Natural Resources

Mines

TILL GEOCHEMISTRY OF FOGO AND THE CHANGE ISLANDS
(NTS MAP AREA 2E/09)

D. Brushett

Open File 002E/09/1736

St. John's, Newfoundland
May, 2014

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Cover: Coastline near Joe Batt's Arm, Fogo Island.

Newfoundland Labrador

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GEOLOGICAL SURVEY NEWFOUNDLAND AND LABRADOR

Celebrating 150 years

St. John's, Newfoundland

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ABSTRACT

This report provides the geochemical data for the Fogo map area (NTS map area 2E/09) and supplements a multiyear till-geochemistry and surficial mapping program conducted in northeastern Newfoundland (Brushett, 2012), commenced in 2009. Geochemical data for 58 elements, from 55 BC- or C-horizon till samples, are presented and include the results of analyses by ICP-OES for aluminum, arsenic, barium, beryllium, cadmium, calcium, cerium, chromium, cobalt, copper, dysprosium, iron, lanthanum, lead, lithium, magnesium, manganese, molybdenum, nickel, niobium, phosphorus, potassium, scandium, sodium, strontium, titanium, vanadium, yttrium, zinc and zirconium; by INAA for antimony, arsenic, barium, bromine, calcium, cerium, cesium, chromium, cobalt, europium, gold, iron, hafnium, iridium, lanthanum, lutetium, mercury, molybdenum, nickel, neodymium, rubidium, scandium, samarium, selenium, silver, sodium, strontium, tantalum, tin, terbium, thorium, tungsten, uranium, ytterbium, zinc and zirconium. A complete data listing, field duplicate data, and individual element distribution maps, on a bedrock geology base map, are also provided.

INTRODUCTION

This report provides the geochemical data for the Fogo map area (NTS 2E/09) and supplements a multiyear till-geochemistry and surficial-mapping program conducted in northeastern Newfoundland (Brushett, 2012), commenced in 2009. The present field program also included the determination of the paleo ice-flow history to aid in the interpretation of geochemical anomalies and the understanding of the regional ice-flow history. Fieldwork consisted of truck traverses along all primary and secondary roads on Fogo and the Change Islands (Figure 1).

REGIONAL SETTING

Fogo and the Change Islands lie within the Exploits Subzone of the Dunnage Zone of the northern Appalachians, defined by the remnants of volcanic arcs and back-arc basins formed on the peri-Gondwanan side of the early Paleozoic Iapetus Ocean (Williams *et al.*, 1988). With the exception of one small area of siliciclastic rocks of the Ordovician Badger Group, the sedimentary and volcanic rocks are Silurian Botwood Group. Silurian to Devonian plutonic rocks (of the Fogo Island granitic batholith) underlie most of Fogo Island but a significant portion of the south-

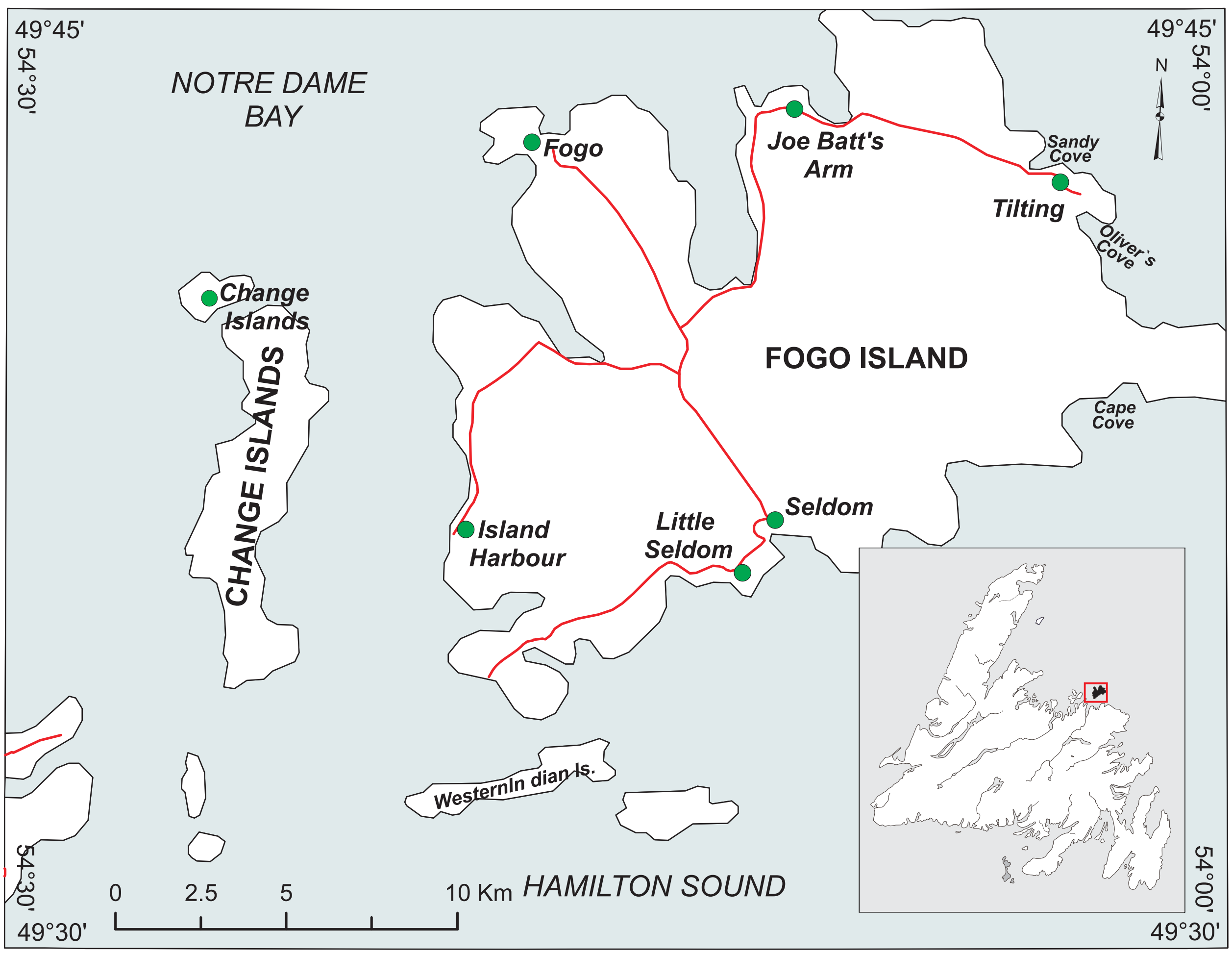

Figure 1. *Map of study area showing place names referred to in the text. The red box in the inset map shows the location of the study area.*

ern and eastern parts of the island consists of dioritic and gabbroic rocks. No plutonic rocks are present on the Change Islands; however, there are numerous dykes in the sedimentary rocks (too small to be represented on a 1:50 000 scale map; Figure 2). For a more detailed description of the bedrock geology the reader is referred to Baird (1958), Sandeman and Malpas (1995), Currie (1997) and Kerr (2011, 2013).

To date, three mineral occurrences have been recorded within the study area, and documented in the provincial Mineral Occurrences System Database (MODS; Newfoundland and Labrador Geological Survey, 2013); these include two gold showings (Change Islands and Western Indian Island) and one copper indication (Change Islands; Figure 2).

SURFICIAL GEOLOGY

Bedrock outcrop is found over much of the study area (Figure 3). Diamicton is generally very thin (less than 70 cm) and discontinuous. The diamicton has a matrix of predominantly light brownish-grey silty sand, and is poorly sorted and slightly to moderately compacted. Clast content varies from 30 to 70 percent and averages 50 percent. Clasts are of granule to boulder size (up to 3 m diameter) and are generally angular to sub-rounded. Some clasts are striated and faceted, and have thin silt coatings on their upper surfaces.

Field observations of the surficial geology were supplemented by surficial mapping (Kirby *et al.*, 2011). Till types identified include: till veneers, hummocky till, eroded till, and streamlined till. Till veneers are most common on the western part of Fogo Island, particularly in the upland regions, and along the coast. Streamlined till was identified in one area northwest of Little Seldom. Areas of hummocky terrain and eroded till were mapped in the southwestern part of Fogo Island; these areas likely reflect ice stagnation during deglaciation. Areas of eroded till are commonly associated with many minor meltwater channels. Fluvial or glaciofluvial deposits include one small deposit emptying into Cape Cove. Organic deposits are also common, particularly in the central part of Fogo Island where they directly overly bedrock. Sandy and gravelly marine deposits are present in Little Seldom and the beaches in Sandy Cove and Oliver's Cove.

QUATERNARY HISTORY

OVERVIEW

Previous work on the glaciation of Newfoundland suggested that during the last glacial maximum (LGM; ~21 ka BP), Newfoundland was covered with multiple local ice caps, producing almost complete glacial cover, and extending out to the continental shelf edge (Grant, 1989; Shaw *et al.*, 2006). The sequence of deglacial events following the LGM are based mostly on striation and landform data which depict a first-order ice divide extending south and southeast across Newfoundland along the axis of the Long Range Mountains, east through central Newfoundland and across the Avalon Peninsula. Early ice retreat was facilitated by calving along deep (>600 m) channels, particularly off northeast Newfoundland – this created a second-order ice divide along the axis of the Cape Freels peninsula that separated ice flow in Notre Dame and Trinity basins (Shaw, 2003). Ice retreat continued via calving embayments until ~13 ka BP when ice margins

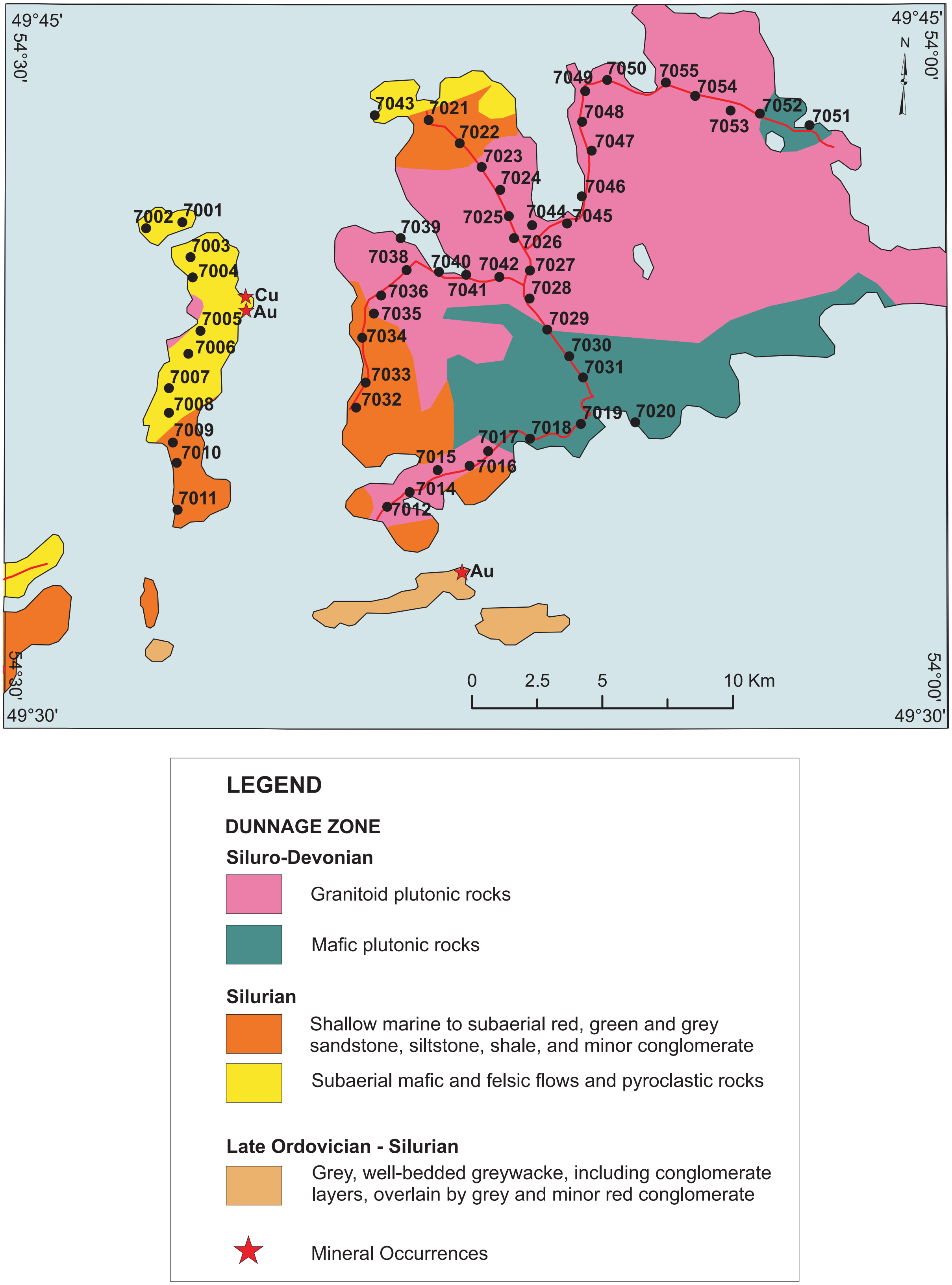

Figure 2. *Bedrock geology of the study area (Colman-Sadd and Crisby-Whittle, 2005 and Williams* et al.*, 1988); also shown are locations of till samples (black dots).*

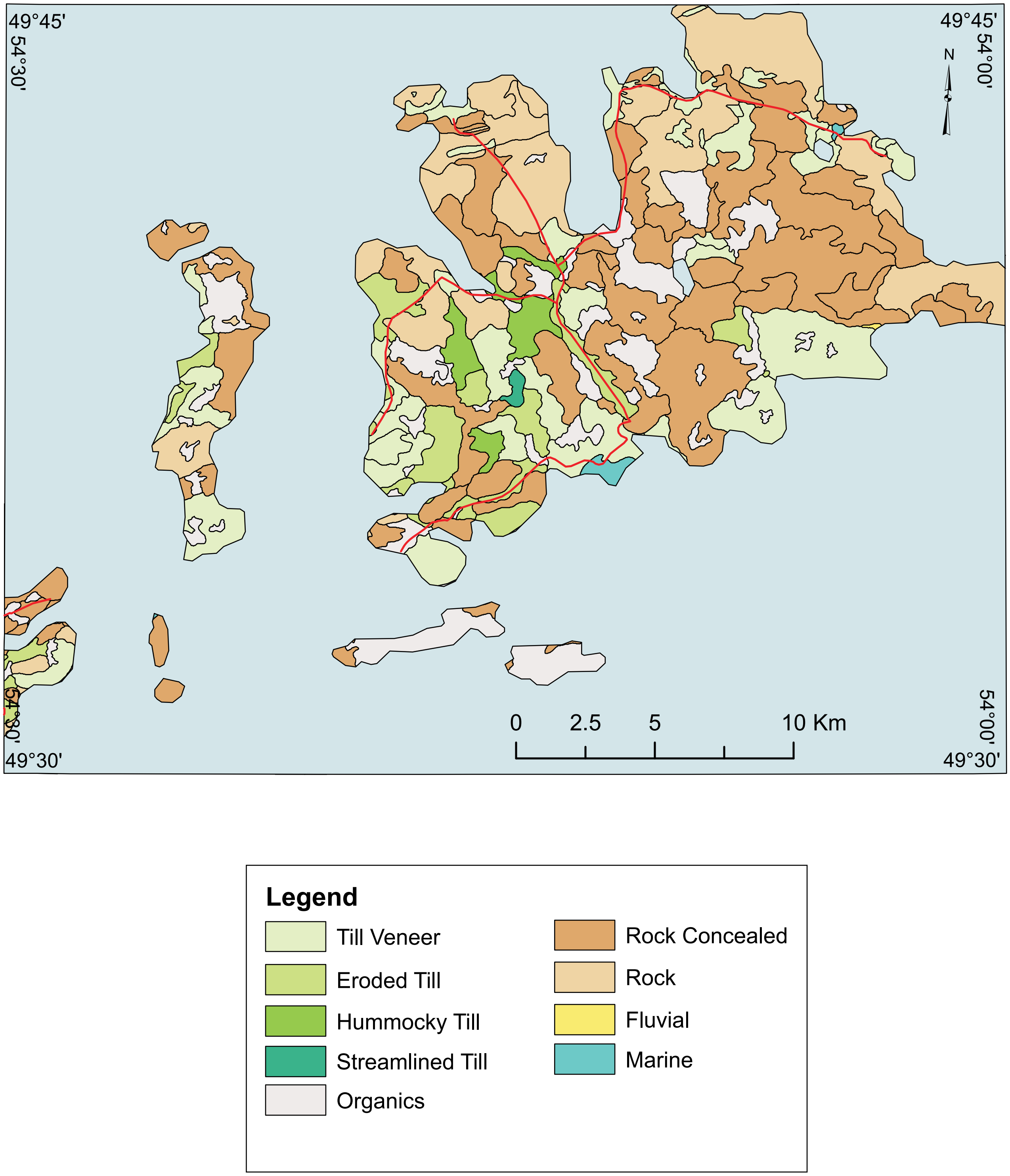

Figure 3. *Surficial geology of study area (modified from Kirby* et al.*, 2011).*

reached coastal areas and the configuration of ice divides shifted as deglaciation became land-based; retreat of isolated ice caps continued by ablation, predominantly through melting (Shaw et al., 2006). At least fifteen of these remnant ice caps were present, five of which had the potential to influence ice flow on Fogo and the Change Islands. These ice caps were located near Red Indian Lake, Meelpaeg Lake, Middle Ridge, north of Grand Falls (in the Twin Ponds area) and in the Gander area (Grant, 1974).

ICE-FLOW PATTERNS

Regional Northeast Newfoundland Ice-flow Patterns

Three ice-flow events affected northeastern Newfoundland (Figure 4a). The earliest ice flow was east-southeastward. Evidence for this flow was not observed on Fogo and the Change Islands but is widespread throughout much of northeastern Newfoundland and has been identified in the Gander River and Gander Bay areas, around Gander Lake and eastward into the Bonavista Bay area (Jenness, 1960; Butler *et al.*, 1984; Vanderveer and Taylor, 1987; Batterson and Vatcher, 1991; St. Croix and Taylor, 1991; Brushett, 2010, 2011, 2012). The probable source of this ice-flow event was from north of Red Indian Lake, based on the presence of eastward striations in the northwest Gander River area (Proudfoot *et al.*, 1988), the Grand Falls–Glenwood area (Batterson and Taylor, 1998) and the Red Indian Lake area (Rogerson, 1982; Vanderveer and Sparkes, 1982; Smith, 2010, 2012).

The eastward ice-flow event was followed by north-northeastward ice flow (~20°). Evidence for this north-northeastward ice flow is present throughout most of northeastern Newfoundland (Vanderveer and Taylor, 1987; St. Croix and Taylor, 1990, 1991; Batterson and Vatcher, 1991; Scott, 1994; Batterson and Taylor, 1998; Brushett, 2010, 2011, 2012). This event crossed Gander Lake and flowed northward into Hamilton Sound. The source of this ice flow was likely an ice divide situated between Middle Ridge and Meelpaeg Lake (Proudfoot *et al.*, 1988; St. Croix and Taylor, 1990, 1991).

The third ice-flow event was northwestward (~340°) and consistently crosscuts the earlier northeastward ice-flow when observed on the same outcrop (Vanderveer and Taylor, 1987; Taylor and St. Croix, 1989; St. Croix and Taylor, 1991; Brushett, 2010, 2011, 2012). This ice-flow was likely from an ice cap situated on Middle Ridge (Grant, 1974; St. Croix and Taylor, 1991).

Fogo and Change Islands Ice-flow Patterns

Two ice-flow directions determined from glacial erosional evidence, consisting mostly of striations, were observed on Fogo and the Change Islands: a northeastward direction (~20°, ranging from 0° to 30°) and a northwestward direction (~343°, ranging from 281° to 357°) (Figure 4b). No age relationships were determined from these two directions; however, based on regional ice-flow directions for northeastern Newfoundland, they represent two separate ice flow events (Figure 4a; St. Croix and Taylor, 1990, 1991; Brushett, 2010, 2011, 2012). There is no consistent spatial relationship between the northeastward and northwestward striations; both are present on Fogo and the Change Islands which means that till dispersal was northward from 281° to 30° in this area.

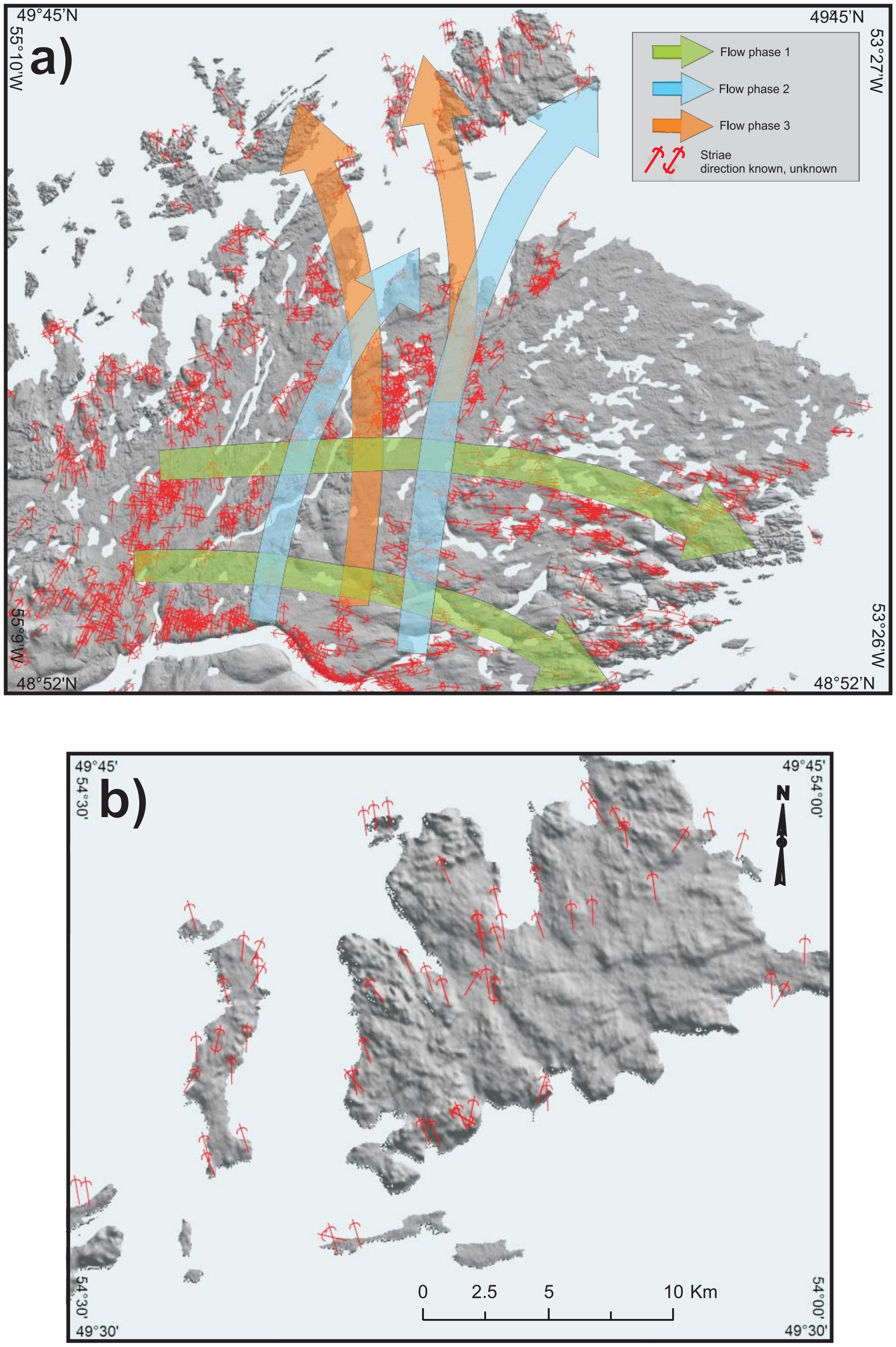

Figure 4. *Ice-flow patterns overlain on SRTM image for (a) and (b). Three ice-flow phases affected northeast Newfoundland. The first (Flow phase 1) was a regionally extensive eastward flow likely sourced from Red Indian Lake. The second (Flow phase 2) was north-northeastward from an ice divide between Middle Ridge and Meelpaeg Lake, and the third (Flow phase 3) was a north-northwestward flow likely sourced from the Middle Ridge area.*

The youngest eastward ice-flow event recorded throughout most of northeastern Newfoundland was not observed on Fogo and the Change Islands. It is possible that the ice related to this event did not cross this area but given its prevalence elsewhere in northeast Newfoundland it is more likely that the area was not affected because it was covered by stagnating ice. The presence of hummocky terrain, here and along the northeast coast, provides supporting evidence for this interpretation (Brushett, 2012).

REGIONAL SURFICIAL SEDIMENT SAMPLING

SAMPLING AND SAMPLE PREPARATION METHODS

Till sampling resulted in 55 samples (including duplicates) being collected from the C- and BC-horizons of test pits (average 55 cm depth), roadcuts (average 60 cm depth) and mudboils (average 25 cm depth). Thirteen samples were collected from bedrock detritus where there was a lack of surficial sediment to collect. Marine and fluvial or glaciofluvial sediments were avoided during sampling, because of the probability of reworking and the difficulty in defining distances and directions of transport. Sample spacing was controlled by access and surficial geology, but was generally one sample every 1 km along all primary and secondary roads. In the field, samples were placed in Kraft-paper sample bags, and sent to the Geological Survey's Geochemical Laboratory in St. John's, where they were air-dried in ovens at 60°C and dry-sieved through 180 μm stainless steel sieves.

GEOCHEMICAL ANALYSES

Analytical work was carried out at the Geological Survey's Geochemical Laboratory, and additional analyses from an external laboratory (a summary of analytical methods is provided in Appendix A). Analyses of 53 samples are presented (Figure 2), excluding field duplicates. Of the 58 elements determined, 16 were determined by both ICP-OES and INAA (As, Ba, Ca, Ce, Co, Cr, Fe, La, Mo, Na, Ni, Rb, Sc, Sr, Zn, Zr) and all are presented in the appended data listings (Appendix B). To distinguish the different analytical methods/laboratories, the element variables are labelled with a combination of the element name, a numeric code denoting the analytical method, and the unit of measurement. A complete list of variables is given in Table 1. Statistics (maximum, minimum, median, mean, standard deviation) were generated from the Excel computer application, and are presented in Table 2.

DISPLAY OF GEOCHEMICAL DATA

Maps showing the aerial distribution of the analyzed elements were created using the ArcMap GIS application. Values of each element are represented by circles whose size represents a particular concentration range, with the largest circles representing the highest values. These concentration ranges were determined using percentiles of the regional till geochemistry dataset (for the island of Newfoundland only); "background" values are less than the 90-percentile, "elevated" values are between the 90- and 97.5-percentile and "anomalous" values exceed the 97.5-percentile. Maps showing the distribution of selected elements of interest (As2, Au1, Be2, Cr2, Cu2, Pb2, Y2 and Zn2) are shown in Figures 5 to 12. Other element maps are included in Appendix C.

Table 1. Variable list and description of data

Variable	Description	Variable	Description
Sample	Unique sample ID. First number represents geologist id, *e.g.*, 7 = Brushett; 4 = Batterson	La1 ppm	Lanthanum, ppm, by INAA
		La2 ppm	Lanthanum, ppm, by ICP
		Li2 ppm	Lithium, ppm, by ICP
NTS_Map	NTS sheet (1:50 000)	LOI	Loss on ignition
UTMEast	UTM map coordinate NAD 27	Lu1 ppm	Lutetium, ppm, by INAA
UTMNorth	UTM map coordinate NAD 27	Mg2 pct	Magnesium, %, by ICP
Elev	Elevation of sample site (m)	Mn2 ppm	Manganese, ppm, by ICP
UTMZone	UTM zone	Mo1 ppm	Molybdenum, ppm, by INAA
Horizon	Soil horizon sampled	Mo2 ppm	Molybdenum, ppm, by ICP
Depth	Sample depth (cm)	Na1 pct	Sodium, %, by INAA
Ag1 ppm	Silver, ppm, by INAA	Na2 pct	Sodium, %, by ICP
Al2 pct	Aluminum, %, by ICP	Nb2 ppm	Niobium, ppm, by ICP
As1 ppm	Arsenic, ppm, by INAA	Nd1 ppm	Neodymium, ppm, by INAA
As2 ppm	Arsenic, ppm, by ICP	Ni2 ppm	Nickel, ppm, by ICP
Au1 ppb	Gold, ppb, by INAA	P2 ppm	Phosphorus, ppm, by ICP
Ba1 ppm	Barium, ppm, by INAA	Pb2 ppm	Lead, ppm, by ICP
Ba2 ppm	Barium, ppm, by ICP	Rb1 ppm	Rubidium, ppm, by INAA
Be2 ppm	Beryllium, ppm, by ICP	Rb2 ppm	Rubidium, ppm, by ICP
Br1 ppm	Bromine, ppm, by INAA	Sb1 ppm	Antimony, ppm, by INAA
Ca2 pct	Calcium, %, by ICP	Sc1 ppm	Scandium, ppm, by INAA
Cd2 ppm	Cadmium, ppm, by ICP	Sc2 ppm	Scandium, ppm, by ICP
Ce1 ppm	Cerium, ppm, by INAA	Se1 ppm	Selenium, ppm, by INAA
Ce2 ppm	Cerium, ppm, by ICP	Sm1 ppm	Samarium, ppm, by INAA
Co1 ppm	Cobalt, ppm, by INAA	Sn1 ppm	Tin, ppm, by INAA
Co2 ppm	Cobalt, ppm, by ICP	Sr2 ppm	Strontium, ppm, by ICP
Cr1 ppm	Chromium, ppm, by INAA	Ta1 ppm	Tantalum, ppm, by INAA
Cr2 ppm	Chromium, ppm, by ICP	Tb1 ppm	Terbium, ppm, by INAA
Cs1 ppm	Cesium, ppm, by INAA	Th1 ppm	Thorium, ppm, by INAA
Cu2 ppm	Copper, ppm, by ICP	Ti2 ppm	Titanium, ppm, by ICP
Dy2 ppm	Dysprosium, ppm, by ICP	U1 ppm	Uranium, ppm, by INAA
Eu1 ppm	Europium, ppm, by INAA	V2 ppm	Vanadium, ppm, by ICP
Fe1 pct	Iron, %, by INAA	W1 ppm	Tungsten, ppm, by INAA
Fe2 pct	Iron, %, by ICP	Y2 ppm	Yttrium, ppm, by ICP
Hf1 ppm	Hafnium, ppm, by INAA	Yb1 ppm	Ytterbium, ppm, by INAA
Hg1 ppm	Mercury, ppm, by INAA	Zn2 ppm	Zinc, ppm, by ICP
Ir1 ppm	Iridium, ppb, by INAA	Zr1 ppm	Zirconium, ppm, by INAA
K2 pct	Potassium, %, by ICP	Zr2 ppm	Zirconium, ppm, by ICP

Note: ppm = parts per million; ppb = parts per billion; pct = %

Table 2. Units, detection limits, ranges, medians and standard deviations of geochemical data. Values below detection are coded as half of the detection limit value

		Detection Limit	Maximum	Minimum	Mean	Median	Standard Deviation
Al2	%	0.01	902.0	4.48	6.80	6.67	0.90
As1	ppm	0.5	606.0	0.25	32.20	10.0	90.70
As2	ppm	2	630.48	1.0	34.65	10.63	94.79
Au1	ppb	1	145.0	0.5	7.92	4.0	19.84
Ba1	ppm	50	650	110.0	358.68	360.0	117.93
Ba2	ppm	50	677.65	140.51	379.8	387.11	116.33
Be2	ppm	0.2	6.31	0.58	2.15	1.75	1.12
Br1	ppm	0.5	261	2.0	48.47	27.0	58.94
Ca2	%	0.01	3.81	0.22	1.15	1.16	0.63
Cd2	ppm	0.1	0.21	0.05	0.08	0.05	0.05
Ce1	ppm	3	280	11.0	75.94	61.0	54.33
Ce2	ppm	2	289.14	12.04	78.06	65.36	48.95
Co1	ppm	1	100	0.5	15.73	11.0	18.89
Co2	ppm	2	77.52	0.5	10.76	7.27	14.59
Cr1	ppm	5	230	12	90.49	72.0	60.80
Cr2	ppm	2	185.2	7.93	52.41	45.76	33.16
Cs1	ppm	1	15	0.5	3.68	2.90	2.62
Cu2	ppm	2	103.96	0.5	19.38	14.03	18.67
Dy2	ppm	0.2	15.79	0.39	4.16	3.23	3.06
Eu1	ppm	0.2	4.3	0.1	1.52	1.50	0.69
Fe1	%	0.01	14.6	0.5	3.73	3.10	2.30
Fe2	%	0.01	13.41	0.58	3.76	3.14	2.15
Hf1	ppm	1	59.0	2.0	13.85	11.0	11.79
K2	%	0.01	2.93	0.23	1.63	1.58	0.62
La1	ppm	0.5	126.0	7.0	34.57	30.0	22.46
La2	ppm	1	116.15	5.39	31.53	24.01	21.96
Li2	ppm	0.2	57.23	1.26	23.95	23.99	12.10
LOI	%	0.01	36.95	2.07	8.17	5.53	7.28
Lu1	ppm	0.05	2.3	0.14	0.78	0.66	0.52
Mg2	%	0.01	3.33	0.01	0.84	0.80	0.54
Mn2	ppm	2	5125.22	74.44	1040.22	916.6	931.09
Mo1	ppm	1	11.0	0.5	1.08	0.50	1.78
Mo2	ppm	1	10.98	0.5	1.72	1.07	2.11
Na1	%	0.01	3.6	0.69	2.03	2.00	0.55
Na2	%	0.01	3.87	0.46	1.86	1.81	0.58
Nb2	ppm	2	3.91	0.5	1.90	1.84	0.59
Ni2	ppm	2	66.19	3.36	14.48	12.35	10.81
P2	ppm	5	61.72	0.5	22.81	17.28	16.31

Table 2. Continued

		Detection Limit	Maximum	Minimum	Mean	Median	Standard Deviation
Pb2	ppm	2	1927.99	65.46	460.27	392.96	376.71
Rb1	ppm	5	150.0	0.25	73.85	67.0	32.78
Rb2	ppm	5	92.5	2.5	16.66	12.2	17.57
Sb1	ppm	0.1	3.6	0.05	0.84	0.7	0.74
Sc1	ppm	0.1	25.9	2.1	12.92	13.7	4.60
Sc2	ppm	1	125.52	13.68	60.81	55.87	23.91
Se1	ppm	1	0.5	0.5	0.5	0.5	0.50
Sm1	ppm	0.1	28.5	0.9	7.89	7.5	4.81
Sr2	ppm	2	24.9	1.7	12.68	13.41	4.51
Ta1	ppm	0.2	6.0	0.3	1.42	1.2	1.02
Tb1	ppm	0.5	4.9	0.25	1.25	1.0	0.85
Th1	ppm	0.2	60.4	1.4	11.48	9.0	9.51
Ti2	ppm	5	525.45	57.15	150.59	149.94	69.28
U1	ppm	0.5	18.4	0.5	4.27	2.90	3.67
V2	ppm	5	13618.1	1770.35	5042.04	4695.26	2198.71
W1	ppm	1	5	0.5	1.73	2.00	0.96
Y2	ppm	2	205.28	16.1	76.84	72.51	39.75
Yb1	ppm	0.2	15.0	0.9	4.60	3.90	3.7
Zn2	ppm	2	98.84	2.65	26.05	20.87	18.21
Zr2	ppm	2	211.87	8.16	64.99	54.76	39.03

Note: ppm = parts per million; ppb = parts per billion; pct = %

For these maps the concentration ranges were determined using Jenks Optimization, also known as the goodness-of-variance fit, a method offered by ArcMap (Jenks, 1967). The method identifies natural breaks in the frequency distribution resulting in 4-6 concentration ranges.

In view of the small number of samples collected no interpretation of the data is attempted within this report. Individuals and companies are encouraged to undertake their own interpretation of the presented data.

ACKNOWLEDGMENTS

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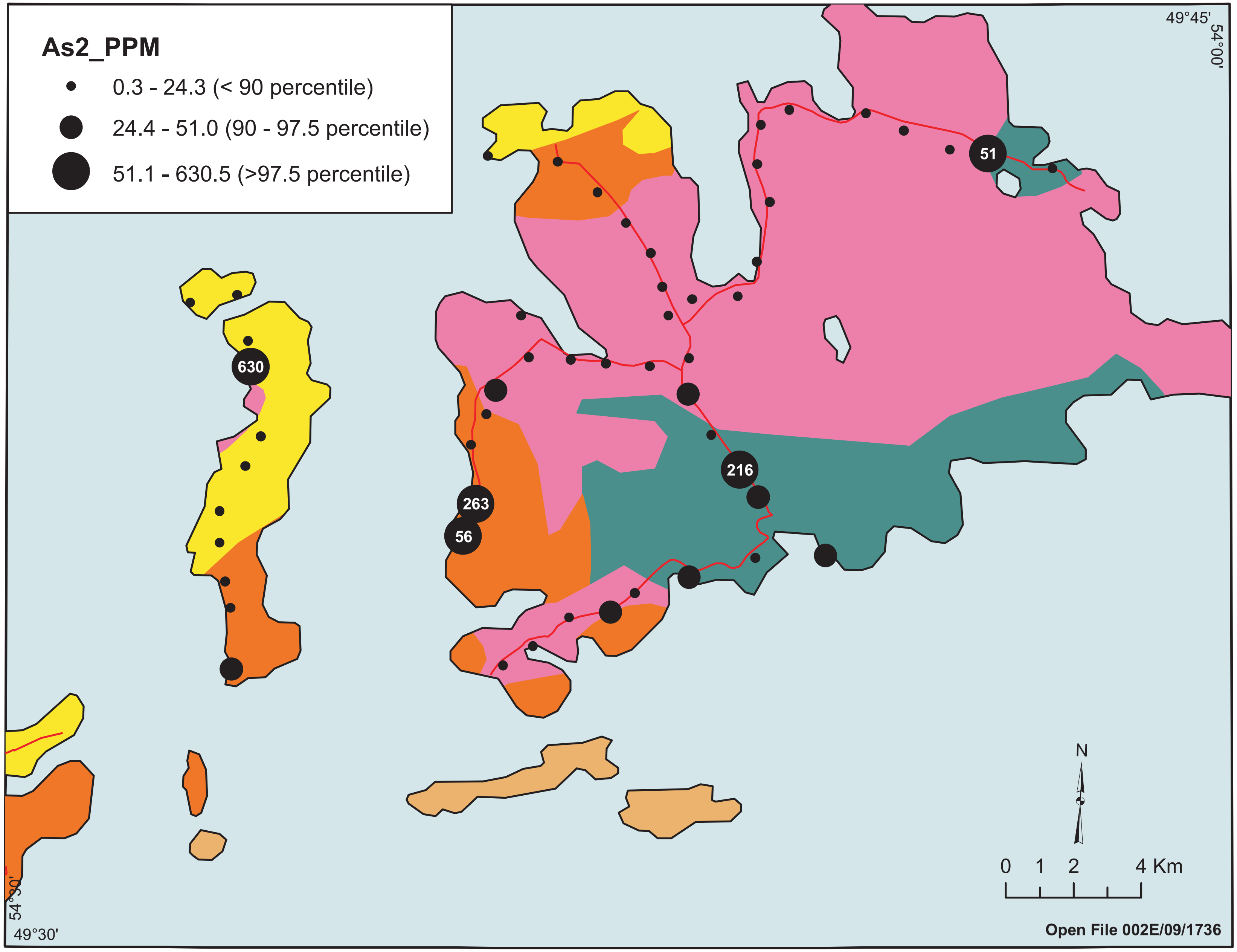

Figure 5. *Distribution of arsenic (As2) in till.*

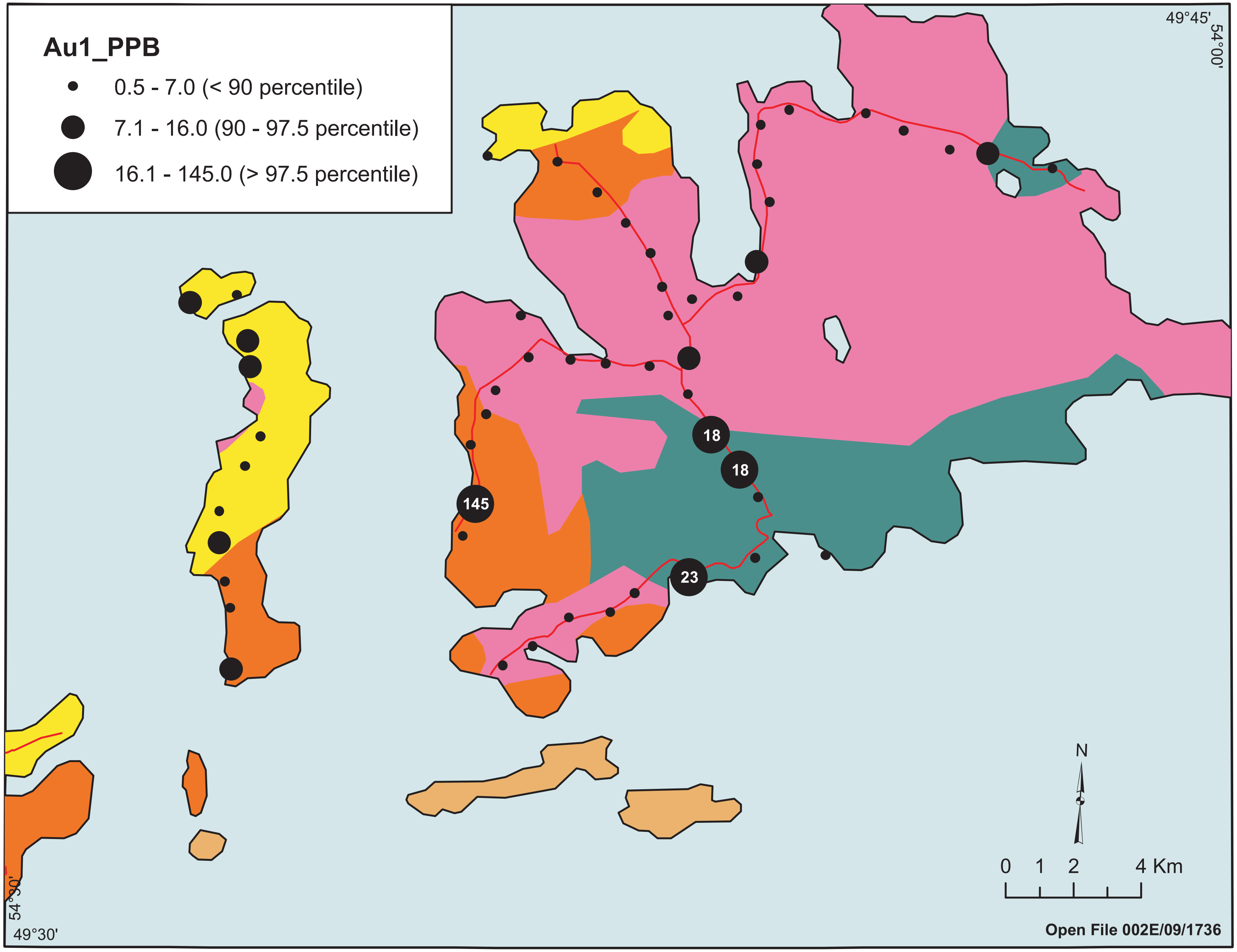

Figure 6. *Distribution of gold (Au1) in till.*

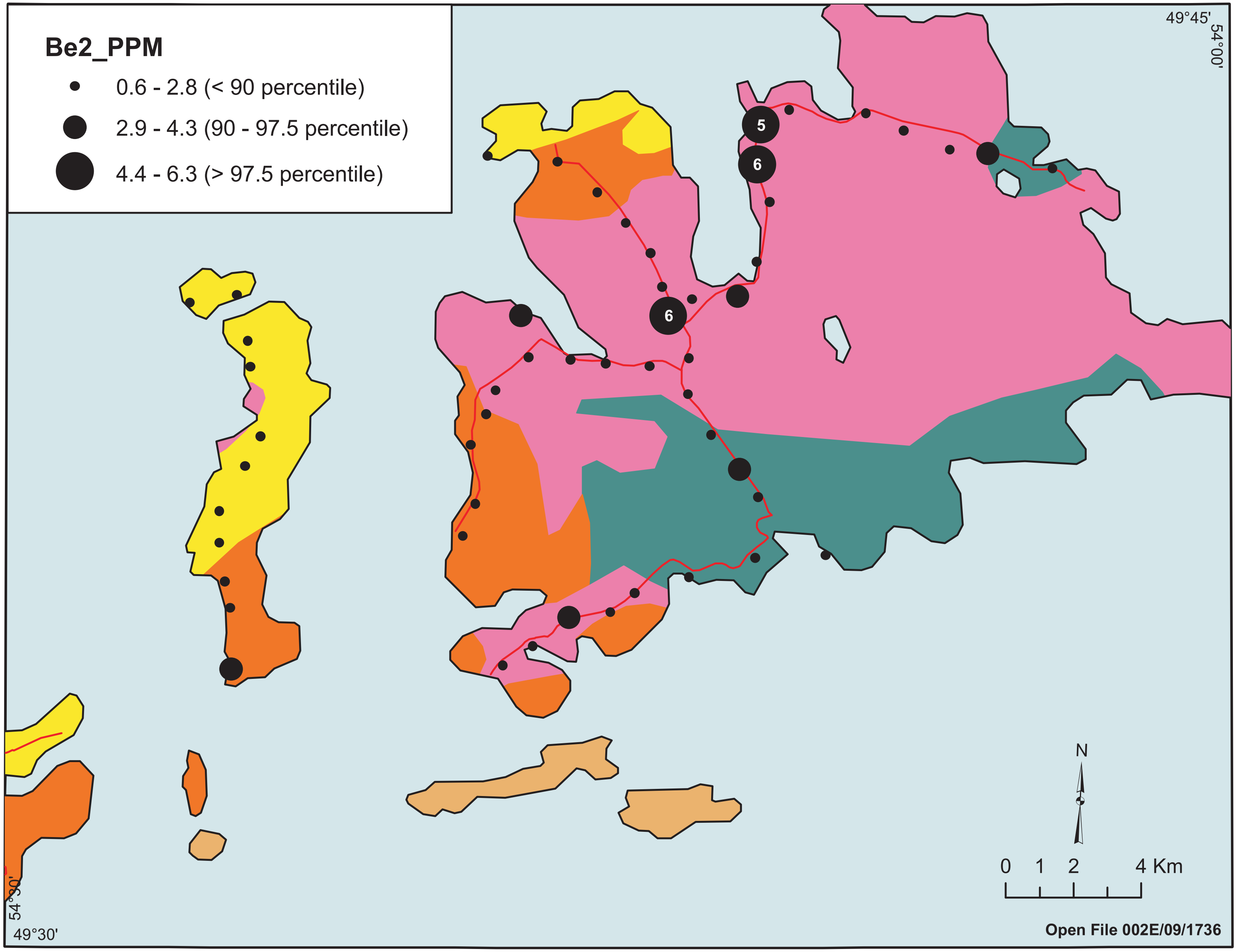

Figure 7. *Distribution of beryllium (Be2) in till.*

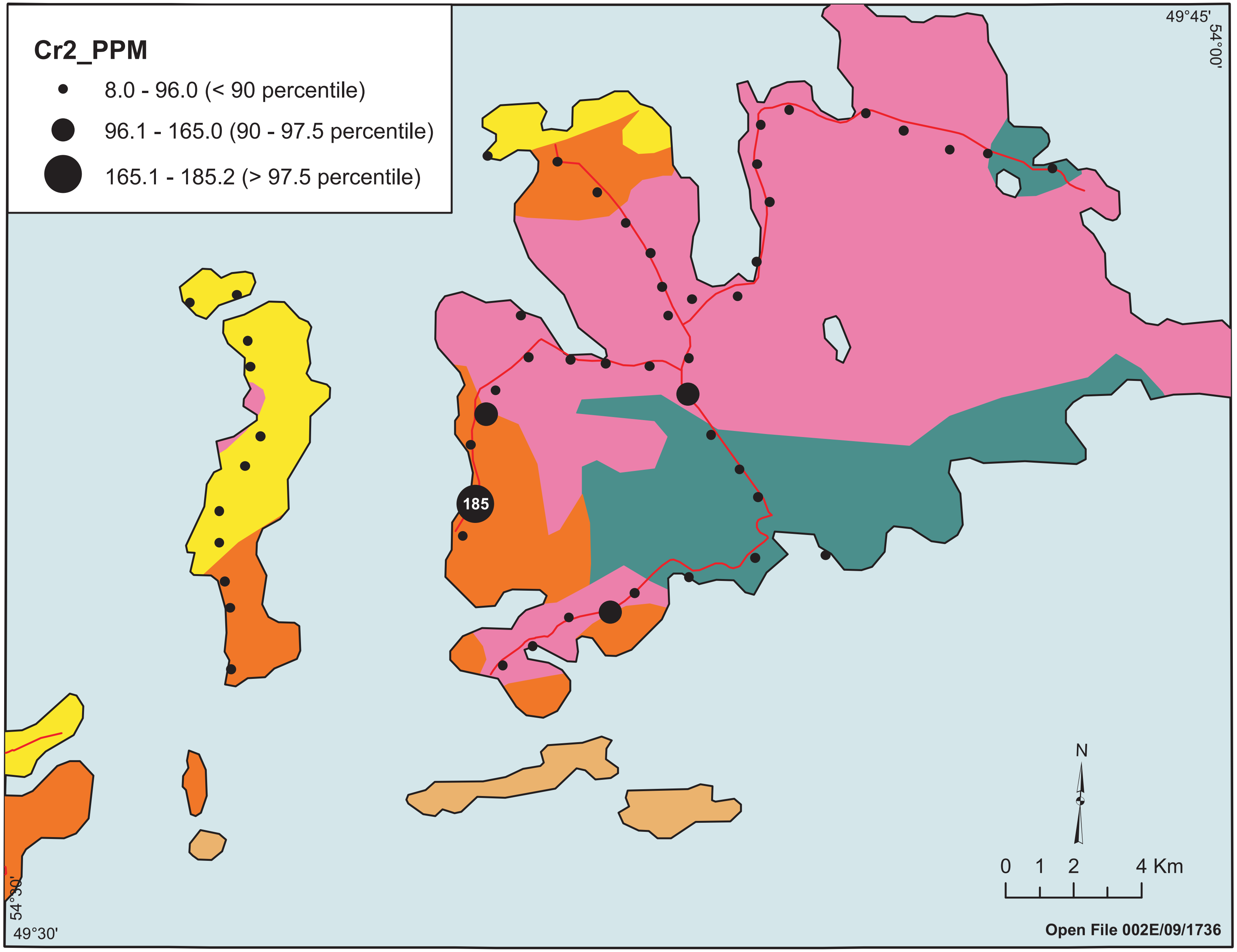

Figure 8. *Distribution of chromium (Cr2) in till.*

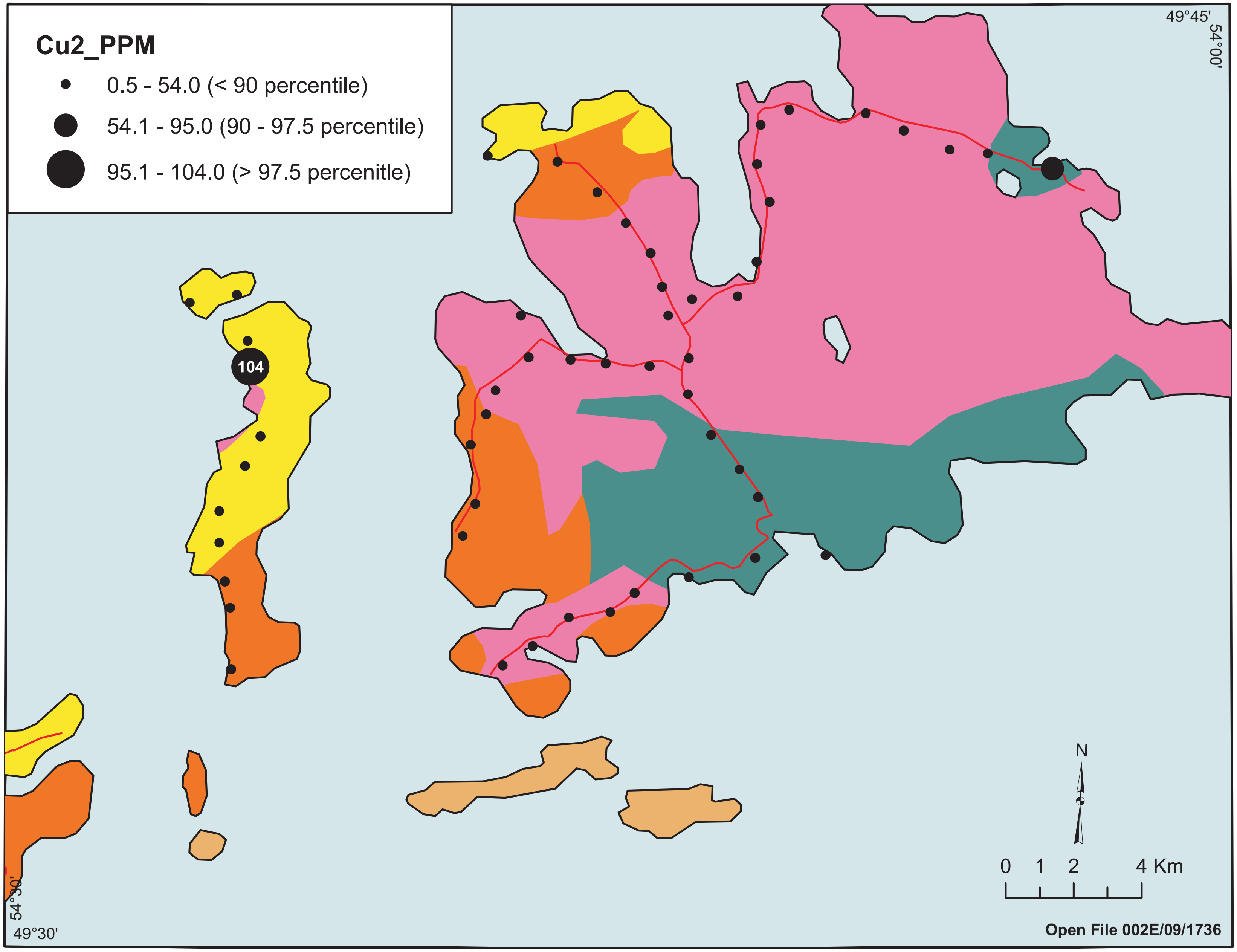

Figure 9. *Distribution of copper (Cu2) in till.*

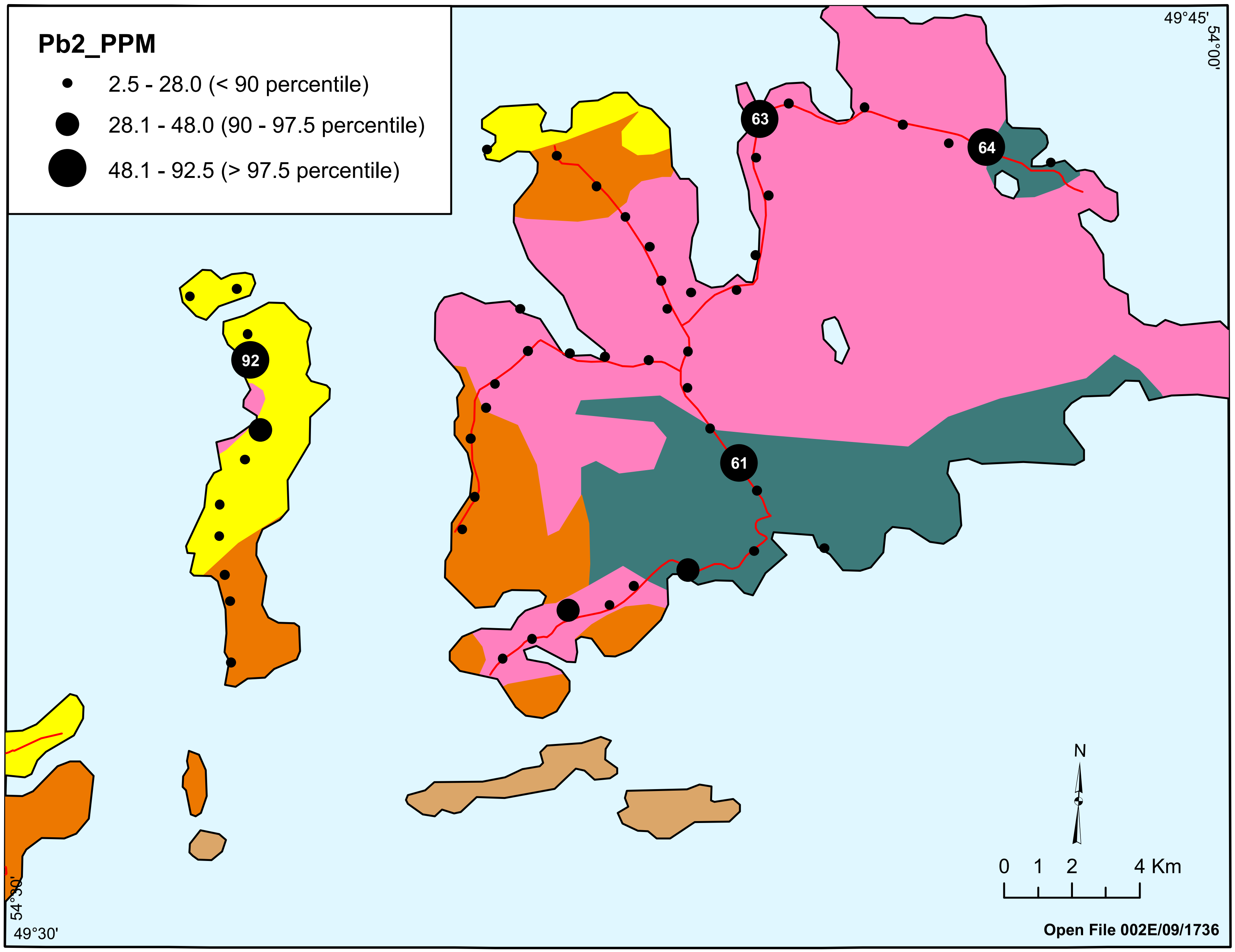

Figure 10. *Distribution of lead (Pb2) in till.*

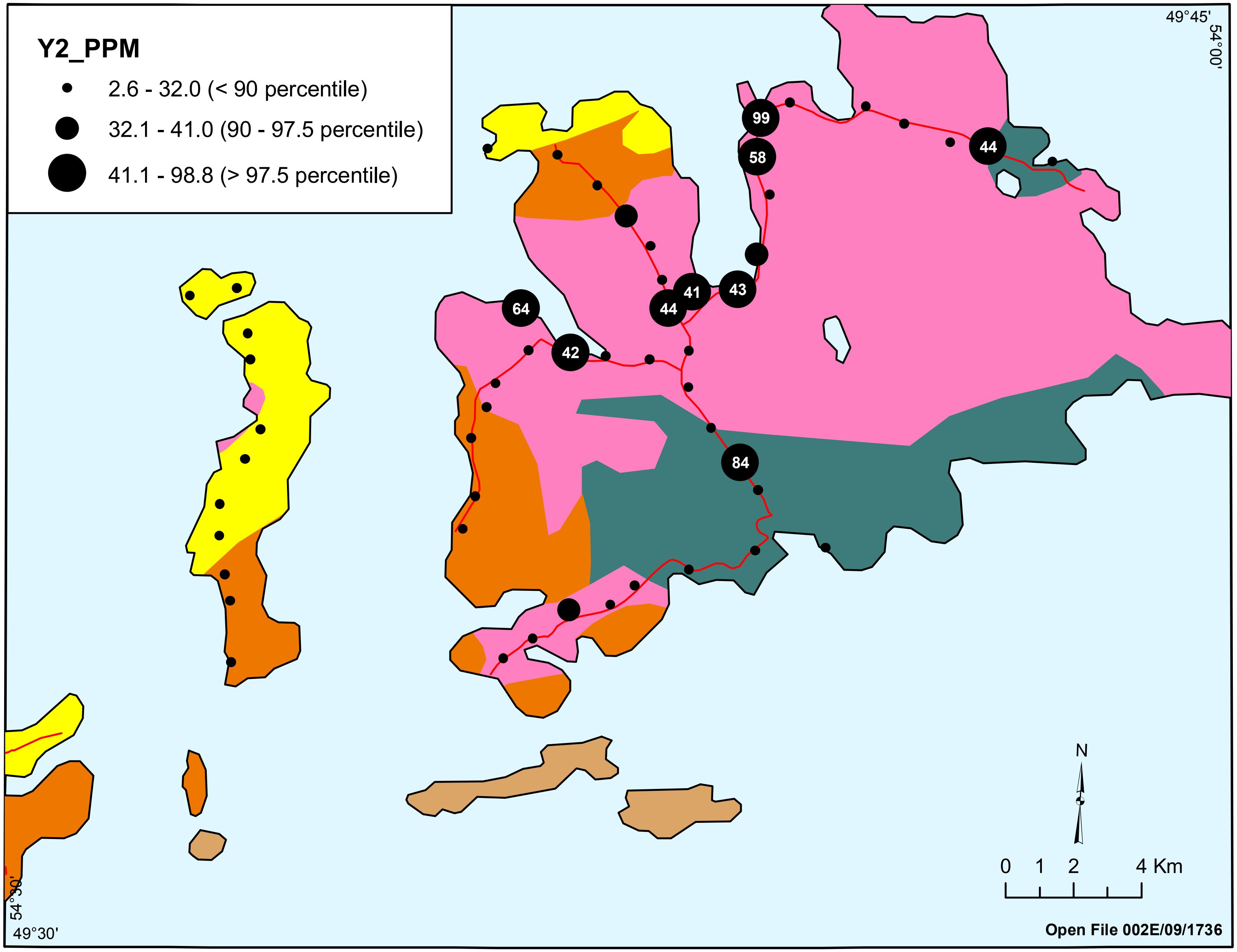

Figure 11. *Distribution of yttrium (Y2) in till.*

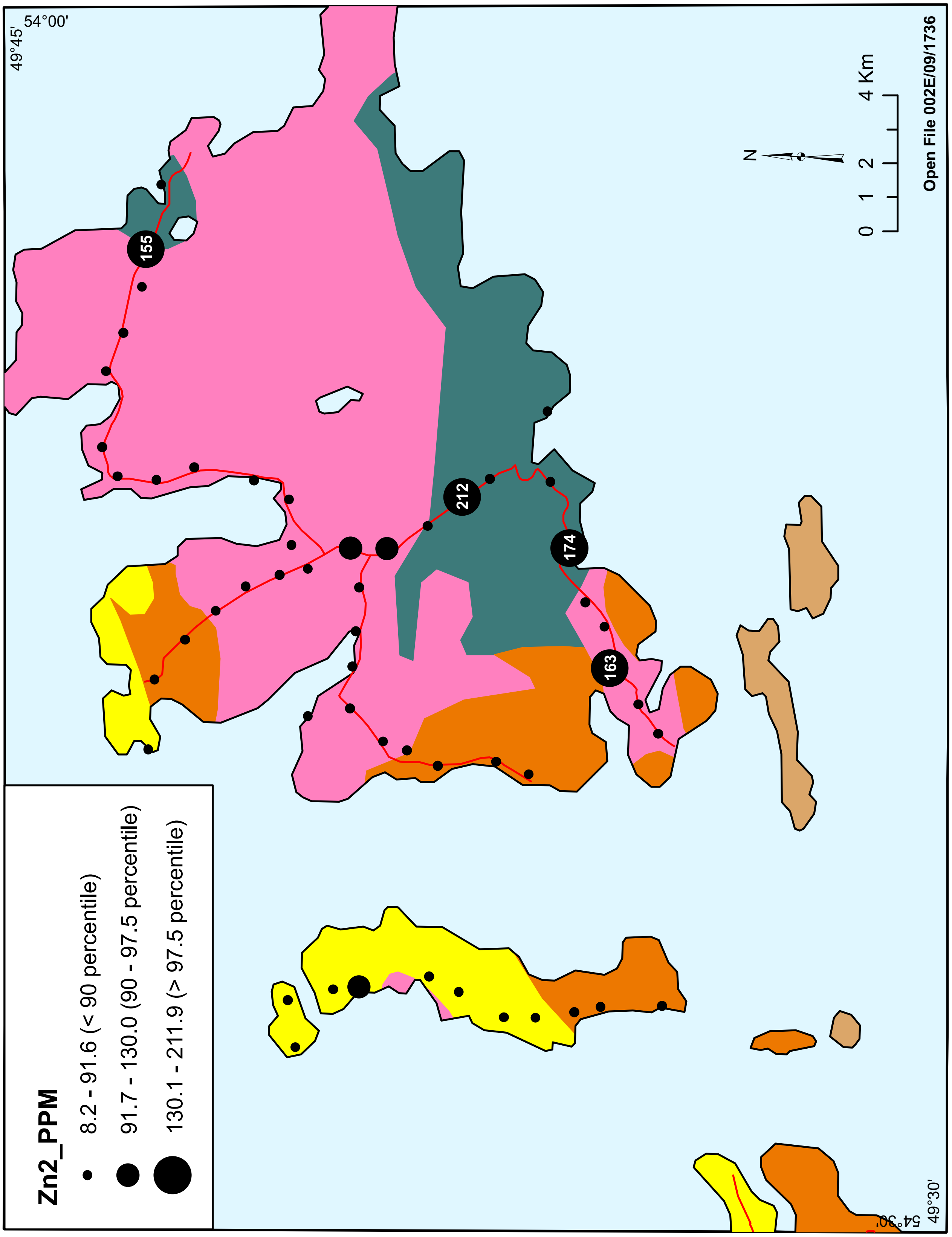

Figure 12. *Distribution of zinc (Zn2) in till.*

REFERENCES

Baird, D.M.
1958: Fogo Island map-area, Newfoundland. Geological Survey of Canada, Memoir 301.

Batterson, M.J. and Taylor, D.M.
1998: Surficial geology and geochemical sampling in the Grand Falls to Glenwood areas (NTS 2D/13, 2D/14, 2E/3). *In* Current Research. Newfoundland Department of Mines and Energy, Geological Survey Branch, Report 98-1, pages 1-8.

Batterson, M.J. and Vatcher, S.
1991: Quaternary geology of the Gander (NTS 2D/15) map area. *In* Current Research. Newfoundland Department of Mines and Energy, Geological Survey Branch, Report 91-1, pages 1-12.

Brushett, D.
2010: Quaternary geology of the Gander Lake and Gambo map area (NTS 2D/16 and 2C/13). *In* Current Research. Newfoundland and Labrador Department of Natural Resources, Geological Survey, Report 10-1, pages 159-170.

2011: Till geochemistry of the Gander Lake and Gambo map area (NTS 2D/16 and 2C/13). Government of Newfoundland and Labrador, Department of Natural Resources, Geological Survey, Open File NFLD/3134, 104 pages.

2012: Till geochemistry of northeast Newfoundland (NTS map areas 2C/13, 2D/15, 2D/16, 2E/01, 2E/08, 2F/04, and 2F/05). Government of Newfoundland and Labrador, Department of Natural Resources, Geological Survey, Open File NFLD/3174, 161 pages.

Butler, A.J., Miller, H.G. and Vanderveer, D.G.
1984: Geoscience studies in the Weir's Pond area, northeast of Gander, Newfoundland. *In* Current Research. Newfoundland Department of Mines and Energy, Mineral Development Division, Report 84-1, pages 271-278.

Colman-Sadd, S.P. and Crisby-Whittle, LV.J.
2005: Partial bedrock geology for the Island of Newfoundland (NTS 02E, 02F, 02L, 02M, 11O, 11P, 12A, 12B, 12G, 12H, 12I, 12P and parts of 01M, 02D). Newfoundland and Labrador Department of Natural Resources, Geological Survey, Open File NFLD/2616 version 6.0.

Currie, K.L.
1997: Fogo map area, Newfoundland. Geological Survey of Canada Open File 3466, 1:50 000 scale map.

Finch, C.J.
1998: Inductively coupled plasma-emission spectrometry (ICP-ES) at the Geochemical Laboratory. *In* Current Research. Newfoundland Department of Mines and Energy, Geological Survey, Report 98-1, pages 179-193.

Grant, D.R.
1974: Prospecting in Newfoundland and the theory of multiple shrinking ice caps. Geological Survey of Canada, Paper 74-1, Part B, pages 215-216.

1989: Quaternary geology of the Atlantic Appalachian region of Canada. *In* Quaternary Geology of Canada and Greenland. *Edited by* R.J. Fulton. Geological Survey of Canada, Geology of Canada No. 1, pages 391-400.

Jenks, G.F.
1967: The Data Model Concept in Statistical Mapping. International Yearbook of Cartography 7, pages 186-190.

Jenness, S.E.
1960: Late Pleistocene glaciation of eastern Newfoundland. Bulletin of the Geological Society of America, Volume 71, pages 161-179.

Kerr, A.
2011: Fogo Island – Exploring a composite bimodal magma chamber and its volcanic superstructure. Unpublished field trip guide and background material for Geological Association of Canada Newfoundland and Labrador Section Fall field trip.

2013: The Fogo Process from a geologist's prospective: a discussion of models and research problems. *In* Current Research. Newfoundland and Labrador Department of Natural Resources, Geological Survey, Report 13-1, pages 233-265.

Kirby, F.T., Ricketts, R.J. and Vanderveer, D.G.
2011: Surficial geology of the Fogo map area (NTS 2E/09). Geological Survey, Department of Natural Resources. Government of Newfoundland and Labrador, Map 2011-27. Open File 02E/09/1699.

Licthe, F.E., Golightly, D.W. and Lamothe, P.J.
1987: Inductively coupled Plasma-Atomic emission Spectrometry. *In* Methods for Geochemical Analysis. U.S. Geological Survey Bulletin 1770, pages B1-B10.

Newfoundland and Labrador Geological Survey
2013: "Mineral Occurrence Database System (MODS)." Newfoundland and Labrador GeoScience Atlas OnLine. [February 7, 2014]. http://gis.geosurv.gov.nl.ca/resourceatlas/viewer.htm

Proudfoot, D.N., Scott, S., St. Croix, L., Taylor, D.M. and Vanderveer, D.G.
1988: Glacial striations in southeast-central Newfoundland. 1:250 000 scale. Newfoundland Department of Mines and Energy, Mineral Development Division, Map 88-102, Open file NFLD 1725.

Rogerson, R.J.
1982: The glaciation of Newfoundland and Labrador. *In* Prospecting in Areas of Glaciated Terrain - 1982. *Edited by* P.H. Davenport. Canadian Institute of Mining and Metallurgy, pages 37-56.

Sandeman, H.A. and Malpas, J.G.
1995: Epizonal I- and A-type granites and associated ash-flow tuffs, Fogo Island, northeast Newfoundland. Canadian Journal of Earth Sciences, Volume 32, pages 1835-1844.

Scott, S.
1994: Surficial geology and drift exploration of Comfort Cove-Newstead and Gander River map areas (NTS 2E/7 and 2E/2). *In* Current Research. Newfoundland Department of Mines and Energy, Geological Survey Branch, Report 94-1, pages 29-42.

Shaw, J.
2003: Submarine moraines in Newfoundland coastal waters: implications for the deglaciation of Newfoundland and adjacent areas. Quaternary International, Volume 99-100, pages 115-134.

Shaw, J., Piper, D.J.W., Fader, G.B., King, E.L., Todd, B.J., Bell, T., Batterson, M.J. and Liverman, D.G.E.
2006: A conceptual model of the deglaciation of Atlantic Canada. Quaternary Science Reviews, Volume 25, pages 2059-2081.

Smith, J.S.
2010: Glacial stratigraphy of the southwest Red Indian Lake Basin, Newfoundland: preliminary results. *In* Current Research. Government of Newfoundland and Labrador, Department of Natural Resources, Geological Survey, Report 10-1, pages 201-217.

2012: The paleogeography of glacial Lake Shanadithit, Red Indian Lake Basin, Newfoundland: implications for drift prospecting. *In* Current Research. Government of Newfoundland and Labrador, Department of Natural Resources, Geological Survey, Report 12-1, pages 207-227.

St. Croix, L. and Taylor, D.M.
1990: Ice flow in north-central Newfoundland. *In* Current Research. Newfoundland Department of Mines and Energy, Geological Survey Branch, Report 90-1, pages 85-88.

1991: Regional striation survey and deglacial history of the Notre Dame Bay area, Newfoundland. *In* Current Research. Newfoundland Department of Mines and Energy, Geological Survey Branch, Report 91-1, pages 61-68.

Vanderveer, D.G. and Sparkes, B.G.
1982: Regional Quaternary mapping; an aid to mineral exploration in west-central Newfoundland. *In* Prospecting in Areas of Glaciated Terrain-1982. *Edited by* P.H. Davenport. Canadian Institute of Mining and Metallurgy, Geology Division, pages 284-299.

Vanderveer, D.G. and Taylor, D.M.
1987: Quaternary mapping in the Gander River area, Newfoundland. *In* Current Research. Newfoundland Department of Mines and Energy, Mineral Development Division, Report 87-1, pages 39-43.

Williams, H., Colman-Sadd, S.P. and Swinden, H.S.
1988: Tectonic-stratigraphic subdivisions of central Newfoundland. *In* Current Research. Geological Survey of Canada, Paper 88-1B, pages 91-98.

APPENDIX A: Analytical Methods

Gravimetric Analysis (LOI)

Organic carbon content was estimated from the weight loss-on-ignition (LOI) during a controlled combustion in which 1g aliquots of sample were gradually heated to 500°C in air over a 3 hour period.

Inductively Coupled Plasma-Optical Emission Spectrometry (ICP-OES)

For these analyses, the procedures outlined by Finch (1998) were followed. One gram of sample was weighed into a 125 ml Teflon beaker, and 15 ml HF (~48%), 5 ml of concentrated HCl and 5 ml of 1:1 $HClO_4$ was added to each sample. The samples were placed on a hotplate at 200°C and evaporated to dryness, after which 5 ml concentrated HCl and 45 ml deionized water were added and returned to the hotplate at 100°C. When the residue was completely dissolved the samples were removed, cooled and transferred to 50 ml volumetric flasks. One ml of 50 g/l boric acid was added to each sample to remove any residual hydrofluoric acid. The samples were made to volume and analyzed by ICP-OES (Licthe *et al.*, 1987). For most minerals dissolution was total; exceptions were chromite, barite and zircon.

Values for the following elements were determined: Al, Ba, Be, Ca, Ce, Co, Cr, Cu, Dy, Fe, Ga, K, La, Li, Mg, Mn, Mo, Na, Nb, Ni, P, Pb, Rb, Sc, Sr, Ti, V, Y, Zn and Zr.

Instrumental Neutron Activation Analysis (INAA)

These analyses were carried out at Becquerel Laboratories, Mississauga, Ontario. An average of 24 g of sample was used for analysis and the samples were weighed and encapsulated in the Geochemical Laboratory of the Department of Natural Resources in St. John's. Samples were irradiated with flux wires and an internal standard (1 for 11 samples) at a thermal neutron flux of 7 x 10^{11} n/cm^{2}s. After 7 days (to allow Na^{24} to decay), samples were counted on a high purity Ge detector with a resolution of better than 1.7 KeV. Using the flux wires, the decay-corrected activities were compared to a calibration developed from multiple certified international reference materials. The standard present is only a check on accuracy of the analysis and is not used for calibration purposes. Ten to 30 percent of the samples were checked by re-measurement.

Total contents of the following elements were determined quantitatively: As, Au, Ba, Br, Ca, Ce, Co, Cr, Cs, Eu, Fe, Hf, Hg, Ir, La, Lu, Mo, Na, Nd, Ni, Rb, Sb, Sc, Se, Sm, Sn, Sr, Ta, Tb, Th, U, W, Yb, Zn, and Zr.

APPENDIX B

Field and Geochemical Data

NTS_MAP	UTMEAST	UTMNORTH	UTMZONE	DATUM	LONG_NAD27	LAT_NAD27	AG1_PPM	AG6_PPM	AL2_PCT	AS1_PPM	AS2_PPM	AU1_PPB	AU27_PPB	BA1_PPM	BA2_PPM	BE2_PPM	BR1_PPM
02E/09	687154	5505497	21	NAD 27	0.00000	0.00000	-9	-9	6.79	0.9	7	5	-9	270	276	1.5	55
02E/09	685786	5505216	21	NAD 27	54.42502	49.67279	-9	-9	5.73	0.3	1	12	-9	190	244	0.6	71
02E/09	687531	5504166	21	NAD 27	54.40137	49.66281	-9	-9	7.31	12.0	14	13	-9	180	216	1.3	59
02E/09	687628	5503397	21	NAD 27	0.00000	0.00000	-9	-9	6.29	606.0	630	9	-9	250	296	1.8	31
02E/09	688007	5501359	21	NAD 27	54.39613	49.63745	-9	-9	6.91	7.8	11	3	-9	240	254	1.6	48
02E/09	687585	5500458	21	NAD 27	54.40240	49.62948	-9	-9	6.79	6.4	7	2	-9	240	276	1.5	17
02E/09	686883	5499108	21	NAD 27	54.41276	49.61757	-9	-9	6.30	8.7	9	3	-9	320	334	1.3	20
02E/09	686908	5498169	21	NAD 27	54.41285	49.60913	-9	-9	5.94	6.9	7	13	-9	220	238	1.3	8
02E/09	687108	5497035	21	NAD 27	54.41063	49.59888	-9	-9	8.76	3.5	3	7	-9	380	393	1.6	8
02E/09	687291	5496255	21	NAD 27	54.40847	49.59181	-9	-9	5.38	3.3	4	4	-9	310	333	1.0	4
02E/09	687390	5494455	21	NAD 27	54.40796	49.57560	-9	-9	9.20	14.0	27	9	-9	110	150	2.8	216
02E/09	695411	5494861	21	NAD 27	54.29694	49.57672	-9	-9	6.88	15.0	15	2	-9	170	205	1.3	16
02E/09	696262	5495468	21	NAD 27	0.00000	0.00000	-9	-9	6.37	4.9	6	5	-9	270	285	1.4	2
02E/09	697294	5496348	21	NAD 27	54.27017	49.58947	-9	-9	6.89	23.0	24	6	-9	310	331	2.8	10
02E/09	698518	5496547	21	NAD 27	54.25315	49.59085	-9	-9	6.39	33.0	33	4	-9	270	294	1.6	13
02E/09	699205	5497146	21	NAD 27	54.24336	49.59601	-9	-9	6.06	19.0	19	5	-9	300	315	1.5	3
02E/09	700800	5497673	21	NAD 27	54.22105	49.60022	-9	-9	6.51	25.0	26	23	-9	430	464	2.7	17
02E/09	702723	5498308	21	NAD 27	54.19414	49.60528	-9	-9	6.10	25.0	24	5	-9	260	271	1.4	2
02E/09	704803	5498461	21	NAD 27	54.16531	49.60595	-9	-9	7.43	21.0	27	4	-9	260	312	1.7	119
02E/09	696464	5509769	21	NAD 27	54.27492	49.71032	-9	-9	6.59	2.5	5	1	-9	470	491	2.3	46
02E/09	697678	5508915	21	NAD 27	54.25853	49.70225	-9	-9	6.09	6.3	8	1	-9	420	453	1.9	49
02E/09	698559	5508033	21	NAD 27	54.24677	49.69403	-9	-9	6.74	6.0	7	2	-9	450	481	2.5	21
02E/09	699305	5507184	21	NAD 27	54.23688	49.68616	-9	-9	6.76	10.0	12	5	-9	380	407	2.1	46
02E/09	699681	5506196	21	NAD 27	54.23218	49.67715	-9	-9	6.77	13.0	16	4	-9	340	361	1.7	70
02E/09	699901	5505358	21	NAD 27	54.22956	49.66956	-9	-9	8.42	10.0	11	1	-9	390	449	6.0	28
02E/09	700557	5504129	21	NAD 27	54.22111	49.65829	-9	-9	6.34	11.0	10	9	-9	380	388	2.0	5
02E/09	700578	5503055	21	NAD 27	54.22136	49.64864	-9	-9	7.27	44.0	38	4	-9	450	424	1.6	8
02E/09	701300	5501883	21	NAD 27	54.21198	49.63787	-9	-9	6.66	15.0	14	18	-9	410	420	1.8	24
02E/09	702181	5500895	21	NAD 27	54.20030	49.62870	-9	-9	6.64	225.0	216	18	-9	360	387	3.1	25
02E/09	702742	5500101	21	NAD 27	54.19296	49.62138	-9	-9	6.60	25.0	26	1	-9	350	382	1.3	26
02E/09	694087	5498630	21	NAD 27	54.31336	49.61101	-9	-9	5.56	48.0	56	1	-9	500	577	1.1	117
02E/09	694423	5499605	21	NAD 27	54.30824	49.61966	-9	-9	8.45	222.0	263	145	-9	270	315	2.3	261
02E/09	694219	5501322	21	NAD 27	54.31021	49.63515	-9	-9	7.25	0.3	1	1	-9	510	560	2.5	32
02E/09	694641	5502255	21	NAD 27	54.30391	49.64340	-9	-9	6.67	18.0	23	5	-9	460	511	2.6	103
02E/09	694893	5502963	21	NAD 27	54.30007	49.64967	-9	-9	5.81	31.0	28	5	-9	280	270	1.4	18
02E/09	695829	5503979	21	NAD 27	54.28661	49.65850	-9	-9	6.29	10.0	10	2	-9	490	484	2.3	5
02E/09	695547	5505196	21	NAD 27	54.28991	49.66953	-9	-9	7.08	17.0	24	5	-9	430	466	3.6	149
02E/09	697065	5503951	21	NAD 27	54.26952	49.65785	-9	-9	7.23	9.1	10	4	-9	560	547	2.6	28
02E/09	698112	5503883	21	NAD 27	54.25507	49.65689	-9	-9	6.42	22.0	20	6	-9	350	336	1.7	4
02E/09	699397	5503840	21	NAD 27	54.23731	49.65608	-9	-9	6.39	3.5	3	3	-9	460	467	2.5	5
02E/09	694395	5509870	21	NAD 27	54.30353	49.71190	-9	-9	4.48	2.7	3	2	-9	440	468	1.6	35
02E/09	700586	5505870	21	NAD 27	54.21981	49.67392	-9	-9	6.85	10.0	10	7	-9	540	530	2.6	17
02E/09	701924	5505995	21	NAD 27	54.20123	49.67461	-9	-9	8.07	1.6	1	4	-9	650	678	2.9	33
02E/09	702443	5507048	21	NAD 27	54.19349	49.68389	-9	-9	6.04	4.3	7	8	-9	580	567	2.1	11
02E/09	702760	5508825	21	NAD 27	54.18819	49.69975	-9	-9	8.36	6.6	11	1	-9	190	210	1.7	139
02E/09	702357	5509919	21	NAD 27	54.19320	49.70971	-9	-9	7.55	4.2	10	1	-9	410	422	6.3	177
02E/09	702432	5511085	21	NAD 27	54.19156	49.72016	-9	-9	6.50	12.0	14	2	-9	430	449	5.2	21
02E/09	703256	5511560	21	NAD 27	54.17989	49.72415	-9	-9	6.00	2.3	4	1	-9	470	475	2.0	62
02E/09	711084	5510104	21	NAD 27	54.07222	49.70838	-9	-9	8.27	0.3	1	1	-9	150	141	1.0	189
02E/09	709160	5510484	21	NAD 27	54.09867	49.71246	-9	-9	7.74	50.9	51	16	-9	360	378	3.6	3
02E/09	708036	5510554	21	NAD 27	54.11420	49.71348	-9	-9	5.84	8.6	9	4	-9	370	399	1.5	35
02E/09	706650	5511067	21	NAD 27	54.13313	49.71857	-9	-9	7.27	8.6	8	2	-9	320	326	1.7	27
02E/09	705511	5511540	21	NAD 27	54.14866	49.72320	-9	-9	7.61	10.0	10	1	-9	410	425	2.0	31

CA1_PCT	CA2_PCT	CD2_PPM	CE1_PPM	CE2_PPM	CO1_PPM	CO2_PPM	CO4_PPM	CR1_PPM	CR2_PPM	CR4_PPM	CS1_PPM	CU2_PPM	CU4_PPM	DY2_PPM	EU1_PPM	FE1_PCT	FE2_PCT	FE4_PCT
-9	1.55	0.05	26	55	8	10	-9	14	58	-9	2.6	37	-9	2.6	0.1	0.5	2.76	-9
-9	0.36	0.05	11	17	8	1	-9	21	22	-9	2.9	4	-9	0.4	0.1	1.0	1.25	-9
-9	1.25	0.2	48	66	22	14	-9	16	17	-9	5.3	42	-9	2.3	2.0	7.8	8.25	-9
-9	0.35	0.2	110	116	97	78	-9	64	52	-9	6.6	104	-9	2.0	1.9	4.2	4.37	-9
-9	0.94	0.05	44	47	9	4	-9	110	36	-9	2.2	6	-9	1.7	1.1	3.2	2.98	-9
-9	1.55	0.05	52	55	13	10	-9	160	58	-9	5.4	37	-9	2.6	1.6	2.7	2.76	-9
-9	1.26	0.05	47	49	20	15	-9	160	71	-9	5.4	36	-9	1.8	1.8	3.4	3.46	-9
-9	1.26	0.05	51	48	8	6	-9	160	53	-9	2.7	19	-9	1.6	1.0	2.2	2.25	-9
-9	0.32	0.05	34	34	12	10	-9	72	46	-9	14.0	8	-9	1.0	0.7	3.0	3.09	-9
-9	0.78	0.05	37	35	2	2	-9	120	41	-9	3.3	3	-9	0.8	0.8	1.0	1.07	-9
-9	1.00	0.1	120	126	34	13	-9	74	70	-9	2.0	35	-9	6.0	2.6	3.1	3.24	-9
-9	1.48	0.05	64	60	11	7	-9	180	76	-9	1.8	15	-9	2.6	1.5	2.6	2.69	-9
-9	1.42	0.1	66	61	12	9	-9	200	81	-9	3.5	25	-9	2.2	1.3	2.9	2.89	-9
-9	1.16	0.1	110	114	17	14	-9	150	79	-9	5.1	35	-9	6.2	2.1	3.5	3.70	-9
-9	1.12	0.2	83	85	19	15	-9	210	97	-9	2.8	35	-9	2.7	1.5	4.0	4.11	-9
-9	1.29	0.2	82	78	17	13	-9	190	78	-9	2.9	23	-9	2.8	1.7	3.4	3.47	-9
-9	0.99	0.2	84	91	12	9	-9	110	66	-9	3.4	27	-9	4.7	1.6	4.0	4.30	-9
-9	2.05	0.2	69	75	22	18	-9	150	87	-9	3.1	38	-9	3.1	1.7	5.0	5.23	-9
-9	1.26	0.2	49	62	100	78	-9	72	65	-9	2.9	18	-9	1.7	1.4	5.4	6.02	-9
-9	1.19	0.05	59	65	8	4	-9	71	44	-9	1.9	6	-9	4.5	1.9	2.2	2.15	-9
-9	0.87	0.05	40	45	7	3	-9	71	42	-9	2.8	7	-9	2.8	0.9	2.3	2.39	-9
-9	1.03	0.05	52	59	5	3	-9	37	25	-9	2.6	5	-9	5.1	1.1	2.4	2.36	-9
-9	1.22	0.05	61	66	9	4	-9	61	40	-9	1.9	5	-9	4.7	1.2	3.1	2.98	-9
-9	1.17	0.05	59	65	12	5	-9	90	56	-9	2.2	7	-9	4.0	1.3	3.5	3.44	-9
-9	0.86	0.1	23	35	3	1	-9	12	8	-9	3.1	2	-9	6.0	0.8	2.3	2.63	-9
-9	1.25	0.1	92	88	12	10	-9	120	58	-9	2.6	23	-9	4.2	1.7	3.1	3.14	-9
-9	2.81	0.2	65	69	24	18	-9	150	105	-9	2.6	22	-9	4.0	2.0	5.2	4.90	-9
-9	1.88	0.05	52	60	11	8	-9	89	64	-9	2.0	10	-9	3.3	1.3	3.5	3.62	-9
-9	1.02	0.05	130	157	11	11	-9	110	70	-9	3.3	17	-9	13.8	4.3	4.1	3.98	-9
-9	1.65	0.05	66	56	9	7	-9	95	62	-9	4.0	4	-9	2.1	1.5	4.6	4.84	-9
-9	0.32	0.05	28	40	18	9	-9	78	70	-9	5.0	10	-9	0.9	0.6	5.8	6.24	-9
-9	0.59	0.05	130	136	26	7	-9	230	185	-9	2.1	53	-9	4.9	1.9	5.2	4.98	-9
-9	2.51	0.05	43	41	6	3	-9	40	31	-9	1.4	25	-9	3.2	3.2	1.6	1.54	-9
-9	0.72	0.1	110	113	33	23	-9	170	140	-9	15.0	22	-9	3.4	1.9	7.8	7.39	-9
-9	1.30	0.05	92	73	19	14	-9	220	83	-9	2.2	28	-9	1.9	1.7	3.8	3.50	-9
-9	1.13	0.05	73	66	7	6	-9	69	39	-9	2.1	11	-9	4.2	1.3	2.8	2.64	-9
-9	0.43	0.05	42	56	10	2	-9	23	21	-9	3.8	14	-9	11.0	1.7	5.3	5.45	-9
-9	0.96	0.05	110	106	7	6	-9	81	45	-9	4.6	5	-9	8.0	2.0	2.9	2.63	-9
-9	1.38	0.05	89	82	13	11	-9	150	68	-9	2.8	25	-9	3.2	1.9	3.7	3.57	-9
-9	1.16	0.05	66	68	5	4	-9	56	33	-9	2.0	8	-9	4.9	1.5	2.1	2.06	-9
-9	0.22	0.05	13	12	1	1	-9	34	11	-9	1.2	1	-9	1.4	0.5	0.6	0.58	-9
-9	0.96	0.05	99	92	9	7	-9	68	36	-9	2.4	12	-9	7.2	1.5	2.8	2.62	-9
-9	0.92	0.05	63	60	3	2	-9	20	13	-9	5.5	1	-9	6.5	1.6	3.1	3.08	-9
-9	0.76	0.05	280	223	3	3	-9	19	9	-9	4.1	9	-9	6.2	1.7	2.4	2.16	-9
-9	1.24	0.1	34	68	12	3	-9	15	17	-9	6.1	10	-9	3.2	2.1	14.6	13.41	-9
-9	0.35	0.05	210	171	18	7	-9	47	28	-9	3.0	7	-9	9.7	1.0	6.3	5.79	-9
-9	0.43	0.05	280	289	2	4	-9	17	9	-9	4.2	22	-9	15.8	1.7	2.0	2.15	-9
-9	0.57	0.05	51	52	5	2	-9	25	15	-9	2.4	6	-9	3.6	1.1	2.6	2.55	-9
-9	3.81	0.1	52	78	51	30	-9	75	65	-9	0.5	67	-9	2.9	1.8	9.1	8.84	-9
-9	1.29	0.2	130	137	14	13	-9	50	40	-9	7.7	24	-9	6.6	2.1	4.2	4.25	-9
-9	1.08	0.05	34	29	5	3	-9	57	25	-9	2.7	2	-9	1.9	1.0	2.5	2.31	-9
-9	1.30	0.05	60	54	7	5	-9	60	30	-9	1.7	6	-9	3.0	1.1	2.8	2.66	-9
-9	1.30	0.05	50	52	6	5	-9	53	40	-9	5.7	4	-9	3.0	1.3	4.7	4.56	-9

GA2_PPM	HF1_PPM	HG1_PPM	IR1_PPB	K2_PCT	LA1_PPM	LA2_PPM	LI2_PPM	LOI_PCT	LU1_PPM	MG2_PCT	MN2_PPM	MN4_PPM	MO1_PPM	MO2_PPM	NA1_PCT	NA2_PCT	NB2_PPM	ND1_PPM
-9	7	-9	-9	1.01	14	24	26.7	9.3	0.25	1.13	919	-9	0.5	0.5	2.40	1.62	6.8	-9
-9	2	-9	-9	1.01	7	7	1.3	24.3	0.14	0.17	74	-9	0.5	1.7	2.50	2.94	5.4	-9
-9	4	-9	-9	1.13	26	26	30.7	14.6	0.26	1.11	1698	-9	0.5	1.0	1.90	1.67	5.5	-9
-9	5	-9	-9	1.64	57	57	40.7	13.3	0.43	0.76	5048	-9	2.0	5.1	1.10	0.98	12.4	-9
-9	7	-9	-9	1.09	24	20	19.3	6.4	0.37	0.59	709	-9	0.5	0.5	2.10	1.81	8.1	-9
-9	7	-9	-9	1.01	26	24	26.7	6.9	0.35	1.13	919	-9	0.5	0.5	1.70	1.62	6.8	-9
-9	7	-9	-9	1.01	24	21	41.2	6.0	0.39	1.07	1666	-9	0.5	0.5	1.60	1.50	7.1	-9
-9	9	-9	-9	0.96	26	22	25.7	3.7	0.35	0.87	1072	-9	0.5	0.5	1.80	1.70	7.4	-9
-9	4	-9	-9	2.25	21	15	27.3	5.5	0.23	1.12	396	-9	0.5	0.5	1.70	1.53	3.4	-9
-9	13	-9	-9	1.36	18	16	4.3	3.0	0.28	0.30	312	-9	0.5	0.5	1.60	1.71	6.3	-9
-9	3	-9	-9	0.51	41	44	42.3	36.9	0.34	0.90	849	-9	0.5	2.0	0.82	0.76	7.2	-9
-9	7	-9	-9	0.78	30	26	22.8	7.1	0.37	0.94	1317	-9	0.5	0.5	1.80	1.75	8.4	-9
-9	8	-9	-9	1.09	33	28	26.8	2.6	0.45	1.08	1237	-9	0.5	0.5	1.80	1.75	9.0	-9
-9	7	-9	-9	1.29	56	54	38.9	5.5	0.68	1.25	1160	-9	0.5	2.0	1.70	1.58	10.1	-9
-9	8	-9	-9	1.21	39	35	31.9	3.4	0.48	1.15	2291	-9	0.5	0.5	1.70	1.59	8.5	-9
-9	9	-9	-9	1.21	38	33	31.1	2.9	0.51	1.03	1628	-9	2.0	2.5	1.80	1.69	9.2	-9
-9	10	-9	-9	1.74	39	40	49.4	7.2	0.68	1.31	1276	-9	0.5	1.0	1.80	1.71	14.4	-9
-9	9	-9	-9	1.09	34	32	25.2	2.5	0.47	1.54	1317	-9	0.5	0.5	1.70	1.64	7.1	-9
-9	6	-9	-9	1.07	21	24	26.0	18.6	0.36	1.04	5125	-9	0.5	2.3	1.60	1.61	12.3	-9
-9	12	-9	-9	2.07	36	34	19.4	4.6	0.64	0.66	474	-9	0.5	0.5	2.20	1.99	12.1	-9
-9	13	-9	-9	1.97	19	17	14.6	9.5	0.56	0.48	480	-9	0.5	0.5	1.90	1.93	14.4	-9
-9	16	-9	-9	2.25	25	23	18.3	3.6	0.91	0.43	427	-9	0.5	0.5	2.60	2.40	13.6	-9
-9	15	-9	-9	1.74	26	23	18.0	5.5	0.92	0.62	585	-9	0.5	0.5	2.40	2.13	15.3	-9
-9	14	-9	-9	1.41	30	27	20.0	8.3	0.73	0.80	762	-9	0.5	1.1	2.00	1.85	14.8	-9
-9	59	-9	-9	2.24	11	11	12.3	5.4	1.90	0.13	351	-9	2.0	4.7	3.60	3.87	66.2	-9
-9	12	-9	-9	1.49	48	41	25.6	3.8	0.70	1.05	945	-9	0.5	2.2	2.00	1.85	9.4	-9
-9	11	-9	-9	1.44	26	23	24.0	5.8	0.72	2.09	1397	-9	0.5	0.5	2.40	2.09	9.7	-9
-9	14	-9	-9	1.58	21	21	14.9	4.3	0.63	1.10	993	-9	0.5	0.5	2.10	2.11	11.4	-9
-9	13	-9	-9	1.46	74	67	38.9	13.4	1.80	1.12	1079	-9	0.5	1.6	1.90	1.57	12.7	-9
-9	18	-9	-9	1.64	33	20	8.9	11.6	0.74	1.09	1136	-9	0.5	1.4	2.30	2.16	17.2	-9
-9	6	-9	-9	2.46	14	14	20.6	4.6	0.34	0.48	991	-9	0.5	1.4	1.20	1.04	17.5	-9
-9	5	-9	-9	1.09	73	66	36.3	26.9	0.46	0.67	367	-9	0.5	1.6	0.69	0.46	11.9	-9
-9	16	-9	-9	1.43	23	17	3.4	6.5	0.66	0.68	468	-9	0.5	1.4	3.10	2.97	12.6	-9
-9	7	-9	-9	1.78	46	40	57.2	18.3	0.74	1.41	850	-9	0.5	1.3	1.00	0.64	16.7	-9
-9	10	-9	-9	1.08	40	31	24.8	2.5	0.56	1.02	2076	-9	0.5	0.5	2.00	1.72	7.5	-9
-9	16	-9	-9	2.15	30	28	18.0	4.7	0.81	0.63	926	-9	1.0	1.5	2.50	2.25	11.3	-9
-9	32	-9	-9	2.17	16	15	20.5	2.5	2.30	0.23	283	-9	6.0	9.2	1.90	1.72	50.3	-9
-9	17	-9	-9	2.51	47	42	25.5	2.8	1.20	0.71	595	-9	0.5	1.2	2.30	1.97	16.1	-9
-9	11	-9	-9	1.41	43	37	26.5	2.4	0.59	1.07	1054	-9	0.5	0.5	2.00	1.79	10.0	-9
-9	14	-9	-9	2.23	30	29	17.0	5.1	0.89	0.60	502	-9	0.5	0.5	2.50	2.40	12.8	-9
-9	16	-9	-9	2.34	7	5	4.2	2.1	0.77	0.01	150	-9	1.0	2.3	1.70	1.81	17.8	-9
-9	18	-9	-9	2.21	40	34	26.6	3.0	1.30	0.73	721	-9	0.5	0.5	2.50	2.13	14.6	-9
-9	59	-9	-9	2.42	27	18	11.9	4.1	1.80	0.28	646	-9	11.0	11.0	3.00	2.87	36.6	-9
-9	18	-9	-9	2.88	126	113	19.9	3.5	1.20	0.28	644	-9	0.5	1.3	2.50	2.07	11.2	-9
-9	51	-9	-9	0.77	20	19	23.7	24.1	1.20	0.37	929	-9	5.0	5.9	1.90	1.25	33.1	-9
-9	16	-9	-9	2.79	41	41	36.4	20.0	2.00	0.65	1208	-9	0.5	2.1	1.40	1.01	22.6	-9
-9	17	-9	-9	2.93	107	116	26.8	6.5	2.20	0.23	820	-9	0.5	1.9	2.10	2.18	22.2	-9
-9	15	-9	-9	2.39	18	17	8.5	7.4	0.72	0.19	364	-9	0.5	1.3	2.30	2.14	16.9	-9
-9	10	-9	-9	0.23	30	24	14.2	11.3	0.41	3.33	1198	-9	0.5	0.5	2.70	2.14	13.1	-9
-9	7	-9	-9	2.04	72	67	48.9	3.6	1.20	1.11	917	-9	4.0	5.3	2.10	1.90	13.8	-9
-9	16	-9	-9	1.73	15	10	6.6	4.1	0.55	0.37	569	-9	0.5	0.5	2.20	2.15	17.2	-9
-9	11	-9	-9	1.61	22	17	16.0	5.1	0.66	0.53	571	-9	0.5	0.5	2.60	2.28	10.0	-9
-9	17	-9	-9	1.85	22	18	22.3	6.4	0.93	0.86	640	-9	2.0	2.0	2.80	2.48	19.8	-9

NI1_PPM	NI2_PPM	NI4_PPM	P2_PPM	PB2_PPM	PB4_PPM	PD27_PPB	PT27_PPB	RB1_PPM	RB2_PPM	RB6_PPM	SB1_PPM	SC1_PPM	SC2_PPM	SE1_PPM	SM1_PPM	SN1_PCT	SR1_PCT
-9	35	-9	486	3	-9	-9	-9	58	40	-9	1.3	19.9	15.5	0.5	2.5	-9	-9
-9	1	-9	244	3	-9	-9	-9	35	35	-9	0.1	7.4	8.7	0.5	0.9	-9	-9
-9	18	-9	866	8	-9	-9	-9	40	39	-9	2.0	16.5	17.3	0.5	4.9	-9	-9
-9	50	-9	393	92	-9	-9	-9	71	64	-9	3.6	15.6	15.8	0.5	8.1	-9	-9
-9	17	-9	140	36	-9	-9	-9	41	35	-9	0.8	8.1	7.8	0.5	4.2	-9	-9
-9	35	-9	486	3	-9	-9	-9	45	40	-9	0.9	15.0	15.5	0.5	5.7	-9	-9
-9	35	-9	777	3	-9	-9	-9	48	43	-9	1.0	15.1	15.0	0.5	5.1	-9	-9
-9	29	-9	509	10	-9	-9	-9	44	35	-9	0.8	10.3	10.2	0.5	4.8	-9	-9
-9	20	-9	387	3	-9	-9	-9	120	89	-9	3.1	17.2	17.5	0.5	2.8	-9	-9
-9	5	-9	94	3	-9	-9	-9	64	51	-9	0.9	8.9	9.0	0.5	3.2	-9	-9
-9	28	-9	1244	19	-9	-9	-9	13	22	-9	0.1	13.6	16.1	0.5	10.5	-9	-9
-9	35	-9	320	3	-9	-9	-9	38	29	-9	0.6	12.7	13.0	0.5	6.4	-9	-9
-9	39	-9	247	13	-9	-9	-9	52	40	-9	0.8	15.0	15.5	0.5	6.3	-9	-9
-9	48	-9	506	29	-9	-9	-9	61	50	-9	0.8	14.7	15.8	0.5	12.8	-9	-9
-9	52	-9	527	11	-9	-9	-9	57	46	-9	0.9	15.5	15.9	0.5	7.8	-9	-9
-9	44	-9	566	7	-9	-9	-9	60	44	-9	0.9	14.4	14.6	0.5	7.7	-9	-9
-9	35	-9	670	30	-9	-9	-9	76	61	-9	0.6	11.3	12.3	0.5	8.4	-9	-9
-9	56	-9	1928	8	-9	-9	-9	56	44	-9	1.3	18.7	20.2	0.5	7.6	-9	-9
-9	23	-9	1041	5	-9	-9	-9	46	46	-9	0.3	15.9	17.5	0.5	4.5	-9	-9
-9	16	-9	364	18	-9	-9	-9	89	66	-9	0.6	8.4	8.4	0.5	8.2	-9	-9
-9	10	-9	107	3	-9	-9	-9	88	65	-9	0.4	8.5	8.4	0.5	4.7	-9	-9
-9	5	-9	65	6	-9	-9	-9	99	72	-9	0.4	8.4	8.2	0.5	7.5	-9	-9
-9	10	-9	100	9	-9	-9	-9	73	56	-9	0.6	12.1	11.5	0.5	7.5	-9	-9
-9	17	-9	154	8	-9	-9	-9	58	48	-9	0.4	13.6	13.3	0.5	7.3	-9	-9
-9	2	-9	163	8	-9	-9	-9	110	88	-9	1.0	6.9	6.8	0.5	5.8	-9	-9
-9	31	-9	639	17	-9	-9	-9	67	55	-9	0.9	13.7	14.0	0.5	10.0	-9	-9
-9	22	-9	632	11	-9	-9	-9	71	59	-9	0.8	25.9	24.9	0.5	7.9	-9	-9
-9	14	-9	400	10	-9	-9	-9	63	57	-9	0.5	14.9	15.8	0.5	6.0	-9	-9
-9	30	-9	548	61	-9	-9	-9	66	54	-9	3.5	17.4	16.7	0.5	23.4	-9	-9
-9	11	-9	152	3	-9	-9	-9	74	65	-9	0.8	17.3	17.3	0.5	7.3	-9	-9
-9	23	-9	517	9	-9	-9	-9	96	87	-9	0.5	7.7	7.4	0.5	2.3	-9	-9
-9	36	-9	535	28	-9	-9	-9	32	44	-9	0.1	15.3	15.0	0.5	10.1	-9	-9
-9	13	-9	117	14	-9	-9	-9	34	35	-9	0.2	9.1	8.7	0.5	5.3	-9	-9
-9	62	-9	625	22	-9	-9	-9	120	100	-9	0.6	15.3	13.8	0.5	7.8	-9	-9
-9	43	-9	515	9	-9	-9	-9	53	43	-9	0.9	15.1	13.7	0.5	7.8	-9	-9
-9	14	-9	345	17	-9	-9	-9	99	73	-9	1.0	10.0	9.9	0.5	8.1	-9	-9
-9	10	-9	481	16	-9	-9	-9	94	81	-9	0.6	7.0	6.5	0.5	8.3	-9	-9
-9	17	-9	319	16	-9	-9	-9	130	101	-9	0.5	11.4	10.6	0.5	13.9	-9	-9
-9	39	-9	772	15	-9	-9	-9	70	56	-9	0.9	14.6	14.2	0.5	9.0	-9	-9
-9	10	-9	355	11	-9	-9	-9	110	81	-9	0.6	9.1	9.1	0.5	8.2	-9	-9
-9	1	-9	176	11	-9	-9	-9	94	77	-9	0.4	2.1	1.7	0.5	1.6	-9	-9
-9	16	-9	129	19	-9	-9	-9	100	78	-9	1.0	12.6	11.3	0.5	12.1	-9	-9
-9	5	-9	133	14	-9	-9	-9	120	103	-9	0.9	15.1	13.4	0.5	11.0	-9	-9
-9	4	-9	195	22	-9	-9	-9	110	83	-9	0.4	7.2	6.9	0.5	14.9	-9	-9
-9	17	-9	654	14	-9	-9	-9	40	43	-9	0.1	18.0	16.0	0.5	5.3	-9	-9
-9	14	-9	526	22	-9	-9	-9	150	126	-9	0.2	14.9	11.7	0.5	11.2	-9	-9
-9	4	-9	185	63	-9	-9	-9	150	116	-9	0.6	4.5	5.0	0.5	28.5	-9	-9
-9	4	-9	153	19	-9	-9	-9	100	80	-9	0.5	4.9	4.6	0.5	5.6	-9	-9
-9	55	-9	1695	3	-9	-9	-9	3	14	-9	0.1	20.5	18.4	0.5	7.0	-9	-9
-9	24	-9	786	64	-9	-9	-9	110	85	-9	1.3	18.6	18.8	0.5	14.9	-9	-9
-9	6	-9	110	13	-9	-9	-9	63	55	-9	0.7	10.0	9.1	0.5	3.9	-9	-9
-9	9	-9	139	14	-9	-9	-9	63	51	-9	0.6	12.1	11.3	0.5	5.9	-9	-9
-9	10	-9	176	12	-9	-9	-9	93	74	-9	1.1	17.0	16.4	0.5	5.6	-9	-9

SR2_PPM	TA1_PPM	TB1_PPM	TH1_PPM	TI2_PPM	U1_PPM	V2_PPM	W1_PPM	Y2_PPM	YB1_PPM	ZN1_PPM	ZN2_PPM	ZN4_PPM	ZR2_PPM	UNIQUE_ID	SITE_NUM	SAMPLE_NUM	FIELD_NUM
200	1.0	0.3	6.4	4379	2.6	79	2.0	14.8	1.2	-9	42	-9	103	02E/09/120001	1	7001	7001
253	0.3	0.3	1.4	4684	0.5	82	0.5	2.6	0.9	-9	8	-9	25	02E/09/120002	2	7002	7002
145	0.6	0.7	3.6	6065	1.8	139	0.5	14.1	1.9	-9	65	-9	71	02E/09/120003	3	7003	7003
104	0.4	0.8	8.3	5371	4.1	134	3.0	16.5	2.5	-9	120	-9	89	02E/09/120004	4	7004	7004
168	0.9	0.6	7.3	2583	2.2	43	1.0	9.8	2.0	-9	59	-9	61	02E/09/120005	5	7005	7005
200	0.7	0.8	4.6	4379	1.8	79	1.0	14.8	2.2	-9	42	-9	46	02E/09/120006	6	7006	7006
161	0.8	0.7	4.8	4710	1.7	91	1.0	12.2	2.3	-9	63	-9	47	02E/09/120007	7	7007	7007
169	0.8	0.7	5.8	3739	1.9	53	1.0	10.7	2.3	-9	46	-9	56	02E/09/120008	8	7008	7008
120	0.7	0.3	4.5	2490	2.0	105	1.0	6.4	1.3	-9	51	-9	47	02E/09/120009	9	7009	7009
137	1.0	0.3	5.3	3522	2.2	56	2.0	4.7	1.8	-9	15	-9	70	02E/09/120010	10	7010	7010
105	0.4	1.6	10.8	3256	2.1	59	0.5	26.9	1.9	-9	69	-9	47	02E/09/120011	11	7011	7011
164	0.9	0.9	7.7	4694	1.8	66	1.0	15.7	2.5	-9	38	-9	47	02E/09/120012	12	7012	7012
169	1.2	0.8	6.7	5274	2.2	85	1.0	14.0	2.6	-9	68	-9	56	02E/09/120013	13	7014	7014
141	1.1	1.9	10.1	4880	4.9	85	2.0	37.1	4.3	-9	163	-9	68	02E/09/120014	14	7015	7015
134	1.1	1.0	8.2	5150	2.6	88	2.0	16.3	3.1	-9	65	-9	59	02E/09/120015	15	7016	7016
154	1.2	1.0	7.7	5056	3.7	80	1.0	17.4	3.1	-9	58	-9	66	02E/09/120016	16	7017	7017
150	1.2	1.3	10.0	4231	2.9	69	2.0	29.7	4.2	-9	174	-9	61	02E/09/120019	19	7018	7018
178	1.0	1.1	7.0	5960	2.1	124	2.0	19.4	2.8	-9	78	-9	49	02E/09/120020	20	7019	7019
176	1.0	0.7	7.5	8231	3.8	116	2.0	15.5	2.0	-9	70	-9	57	02E/09/120021	21	7020	7020
163	1.0	1.3	10.1	3263	2.6	40	1.0	26.6	3.9	-9	54	-9	78	02E/09/120022	22	7021	7021
124	1.2	0.8	8.0	4695	2.5	55	2.0	18.0	3.3	-9	30	-9	65	02E/09/120023	23	7022	7022
120	1.3	1.4	14.1	3113	4.2	36	1.0	32.5	5.5	-9	35	-9	68	02E/09/120024	24	7023	7023
136	1.5	1.4	17.1	4620	4.1	53	2.0	29.2	5.4	-9	41	-9	76	02E/09/120025	25	7024	7024
135	1.4	1.2	11.1	5792	4.4	77	1.0	23.8	4.6	-9	45	-9	70	02E/09/120026	26	7025	7025
87	6.0	1.3	23.8	6021	10.7	46	2.0	44.2	11.0	-9	33	-9	317	02E/09/120027	27	7026	7026
154	1.2	1.4	9.4	4540	4.3	73	2.0	27.0	4.4	-9	93	-9	51	02E/09/120028	28	7027	7027
194	1.0	1.4	7.5	7311	2.6	130	2.0	28.2	4.8	-9	103	-9	39	02E/09/120029	29	7028	7028
168	1.1	1.1	6.6	7382	2.5	96	1.0	23.2	3.9	-9	57	-9	56	02E/09/120030	30	7029	7029
125	1.2	3.9	12.8	5856	17.5	85	2.0	84.0	10.0	-9	212	-9	60	02E/09/120031	31	7030	7030
157	1.6	1.1	6.6	11931	2.3	169	3.0	15.8	4.6	-9	48	-9	73	02E/09/120032	32	7031	7031
105	1.4	0.3	5.9	7758	2.3	151	2.0	8.8	1.6	-9	53	-9	65	02E/09/120033	33	7032	7032
81	0.8	1.3	26.7	4975	3.3	104	2.0	24.9	2.6	-9	39	-9	43	02E/09/120034	34	7033	7033
313	1.0	0.9	4.7	4790	1.4	51	0.5	22.0	4.0	-9	39	-9	55	02E/09/120035	35	7034	7034
106	1.5	1.0	11.2	7416	10.4	153	2.0	23.2	3.6	-9	89	-9	40	02E/09/120036	36	7035	7035
154	1.2	1.0	9.0	4968	2.8	74	2.0	16.4	3.4	-9	52	-9	53	02E/09/120037	37	7036	7036
133	1.3	1.3	8.8	3275	3.1	48	3.0	28.7	4.9	-9	55	-9	58	02E/09/120038	38	7038	7038
78	5.3	2.8	22.4	3710	8.2	48	5.0	63.6	15.0	-9	49	-9	176	02E/09/120039	39	7039	7039
122	1.6	2.4	16.9	3647	4.3	50	1.0	42.4	7.6	-9	67	-9	69	02E/09/120040	40	7040	7040
152	1.1	1.2	9.4	4663	2.5	78	2.0	21.1	3.9	-9	77	-9	51	02E/09/120041	41	7041	7041
135	1.2	1.4	10.0	3282	3.1	40	2.0	31.3	5.5	-9	54	-9	62	02E/09/120042	42	7042	7042
58	1.7	0.3	7.6	2538	3.5	16	1.0	12.1	4.0	-9	11	-9	171	02E/09/120043	43	7043	7043
120	1.7	2.0	19.6	3644	5.4	50	2.0	41.4	8.3	-9	64	-9	57	02E/09/120044	44	7044	7044
178	3.1	1.9	14.1	7204	7.3	63	3.0	42.6	10.0	-9	39	-9	188	02E/09/120045	45	7045	7045
100	1.2	1.8	25.9	1842	6.8	18	1.0	39.8	6.8	-9	56	-9	92	02E/09/120046	46	7046	7046
152	2.3	0.9	9.1	8038	4.4	41	2.0	19.0	6.4	-9	90	-9	106	02E/09/120047	47	7047	7047
57	3.1	2.4	60.4	3731	8.8	58	2.0	57.6	11.0	-9	81	-9	92	02E/09/120048	48	7048	7048
60	2.6	4.9	36.2	1770	11.8	16	2.0	98.8	13.0	-9	70	-9	112	02E/09/120049	49	7049	7049
104	1.6	1.0	11.5	2630	3.1	25	1.0	20.5	4.1	-9	47	-9	69	02E/09/120050	50	7050	7050
525	0.8	1.0	2.2	13618	0.8	205	0.5	17.9	2.6	-9	85	-9	15	02E/09/120051	51	7051	7051
157	1.6	2.1	12.9	4981	18.4	81	5.0	43.6	6.4	-9	155	-9	61	02E/09/120052	52	7052	7052
152	1.3	0.7	6.3	5509	2.6	67	1.0	13.6	3.2	-9	33	-9	81	02E/09/120053	53	7053	7053
156	1.0	1.0	10.0	3916	2.6	47	1.0	19.1	4.0	-9	42	-9	53	02E/09/120054	54	7054	7054
192	2.1	1.0	13.1	6144	4.6	95	3.0	20.9	5.4	-9	54	-9	136	02E/09/120055	55	7055	7055

LAB_NUM	GEOLOGIST	YEAR_	DATE_D_M	OPEN_FILE	ELEV_M	ELEV_BASIS	EXP_TYPE	EXPDIMEN_M	DEPTH_CM	SOIL_HORIZ	MAP_UNIT	SED_TYPE	INTERP
10231731	D.M. Brushett	2012	7/8/2012	002E/09/1736	36	gps	test pit		25	b	Rc/R	weathered bedrock	weathered bedrock
10231732	D.M. Brushett	2012	7/8/2012	002E/09/1736	35	gps	test pit		25		R-Rc	weathered bedrock	weathered bedrock
10231733	D.M. Brushett	2012	7/8/2012	002E/09/1736	64	gps	test pit		30		Rc/O	weathered bedrock	weathered bedrock
10231734	D.M. Brushett	2012	7/8/2012	002E/09/1736	64	gps	pit/quarry		30		Rc/O	weathered bedrock	weathered bedrock
10231735	D.M. Brushett	2012	7/8/2012	002E/09/1736	55	gps	test pit		35	b	Rc/O/Tv	diamicton	till
10231736	D.M. Brushett	2012	7/8/2012	002E/09/1736	62	gps	test pit		35	c	Rc/O/Tv	diamicton	till
10231737	D.M. Brushett	2012	7/8/2012	002E/09/1736	59	gps	test pit		40	c	Rc/O-Tv	diamicton	till
10231738	D.M. Brushett	2012	7/8/2012	002E/09/1736	70	gps	roadcut		40	c	Rc/O/Tv	diamicton	till
10231739	D.M. Brushett	2012	7/8/2012	002E/09/1736	60	gps	roadcut		45	c	Rc/O/Tv	diamicton	till
10231741	D.M. Brushett	2012	7/8/2012	002E/09/1736	42	gps	test pit		40	c	Rc-Tv/O	diamicton	till
10231742	D.M. Brushett	2012	7/9/2012	002E/09/1736	37	gps	roadcut		65	c	Rc/O-Tv	diamicton	till
10231743	D.M. Brushett	2012	7/9/2012	002E/09/1736	38	gps	roadcut		55	c	O-R/Tv	diamicton	till
10231745	D.M. Brushett	2012	7/9/2012	002E/09/1736	56	gps	test pit		45	c	O-Rc//Tv	diamicton	till
10231746	D.M. Brushett	2012	7/9/2012	002E/09/1736	72	gps	pit/quarry		50	c	Rc-Tv	diamicton	till
10231747	D.M. Brushett	2012	7/9/2012	002E/09/1736	100	gps	roadcut		55	c	T	diamicton	till
10231748	D.M. Brushett	2012	7/9/2012	002E/09/1736	86	gps	roadcut		50	c	Tv/Rc	diamicton	till
10231749	D.M. Brushett	2012	7/9/2012	002E/09/1736	54	gps	roadcut		60	c	Tv/Rc	diamicton	till
10231751	D.M. Brushett	2012	7/9/2012	002E/09/1736	70	gps	roadcut		60	c	Tv/Rc	diamicton	till
10231752	D.M. Brushett	2012	7/9/2012	002E/09/1736	51	gps	ditch		60	c	T	diamicton	till
10231753	D.M. Brushett	2012	7/9/2012	002E/09/1736	65	gps	roadcut		60	c	R/O/Tv	diamicton	till
10231754	D.M. Brushett	2012	7/9/2012	002E/09/1736	92	gps	test pit		40	c	Rc-O/Tv	diamicton	till
10231755	D.M. Brushett	2012	7/9/2012	002E/09/1736	94	gps	mudboil		45	c	R-O/Tv	diamicton	till
10231756	D.M. Brushett	2012	7/9/2012	002E/09/1736	104	gps	mudboil		40	c	R/O/Tv	diamicton	till
10231757	D.M. Brushett	2012	7/9/2012	002E/09/1736	112	gps	mudboil		35	c	R-O/Tv	diamicton	till
10231758	D.M. Brushett	2012	7/9/2012	002E/09/1736	82	gps	mudboil		30	bc	R/O/Tv	diamicton	till
10231759	D.M. Brushett	2012	7/9/2012	002E/09/1736	59	gps	roadcut		40	c	Rc/Tv	diamicton	till
10231761	D.M. Brushett	2012	7/9/2012	002E/09/1736	53	gps	roadcut		55	c	Tv/Rc	diamicton	till
10231762	D.M. Brushett	2012	7/9/2012	002E/09/1736	69	gps	test pit		50	c	Tv/Rc-O	diamicton	till
10231763	D.M. Brushett	2012	7/9/2012	002E/09/1736	91	gps	test pit		35	c	Tv-Rc/O	diamicton	till
10231764	D.M. Brushett	2012	7/9/2012	002E/09/1736	52	gps	test pit		45	c	Tv-Rc/O	diamicton	till
10231765	D.M. Brushett	2012	7/10/2012	002E/09/1736	60	gps	roadcut		40	c	Tv-Rc/O	diamicton	till
10231766	D.M. Brushett	2012	7/10/2012	002E/09/1736	48	gps	test pit		35	bc	R/Tv/O	diamicton	till
10231767	D.M. Brushett	2012	7/10/2012	002E/09/1736	41	gps	test pit		30	c	Rc/Tv/O	diamicton	till
10231768	D.M. Brushett	2012	7/10/2012	002E/09/1736	57	gps	pit/quarry		65	c	Rc//Tv	diamicton	till
10231769	D.M. Brushett	2012	7/10/2012	002E/09/1736	99	gps	pit/quarry		65	c	Rc/Tv	diamicton	till
10231772	D.M. Brushett	2012	7/10/2012	002E/09/1736	65	gps	roadcut		30	c	Rc/Tv	diamicton	till
10231773	D.M. Brushett	2012	7/10/2012	002E/09/1736	54	gps	test pit		30		Re-Rc	weathered bedrock	weathered bedrock
10231774	D.M. Brushett	2012	7/10/2012	002E/09/1736	37	gps	roadcut		45	c	Rc/O-Tv	diamicton	till
10231775	D.M. Brushett	2012	7/10/2012	002E/09/1736	35	gps	roadcut		55	c	Rc/Tv/O	diamicton	till
10231776	D.M. Brushett	2012	7/10/2012	002E/09/1736	43	gps	ditch		50	c	T-O/Rc	diamicton	till
10231777	D.M. Brushett	2012	7/10/2012	002E/09/1736	116	gps	mudboil		30	c	Re//O	diamicton	till
10231778	D.M. Brushett	2012	7/10/2012	002E/09/1736	48	gps	pit/quarry		50	c	Rc//Tv	diamicton	till
10231779	D.M. Brushett	2012	7/10/2012	002E/09/1736	53	gps	mudboil		25		R/O	weathered bedrock	weathered bedrock
10231781	D.M. Brushett	2012	7/10/2012	002E/09/1736	40	gps	roadcut		35		R/O	weathered bedrock	weathered bedrock
10231782	D.M. Brushett	2012	7/10/2012	002E/09/1736	77	gps	mudboil		30		Re/R/O	weathered bedrock	weathered bedrock
10231783	D.M. Brushett	2012	7/10/2012	002E/09/1736	57	gps	roadcut		30	c	Re/Rc/O	diamicton	till
10231784	D.M. Brushett	2012	7/10/2012	002E/09/1736	43	gps	roadcut		35		Re/Rc/O	weathered bedrock	weathered bedrock
10231785	D.M. Brushett	2012	7/10/2012	002E/09/1736	75	gps	other		30		Re/Rc/O	weathered bedrock	weathered bedrock
10231786	D.M. Brushett	2012	7/10/2012	002E/09/1736	51	gps	other		30		Re/Rc/O	weathered bedrock	weathered bedrock
10231787	D.M. Brushett	2012	7/10/2012	002E/09/1736	71	gps	pit/quarry		30		Rc//O	weathered bedrock	weathered bedrock
10231788	D.M. Brushett	2012	7/10/2012	002E/09/1736	135	gps	other		30		R/O	weathered bedrock	weathered bedrock
10231789	D.M. Brushett	2012	7/10/2012	002E/09/1736	88	gps	pit/quarry		40	c	R//Tv	diamicton	till
10231791	D.M. Brushett	2012	7/11/2012	002E/09/1736	60	gps	mudboil		35	c	R/O/Tv	diamicton	till

SUPPORT	STRUCTURE	MATRIX	FABRIC	FINES_PCT	COLOUR_OBS	MUNSELLCOL	SORTING	CLAST_CONC	PEBL_SAMPL	MINCLST_CM	MEDCLST_CM	MAXCLST_CM
matrix		silty clay	No	high >20%	greyish brown			low 1-20%	No		1	3
matrix		silty clay	No	high >20%	greyish brown			low 1-20%	No		1	3
matrix		silty clay	No	high >20%	brown			high >40%	No		1	10
matrix		silty clay	No	high >20%	brownish grey			medium 21-40%	No		1	3
matrix		silty sand	No	low 1-10%	reddish brown			medium 21-40%	No		1	4
matrix		silty sand	No	medium 11-20%	greyish brown			low 1-20%	No		1	4
matrix		silty sand	No	medium 11-20%	brownish grey			medium 21-40%	No		1	5
matrix		silty sand	No	high >20%	light brownish grey			low 1-20%	No		1	3
matrix		silty sand	No	high >20%	light brownish grey			high >40%	No		1	8
matrix		silty sand	No	high >20%	light grey			high >40%	No		1	6
matrix		silty sand	No	medium 11-20%	greyish brown			medium 21-40%	No		2	10
matrix		silty sand	No	high >20%	light brownish grey			low 1-20%	No		1	10
matrix		silty sand	No	low 1-10%	light brownish grey			low 1-20%	No		2	12
matrix		sandy silt	No	high >20%	light brownish grey			medium 21-40%	No		1	8
matrix		sandy silt	No	high >20%	light brownish grey			low 1-20%	No		2	10
matrix		clayey silt	No	high >20%	grey			low 1-20%	No		1	3
matrix		silty sand	No	medium 11-20%	light brownish grey			medium 21-40%	No		2	10
matrix		silty sand	No	high >20%	light brownish grey			low 1-20%	No		1	8
matrix		silty sand	No	low 1-10%	greyish brown			medium 21-40%	No		2	15
matrix		silty sand	No	low 1-10%	light greyish brown			high >40%	No		1	8
matrix		silty sand	No	medium 11-20%	greyish brown			medium 21-40%	No		1	8
matrix		silty sand	No	medium 11-20%	greyish brown			low 1-20%	No		1	6
matrix		silty sand	No	medium 11-20%	light brownish grey			medium 21-40%	No		1	12
matrix		silty sand	No	high >20%	light brownish grey			medium 21-40%	No		2	12
matrix		silty sand	No	medium 11-20%	reddish brown			medium 21-40%	No		1	5
matrix		silty sand	No	medium 11-20%	light grey			medium 21-40%	No		1	8
matrix		silty sand	No	high >20%	light brownish grey			medium 21-40%	No		2	20
matrix		silty sand	No	high >20%	light brownish grey			medium 21-40%	No		2	12
matrix		silty sand	No	medium 11-20%	brownish grey			high >40%	No		2	20
matrix		silty sand	No	medium 11-20%	light brownish grey			medium 21-40%	No		2	20
matrix		silty sand	No	high >20%	light brownish grey			high >40%	No		2	10
matrix		silty sand	No	medium 11-20%	reddish brown			high >40%	No		1	15
matrix		silty sand	No	medium 11-20%	light brownish grey			low 1-20%	No		2	10
matrix		clayey silt	No	medium 11-20%	brownish			high >40%	No		2	10
matrix		silty sand	No	medium 11-20%	light brownish grey			low 1-20%	No		2	10
matrix		silty sand	No	high >20%	light pinkish grey			low 1-20%	No		1	8
matrix		silty sand	No	low 1-10%	brownish			high >40%	No		1	12
matrix		silty sand	No	low 1-10%	light brownish grey			medium 21-40%	No		1	15
matrix		silty sand	No	high >20%	light grey			low 1-20%	No		1	8
matrix		silty sand	No	low 1-10%	light brownish grey			high >40%	No		1	12
matrix		sandy silt	No	high >20%	grey			high >40%	No		1	6
matrix		silty sand	No	medium 11-20%	light pinkish grey			high >40%	No		1	12
matrix		silty sand	No	low 1-10%	brownish grey			low 1-20%	No		1	10
matrix		silty sand	No	low 1-10%	light pinkish grey			medium 21-40%	No		1	12
matrix		silty sand	No	low 1-10%	reddish brown			medium 21-40%	No		1	10
matrix		silty sand	No	low 1-10%	light brownish grey			high >40%	No		2	18
matrix		silty sand	No	low 1-10%	light pinkish grey			low 1-20%	No		1	12
matrix		silty sand	No	low 1-10%	light brownish			high >40%	No		1	12
matrix		silty sand	No	low 1-10%	greyish brown			low 1-20%	No		1	10
matrix		sandy silt	No	high >20%	light grey			low 1-20%	No		1	20
matrix		silty sand	No	high >20%	light brownish grey			medium 21-40%	No		1	15
matrix		silty sand	No	high >20%	light pinkish grey			medium 21-40%	No		1	12
matrix		silty sand	No	low 1-10%	reddish brown			high >40%	No		2	10

MED_ROUND	RANG_ROUND	STR_CLST	FACET_CLST	FISSILITY	COMPACTION	OXIDATION	JOINTING	SEE_NOTES	COMMENTS	PHOTOID	PHOTOCAPTN
	very angular to subangular	No	No					No			
very angular	very angular to subangular	No	No					No			
very angular	very angular to subrounded	No	No					No	taken from top of small quarry		
very angular	very angular to angular	No	No					No			
angular	very angular to angular	No	No					No			
angular	very angular to subangular	No	No					No			
angular	very angular to subangular	No	No					No			
subangular	very angular to subrounded	No	No					No			
very angular	very angular to subangular	No	No					No			
subangular	very angular to subrounded	No	No					No			
angular	very angular to subrounded	No	No					No			
subangular	very angular to subrounded	No	No					No			
angular	very angular to subrounded	No	No					No			
angular	very angular to subrounded	No	No					No			
angular	very angular to subrounded	No	No					No			
subangular	angular to subrounded	No	No					No			
angular	very angular to subangular	No	No					No			
angular	very angular to subrounded	No	No					No			
subangular	very angular to subrounded	No	No					No			
very angular	very angular to subangular	No	No					No			
angular	very angular to subangular	No	No					No			
angular	very angular to subrounded	No	No					No			
angular	very angular to subrounded	No	No					No			
subangular	very angular to subrounded	No	No					No			
subangular	very angular to rounded	No	No					No			
angular	very angular to subangular	No	No					No			
subangular	very angular to subrounded	No	No					No			
subangular	very angular to subrounded	No	No					No			
very angular	very angular to subrounded	No	No					No			
angular	very angular to subrounded	No	No					No			
very angular	very angular to subangular	No	No					No			
very angular	very angular to subangular	No	No					No			
subangular	very angular to subrounded	No	No					No			
very angular	very angular to subangular	No	No					No			
subangular	very angular to subrounded	No	No					No			
angular	very angular to subrounded	No	No					No			
angular	very angular to subrounded	No	No					No			
angular	very angular to subrounded	No	No					No			
subangular	very angular to subrounded	No	No					No			
subangular	very angular to subrounded	No	No					No			
very angular	very angular to subangular	No	No					No			
very angular	very angular to subangular	No	No					No			
very angular	very angular to subangular	No	No					No			
angular	very angular to subangular	No	No					No			
subangular	very angular to subrounded	No	No					No			
very angular	very angular to subangular	No	No					No			
angular	very angular to angular	No	No					No			
subangular	very angular to subrounded	No	No					No			
very angular	very angular to subangular	No	No					No			
very angular	very angular to subrounded	No	No					No			
very angular	very angular to subangular	No	No					No			
very angular	very angular to angular	No	No					No			
very angular	very angular to subrounded	No	No					No			

PHOTOKEYWD	PHOTOCMNT

APPENDIX C: Figures 13-67. Symbol Plots of Element Distributions

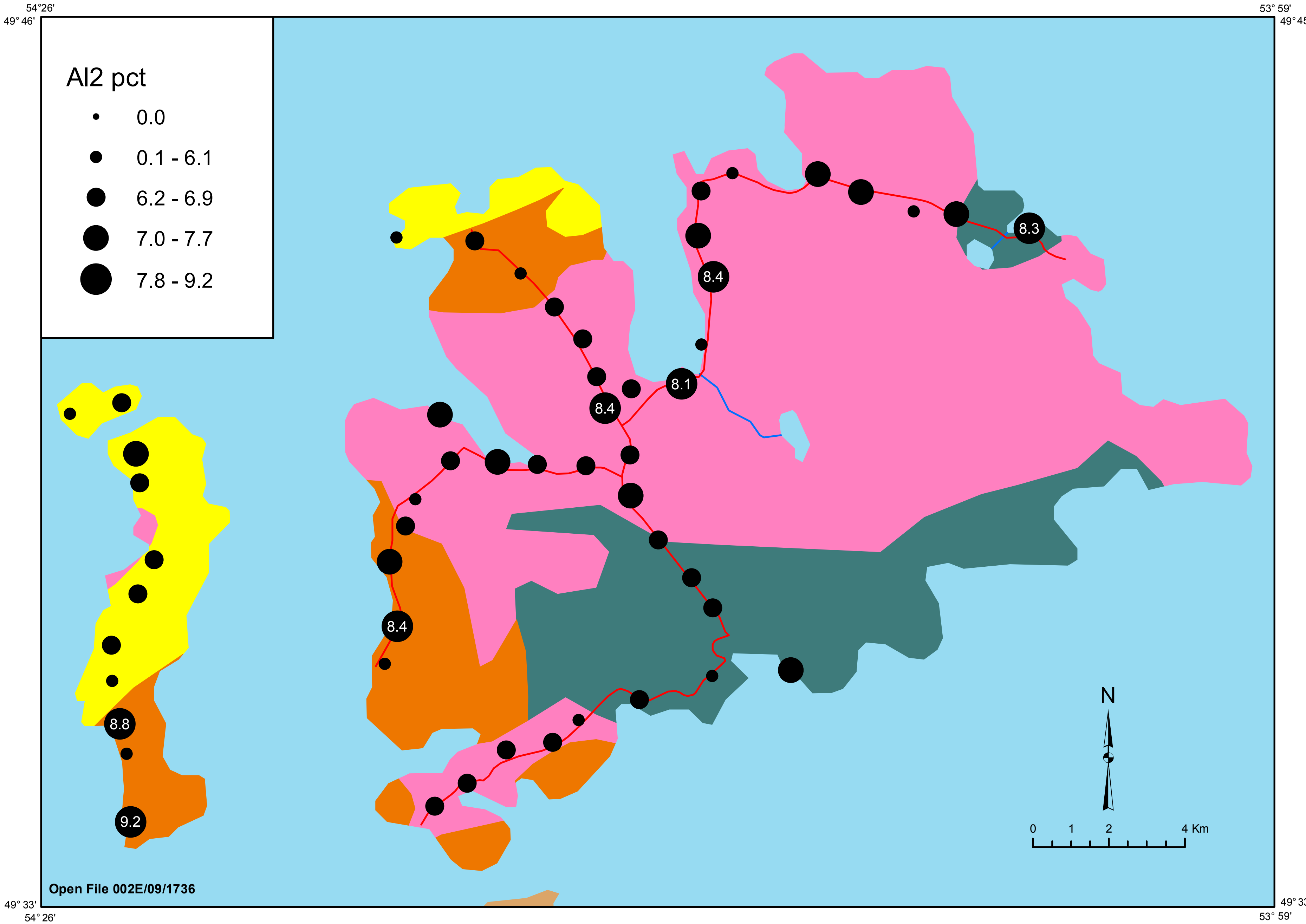

Figure 13. *Distribution of aluminum (Al2) in till.*

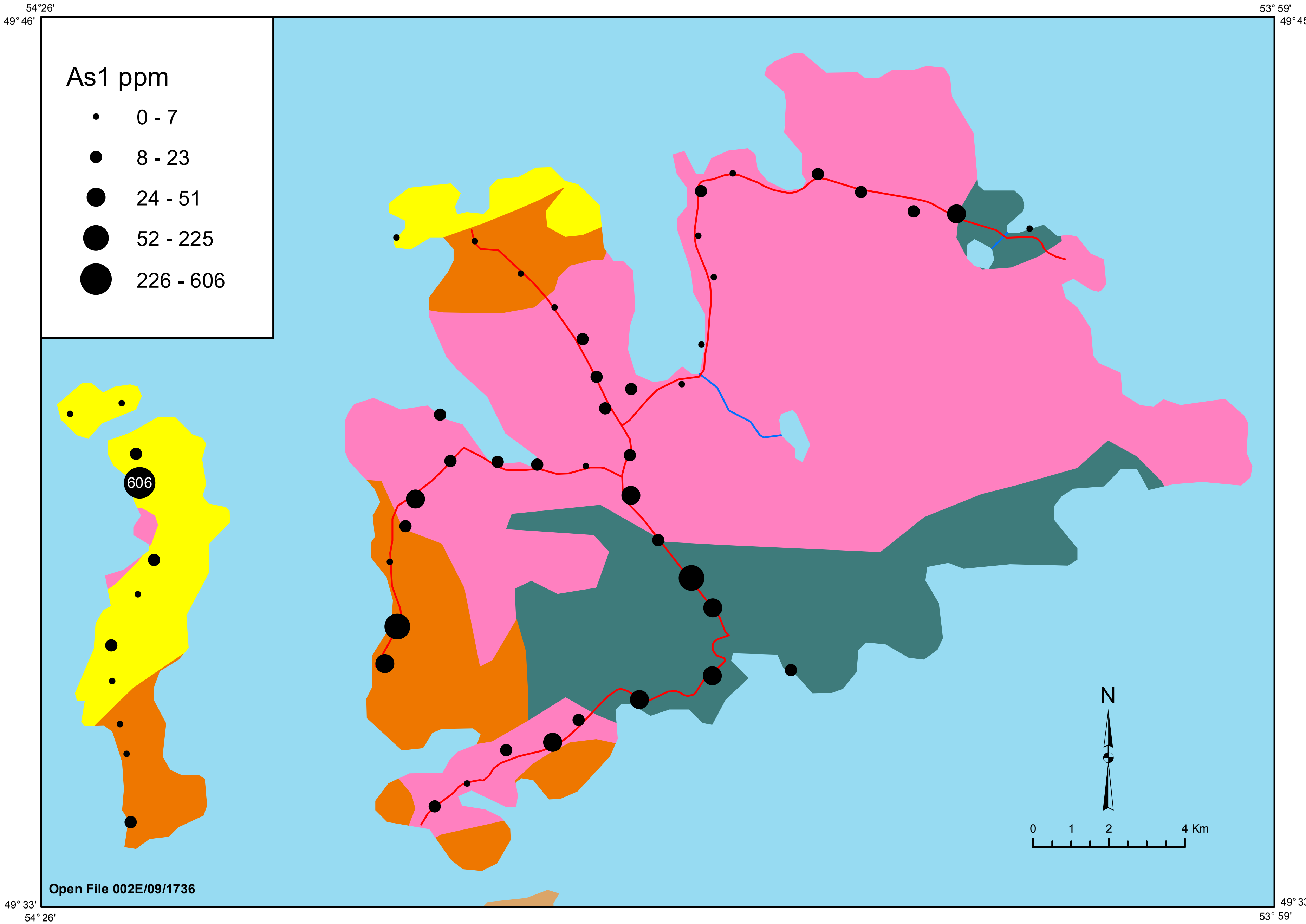

Figure 14. *Distribution of arsenic (As1) in till.*

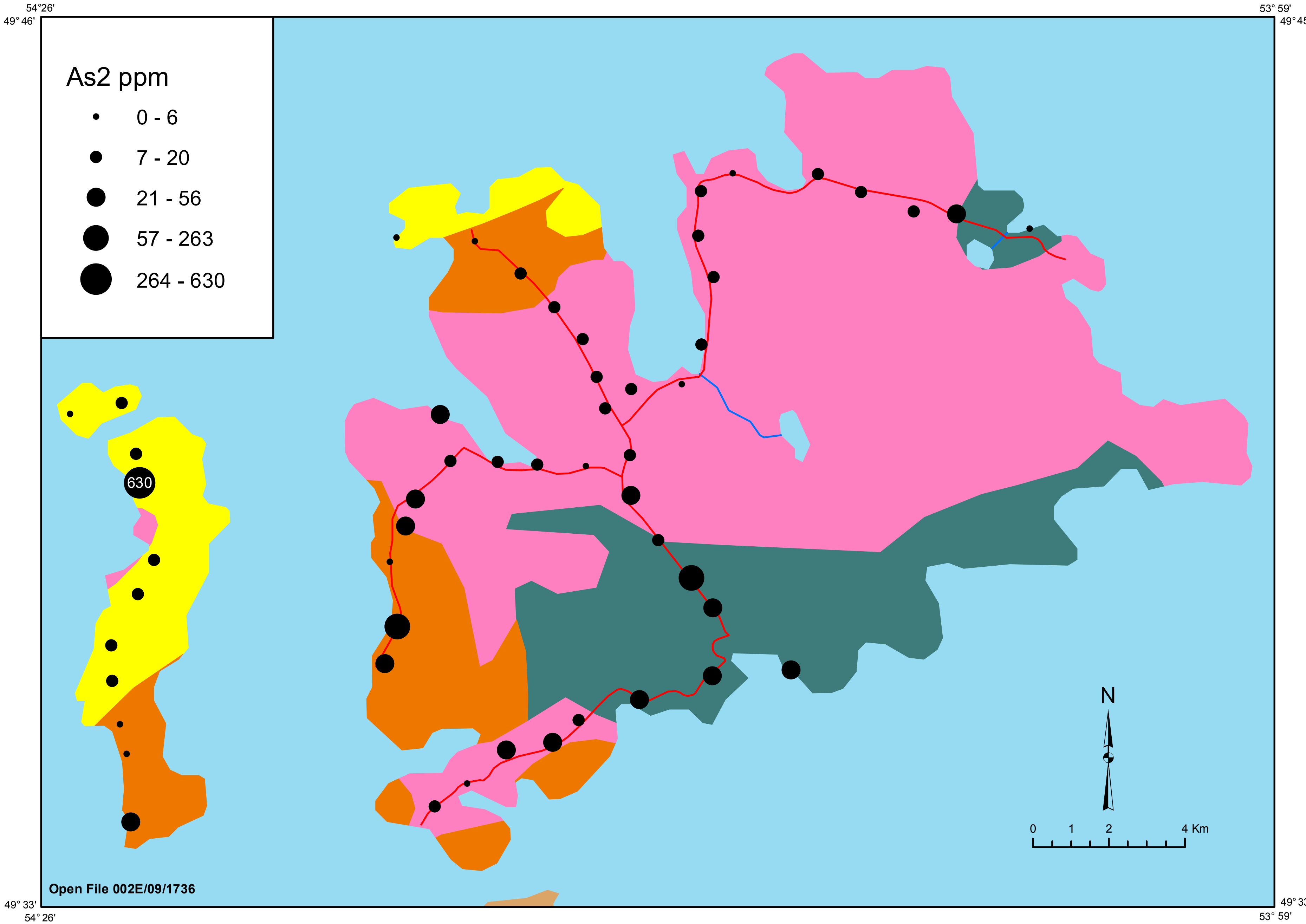

Figure 15. *Distribution of arsenic (As2) in till.*

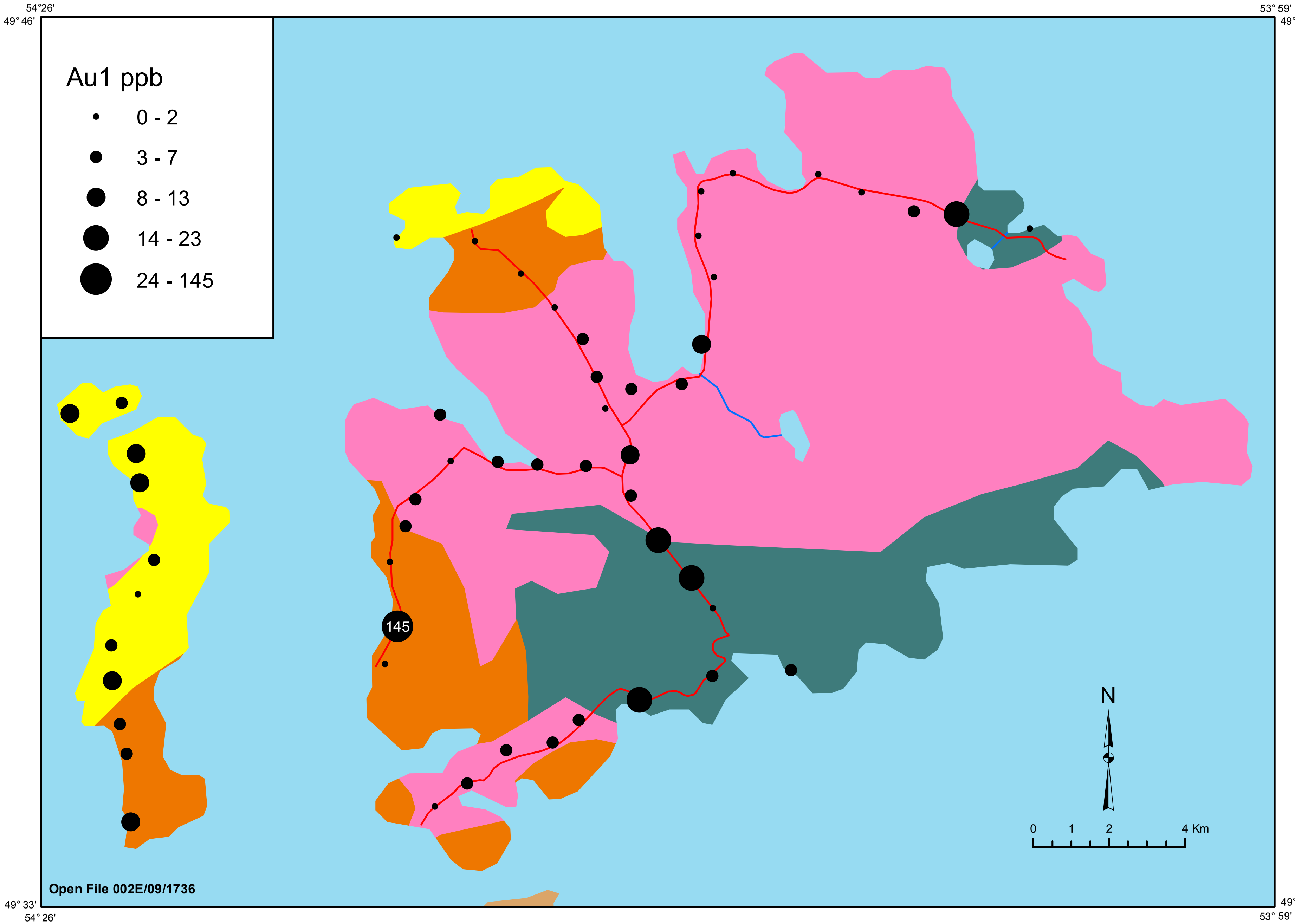

Figure 16. *Distribution of gold (Au1) in till.*

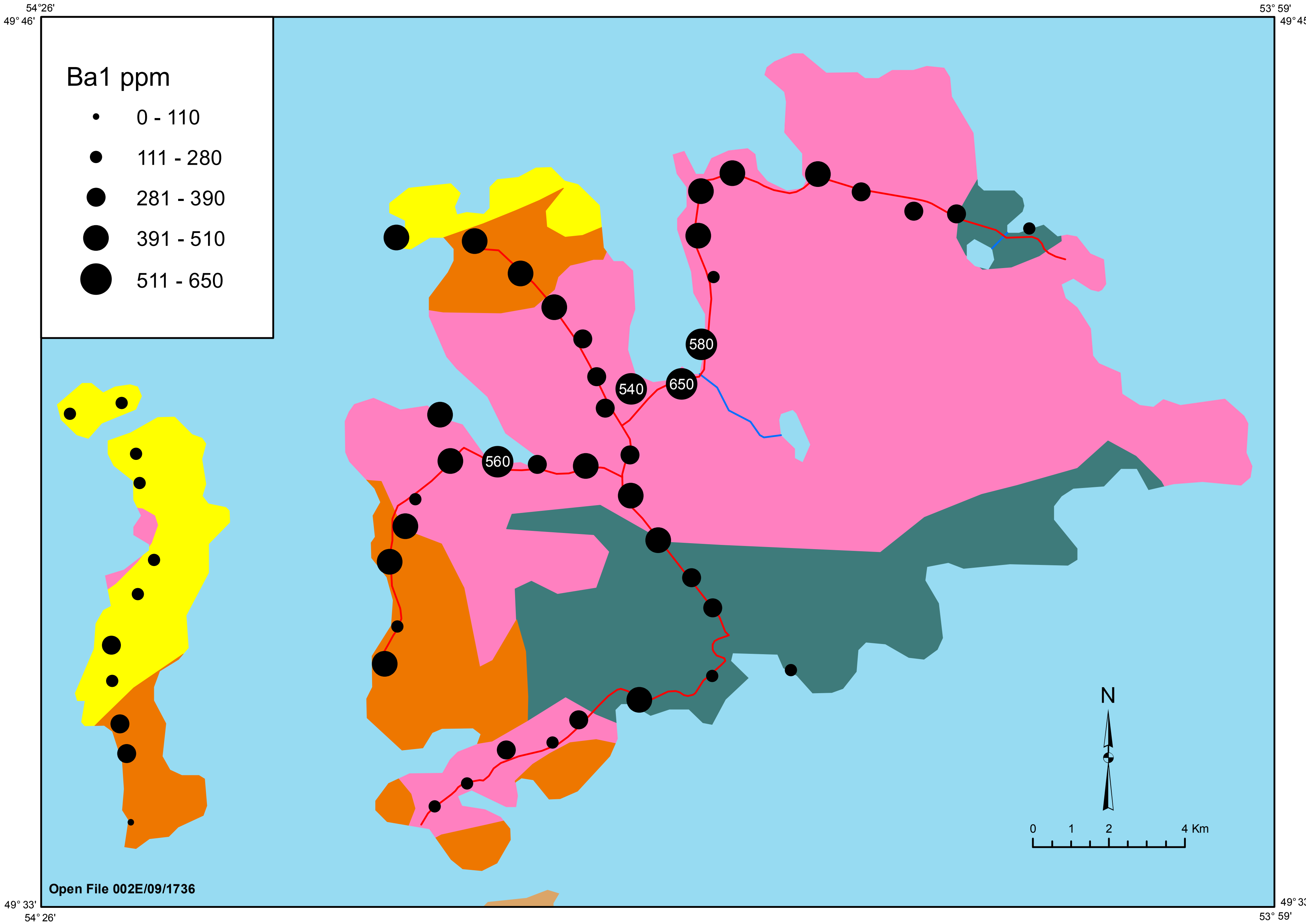

Figure 17. *Distribution of barium (Ba1) in till.*

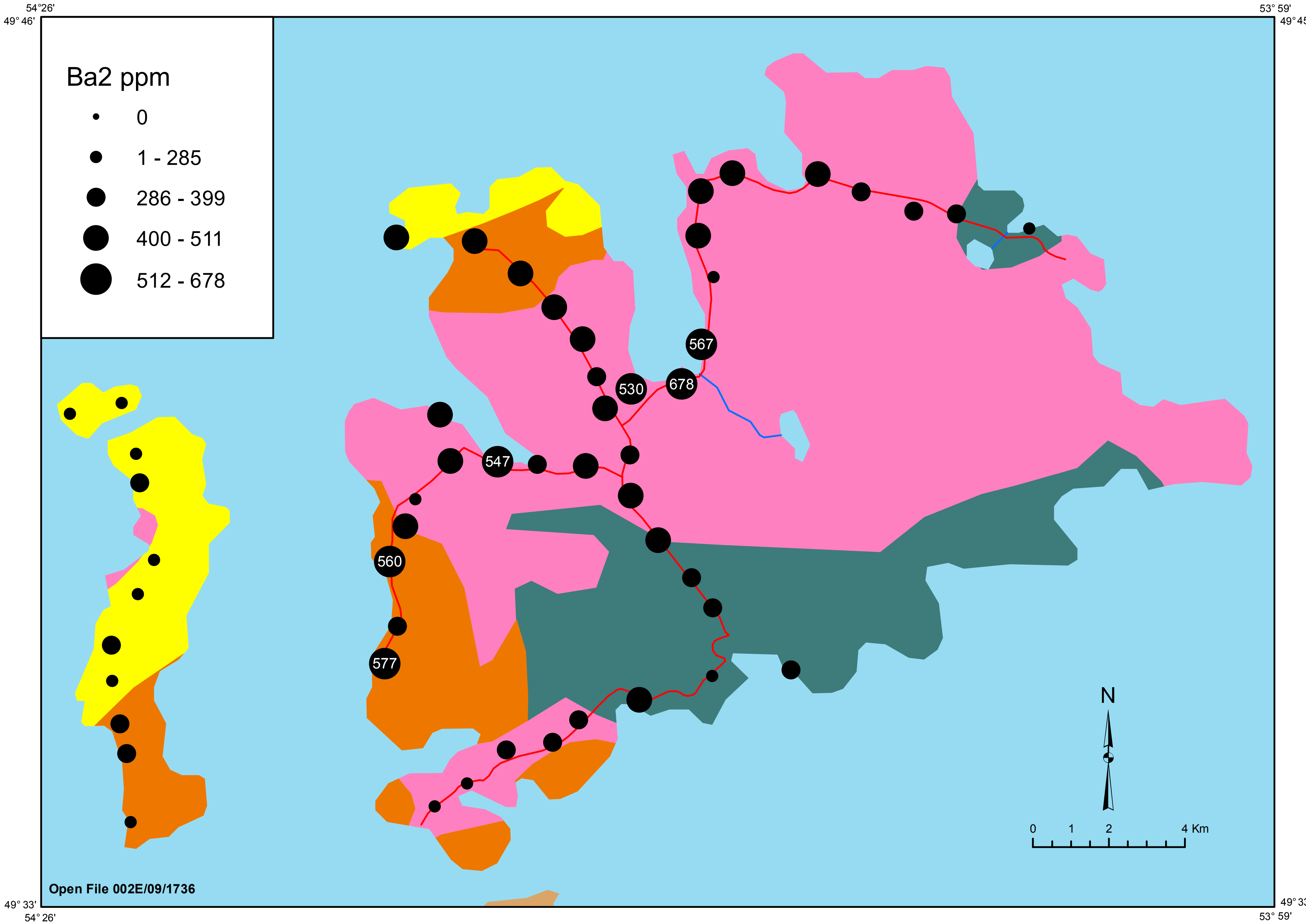

Figure 18. *Distribution of barium (Ba2) in till.*

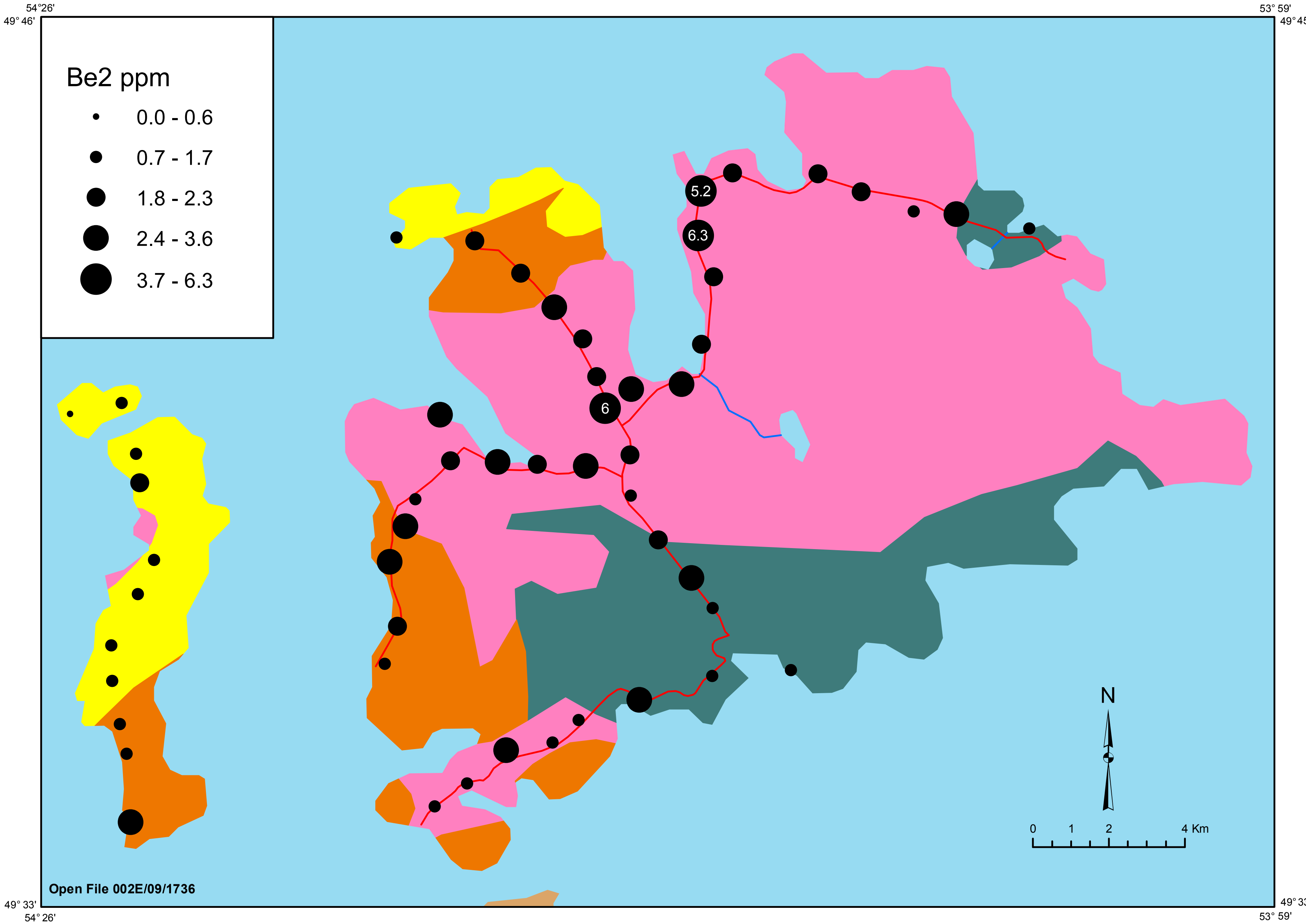

Figure 19. *Distribution of beryllium (Be2) in till.*

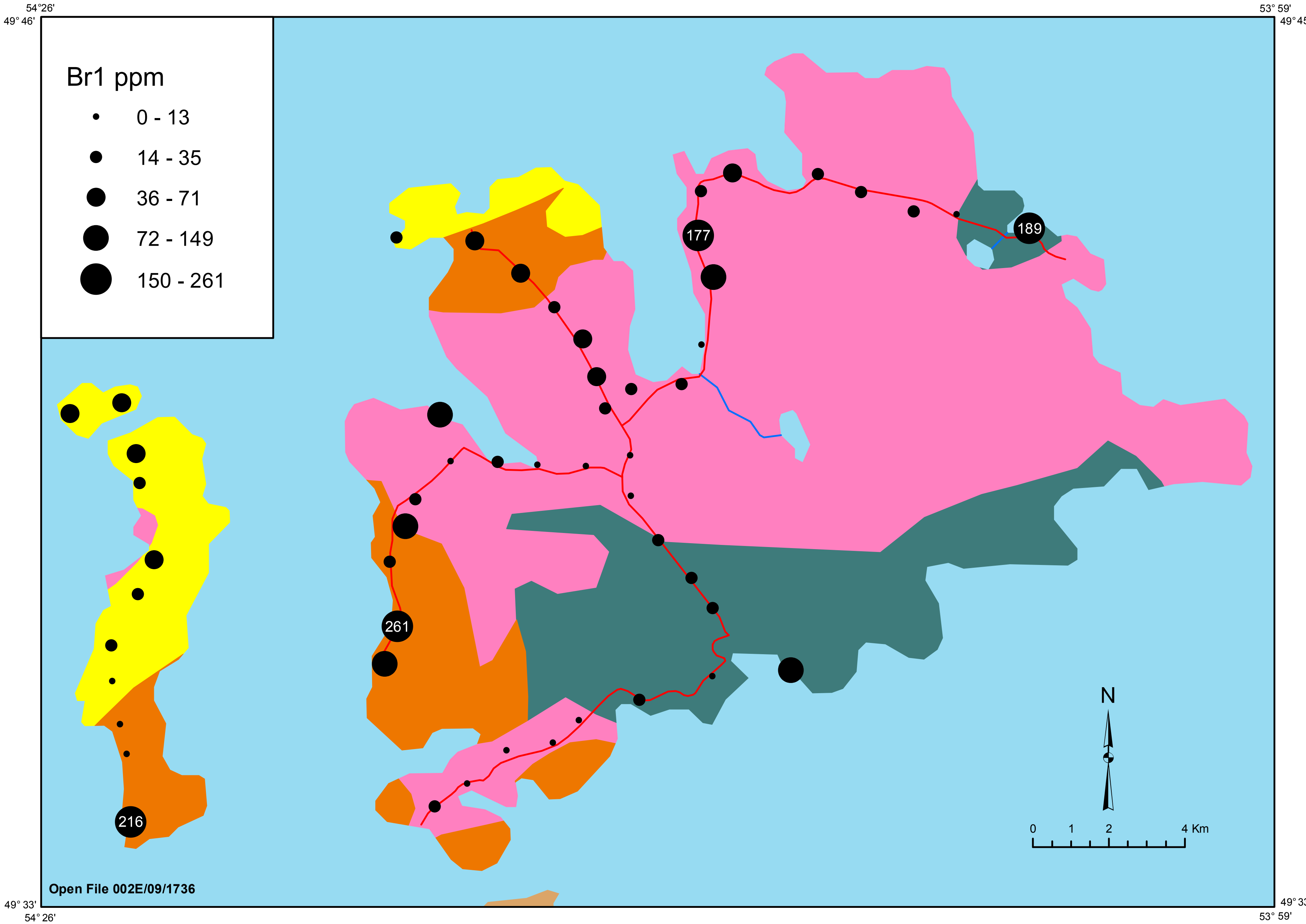

Figure 20. *Distribution of bromine (Br1) in till.*

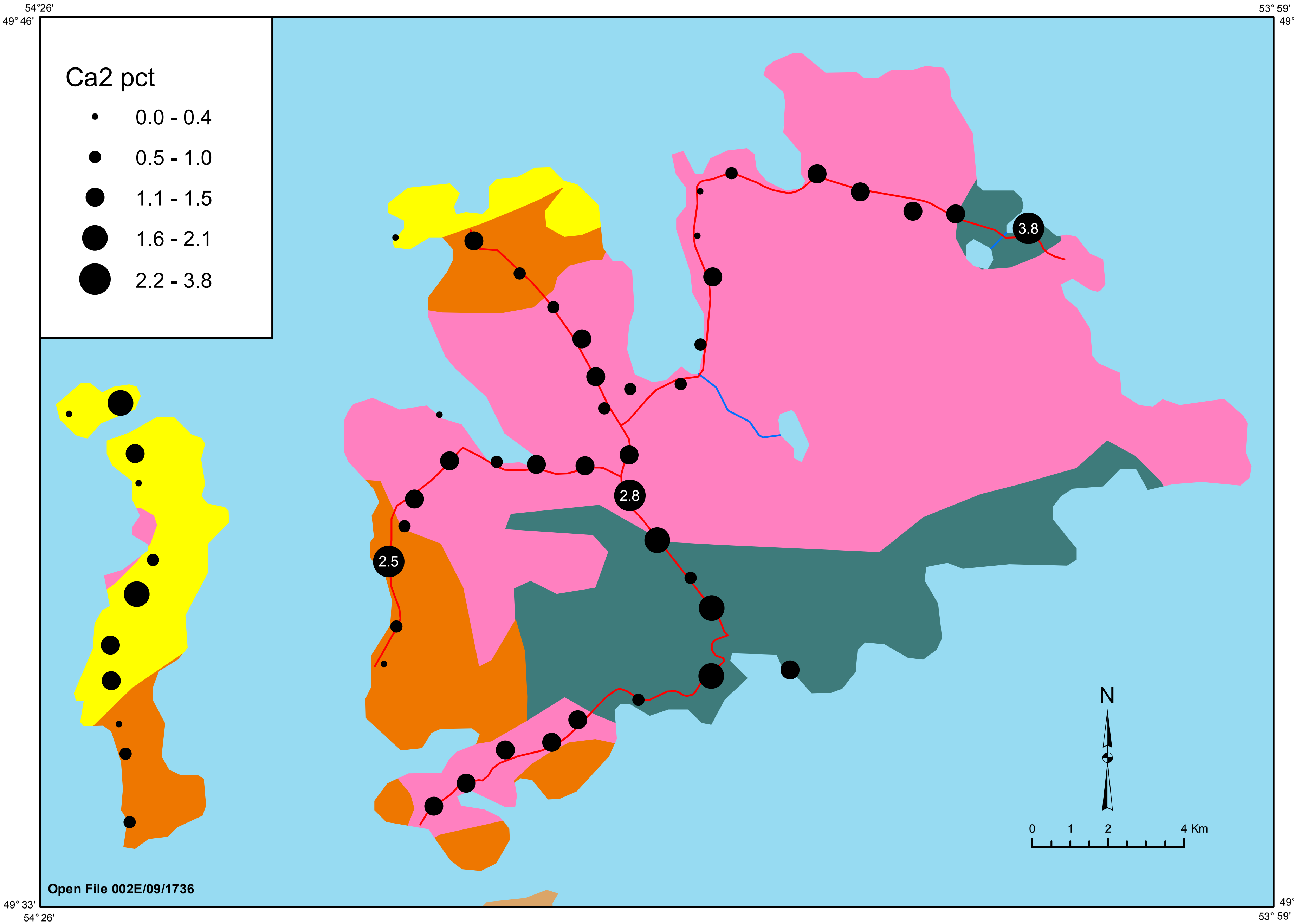

Figure 21. *Distribution of calcium (Ca2) in till.*

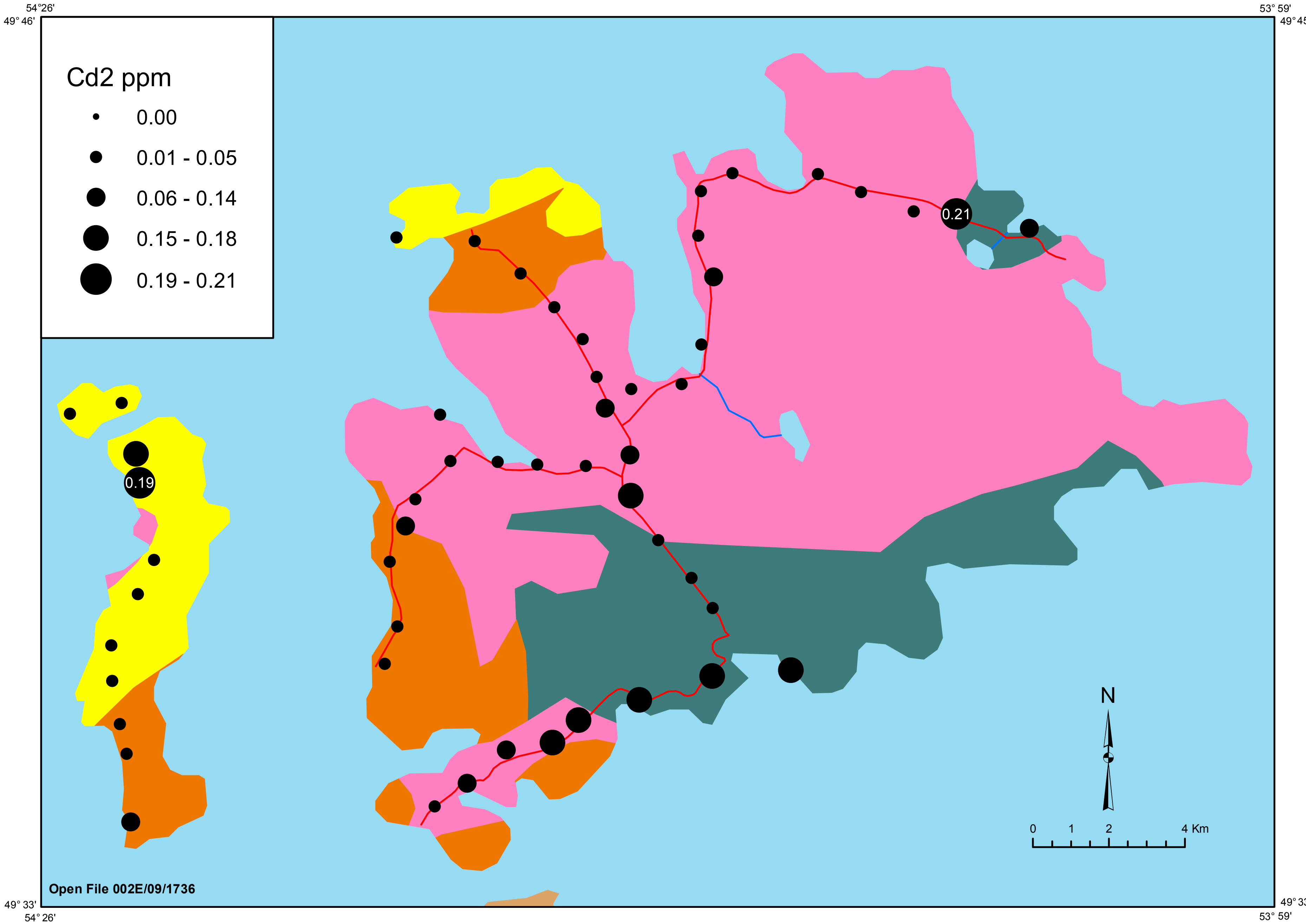

Figure 22. *Distribution of cadmium (Cd2) in till.*

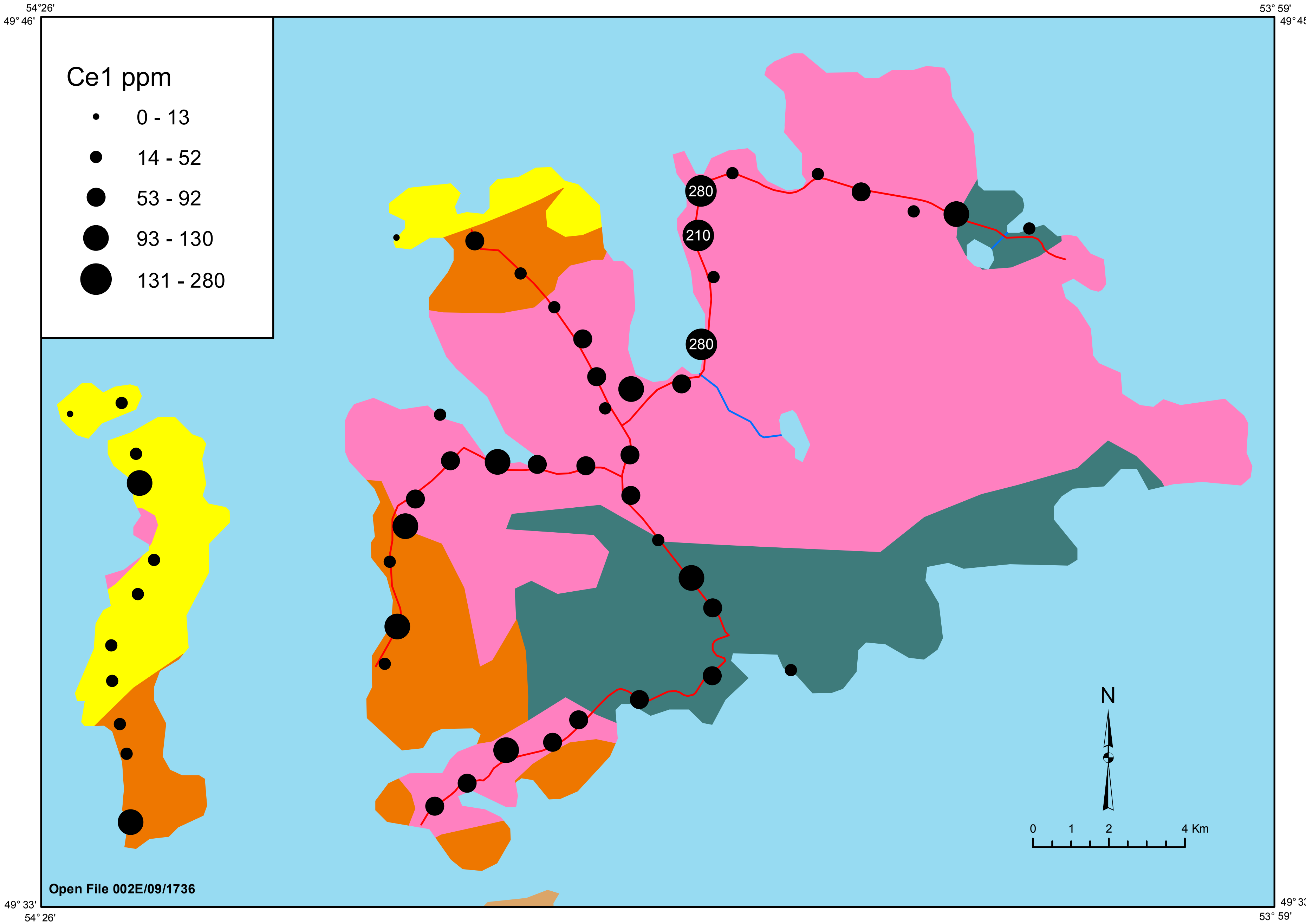

Figure 23. *Distribution of cerium (Ce1) in till.*

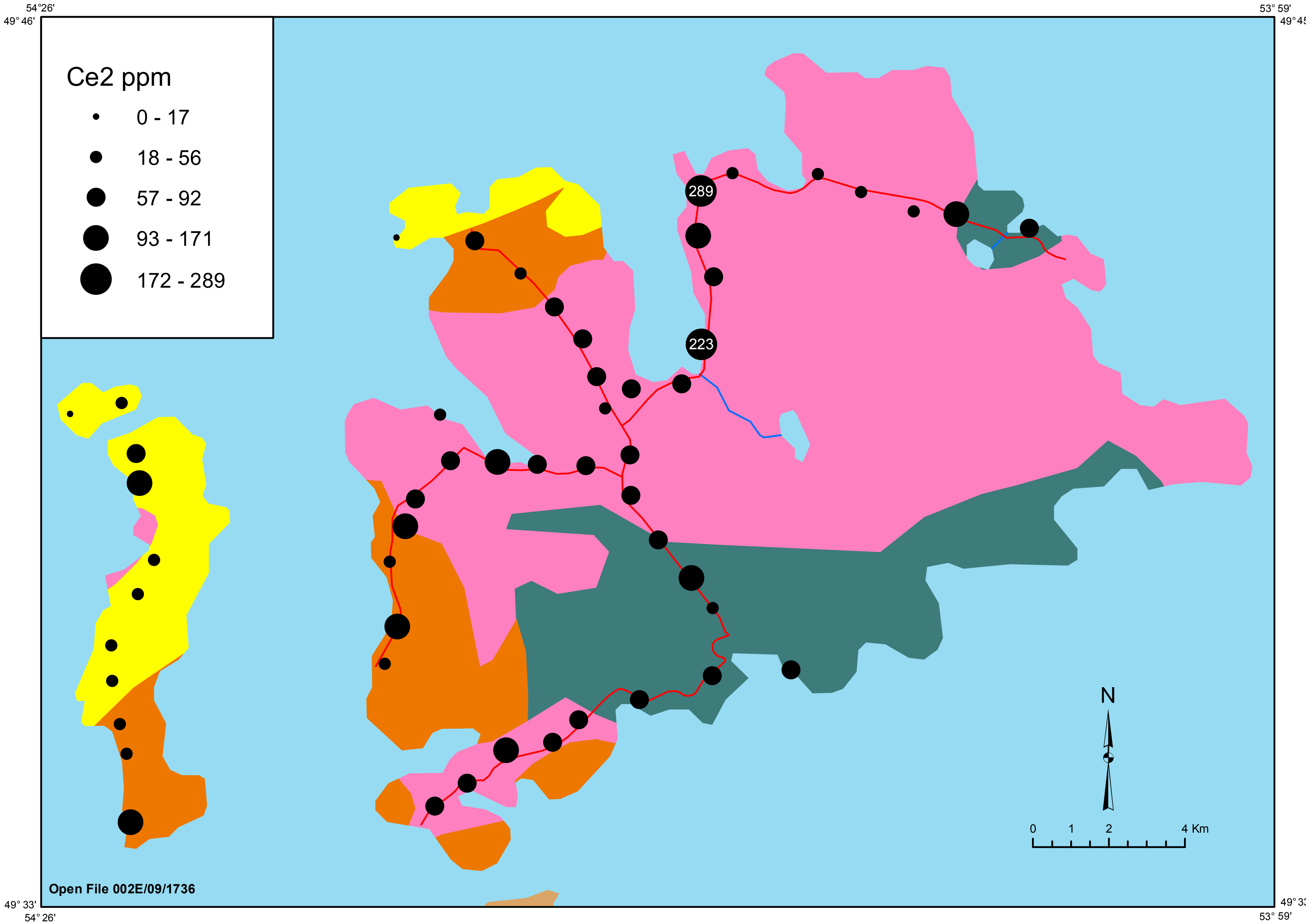

Figure 24. *Distribution of cerium (Ce2) in till.*

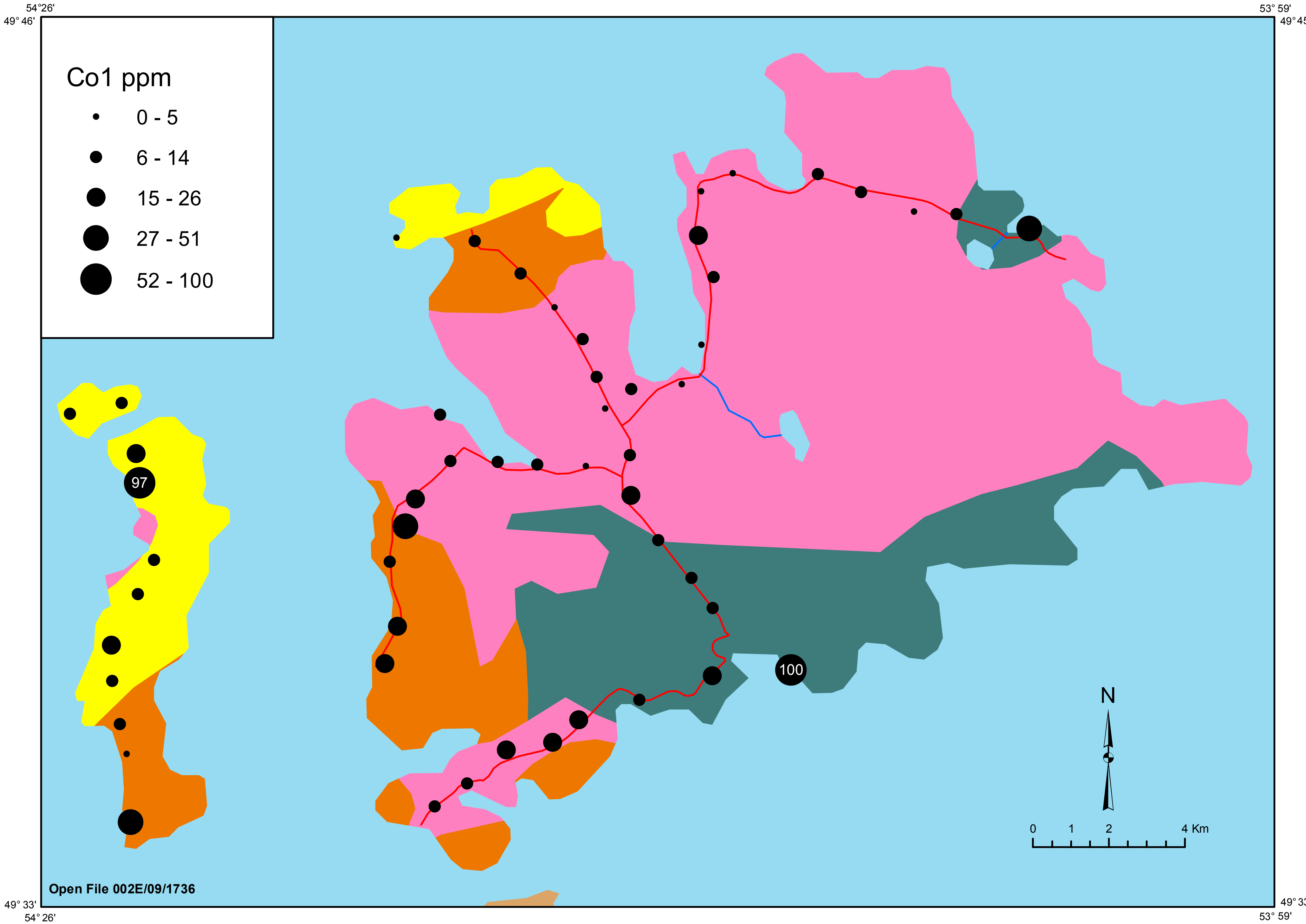

Figure 25. *Distribution of cobalt (Co1) in till.*

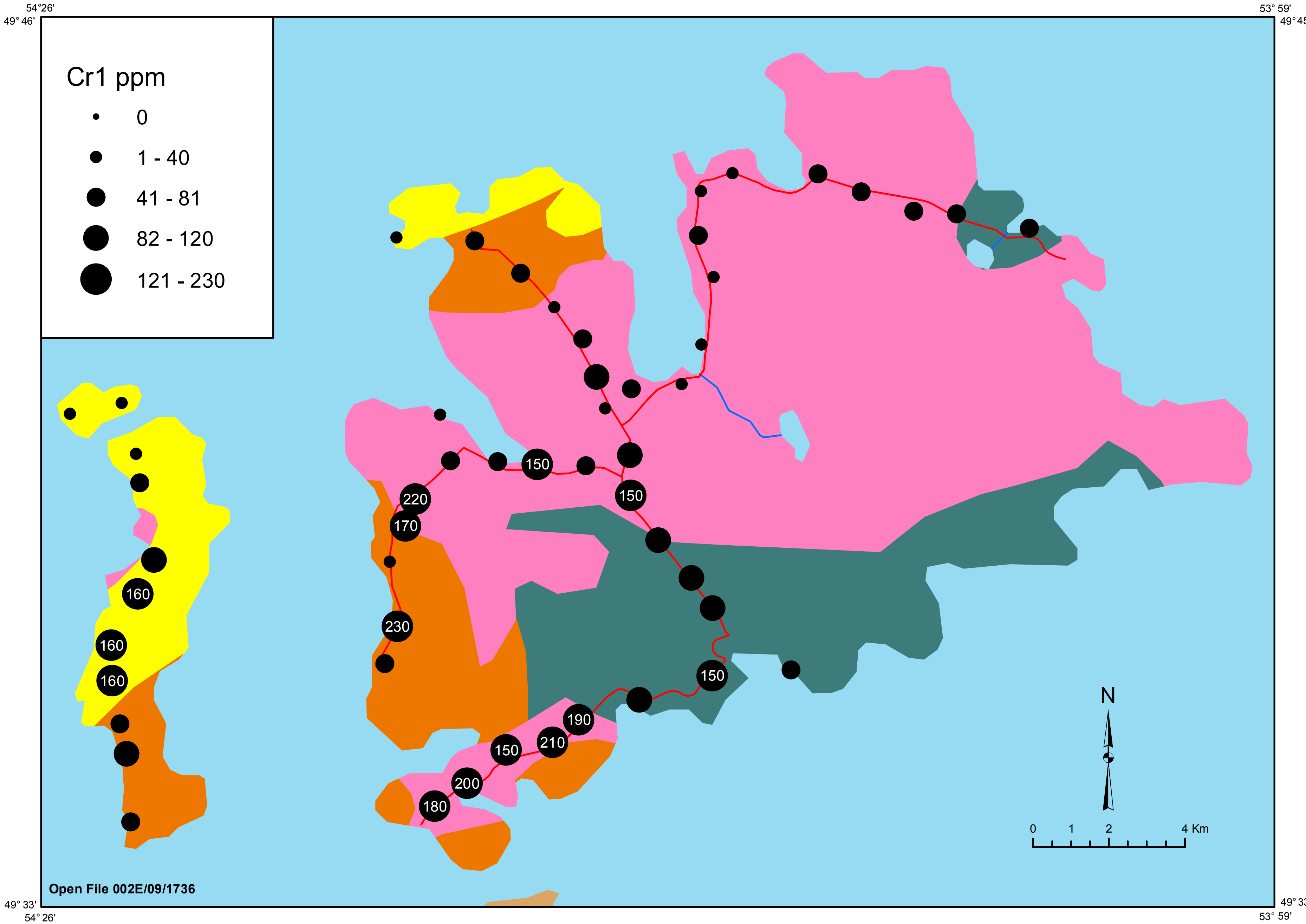

Figure 26. *Distribution of chromium (Cr1) in till.*

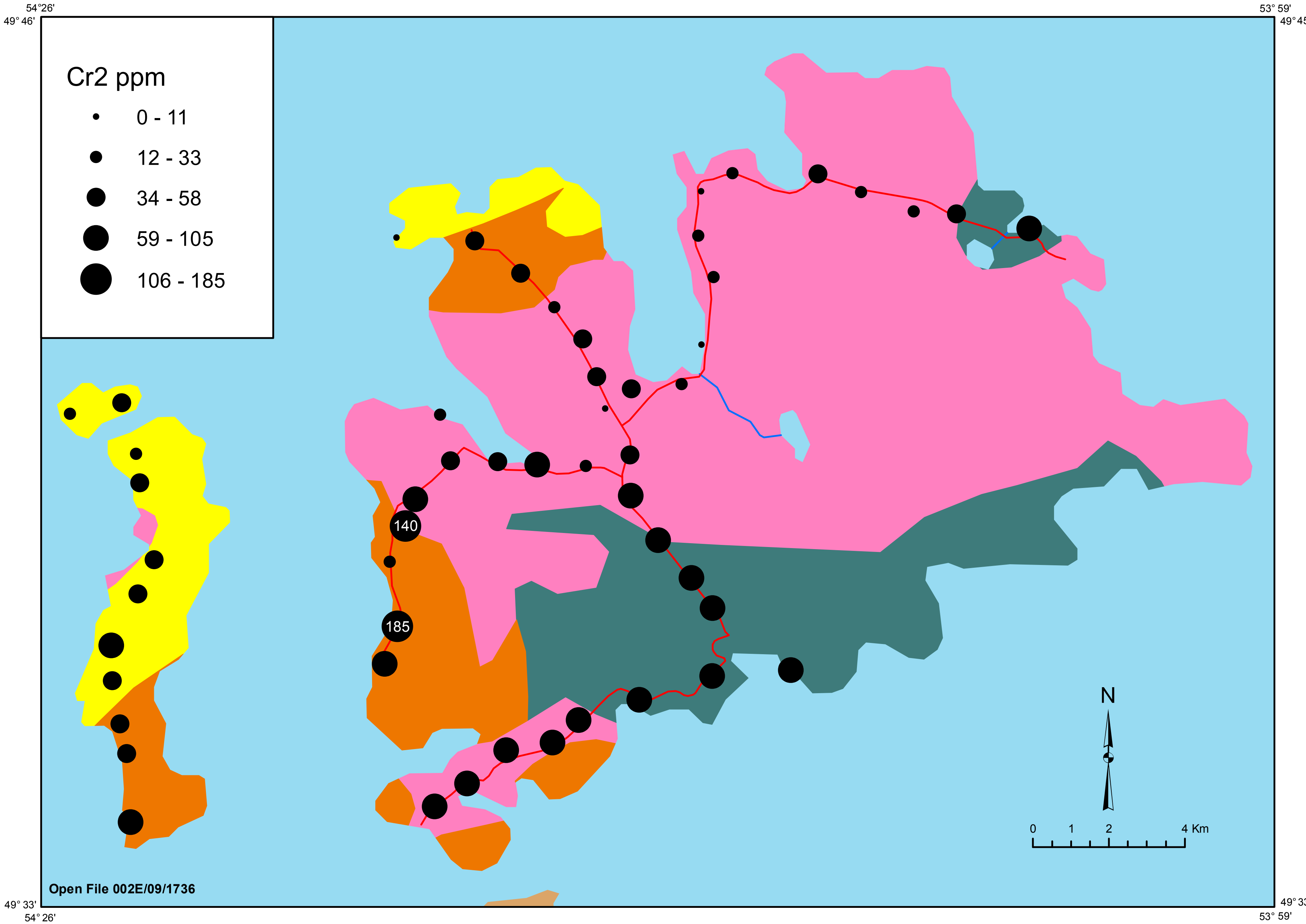

Figure 27. *Distribution of chromium (Cr2) in till.*

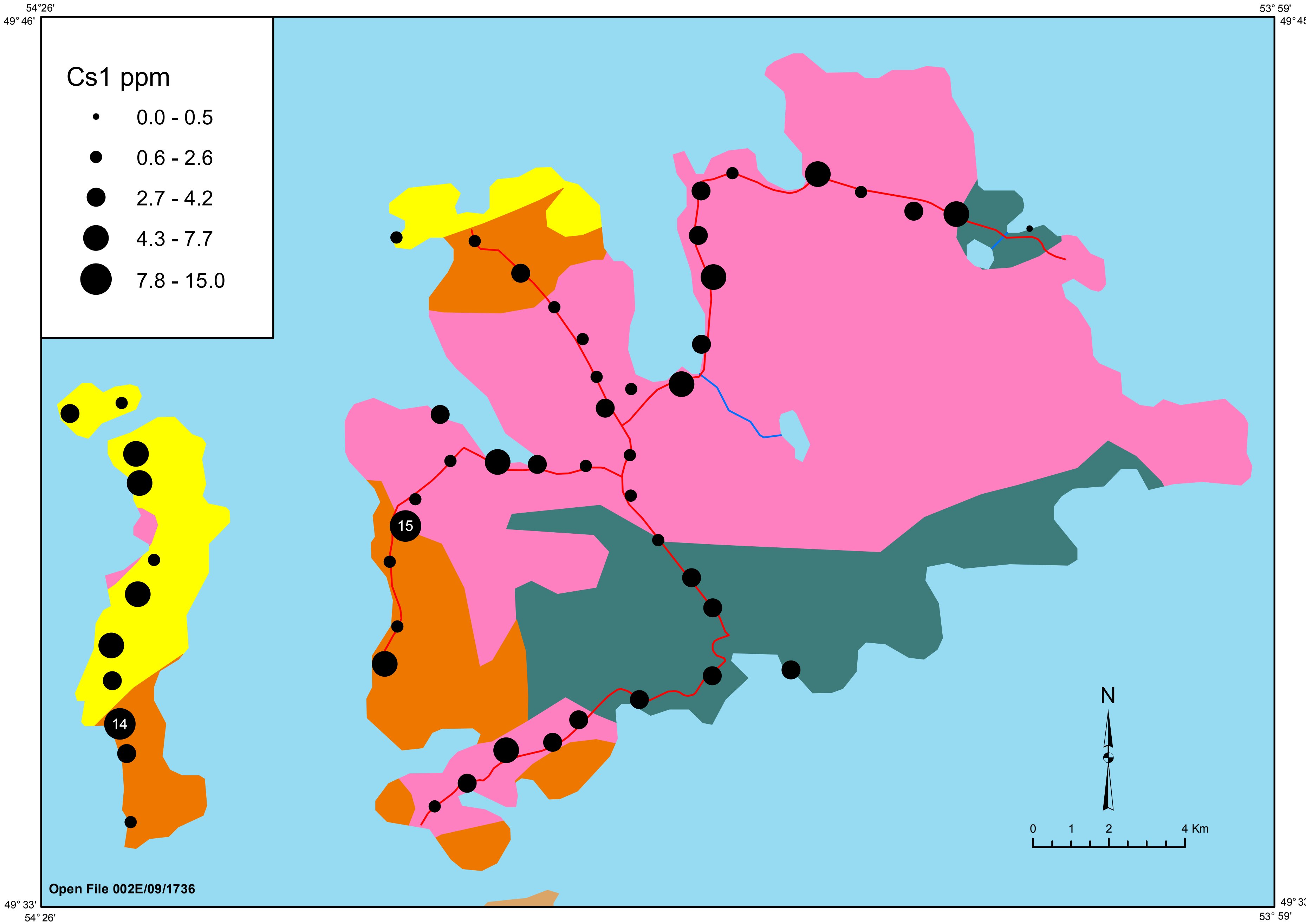

Figure 28. *Distribution of cesium (Cs1) in till.*

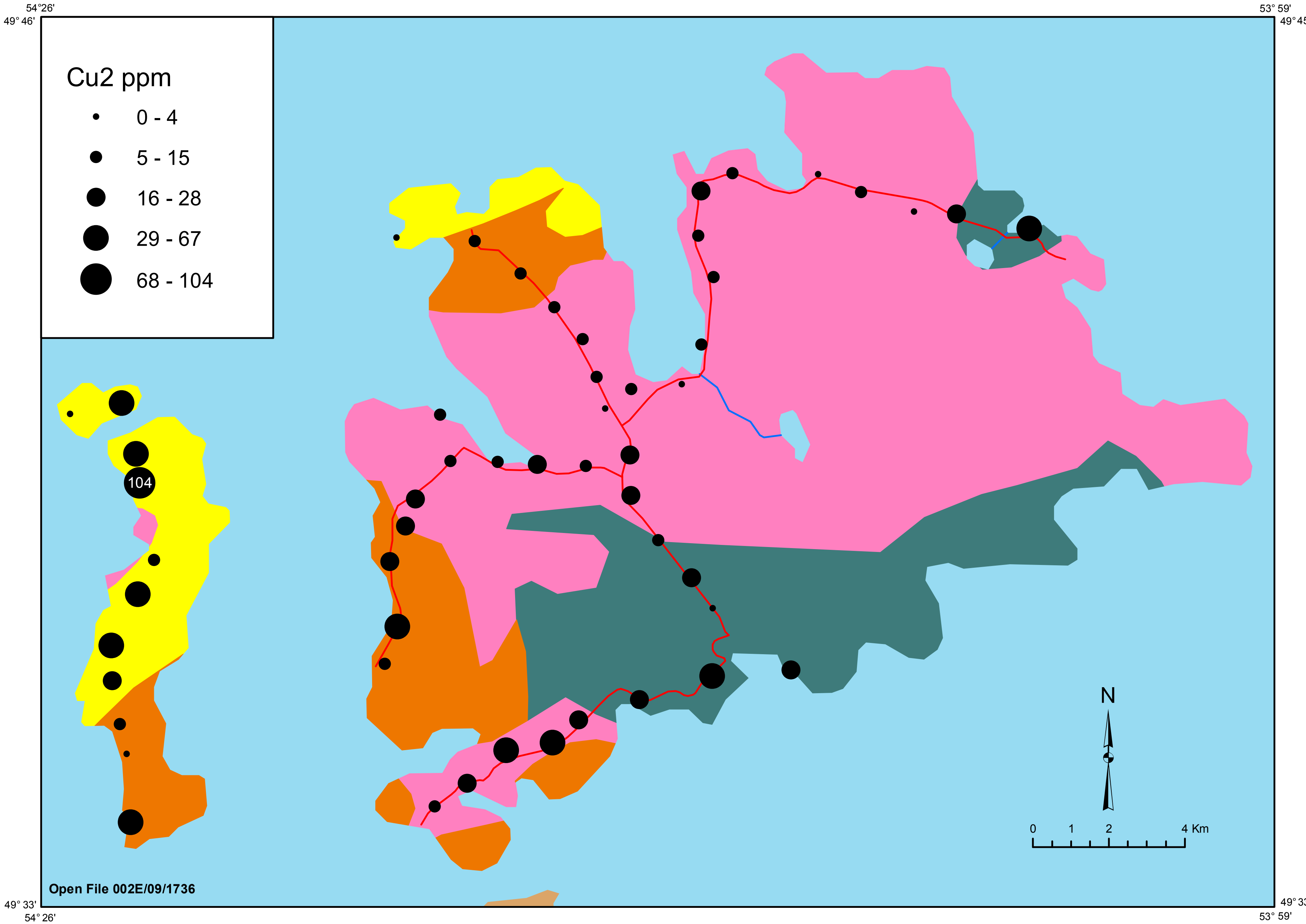

Figure 29. *Distribution of copper (Cu2) in till.*

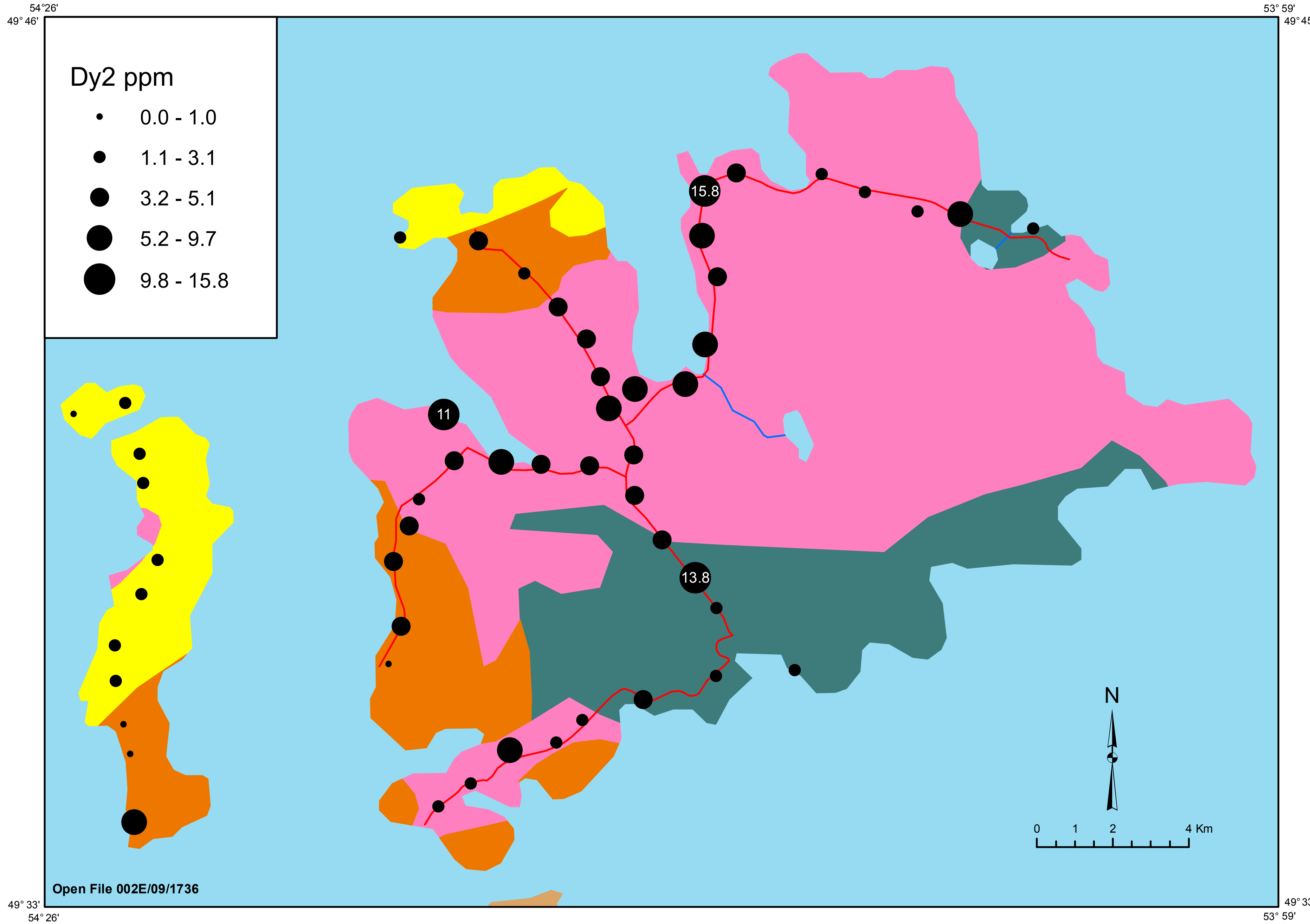

Figure 30. *Distribution of dysprosium (Dy2) in till.*

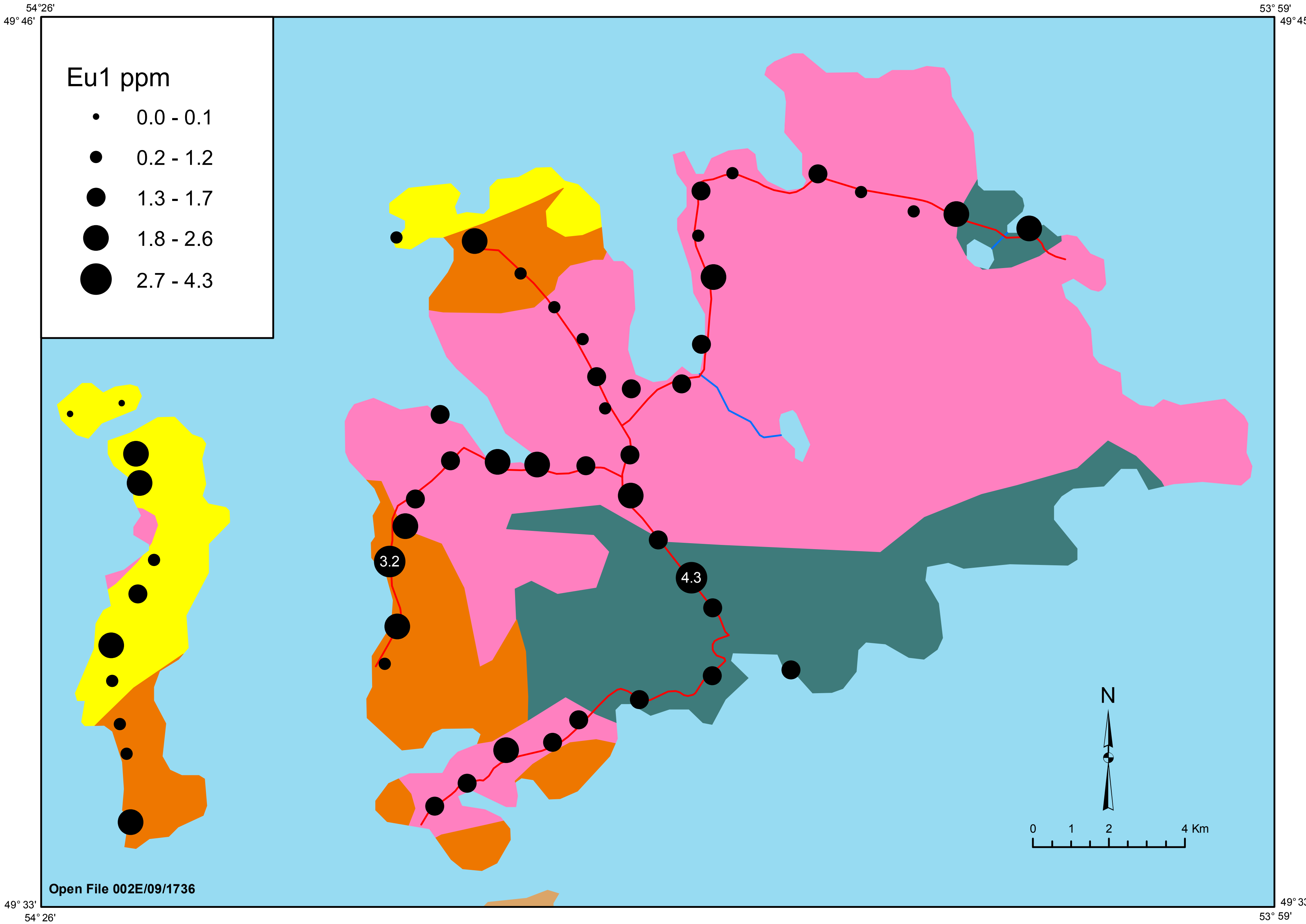

Figure 31. *Distribution of europium (Eu1) in till.*

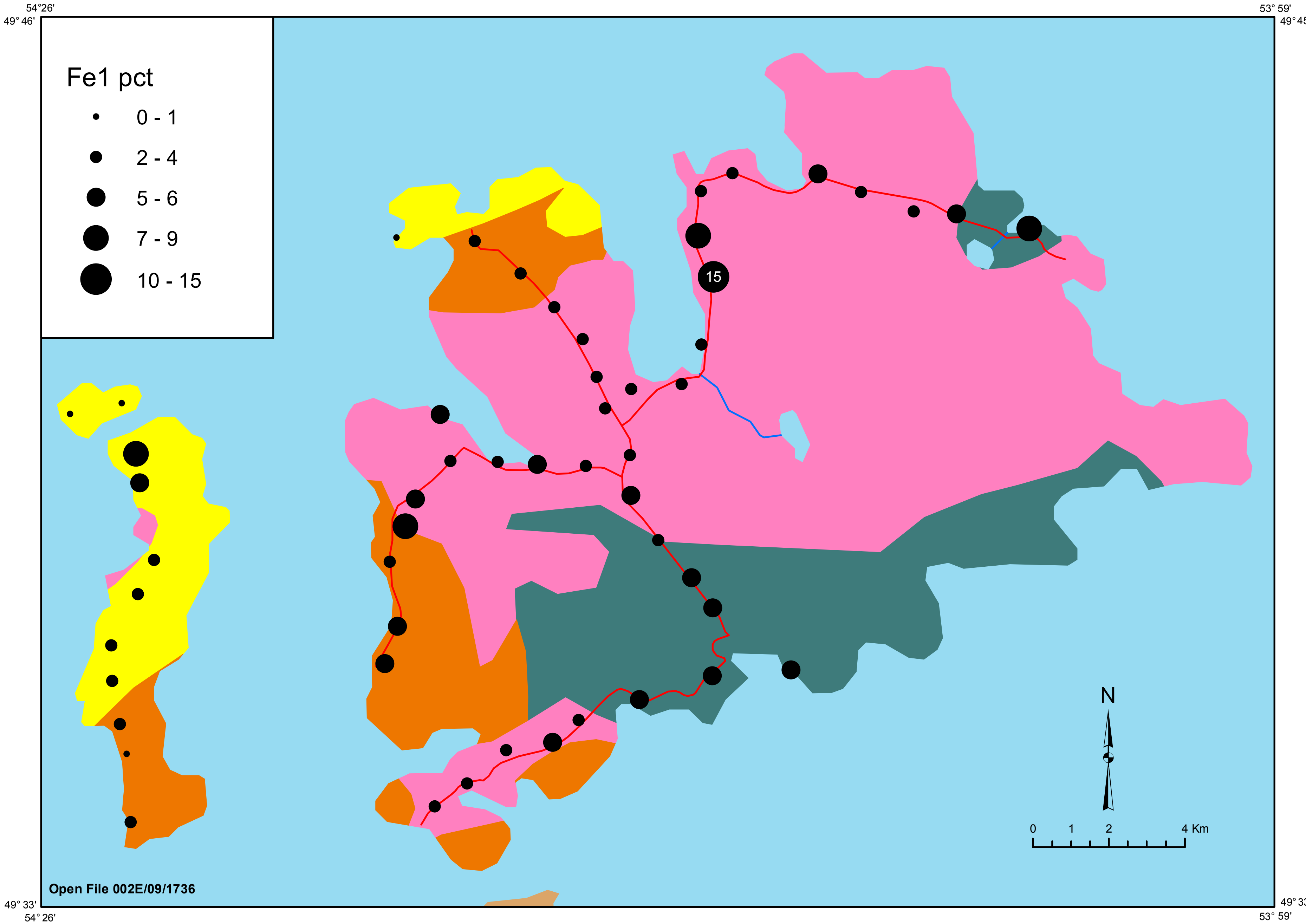

Figure 32. *Distribution of iron (Fe1) in till.*

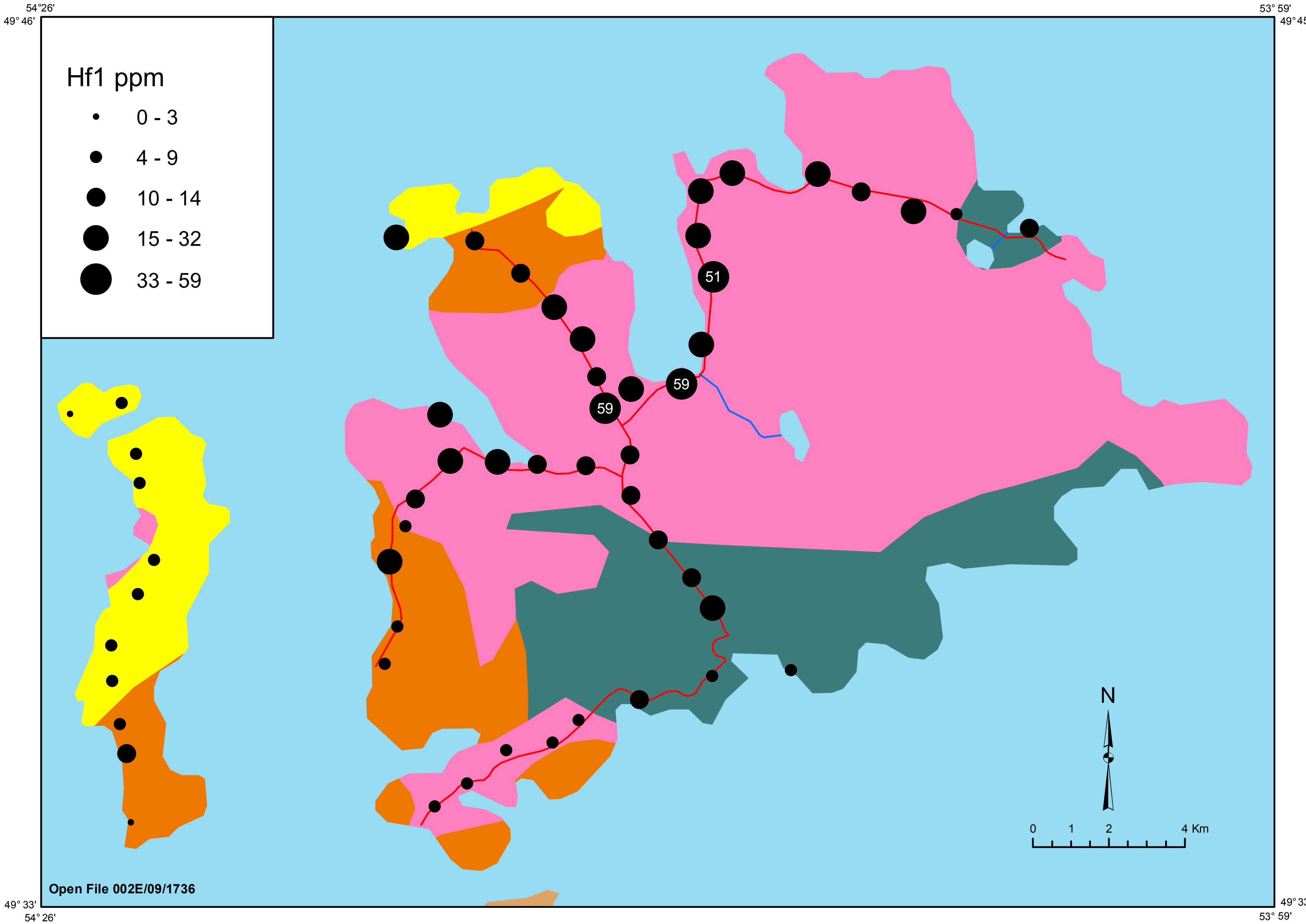

Figure 33. *Distribution of hafnium (Hf1) in till.*

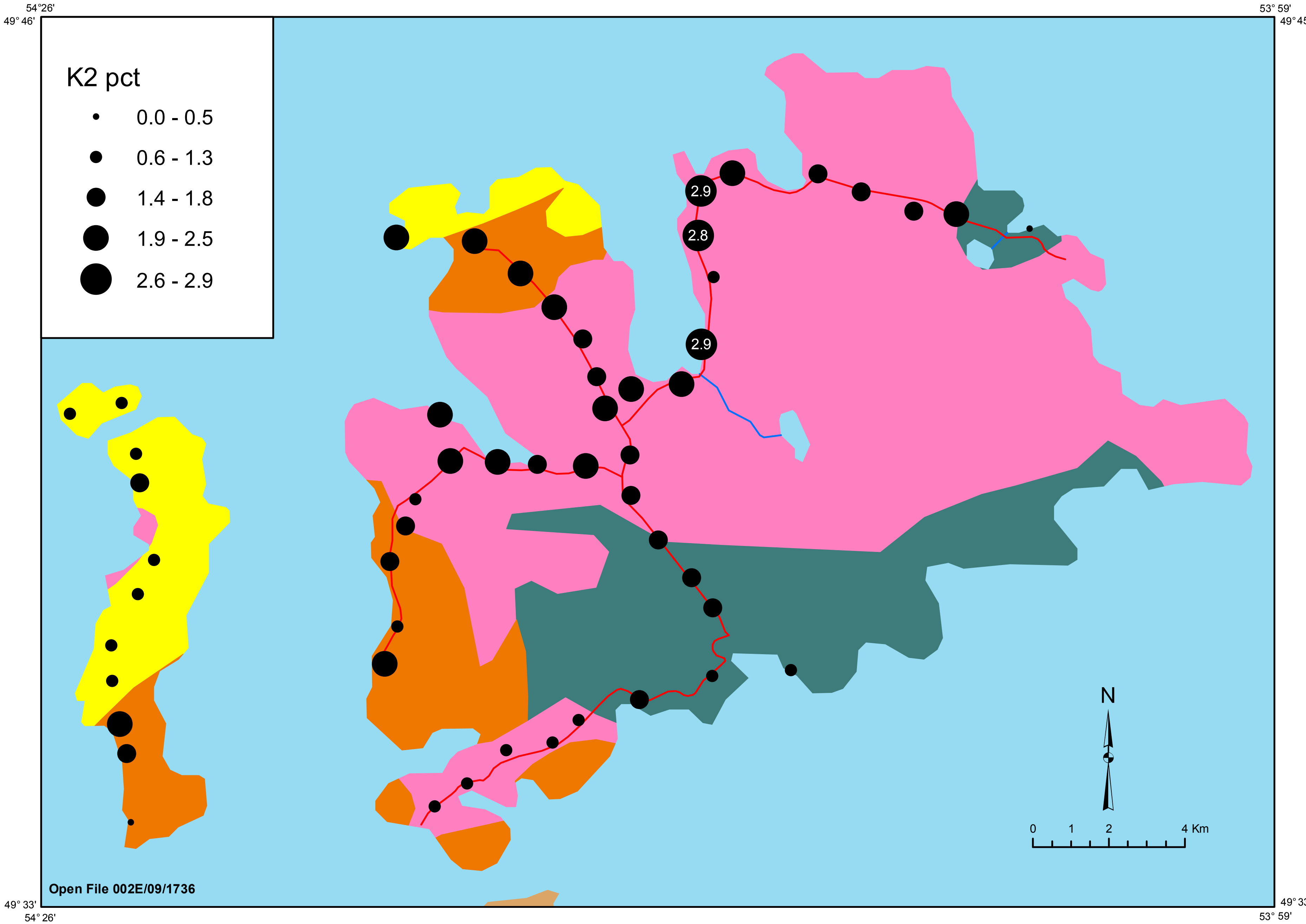

Figure 34. *Distribution of potassium (K2) in till.*

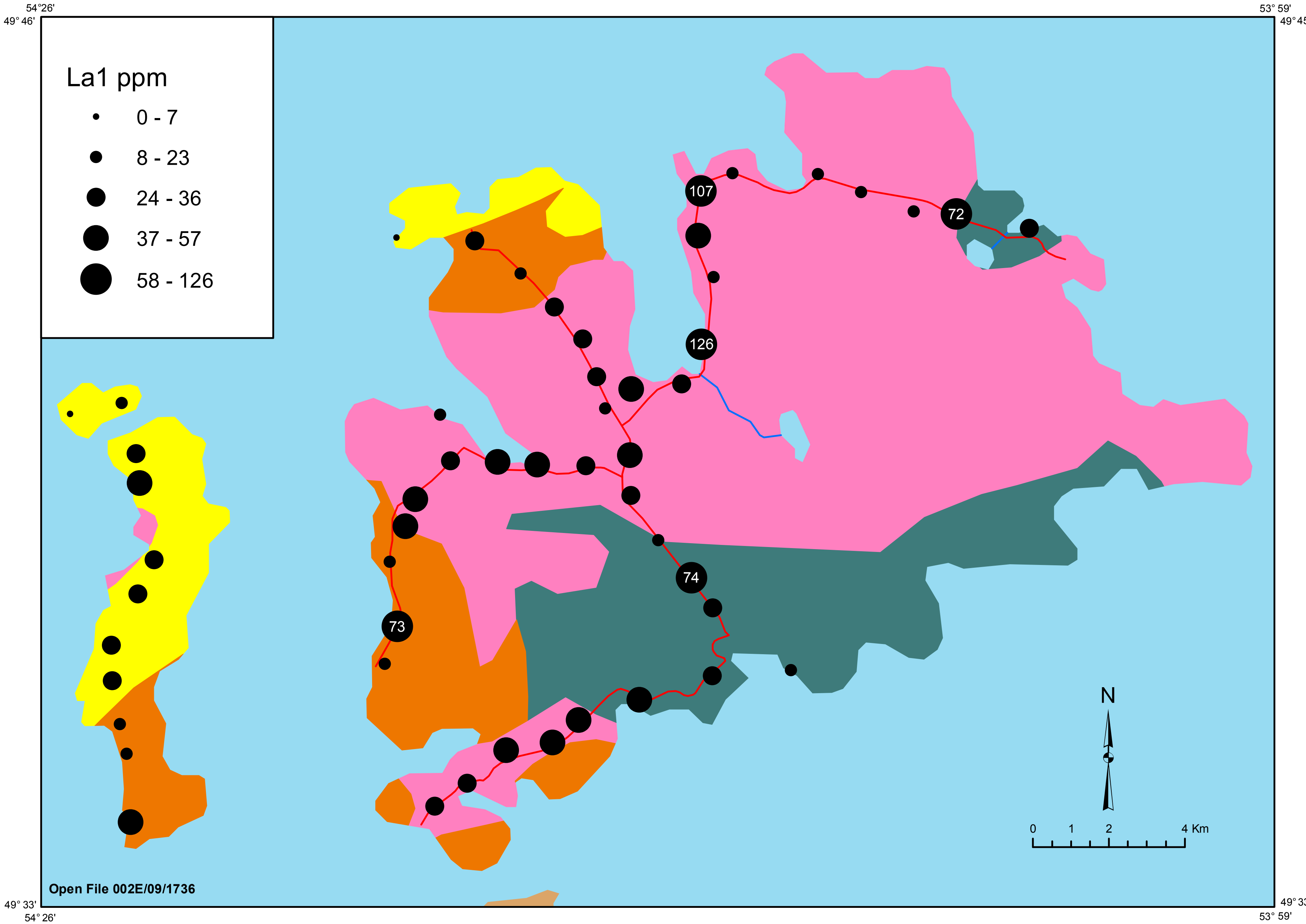

Figure 35. *Distribution of lanthanum (La1) in till.*

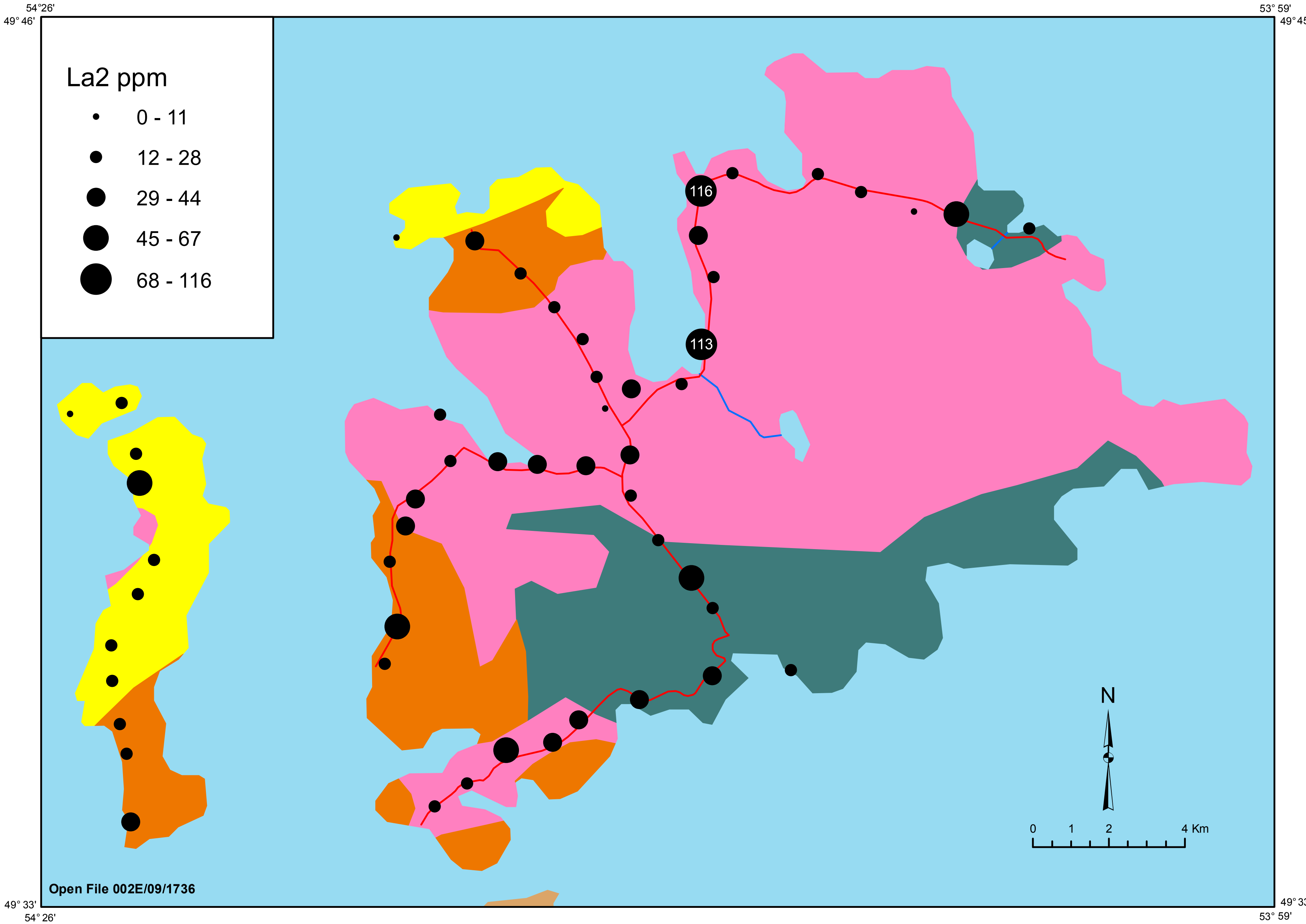

Figure 36. *Distribution of lanthanum (La2) in till.*

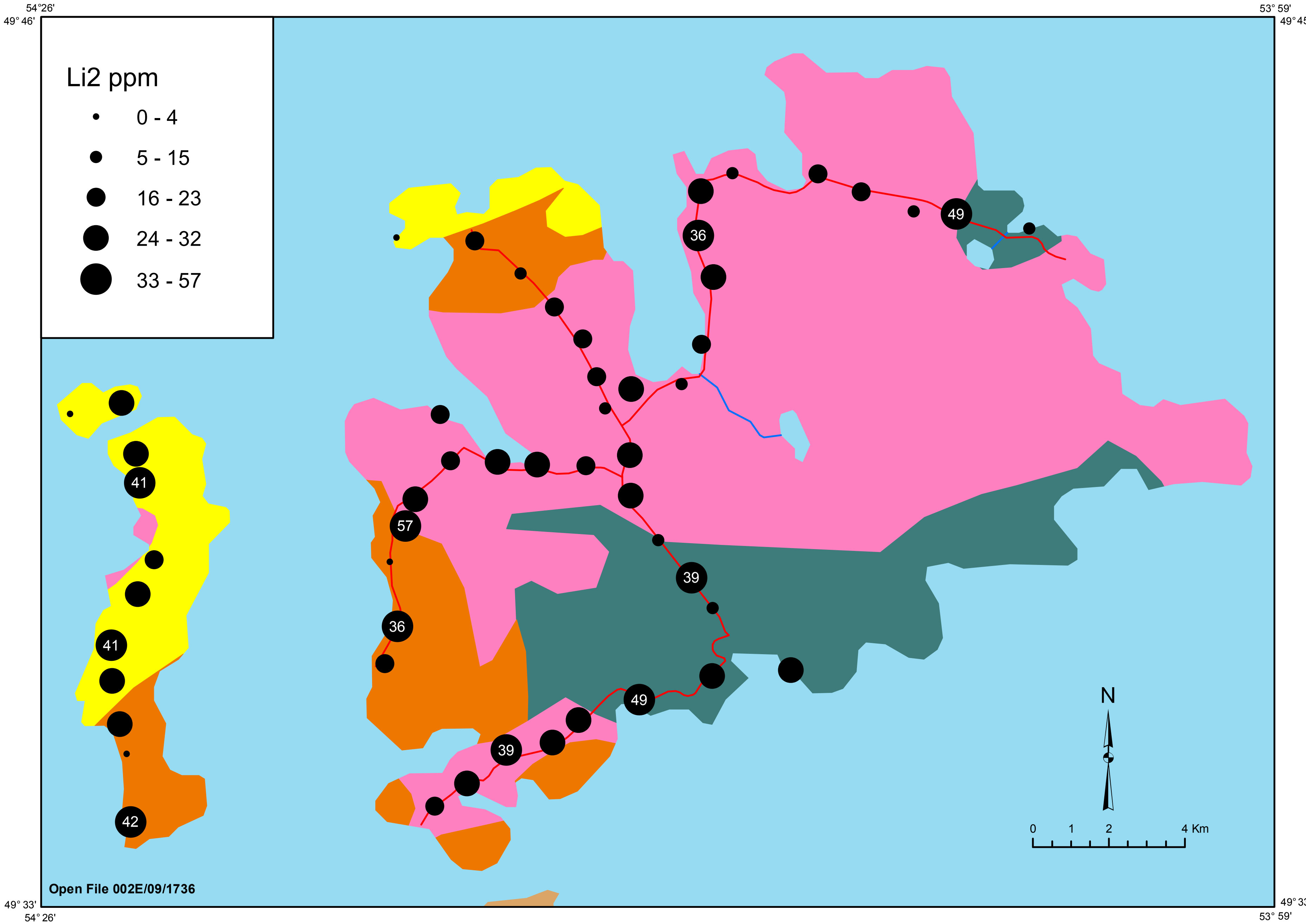

Figure 37. *Distribution of lithium (Li2) in till.*

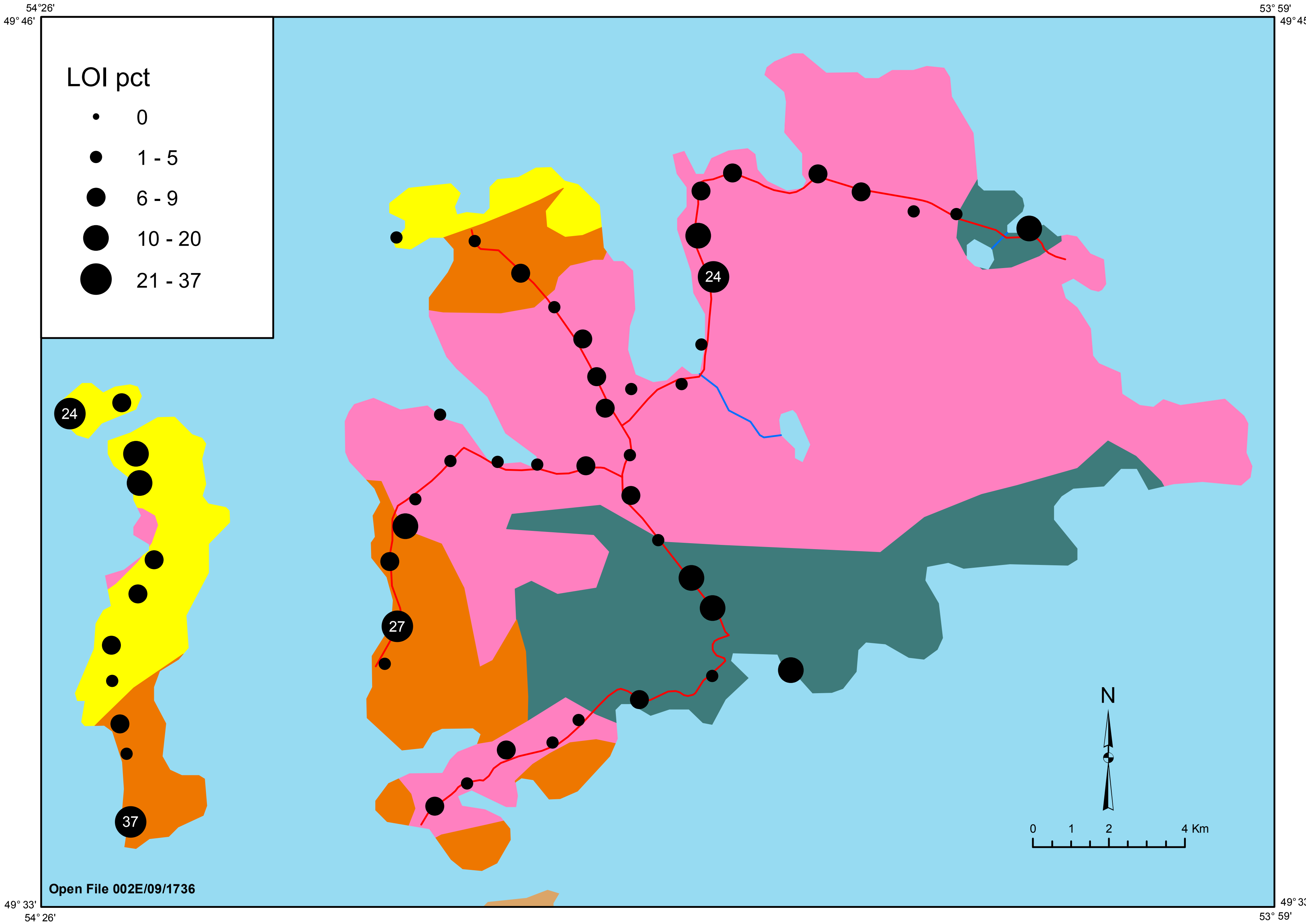

Figure 38. *Distribution of loss-on-ignition (LOI) in till.*

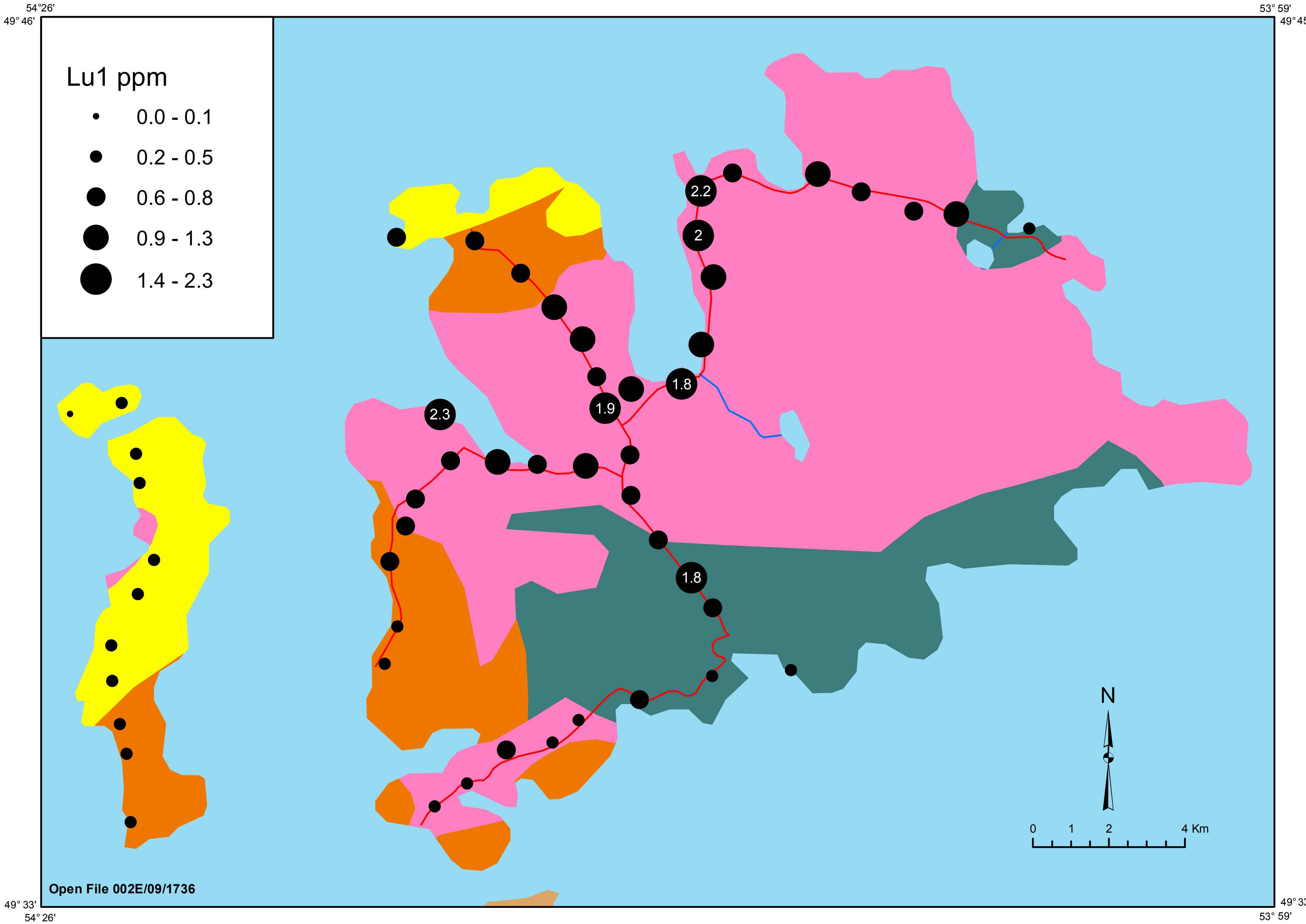

Figure 39. *Distribution of lutetium (Lu1) in till.*

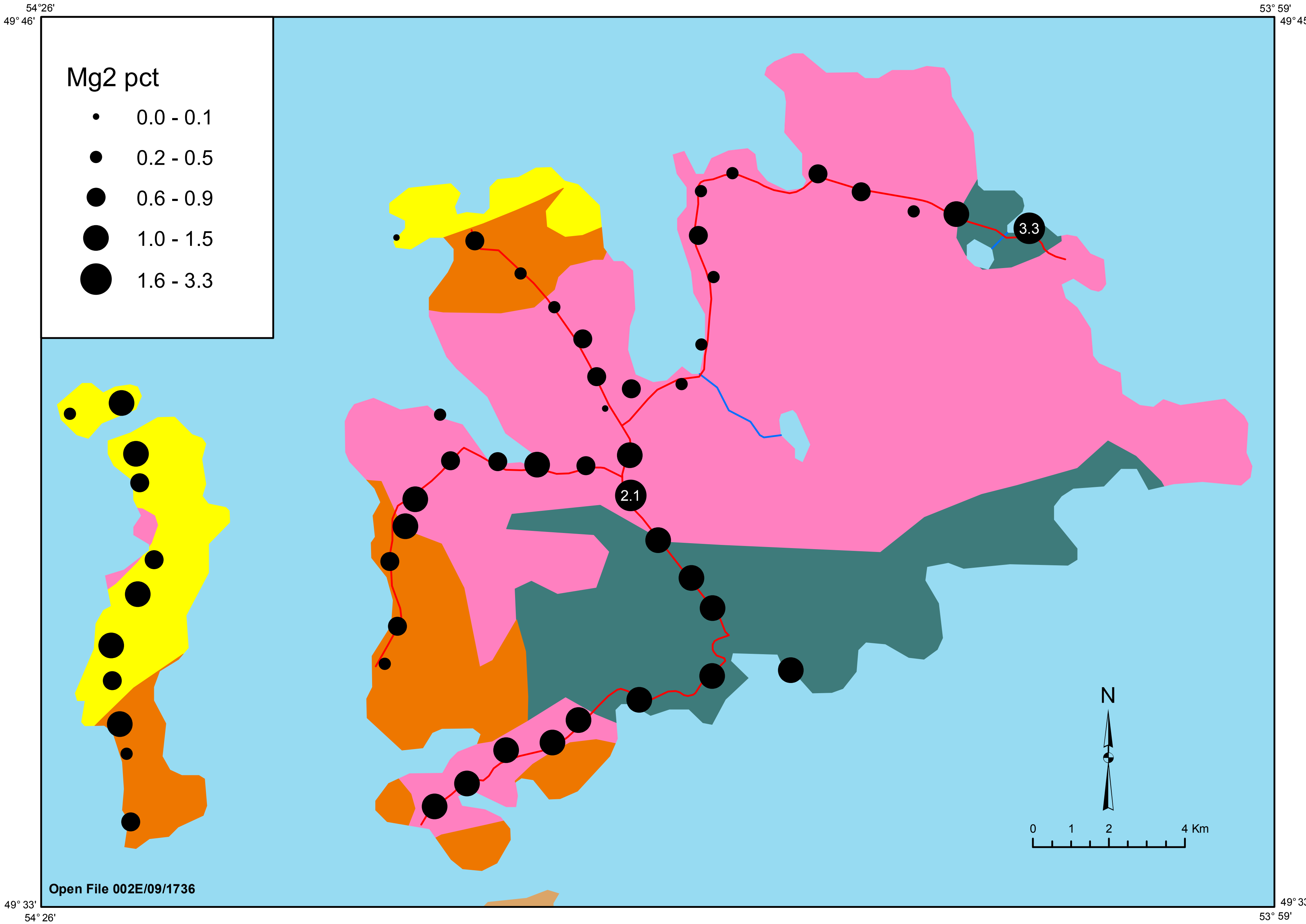

Figure 40. *Distribution of magnesium (Mg2) in till.*

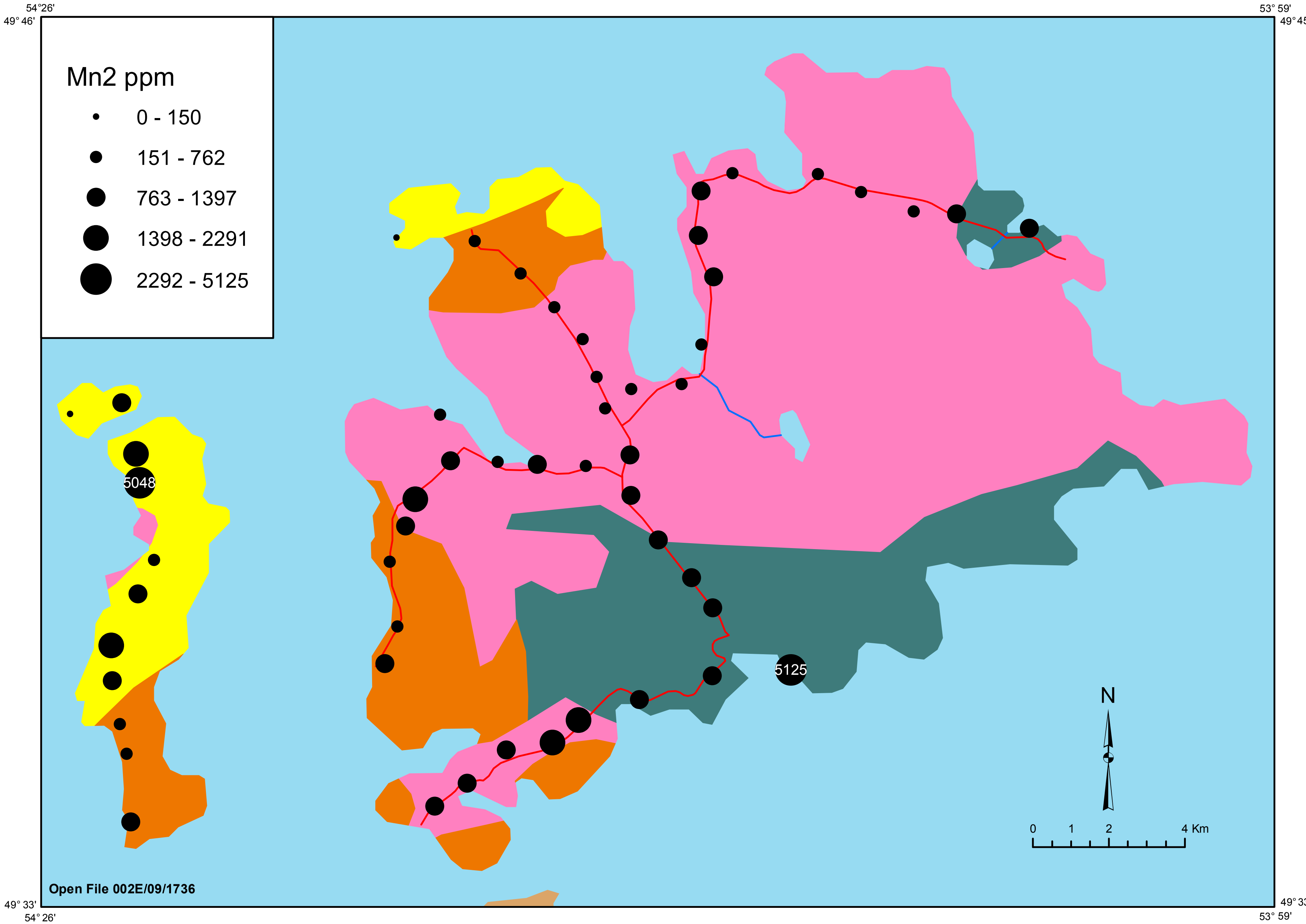

Figure 41. *Distribution of manganese (Mn2) in till.*

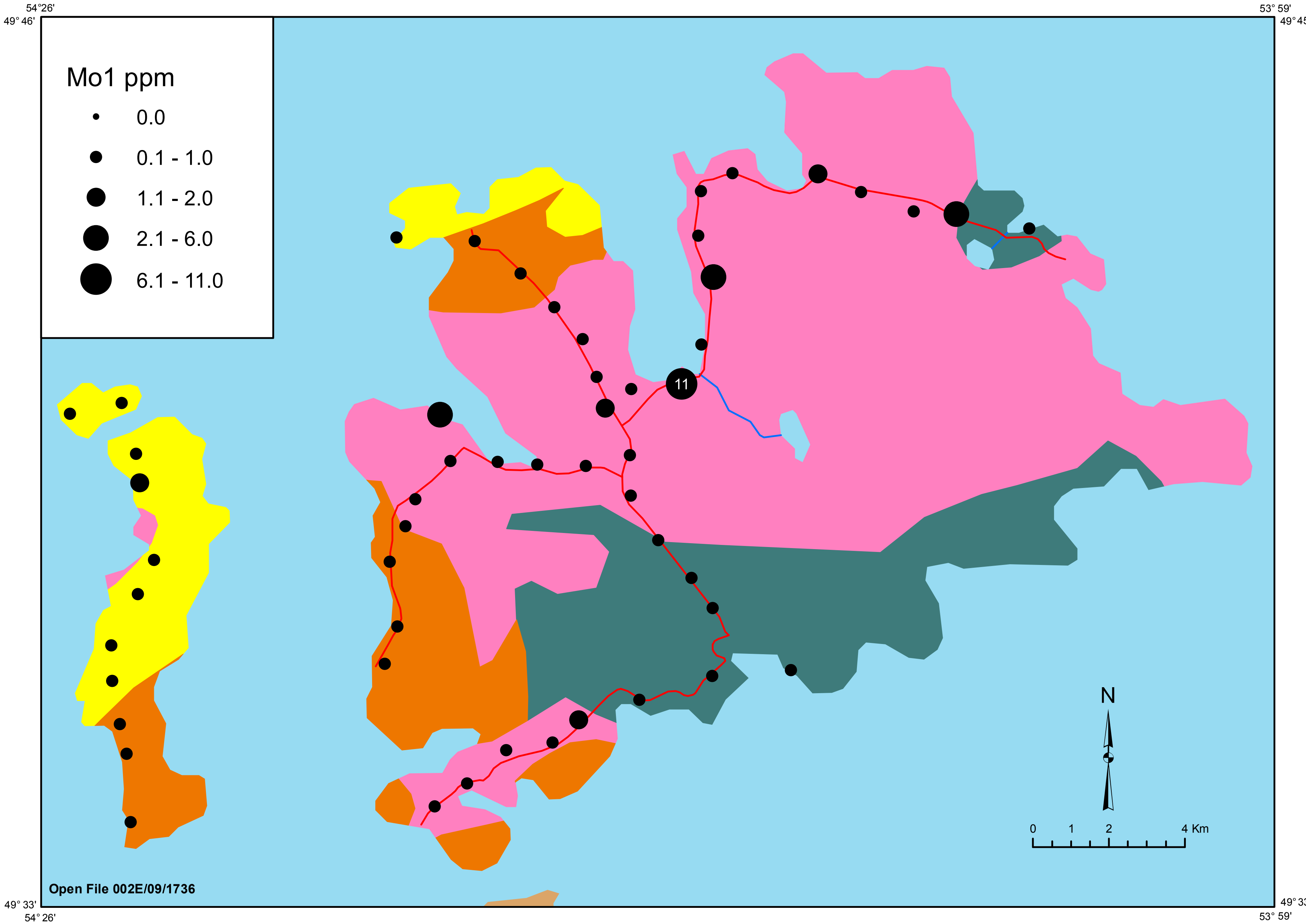

Figure 42. *Distribution of molybdenum (Mo1) in till.*

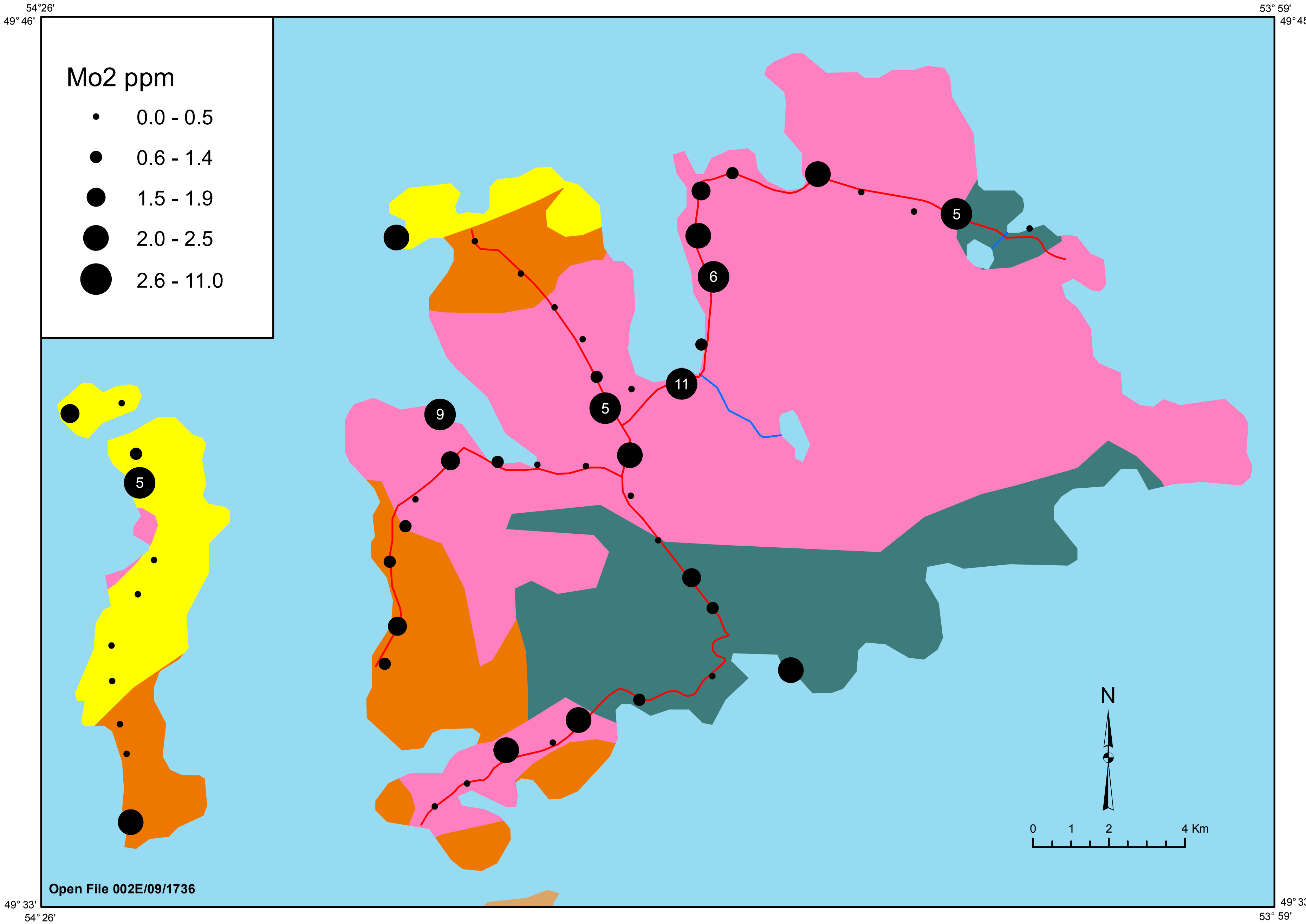

Figure 43. *Distribution of molybdenum (Mo2) in till.*

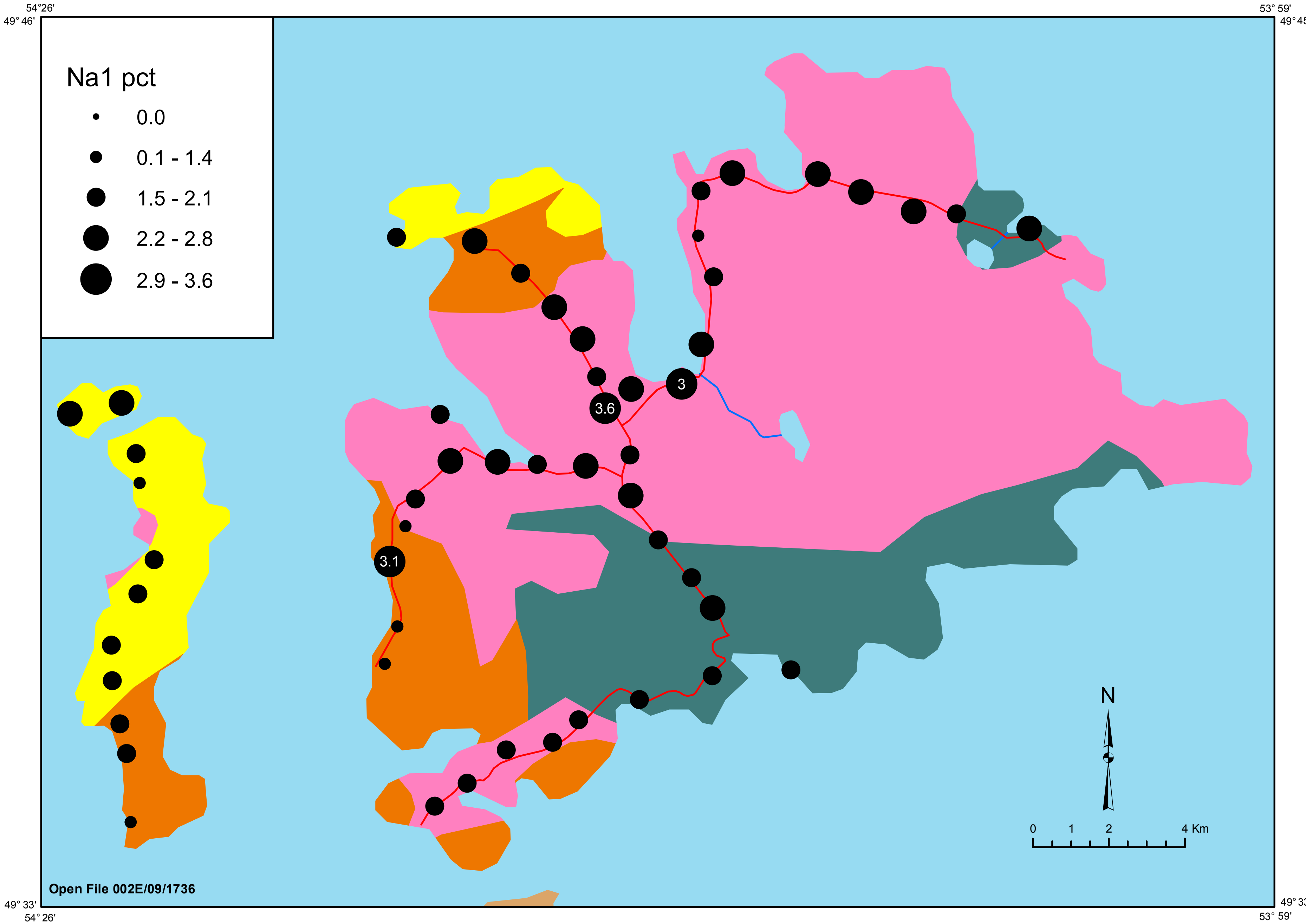

Figure 44. *Distribution of sodium (Na1) in till.*

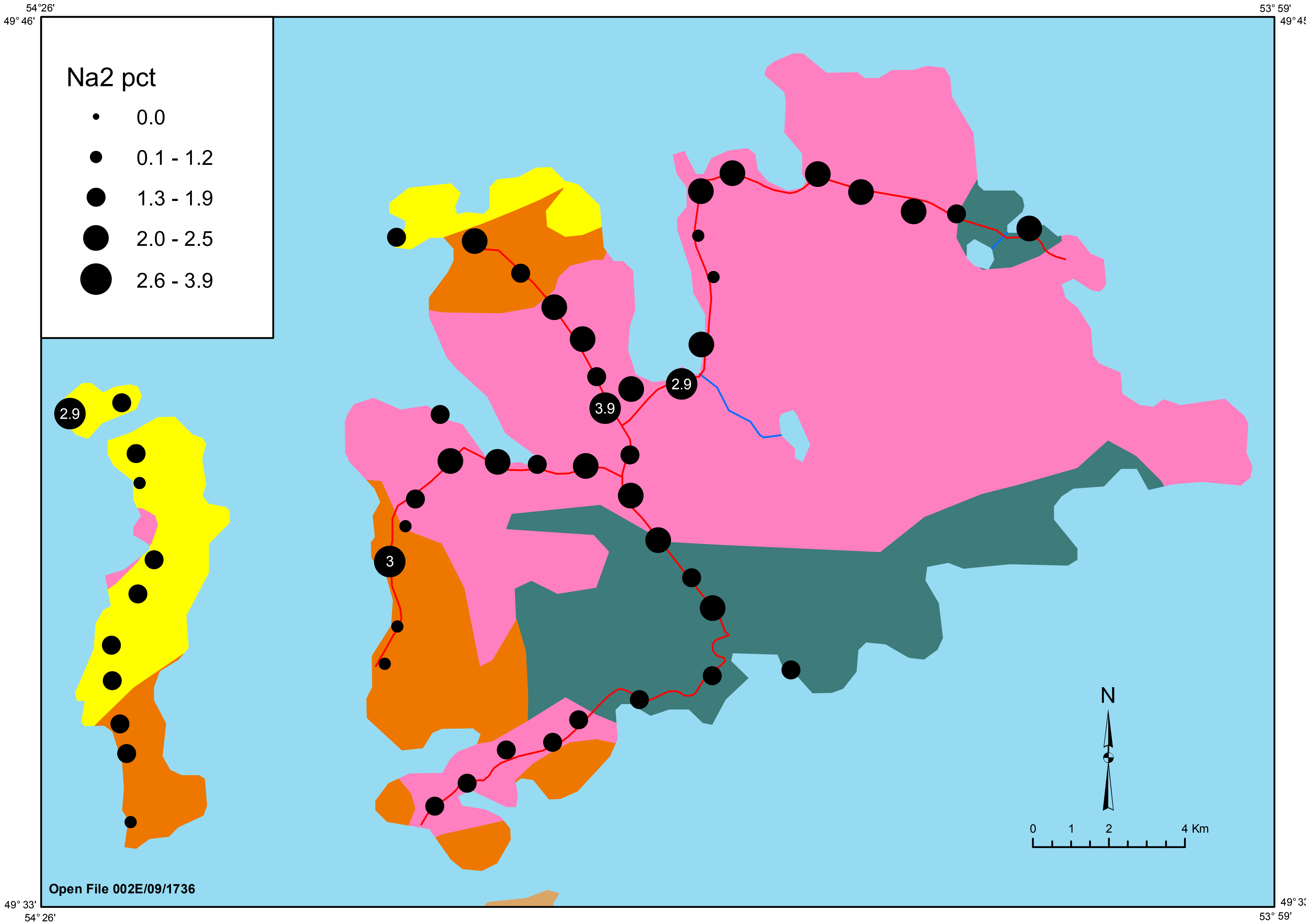

Figure 45. *Distribution of sodium (Na2) in till.*

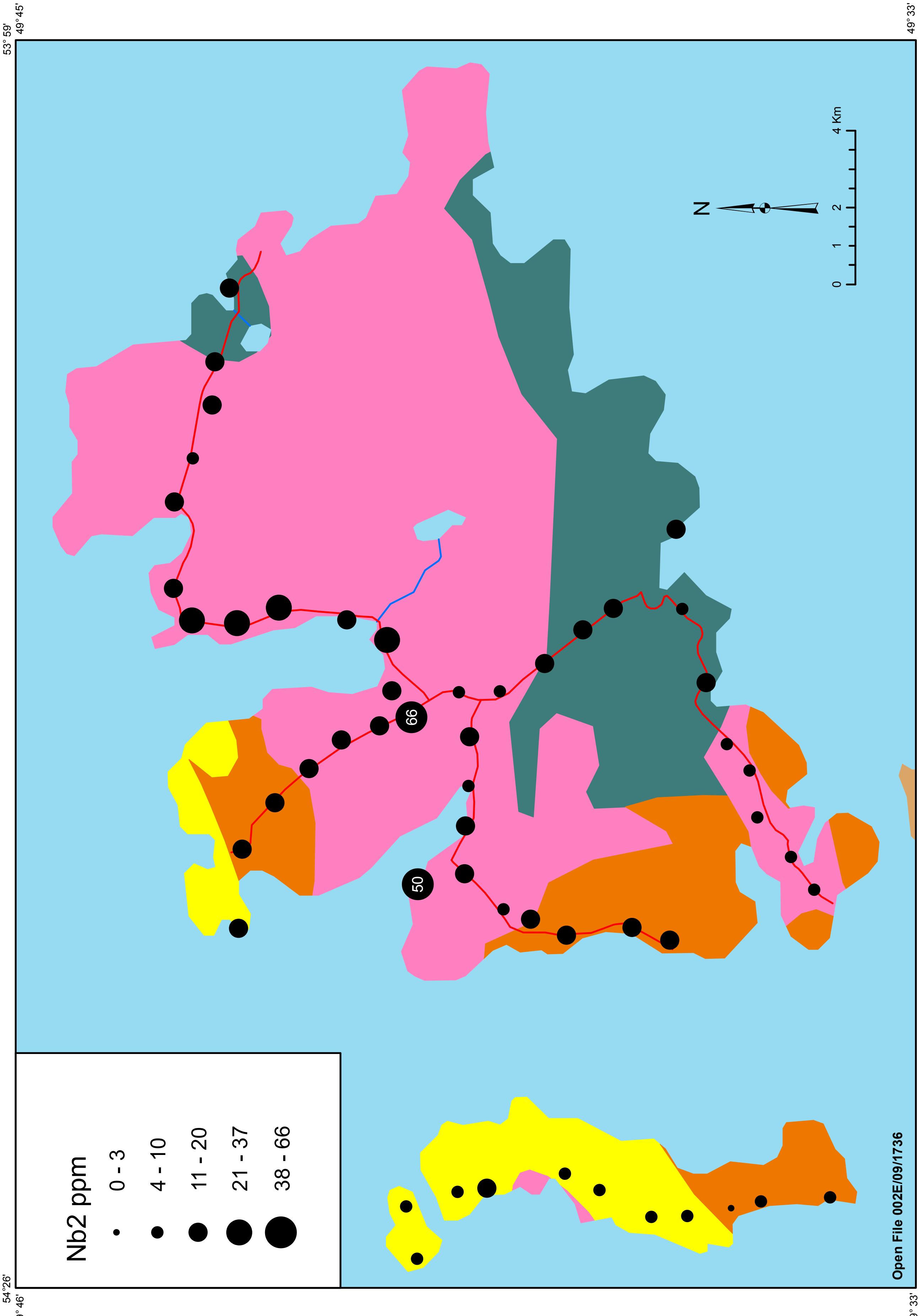

Figure 46. *Distribution of niobium (Nb2) in till.*

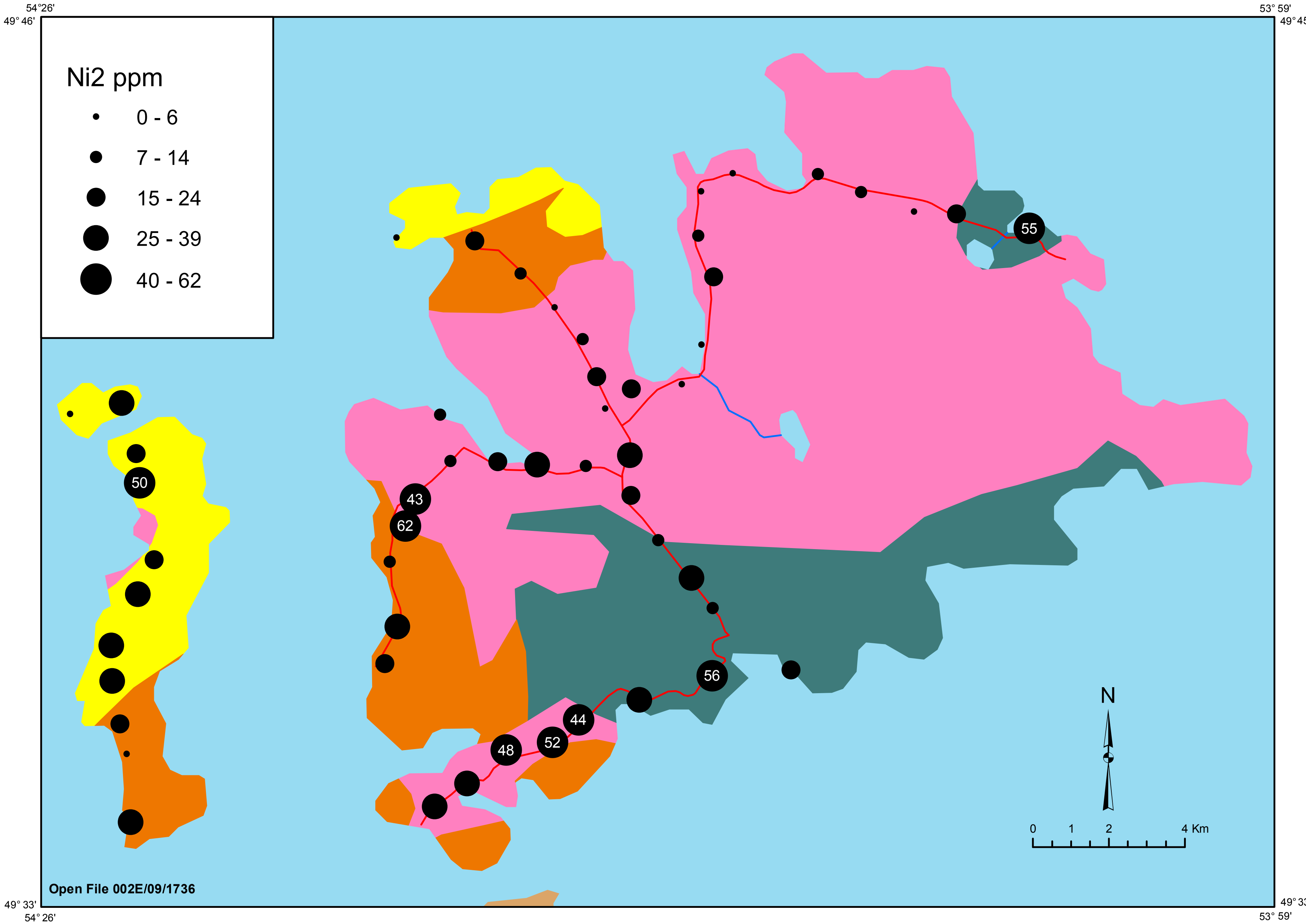

Figure 47. *Distribution of nickel (Ni2) in till.*

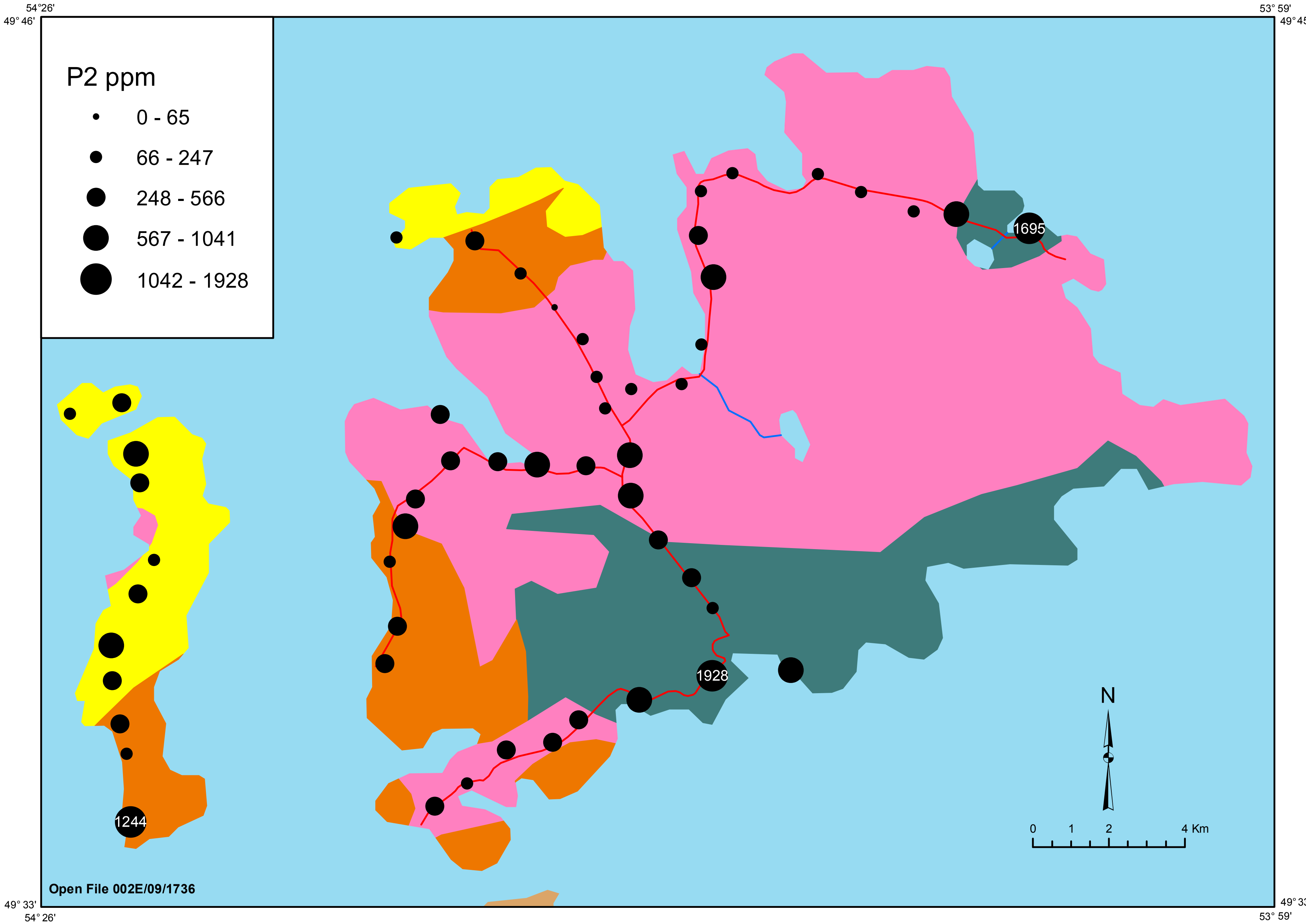

Figure 48. *Distribution of phosphorous (P2) in till.*

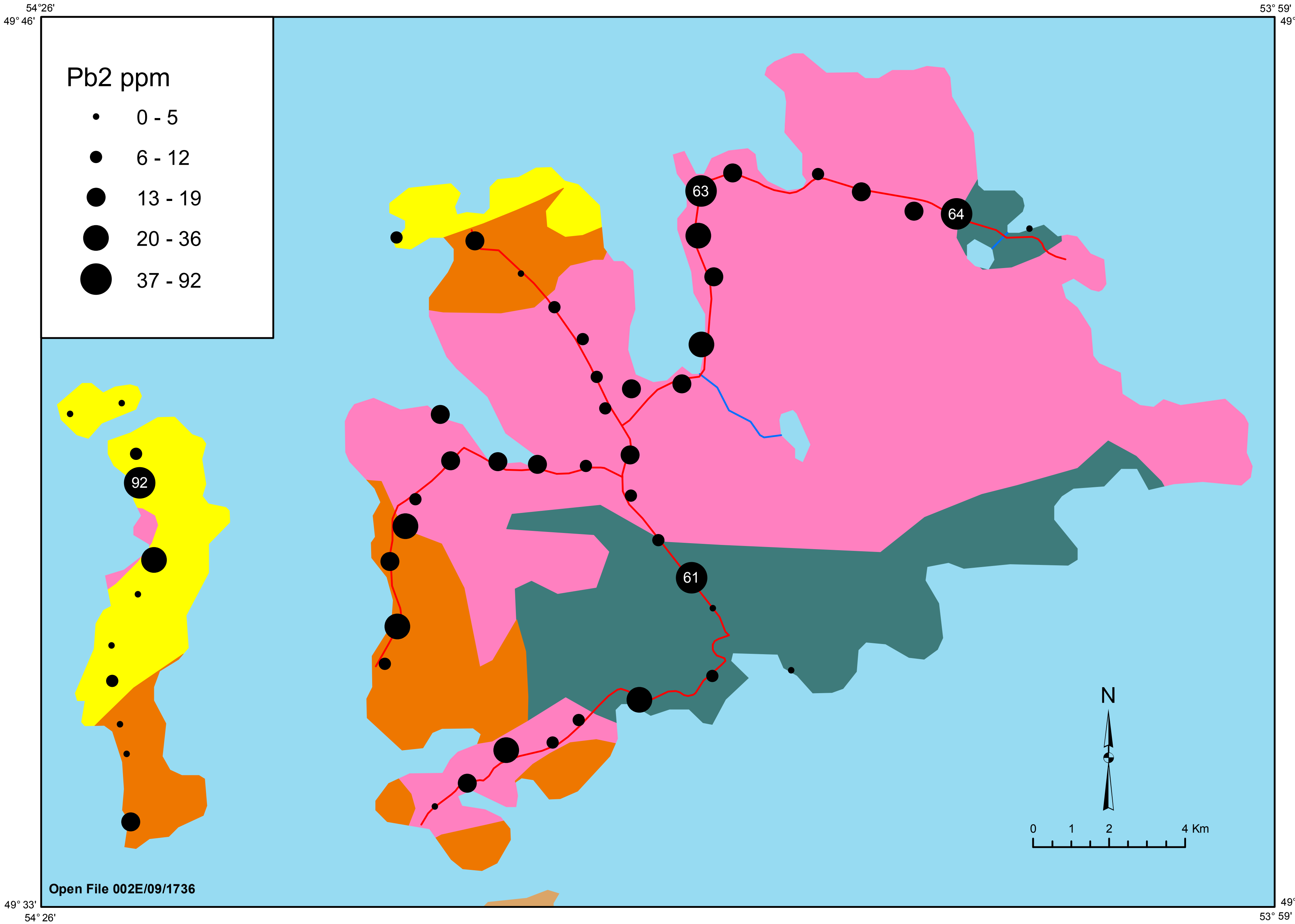

Figure 49. *Distribution of lead (Pb2) in till.*

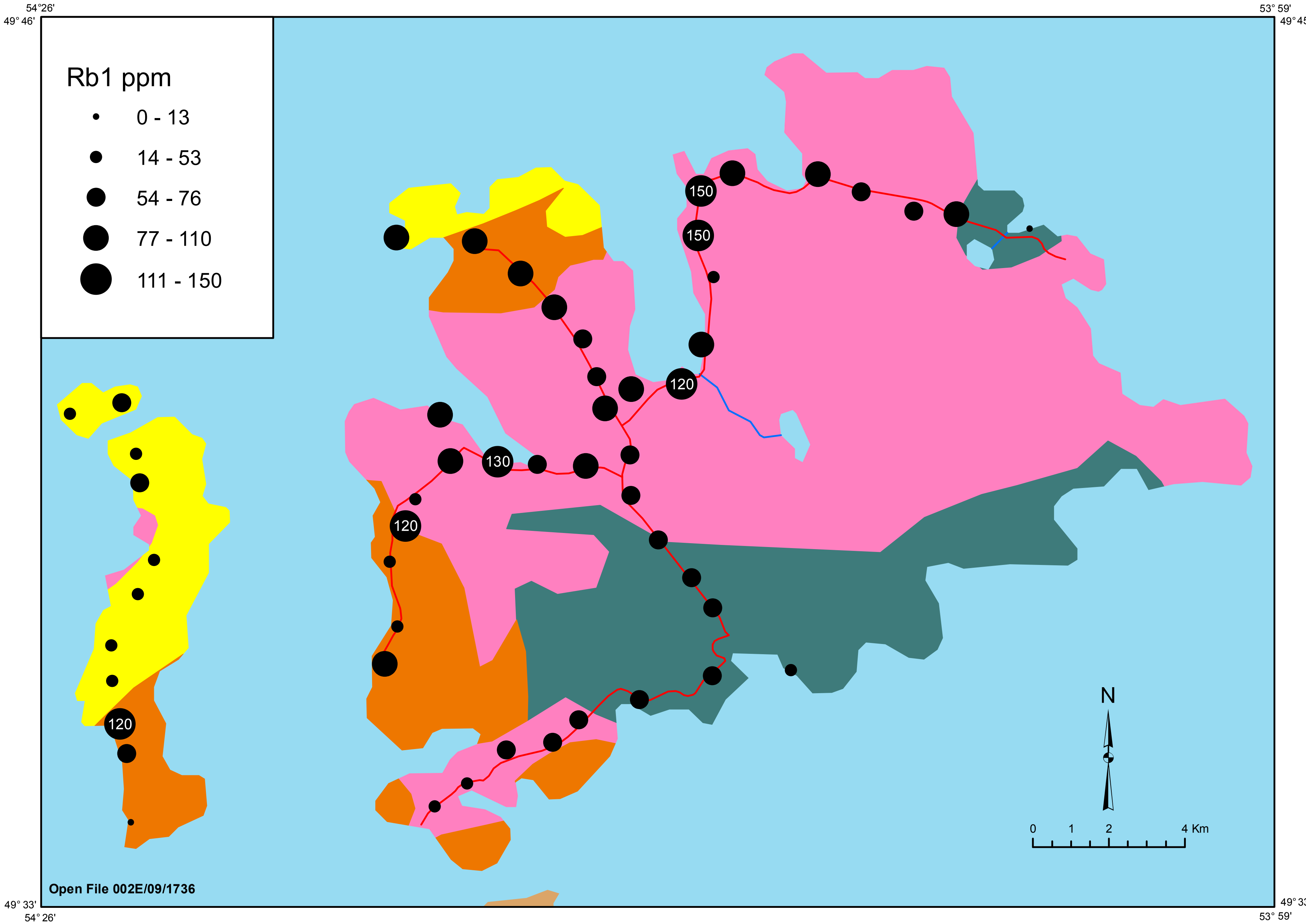

Figure 50. *Distribution of rubidium (Rb1) in till.*

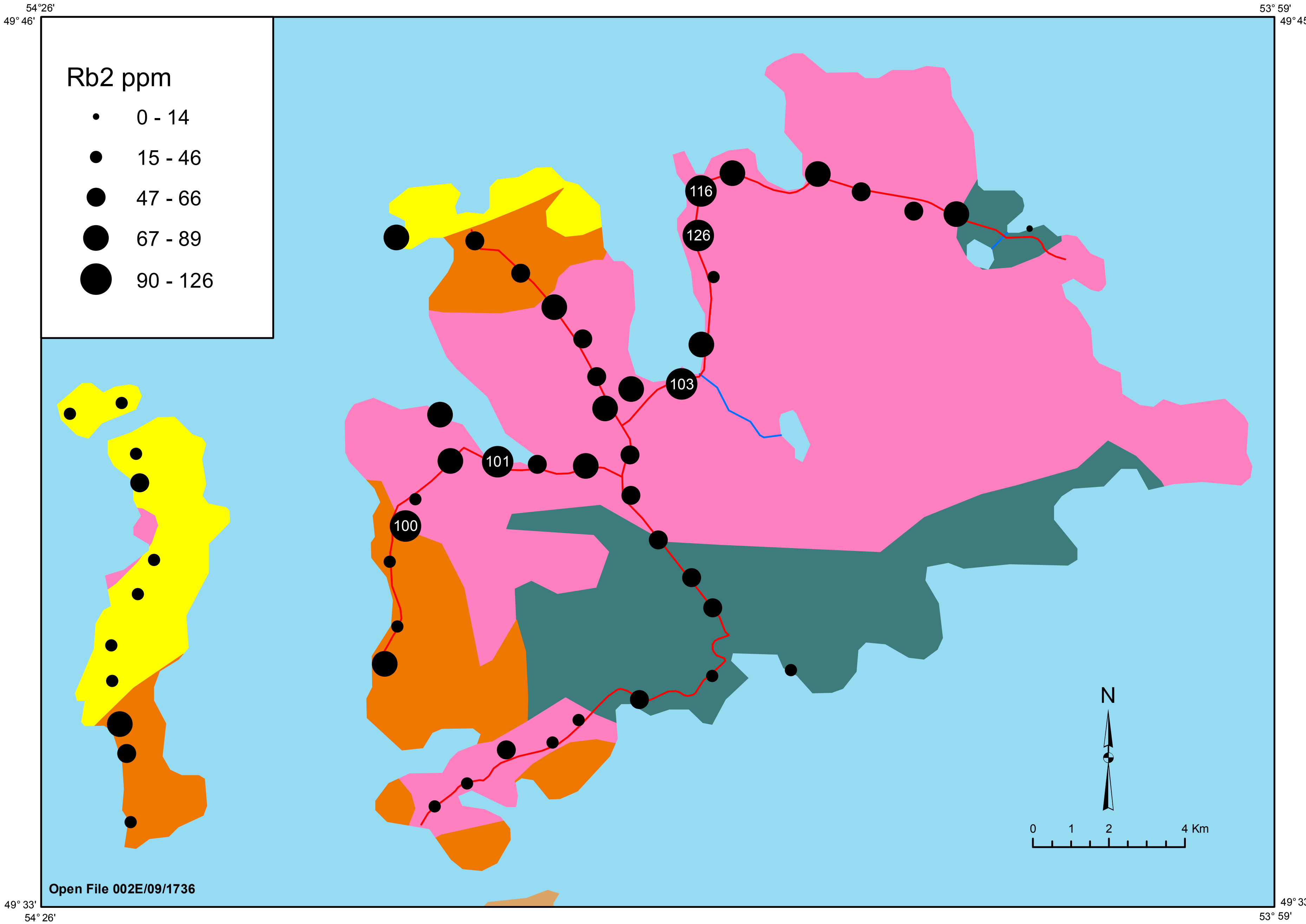

Figure 51. *Distribution of rubidium (Rb2) in till.*

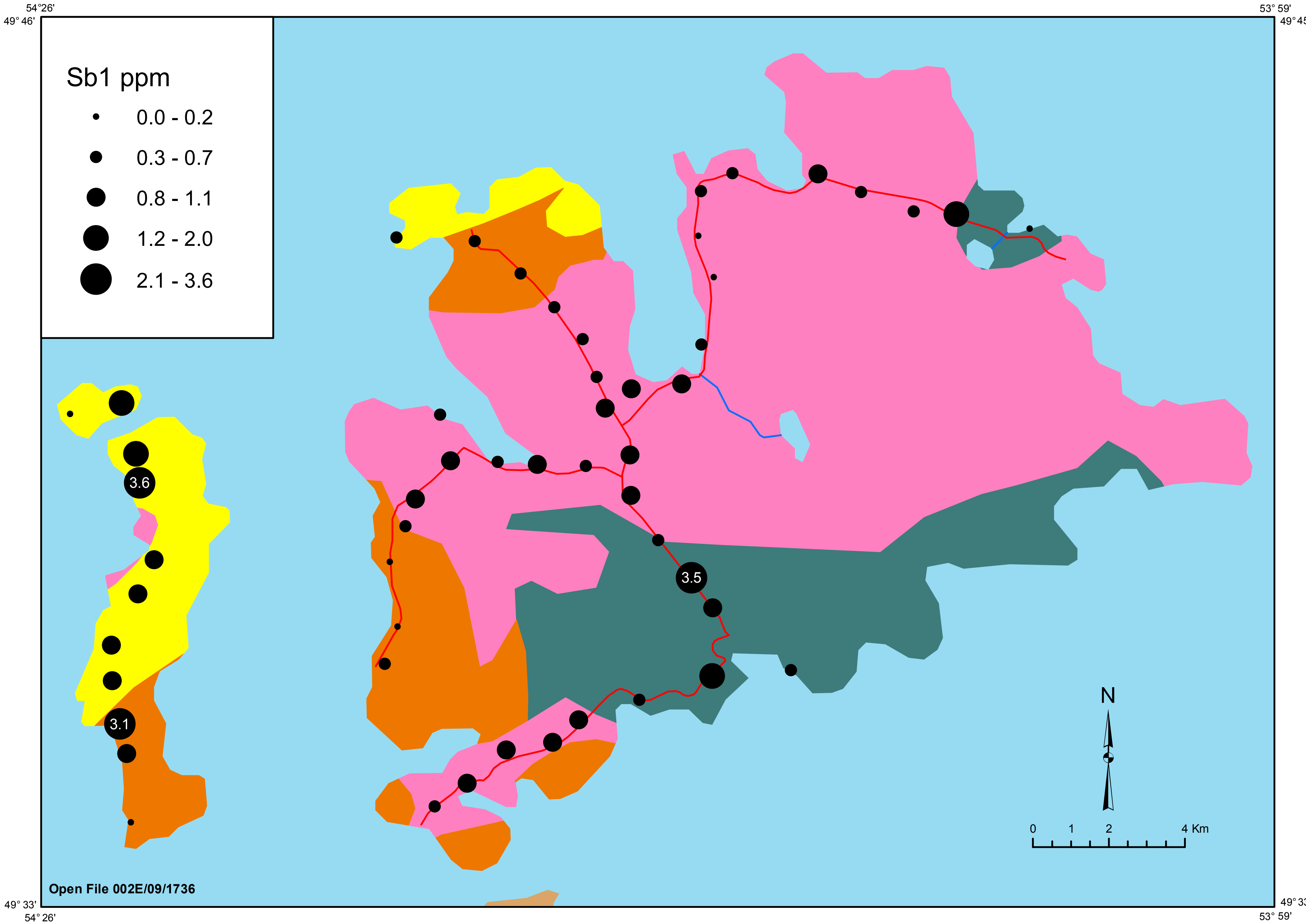

Figure 52. *Distribution of antimony (Sb1) in till.*

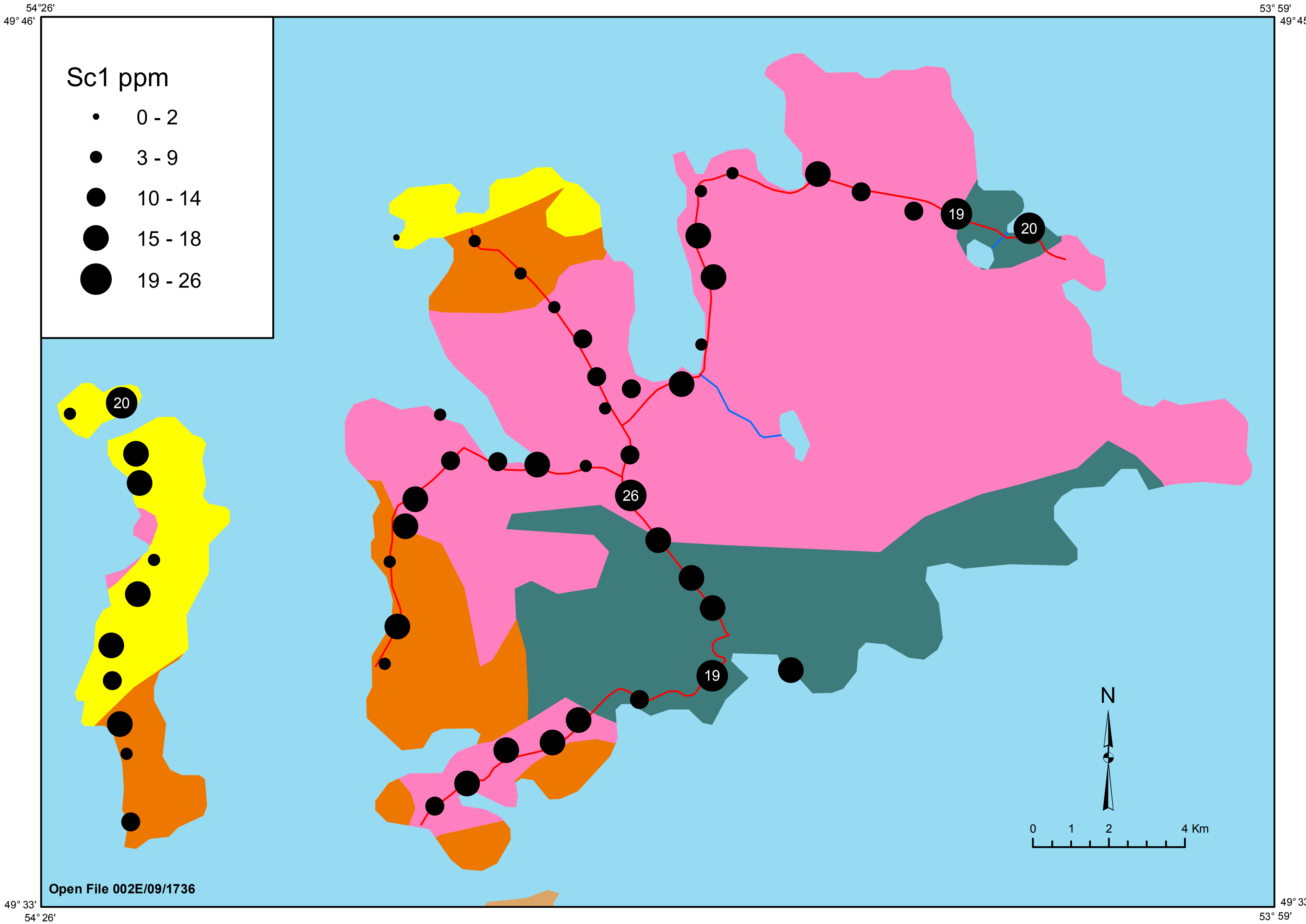

Figure 53. *Distribution of scandium (Sc1) in till.*

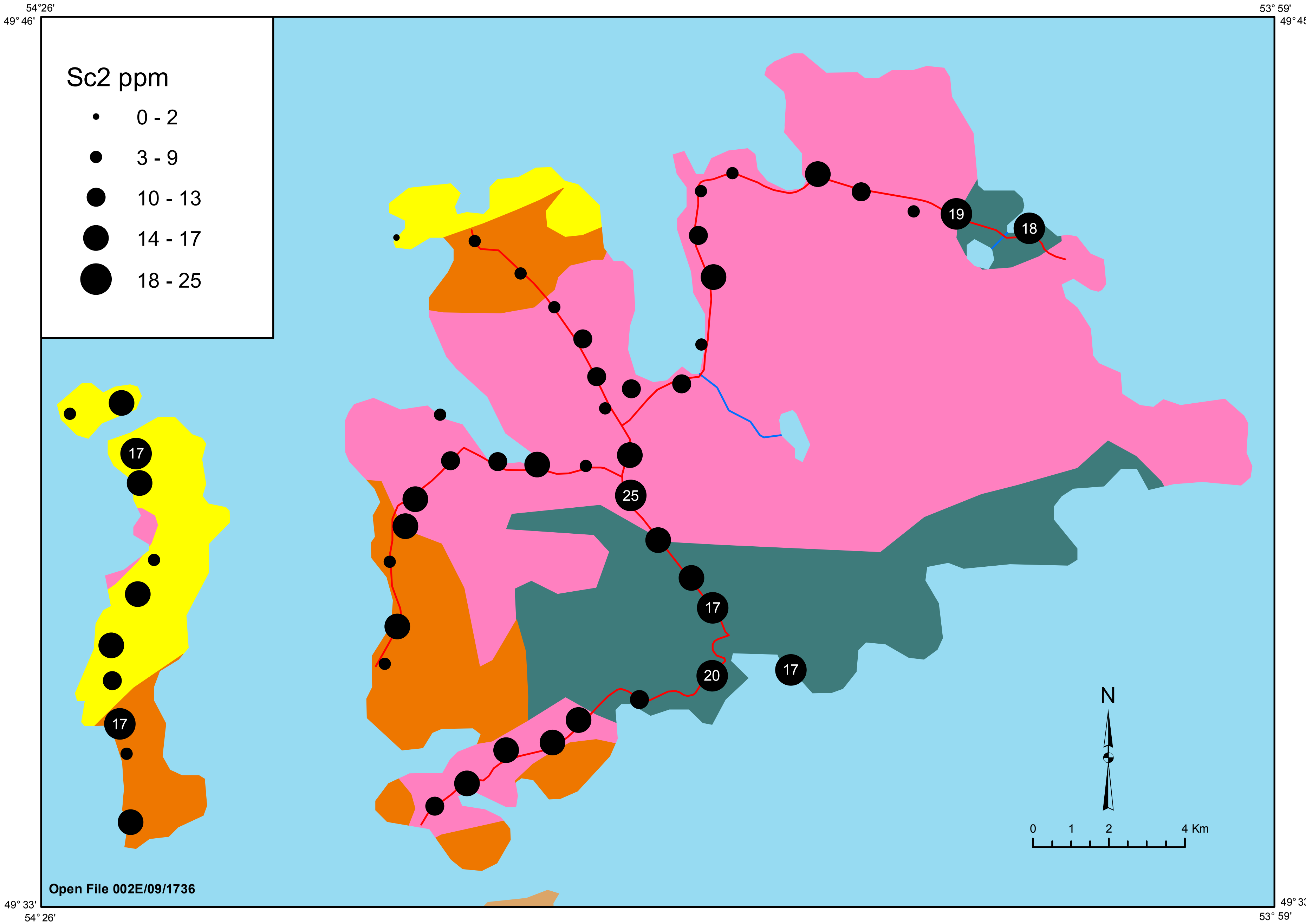

Figure 54. *Distribution of scandium (Sc2) in till.*

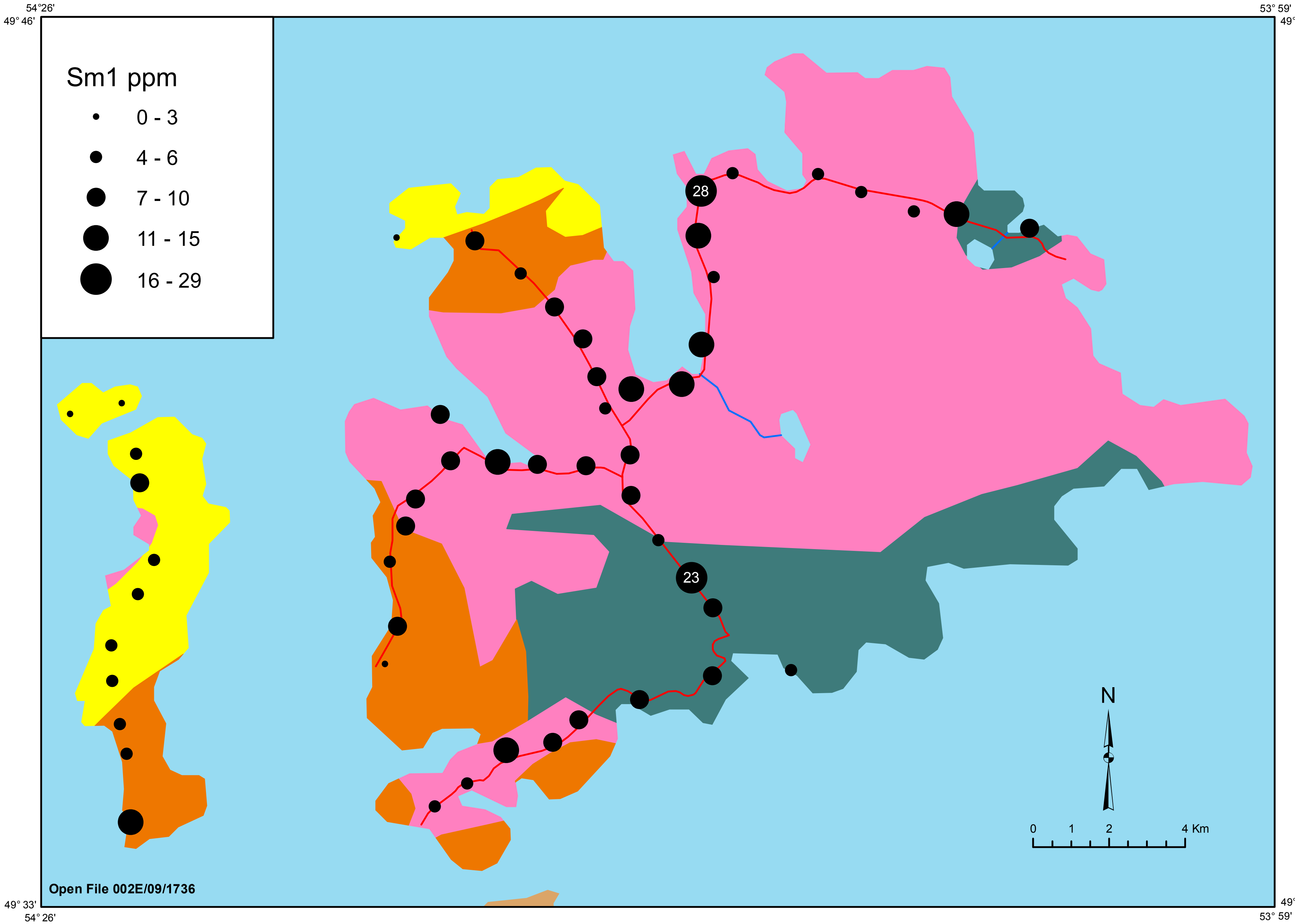

Figure 55. *Distribution of samarium (Sm1) in till.*

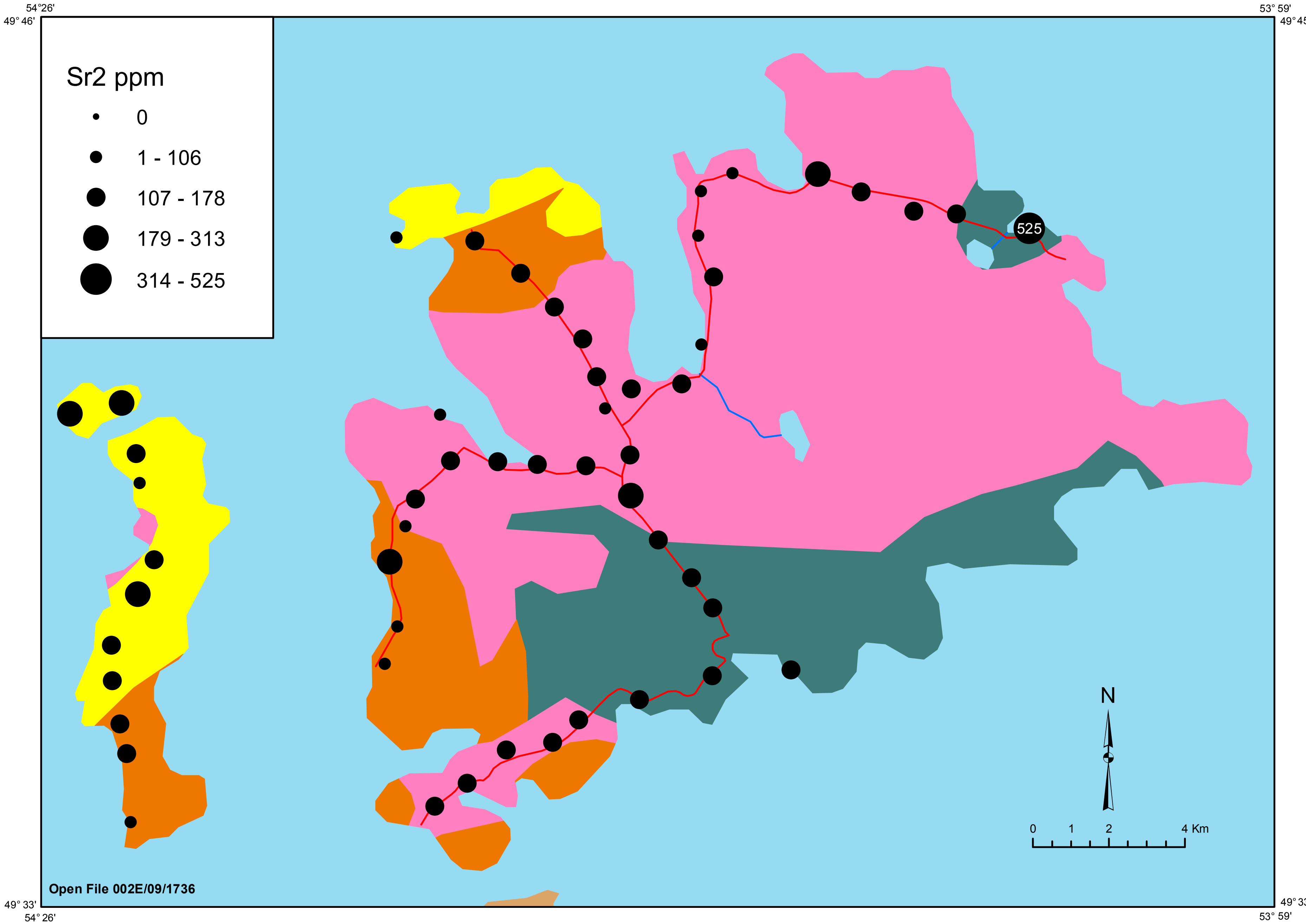

Figure 56. *Distribution of strontium (Sr2) in till.*

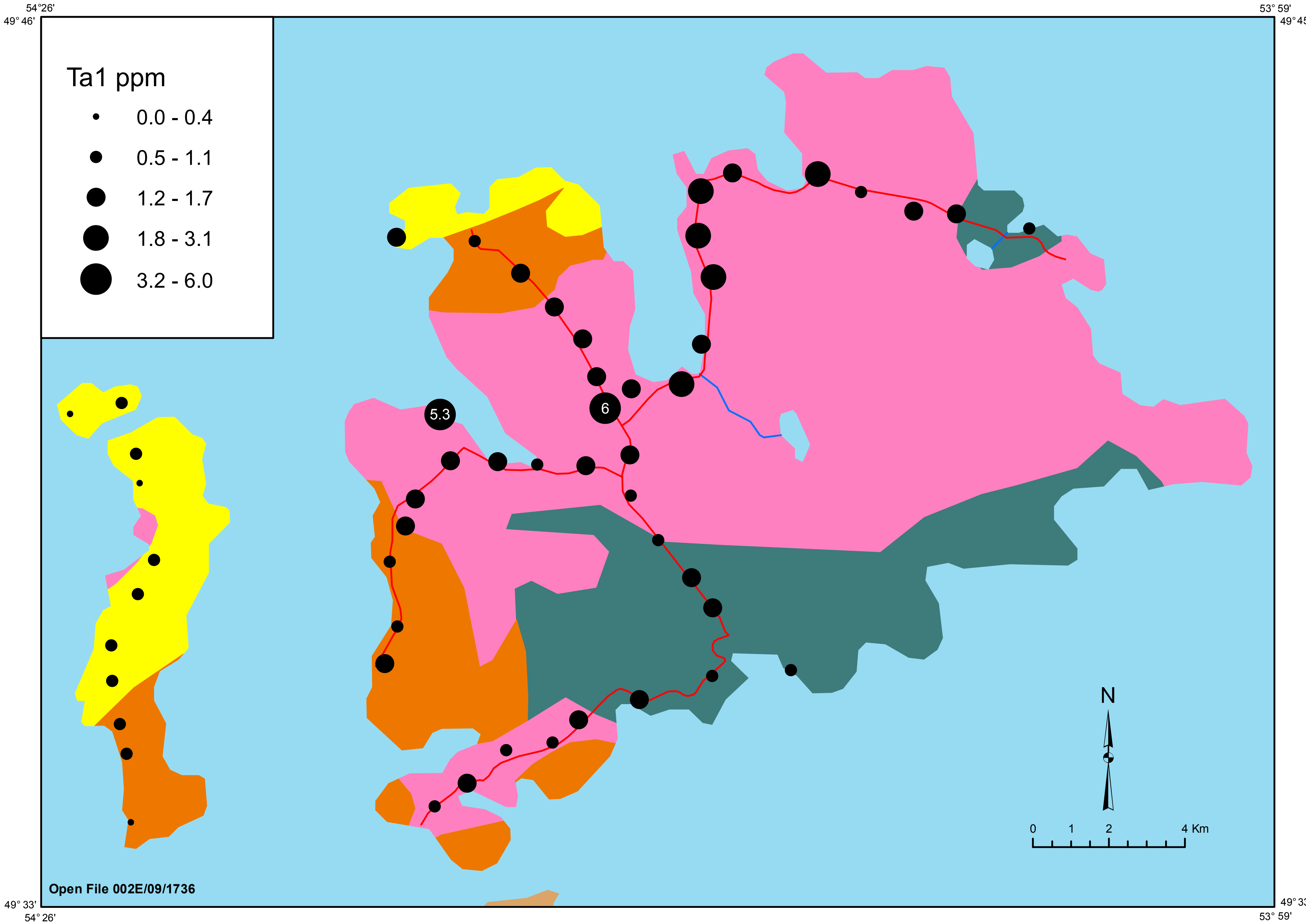

Figure 57. *Distribution of tantalum (Ta1) in till.*

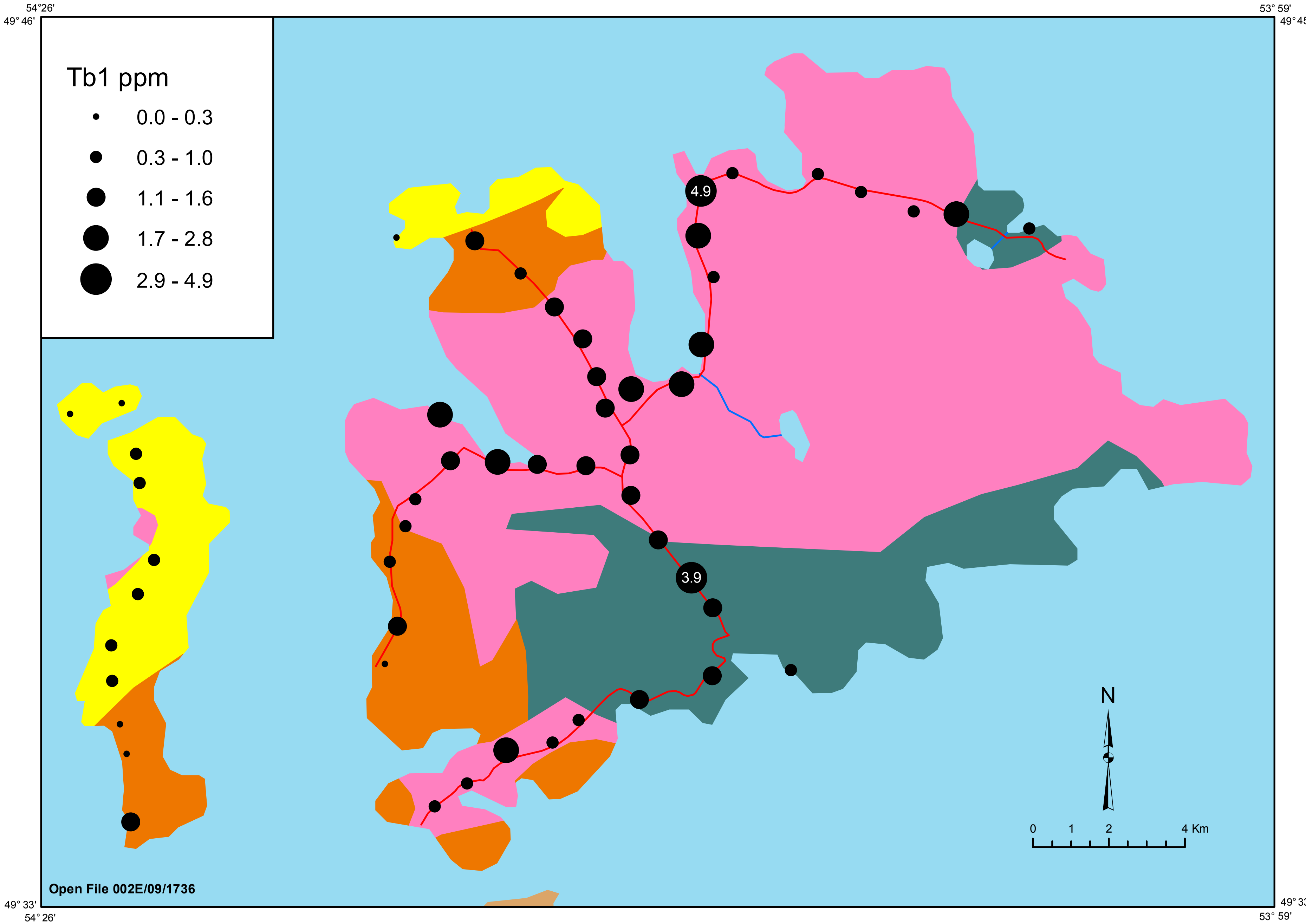

Figure 58. *Distribution of terbium (Tb1) in till.*

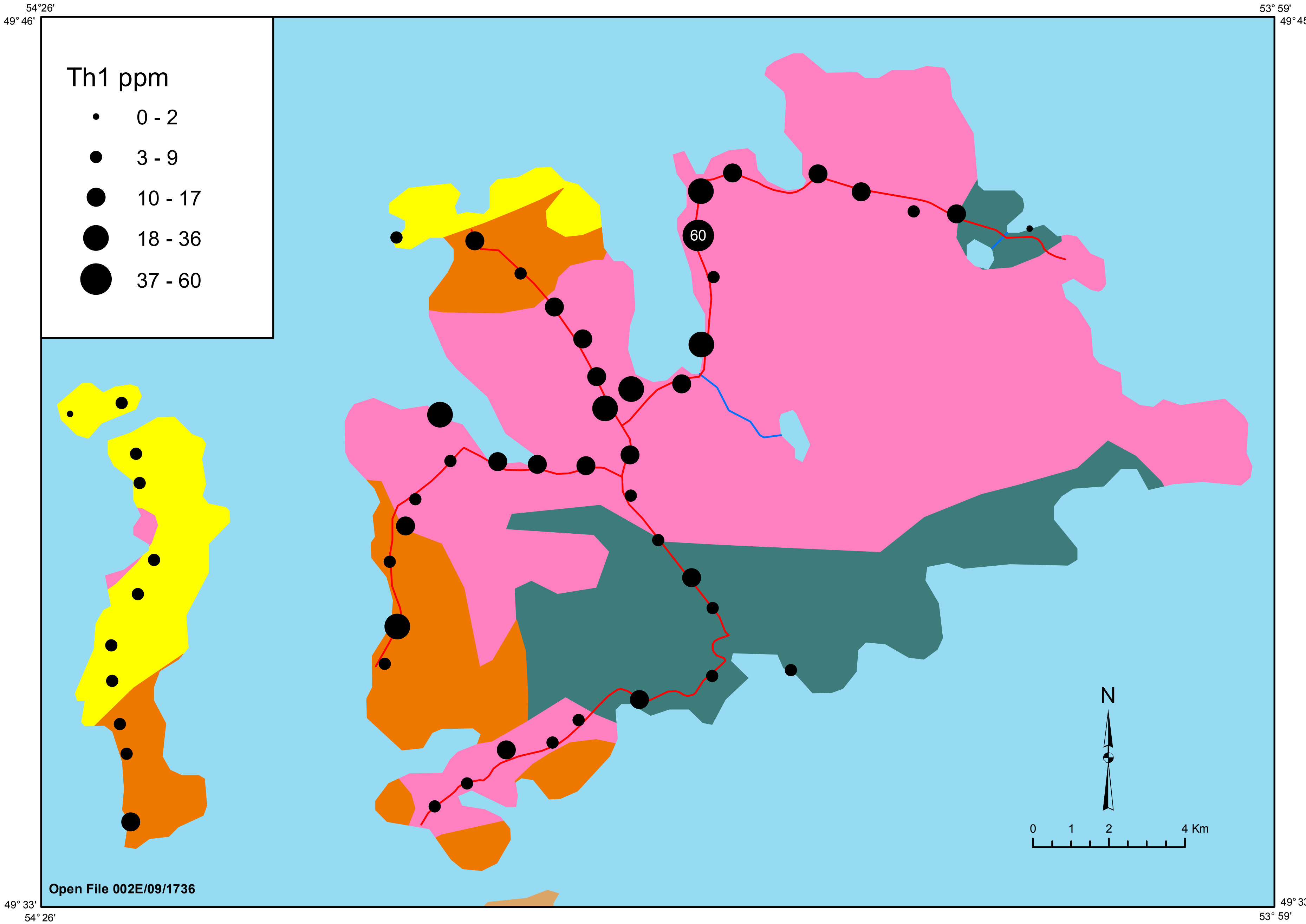

Figure 59. *Distribution of thorium (Th1) in till.*

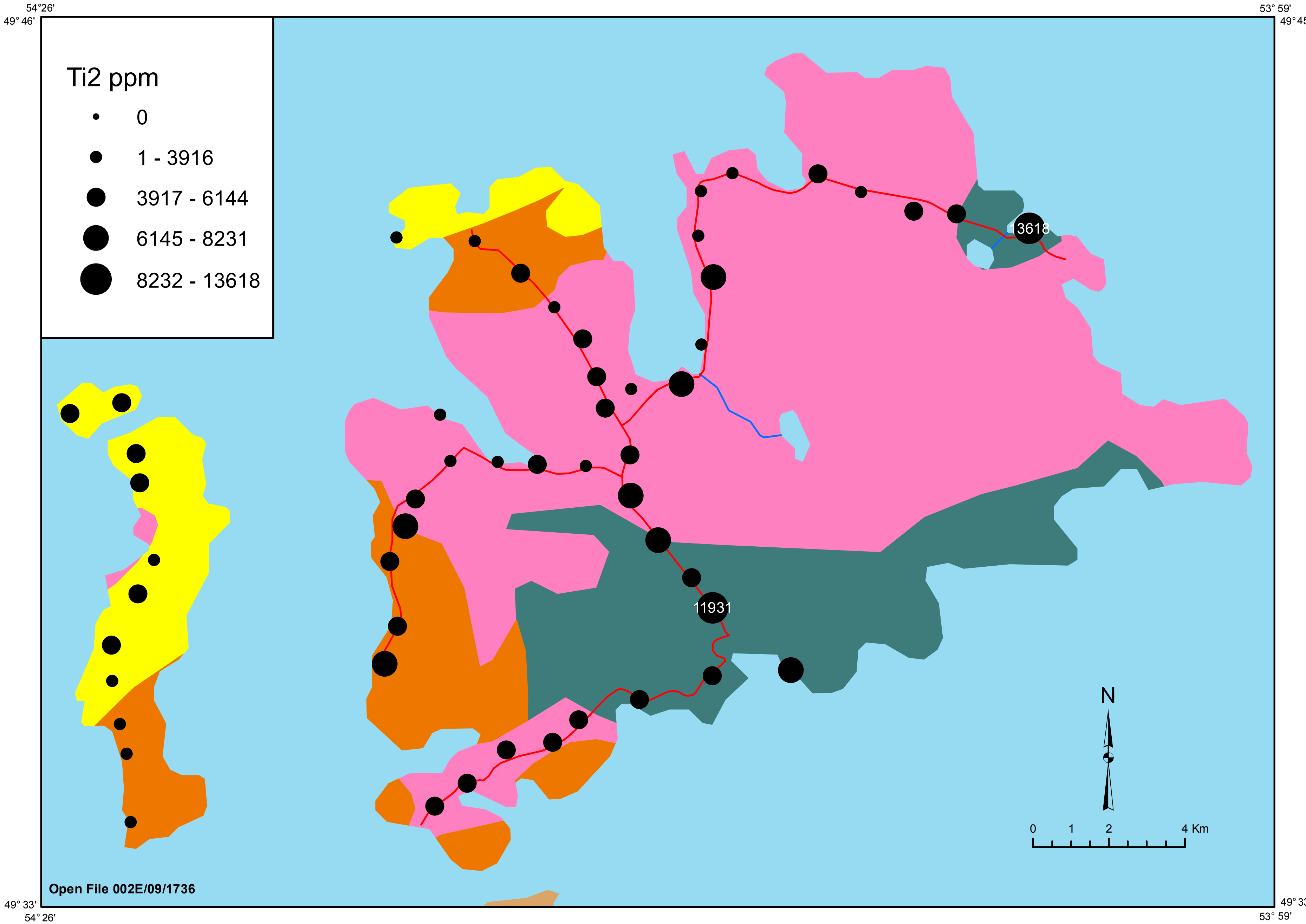

Figure 60. *Distribution of titanium (Ti2) in till.*

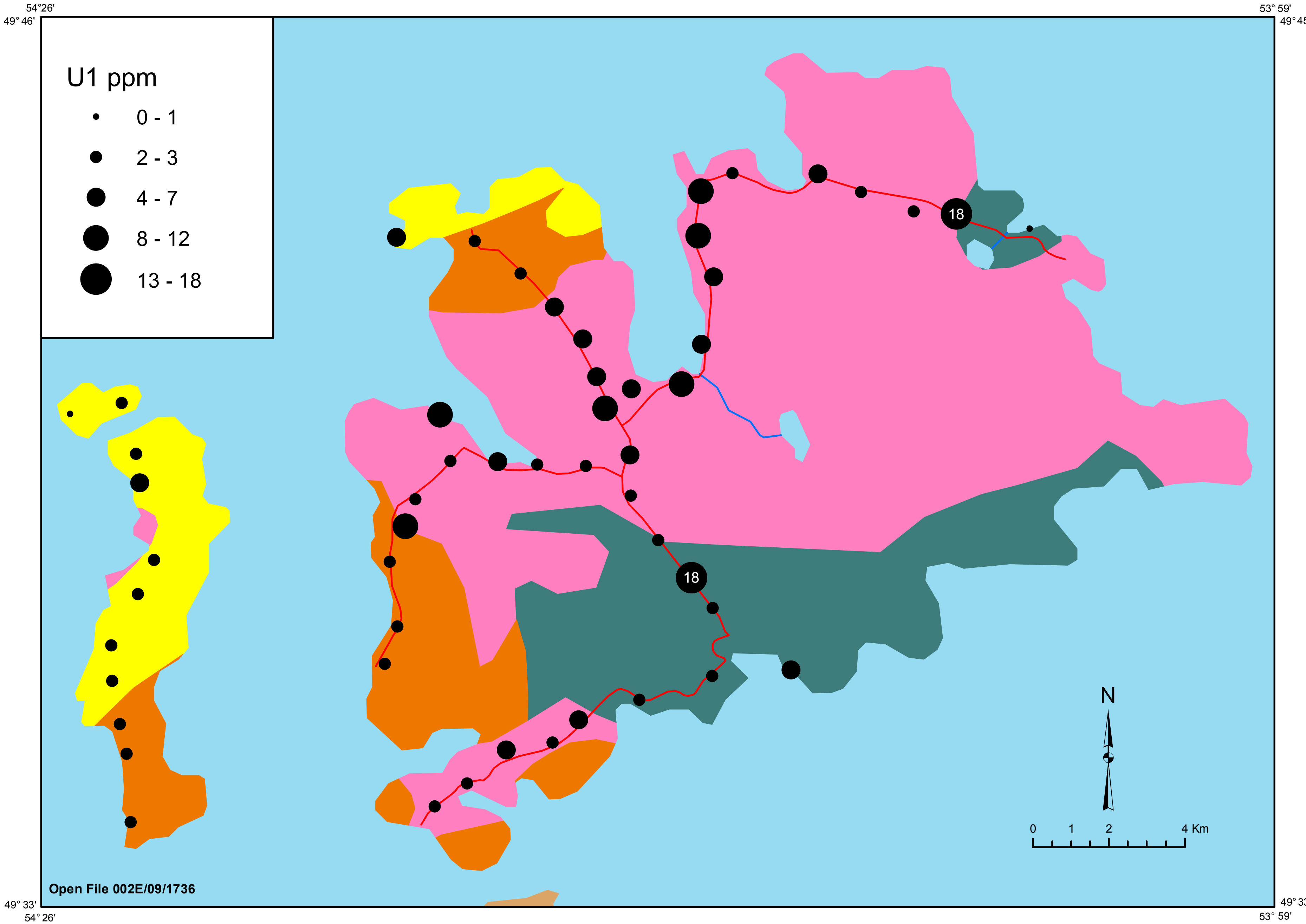

Figure 61. *Distribution of uranium (U1) in till.*

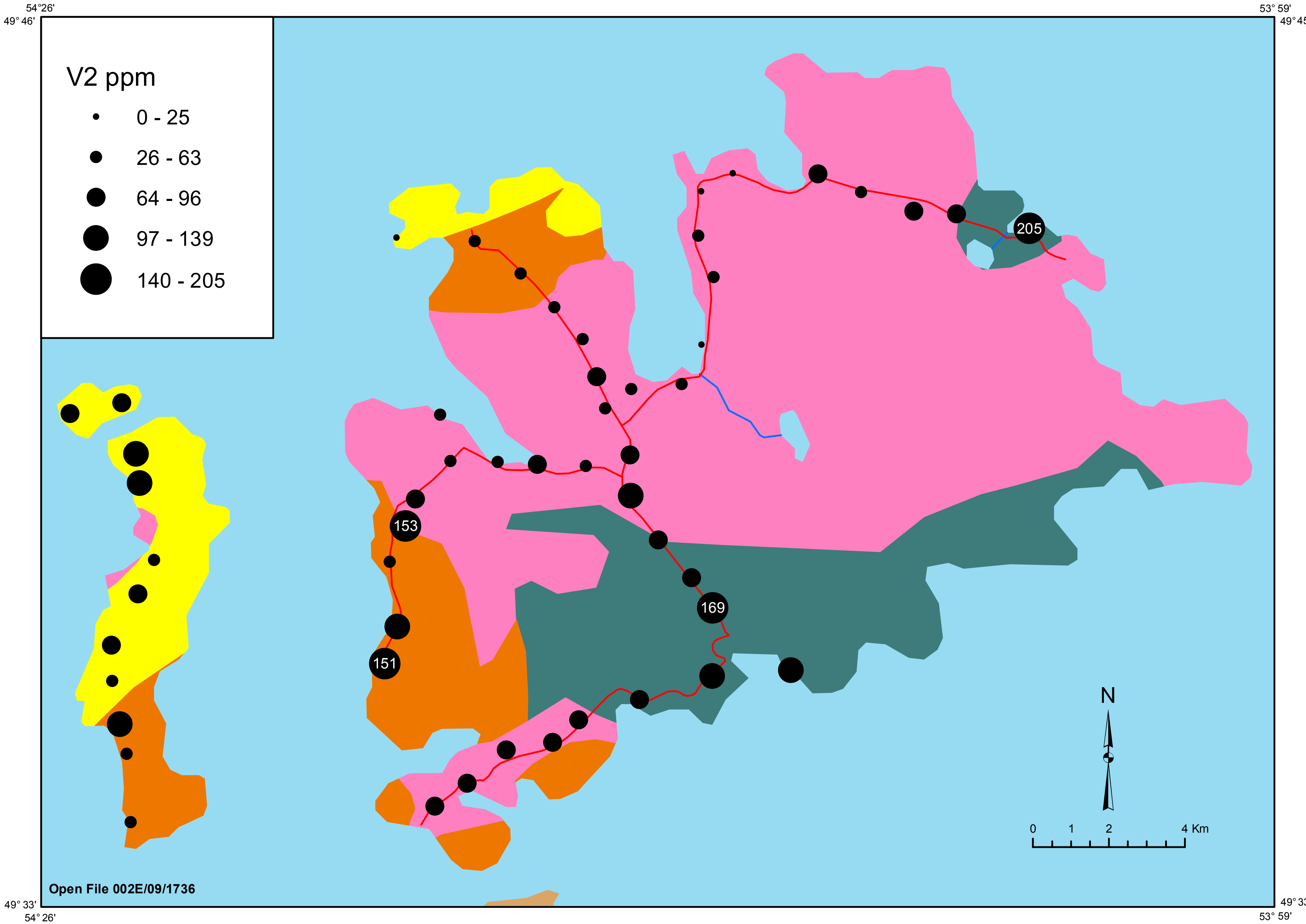

Figure 62. *Distribution of vanadium (V2) in till.*

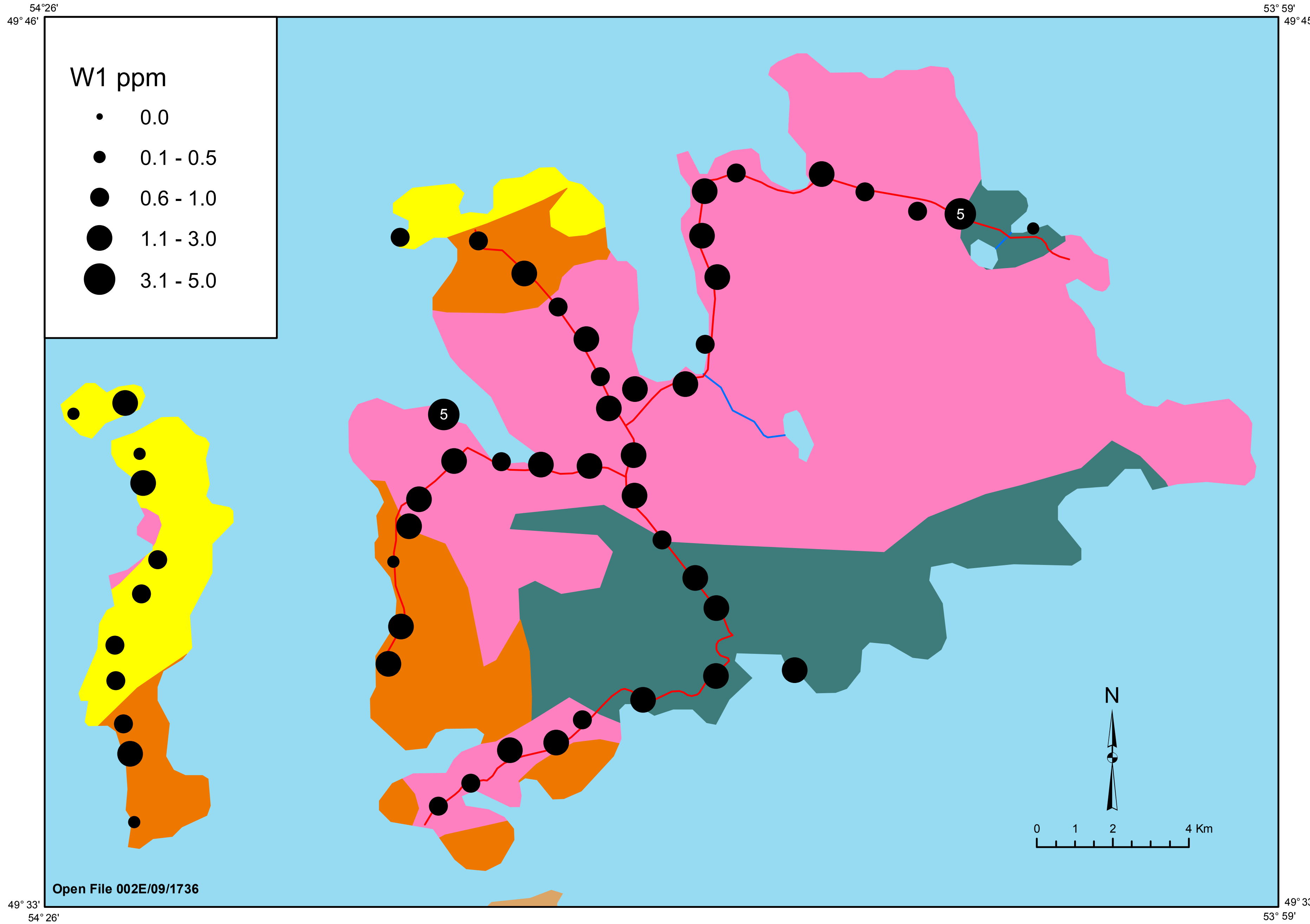

Figure 63. *Distribution of tungsten (W1) in till.*

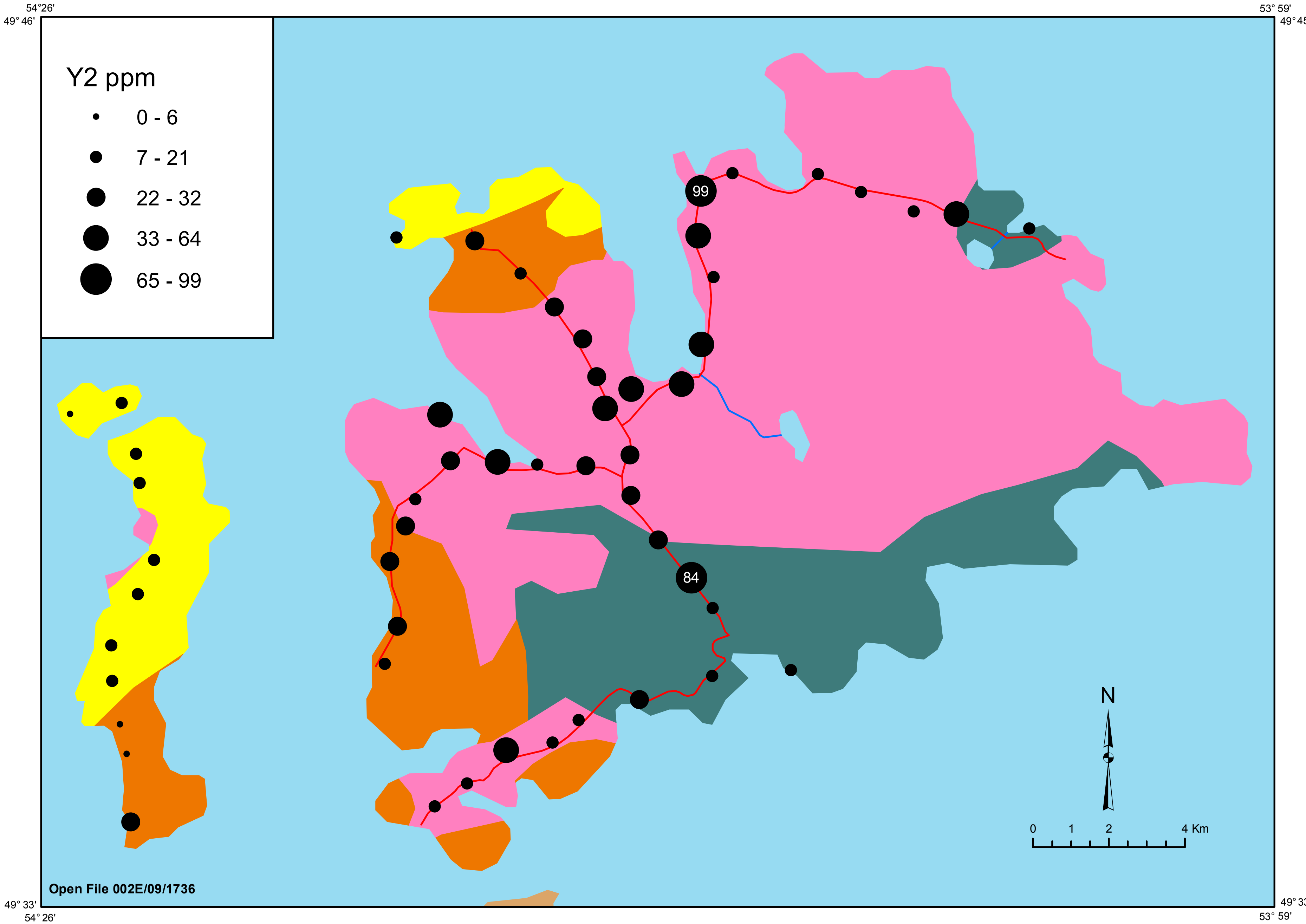

Figure 64. *Distribution of yttrium (Y2) in till.*

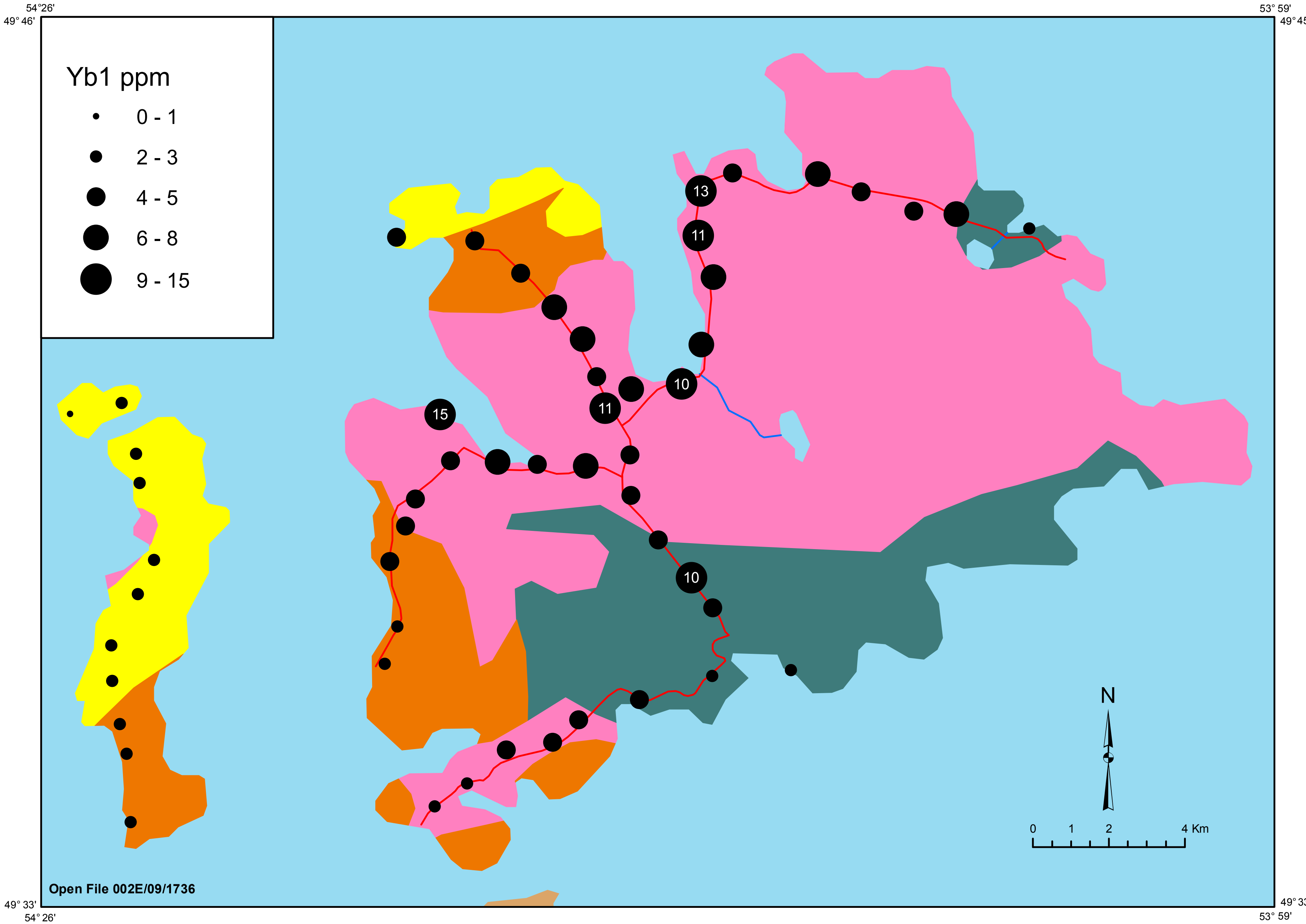

Figure 65. *Distribution of ytterbium (Yb1) in till.*

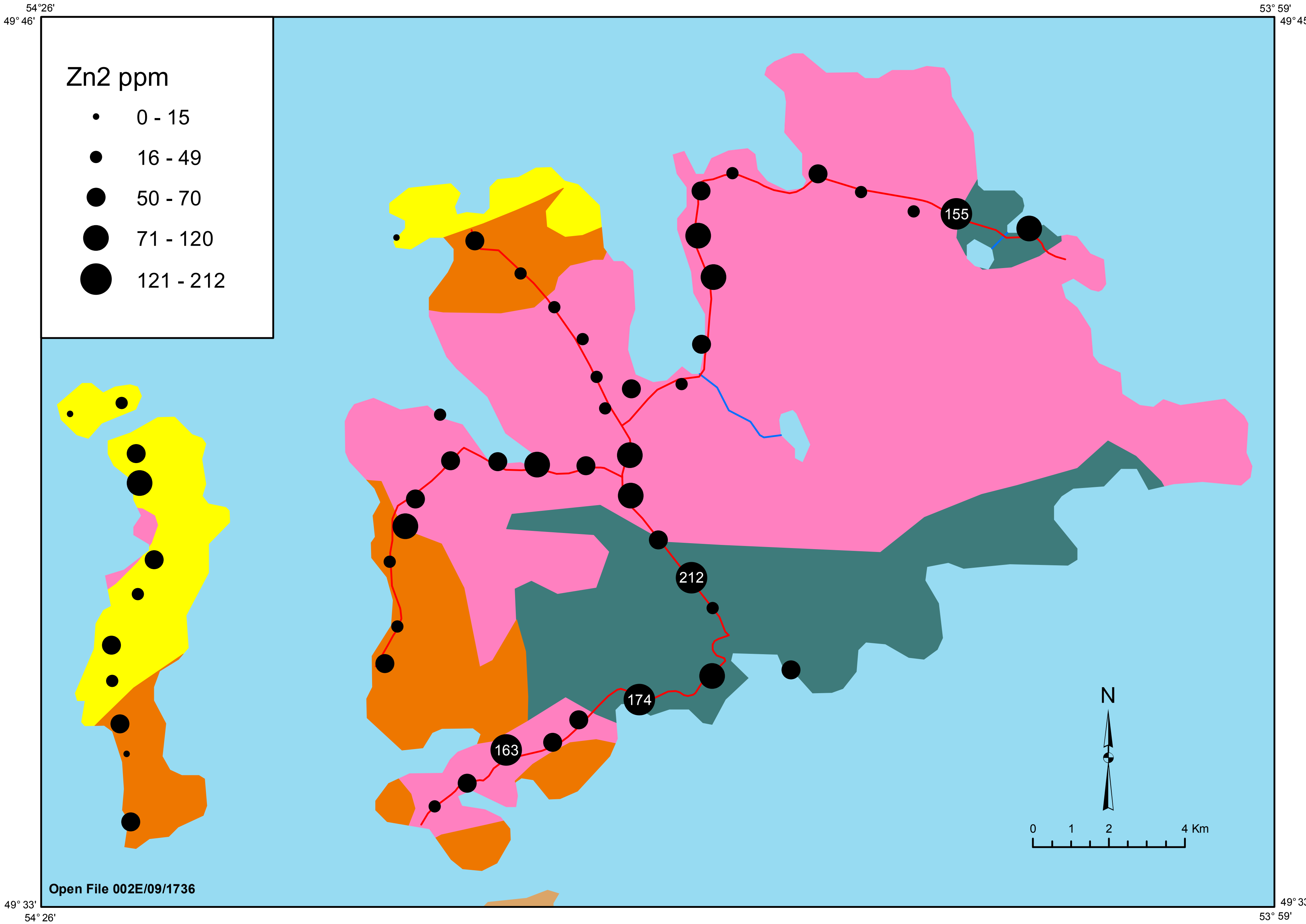

Figure 66. *Distribution of zinc (Zn2) in till.*

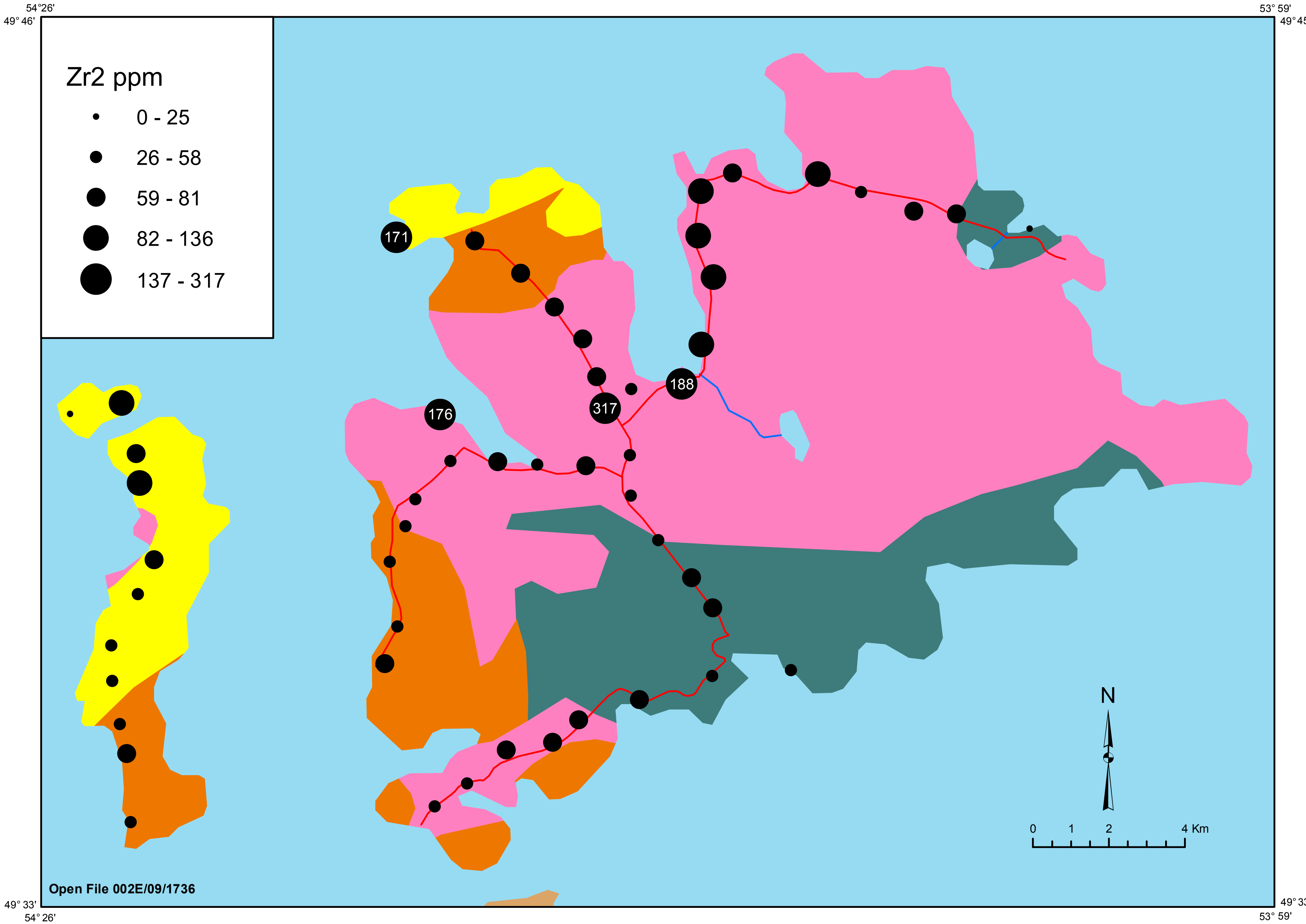

Figure 67. *Distribution of zirconium (Zr2) in till.*