aeromagnetic map (96/1-101) to the west of the main complex. A small, round, slightly diffuse magnetic anomaly *c. 10* kilometres to the north-east could represent another buried intrusion. The predominant rock type within the Mintum complex is characterised by an elevated content of magnetite (to produce the magnetic anomaly) and apatite (to produce the high P content of stream sediment and soil, see map 96/1-210). The monzonitic to syenitic character of the complex has been confirmed by chemical analyses of rock samples (Steenfelt & Dam, 1996). Black coating and overgrowth of black lichens make the outcropping parts of the complex distinguishable in the satellite image as a bluish black area (map 96/1-002). Thus the Mintum intmsive complex differs from the other felsic-intermediate igneous intmsives in the area. It is assumed that the amphibolite and ultramafic rocks occurring west of the southern part of the Mintum complex are associated with the complex, although relations have not been studied in detail (Appel *et ai,* 1995).

The geochemical mapping has shown element concentrations in the basal formation of the Franklinian basin which have a bearing on the provenance of the sediments. The satellite image, the apparent conductivity, the geochemistry and field observations during geochemical sampling have shown that there is a thin layer of carbonates or carbonate rich overburden locally in south-western Inglefield Land which presumably belongs to the Franklinian succession. This has not previously been recognised.

Implications for the mineral potential

The most important new information with implications for the evaluation of the mineral potential of Inglefield Land comprises 1) the discovery of strong formational conductors in the early Proterozoic (or Archaean) metasediments; 2) the indication of gold mineralisation and 3) the indication of magnetite mineralisation.

The disseminated sulphides or small lenses of massive sulphide found at the surface are inadequate to explain the magnitude of the GEOTEM anomalies. Hence there remains the possibility of a large, buried, massive sulphide unit.

The geochemical data indicate that gold mineralisation has occurred. A preliminary evaluation of the existing data suggests that primary accumulation of Au took place during sedimentation where the organic rich sediments provided a favourable environment for retaining As and Au. The distribution of elevated concentrations of other elements with affinity to organic matter, such as Mo, Cu, Ni and Co (maps 96/1-221, 219, 222, 217, respectively) largely within areas occupied by graphite or sulphide-rich facies of the metasediments (as depicted by the map of apparent conductivity, map 96/1-104) provides additional evidence for this environment. Subsequent hydrothermal mobilisation and redeposition of the metals from the sedimentary packages is favoured by the widespread occurrence of syn- and post-tectonic granites, some of which appear to be reflected geochemically by elevated Be and U in stream sediment. Hence, shear zones and fractures in areas where granites have intruded graphite rich metasediments should be considered favourable targets for gold exploration.

The potential for a magnetite deposit in the eastern end of the straight belt is indicated by the strong aeromagnetic anomaly and the occurrence of boulders of pure magnetite, as described in the section on ‘Mineral occurrences’.

(Agnete Steenfelt)

Acknowledgments

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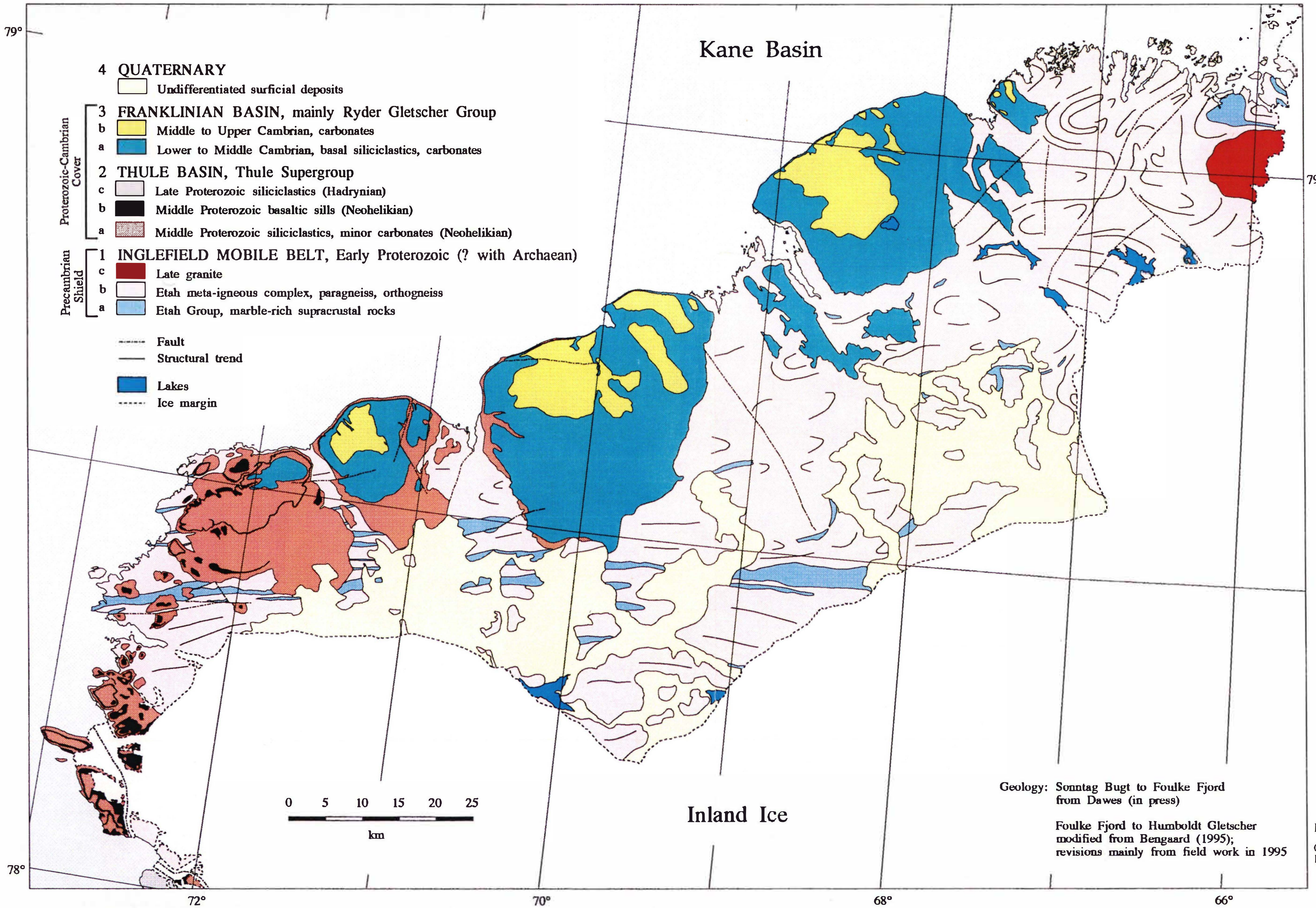
Geological map

Compiled by P. R. Dawes

96/1 - 011 Inglefield Land



Geology: Sonntag Bugt to Foulke Fjord from Dawes (in press)

Foulke Fjord to Humboldt Gletscher modified from Bengaard (1995); revisions mainly from field work in 1995

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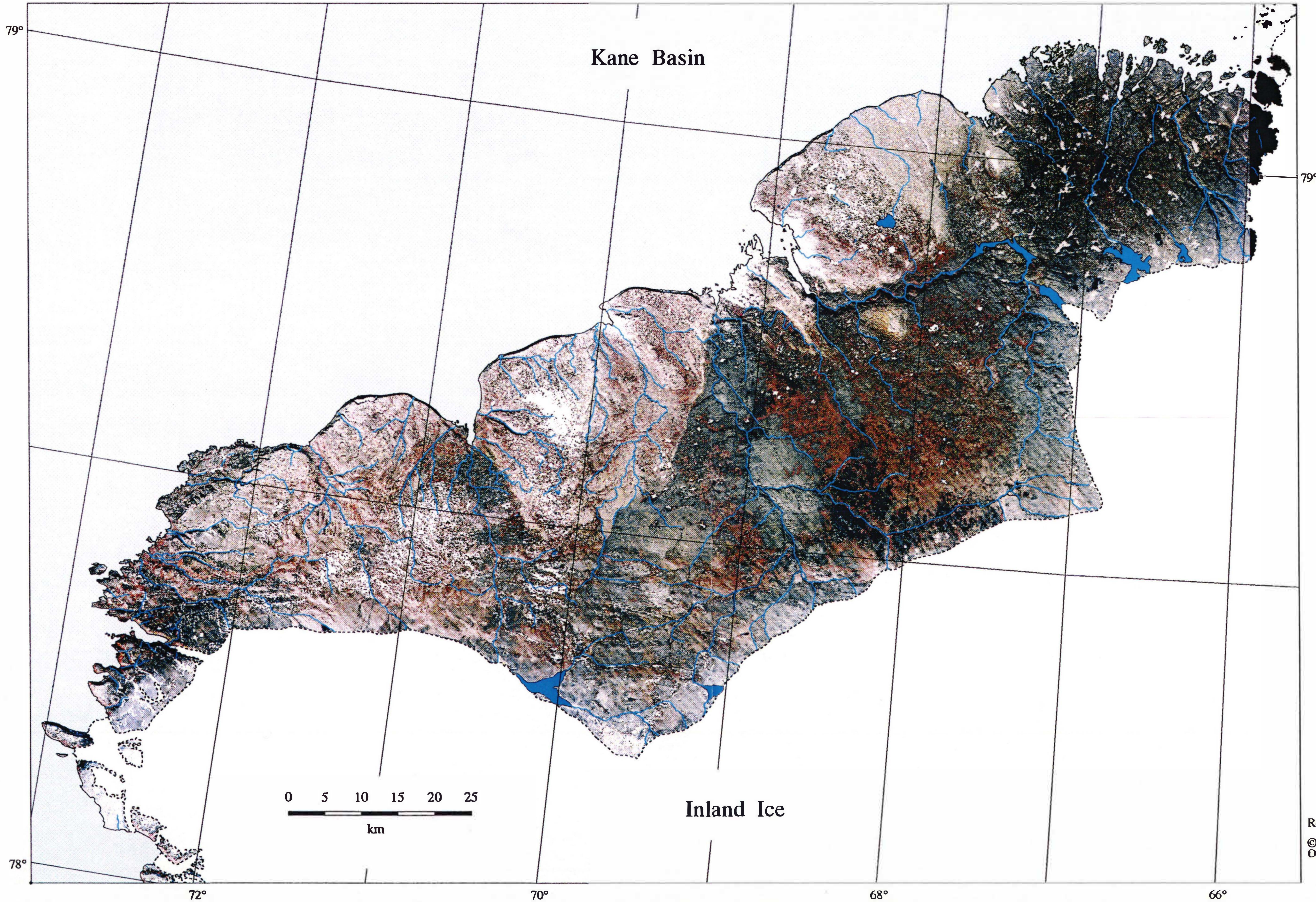
Landsat TM Map

Compiled by T. Tukiainen

96/1 - 002 Inglefield Land



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Topographic, Drainage and Place name map

Compiled by P. R. Dawes and F. Schjøth

96/1 - 001 Inglefield Land

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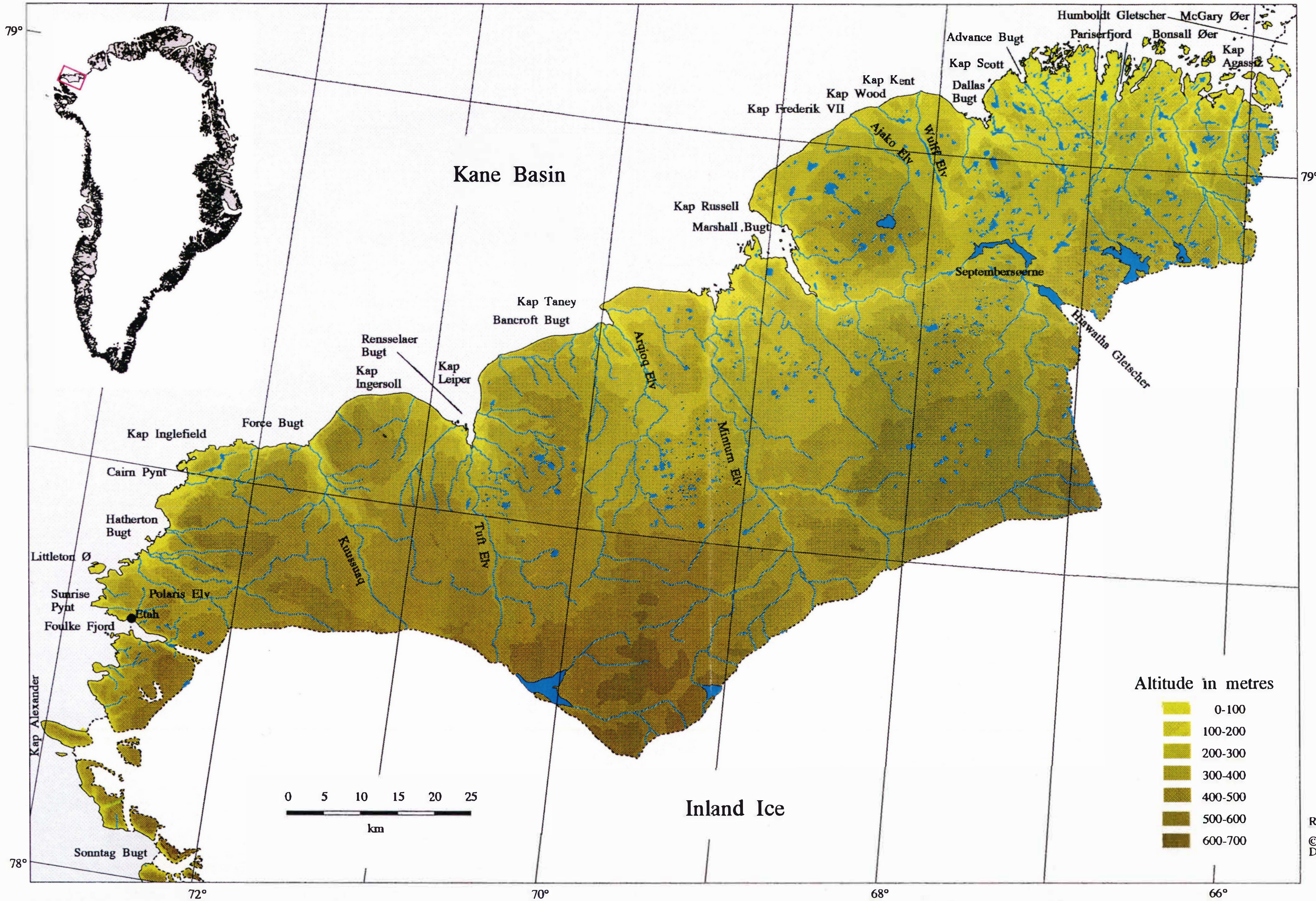

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Aeromagnetic anomaly map: Total magnetic intensity with shaded relief

Compiled by L. Thorning

96/1 - 101 Inglefield Land

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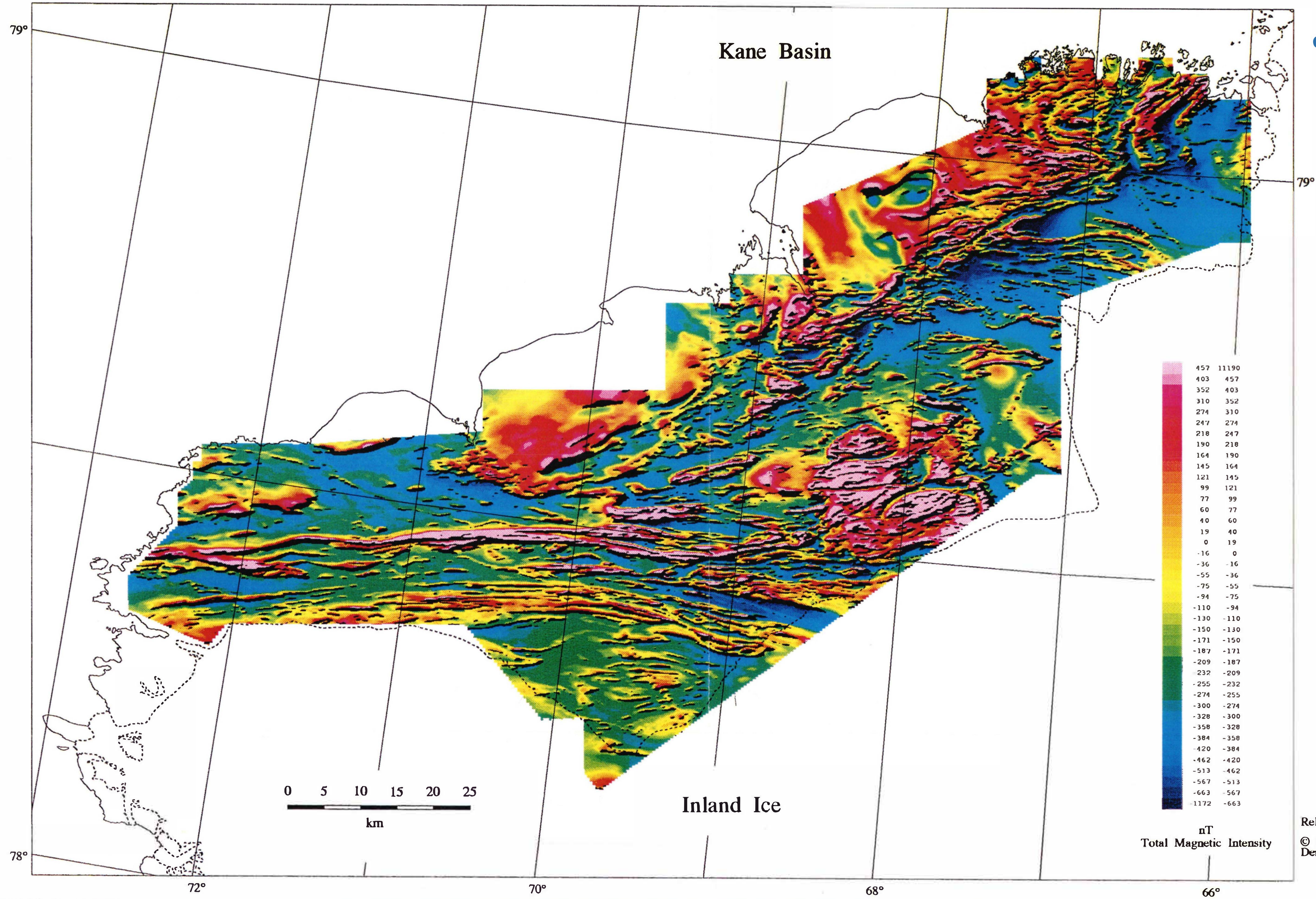

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Aeromagnetic anomaly map: Calculated magnetic vertical gradient

96/1 - 102 Inglefield Land

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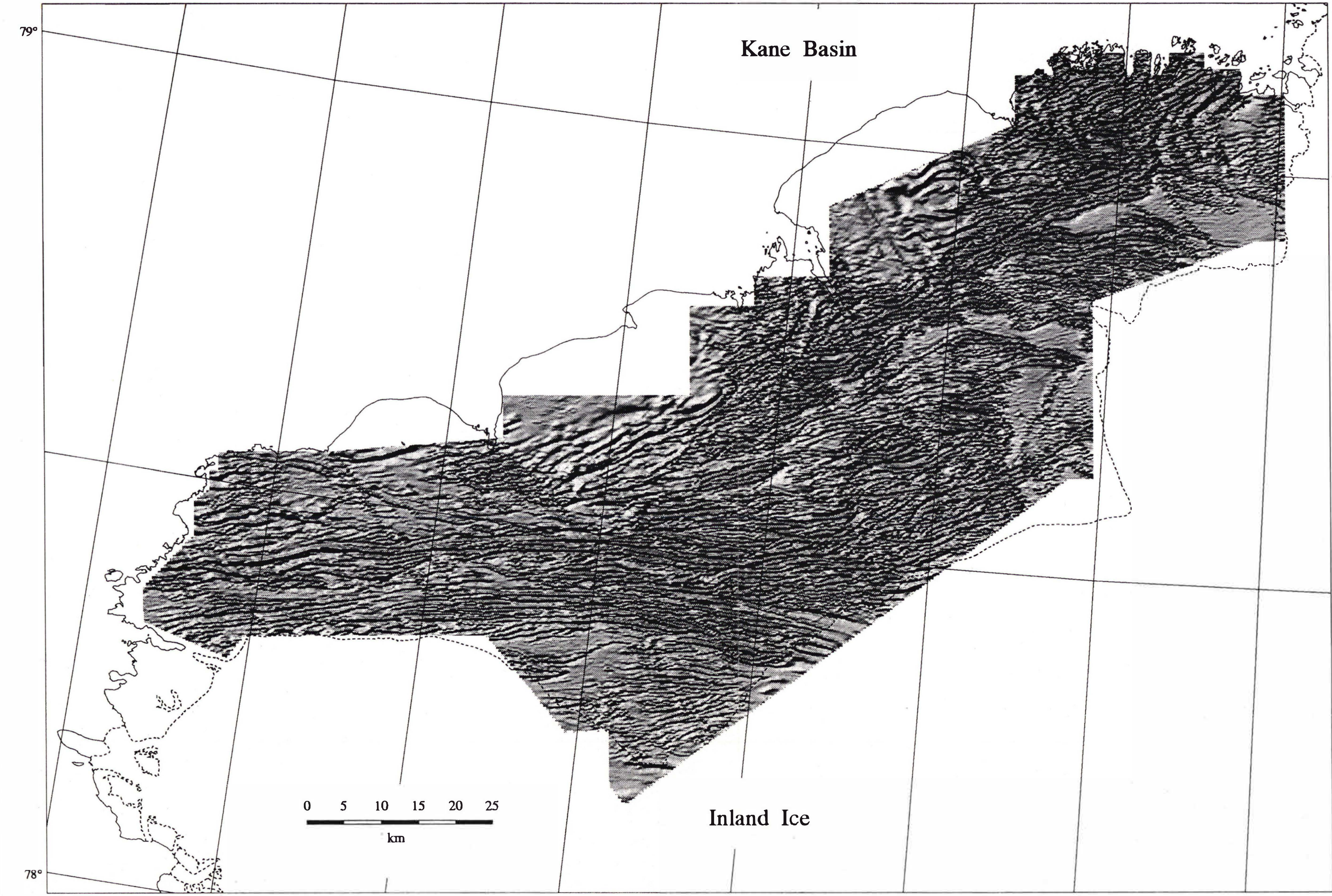

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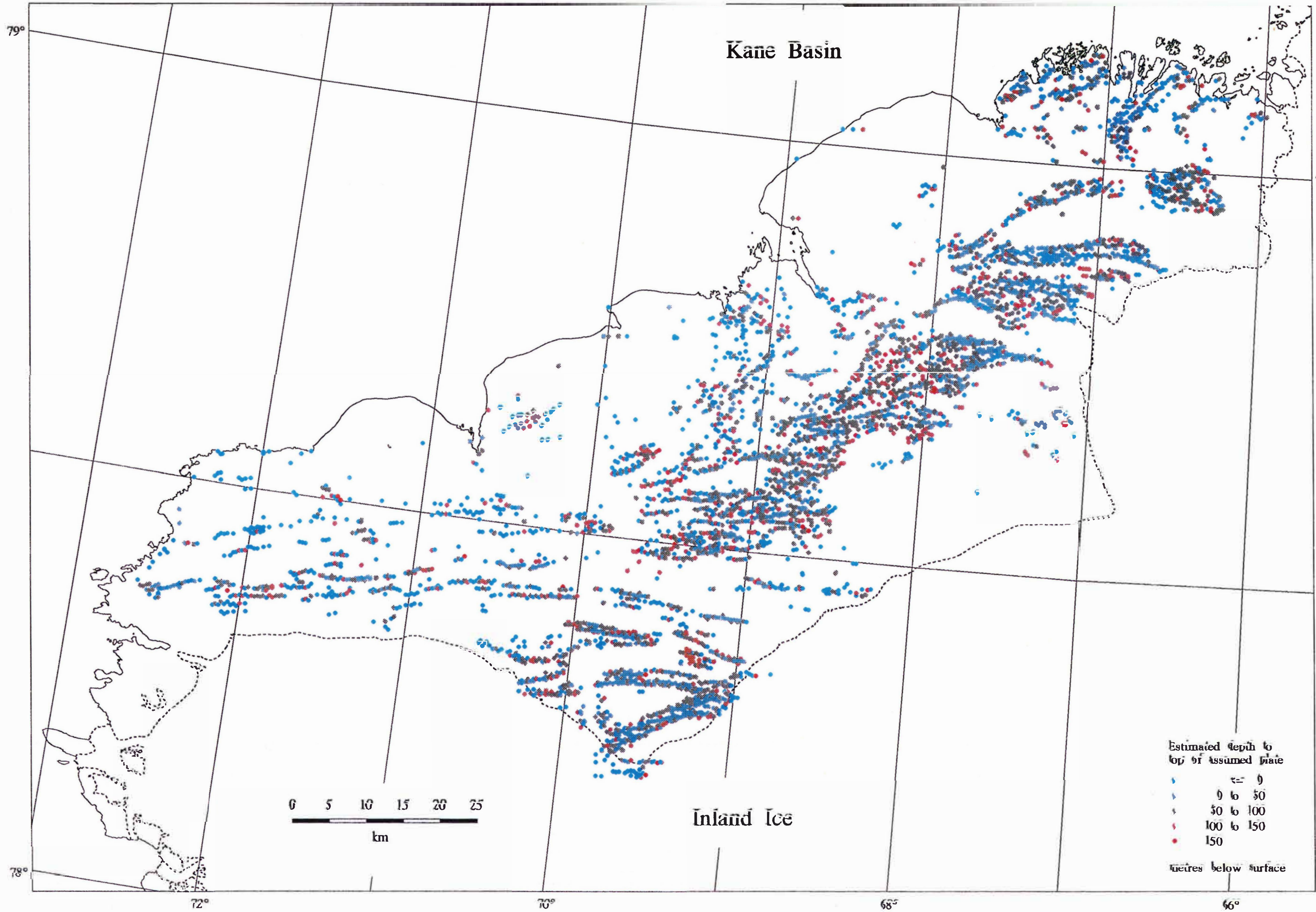
GEOTEM transient EM anomaly map

96/1 - 103 Inglefield Land

Compiled by L. Thorning



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Calculated apparent conductivity map

Compiled by L. Thorning

96/1 - 104 Inglefield Land

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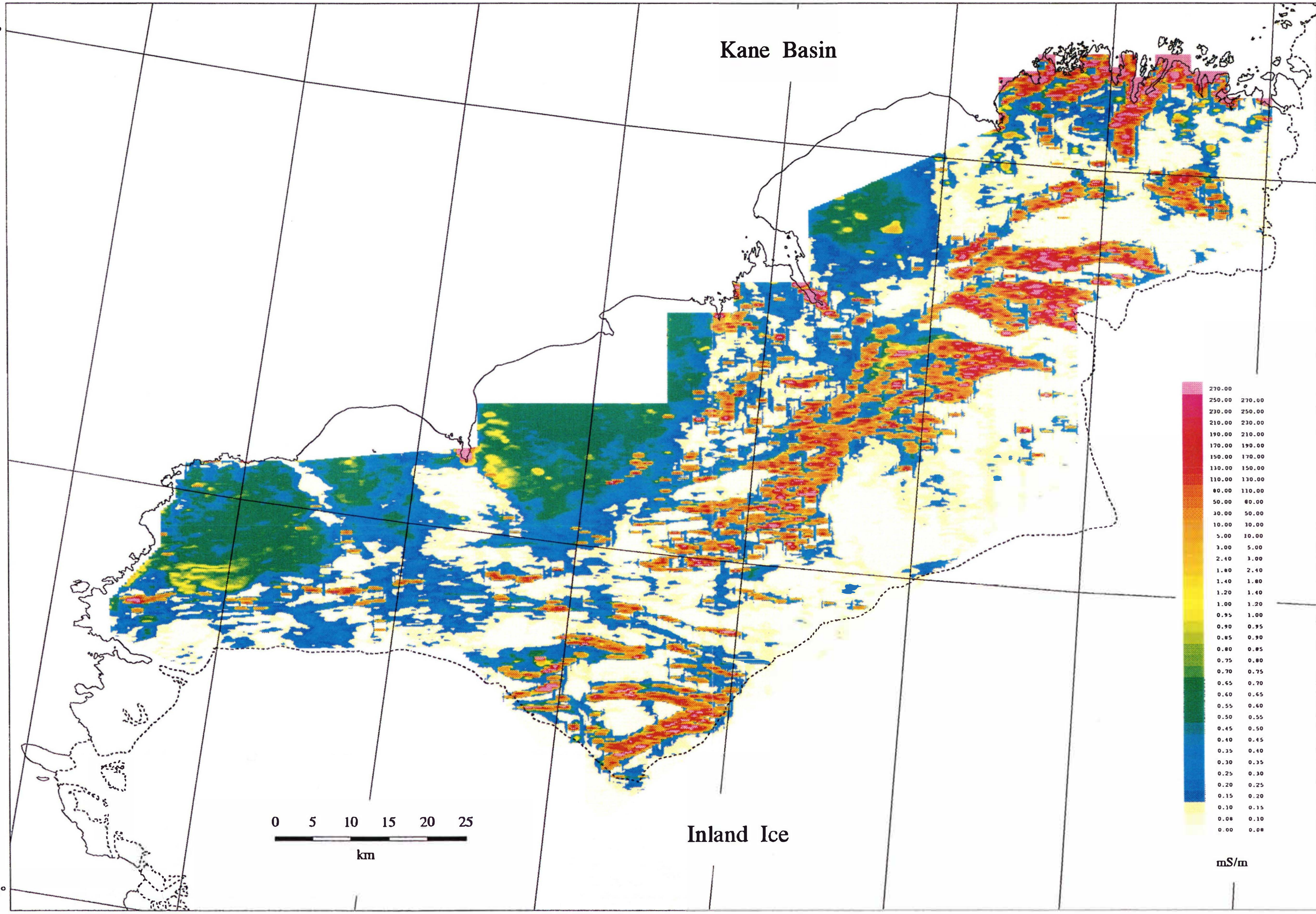

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Bouguer anomaly map

Compiled by L. Thorning

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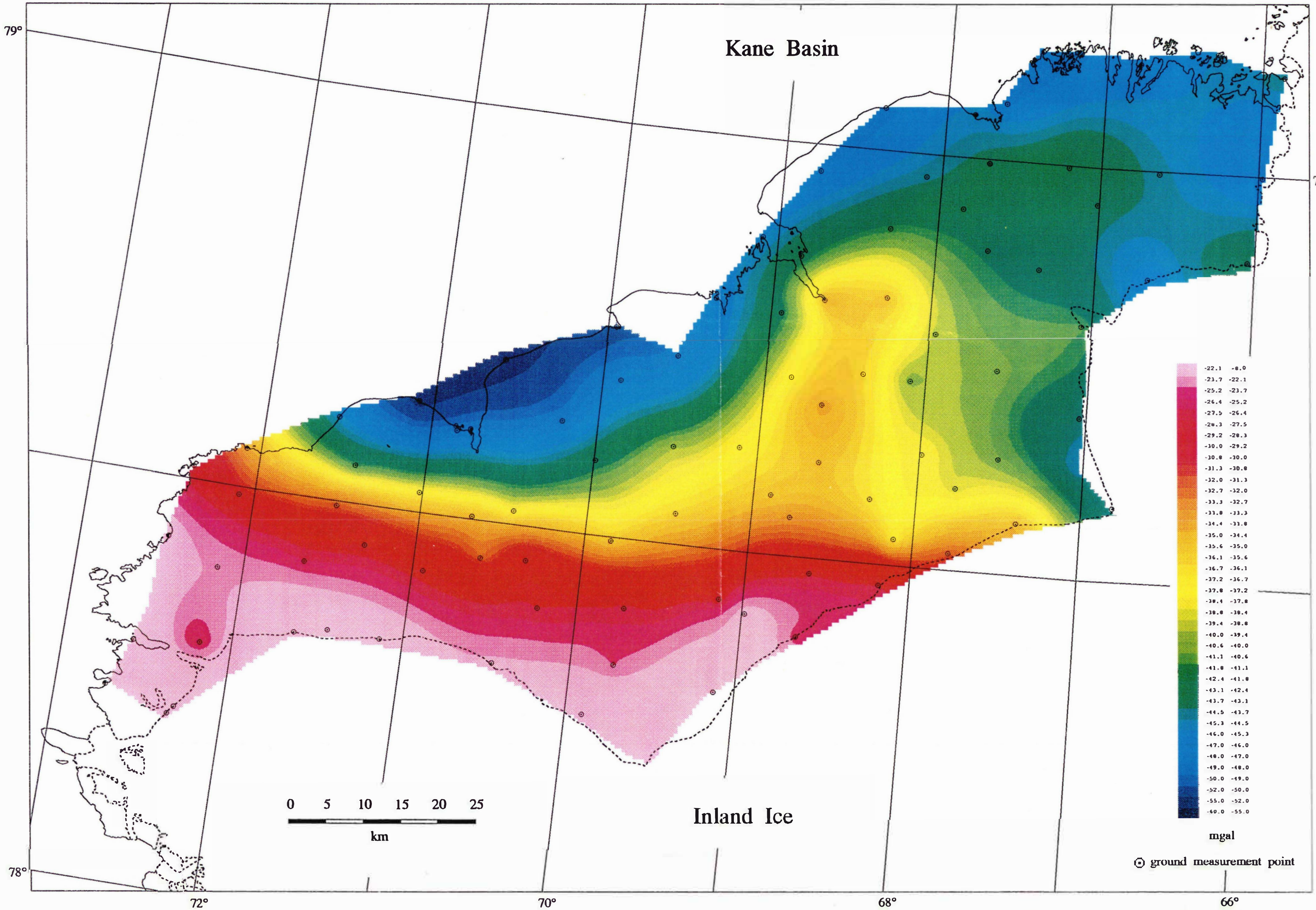

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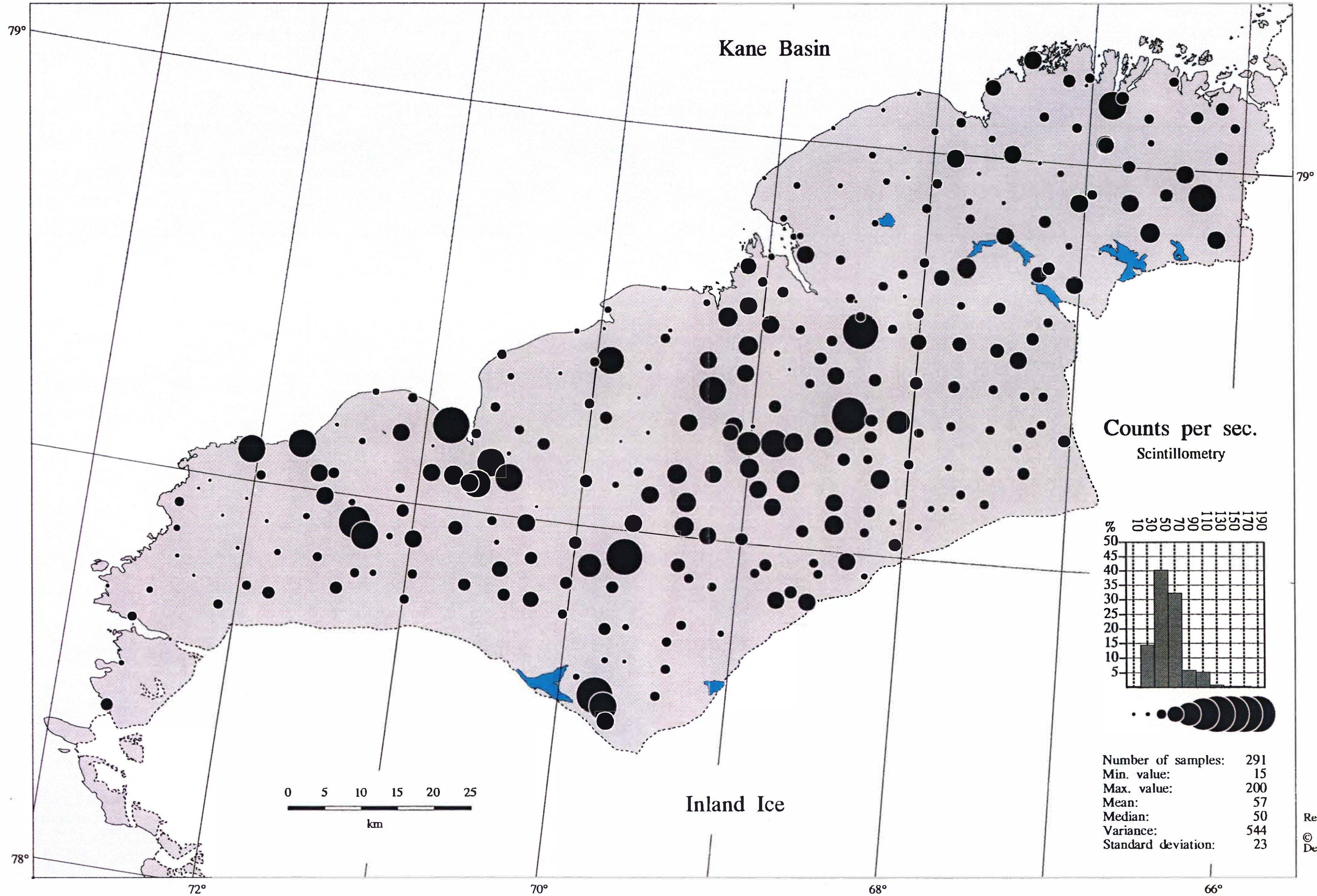
Geophysical Map: Total Gamma - Radiation

96/1 - 131 Inglefield Land

Compiled by A. Steenfelt and E. Dam



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Geochemical map: SiO_2 in stream sediment and soil

96/1 - 201 Inglefield Land

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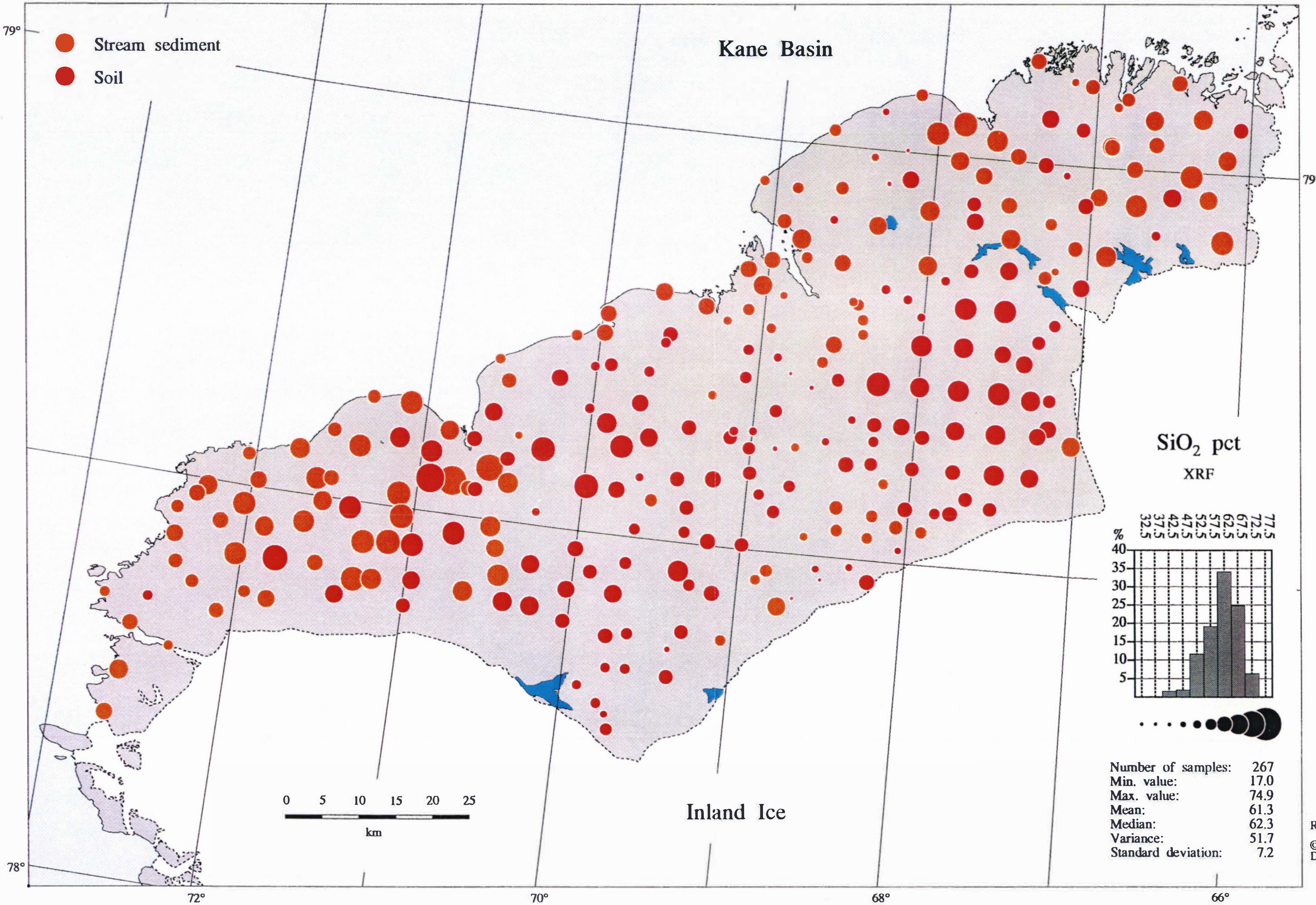

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Geochemical map: TiO_2 in stream sediment and soil

96/1 - 202 Inglefield Land

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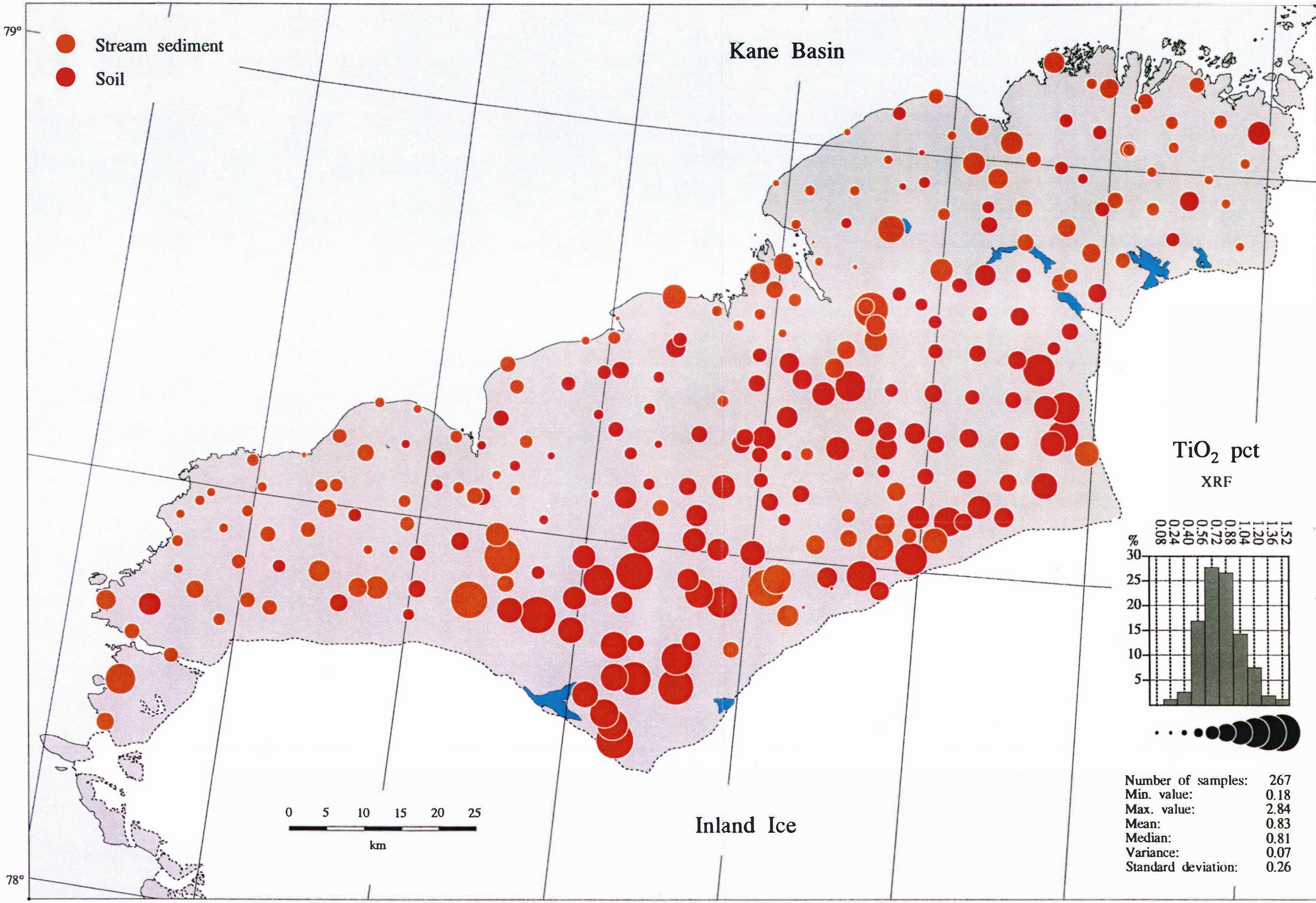

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Geochemical map: Al_2O_3 in stream sediment and soil

96/1 - 203 Inglefield Land

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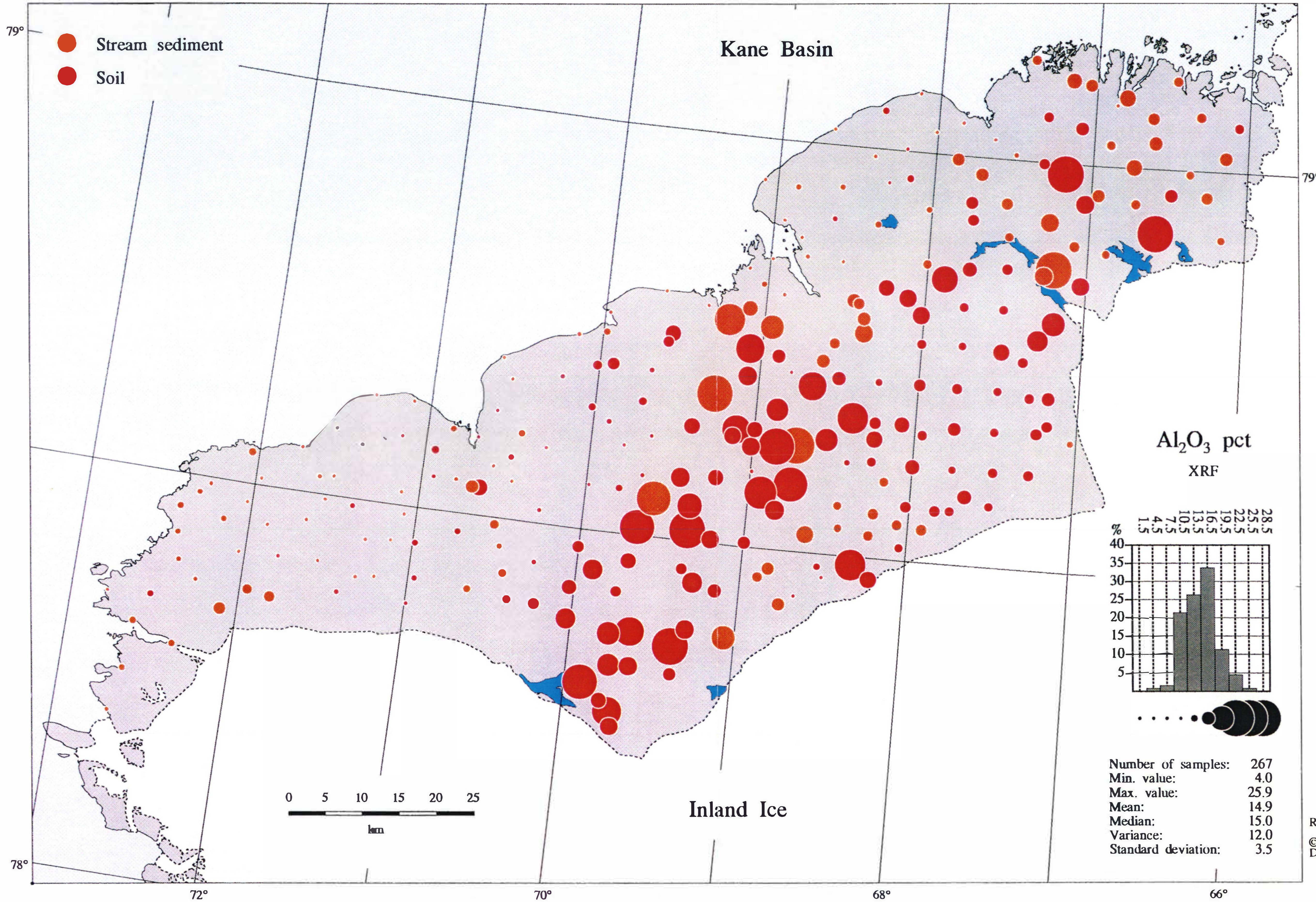

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Geochemical map: Fe_2O_3 in stream sediment and soil

96/1 - 204 Inglefield Land

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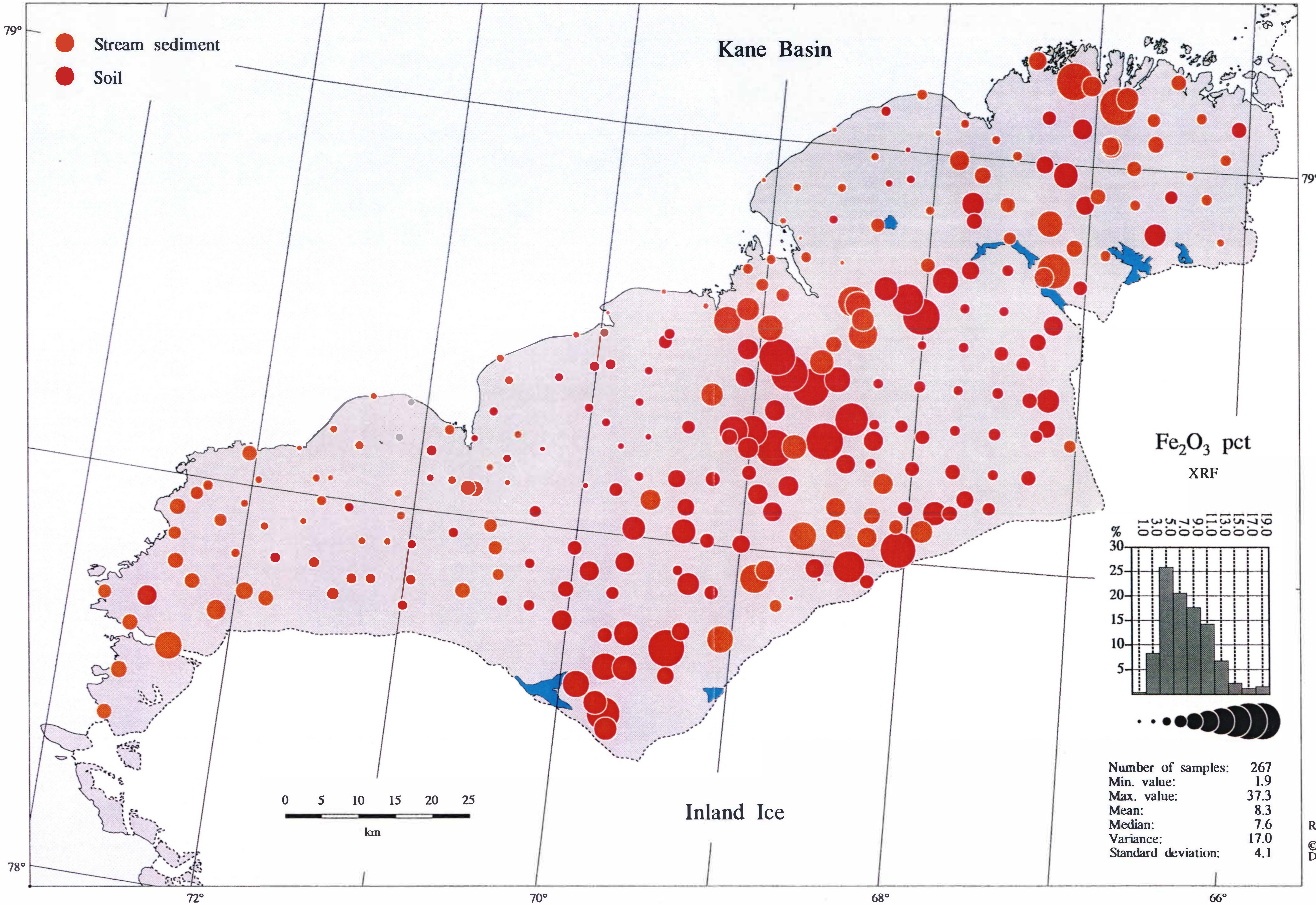

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Geochemical map: MnO in stream sediment and soil

96/1 - 205 Inglefield Land

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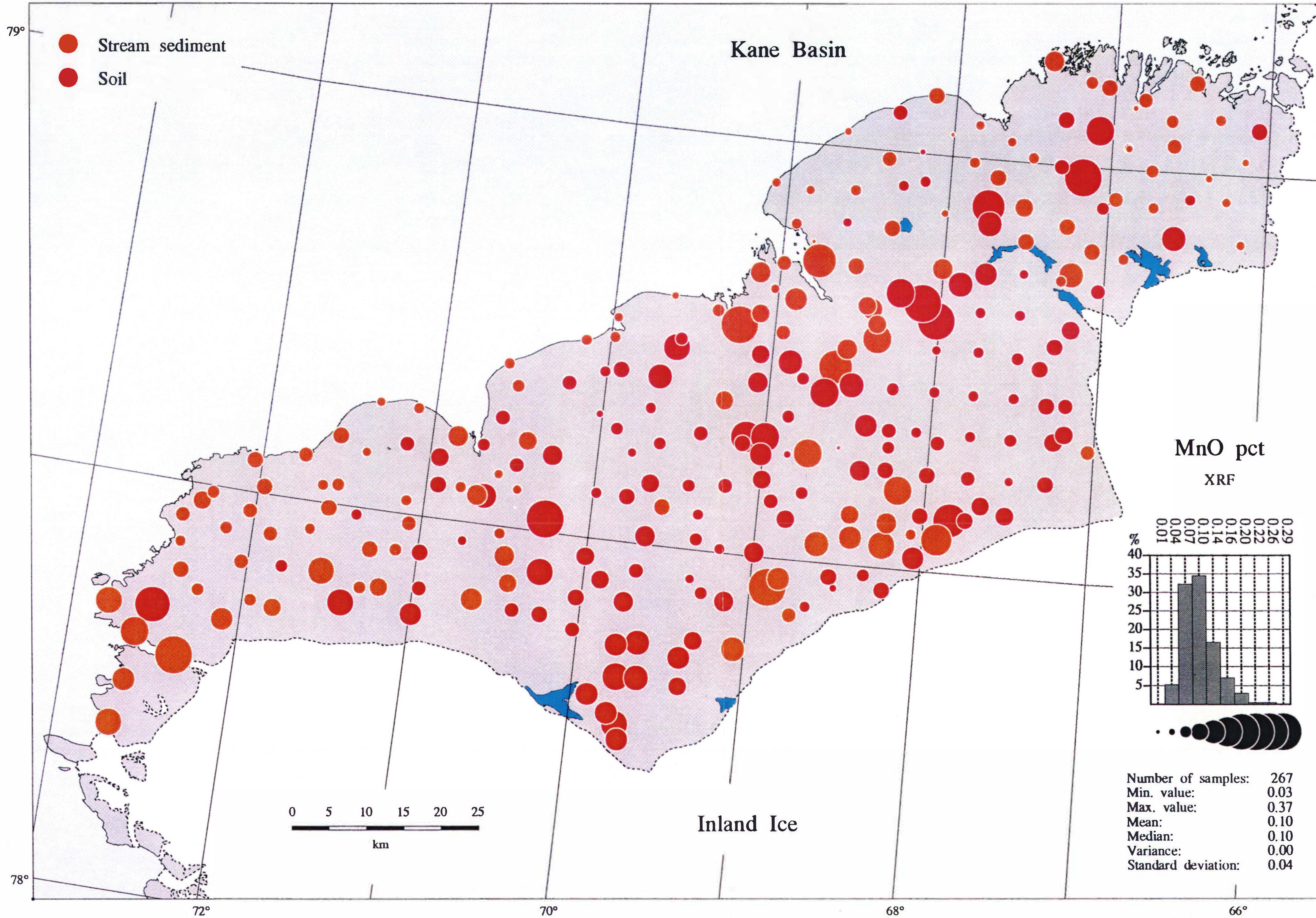

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Geochemical map: MgO in stream sediment and soil

Compiled by A. Steenfelt and E. Dam

96/1 - 206 Inglefield Land

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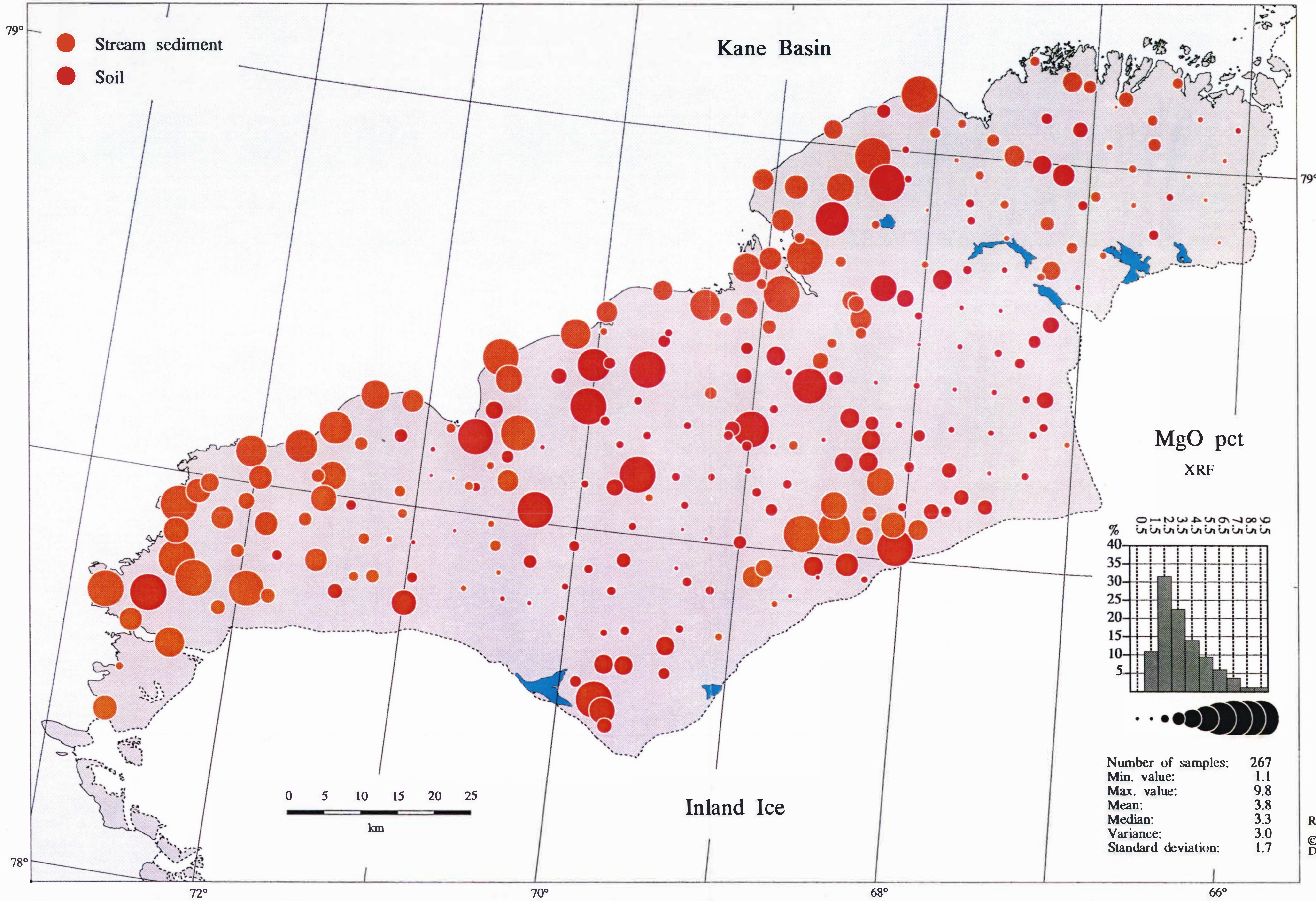

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Geochemical map: CaO in stream sediment and soil

Compiled by A. Steenfelt and E. Dam

96/1 - 207 Inglefield Land

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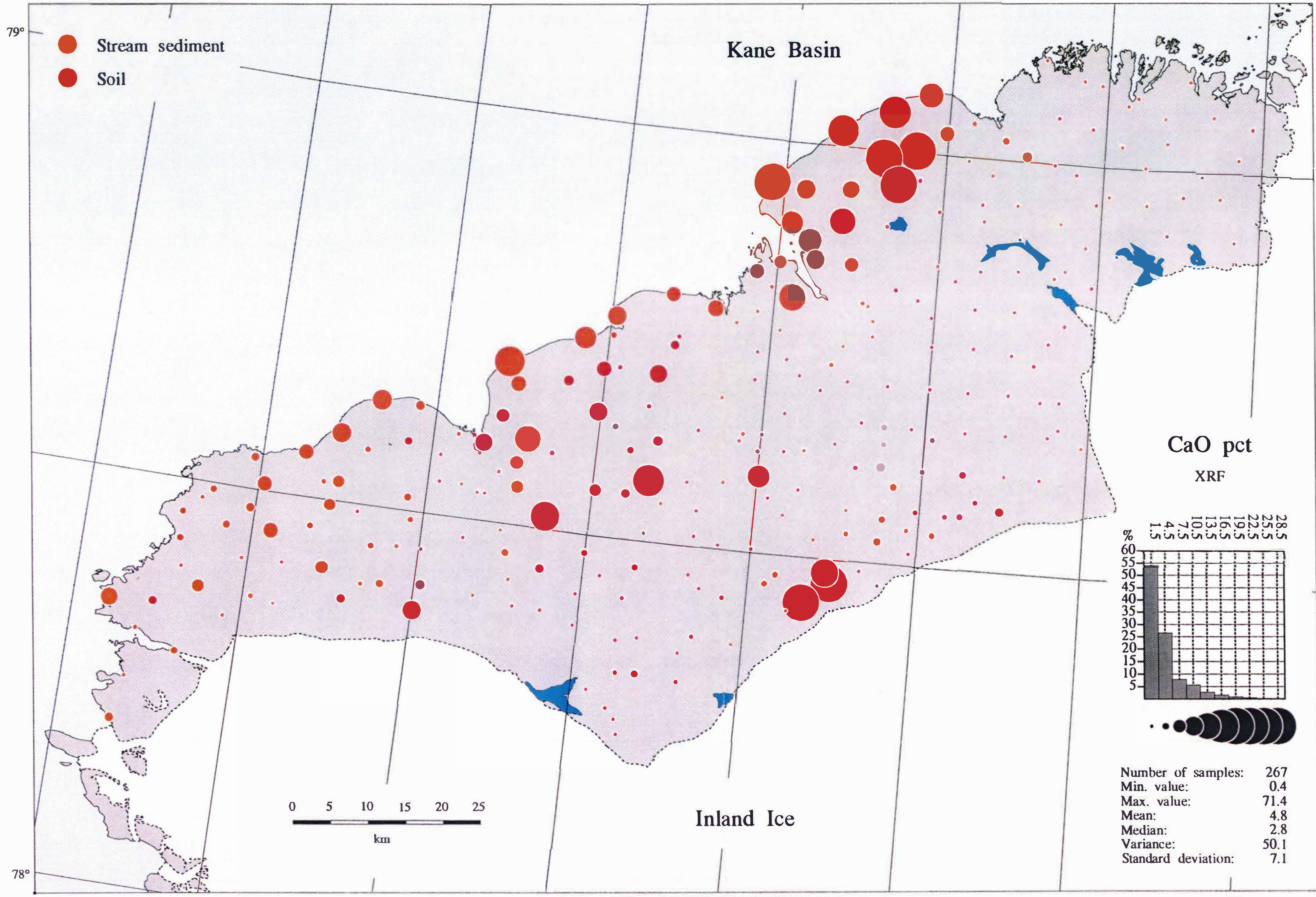

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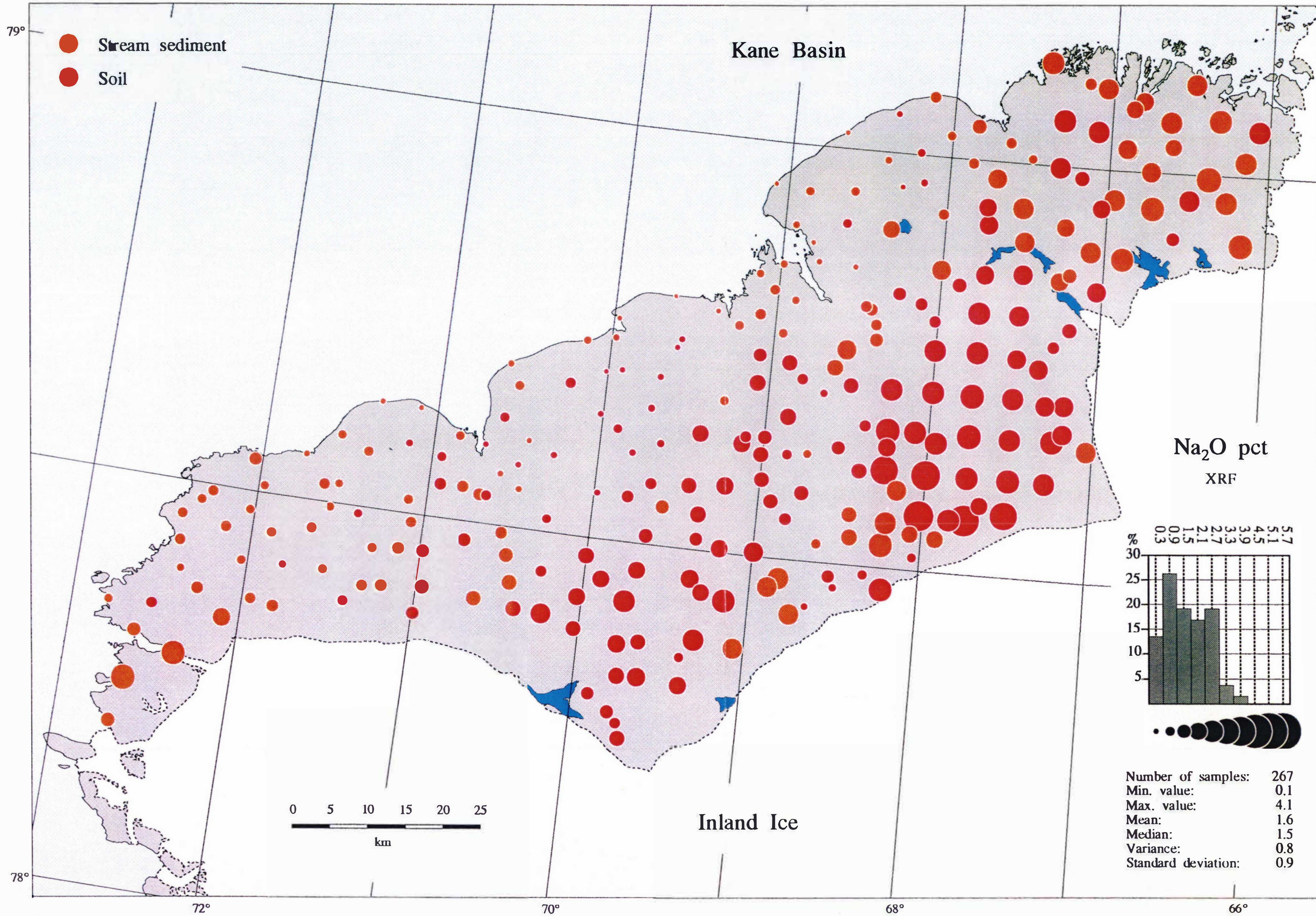
Geochemical map: Na_2O in stream sediment and soil

Compiled by A. Steenfelt and E. Dam

96/1 - 208 Inglefield Land

GEUS



Number of samples:	267
Min. value:	0.1
Max. value:	4.1
Mean:	1.6
Median:	1.5
Variance:	0.8
Standard deviation:	0.9

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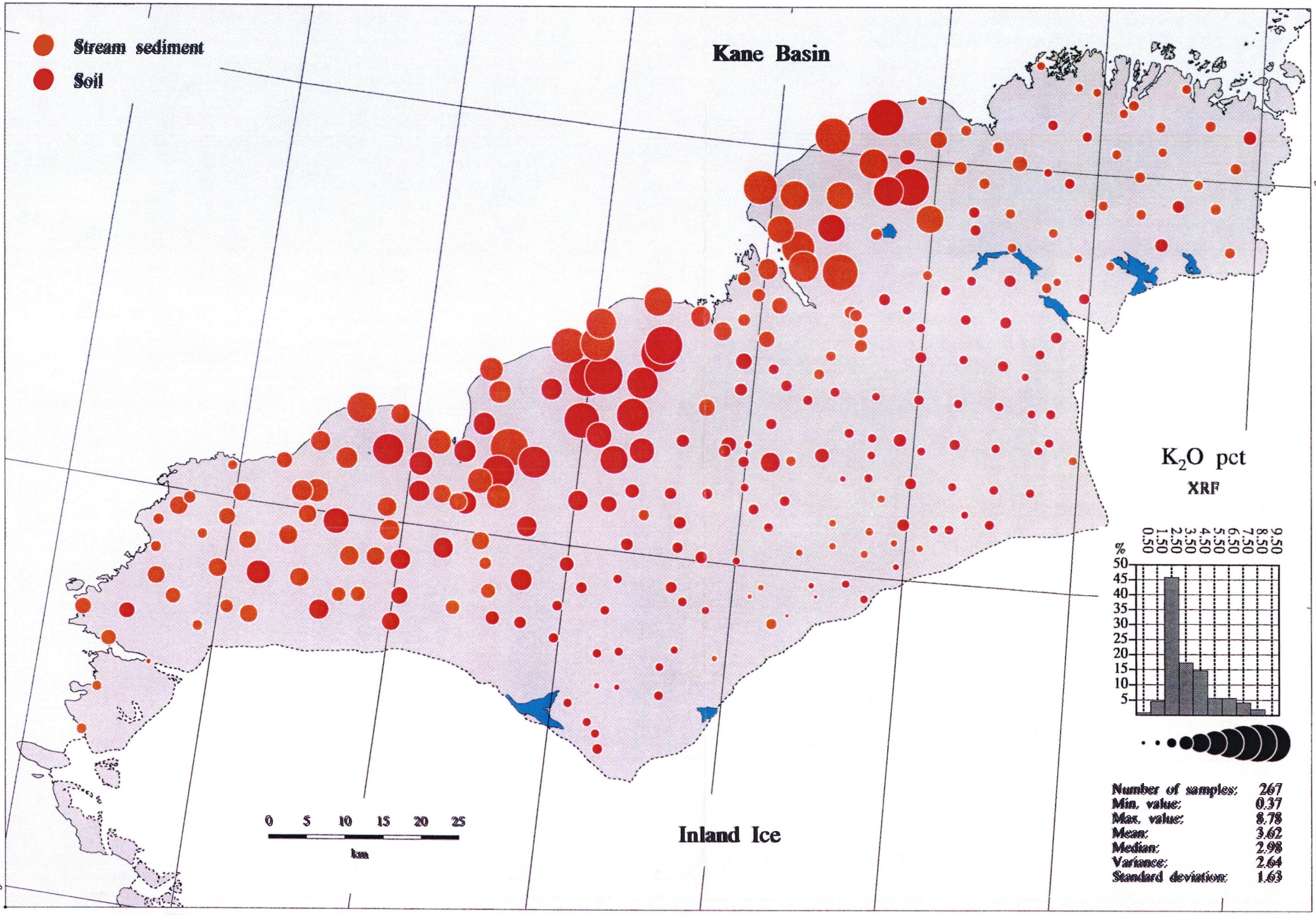
Geochemical map: K_2O in stream sediment and soil

Compiled by A. Steenfelt and E. Dam

96/1 - 209 Inglefield Land

GEUS



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Geochemical map: P_2O_5 in stream sediment and soil

96/1 - 210 Inglefield Land

Compiled by A. Steenfelt and E. Dam

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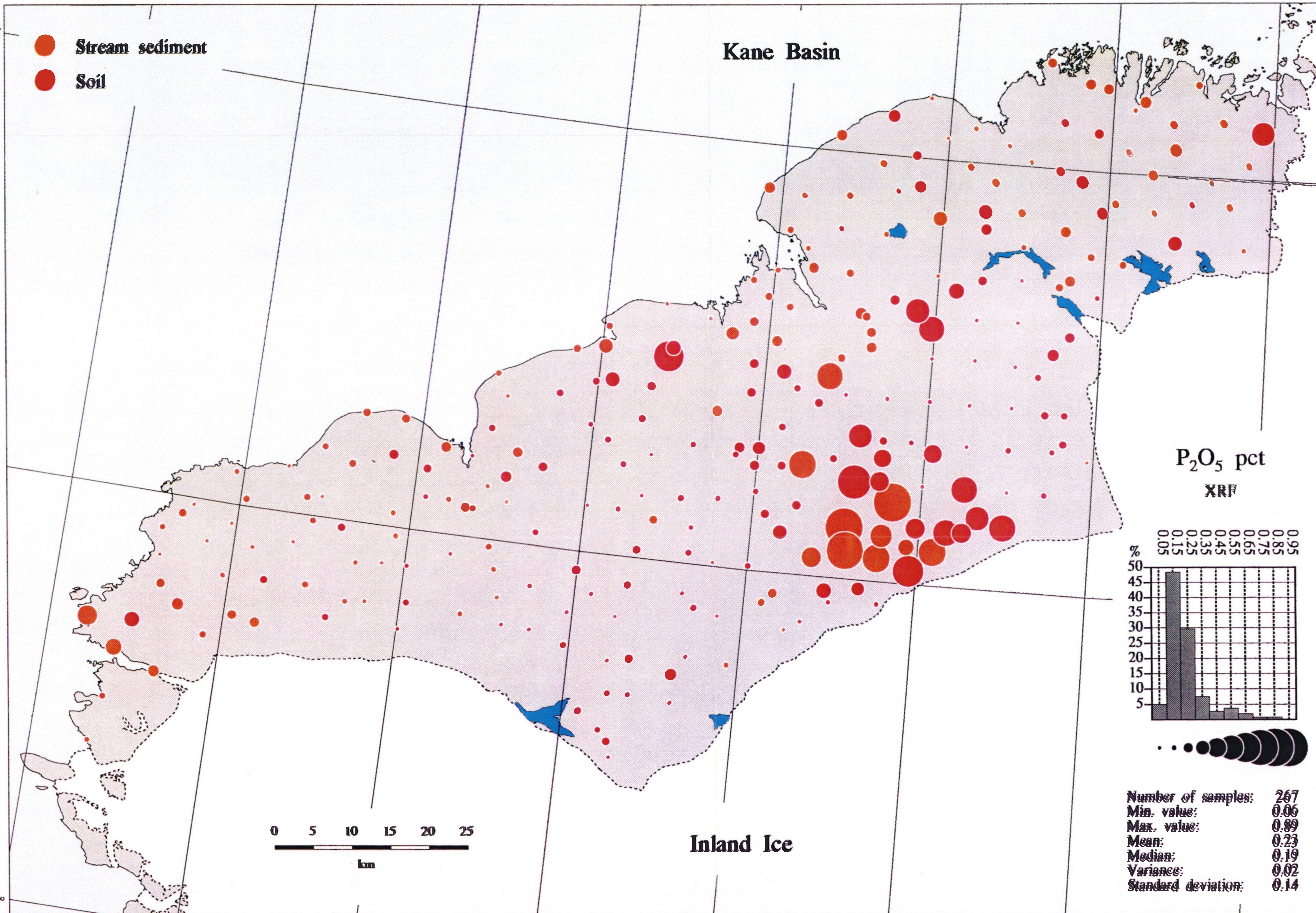

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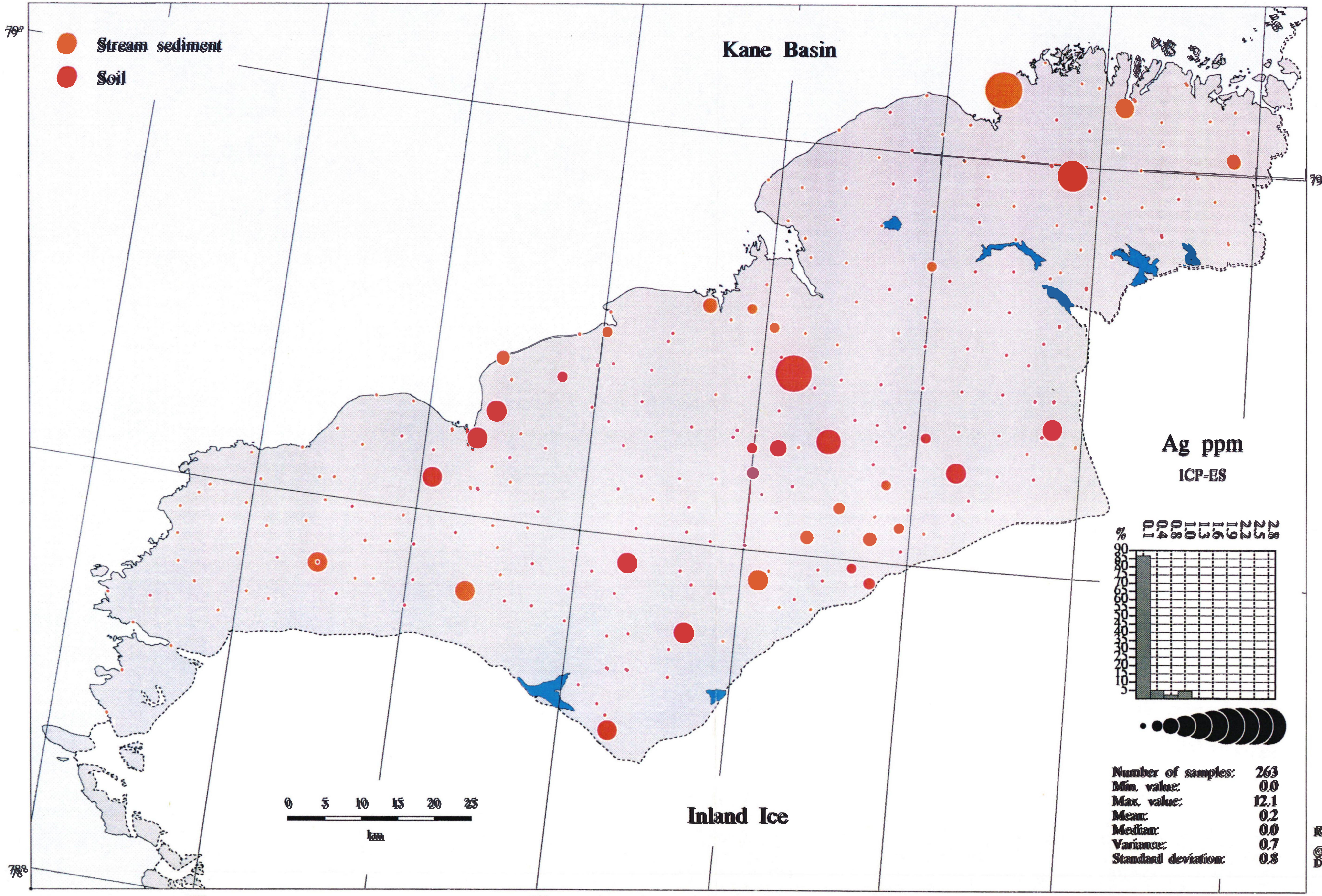
GimmeX

Geochemical map: Ag in stream sediment and soil

Compiled by A. Steenfelt and E. Dam

96/1 - 211 Inglefield Land

GEUS



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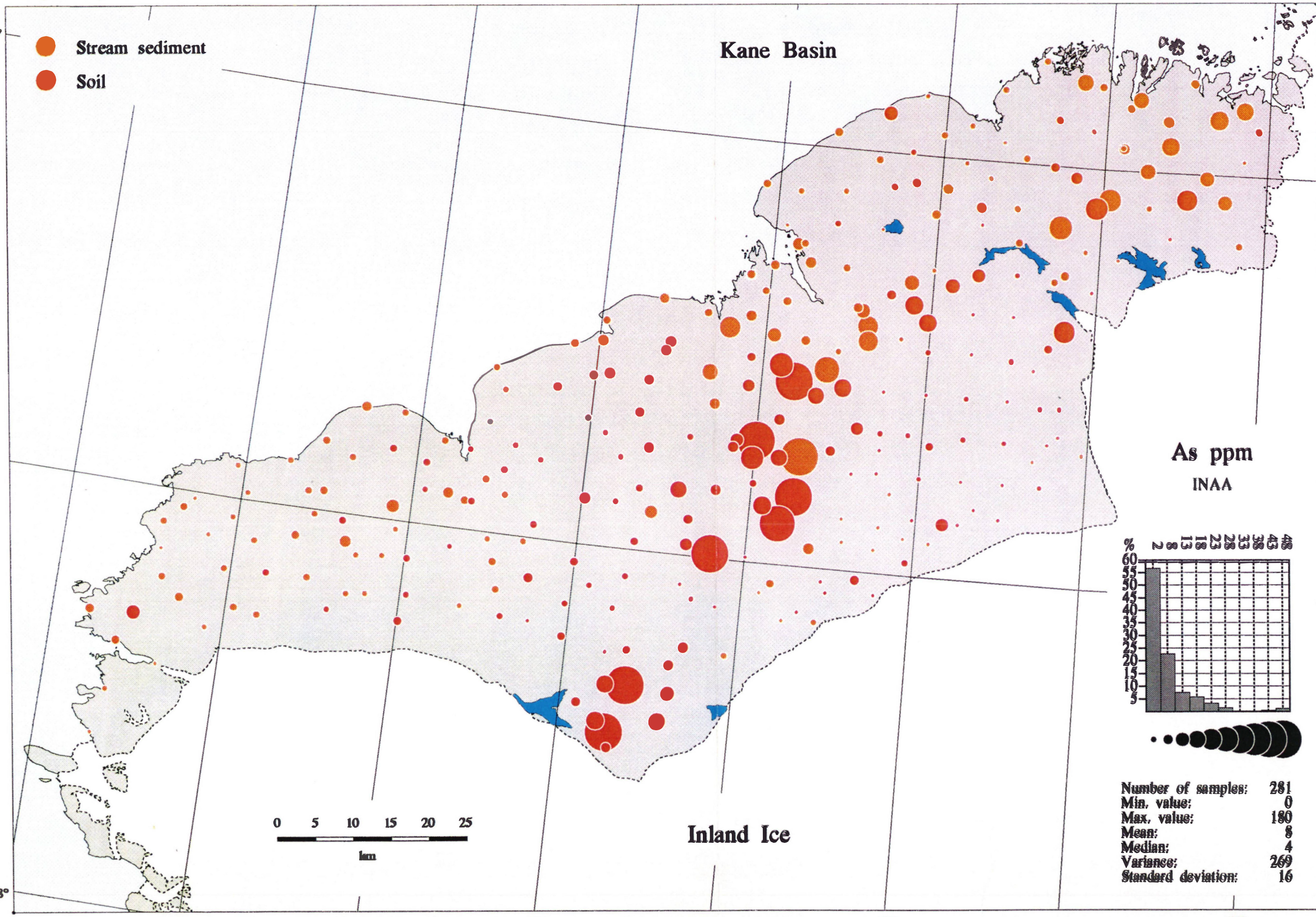
Geochemical map: As in stream sediment and soil

96/1 - 212 Inglefield Land

Compiled by A. Steenfelt and E. Dam

GEUS



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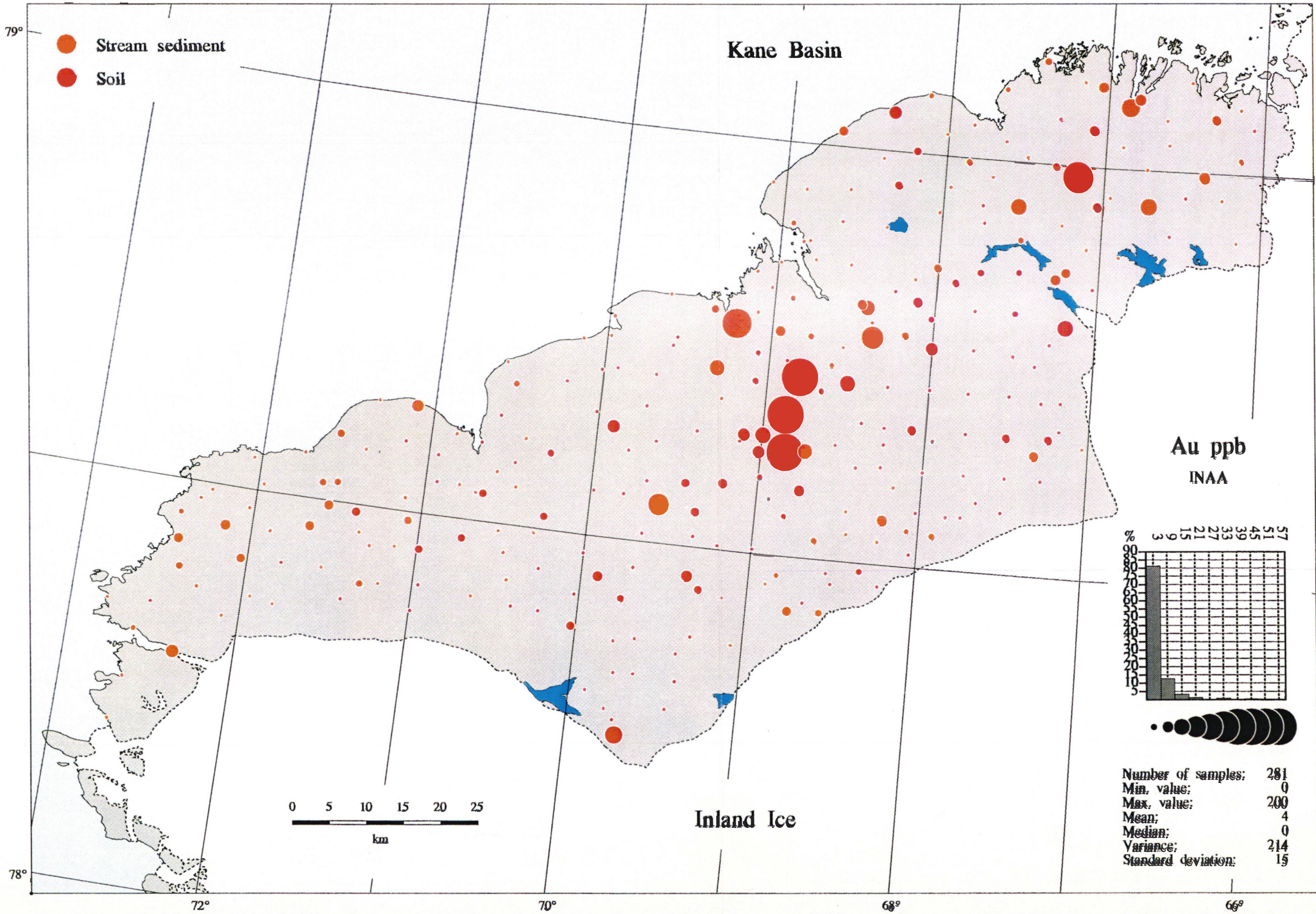
GimmeX

Geochemical map: Au in stream sediment and soil

96/1 - 213 Inglefield Land

Compiled by A. Steenfelt and E. Dam

GEUS



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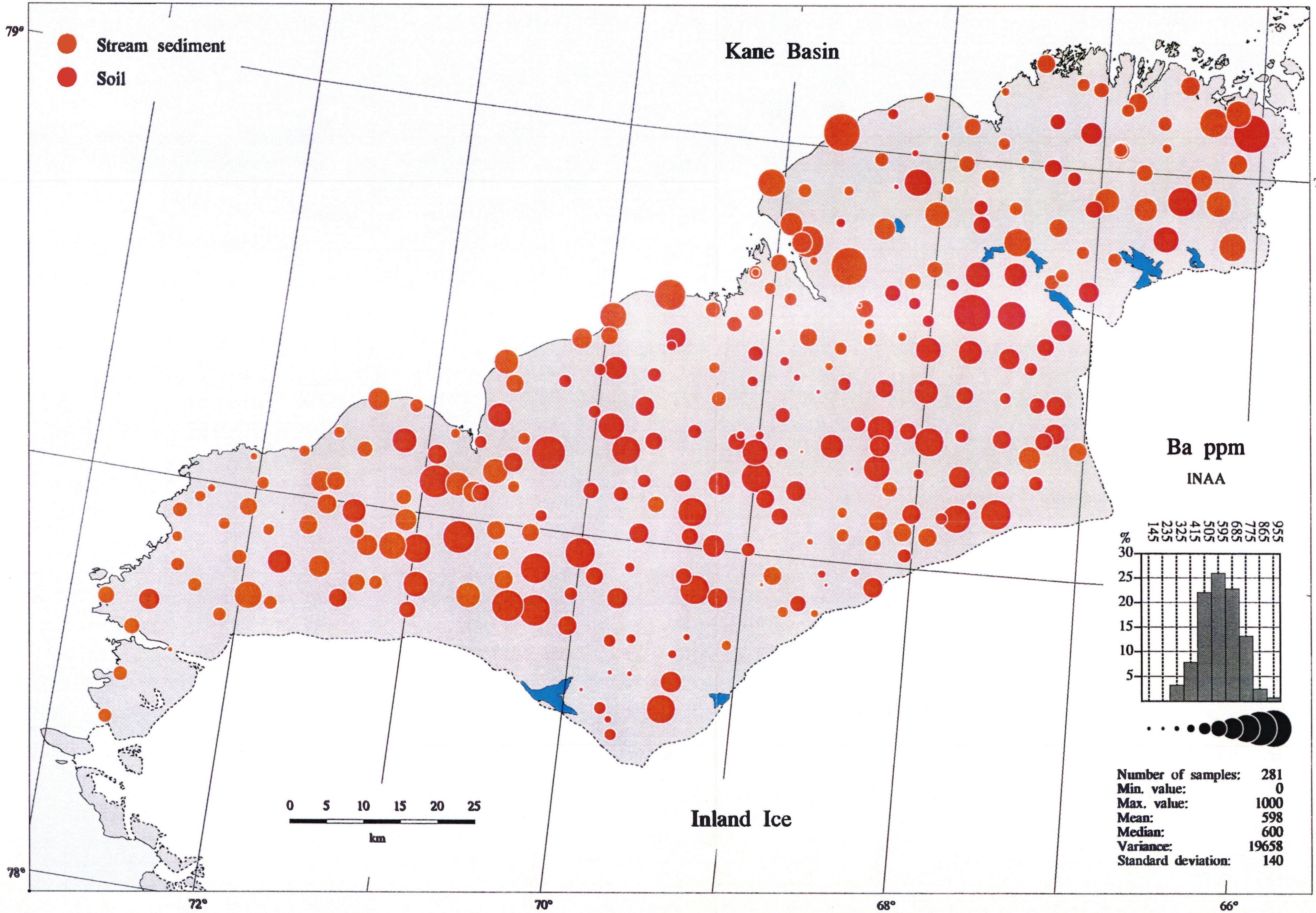
Geochemical map: Ba in stream sediment and soil

Compiled by A. Steenfelt and E. Dam

96/1 - 214 Inglefield Land

GEUS



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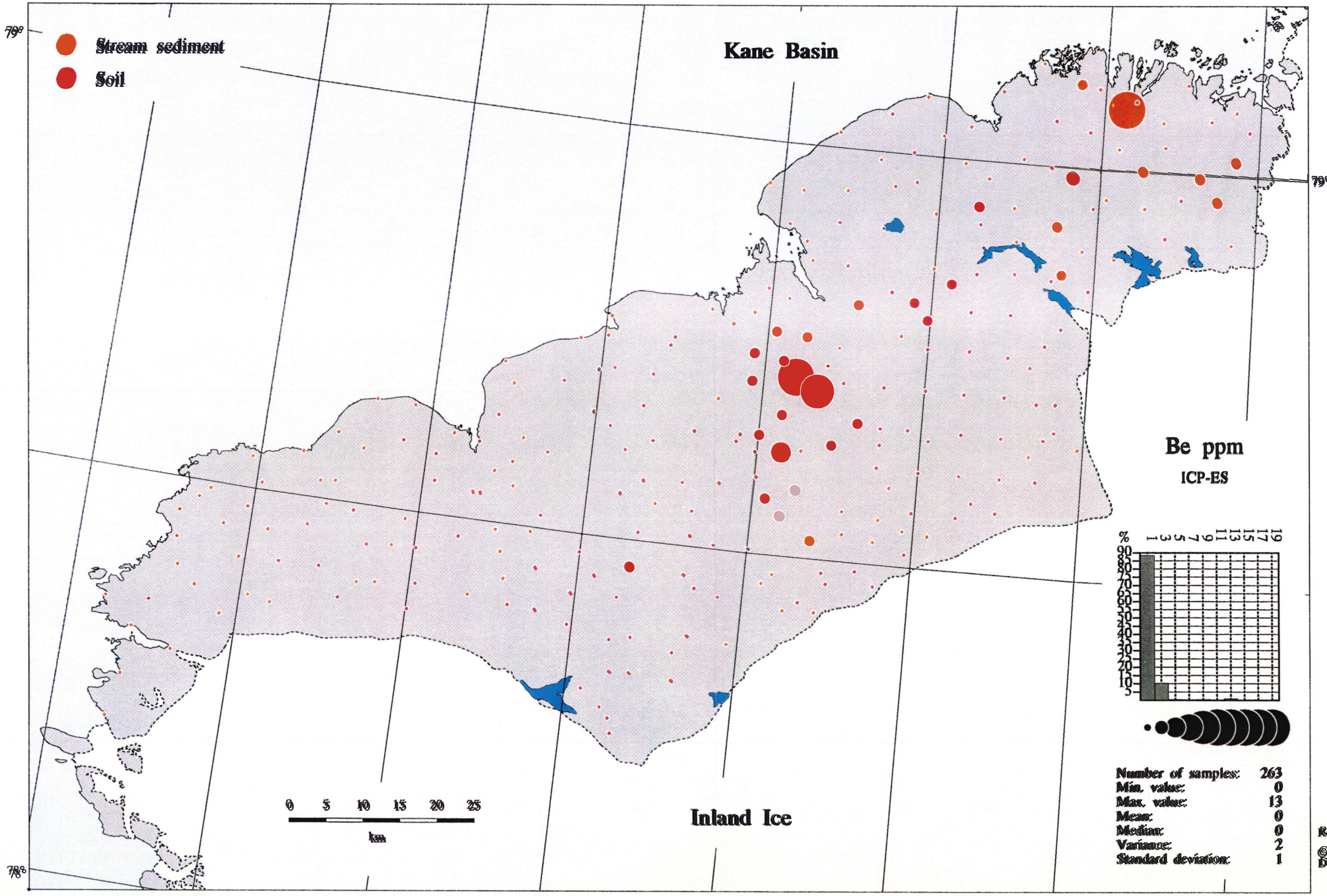
Geochemical map: Be in stream sediment and soil

Compiled by A. Steenfelt and E. Dam

96/1 - 215 Inglefield Land

GEUS



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Geochemical map: Br in stream sediment and soil

96/1 - 216 Inglefield Land

Compiled by A. Steenfelt and E. Dam

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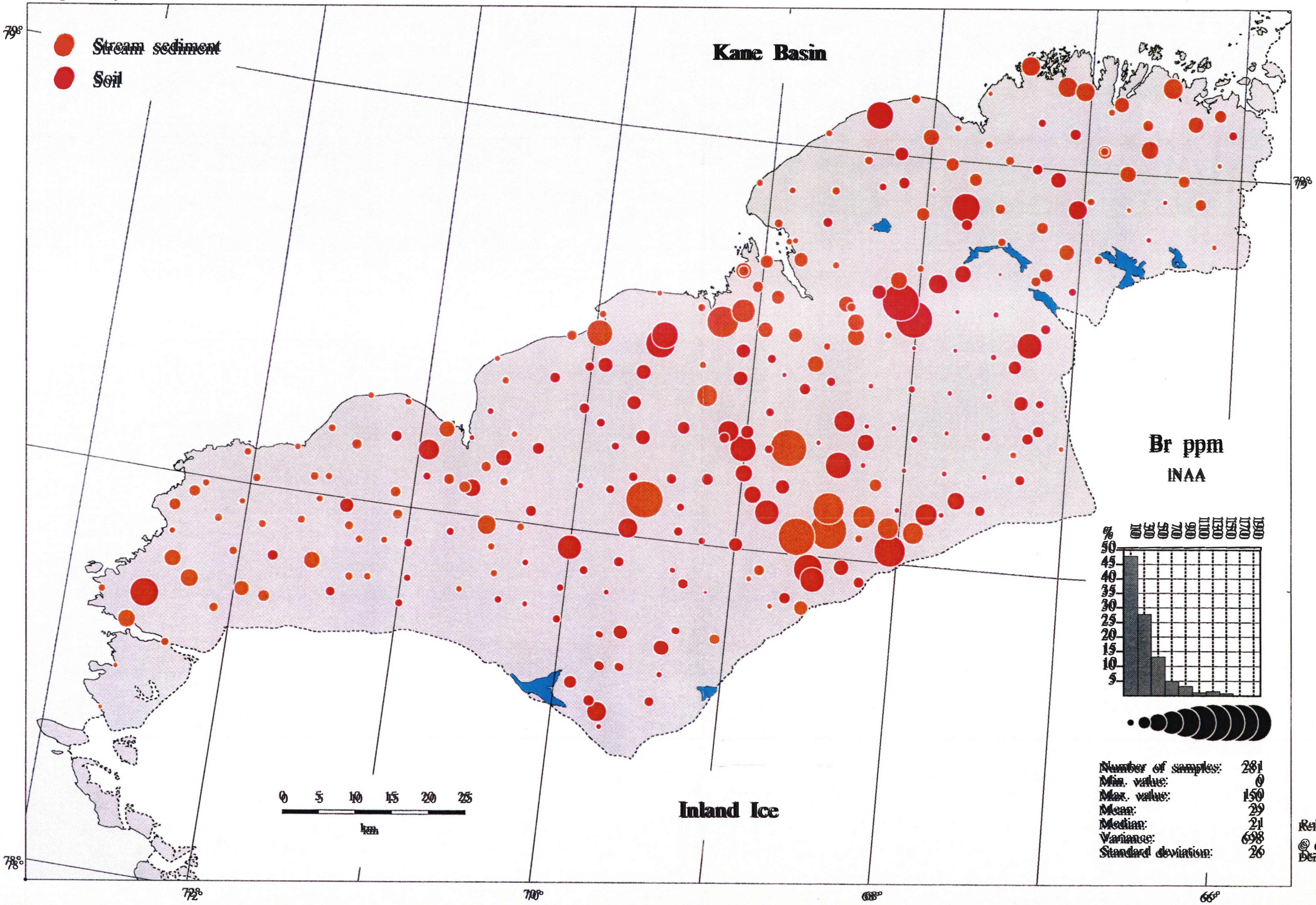

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Geochemical map: Co in stream sediment and soil

96/1 - 217 Inglefield Land

Compiled by A. Steenfelt and E. Dam

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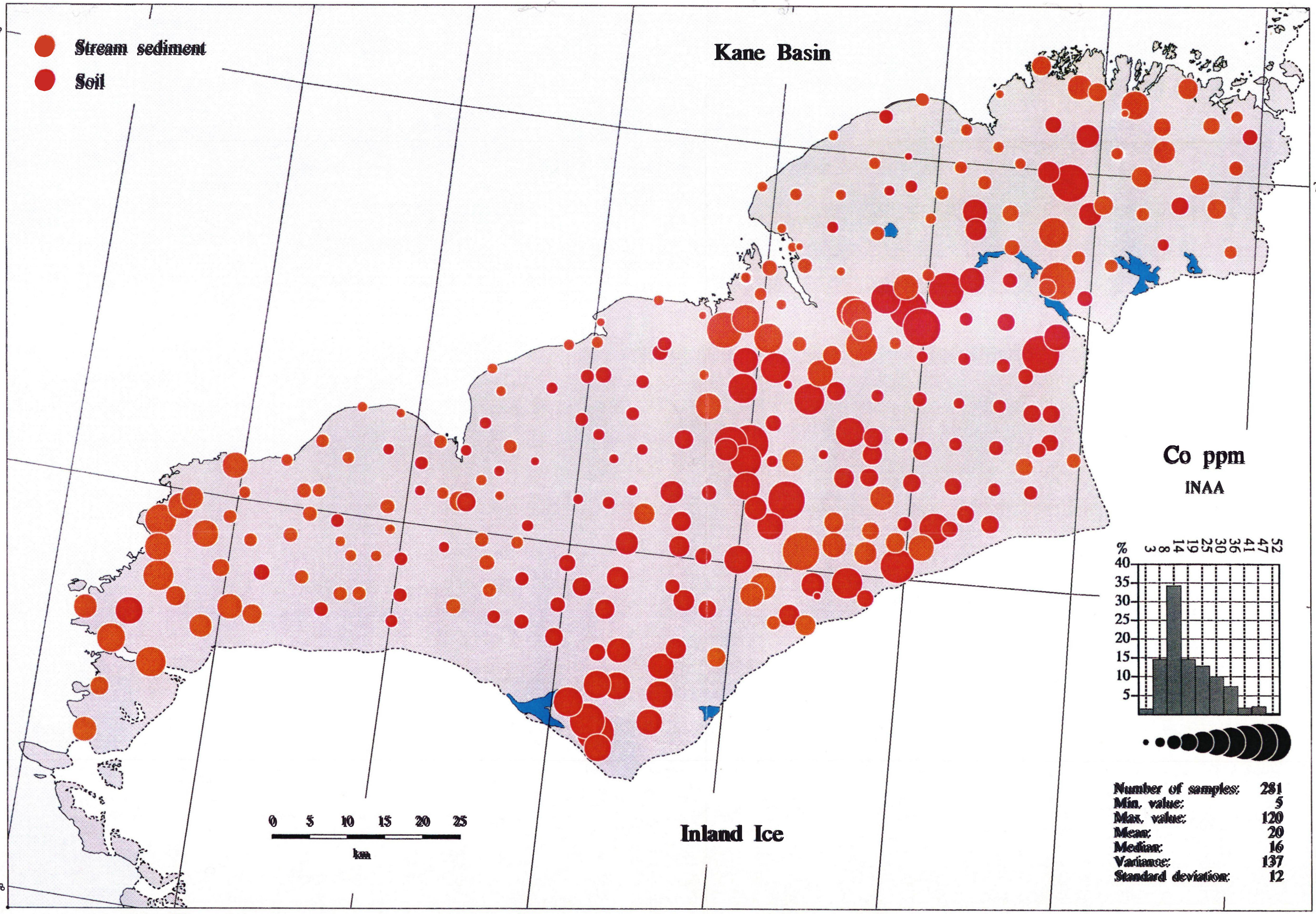

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Geochemical map: Cr in stream sediment and soil

96/1 - 218 Inglefield Land

Compiled by A. Steenfelt and E. Dam

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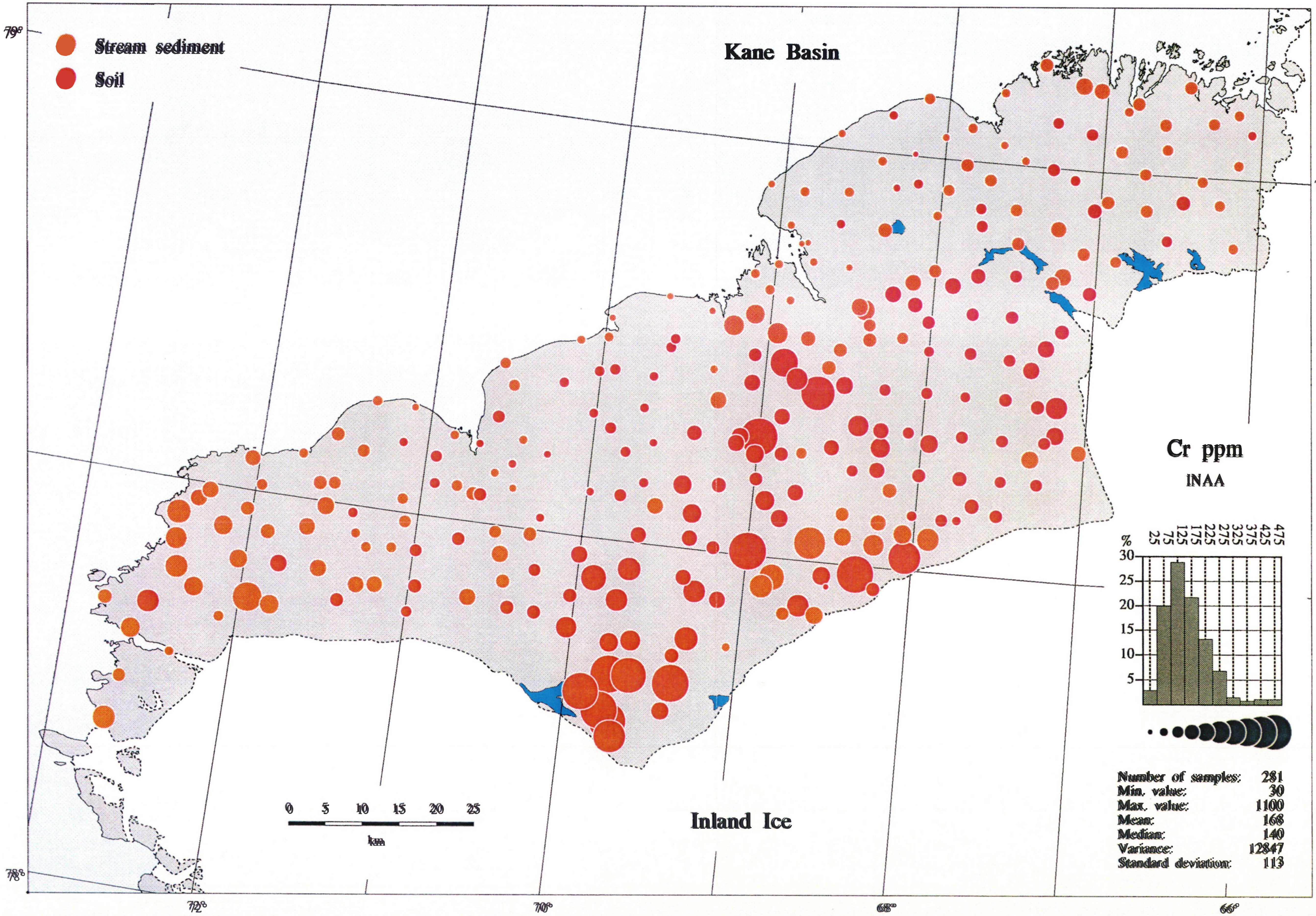

Number of samples:	281
Min. value:	30
Max. value:	1100
Mean:	168
Median:	140
Variance:	12847
Standard deviation:	113

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Geochemical map: Cu in stream sediment and soil

96/1 - 219 Inglefield Land

Compiled by A. Steenfelt and E. Dam

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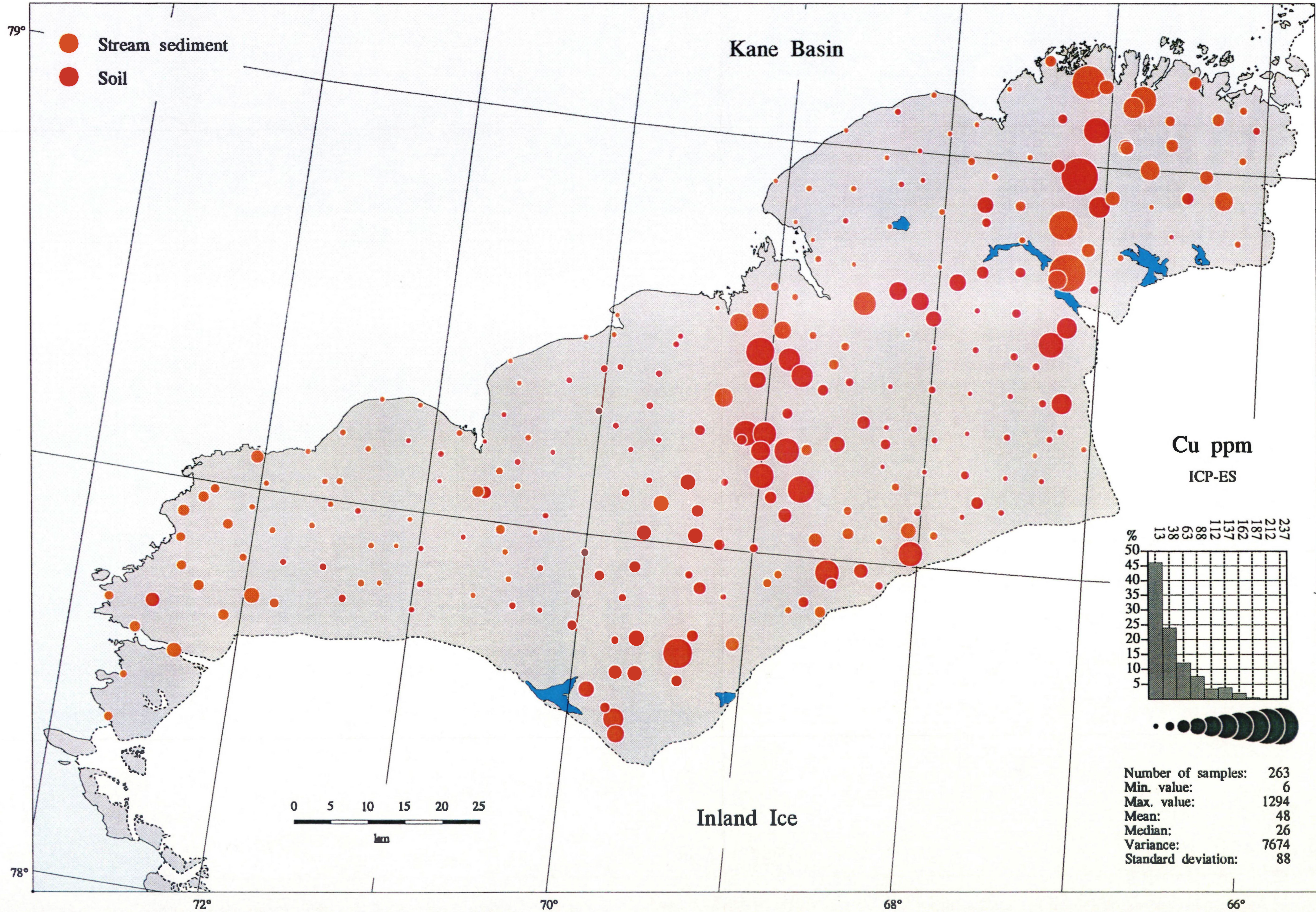

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Geochemical map: Hf in stream sediment and soil

96/1 - 220 Inglefield Land

Compiled by A. Steenfelt and E. Dam

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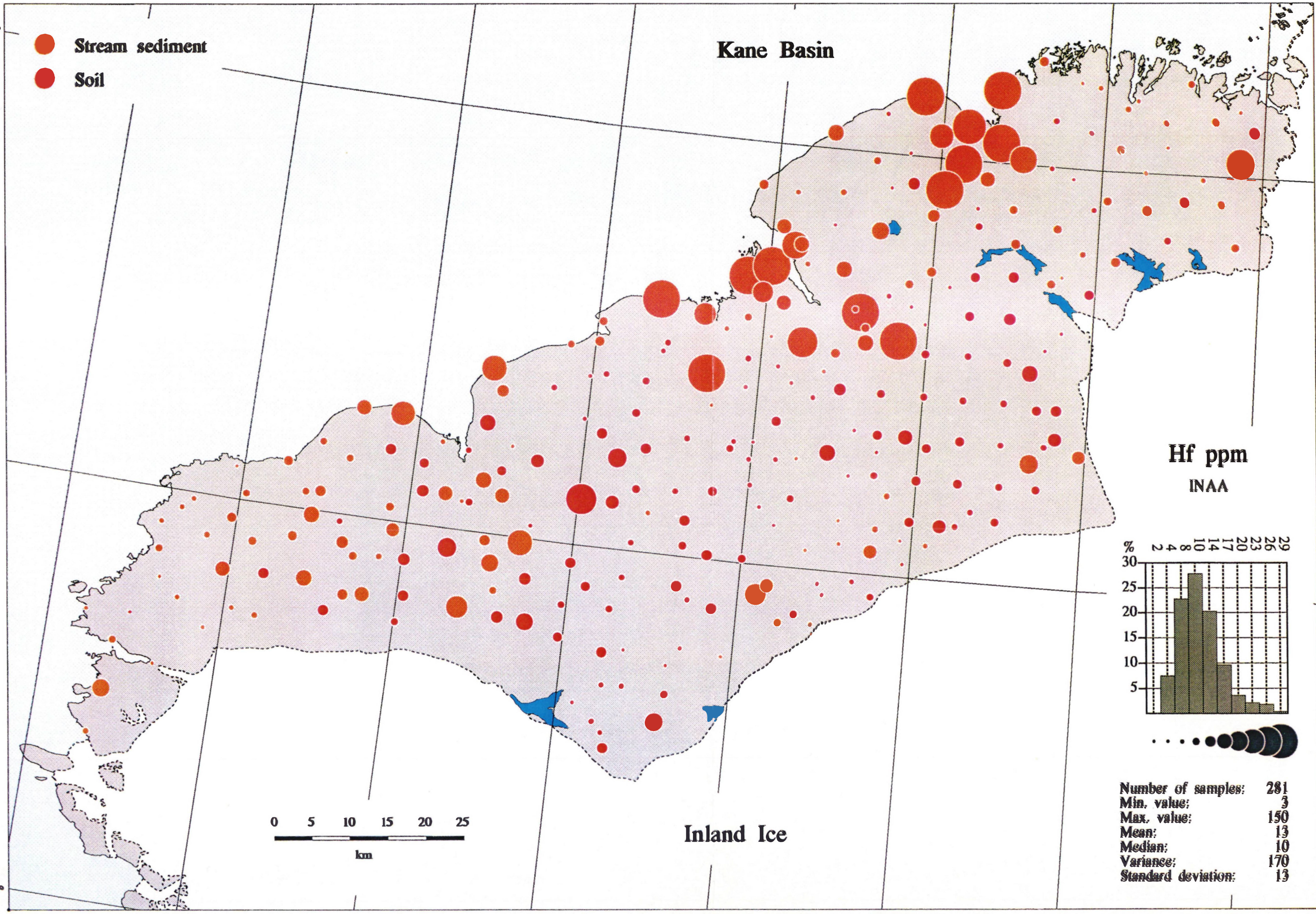

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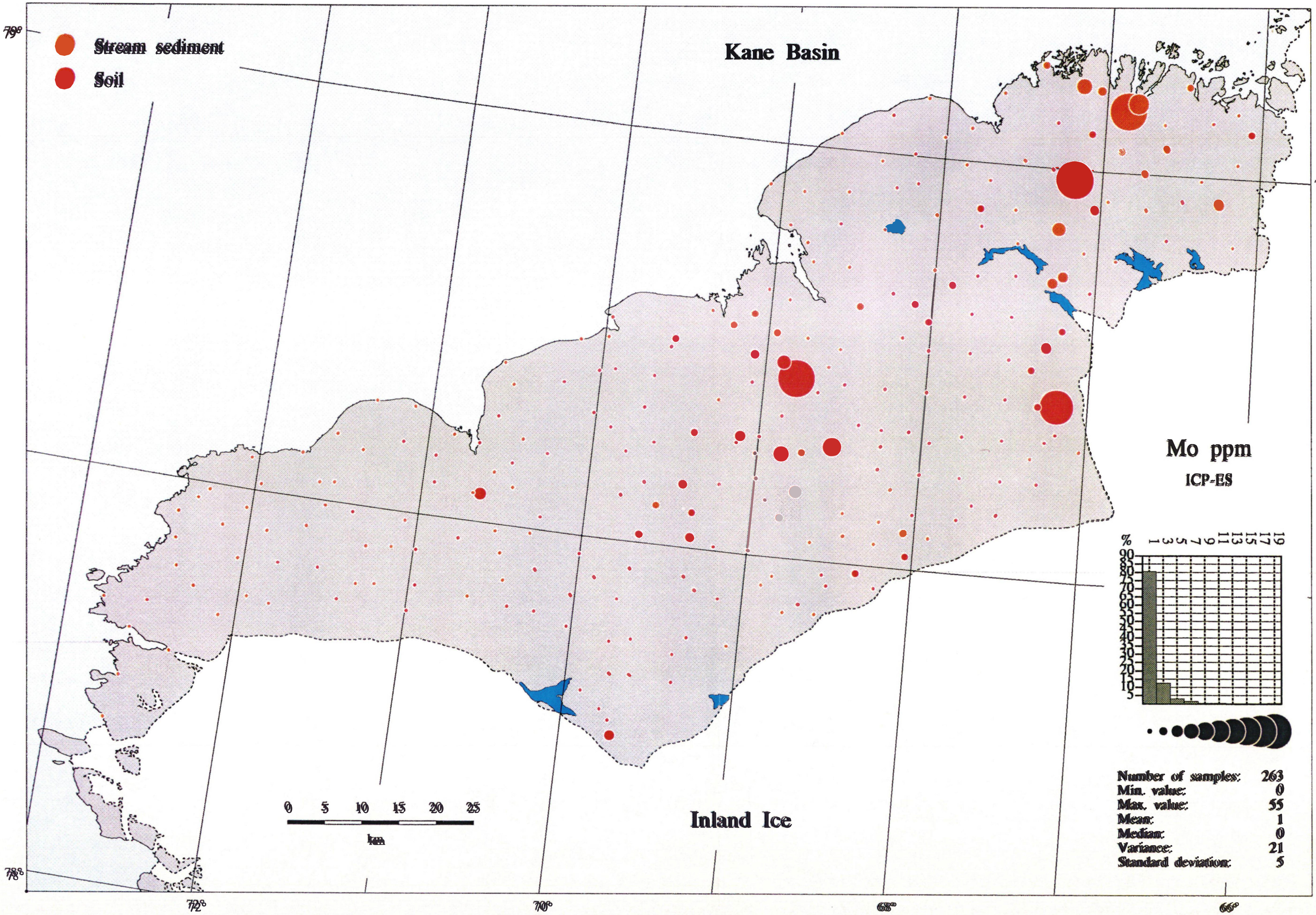
Geochemical map: Mo in stream sediment and soil

96/1 - 221 Inglefield Land

Compiled by A. Steenfelt and E. Dam



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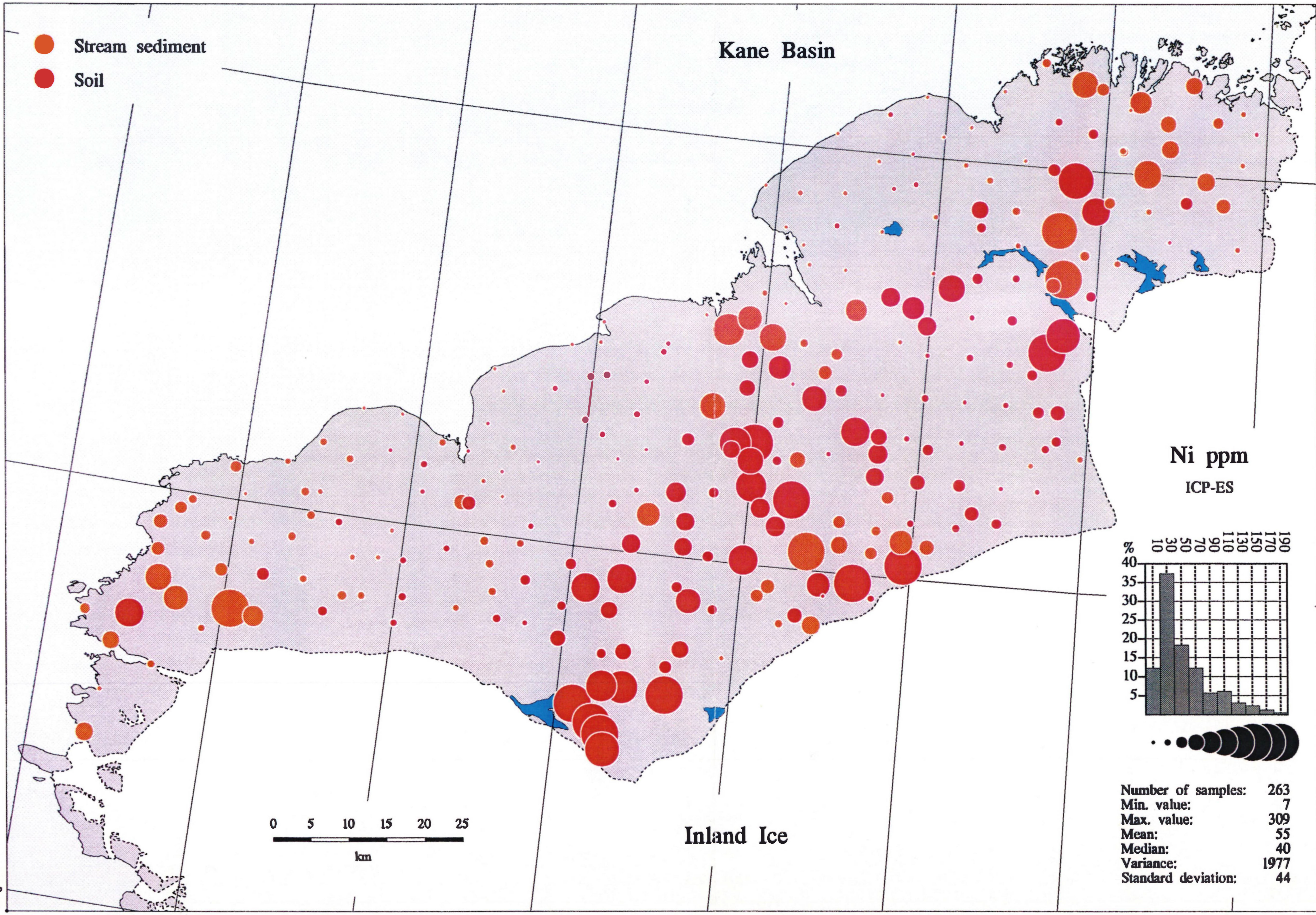
Geochemical map: Ni in stream sediment and soil

96/1 - 222 Inglefield Land

Compiled by A. Steenfelt and E. Dam



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Geochemical map: Pb in stream sediment and soil

96/1 - 223 Inglefield Land

Compiled by A. Steenfelt and E. Dam

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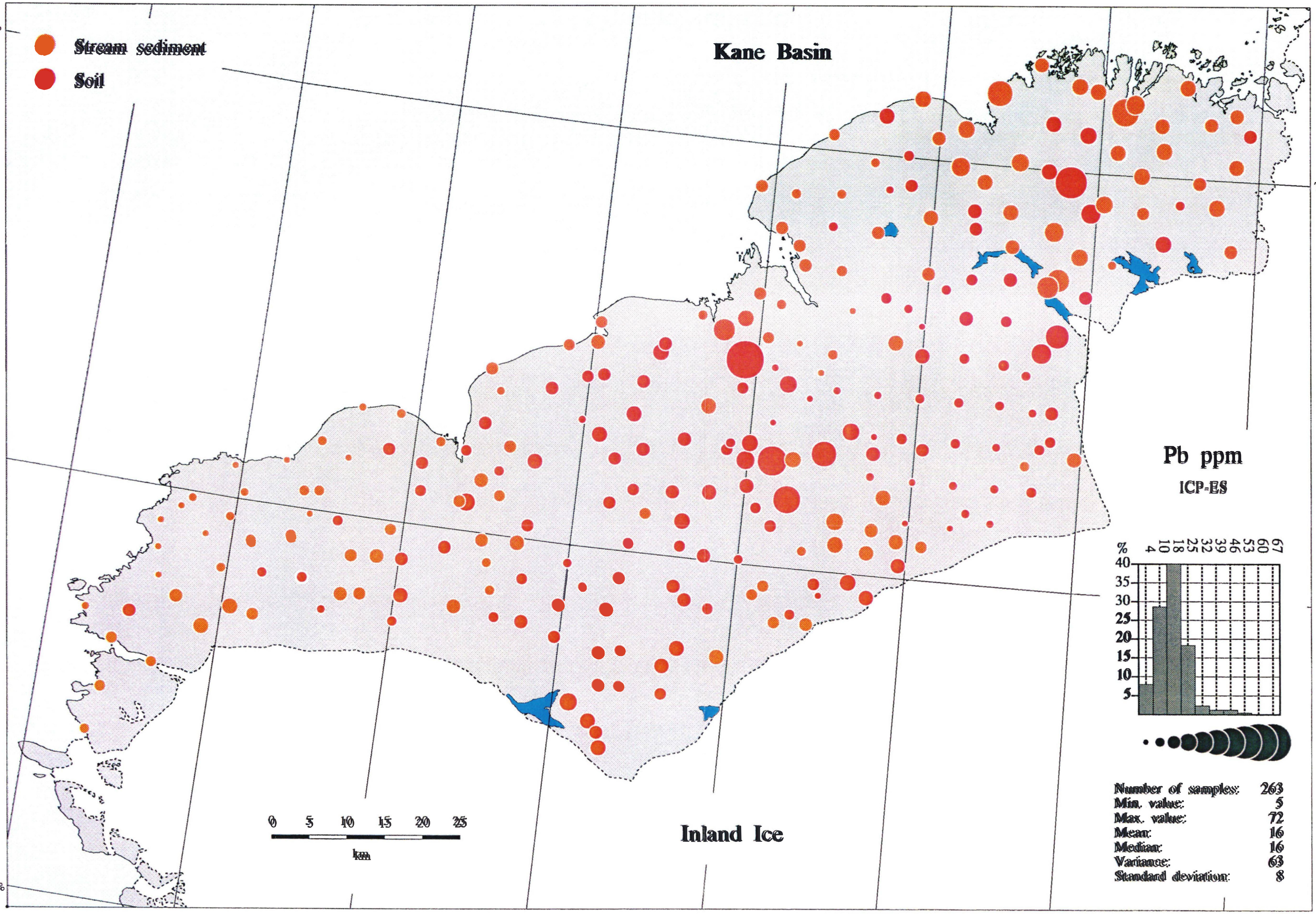

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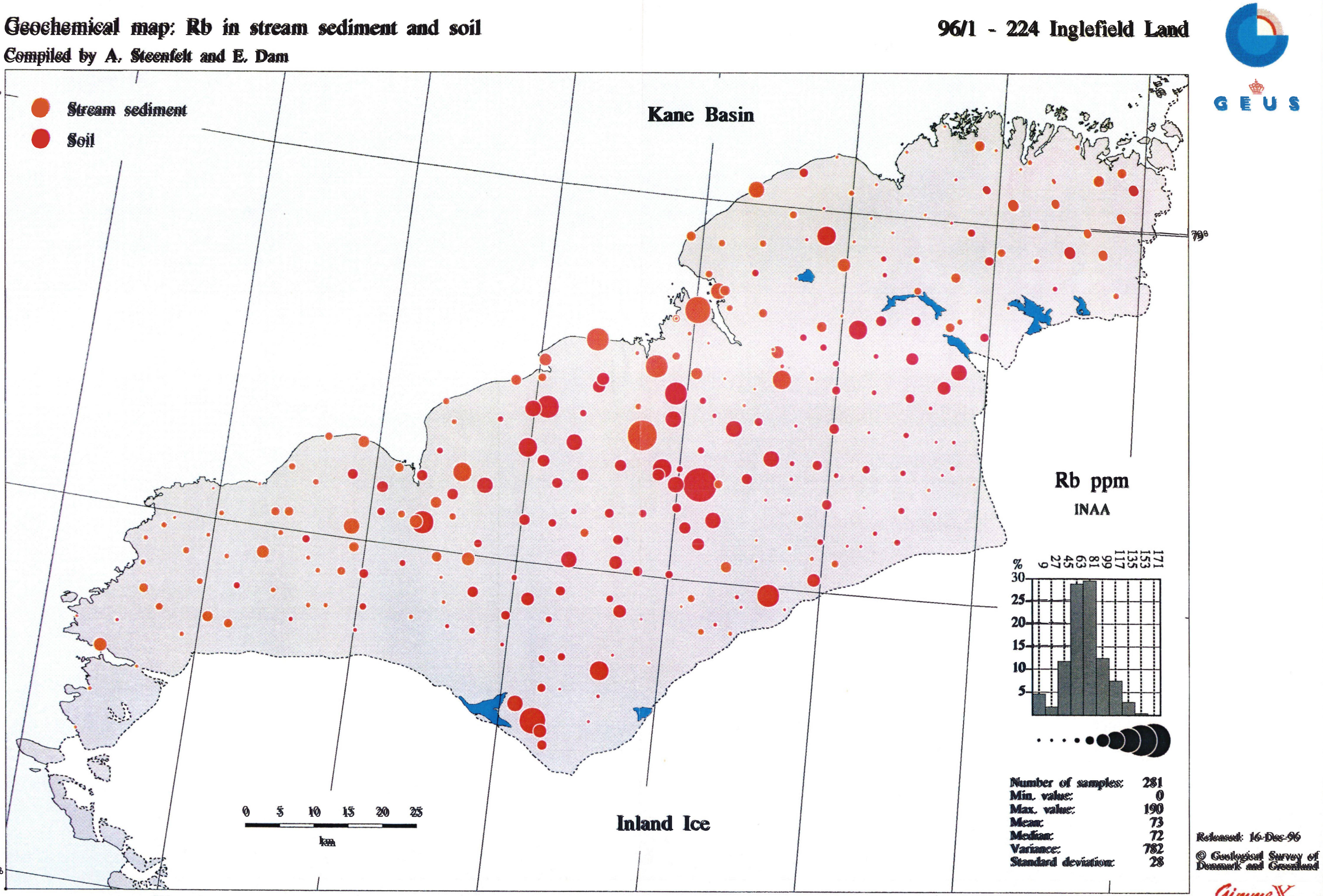
Geochemical map: Rb in stream sediment and soil

Compiled by A. Steenfelt and E. Dam

96/1 - 224 Inglefield Land



Number of samples:	281
Min. value:	0
Max. value:	190
Mean:	73
Median:	72
Variance:	782
Standard deviation:	28

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Geochemical map: Sb in stream sediment and soil

96/1 - 225 Inglefield Land

Compiled by A. Steenfelt and E. Dam

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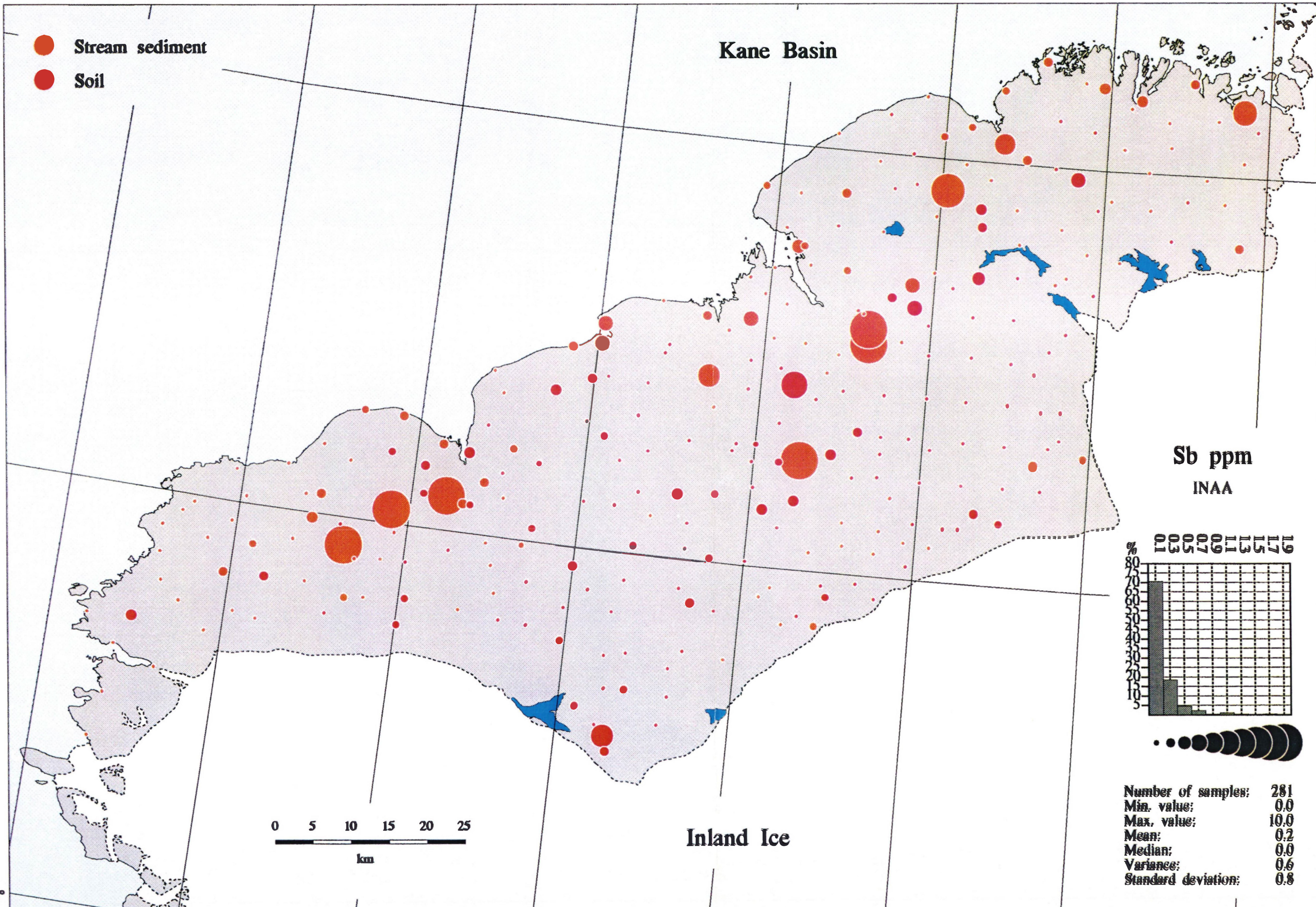

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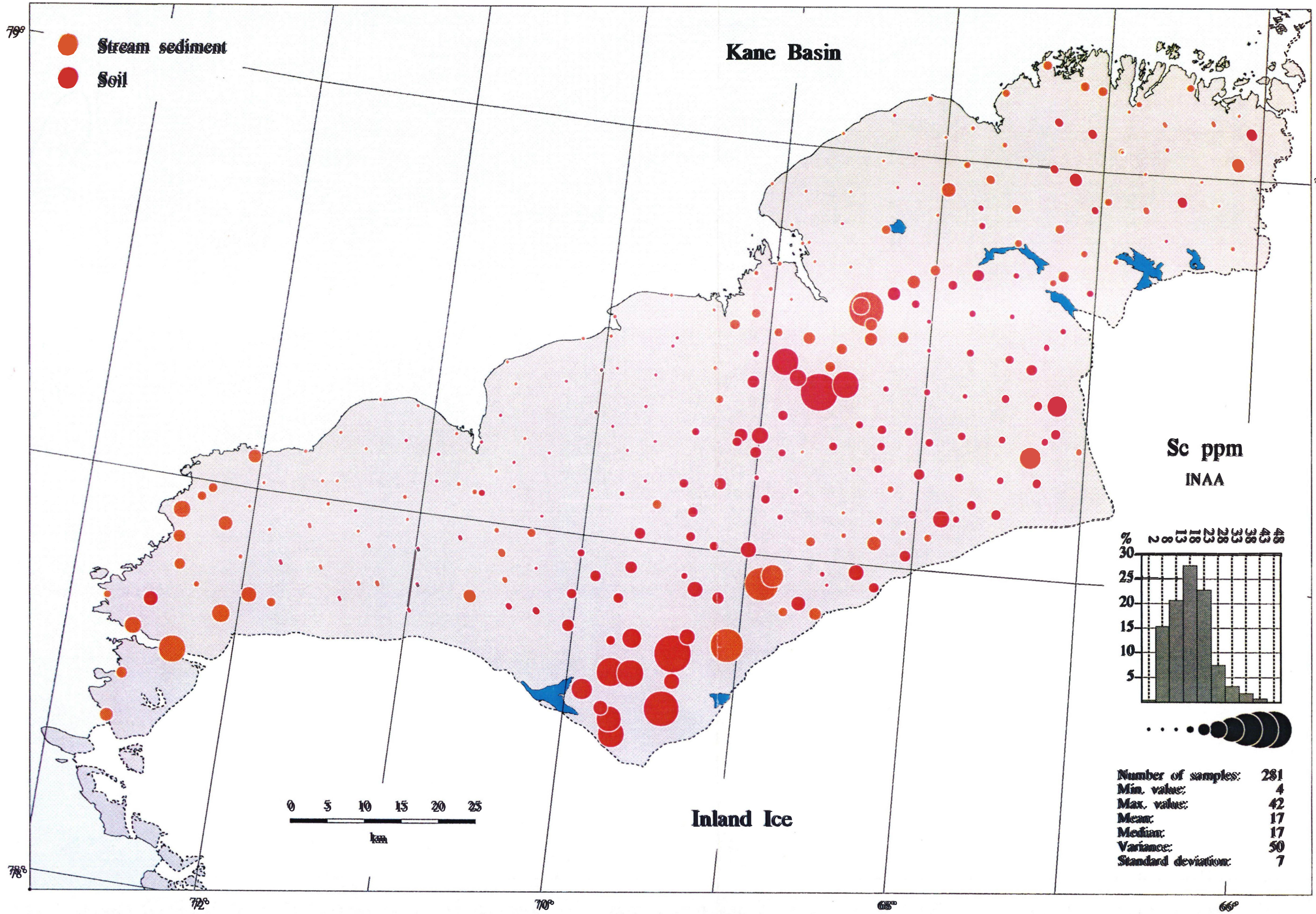
Geochemical map: Sc in stream sediment and soil

Compiled by A. Steenfelt and E. Dam

96/1 - 226 Inglefield Land

GEUS



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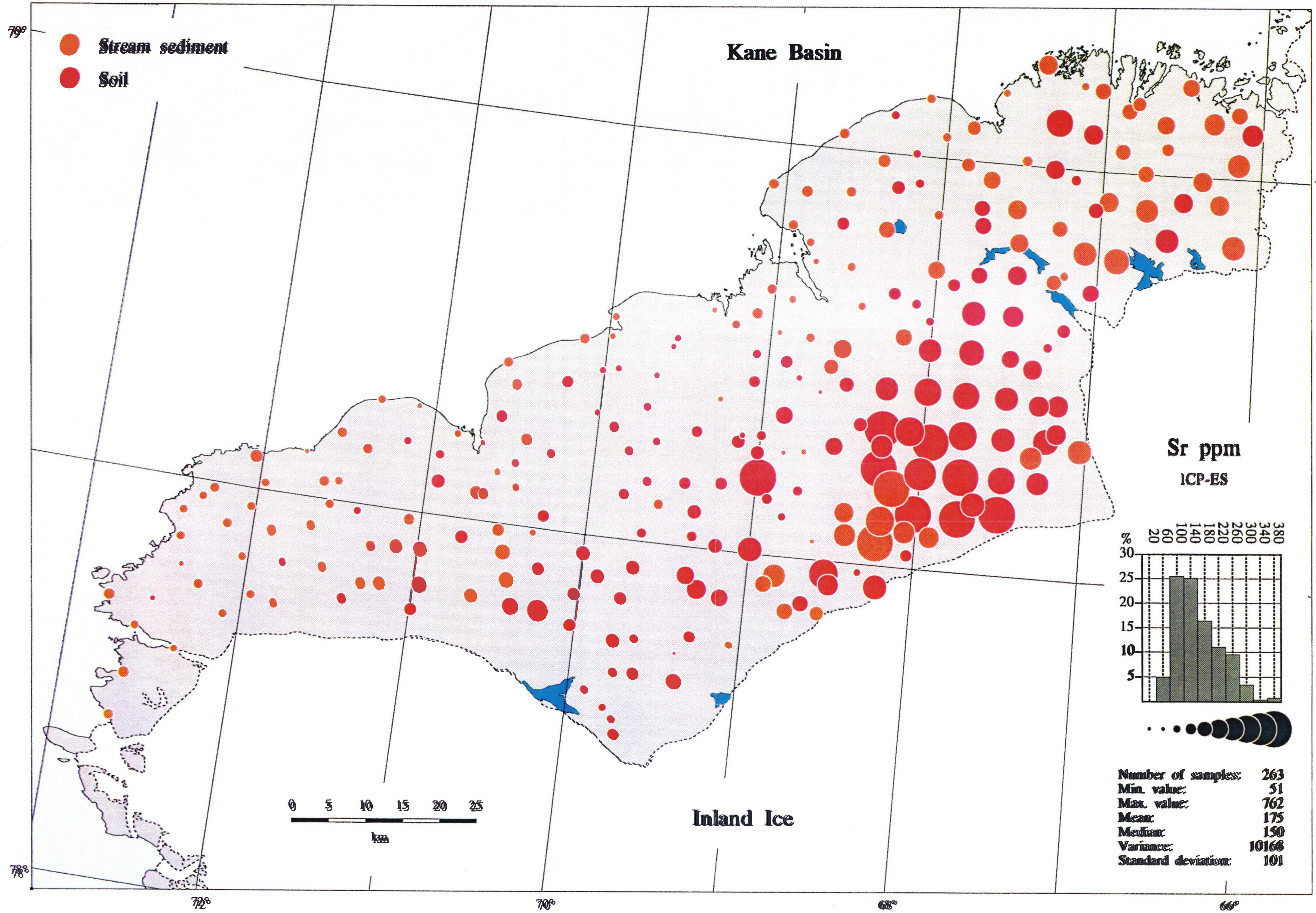
Geochemical map: Sr in stream sediment and soil

96/1 - 227 Inglefield Land

Compiled by A. Steenfelt and E. Dam

GEUS



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Geochemical map: Ta in stream sediment and soil

Compiled by A. Steenfelt and E. Dam

96/1 - 228 Inglefield Land

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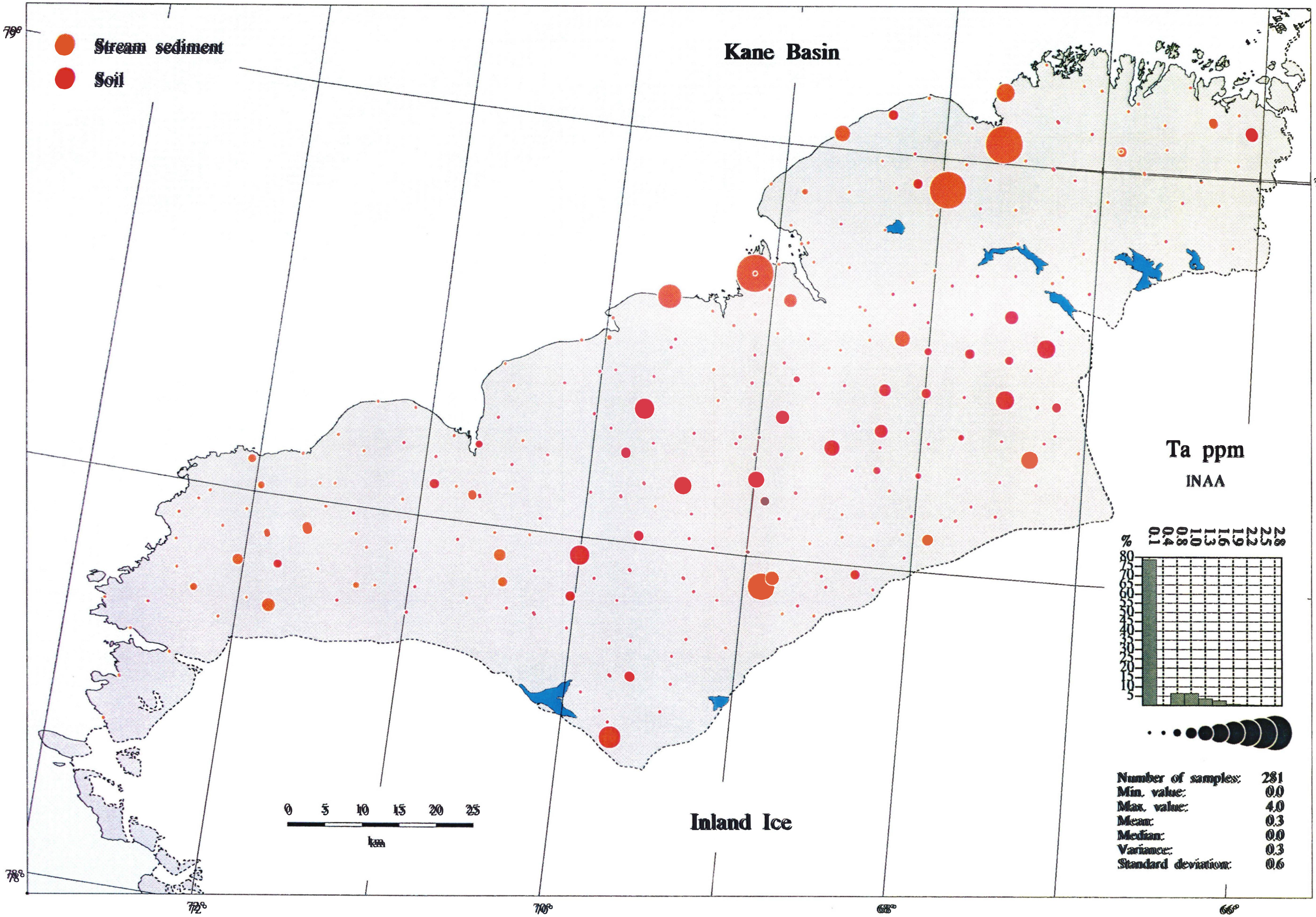

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Geochemical map: Th in stream sediment and soil

96/1 - 229 Inglefield Land

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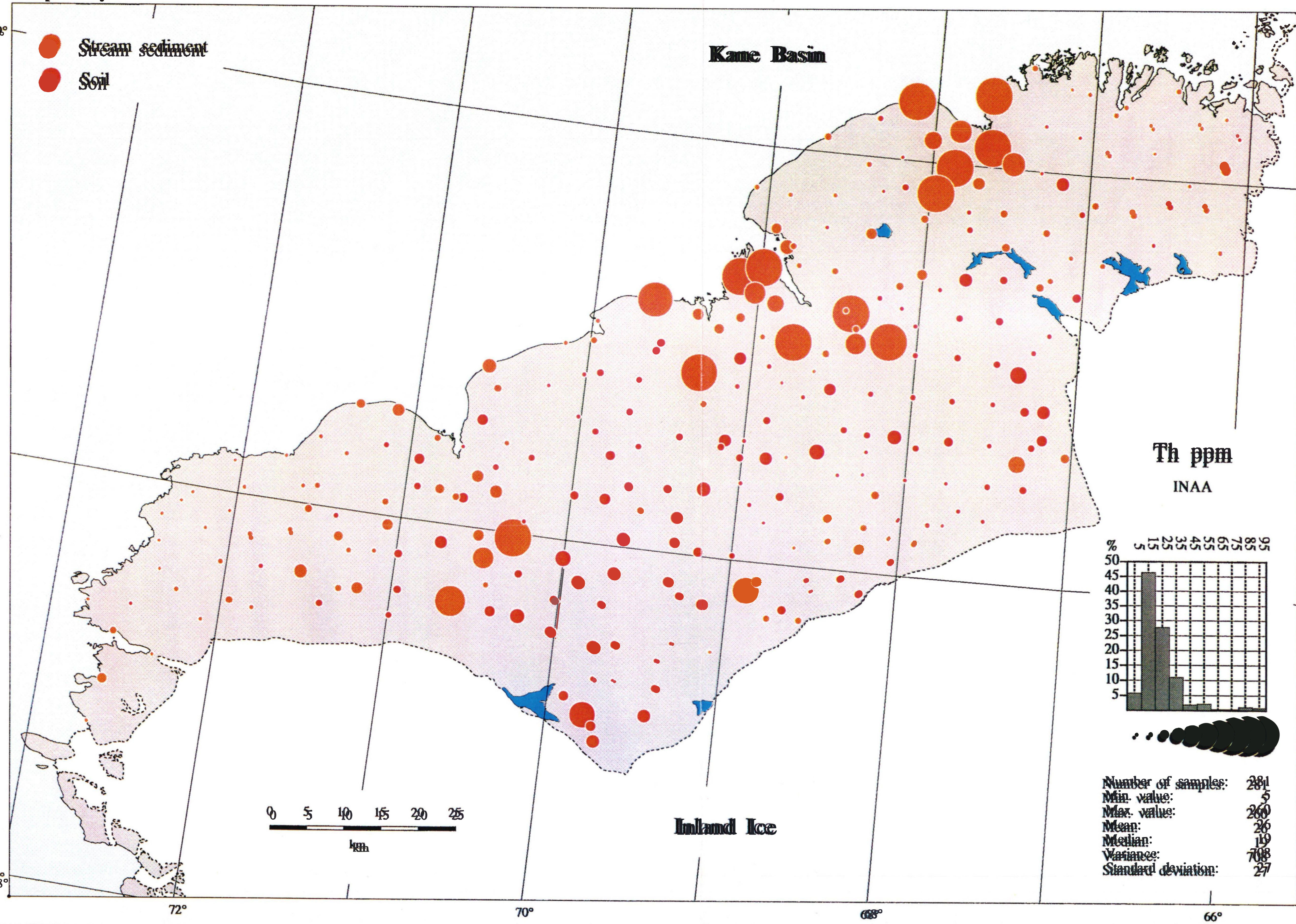

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Geochemical map: U in stream sediment and soil

96/1 - 230 Inglefield Land

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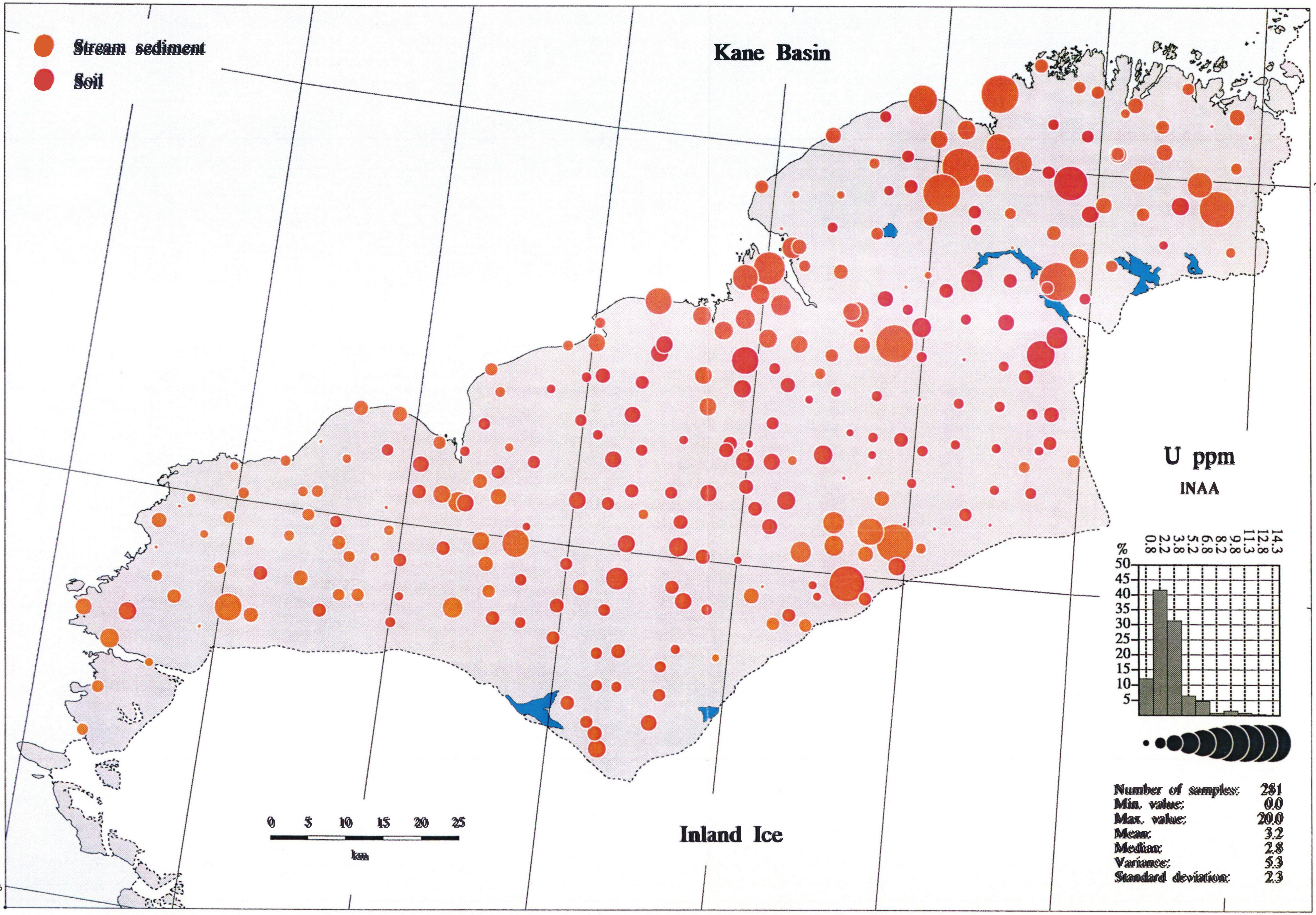

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Geochemical map: V in stream sediment and soil

96/1 - 231 Inglefield Land

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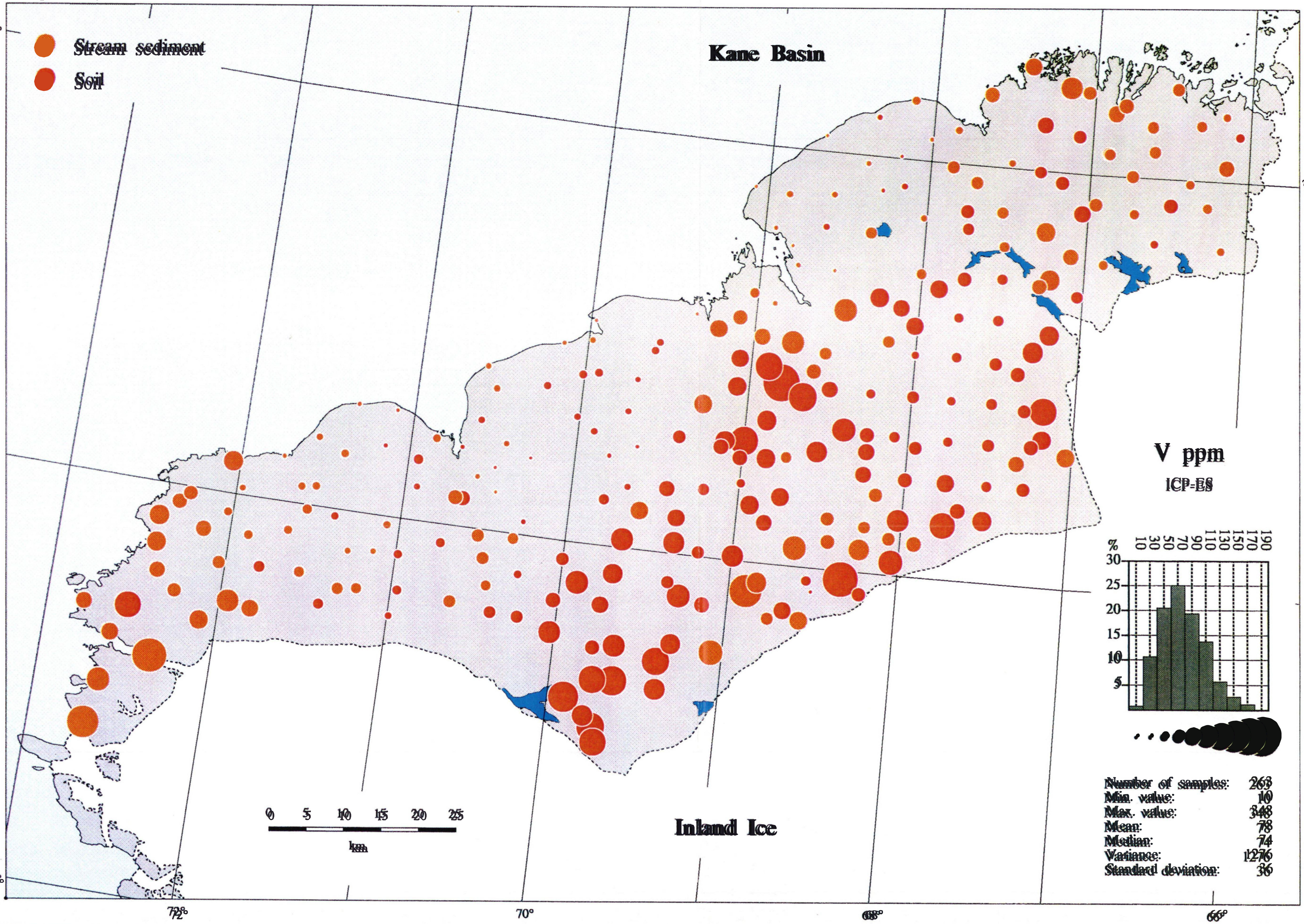

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Geochemical map: Y in stream sediment and soil

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96/1 - 232 Inglefield Land

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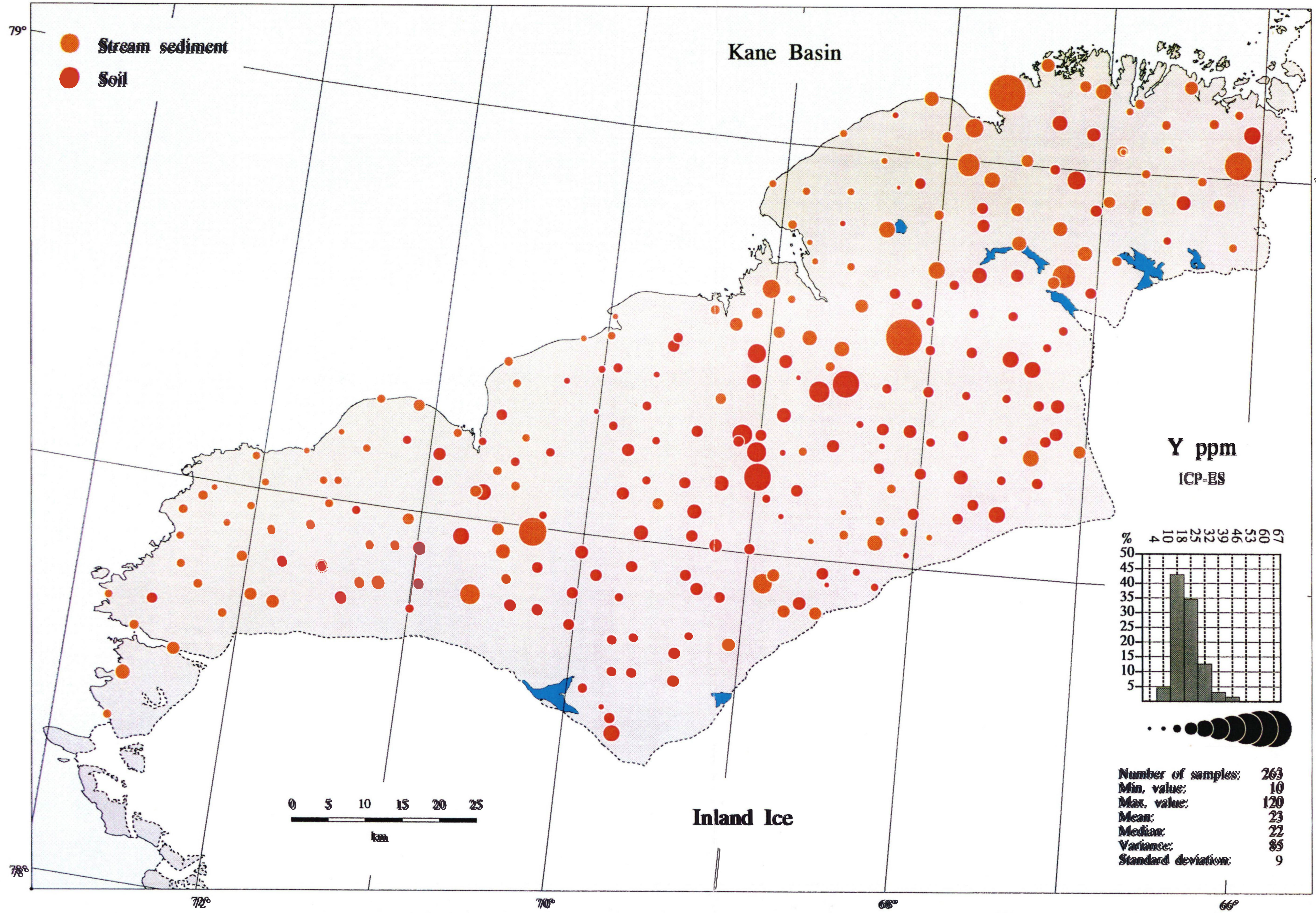

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Geochemical map: Zn in stream sediment and soil

96/1 - 233 Inglefield Land

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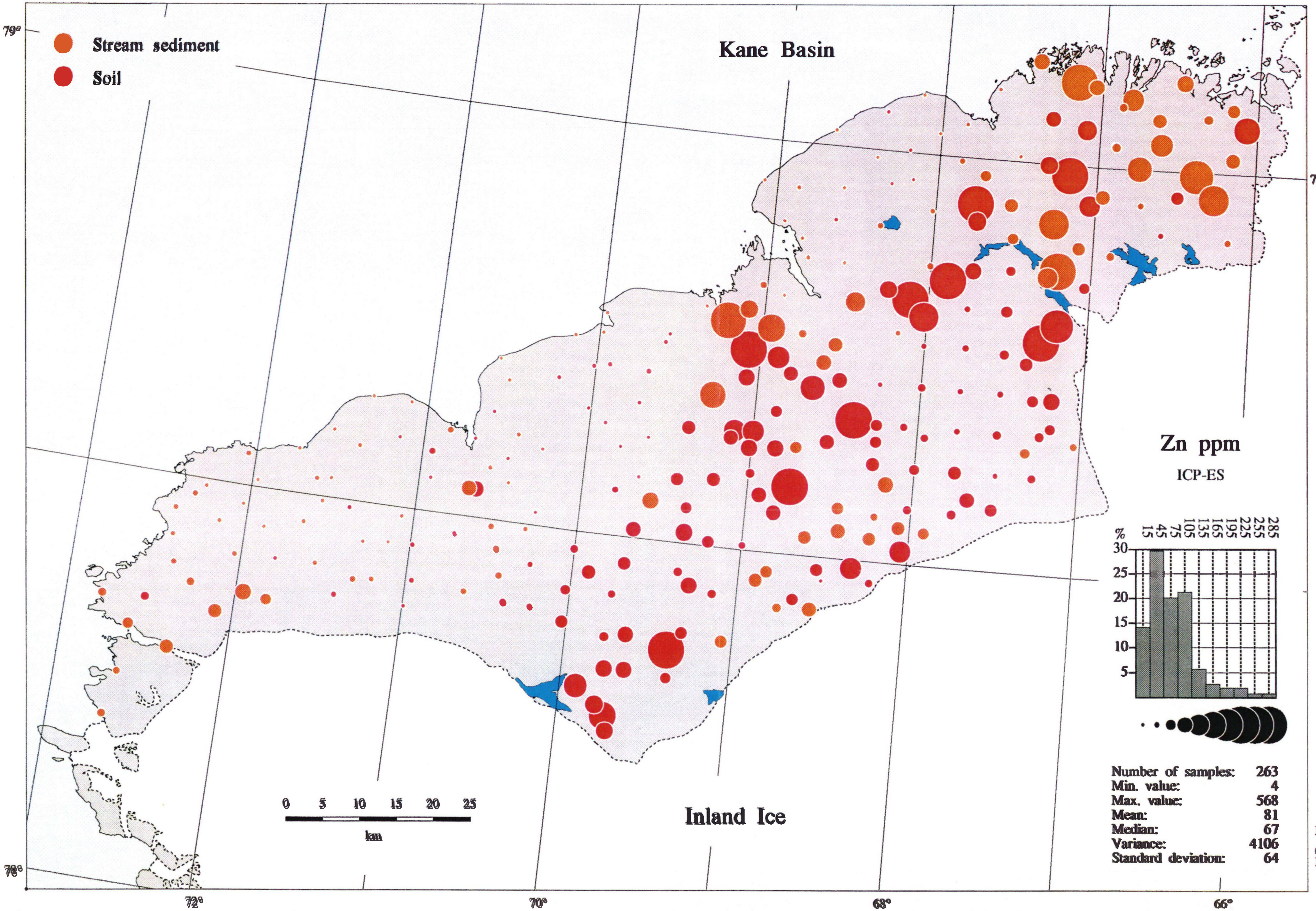

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Geochemical map: La in stream sediment and soil

96/1 - 234 Inglefield Land

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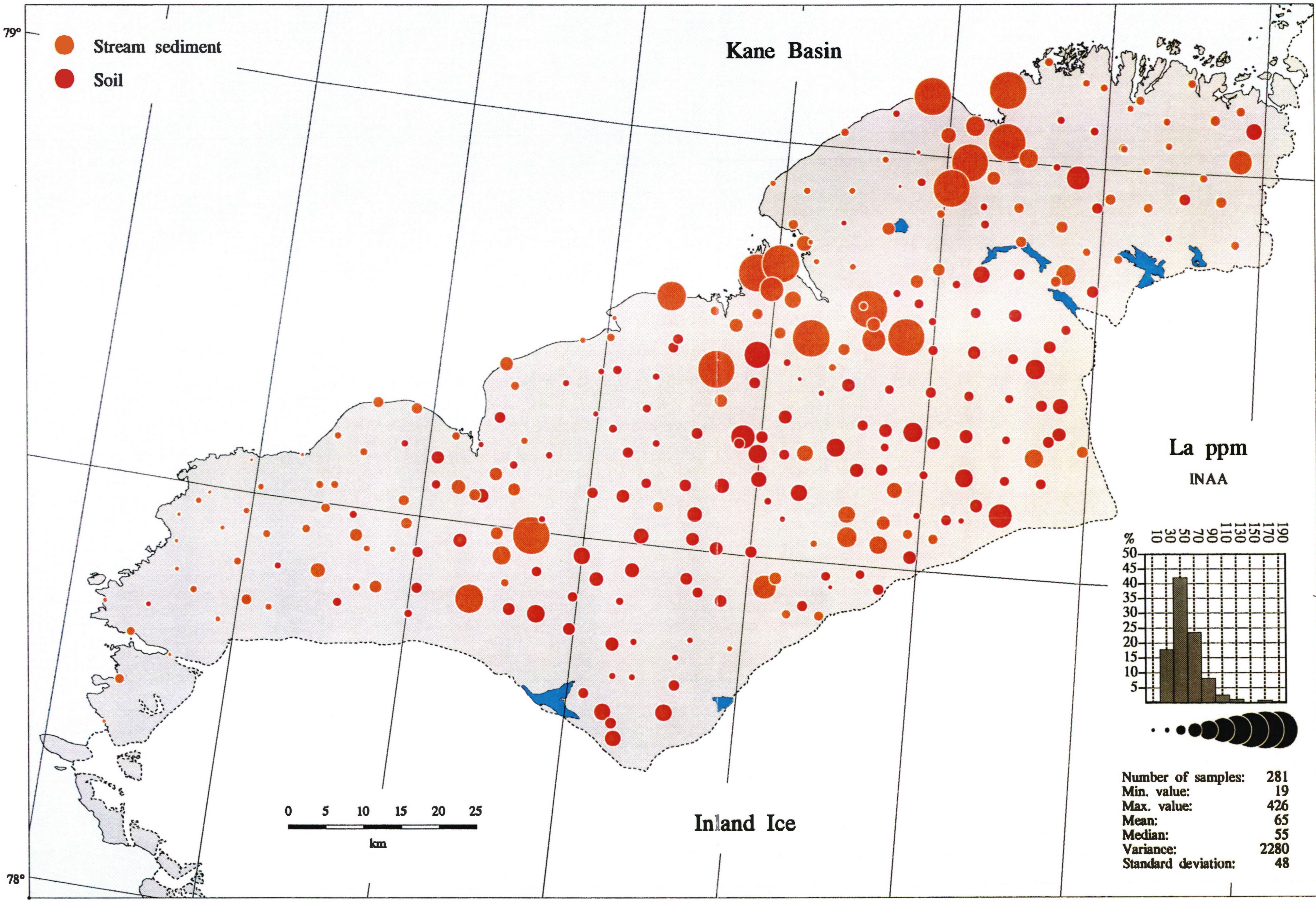

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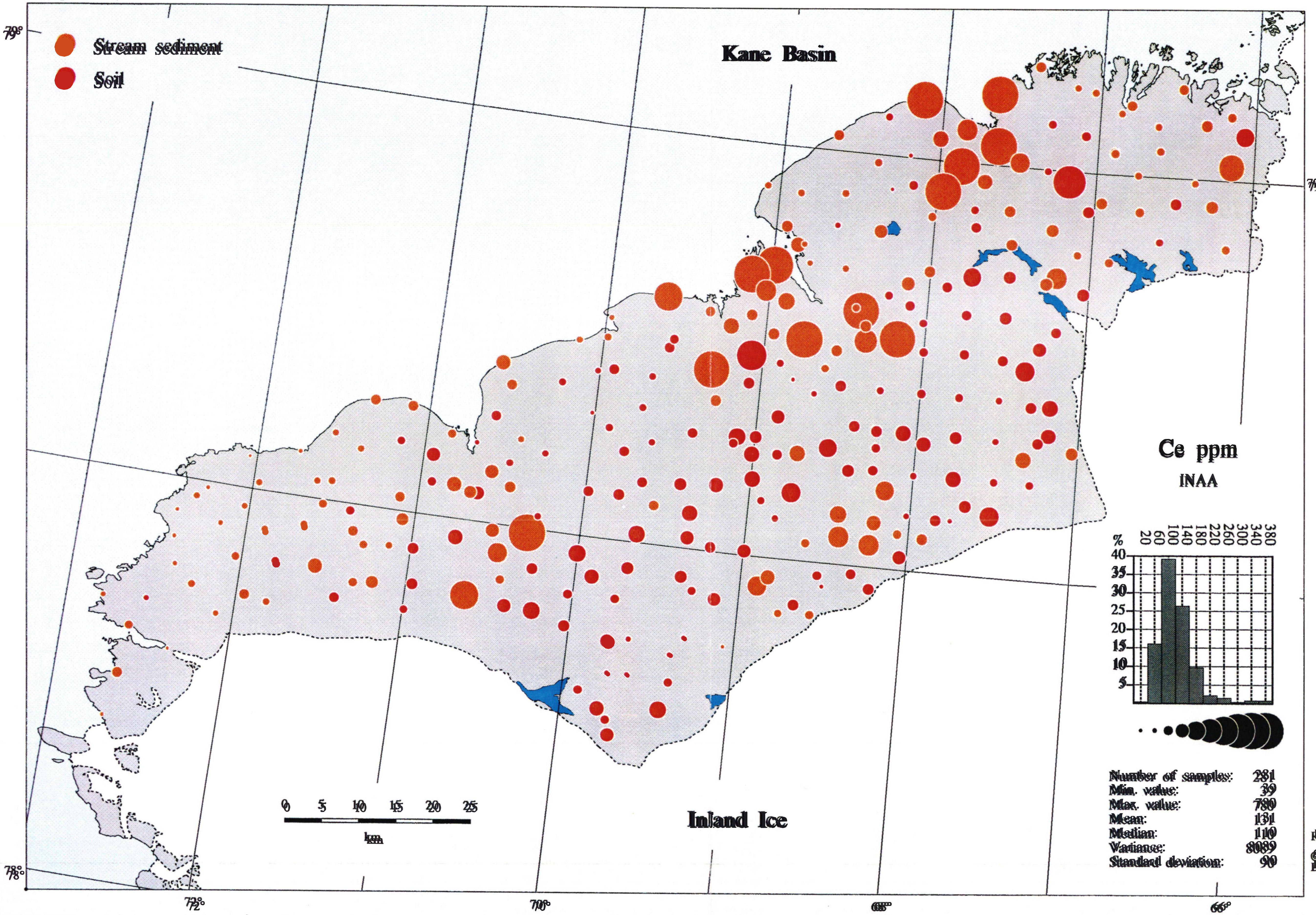
Geochemical map: Ce in stream sediment and soil

Compiled by A. Steenfelt and E. Dam

96/1 - 235 Inglefield Land



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Geochemical map: Nd in stream sediment and soil

Compiled by A. Steenfelt and E. Dam

96/1 - 236 Inglefield Land

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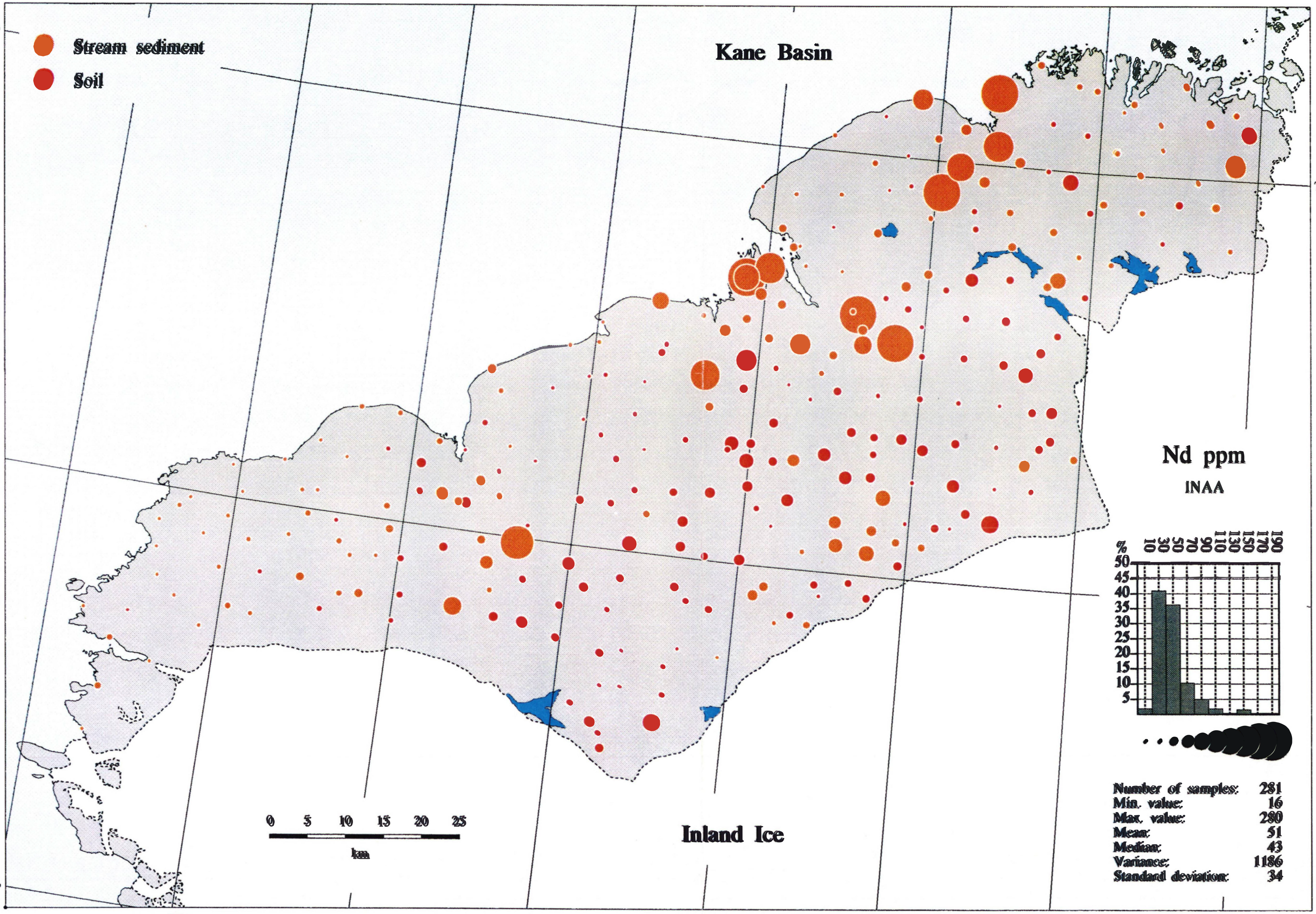

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Geochemical map: Sm in stream sediment and soil

96/1 - 237 Inglefield Land

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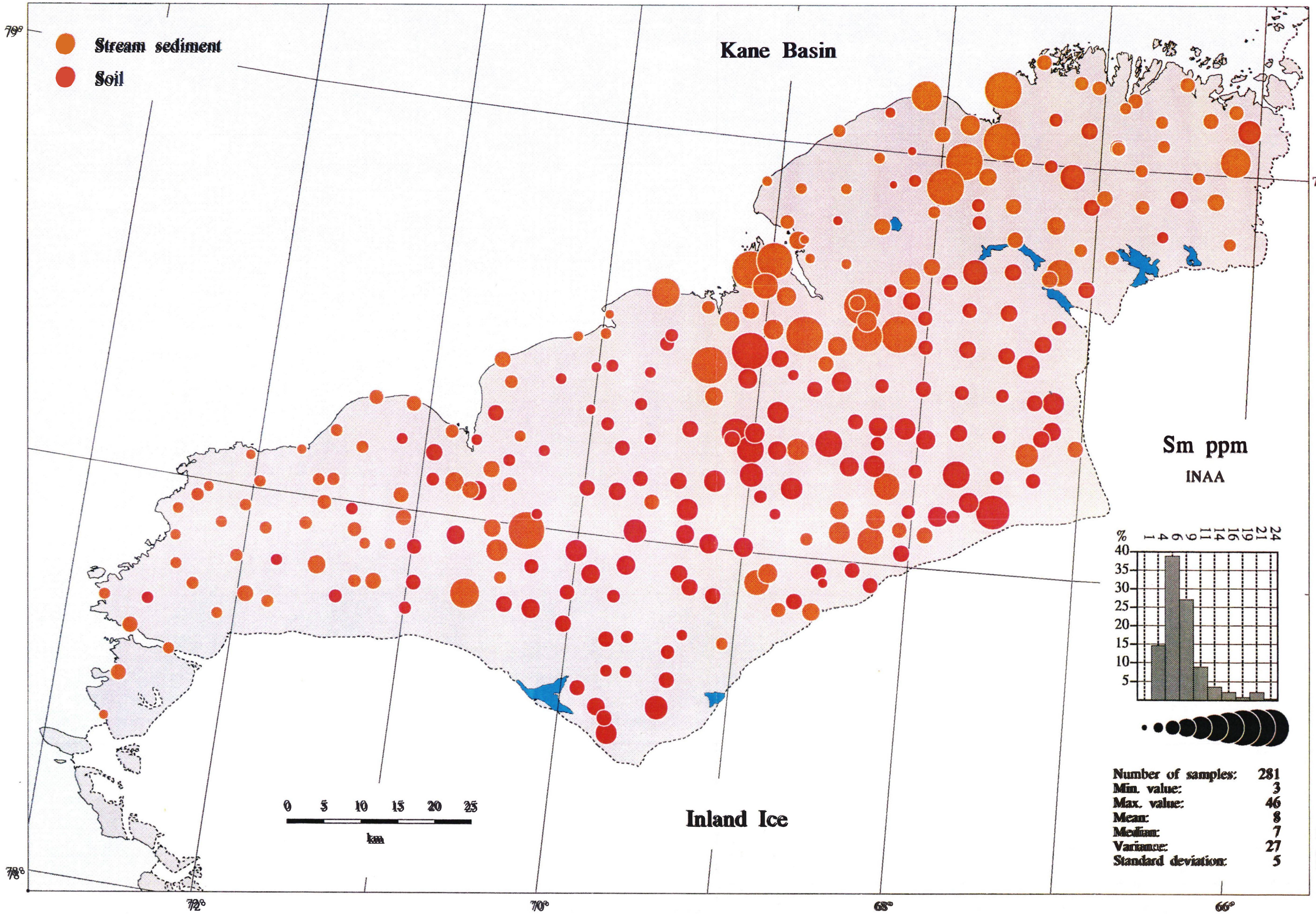

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Geochemical map: Eu in stream sediment and soil

96/1 - 238 Inglefield Land

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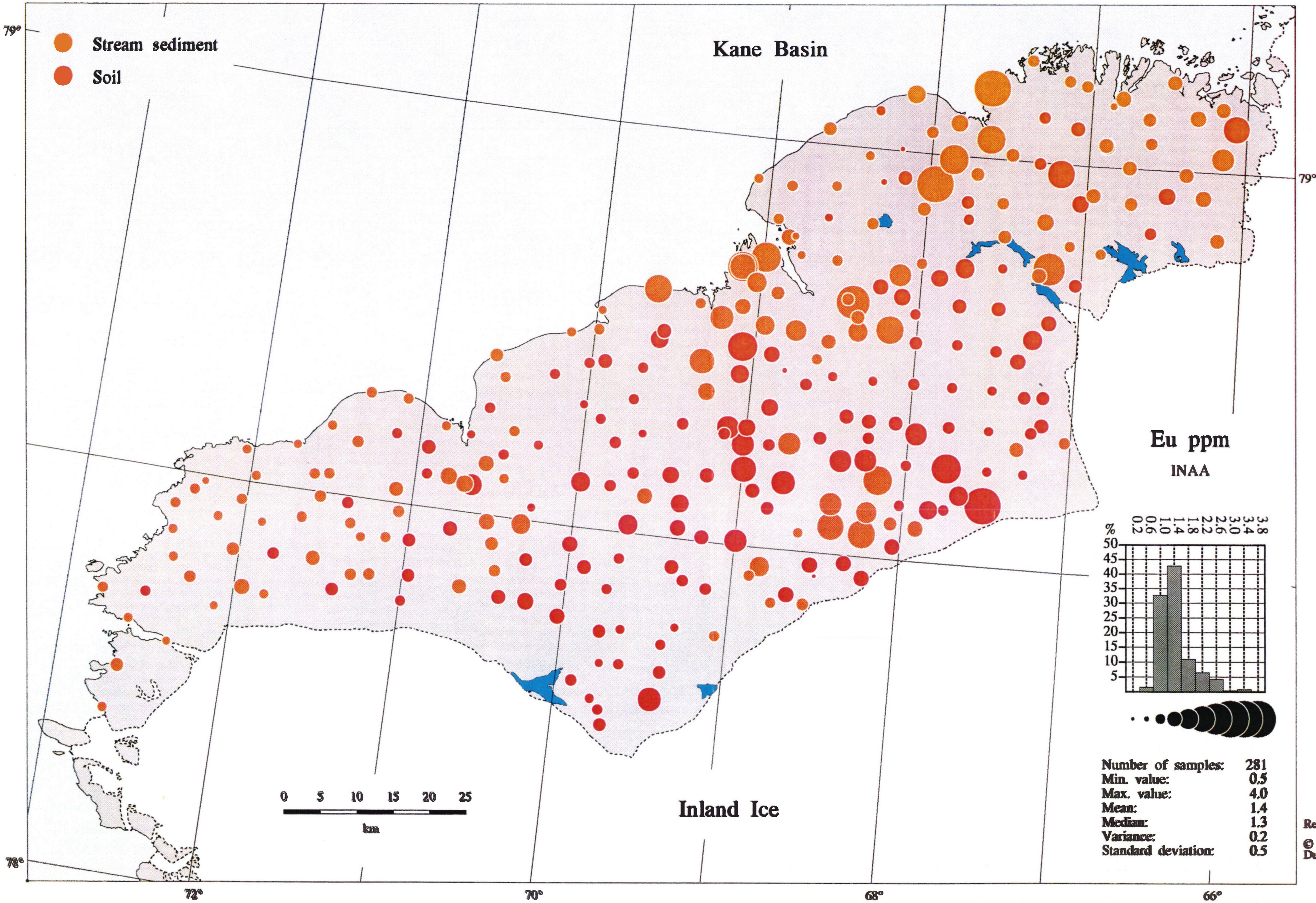

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Geochemical map: Yb in stream sediment and soil

96/1 - 239 Inglefield Land

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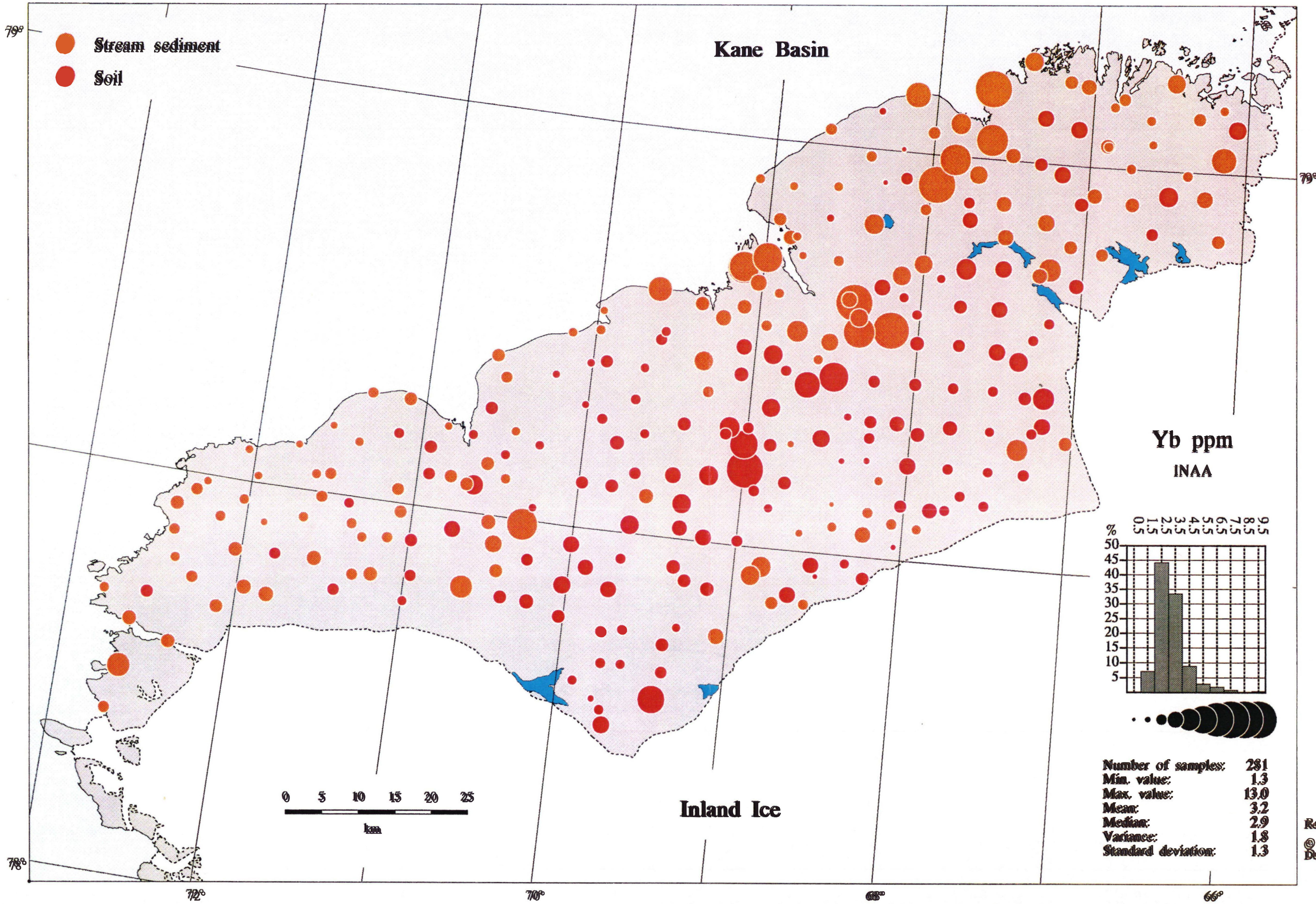

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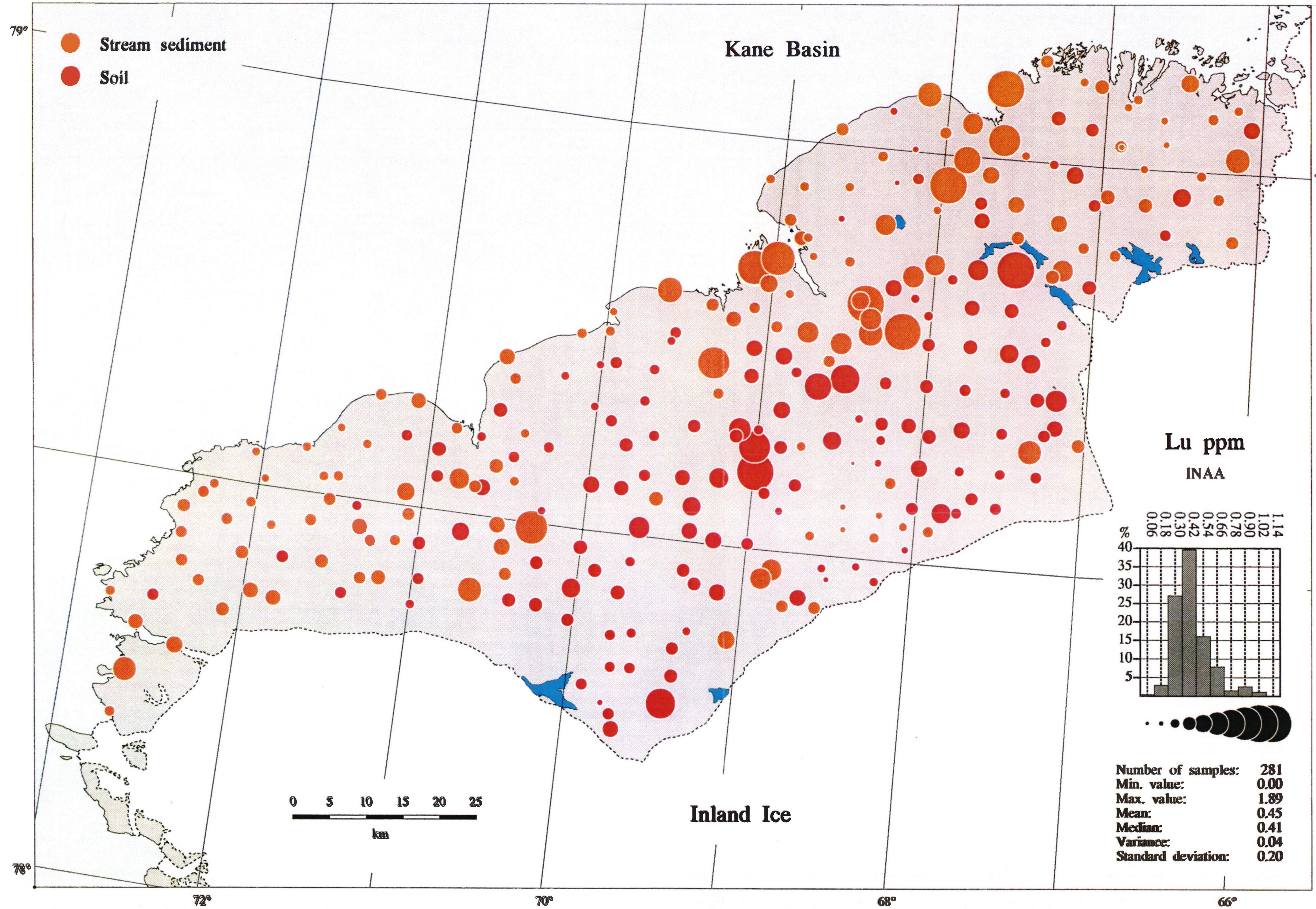
Geochemical map: Lu in stream sediment and soil

96/1 - 240 Inglefield Land

Compiled by A. Steenfelt and E. Dam



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Mineral Occurrences: Fe - sulphides

Compiled by P. W. U. Appel and B. Thomassen

96/1 - 401 Inglefield Land

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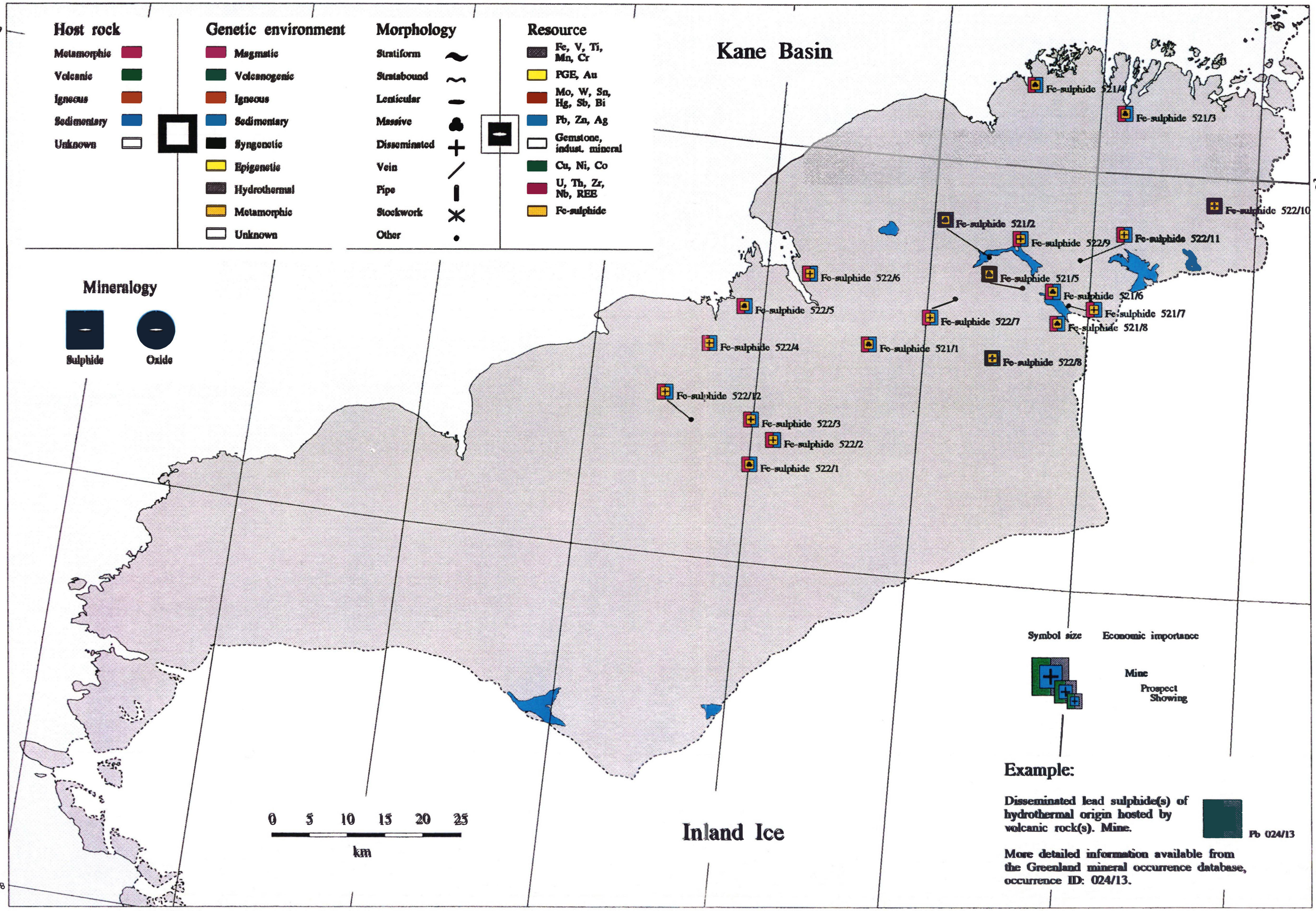

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Mineral Occurrences: Cu, Au, Zn and Fe

96/1 - 402 Inglefield Land

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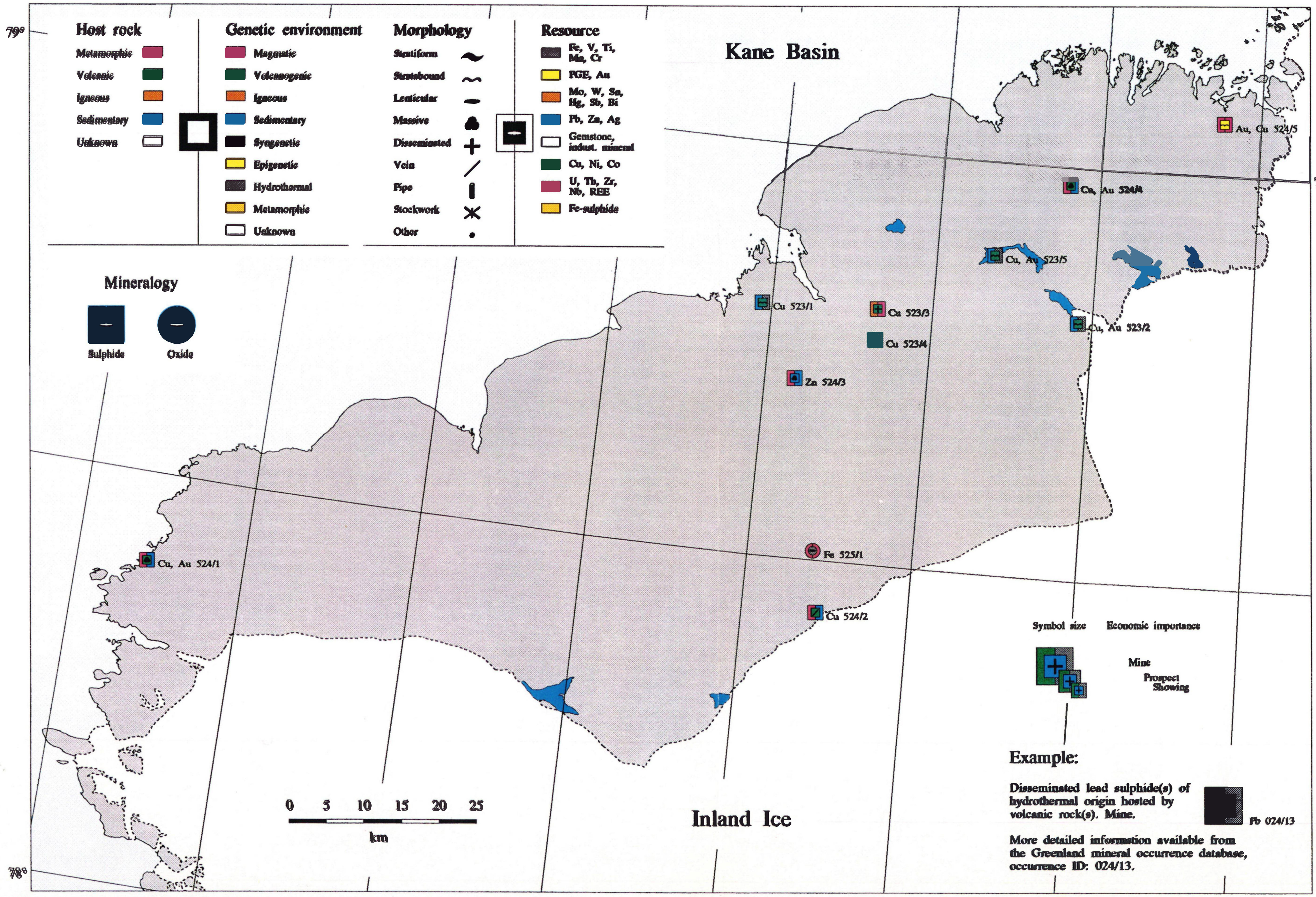

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