Exploration and Geological Services Division, Yukon Region

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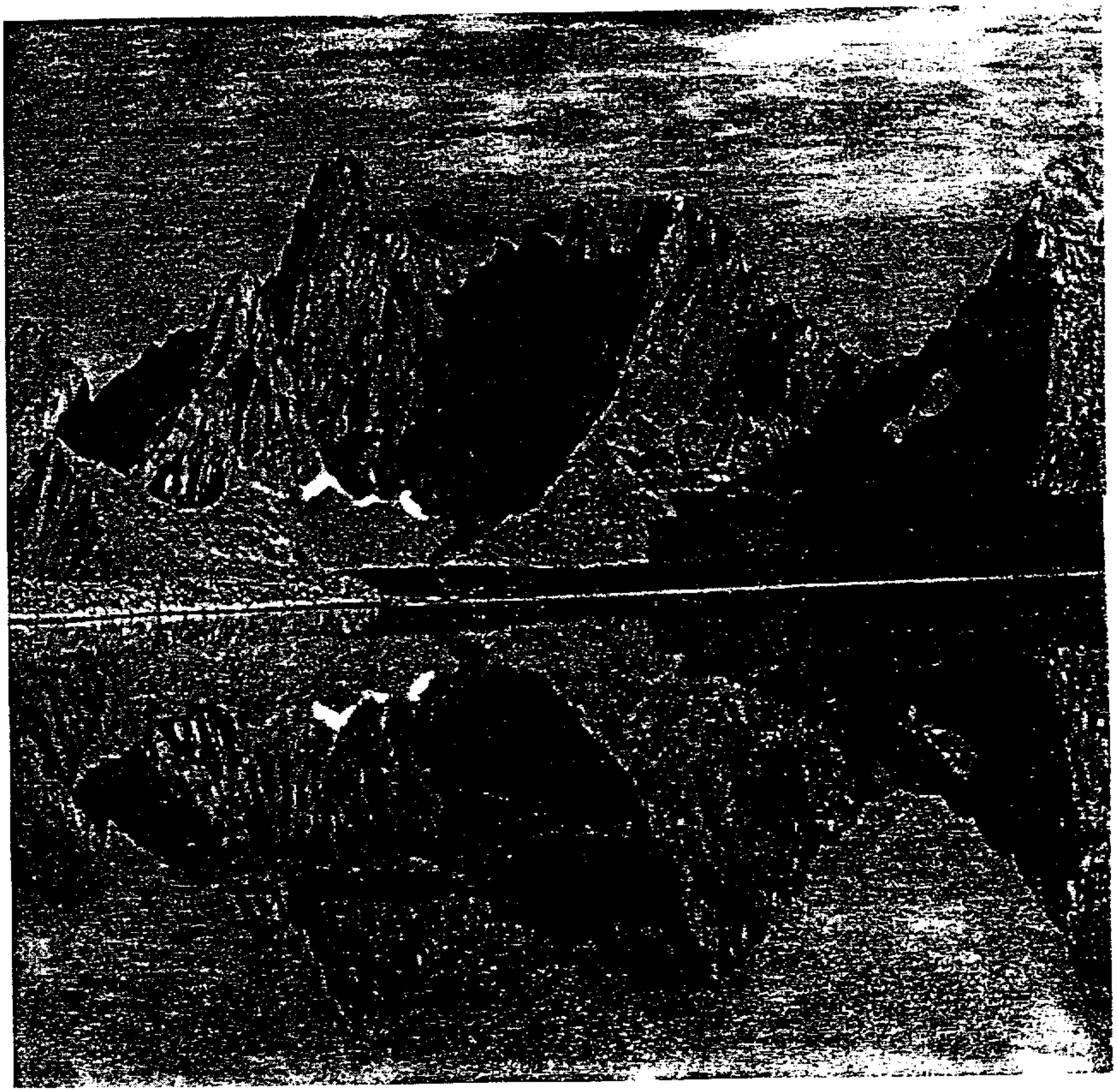
PROPOSED TOMBSTONE AREA PARK
A PRELIMINARY REVIEW OF MINERAL POTENTIAL



T.J. Bremner

April, 1994

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PROPOSED TOMBSTONE PARK

PRELIMINARY REVIEW OF MINERAL POTENTIAL

T.J. Bremner
Exploration and Geological Services Division
Indian and Northern Affairs Canada

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PREFACE

This six-week study briefly reviews the mineral potential of the proposed Tombstone park and the surrounding area. It is a compilation of all available data, including information from mining company assessment reports, published geological maps and reports, aerial photographs, airborne magnetic surveys, and government rock and stream sediment geochemical data.

A proper assessment of the mineral potential of this area would require an update of the geological mapping and the collection of more geochemical and geophysical data.

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SUMMARY

Although the first claims in the Tombstone area were staked in 1901, most exploration to date has focused on high grade veins, skarns and uranium deposits, and pre-dates the search for bulk tonnage gold or shale-hosted nickel. Early reconnaissance geochemical programs by mining companies analysed a very limited range of elements, and assessment work on file covers only a small part (3.6%) of the study area. Recent GSC stream sediment geochemistry shows that compared to the rest of the Dawson map sheet, the Tombstone area contains highly anomalous gold, copper, molybdenum, tungsten, uranium, copper and rare earth values clustered around the Tombstone Suite intrusions, and anomalous nickel, copper, cobalt, chromium, zinc, iron and rare earth elements associated with a belt of Earn Group shale north of the proposed park.

Known mineral deposits in the area include the Marn deposit (Minfile #116B 147), a small, high-grade gold skarn with about 300 000 tonnes grading 8.6 g/t Au, 1% Cu, 0.1% W and 17 g/t Ag, and the Tombstone deposit (Minfile #116B 151), a very large, low-grade uranium resource with no published reserves. The entire tinguaite phase of the Tombstone Stock averages 78 ppm U (Olade and Goodfellow, 1978), with a number of high grade zones containing up to 2% U_3O_8. High grade silver veins on the south side of Tombstone Mountain were mined briefly in 1920 (Spotted Fawn occurrence, Minfile 116B 057) but smelter results are not available.

The best potential in the Tombstone area appears to be for large porphyry-type deposits associated with the Tombstone Suite intrusions. These could include Fort Knox-type porphyry gold deposits, porphyry or "granite-hosted" uranium deposits, and porphyry molybdenum, tungsten or copper deposits. Near intrusive contacts, several limy units have the potential to host high grade copper-gold-tungsten skarns or low grade Carlin-type gold replacement deposits. Other likely targets include rare earth veins within the intrusions, high grade silver-lead veins in Keno Hill Quartzite, and sedex nickel-zinc deposits in Earn Group strata to the north. The area may also have significant gemstone potential, due to the unusual chemistry of the intrusions.

Within the area of the proposed park there are only three quartz claims and two quartz leases in good standing, and there has been no significant work filed since 1988. However, industry sources acknowledge that over the last decade, the proposal to create a park in the area has been a major deterrent to mineral exploration on and around Tombstone Mountain.

These preliminary findings indicate that the Tombstone area has high mineral potential and further work is warranted before any land is permanently withdrawn from mineral development. A thorough study would require sampling of limy units in the area for silicification and gold content, evaluation of gold-bearing quartz veins in the Tombstone Stock for bulk tonnage gold potential, and systematic prospecting for evidence of buried intrusions and alteration zones. Heavy mineral concentrates from stream sediments in the area should be examined for gold, tungsten, tin, gemstones and diamond indicator minerals. More multi-

element geochemistry is required, notably for mercury, bismuth, beryllium and tin. Further geophysical work should include an airborne EM survey to detect massive sulphide targets and an airborne gamma-ray survey to outline areas of potassic alteration which may be associated with porphyry centres.

INTRODUCTION

A Territorial Park covering 389 square kilometres has been proposed in the Tombstone Mountain area, approximately 50 km northeast of Dawson (Fig. 1). The area is rugged and scenic, with average relief over 1000 m and sharp, jagged pinnacle ridges rising to an elevation of 2193 m at Tombstone Mountain itself. The spectacular topography is the result of well developed vertical joints in syenite and three episodes of Pleistocene glaciation.

Figure 2, taken from a surficial geology map by Thomas and Rampton (1980) shows that the area is largely covered by colluvium (64%) and rock glacier and moraine deposits (23%), with about 7% bedrock exposure, much of it in the form of inaccessible cliffs. The remaining 6% consists of alluvium in the major valleys, and minor glaciofluvial terraces in the Chandindu and North Klondike river valleys. Thomas and Rampton estimated that permafrost is probably more than 100 m thick throughout much of the area, except beneath some south-facing slopes.

PREVIOUS WORK

The Tombstone area was extensively prospected by gold seekers in the early 1900's, leading to the discovery of high grade silver veins in Spotted Fawn Gulch in 1901, and gold-stibnite veins on Antimony Mountain in 1916. Nine tonnes of ore from the Spotted Fawn occurrence were mined and sacked for shipment in 1920, but no smelter records are available.

In 1961, L.H. Green carried out 1:250 000 scale geological mapping in the area as part of a Geological Survey of Canada reconnaissance of the Ogilvie Mountains. In 1964-1965 D.J. Tempelman-Kluit mapped the Tombstone area at a scale of 1:63 360 as part of a PhD thesis project.

Uranium exploration in the 1970's was driven by a meteoric rise in the price of uranium between 1973 and 1978 (Fig. 3), and led to the discovery of a large resource of low-grade uranium on the southwest flank of Tombstone Mountain in 1976. As a result of regional lead-zinc exploration, the Rein barite deposit was discovered in Earn Group shale in the northeast part of the study area, also in 1976.

Recent geological mapping in the area was carried out by Thompson and Roots (1982). Detailed studies include a geochemical study of the Tombstone Stock by Olade and Goodfellow (1978), and a study of the Tombstone Plutonic Suite by Anderson (1987, 1988).

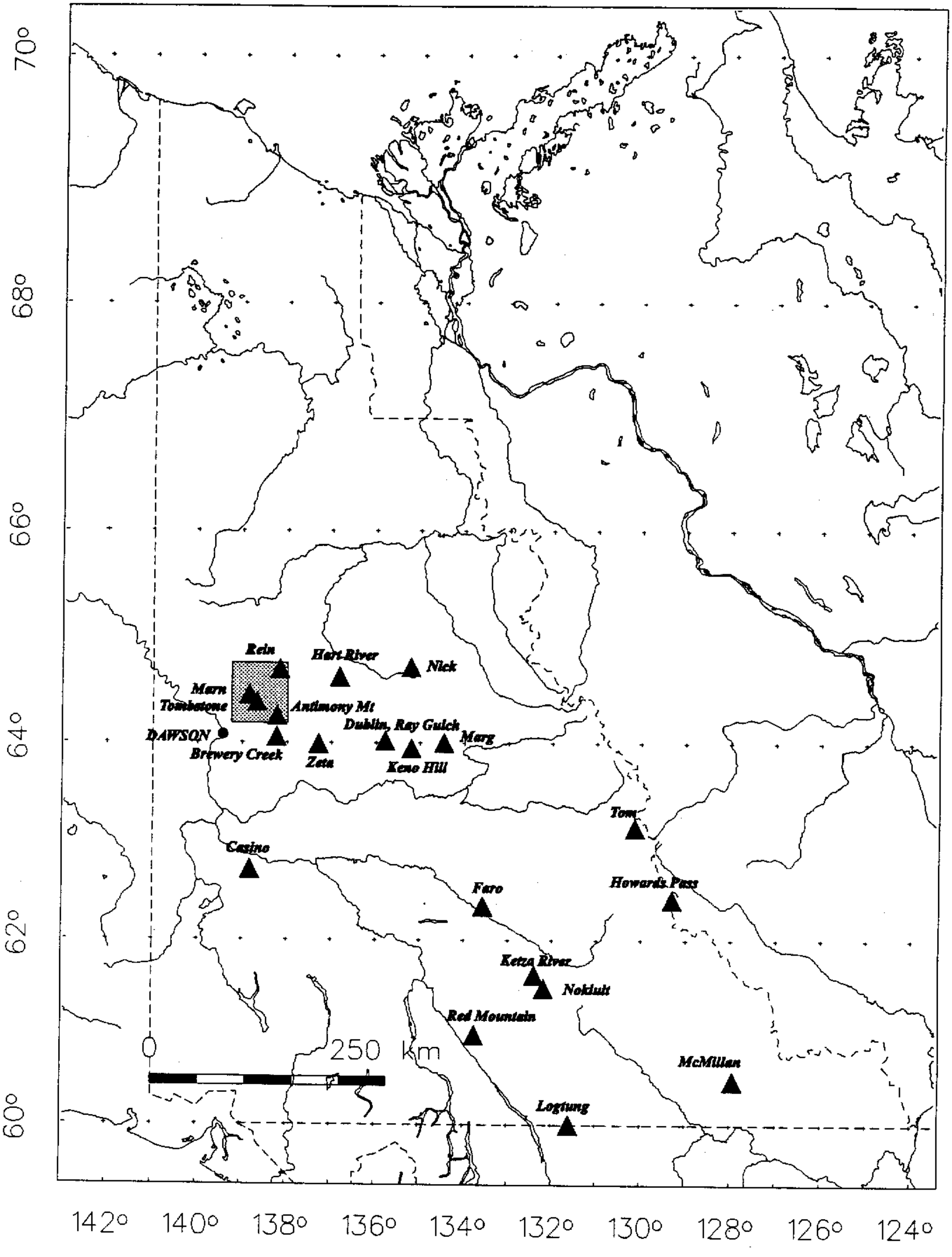


Fig. 1. Location map with selected Yukon mineral deposits

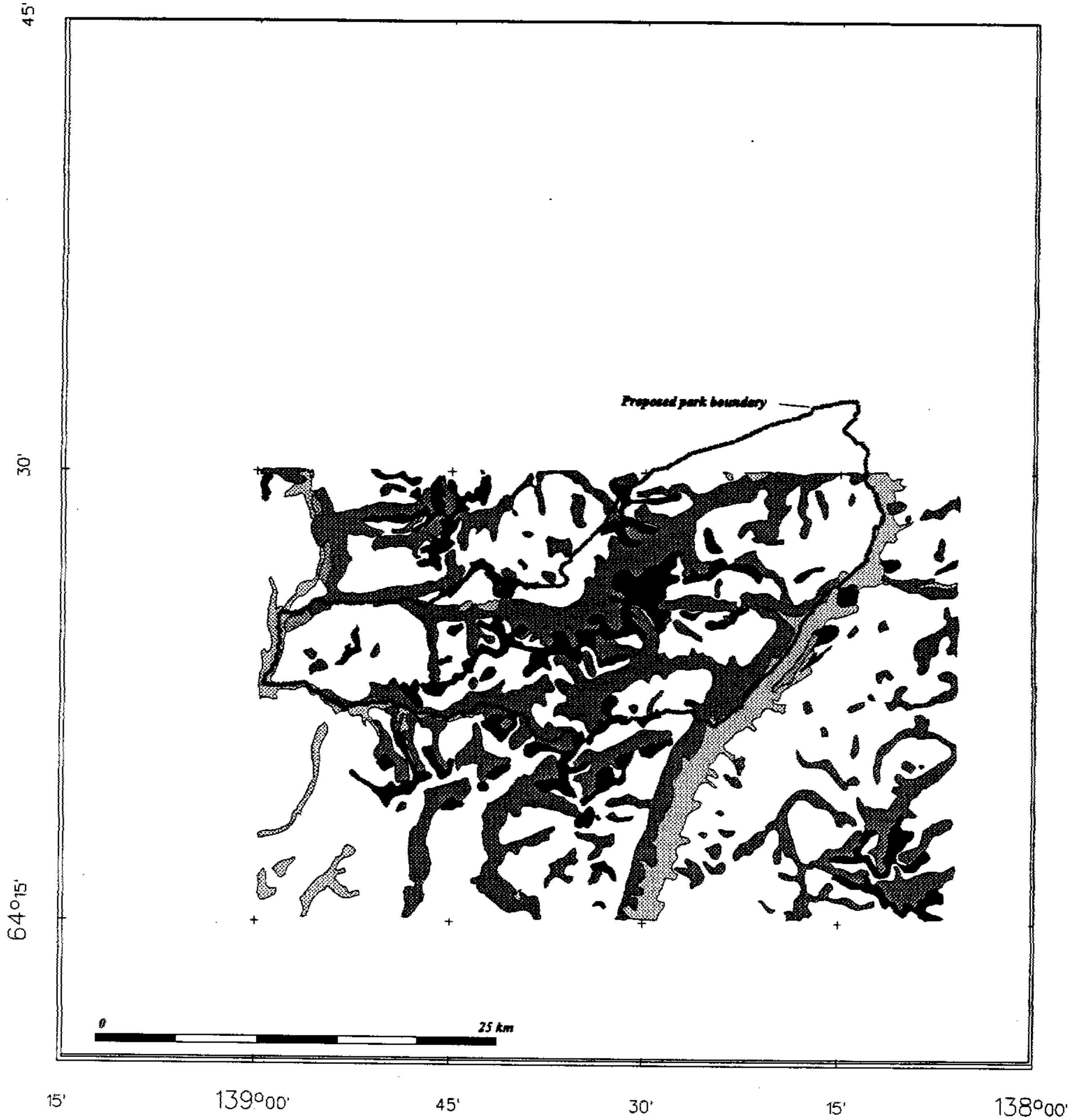
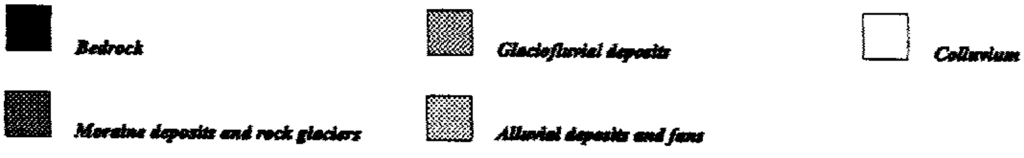


Fig. 2. Tombstone area: simplified surficial geology (from Thomas and Rampton 1980).



RESPONSIVENESS OF URANIUM EXPLORATION EXPENDITURES IN CANADA TO URANIUM PRICE MOVEMENTS, 1971-1983

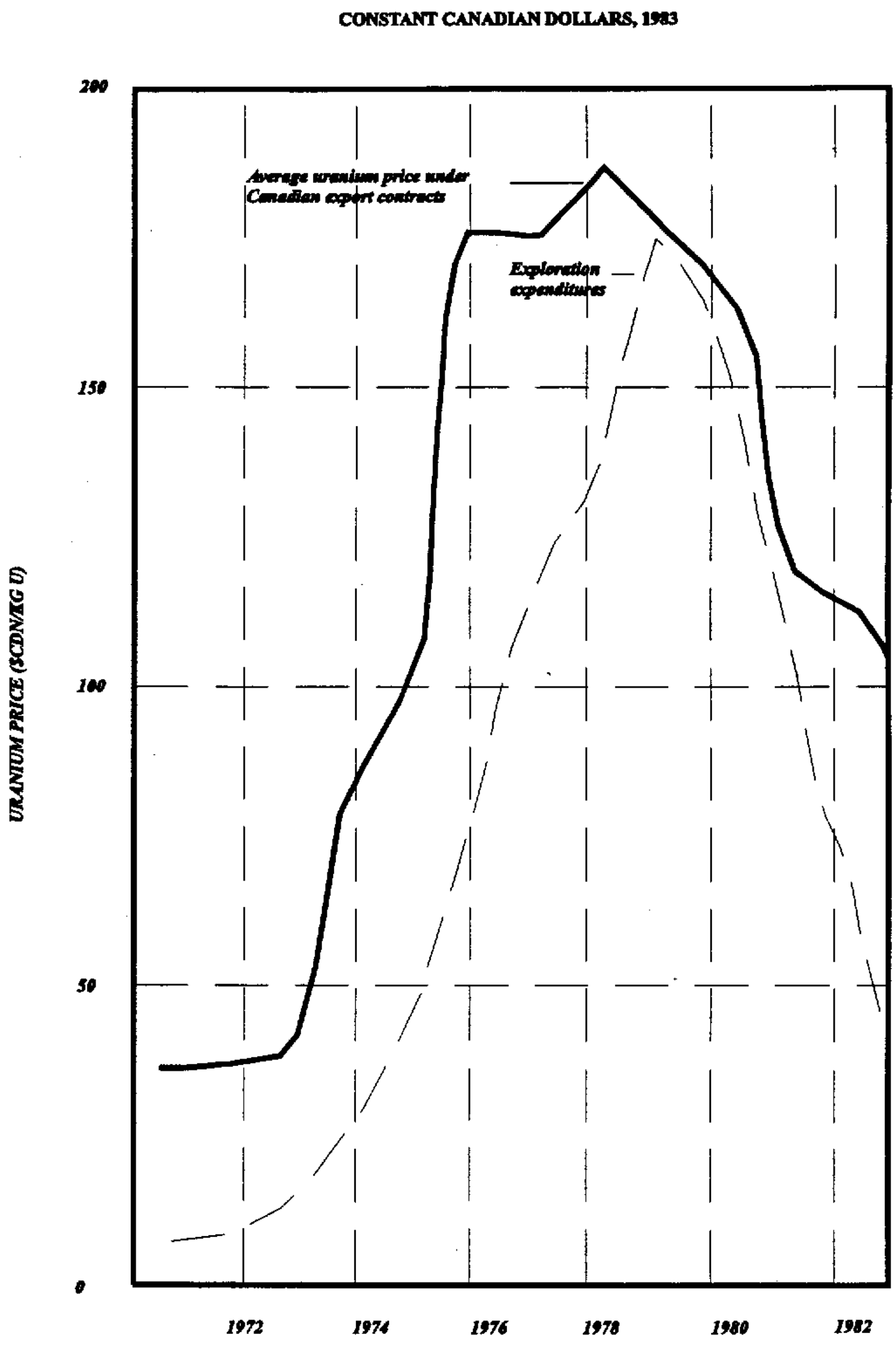


Fig. 3. Uranium price and exploration expenditures, 1971-1983.

From: Canada Mines and Minerals Yearbook, 1983-1984.

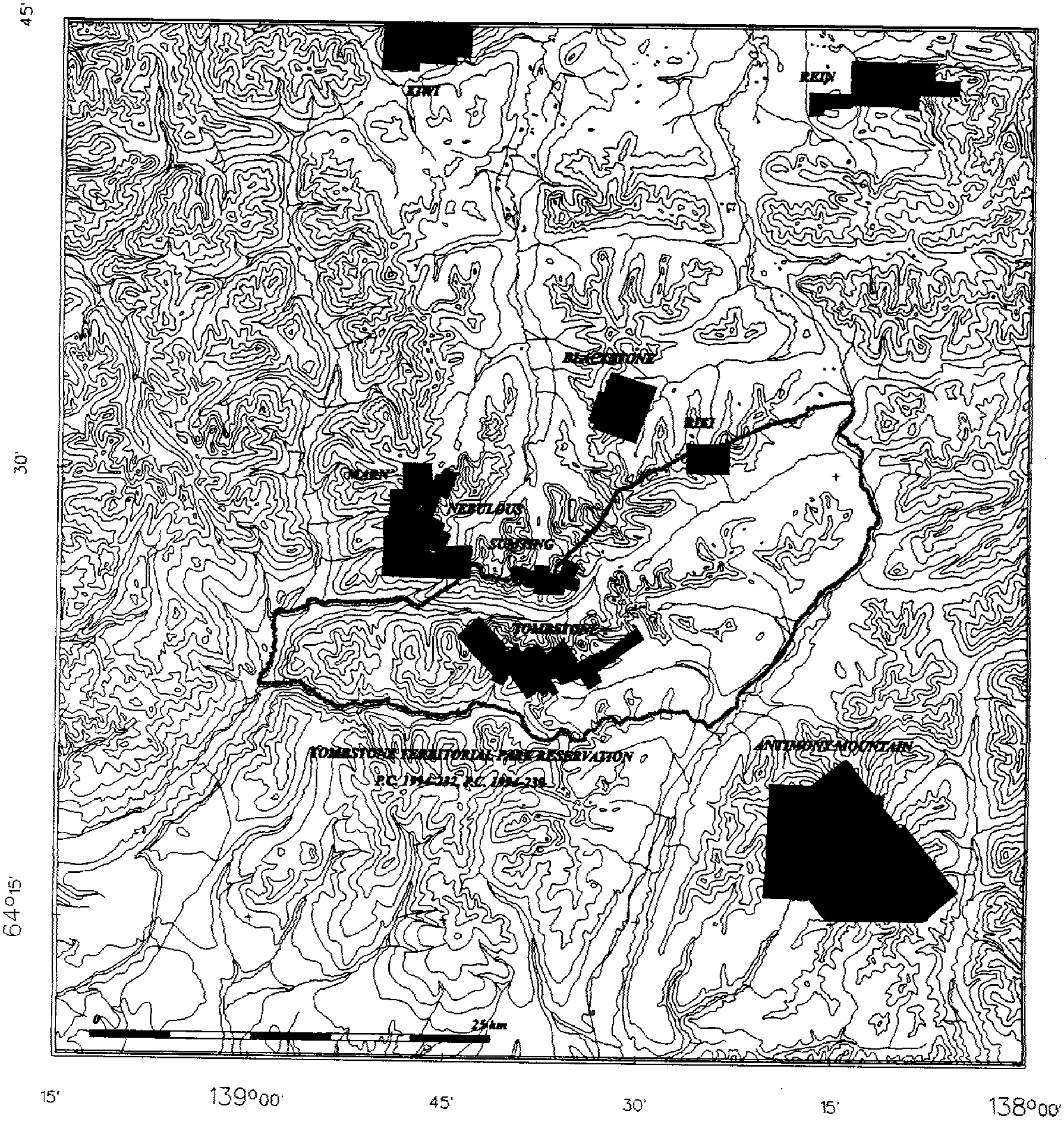


Fig. 4. Tombstone area: properties with assessment work

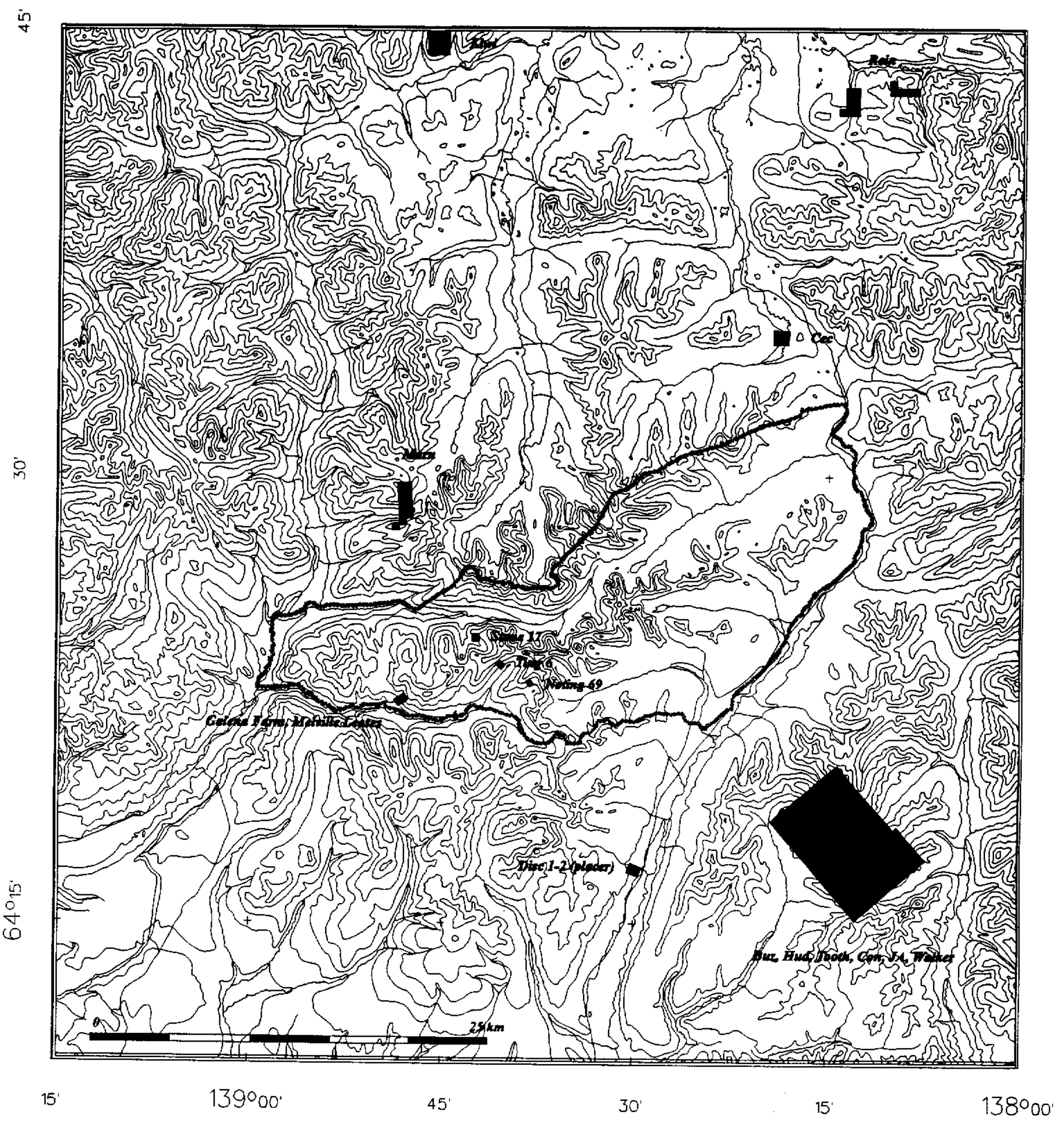


Fig. 5. Tombstone area: claims in good standing, 8 April 1994

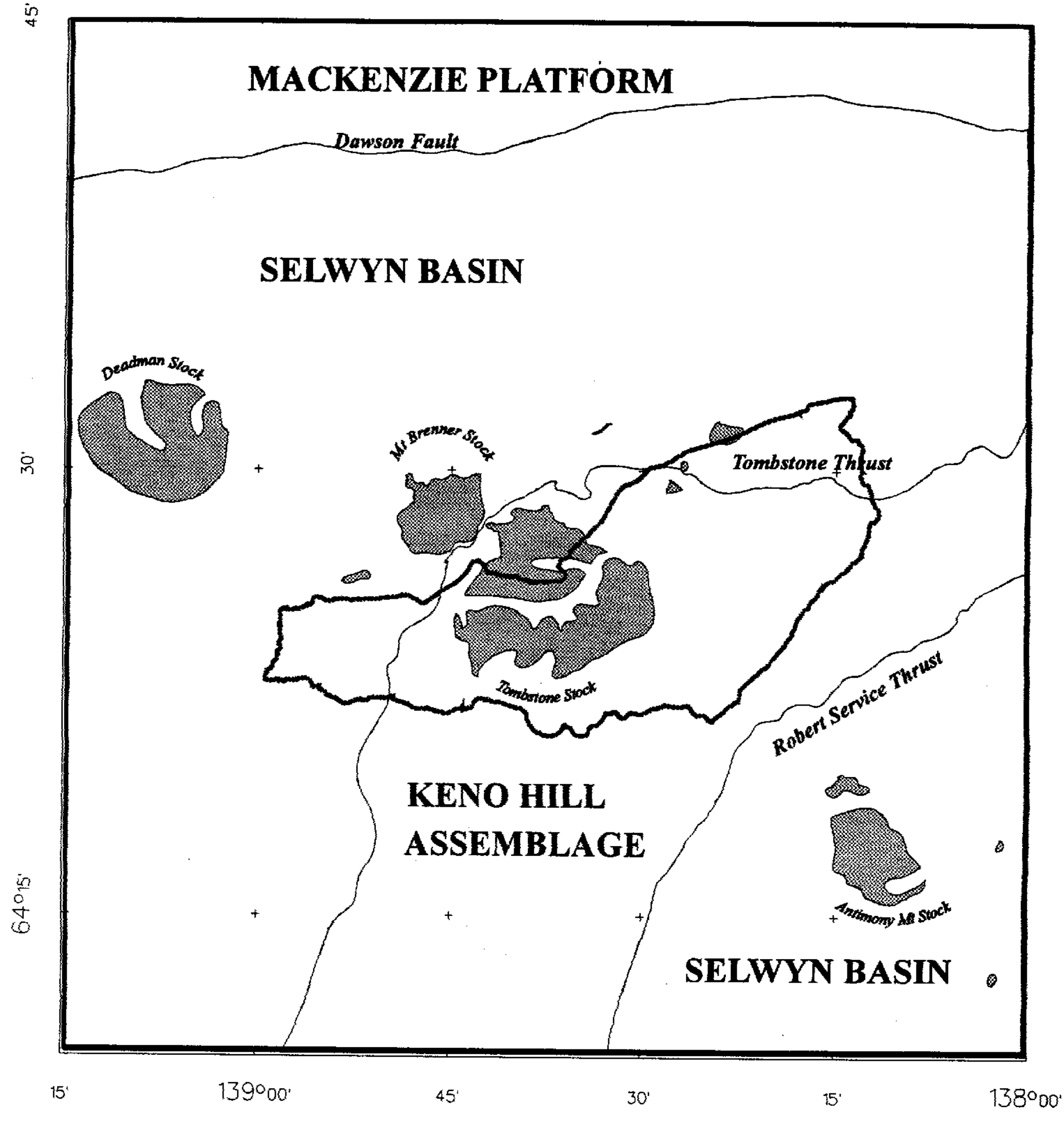


Fig. 6. Tombstone area: main tectonic elements

Tombstone Plutonic Suite

STAKING ACTIVITY

The first claims in the Tombstone area were staked on the Spotted Fawn high grade silver-lead veins (Minfile 116B 057) in 1901. Since then, assessment work has been filed in eight separate areas which cover about 4.1% of the study area. These include the Antimony Mountain, Tombstone, Sumting, Nebulous, Marn, Blackstone, Riki and Kiwi properties (Fig. 4). Several of these properties covered more than one occurrence. For example, more than 29 separate mineral showings were discovered within the boundaries of Ukon Joint Venture's Tombstone property.

In March 1994, there were 276 active quartz claims, 2 quartz leases and 2 placer claims within the study area, located on map sheets 116 B 7, 8 and 10 (Fig. 5). The largest block of 234 claims (BUZ, CON, JA, TOOTH and WALKER) covers high grade gold showings on Antimony Mountain (Minfile 116B 001, 094-097). Twelve MARN claims cover the Marn Cu-Au-W skarn deposit on the northwest flank of the Mt Brenner Stock (Minfile 116B 147), 14 REIN claims cover the Ridge and Cliff zone deposits on the Rein barite property (Minfile 116B 132), and 9 KIWI claims cover the Kiwi Mississippi Valley-type Pb-Zn-Ag-Cu drilled prospect (Minfile 116B 087). Four CEC claims on the Eastblack occurrence near North Fork Pass (Minfile 116B 162) are also in good standing, and two placer claims are located near the Dempster Highway at the mouth of Peasoup Creek.

Within the boundary of the proposed park, three remaining STONE and TING claims cover key showings on the former Tombstone property (Minfile 116B 109, 150, 152), and two quartz leases (GALENA FARM and MELVILLE) cover high grade silver-lead veins of the Spotted Fawn Deposit (Minfile 116B 057).

The absence of recent exploration activity is largely due to a proposal for a Territorial park in the area as early as 1980. A proposed park boundary was included by Archer, Cathro and Associates on the Yukon Minfile (then Northern Cordillera Mineral Inventory) map of the Dawson area, and Canadian Minerals Yearbook reported in 1983-34 that proposals to create parks in favourable areas of Yukon and NWT, along with exploration moratoria in B.C. and Nova Scotia, helped to account for an exponential decline in uranium exploration across Canada between 1980 and 1982. Over the last decade, uncertainty over future park boundaries and regulations with respect to mining have acted as a deterrent to exploration in the Tombstone Mountain area, despite the favourable geochemistry and the current high level of interest in porphyry gold deposits.

TECTONIC SETTING

The Tombstone area is located on the west edge of the Selwyn Basin, immediately south of the Mackenzie Platform (Fig. 6). The Mackenzie Platform consists of a sequence of Middle Proterozoic to Middle Paleozoic carbonate and clastic sedimentary and volcanic rocks which were deposited on a subsiding continental shelf and onlap the Canadian Shield to the east. In the Selwyn Basin, clastic and volcanic rocks ranging in age from Late Proterozoic to Jurassic were deposited in a deep basin formed by intermittent rifting at or near the western margin of North America (Abbott et al., 1986). The Selwyn Basin rocks are separated from the Mackenzie Platform by the Dawson Fault, a deep seated structure which may represent the block faulted margin of the early Selwyn Basin.

The region is part of the Cordilleran foreland fold and thrust belt, and strata were imbricated by a series of moderately dipping, north and northwest-directed thrust faults of Early Cretaceous age. Thirty kilometres south of the map-area, the Tintina Fault separates Selwyn Basin rocks from highly sheared and metamorphosed sedimentary and volcanic rocks of the Yukon-Tanana Terrane.

More than forty lithologically similar granitic intrusions are distributed in a broad arc northeast of the Tintina Fault. These intrusions constitute two lithogeochemical suites that differ in age: the Tombstone Suite (92 Ma) and the Selwyn Suite (97-112 Ma)(J. Mortensen, personal communication). Restoration of movement on the Tintina Fault shows a cluster of similar intrusions southwest of the fault in the Fairbanks area, including the Fort Knox pluton. Recognition of the relationship between intrusions in the Fairbanks and Dublin Gulch areas led to the discovery of a major porphyry gold deposit at Dublin Gulch in 1990.

Both the Tombstone and Selwyn suite rocks are believed to be derived from partial melting of underlying continental crust. The Tombstone Suite plutons have A-type characteristics, while the Selwyn Suite plutons are typically S-type (Anderson, 1987). These intrusions form the outer part of a continental arc associated with a shallow subduction zone which was active during the Cretaceous. The inner part of the arc is represented by I-type granodiorite intrusions and related volcanic rocks of the same age southwest of the Tintina Trench.

Displacement on the Tintina Fault occurred during the Late Cretaceous or early Tertiary, based on the age of coal deposited in small strike-slip basins along the Tintina Trench. Offset of the northwest edge of the Cassiar Platform, a continental margin assemblage which may have originally connected with the Mackenzie Platform, includes 450 km of right lateral movement. The Tintina Fault continues into Alaska, where it appears to join the Kaltag Fault, forming a single arcuate structure more than 1600 km long.

STRATIGRAPHY

Figure 7 is a simplified geological map of the Tombstone area taken from Green (1973). The most conspicuous features are the Tombstone Suite intrusions and a series of Triassic gabbro sills which intrude sedimentary strata of the Selwyn Basin. Cambro-Ordovician basaltic volcanic rocks which may be the stratigraphic equivalent of the Menzie Creek volcanics at Faro are also highlighted.

QUARTET GROUP (MIDDLE PROTEROZOIC)
Unit 1 (Green)

The Quartet Group consists of thin bedded dark grey argillite, slate and phyllite with minor grey quartzite and orange-weathering dolomite and conglomerate. It is confined to a small area of the Mackenzie Platform in the northwest corner of the map sheet.

GILLESPIE LAKE GROUP (MIDDLE PROTEROZOIC)
Unit 2 (Green)

The Gillespie Lake Group consists of orange weathering platy dolomite and minor slate, phyllite and quartzite. It is confined to the Mackenzie Platform in the northwest part of the map area. The contact with the underlying Quartet Group is gradational.

Dolomite of the Gillespie Lake Group hosts a number of lead-zinc-silver occurrences along the edge of the Mackenzie Platform, including Kiwi (Minfile 116B 087), Carpenter Ridge (Minfile 106D 040), and Blende (106D 064).

HYLAND GROUP (LATE PROTEROZOIC-EARLY CAMBRIAN)
Unit 3 (Green); units 1-4 (Tempelman-Kluit)

The oldest Selwyn Basin rocks in the Tombstone area belong to the late Proterozoic and Early Cambrian Hyland Group, described regionally by Abbott (1992) and Gordey (1993). Tempelman-Kluit recognized four divisions in the Tombstone area:

Unit	Description	Thickness
Hyland 4	Maroon and green shale, slate and argillite	± 450 m
Hyland 3	Calcareous sandstone; oncolitic sandstone near base	± 450 m
Hyland 2	Oncolitic limestone; siliceous and dolomitic	+ 15 m
Hyland 1 (oldest)	Feldspathic grit, quartz pebble conglomerate and interbedded green shale	3000 m?

Elsewhere in Yukon, Hyland Group limestone hosts several manto-type replacement deposits, including Clark (Pb-Zn-Ag)(Minfile 106D 011), McMillan (Zn-Pb-Ag)(095D 006) and Hyland Gold (Au)(Minfile 095D 011).

CAMBRIAN AND ORDOVICIAN VOLCANIC ROCKS
Unit 4 (Green); Unit 5 (Tempelman-Kluit)

Table 1. COMPOSITE TABLE OF FORMATIONS

Age	Map Unit (Green, 1961)	Map Unit (T-K 1970)	Lithology	Thickness (m)
Tombstone Plutonic Suite (92 Ma)	21	18	Coarse to medium grained syenite, monzonite, quartz monzonite and quartz diorite stocks	
Jurassic	17	11-12	KENO HILL LOWER SCHIST EQUIVALENT: graphitic slate and phyllite, minor greywacke	± 460
Triassic	16	16	Tholeiitic diabase and gabbro sills	90-240
Triassic	16	9-10	Dark grey siltstone and shaly fossiliferous limestone (lateral facies equivalents)	0-60
Permian and Triassic	19	14-15	Green and red phyllite and slate (Triassic), calcareous siltstone (Permian)	760
Permian	15a	8	TAHKANDIT FORMATION: Crinoidal limestone, chert and chert pebble conglomerate	6-30
Mississippian	18	13	KENO HILL QUARTZITE: massive grey orthoquartzite; interbedded slate limestone	550
			UNCONFORMITY	
Devonian & Mississippian	13	Not mapped	EARN GROUP: Black shale, greywacke, chert pebble conglomerate and bedded barite	Unknown
Ordovician-L. Devonian	9	7	ROAD RIVER GROUP: Black chert and argillite	± 150
Ordovician-Silurian	8	not mapped	ROAD RIVER EQUIVALENT: Medium to thick bedded grey limestone (Mackenzie Platform)	
Cambro-Ordovician	not mapped	6	? VANGORDA FORMATION EQUIVALENT: Brown-weathering calcareous siltstone, minor shale and chert	0-150
Early Ordovician	4	5	? MENZIE CREEK EQUIVALENT VOLCANICS: amygdaloidal basalt and volcanic breccia	0-600
Proterozoic-L. Cambrian	3	4	HYLAND GROUP: Maroon & green shale, chert and argillite	± 460
Proterozoic-L. Cambrian	3	3	HYLAND GROUP: Calcareous quartzite; oncolitic sandstone near base.	± 460
Proterozoic-L. Cambrian	3	2	HYLAND GROUP: Massive oncolitic limestone, silicified and dolomitized	± 15
Proterozoic-L. Cambrian	3	1	HYLAND GROUP: Feldspathic quartz pebble conglomerate and interbedded green shale	> 3000
Middle Proterozoic	2	Not mapped	GILLESPIE LAKE GROUP: Orange weathering dolomite (Mackenzie Platform)	
Middle Proterozoic	1	Not mapped	QUARTET GROUP: Thin-bedded dark grey argillite (Mackenzie Platform)	

Fig. 7. Tombstone area: geology

Tombstone Plutonic Suite — *Menzie Creek Volcanics* — *Gabbro and diabase sills*

Amygdaloidal augite basalt, and volcanic breccia with calcite-filled vesicles and fractures, form a resistant unit which conformably overlies Hyland Group slate. Volcanic rock lenses are also present within rocks of the overlying Road River Group. Some volcanic accumulations are Early Ordovician in age based on a conodont found in a limestone reef in the volcanic succession northeast of the Tombstone area (C. Roots, personal communication). Similar volcanic rocks elsewhere in the Selwyn Basin are as old as Lower Cambrian and as young as Devonian.

These Lower Paleozoic volcanics are related to Early Paleozoic rifting. The Menzie Creek volcanics are spatially associated with shale-hosted lead-zinc-silver deposits in the Faro area.

LATE CAMBRIAN? SILTSTONE AND SHALE
Unit 6 (Tempelman-Kluit)

Tempelman-Kluit's Unit 6 consists of brown-weathering calcareous siltstone and minor shale and chert. It is believed to be roughly contemporaneous with Green's Unit 4 volcanics and is probably equivalent to the Late Cambrian Vangorda Formation which immediately overlies the orebodies at Faro.

ROAD RIVER GROUP (ORDOVICIAN TO LOWER DEVONIAN)
Unit 9 (Green); Unit 7 (Tempelman-Kluit)

In the Tombstone area, the Road River Group consists of interbedded black chert and argillite, with minor quartzite and chert pebble conglomerate.

Black shales of this unit host the 360 million tonne Howards Pass sedex lead-zinc deposit (Minfile 105I 012).

EARN GROUP, (DEVONO-MISSISSIPPIAN)
Unit 13 (Green)

The Earn Group has only recently been recognized in the Tombstone area (J.G. Abbott, personal communication). Rocks now assigned to Earn Group were previously mapped as Lower Schist or Road River Group (Tempelman-Kluit (1970), Green (1972)). Green (1972) commented that in the Dawson map-area, Earn Group rocks are poorly understood because they are recessive weathering, and vary widely in lithology and thickness over short distances, especially compared to the underlying Road River chert and the overlying Tahkandit limestone. At Brewery Creek, 45 km southeast of Tombstone Mountain, and elsewhere in the Selwyn Basin, Earn Group rocks consist of black shale, greywacke and chert pebble conglomerate, and bedded barite.

Black shales of the Earn Group host the Tom and Jason lead-zinc-silver deposits (Minfile 105O 001, 019), a sedex nickel-zinc occurrence on the Nick property (Minfile 106D 092) and numerous stratabound barite deposits including the Rein deposit (116B 128) in the northeast corner of the present study area.

KENO HILL QUARTZITE (MISSISSIPPIAN)
Unit 18 (Green); Unit 13 (Tempelman-Kluit)

The Keno Hill Quartzite underlies much of the central part of the proposed park. It consists uniform, massive to thick bedded grey orthoquartzite with interbeds of black slate and calcareous siltstone. Two limestone layers occur within the unit, and layers of rhodochrosite nodules (sedimentary manganese) up to 10 cm thick occur in a thin bed of siliceous slate near the base. Veins of remobilized quartz comprise about about 1% of the rock.

In the Keno Hill district, this unit is a brittle host rock for numerous high grade silver-lead veins which were mined between 1921 and 1988.

TAHKANDIT FORMATION, UNIT 15A (PERMIAN)
Unit 15a (Green); Unit 8 (Tempelman-Kluit)

This unit consists of limestone interbedded with chert and chert pebble conglomerate. At the Marn property (Minfile 116B 147) on the west side of the Mt Brenner Stock, it consists of a lower limestone member with chert nodules and beds of chert pebble conglomerate; a middle limestone unit with interbedded chert, and an upper member of massive thick-bedded limestone. At this location, the Tahkandit limestone is underlain by Keno Hill Quartzite (Mississippian) and cut by a 600 to 800 m wide lobe of diorite. In the contact aureole of the intrusion, the limestone has been metamorphosed to biotite-actinolite-calcite, diopside-calcite, quartz-diopside-K feldspar, diopside-quartz-tremolite and diopside-idocrase-biotite-anthophyllite-grunerite assemblages, and a 300 000 tonne copper-gold-tungsten skarn deposit has been outlined by drilling.

PERMO-TRIASSIC PHYLLITE, SLATE AND CALCAREOUS SILTSTONE
Unit 19 (Green); Units 14 and 15 (Tempelman-Kluit)

Formerly mapped as Cretaceous, these units consist of green and red phyllite and slate (Permian) overlain by calcareous siltstone (Triassic). In the Grizzly Creek area, these rocks overlie overlie Mississippian Keno Hill Quartzite.

TRIASSIC LIMESTONE
Unit 16 (Green); Units 9 and 10 (Tempelman-Kluit)

This unit consists of black limestone and shale which disconformably overlie the Tahkandit Formation on the west side of the map area. Tempelman-Kluit described two stratigraphically equivalent units, one consisting entirely of fetid, shaly limestone, and the other consisting of thin-bedded siltstone and shale, overlain by fetid carbonaceous wackestone with up to 50%

pelecypod fragments. Although the maximum thickness of the unit is only 180 m, fossil age determinations range from mid-Lower Triassic to uppermost Triassic.

GABBROIC INTRUSIONS (TRIASSIC)
Unit 20 (Green); Unit 16 (Tempelman-Kluit)

A 180 m thick diabase sill of tholeiitic composition intrudes the black slate member at the base of the Keno Hill Quartzite. Thrust faults structurally repeat this sill more than a dozen times to create the illusion of numerous intrusions. One or two additional diabase sills 3 to 15 m thick occur above the main sill. Taking structural repetitions into account, Tempelman-Kluit calculated the volume of the main sill to be approximately 246 cubic kilometres (60 cubic miles). The sill has narrow (1.5 m) chilled margins at the top and base. Its composition varies from base to top, with olivine and hypersthene in the bottom 60 m and plagioclase and augite forming the upper part. Within 30 m of the sill, quartzite is bleached and recrystallized, and the slate is metamorphosed to green, spotted phyllite of the albite-epidote hornfels facies. Mortensen and Thompson (1990) dated the sill at 232 Ma (latest Middle Triassic).

LOWER SCHIST (JURASSIC)
Unit 17 (Green); Units 11-12 (Tempelman-Kluit)

This unit consists of graphitic slate and phyllite and minor greywacke, and is correlative with rocks which underlie the Keno Hill Quartzite in the Keno Hill District.

TOMBSTONE INTRUSIONS (CRETACEOUS)
Unit 20 (Green); Unit 18 (Tempelman-Kluit)

Major intrusions in the area include the Deadman, Tombstone Mountain, Mt Brenner and Antimony Mountain stocks. Six smaller stocks are also mapped, suggesting the presence of larger intrusions at depth. The intrusions consist mainly of syenite and quartz monzonite. These rocks have a high geochemical background in tungsten, gold pathfinder elements, rare earth and radioactive elements.

The Tombstone Stock is a 35 square km zoned syenitic intrusion of Middle Cretaceous age. It is surrounded by a contact metamorphic aureole up to 1 km wide. Coexisting biotite and hornblende in the syenite yielded K-Ar ages of 91 $\pm$ 5 Ma and 80 $\pm$ 13 Ma respectively (Tempelman-Kluit, 1970). Four intrusive phases are recognised:

(1) Tinguaite (porphyritic nepheline syenite)

(2) Leucocratic, pyritic syenite

(3) Porphyritic syenite

(4) Equigranular syenite

The tinguaite is believed to be the oldest phase. It is sheared and foliated in a 200 m wide band parallel to the syenite contact. Chlorite alteration is associated with the shearing, and biotite alteration is associated with areas of autobrecciation. Ukon Joint Venture found that the tinguaite covers an area four times larger than indicated by existing maps.

The Mt Brenner stock is concentrically zoned with a porphyritic quartz monzonite core surrounded by successive zones of porphyritic hornblende monzonite, monzonite porphyry, and augite-biotite porphyry. The intrusion is cut by dykes of radioactive porphyritic syenite, pyroxenite, and biotite lamprophyre. It outcrops over an area of 20 square kilometres and is surrounded by a contact aureole 250 m wide.

The Antimony Mountain stock is a syenite intrusion cutting sedimentary rocks of the Late Proterozoic-Early Cambrian Hyland Group and the Ordovician to Lower Devonian Road River Group, which are intensely silicified and pyritized up to 2 km away from the contact.

All three stocks were intruded at a high level in the crust, probably 1000-3000 m below surface, and based on the presence of several large roof pendants in the Tombstone Stock, the tops of the intrusions are now exposed by erosion.

Elsewhere in Yukon, intrusions of this age are associated with a variety of porphyry deposits: Au (Dublin Gulch, Minfile 106D 025); Mo-W (Red Mountain, Minfile 105C 009); and W-Mo-Sn-Au-Ag (Logtung, Minfile 105B 039). A tin greisen deposit (Minfile 115P 047) is associated with the Zeta intrusion which lies approximately 150 km southeast of Tombstone Mountain.

QUATERNARY GRAVELS, UNIT 26

Valleys in the Tombstone area were glaciated three times during the Pleistocene, and outwash gravels to the south show evidence of a complex glacial history.

STRUCTURE

Two major regional thrust faults, the Tombstone Thrust and the Robert Service Thrust, divide rocks of the area into three southeast-dipping panels (Fig. 8). The northwest panel contains rocks of Selwyn Basin, including the Hyland, Road River and Earn Groups, unconformably overlain by a Permian to Jurassic sequence. The central panel consists of Mississippian Keno Hill Quartzite, Permian siltstone, Triassic shale and Triassic gabbro sills. Rocks of the central panel are continuous along strike with the sequence which hosts high grade silver veins in the Keno Hill area (Abbott, 1990; Roots and Murphy, 1992). The southwest panel consists of Lower Paleozoic rocks of the Hyland, Road River and Earn Groups.

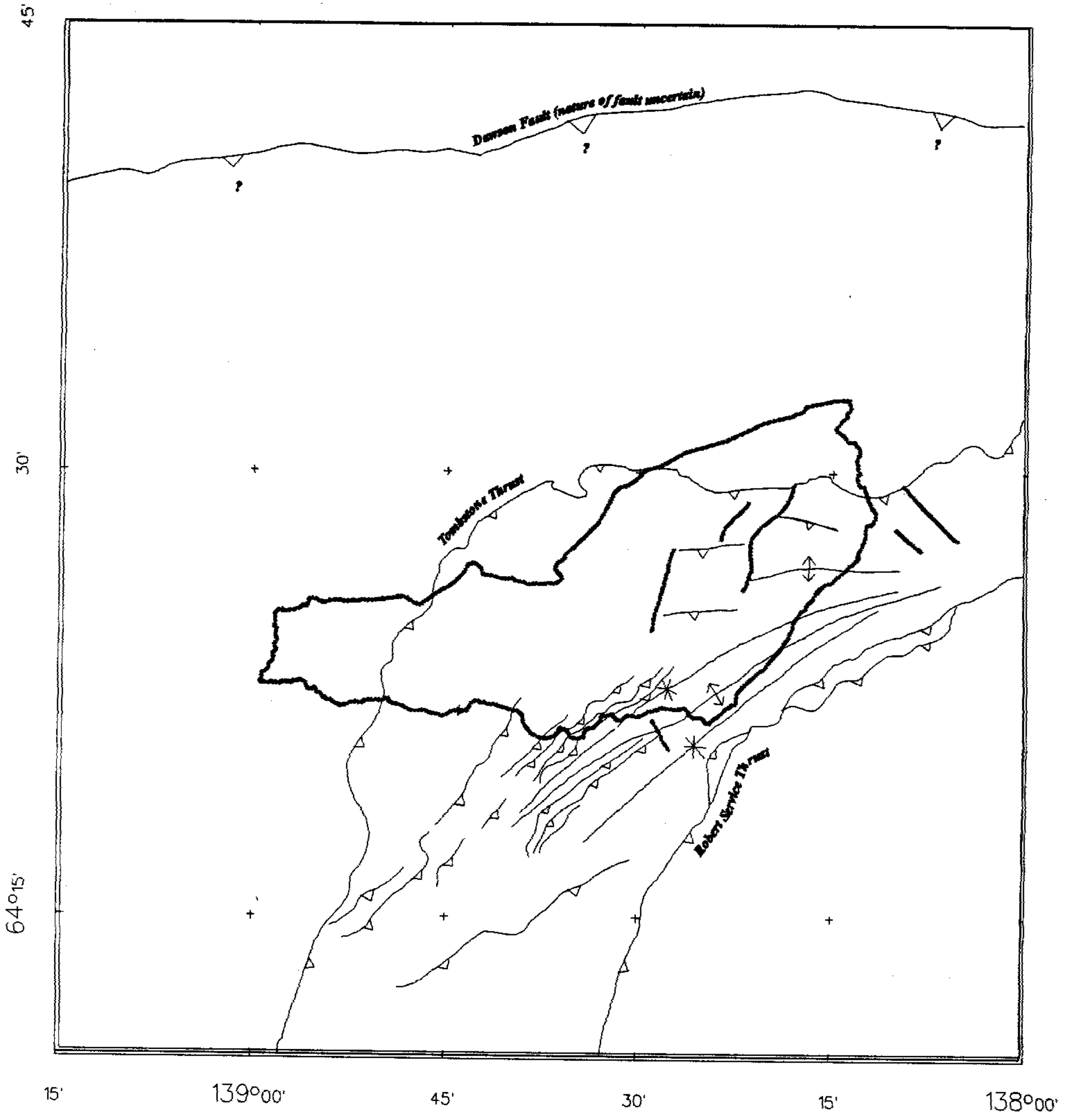


Fig. 8. Tombstone area: major structures (from Green, 1973)

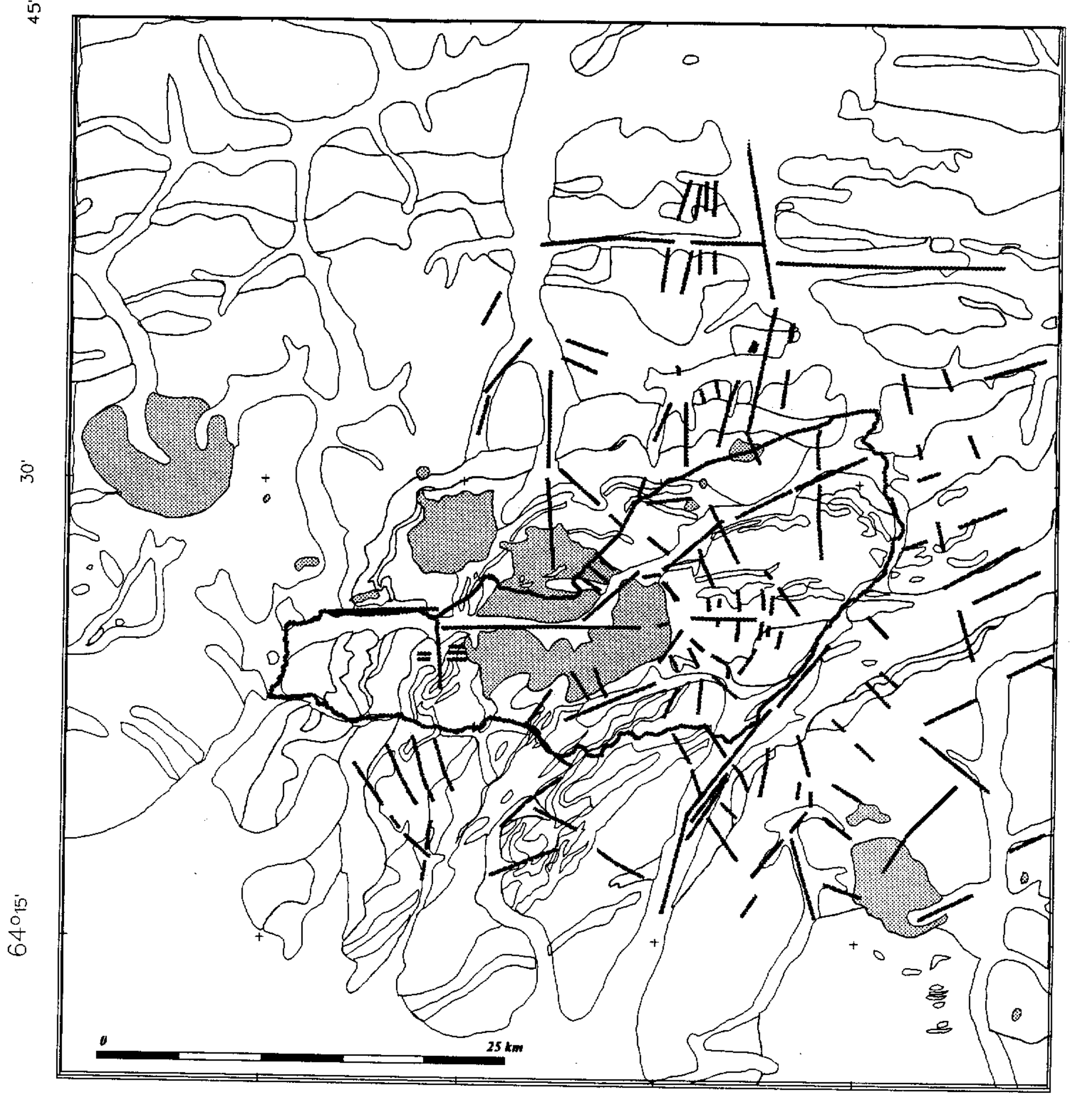


Fig. 9. Tombstone area: air photo lineaments

The central panel contains several smaller thrust faults and is deformed by asymmetric open folds related to the thrusting. A major change in structural trend occurs in the Wolf Creek area. South of Wolf Creek, folds and thrust faults strike northeast-southwest and verge northwest, resembling structures in the Keno Hill district. This northwest-verging deformation is currently believed to be Early Cretaceous in age (D. Murphy, personal communication), based on the Oxfordian age of overthrust rocks and the mid-Cretaceous age of cross-cutting intrusions. North of Wolf Creek, the structural trend is east-west, typical of the Ogilvie and Wernecke Mountains and the Macmillan Pass area. The east-west folds and thrust faults verge north and are believed to be younger (Late Cretaceous or early Tertiary). Normal faults striking east-west, northeast-southwest and northwest-southeast offset both the northeast and the east-west structures.

The southeast panel consists of a south-dipping sequence of Hyland Group rocks and Lower Paleozoic rocks that are thickened by isoclinal folding and layer-parallel minor thrusts.

The four major intrusions in the Tombstone Mountain area are aligned along a northwest trend, perpendicular to the Early Cretaceous structures, and may have been emplaced along a deep-seated basement structure parallel to the Tintina Fault. The intrusive rocks show steep discordant contacts and are surrounded by contact metamorphic aureoles up to 2.5 km wide.

High angle shear zones striking east, northeast, north and northwest cut both the igneous and sedimentary rocks in the Tombstone area, and have controlled the emplacement of feldspar porphyry dykes (Late Cretaceous?) and mineralized veins. These shear zone directions are visible as lineaments on aerial photographs (Fig. 9), and their orientations are identical to east, northeast, north and northwest shears which control the distribution of gold at the Brewery Creek deposit (Minfile 116B 160) which lies 45 km southeast of Tombstone Mountain.

Several major lineaments bisect the Tombstone Stock, and gneissic shear zones appear to control the distribution of mineralization within it. Northwest shears are associated with silicification, magnetite, fluorite and uranium, and northeast shears are reported to control the distribution of quartz-arsenopyrite-chalcopyrite-molybdenite-gold veins. Anderson (1977) and Woodsworth et al. (1992) attributed similar shear zones in Selwyn Suite plutons to semi-solid emplacement of the intrusions.

East-west vein faults are associated with high grade arsenopyrite-gold veins at Antimony Mountain (Minfile 116B 001 etc.) and silver-lead veins on the Blackstone property (Minfile 116B 132).

MINERAL OCCURRENCES IN THE TOMBSTONE AREA

Yukon Minfile records indicate that mineral claims have been staked at 36 localities in the Tombstone area (Fig. 10). Table 2 summarizes available information on these occurrences, which include 9 localities with no known mineral occurrence or geochemical anomaly, 8 geochemical anomalies or mineralized float occurrences, 7 showings, one prospect with a specified width and grade, 7 drilled prospects and four deposits, two with and two without published reserves. The most significant occurrences in the area are described below:

MARN COPPER-GOLD SKARN DEPOSIT

The Marn deposit (Minfile 116B 147) is a copper-gold-tungsten skarn at the contact between quartz monzonite of the Mt Brenner Stock and limestone of the Permian Tahkandit Formation. It is a small, relatively high grade deposit containing an estimated 275 000 to 330 000 tonnes grading 8.6 g/t Au, 1% Cu, 0.1% W and 17 g/t Ag. Mining is currently uneconomic, but its owner, Noranda Exploration Co. Ltd, has maintained 11 core claims in good standing and carries out a biennial review of the property with respect to changing metal prices, advances in mining technology and new exploration concepts.

Two zones of gold-bearing massive sulphide skarn are present, one on either side of the monzonite lobe. The massive sulphide skarn occurs in a 30 m thick band of pyroxene skarn containing minor garnet and scheelite. During the main stage of sulphide enrichment, primary skarn minerals were replaced by an assemblage that averages 70% pyrrhotite and 20% chalcopyrite, and also contains minor sphalerite, arsenopyrite, pyrite and trace cubanite and pentlandite. The final stage of mineralization consisted of veinlets of electrum, native bismuth, bismuthinite, bismuth telluride (possibly hedleyite) and silver minerals, which cut the earlier sulphides and silicates.

The calculated reserves occur in the Mini Grid Zone, which strikes 120° and dips 15-30° southwest. The east end of the zone is exposed in outcrop and it has been traced by drilling over a strike length of 110 m and a width of 85 m. Gold grades up to 360 g/t Au have been obtained and the highest copper values (up to 1.5%) correlate with high gold grades. Tungsten, which grades up to 5.3% WO_3 across short intervals, is only present in the Mini Grid Zone. A deep geological target on the south part of the Marn property remains untested.

SPOTTED FAWN & BLACKSTONE SILVER-LEAD VEINS

In 1901, two high grade silver lead veins were discovered on the south side of Tombstone Mountain (Spotted Fawn occurrence, Minfile 116B 057). The veins were explored underground with a 55 m adit in 1905-1906 and taken to lease in 1907. Numerous claims were staked around the 2 leases, which are still in good standing. The last recorded exploration in this area was in 1976.

As at Keno Hill, the Spotted Fawn veins strike northeast and consist mainly of siderite and argentiferous galena. Grades range up to 4388 g/t Ag. The longer vein has a strike length of 18 m, but both veins are less than 1 m wide. Nine tonnes of ore were reportedly mined in 1920, but no smelter results are available. The 1920 report also documented 16 veins on the Ophir, one of the many fringe claims which surrounded the property.

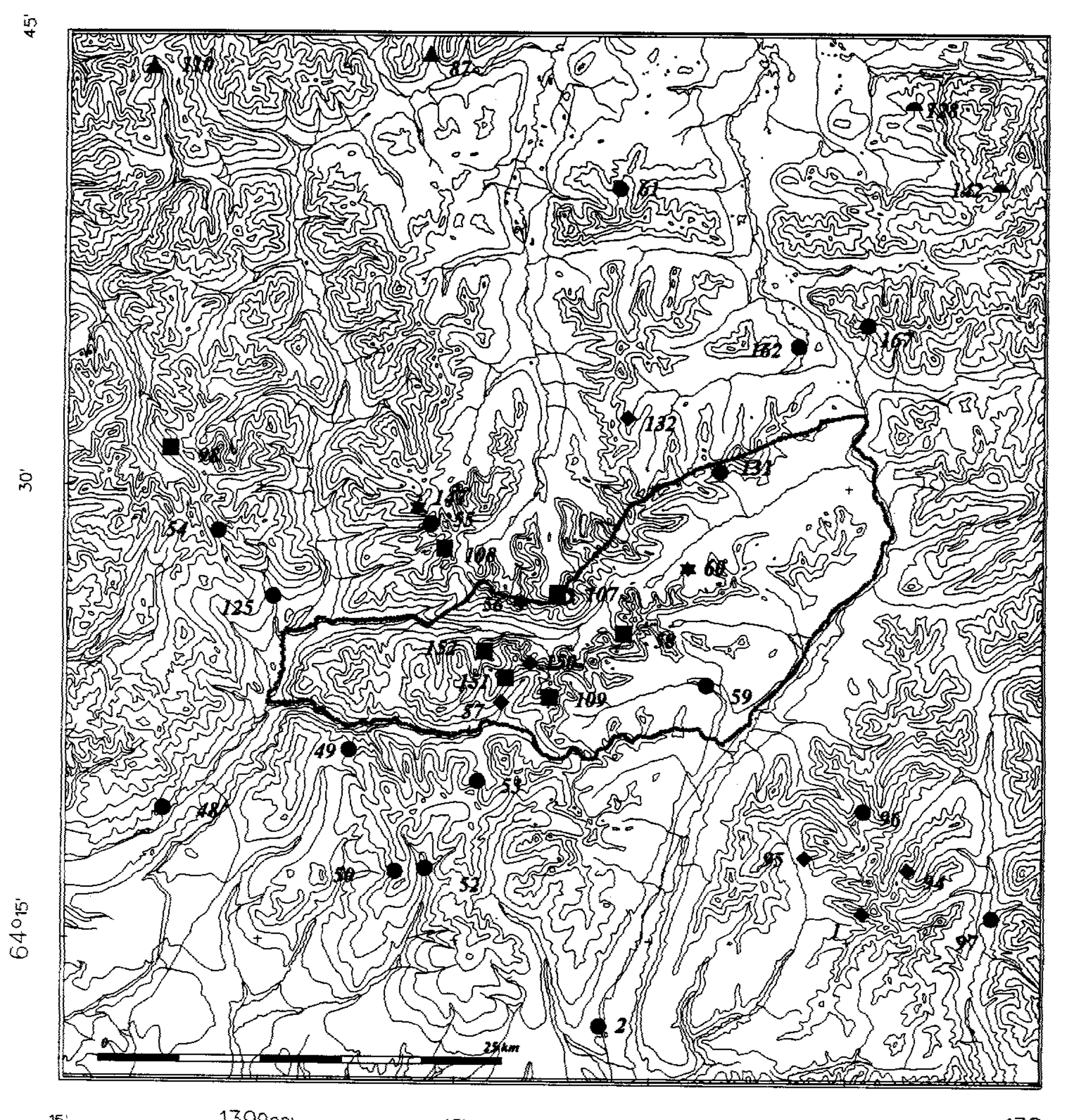


Fig. 10. Tombstone Area: mineral occurrences (Yukon Minfile reference numbers)

●	*Unknown*	▲	*Mississippi Valley*
■	*Porphyry*	✱	*Skarn*
◓	*Sedex*	◆	*Vein*

Table 2. TOMBSTONE AREA MINERAL SHOWINGS

MINFILE NO.	NAME	STATUS	DEPOSIT TYPE	HOST ROCK	MAJOR COMMODITY	MINOR COMMODITY
116B 001	Index	Deposit	Vein	Tombstone Ste	Au,Sb,Cu,Ag	Pb
116B 002	Benson	Moly float	Unknown	Tombstone Ste	Mo	
116B 048	Rickard	Uncertain	Unknown	Hyland Group	-	-
116B 049	Hay Meadow	Anomaly Pb,Zn	Unknown	Tombstone Ste	-	-
116B 050	Jeckell	Anomaly Cu,Zn	Unknown	Tombstone Ste	-	-
116B 052	Snyder	Uncertain	Unknown	Lower Schist	-	-
116B 053	Cable	Uncertain	Unknown	Lower Schist	-	-
116B 054	Lighthouse	Uncertain	Unknown	Hyland Group	-	-
116B 055	Fireweed	Moly float	Unknown	Lower Schist	-	-
116B 056	Trix	Showing	Skarn	Tahkandit Fm	-	-
116B 057	Spotted Fawn	Drilled prospect	Veins	Keno Hill Qzte	Ag,Pb	-
116B 058	Subtract	Showing	Porphyry	Tombstone Ste	U,Th	-
116B 059	Robert Service	Galena float	Unknown	Tombstone Ste	Pb	-
116B 060	Multiply	Showing	Skarn	Lower Schist	Cu,Mo	-
116B 061	Crawford	Chalco float	Unknown	Hyland Group	Cu	-
116B 087	Kiwi	Drilled prospect	Miss. Valley	Gillespie Group	Pb,Zn	Ag,Cu
116B 094	O'Brien	Drilled prospect	Vein	Tombstone Ste	Au	Ag,Cu
116B 095	Sandow	Showing	Vein	Hyland Group	Cu	-
116B 096	Brewery	Anomaly	Porphyry	Tombstone Ste	U,Au	-
116B 097	Burr	Uncertain	Unknown	Hyland Group	-	-
116B 098	Combination	Drilled prospect	Porphyry	Tombstone Ste	U,Th	-
116B 107	Sumting	Showing	Skarn	Tahkandit Fm	U	-
116B 108	Nebulous	Prospect	Porphyry	Tombstone Ste	U	-
116B 109	Ting	Drilled prospect	Porphyry	Tombstone Ste	U	-
116B 110	Rayner	Sphalerite float	Miss. Valley	Gillespie Group	Zn	-
116B 125	Liedtke	Uncertain	Unknown	Hyland Group	-	-
116B 128	Rein	Deposit	Sedex	Earn Group	Ba	Zn,Cu,Pb,V
116B 131	Riki	Uncertain	Unknown	Lower Schist	-	-
116B 132	Blackstone	Drilled prospect	Vein	Road River Gp	Pb,Ag	-
116B 142	Graps	Showing	Sedex	Earn Gp	Ba	Pb,Zn
116B 147	Marn	Deposit	Skarn	Tahkandit Fm	Au,Cu,W	Ag,Bi,Zn,Ni
116B 150	Hester	Showing	Vein	Tombstone Ste	Ag,Zn,Cu	Au,Pb,F
116B 151	Tombstone	Deposit[1]	Porphyry	Tombstone Ste	U	Mo,F,Au,Ag,Cu
116B 152	Teta	Drilled prospect	Porphyry	Tombstone Ste	U	Mo, F
116B 162	Eastblack	Uncertain	Unknown	Menzie Creek?	-	-
116B 167	Trapper	Uncertain	Unknown	Menzie Creek?	-	-

[1]Large low grade resource, no official reserves

In a poorly exposed area north of Tombstone Mountain, Mattagami Lake Mines staked the Tak claims in 1980 (Blackstone occurrence, Minfile 116B 132) to cover similar veins hosted by Road River Group chert and argillite. Two parallel northeast vein structures were traced over strike lengths of 975 and 600 m, with specimens grading up to 8571.2 g/t Ag, >40% Pb, 0.5% Zn and 11.3 g/t Au, but both veins are narrow (30 cm or less).

ANTIMONY MOUNTAIN GOLD-ARSENOPYRITE VEINS

The original Index showing (Minfile 116B 001) consists of pods of stibnite in the contact aureole of the Antimony Mountain intrusion, but recent exploration has focused on a swarm of 8 tourmaline-bearing quartz-sulphide veins which cut Hyland Group rocks near the summit. Mineralization consists of pyrite, arsenopyrite, pyrrhotite and minor chalcopyrite and sphalerite. The veins are up to 1 m wide and tens of metres long and have returned assays as high as 10% Cu, 3% Pb, 2.5% Zn, 300 g/t Ag and 30 g/t Au. Trenching and drilling in 1980 outlined reserves of 9072 tonnes grading 20.6 g/t Au.

On the east side of the mountain, similar veins occur on the O'Brien property (Minfile 116B 096, where a 1989 drill intersection on the North vein assayed 22.8 g/t over a true thickness of 1.53 m.

TOMBSTONE MOUNTAIN URANIUM DEPOSIT AND ASSOCIATED SHOWINGS

The Tombstone deposit (Minfile 116B 109,150,151,152) is a giant low grade uranium resource on the southwest side of Tombstone Mountain. It was discovered by Ukon Joint Venture in 1976 and explored with some drilling during the late 1970's but never fully outlined, but may be the largest single uranium resource in Canada. The mineralization is disseminated and also occurs in veins and shears within a tinguaite phase of the Tombstone intrusion. Olade and The entire tinguaite phase of the Tombstone intrusion is mineralized with an average concentration of 78 ppm U (Olade and Goodfellow (1978). Like other deposits of its type, the grade is highly variable and the average grade is low, but the ore can be upgraded using modern concentrating techniques.

Within the area of low grade uranium, Ukon Joint Venture found more than 20 high grade uranium showings (Fig. 11). A north-northwest trending shear zone near the head of Spotted Fawn Gulch was explored by trenching and 12 diamond drillholes. A small high grade deposit was outlined, with preliminary reserves estimated at 27 000 tonnes grading 0.232% U_3O_8 over a strike length of 75 m and to a depth of 50 m. Archer, Cathro and Associates (1981) Ltd, the present owner, currently maintains three claims which cover the best showings.

The former Nebulous claims covered a porphyritic monzonite phase of the Mt Brenner stock which is also radioactive. At two locations (Minfile 116B 108) joints and fractures in the

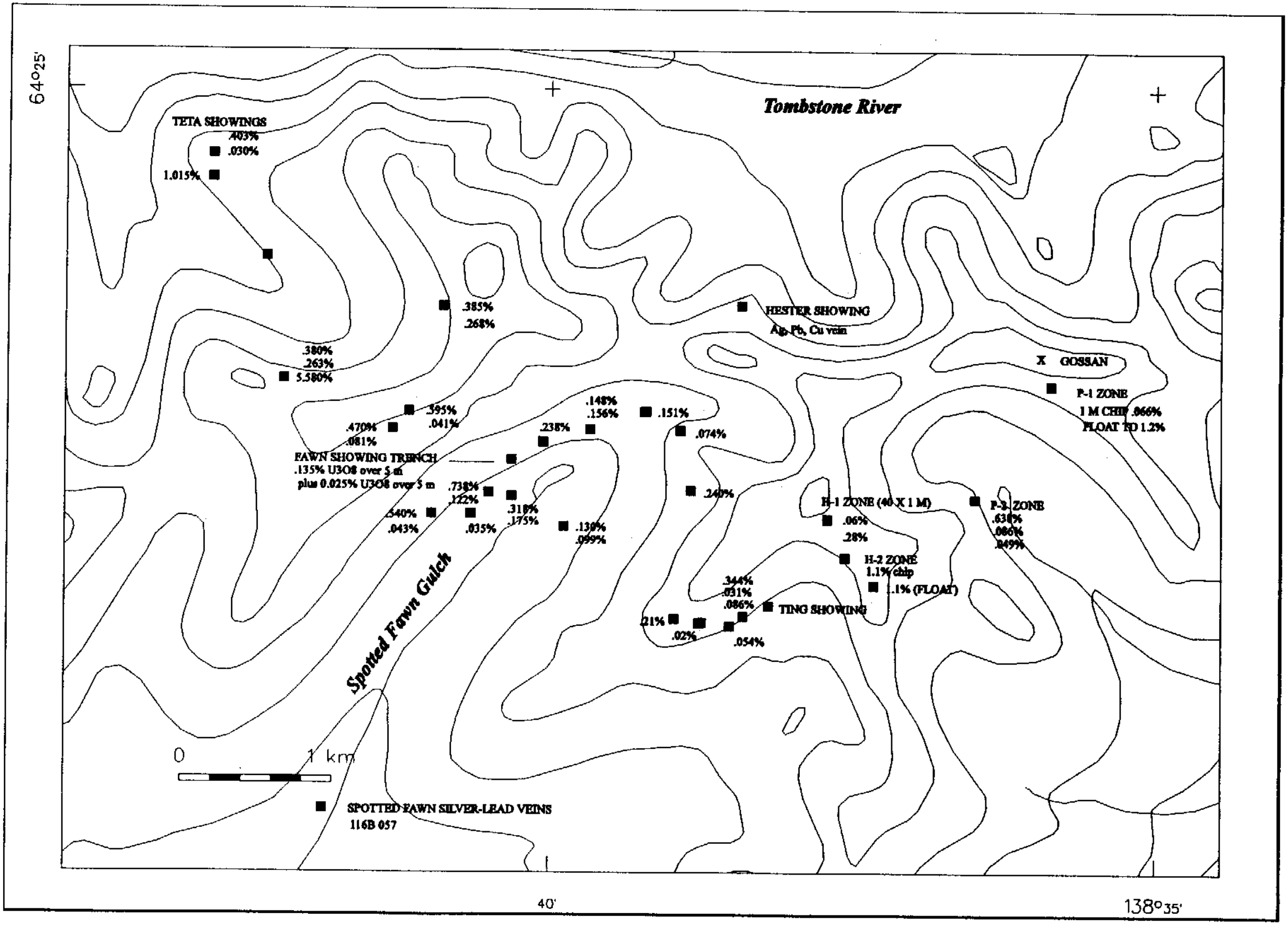


Fig. 11. Uranium showings on Tombstone Mountain (values in % U3O8)

Data from assessment report #92764 with permission of Archer, Cathro & Associates (1981) Ltd

monzonite are coated with secondary uranium minerals. Assays were as high as 1.1% U_3O_8, and a chip sample averaged 0.015% U_3O_8 over 10 m. About half of this grade is believed to be due to secondary enrichment. Specimens from the east zone returned rare earth values up to 1000 ppm Ce, 300 ppm La, 30 ppm Tb, 15 ppm Sc and 100 ppm Y, although the correlation between uranium and rare earth elements is generally poor in this area.

REIN BARITE DEPOSIT

The Rein deposit (Minfile 116B 128) is located in the northeast corner of the map area. It consists of two exhalative barite lenses 1 km apart, hosted by Devono-Mississippian silty argillite and shale on the south edge of the Mackenzie Platform. Drillholes intersected up to 42.1 m of barite, but no reserves have been published.

KIWI MISSISSIPPI VALLEY-TYPE ZINC-LEAD-SILVER PROSPECT

The Kiwi drilled prospect (Minfile 116B 087) is located at the north edge of the Tombstone area. Seven zinc-lead-silver showings occur in fractured Gillespie Group dolomite over a 1000 m strike length. The main showing consists of strongly oxidized sphalerite and galena within an east-trending fault breccia zone 8 m wide. A channel sample from a trench assayed 19.8% Zn, 16.3% Pb, 116 g/t Ag and 0.05% Cu across 10.6 m, and a drillhole intersected two zones assaying 13.8% Zn over a true width of 3.5 m, and 3.4% Zn over 4.8 m.

STREAM SEDIMENT GEOCHEMISTRY

As a result of the Canada-Yukon Mineral Development Agreement, stream sediment geochemical coverage is available for the entire Dawson map sheet (116BC) and the south half of Ogilvie River (116FG). In Appendix A, anomalous values (generally those that exceed the 70th, 90th and 95th percentiles for the Dawson map sheet) are plotted for samples collected in the Tombstone area.

The maps in Appendix A show that stream sediments in the Tombstone area are strongly anomalous in many elements. A correlation matrix shows moderate to strong relationships between gold, antimony, arsenic and cesium; gold and tungsten; molybdenum and fluorine; uranium, thorium, tungsten, bromine, rubidium, cesium, iron and rare earth elements; nickel, iron, copper, cobalt, chromium and rare earth elements; and zinc and nickel.

Figure 12 outlines 16 multielement anomalies, which show a clustering of gold and gold pathfinder elements (mercury, arsenic, antimony), radioactive and rare earth elements, molybdenum and tungsten, halogens and alkali metals around the Cretaceous intrusions, copper and cobalt peripheral to the intrusions and a strong nickel-cobalt-chromium-zinc-copper-iron and rare earth anomaly associated with Earn Group shale in an east-west belt north of the proposed park.

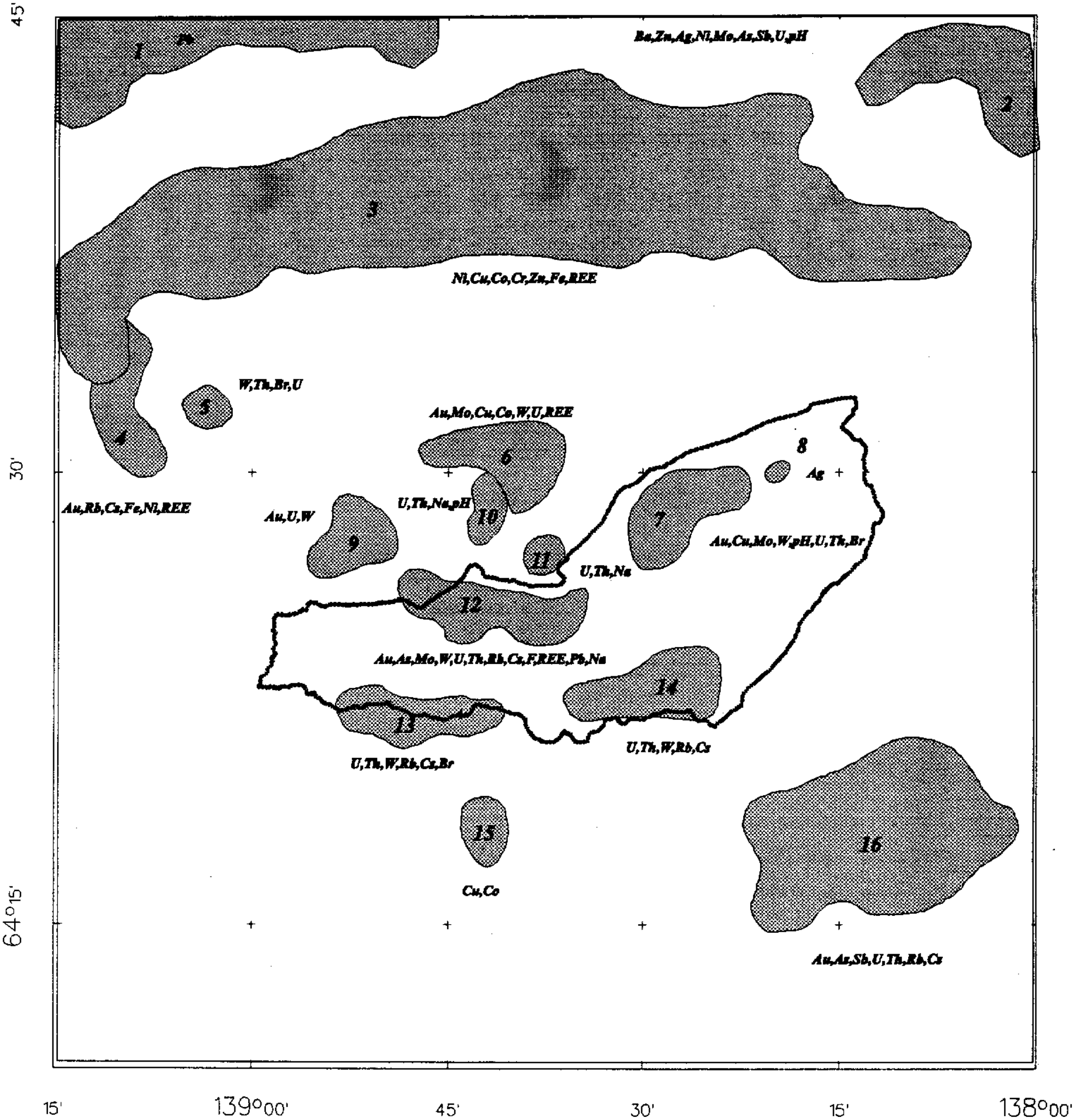


Fig. 12. Major stream sediment geochemical anomalies

Anomaly 1 indicates the potential for Mississippi-Valley type lead-zinc-silver deposits along the south edge of the Mackenzie Platform.

Anomaly 2 is a barite-base metal anomaly in Earn Group shale on the Rein property. The pH anomaly and elevated levels of antimony and arsenic are characteristic of Earn Group rocks near the Tom deposit at Macmillan Pass (R. Stroshein, personal communication).

Anomaly 3 shows that a regional sedex zinc-nickel horizon near the base of the Earn Group passes through the north part of the Tombstone area. The unit is widespread in Selwyn Basin but exploration has proved difficult due to poor exposure and the diffuse nature of the target. North of Mayo, a layer of high grade nickel sulphide is associated with this horizon on the Nick property (106D 064) but is too thin to be economic.

Anomalies 4-7, 9-14 and 16 are related to the Tombstone Suite Intrusions. Transported anomalies 13 and 14 reflect known mineralization on the south side of Tombstone Mountain. Anomaly 12 is a strongly anomalous area in the Tombstone Valley which was documented by Olade and Goodfellow (1978). Their work indicates a strong uranium-molybdenum-tungsten source near the centre of the Tombstone Stock on the south side of Tombstone River Valley. The area is covered by glacial debris and the source of the anomaly has not been found.

Anomaly 7 covers an area where small stocks intrude Keno Hill Quartzite and Jurassic slate, and buried intrusions are likely to occur at depth. A copper and molybdenum skarn showing occurs in the area (Multiply occurrence, Minfile 116B 060) but anomalous uranium, thorium and bromine along with gold and tungsten suggest the possibility of porphyry-style mineralization in this area.

Silver is not closely associated with other elements in Tombstone area stream sediments and is concentrated in small well-defined areas like anomaly 8. Anomalies of this type are most likely related to high grade silver veins in Keno Hill Quartzite.

Isolated copper-cobalt anomalies like 15 may be related to disseminated chalcopyrite in Triassic gabbro.

Unfortunately, there are no stream sediment data for mercury, bismuth, tin, beryllium, boron or lithium in the Tombstone area. According to Garrett (1973), mercury is an important indicator of granite-hosted gold in intrusions northeast of the Tintina Trench, and a weak mercury anomaly led to Noranda's discovery of the Brewery Creek deposit. Bismuth is characteristic of gold porphyry deposits. Beryllium is closely associated with rare earth pegmatites and veins, and boron and lithium are associated with tin granites. Except for mercury, which is volatile, this data could be obtained by reanalysing 341 archived samples.

LITHOGEOCHEMISTRY

Some lithogeochemical data on the Tombstone Suite Intrusions is available as a result of studies by Garrett (1973) and Olade and Goodfellow (1978). A correlation matrix based on Garrett's data (Appendix B) shows a strong positive correlation between tin, beryllium, cobalt, calcium, magnesium, iron and zinc, and negative correlations between these elements and silicon, aluminum, sodium and potassium suggesting that any tin in the area is likely to occur in skarns. A similar set of correlations exists for copper, suggesting that it too is confined to skarn occurrences. Maps in Appendix B show anomalous iron, copper, cobalt, molybdenum, titanium, vanadium, tungsten and tin adjacent to the Marn deposit (Minfile 116B 056), near known skarn showings on the Trix property (Minfile 116B 147) and at the northeast corner of the Antimony Mountain Stock.

URANIUM

Olade and Goodfellow (1978) showed that the tinguaite phase of the Tombstone Stock is highly enriched in uranium, with concentrations of 3-264 ppm U in unmineralized areas and values which exceed 200 ppm and commonly reach 10 000 ppm U close to mineralized zones. The elevated uranium values are due to disseminated uraninite in the tinguaite and in crosscutting veins. Fluorine correlates well with uranium, and is strongly anomalous in all phases of the stock.

The syenite phase of the Tombstone Stock contains uranium concentrations ranging from 3 to 86 ppm. Anomalous tungsten and molybdenum are concentrated in the quartz monzonite phase.

RARE EARTHS

Archer, Cathro obtained rare earth values up to 1000 ppm Ce, 300 ppm La, 30 ppm Tb, 15 ppm Sc and 100 ppm Y from the east zone on the Nebulous property (Minfile 116B 108), associated with 0.107% U_3O_8 and 0.58% ThO_2, and a high grade uranium specimen on the Tombstone property contained 4.68% U_3O_8, 0.005% ThO_2, 3.0% K, 500 ppm Ce, 200 ppm Nd, 20 ppm Tb, 5 ppm Yb and 50 ppm Y. However, in general, rare earth elements and uranium were found not to be associated.

GOLD

Analyses of quartz vein material from the Teta (Minfile 116B 152) and Tombstone (116B 151) showings returned values of >10 000 ppb Au, >10 000 ppm As, Cu, Bi, and Mn; >200 ppm Ag; and up to 5380 ppm Co, 21.5 ppm Be, 180 ppm W, 1320 ppm Pb and 2760 ppm Zn and 430 ppm Sb. These veins returned only background values of uranium, but the strong gold-bismuth response indicates potential for a bulk tonnage gold deposit of the Fort Knox type.

SOIL GEOCHEMISTRY

Systematic soil sampling in the Tombstone area was confined to only a few properties and was severely hampered by talus, glacial deposits, thick overburden in valleys, and permafrost. The large amount of glacial till and the poor soil development suggest that most anomalies are transported. No soil sampling was done on the Sumting, Trix or Riki claims. Most soil sampling programs analysed a limited range of elements, and exploration of the area for porphyry gold, copper or molybdenum targets, tin greisens or metasomatic veins would require a completely different set of analyses.

As a result of the work of several companies, Antimony Mountain has the most complete soil geochemical coverage with analyses for Au, Ag, As, Pb, Zn and U. On the Blackstone property, anomalous lead values up to 5760 ppm successfully outlined silver-bearing galena veins and were overlapped by smaller silver (up to 50 ppm Ag) and copper (up to 455 ppm) anomalies. Noranda analysed soil samples from the Marn property for Cu, Zn, Pb, Ag, Mo, W and U and obtained values up to 1600 ppm Cu, 73 ppm Mo and 82 ppm W related to the skarn occurrence. Exploration on the Tombstone property depended mostly on radiometric surveys with hand held scintillometers. Background uranium values in soil were as high as 175 ppm.

WATER GEOCHEMISTRY

Uranium is transported in water as a complex ion in acidic solutions (Olade and Goodfellow 1978) and is strongly concentrated in acidic, swampy waters along the Tintina Trench, 25 km to the south. Water draining the uranium-bearing tinguaite phase of the Tombstone Stock is slightly alkaline, so that even creeks draining the best showings gave background water assays. Creeks with slightly acidic water draining the syenite were anomalous, with values of 1-5 ppb U. Olade and Goodfellow (1978) outlined two water anomalies, one along the Tombstone River and at the other at the head of the Blackstone River, which probably originate from uranium-bearing tinguaite buried beneath overburden.

Water draining the anomalous area around the Nebulous showing on Mt Brenner contained up to 8.3 ppb U, coincident with a silt anomaly of 22 to 149 ppm U.

GEOPHYSICS

The only regional geophysical data consists of government airborne magnetic surveys at a scale of 1:50 000 and an airborne radiometric survey flown over the Tombstone, Mt Brenner and Antimony Mountain intrusions by Ukon Joint Venture. Twenty-two large scale magnetic anomalies in the map area are mostly clustered around the Tombstone and Mt Brenner stocks (Fig. 13). These anomalies are too big to identify individual showings but may help to distinguish different intrusive phases and identify structures related to mineral deposits. M. Power (Amerok Geophysics) categorized the anomalies as follows:

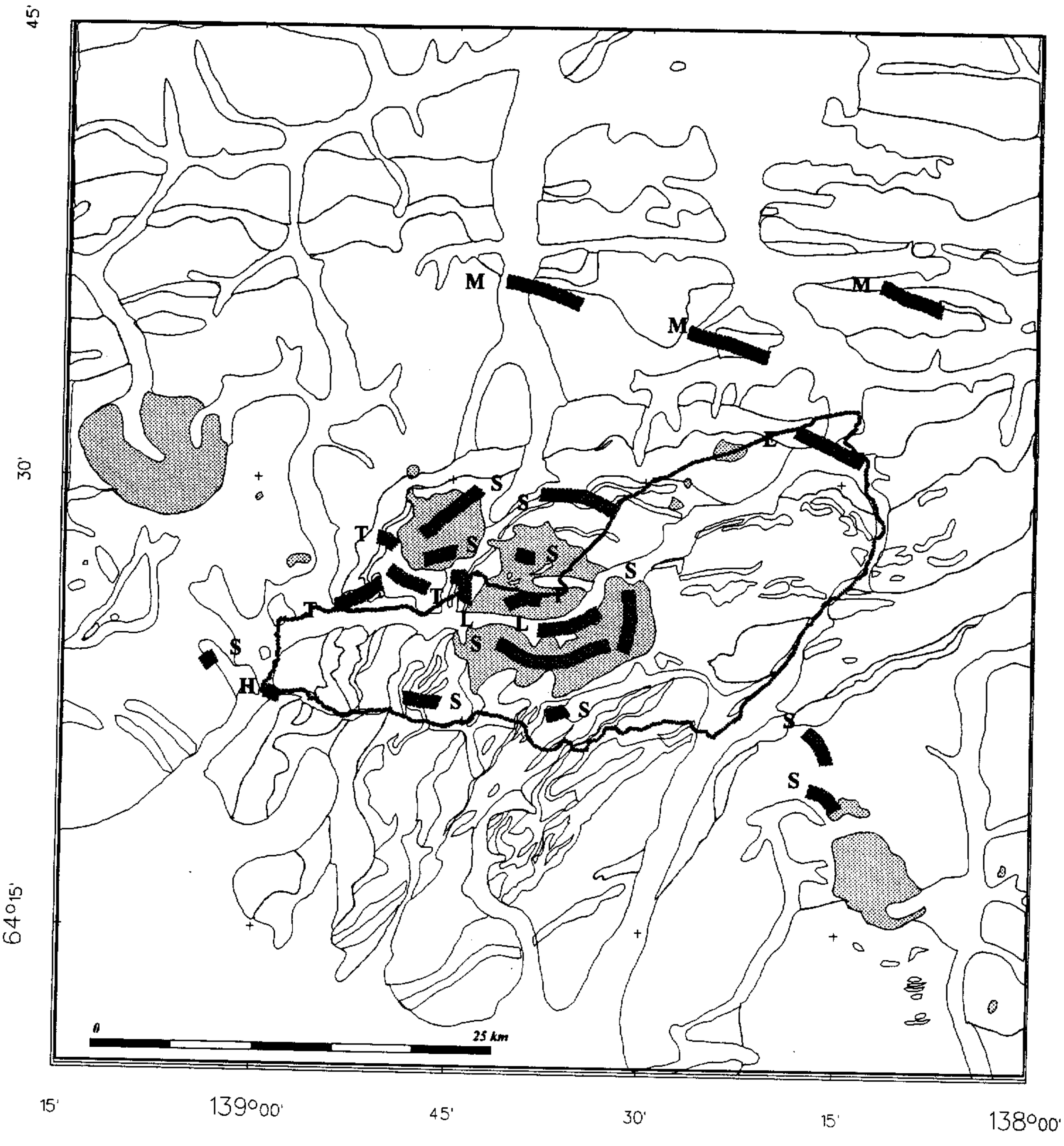


Fig. 13. Tombstone area: magnetic anomalies

S Syenite	*H Hyland Group*		*Magnetic anomaly axis*
T Tahkandit Formation	*E Earn Group*		
L Magnetic lows within syenite	*M Menzie Creek Volcanics*		

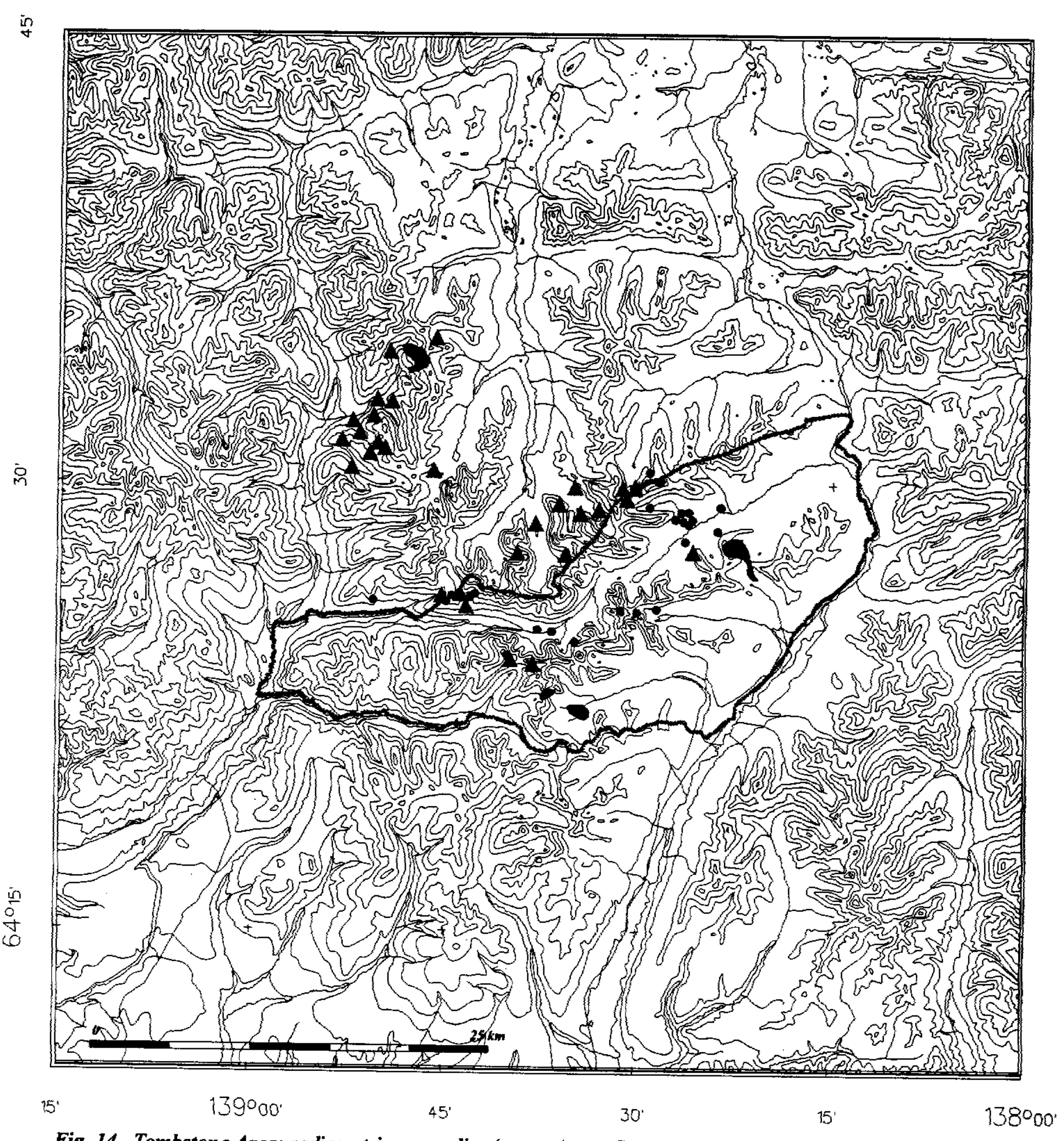


Fig. 14. Tombstone Area: radiometric anomalies (counts/second)

▲ ***Anomaly >1000 cps***

• ***Anomaly <1000 cps***

Clustered anomalies >1000 cps

Data from assessment reports with permission of Archer, Cathro & Associates (1981) Ltd

TYPE S ANOMALIES probably represent magnetic phases in the syenite, or buried intrusions in other parts of the area. Several anomalies of this type are closely associated with radiometric anomalies which follow the tinguaite-syenite contact. Analyses by Olade and Goodfellow showed that the tinguaite phase of the Tombstone Stock is enriched in ferric iron relative to the syenite, which in turn contains more iron than the quartz monzonite. A large S-type anomaly south of Tombstone River is therefore probably related to the tinguaite unit. Other type S anomalies may be caused by magnetite in the potassic core of a porphyry system.

TYPE T ANOMALIES indicate magnetic highs in or near the Tahkandit Formation, and may represent magnetite-rich skarns.

TYPE L ANOMALIES are large magnetic lows which represent magnetite-deficient intrusive phases (possibly monzonite) or areas of hydrothermal alteration associated with a porphyry system. A large magnetic low on the south side of the Tombstone Valley coincides with a strong multi-element geochemical anomaly described by Olade and Goodfellow (1978) and outlined in Figure 10.

A SINGLE TYPE H ANOMALY may represent skarn development in Hyland Group limestone, at the southeast end of the proposed park near Chandindu River.

E AND M-TYPE ANOMALIES are broad magnetic highs in the Paleozoic sedimentary and volcanic rocks which could be associated with pyrrhotite-bearing massive sulphide deposits. However, the M-type anomalies coincide with the base of the Menzie Creek volcanics, and more likely indicate magnetic flows which have been documented elsewhere in Selwyn Basin (R. Stroshein, personal communication).

Radiometric anomalies are clustered around the Tombstone and Mt Brenner stocks (Fig. 14).

MINERAL POTENTIAL

The mineral potential of prospective stratigraphic units in the Tombstone area is discussed below. Although there is no guarantee that some of these deposit types will ever be found in the Tombstone area, a wide variety of mineral deposit types must be considered possible, based on favourable geology, geochemistry or geophysics. Examples of most of these deposit types can be found elsewhere in Yukon, and are documented in Table 3.

The most significant mineral potential is associated with the Cretaceous intrusions such as the Tombstone Stock in the centre of the proposed park. Syngenetic base metal deposits related to Lower Paleozoic rifting may occur in sedimentary and volcanic rocks of Cambrian to Mississippian age.

Table 3. YUKON EXAMPLES OF DEPOSIT TYPES WHICH COULD OCCUR IN THE TOMBSTONE AREA

Potential Deposit type	Possible Host Rock (units based on Green 1973	Commodities	Yukon Example	Minfile No.	Reserves	Grade	Estimated Gross metal value[1] ($CDN), 25 Oct/93
WITHIN PROPOSED PARK OUTLINE							
Gold porphyry	Syenite (Unit 21)	Au	Dublin Gulch	106D 025	54-136 million tonnes	1.1-1.4 g/t Au	2.4 billion
Other disseminated gold	Quartz Monzonite (Unit 21)	Au,Sb	Brewery Creek	116B 160	15 million tonnes	1.85 g/t Au	440 million
Copper-gold porphyry	Quartz monzonite (Unit 21)	Cu,Au,Mo	Casino	115J 028	378 million tonnes	0.30% Cu, 0.038% Mo, 0.34 g/t Au	6.1 billion
Molybdenum-tungsten porphyry	Quartz monzonite (Unit 21)	Mo,W	Red Mountain	105C 009	187 million tonnes	0.167% MoS_2 (0.111% Mo)	2.3 billion
Uranium porphyry	Tinguaite (Unit 21)	U	Tombstone	116B 151	Very large[2]	Avg 76 ppm U	No reserves published
Tin-tungsten-molybdenum porphyry	Quartz monzonite (Unit 21)	W,Mo,Sn,Au,Ag	Logtung	105B 039	230 million tonnes	0.104% WO_3 (0.082% W), 0.05% MoS_2 (0.033% Mo)	2.1 billion
Rare Earth pegmatite/metasomatic vein	Syenite (Unit 21)	REE,U,Th	Nokluit (Lancer)	105F 080	None published	Chip sample 1.2% REE, 0.5% Nb/10 m	No reserves published
Greisen	Quartz monzonite, syenite (Unit 21)	Sn,Cu,Ag,Zn	Zeta	115P 047	980 000 tonnes	557.8 g/t Ag, 0.1% Sn	699 million
Copper-gold skarn	Limestone (Units 2,8,15)	Au,Cu,W	Marn	116B 147	275 000 to 330 000 tonnes	8.6 g/t Au, 1% Cu, 0.1% W, 17 g/t Ag	55 million
Tungsten skarn	Limestone (Units 2,8,15)	W	Ray Gulch	106D 027	7.3 million tonnes	0.87% WO_3 (0.69% W)	337 million
Replacement manto	Limestone (Units 3,15,16)	Au	Ketza River	105F 019	250 000 tonnes (oxide); 390 000 tonnes (sulphide)	12.5 g/t Au (oxide); 8.6 g/t (sulphide)	102.6 million
Replacement manto	Limestone (Units 3,15,16)	Pb,Ag,Zn	McMillan	095D 006	1.1 million tonnes	8.3% Zn, 4.1% Pb, 62 g/t Ag	149 million
Polymetallic vein	Keno Hill Quartzite	Ag,Pb,Zn	Keno Hill	105M 001	Total production 4.8 million tonnes	960 g/t Ag, 4.6% Pb (grade of 1988 reserves)	971 million (produced)
Gold vein	Hyland Group quartzite (Unit 3)	Au,Sb or Au,As	Antimony Mt	116B 001	9072 tonnes	20.6 g/t Au	2.9 million

Potential Deposit type	Possible Host Rock (units based on Green 1973	Commodities	Yukon Example	Minfile No.	Reserves	Grade	Estimated Gross metal value[1] ($CDN), 25 Oct/93
Uranium vein	Tinguaite (Unit 21)	U,F,Mo,Pb,Zn	Tombstone	116B 151	27 000 tonnes	0.232% U_3O_8 (0.197% U)	1.5 million
IN SURROUNDING AREA							
Volcanogenic massive sulphide	Mafic Volcanics (Unit 4)	Cu,Pb	Hart River	116A 009	1.06 million tonnes	3.6% Zn, 1.45% Cu, 0.9% Pb, 49.7 g/t Ag, 1.4 g/t Au	118 million
Volcanogenic massive sulphide	Felsic Volcanics (Earn Gp)	Cu-Pb-Zn-Ag-Au	Marg	106D 009	4.88 million tonnes	1.8% Cu, 2.7% Pb, 5.0% Zn, 65 g/t Ag and 1.2 g/t Au	709 million
Sedex	Shale (Earn Gp)	Zn,Pb,Ag	Tom	105O 001	9 283 700 tonnes	69.4 g/t Ag, 7.5% Pb and 6.2% Zn	1.2 billion
Sedex	Shale (Earn Gp)	Ni,Zn	Nick	106D 092	None calculated	Drill intersection 2.9% Ni, 0.7% Zn, 0.16% Mo, 70 ppb Pt, 70 ppb Pd and 0.8 ppm Ag over 10 cm.	Widespread but thin horizon, no reserves
Sedex	Shale (Earn Gp)	Ba	Rein	116B 128	None published; Intersections of 16 to 64 m barite in 18 drillholes.	Specific gravities of barite intervals range from 4.18 down to 3.18	No reserves published
Sedex	Shale (Road River Gp)	Zn,Pb,Ag	Howards Pass	105I 012	362.9 million tonnes	5.4% Zn, 2.1% Pb	28.2 billion
Sedex	Late Cambrian siltstone and shale	Zn,Pb,Ag	Faro	105K 061	57.6 million tonnes	3.4% Pb, 4.7% Zn, 36 g/t Ag	4.8 billion
Carbonate-hosted breccia/Miss. Valley	Proterozoic dolomite (Unit 2)	Zn,Pb,Ag, possible Cu	Blende	106D 064	19.4 million tonnes	3.04% Zn, 2.81% Pb, 55 g/t Ag	1.2 billion

[1]Gross metal value is the total value of all commodities in the deposit, if extracted and sold at October, 1993 prices. Because it does not consider mining, shipping or processing costs, losses during processing, or smelter penalties, it is no indication of whether the deposit will ever be economic.

[2]Since 1978 the price of uranium has dropped from about Cdn $190/kg to $27.40/kg. Due to the strategic nature of uranium in the late 1970's, even low grade material with mining costs as high as $340/kg U was included in EMR's resource estimates. Costs of mining at Tombstone Mountain were probably about $30-40/kg U at the time (W.D. Eaton, personal communication).

GILLESPIE LAKE GROUP (MAP UNIT 2)

Several important carbonate-hosted lead-zinc-silver replacement deposits occur in brecciated Gillespie Lake Group dolomite along the south edge of the Mackenzie Platform. The most important Yukon discovery to date is the Blende (Minfile 106D 064), which contains about 23.7 million tonnes grading 2.81% Pb, 3.04% Zn and 55.9 g/t Ag. Although it resembles a Mississippi Valley-type deposit, the Blende mineralization is believed to be related to intrusions of Middle Proterozoic age which are not present in the Tombstone area. The Kiwi prospect (Minfile 116B 087) is a true Mississippi Valley-type occurrence near the north edge of the Tombstone map area. These deposits are most likely confined to the Mackenzie Platform, and are unlikely to occur close to the proposed park boundary.

HYLAND GROUP (MAP UNIT 3)

Hornfelsed sedimentary rocks of the Hyland Group host intrusive-related veins on Antimony Mountain, and may act as a passive host for intrusive-related replacement mantos and other deposits. These will be discussed below in conjunction with the Tombstone Suite Intrusions.

CAMBRIAN AND ORDOVICIAN VOLCANIC ROCKS (MAP UNIT 4)

These volcanic rocks are probably related to Early Paleozoic rifting and are in the same stratigraphic position as the Late Cambrian Menzie Creek volcanics which overlie the shale-hosted sedex lead-zinc-silver deposits at Faro (Minfile 105K 061 etc). They outcrop along the Chandindu River and have the potential to host copper and zinc-rich volcanogenic massive sulphide lenses similar to those found in older Proterozoic volcanic rocks at Hart River (Minfile 116A 009). No showings of this type have been found in the Tombstone area to date.

LATE CAMBRIAN? SILTSTONE AND SHALE (MAP UNIT 5)

This unit is believed to be roughly contemporaneous with the Unit 4 volcanics and is probably equivalent to the Late Cambrian Vangorda Formation which hosts the Faro sedex zinc-lead-silver deposits (Minfile 105K 061 etc). No massive sulphide showings have been reported from this unit in the Tombstone area to date.

ROAD RIVER GROUP

The Road River Group hosts the 362 million tonne shale-hosted lead-zinc-silver deposit at Howards Pass (Minfile 105I 012), and similar deposits should occur elsewhere in Selwyn Basin. The Styx property (Minfile 116B 047) covers a showing of this type immediately west of the Tombstone map area. It was staked on a stream sediment anomaly, and detailed soil geochemistry outlined two copper-lead-zinc-silver anomalies in black Road River Group slate and argillite. One of three drillholes testing EM conductors intersected 1.5 m of massive pyrite, but no other minerals were found.

Within the map area, the only similar showings found to date are in the overlying Earn Group, but reconnaissance surveys have been hampered by permafrost and poor exposure. Drilling on the Blackstone occurrence (Minfile 116B 132) intersected structurally controlled high grade lead-silver veins in Road River chert and argillite north of the proposed park. The veins consist of quartz, siderite and galena, and could possibly be feeders to a sedex deposit, but are more likely related to Cretaceous intrusions nearby.

EARN GROUP

This unit hosts the Tom and Jason sedex lead-zinc-silver deposits (Minfile 105O 001, 019) at Macmillan Pass, and numerous other lead-zinc-silver and barite occurrences in Yukon and Northern B.C. Because Earn Group rocks have only recently been recognized in the proposed park area it is likely that the potential for base metal occurrences was underestimated. Recent excavations on the Brewery Creek deposit (Minfile 116B 160), which lies 45 km south of Tombstone Mountain, exposed a thick sequence of unmapped Earn Group strata including 15 m of bedded barite, and an overburden drillhole elsewhere on the property intersected black shale containing 3% Zn (R. Diment, personal communication).

North of Mayo, a thin, high grade sedex nickel-zinc horizon with anomalous platinum, silver, gold and other elements occurs in Earn Group-equivalent strata at the Nick property (Minfile 106D 092) and although it has proved uneconomic to date, exploration has shown that the anomalous horizon is widespread across the Selwyn Basin. Government stream sediment geochemical data show that a similar metalliferous horizon extends across the north part of the Tombstone map area (Appendix 1).

Two hundred kilometres east of the Tombstone area, metavolcanic rocks in the Earn Group contain volcanogenic massive sulphide lenses on the Marg property (Minfile 106D 009) with a total of 3.4 million tonnes grading 9.5% Cu-Pb-Zn and 65 g/t Ag and 1.2 g/t Au. Similar volcanic rocks have recently been recognized in the upper part of the Earn Group sequence at Brewery Creek, 45 km southeast of Tombstone Mountain, and may occur in the area north of the proposed park.

A significant barite deposit occurs on the Rein property, in the northeast corner of the map area. Milchem, a Houston based drilling mud manufacturer, intersected up to 40 m of massive barite in drillholes, but no reserves have been published. Barite is an industrial mineral used in drilling mud. Stream sediment geochemistry suggests that barite potential in the area of the proposed park is low.

KENO HILL QUARTZITE

In the Keno Hill area, this unit is the host rock for high grade silver-lead-zinc veins, which were mined between 1921 and 1988. Similar veins cut Keno Hill Quartzite on the south side of Tombstone Mountain and were mined briefly in 1920. Because these veins are believed to be related to Cretaceous intrusive activity, they will be described below under Tombstone Plutonic Suite.

TAHKANDIT FORMATION

This unit hosts the Marn copper-gold skarn on the west margin of the Mt Brenner Stock. It may also have potential to host replacement mantos and Carlin-type gold deposits. Because these deposits are related to intrusive activity they will be discussed under Tombstone Plutonic Suite.

TRIASSIC LIMESTONE

This unit may form skarns related to buried intrusions. Away from intrusions, this unit could host massive sulphide replacement mantos or Carlin-type gold deposits. Because these deposits relate to Cretaceous igneous activity, they will be discussed under Tombstone Plutonic Suite.

GABBROIC INTRUSIONS

Triassic diabase and gabbro are likely to contain some disseminated chalcopyrite, and several copper-cobalt anomalies south of Tombstone Mountain probably originate from these sills. However, the absence of ultramafic cumulates at the base of the sills suggests that magmatic copper-nickel sulphide deposits of the Wellgreen type are unlikely.

TOMBSTONE INTRUSIONS

The Tombstone intrusions are enriched in a large number of elements including gold, arsenic, antimony, molybdenum, bromine, fluorine, uranium, thorium and rare earths. They could be both a source and a host for a number of different types of mineral deposits including porphyries, skarns, and precious metal and rare earth veins and replacement deposits.

1. Porphyry Deposits

These are large, low to medium grade deposits formed in and around high level intrusions as late-stage water-rich fluids are expelled from a cooling magma. The late stage fluids are enriched in metals like copper, molybdenum, gold, tungsten, uranium and tin, which crystallize as disseminations in the host rock or in late stage veins and stockworks formed by shrinkage of the outer shell of the intrusion. Typical porphyry deposits are concentrically zoned, with an inner zone of silicification and potassic alteration and successive outer zones of sericite alteration, kaolinite alteration and propylitic alteration. Beyond the intrusive contact, veins of lead, zinc, manganese, silver and gold may extend far into the wall rocks. Granite-hosted gold and uranium deposits differ from the standard porphyry model but the term "porphyry" has been assigned to both based on their size and association with felsic intrusive rocks.

Porphyry molybdenum, tungsten and tin deposits are typical of the outer side of a continental arc. Several multi-element geochemical anomalies in the Tombstone area may be related to porphyry deposits. Porphyry-style molybdenum and copper mineralization has been found in float at several locations (J. Duke and W.D. Eaton, personal communication), and the potential for porphyry molybdenum and tungsten is substantiated by stream sediment geochemistry and descriptions of mineralized veins cutting the Tombstone Stock.

Although tin is associated with similar plutons in the McQuesten Area, tin mineralization has not been documented in the Tombstone area. Tin was not assayed in stream sediment samples, but limited lithogeochemical data suggests that the background values for tin in the Tombstone area rocks are an order of magnitude smaller than tin-bearing granites near Fairbanks (Wilkinson, 1987). Tin potential can not be completely discounted, as the Zeta deposit 100 km to the southeast contains almost a million tonnes of silver-tin mineralization in greisen zones which cut a zoned syenite-monzonite intrusion similar to the Tombstone Stock in both age and composition.

Porphyry uranium mineralization is known to occur on Tombstone Mountain and Mt Brenner, and porphyry gold deposits are a relatively new type of target which appears to have good potential in the Tombstone area based on high grade gold-bismuth veins which cut the Tombstone Stock.

(a) "Porphyry" Uranium Deposits

Porphyry uranium deposits resemble porphyry copper deposits, but lack the characteristic alteration patterns. Typical host rocks are granite, alkali granite and syenite. They may occur in either I or S-type granitic rocks, but are more common in the latter which are derived from the partial melting of crustal rocks. The uranium is typically concentrated with tin, molybdenum and fluorine in late stage fluids and precipitates as disseminated uraninite or as late magmatic veinlets similar to chalcopyrite veinlets in a porphyry copper deposit.

Uranium deposits of this type are numerous worldwide, and include the largest single deposit of uraninite known in the earth's crust and the world's largest uranium mine, at Rossing, South West Africa. Grades at Rossing range from 30 to 1000 ppm U, and reserves of several hundred million tonnes have been outlined to a depth of 500 m, making this a deposit of crucial geopolitical significance (Guilbert and Park, 1986).

The large, low grade Tombstone deposit on the southwest flank of Tombstone Mountain incorporates a number of occurrences (Minfile 116B 57, 102, 109, 150, 151) and may be the largest single uranium resource in Canada. Like other deposits of its type, the grade is highly variable and the average grade is low, but the ore can be upgraded using modern concentrating techniques. Numerous showings indicate the potential for high grade zones, including a small zone in Spotted Fawn Cirque where a preliminary reserve of 27 000 tonnes grading 0.232% U_3O_8 was estimated based on trenching and diamond drilling.

Regional geochemistry and a study of the Tombstone intrusion by Olade and Goodfellow (1978) suggest undiscovered uranium resources may be present on the south side of the Tombstone River valley and near the head of the Blackstone River.

The former Nebulous claims covered a porphyritic monzonite phase of the Mt Brenner stock which is also radioactive. At two locations, joints and fractures in the monzonite coated with secondary uranium minerals. Assays were as high as 1.1% U_3O_8, and a chip sample averaged 0.015% U_3O_8 over 10 m. About half of this grade is believed to be due to secondary enrichment.

(b) "Porphyry" gold deposits

The most significant potential in the Tombstone area is for bulk tonnage granite-hosted "porphyry" gold deposits similar to the 3.6 million ounce Fort Knox deposit near Fairbanks, Alaska, and the Dublin Gulch deposit (Minfile 106D 025), located 120 km southeast of the study area. The intrusion hosting the Fort Knox deposit has the same radiometric age as the Tombstone Stock (92 Ma - J. Mortensen, personal communication) and is characterized by a similar association between gold and bismuth.

At Fort Knox, gold occurs with bismuthinite in fine quartz stockworks and along sheared northeast-trending quartz veins which cut unaltered granite (Bakke, 1991). The veins are up to 3 m wide are spaced about 9 m apart throughout the intrusion. The veins are high grade, averaging about 223-257 g/t Au, but because of the low vein density, the average grade of the deposit is only 0.82 g/t Au. The veins are syntectonic late-stage features associated with siliceous pegmatites which also contain gold. The Fort Knox deposit is being developed for production in early 1994, using an upgrading technique which separates the sheared gold-bearing quartz from the more resistant barren granite by a centrifuging process.

Archer, Cathro and Associates (1981) Ltd described veins of this type on the Tombstone property in 1988, obtaining significant gold values from every vein sampled. Analyses of quartz veins from the Tombstone and Teta showings (Minfile 116B 151,152) show a strong relationship between gold and bismuth similar to that seen at Fort Knox (Fig. 15). The showings occur in difficult terrain on the southwest flank of Tombstone Mountain, and outlining and mining such a deposit would be difficult in this area.

(c) Porphyry copper-molybdenum-gold deposits

On the Marn property, some copper porphyry mineralization was found in float (J. Duke, personal communication). Because of the rugged terrain the source was not found. Due to the amount of uplift and glaciation there is no possibility of a finding a leached cap or supergene zone, but large reserves of hypogene mineralization are possible. Similar mineralization was reported on the Tombstone property (W.D. Eaton, personal communication), and molybdenum is common along late-stage fractures in the Tombstone stock. Deposits of this type are well known in other parts of Yukon (Casino, Red Mountain, Logtung).

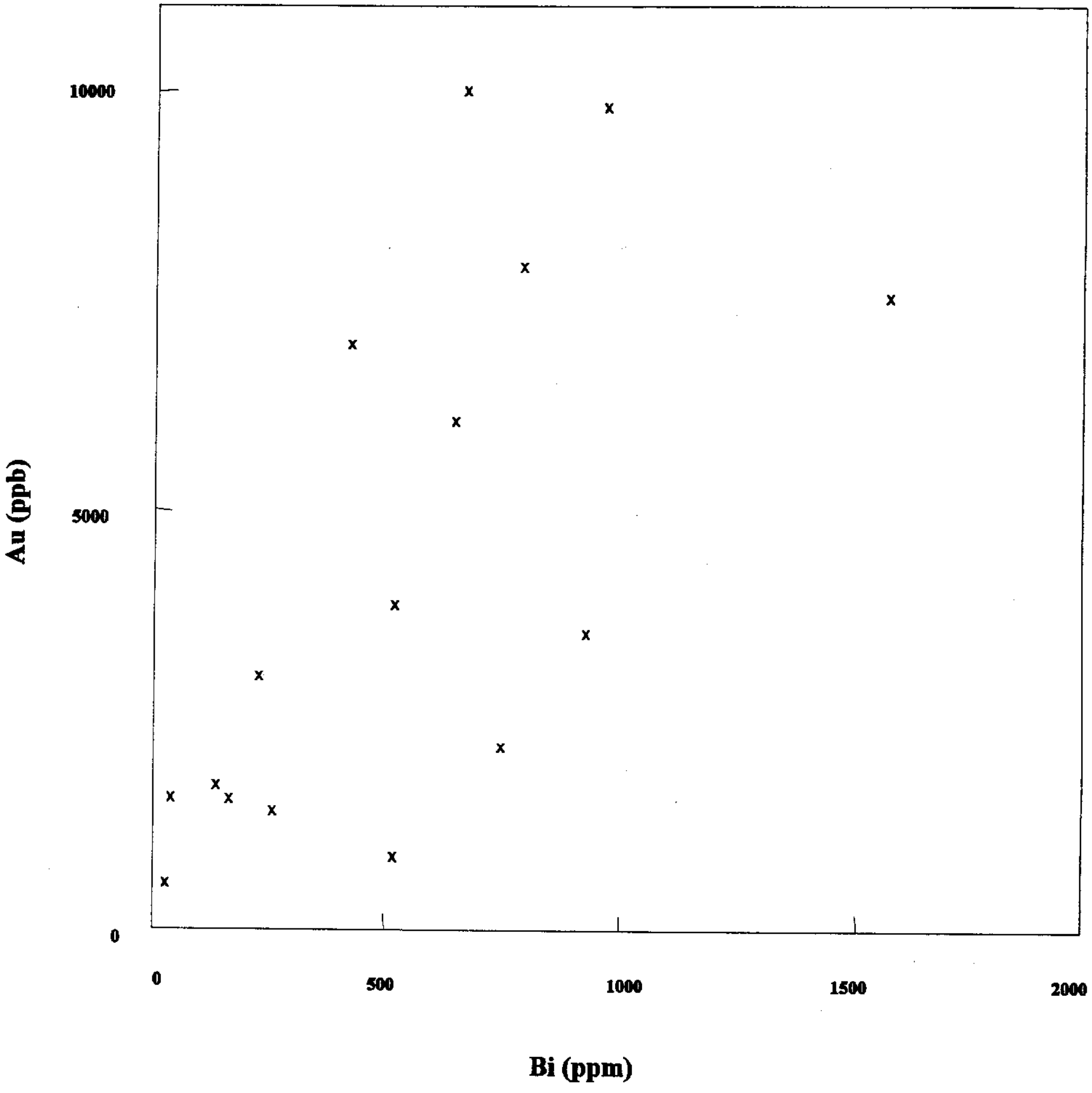


Fig. 15. Plot of gold vs bismuth for Tombstone Mountain veins

Data from assessment report 092674 with permission from Archer, Cathro & Associates (1981) Ltd

2. Other disseminated gold deposits

Disseminated gold deposits which are intrusive-related but do not fit the standard porphyry model are rapidly becoming an important exploration target, but are still poorly understood. They are difficult to recognize as the gold is extremely fine grained (may be micron-sized) and may have no significant sulphides associated with it. The gold may occur in a variety of rock types including igneous dykes, sandstone and silicified limestone. Grades are typically in the 1-2 g/t range and mining these deposits economically depends on upgrading the ore or developing new processing technologies like heap leaching and bioleaching.

In 1991 gold and disseminated arsenopyrite was discovered in a wide shear zone cutting silicified Hyland Group argillite near the contact of the Josephine Stock in the Clear Creek area (Minfile 115P 011) during exploration of a porphyry gold target. Preliminary results indicated anomalous gold values across a width of 160 m, including 2.11 g/t Au across 24 m which contained a high grade section grading 6.05 g/t across 5 m.

Similar deposits may occur near intrusive contacts in the Tombstone area, particularly in limy units. For example, Hyland Group sandstone outcropping along the Chandindu River (Tempelman-Kluit's Unit 3) may be a suitable host due to its calcareous cement which could be replaced by silica and gold to form a Carlin-type bulk tonnage deposit.

Another recent discovery of this type in Yukon is the 15 million tonne Brewery Creek gold deposit (Minfile 116B 160) hosted by shallow subvolcanic sills the same age as the Tombstone intrusions. The deposit is located about 45 km southeast of Tombstone Mountain and was discovered by Noranda in 1987 as a result of following up a weak mercury stream sediment anomaly in an overburden-covered area. Soil samples in the area returned values up to 2000 ppb Au, and subsequent trenching exposed a swarm of high level quartz monzonite porphyry sills which are silicified and mineralized with micron-sized gold where they are cut by north-northwest, northeast and east-trending shear zones. Drilling has indicated 11 million tonnes of mineable oxide reserves grading 1.85 g/t Au and the feasibility of a small heap leach operation is currently under study.

Soil geochemistry has been the most successful exploration tool on the Brewery Creek property, as gold, arsenic, antimony and mercury are strongly anomalous over the deposit. Stibnite veins are closely associated with gold mineralized areas. Potential for Brewery Creek type deposits in the Tombstone area is indicated by extensive gold and arsenic stream sediment anomalies and an identical pattern of shear zones suggested by air photo lineaments.

On the ridge overlooking the Tombstone River valley at the south end of the Marn property, Noranda Exploration Co. Ltd discovered narrow, gold-bearing dykes of intermediate composition. This occurrence has not previously been documented and is included with Noranda's permission. The gold occurs with pyrite and arsenopyrite and values are in the 1-2 g/t range (J. Duke, personal communication). Processing of this kind of material may become feasible in the future as a result of new technology such as bioleaching.

3. Rare earth pegmatites and metasomatic veins

Pegmatites consist of the late stage, volatile-rich portion of a magma, enriched in silica, alumina, water, halogens, alkali metals and elements not easily accommodated by common rock forming silicate minerals, such as beryllium, uranium, and rare earth elements. They are important sources of beryllium, lithium, rubidium, cesium, tantalum, niobium, and lesser sources of uranium, thorium, rare earth elements, molybdenum, tin and tungsten. They are also a major source of many gemstones and saleable mineral specimens including emeralds, topaz and tourmaline. Rare earth pegmatites of this type are mined in New Mexico. Studies have shown that commercial pegmatites are generally formed by metasomatism and replacement of wall rocks by residual fluids which travelled along fractures (Guilbert and Park, 1986).

A significant metasomatic vein deposit of this type is already known in Yukon, the Nokluit showing near Ketza River (Minfile 105F 080). Mapping by J. Dodge in 1991 showed that radioactive and rare earth elements are concentrated in a 3 to 8 m wide silicified and carbonatized zone in a metasomatized syenite dyke similar to Tombstone area rocks. Along the mineralized zone the syenite is altered to an almost featureless quartz-carbonate rock with relict trachytic texture. Assays range up to 3200 ppm Th, 74 ppm U, 2000 ppm Ce, 2000 ppm La, 2000 ppm Nd, 2000 ppm Y and 0.95% Cb_2O_5, and a chip sample contained 1.2% rare earth elements and 0.5% niobium across 10 m.

Strong rare earth element anomalies suggest the presence of similar deposits in the Tombstone area. Assays from the east showing on Mt Brenner returned up to 0.107% U_3O_8, 0.58% ThO_2, 2% K, 1000 ppm Ce, 300 ppm La, 30 ppm Tb, 15 ppm Sc and 100 ppm Y from fractured, magnetite bearing monzonite, but in general uranium and rare earth elements show a weak correlation in the Tombstone area and rare earth targets, which are generally small and inconspicuous, have not been adequately explored.

4. Skarns

With several limestone units in the stratigraphic sequence and numerous small stocks, the Tombstone area has good potential for high grade skarn deposits formed by contact metasomatism of the limestone at intrusive contacts. Surface exposures have been well prospected for skarn deposits, but possible targets are indicated by several untested geophysical anomalies.

Limestone units have a limited distribution in the area. Hyland Group limestone occurs only near Antimony Mountain and at the mouth of Little Twelve Mile River. The Tahkandit limestone occurs in a narrow belt on the west side of the map area, and the Triassic limestone unit is restricted to the hanging wall of the Robert Service Thrust and an area near the confluence of Horsetrack Creek and Tombstone River. Even in areas away from mapped intrusive contacts, skarns may have formed in limestone which overlies buried intrusions.

(a) Copper-gold skarns
The Marn deposit described earlier in the report provides evidence for copper-gold skarn deposits in the Tombstone area. A deep geological target on the south part of the Marn property remains untested, and similar skarns were explored on the Trix claims (Minfile 116B 056), where a roof pendant of Triassic limestone occurs in the central part of the Tombstone stock. Although barren, skarns on the Trix property are cut by several kinds of sulphide-bearing veins which contained pyrite, chalcopyrite, galena, molybdenite and arsenopyrite. It appears that these veins on the Trix property were never assayed for precious metals.

(b) Tungsten skarns
In the McQuesten area, 150 km to the southeast, tin and tungsten-bearing greisens, veins and skarns are related to intrusions similar in chemistry to the Tombstone area plutons. At Ray Gulch (Minfile 106D 027), reserves of 7.3 million tonnes grading 0.87% WO_3 are contained in a buried skarn deposit near the margin of a Cretaceous stock. Tungsten is strongly anomalous in stream sediments in the Tombstone area, and tungsten skarns could be hosted by any of the calcareous sedimentary rocks.

5. Replacement mantos

Base metal and gold replacement mantos related to intrusive activity occur in several areas of Yukon. Examples include a lead-zinc-silver replacement manto in Hyland Group limestone on the Clark property north of Mayo (Minfile 106D 011), the Ketza River gold deposit hosted by Lower Cambrian limestone near Ross River (Minfile 105F 019), and the McMillan lead-zinc-silver deposit (095D 006) and the Hyland Gold deposit (Minfile 095D 011) both hosted by Hyland Group limestone east of Watson Lake.

Several limestone units in the Tombstone area could contain deposits of this type. However, the limestone units have a limited distribution, lead and zinc silt values are low near the intrusions, and in no showings of this type have been recognized in the area to date.

6. Tin Greisens

Tin is concentrated in late magmatic, alkali and volatile-rich phases of S-type two mica intrusions with accessory garnet, similar to the Tombstone suite plutons. Low Sr and Ba values, and anomalously high Li, B, Be, Rb and F are regarded as good indicators of tin potential. Typical tin targets consist of small bodies of quartz, fluorite, calcite and cassiterite enclosed in subcircular greisen envelopes, which form small, easily overlooked targets. In the Tasmanian tin deposits, for example, the tin-rich phase makes up only 2% of the intrusion by volume (Guilbert and Park, 1986).

In the Tombstone area, the presence of abundant tungsten, molybdenum and bismuth and favourable granite composition suggest a suitable environment for tin greisens. Tin was not analysed as part of the stream sediment survey, but is included in a lithogeochemical study of Selwyn Basin plutonic rocks by Garrett (1974). Garrett's highest tin value in Tombstone area plutons based on 108 analyses was 4.9 ppm (Appendix B), which compares unfavourably with an average value of 15 ppm Sn for tin granites worldwide, and 22 ppm Sn in tin-bearing plutons of the Hope Intrusive Suite near Fairbanks, Alaska (Burns and Newberry, 1987). A correlation matrix (Appendix B) shows that tin correlates negatively with tin and silicon, aluminum, sodium and potassium in Tombstone area plutonic rocks, and a strong positive correlation with calcium, magnesium, iron, titanium and manganese, suggesting that any tin in the area occurs in skarns and not in the granitic rocks. The lithogeochemical map for tin shows several anomalous values adjacent to the Marn copper-gold-tungsten skarn on the northwest flank of Mt Brenner.

A significant tin deposit occurs in an intrusion of similar composition in the McQuesten area, about 150 km south of the proposed park. The Zeta deposit (Minfile 115P 047) contains almost a million tonnes grading 0.1% Sn in three parallel greisen zones cutting a zoned granite-monzonite-syenite intrusion. The Zeta intrusion is the same age as the Tombstone Stock and has a similar composition, so the tin potential of the Tombstone area can not be completely discounted.

7. Precious metal veins

(a) Silver-lead-zinc veins

Keno Hill Quartzite is the host rock for high grade silver-lead-zinc veins in the Keno Hill district, which were mined between 1921 and 1988. Almost 68 billion grams of silver, 274 million kg of lead and 153 million kg of zinc were produced before mining ceased in 1989 due to low silver prices. Abercrombie (1990) reported similar lead isotope ratios for feldspars from the Zeta deposit and galena from the Keno Hill Quartzite, suggesting that mineralization at Keno Hill may have been derived from local intrusions.

The potential for silver-lead-zinc veins in the Tombstone area has been known since the discovery of the Silver Fawn occurrence (Minfile 116B 057) in 1901. Much of the proposed Tombstone park is underlain by Keno Hill Quartzite, and the area has been fairly thoroughly prospected for high grade silver veins, but detailed soil geochemistry in areas of poor exposure would probably reveal more. Strong silver anomalies in stream sediments northeast of Tombstone Mountain are likely derived from undiscovered veins of this type.

Similar high grade silver-lead-zinc-gold veins on the Blackstone property (Minfile 116B 132) show that other lithologies may also host high grade silver veins. However, the Blackstone veins are narrow, suggesting that the Road River Group argillite on this property is a less favourable host than the brittle Keno Hill Quartzite.

(b) Gold veins

High grade quartz-gold-arsenopyrite veins occur in east-west shear zones cutting Hyland Group rocks near the Antimony Mountain stock, but so far these appear to have limited tonnage potential (drilling on Index Showing (Minfile 116B 001) outlined 9072 tonnes grading 20.6 g/t Au). Similar veins, however, occur peripheral to the Fort Knox gold porphyry deposit in Alaska, and quartz-arsenopyrite-gold veins have also been found near the Marn copper-gold skarn deposit (Minfile 116B 147).

8. Gemstones

Syenitic intrusions like the Tombstone stock typically have good potential for several kinds of gemstones such as ruby, sapphire, emerald and topaz (D.J. Ouellette, personal communication). The gemstones can occur in the syenite, in contact metamorphosed shale, or in contact-metamorphosed limestone, or may be found in alluvial deposits derived from such rocks (Read, 1980). Specimen-quality molybdenite has been collected from veins on Tombstone Mountain, but no prospecting for gemstones has been reported.

QUATERNARY GRAVELS

Valleys in the Tombstone area were glaciated three times during the Pleistocene, and outwash gravels to the south show evidence of a complex glacial history. Because of the glaciation, stream gravels in the area are unlikely to contain rich placer deposits, and none are known. However, post-glacial sediments are likely to contain weak placers which could be a valuable prospecting tool for tin, tungsten, gold and gemstones. Tungsten and tin-bearing placers led to the discovery of tin and tungsten showings in the McQuesten area (Minfile 115P 004 etc.)

MISCELLANEOUS

Because of recent activities in the Northwest Territories, the possibility of diamond-bearing kimberlites and lamproites in any area with a continental basement should at least be mentioned. Erdmer and Downing (1992) reported that alluvial diamonds have been recovered by placer operations in Alaska and in the Klondike district and that indicator minerals have been reported from several areas of Yukon. Erdmer and Downing suggested that all of Yukon east of the Tintina Fault has a high potential for diamond exploration, particularly in areas close to deep faults and other lineaments. The Tintina trench and parallel, or splay faults related to it are of particular interest. The Tombstone area lies close to the Tintina Trench, and a the presence of a deep-seated structure parallel to the trench is suggested by the alignment of Tombstone area plutons.

Both kimberlites and lamproites have elevated levels of uranium, potassium and thorium compared to most crustal rocks, and can be detected by radiometric surveys if exposed at surface. However, they are normally small, recessive-weathering targets (0.4-200 ha) and other detection methods like remote sensing and low-level airborne magnetic and electromagnetic surveys are more likely to be used in areas with significant overburden.

The suggestion that diamonds may occur in the Tombstone area is highly speculative, but until heavy minerals from Tombstone area streams have been examined for diamond indicator minerals it can not be discounted.

CONCLUSIONS

Available geochemical and geophysical data suggest that the Tombstone area has unusually good potential for large mineral deposits related to the Cretaceous intrusions. Geochemical maps of 116BC and the south half of 116G show 90th to 95th percentile anomalies for many elements centred on the Tombstone Suite intrusions, and a number of significant mineral occurrences have been documented, including high grade silver and gold veins, copper-gold tungsten skarns and a large uranium deposit, all of which occur in or close to the proposed park. Mining companies have noted altered and hornfelsed rocks in areas underlain by sedimentary strata which are evidence of shallow buried intrusions. High grade gold-bismuth veins on Tombstone Mountain strongly resemble those which form the large gold porphyry deposits at Dublin Gulch and Fort Knox. Carlin-type gold replacement deposits are possible in the area due to the presence of at least four limy horizons in the stratigraphic section, and have not been looked for to date. North of the proposed park, the Tombstone area also has potential for syngenetic base metal deposits in Lower Paleozoic sedimentary rocks, including a broad sedex nickel target in the Earn Group.

The argument that any significant deposits in the Tombstone area would have been found by previous exploration is not defendable in the light of recent discoveries and new mineral deposit models. The Brewery Creek gold deposit located 45 km to the southeast had no surface expression and was discovered by soil sampling as recently as 1987. The Dublin Gulch gold porphyry deposit in the Mayo district was discovered by drilling in 1990, after applying the newly developed Fort Knox model to an intensively explored area with many known showings. Even Earn Group sedimentary rocks which host large base metal deposits elsewhere in the Selwyn Basin were unrecognized in the Tombstone area until recently, and their nickel potential has not been investigated. A new exploration strategy would be required to fully explore this area, as some of the most desirable targets are not amenable to conventional prospecting.

Because of the elevated topography and good exposure in the central area of the proposed park, it has been suggested that most mineral deposits should have already been found. However, a surficial geology map shows only 7.4% bedrock exposure, much of it forming inaccessible cliffs and pinnacle ridges which provide the spectacular scenery. Most of the area is covered with colluvium, rock glaciers and moraine deposits, making the area difficult to explore. Prospective Lower Paleozoic strata are poorly exposed, and deep permafrost underlies all but south slopes.

Stakeholders in the area indicate that the present lack of activity in the Tombstone area is due in part to low metal prices and in part to the "Tombstone Recreational Reservation" boundary which has appeared on Yukon Minfile (formerly Northern Cordillera Mineral Inventory) maps for many years. It is not due to a perceived lack of mineral potential. The proposal to create parks in prospective areas of Yukon and NWT is listed by the Canada Mines and Minerals Yearbook (1983-84) as a factor in the rapid decline of uranium exploration in Canada in the early 1980's.

Thorough exploration of the mineral potential in the area would require an update of the geological mapping; more geochemical analyses, particularly tin, bismuth and mercury; airborne EM surveys to identify massive sulphide targets; gamma ray surveys to outline areas of potassic alteration which could be related to porphyry centres; and heavy mineral sampling to look for gold, tin and tungsten concentrations, gemstones and diamond indicator minerals.

ACKNOWLEDGEMENTS

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REFERENCES:

ABBOTT, J.G., GORDEY, S.P., AND TEMPELMAN-KLUIT, D.J., 1986. Setting of stratiform, sediment-hosted lead-zinc deposits in Yukon and northeastern British Columbia. In: Mineral Deposits of Northern Cordillera, J.E. Morin (ed.), Canadian Institute of Mining and Metallurgy Special Volume 37, p. 1-18.

ABBOTT, J.G., 1992. Revised stratigraphy and new exploration targets in the Hart River Region (NTS 116A/10, 116A/11), Southeastern Ogilvie Mountains. In: Yukon Exploration and Geology, 1992, Exploration and Geological Services Division, Yukon, Indian and Northern Affairs Canada, p. 13-23.

ABERCROMBIE, S., Feb. 1990. Petrology, geochronology and economic geology: the Zeta Sn-Ag prospect, Arsenic Ridge, West Central Yukon (115P/14, 116A/3). Unpublished MSc thesis, University of British Columbia.

ACHERON MINES LTD, Nov/75. Assessment Report #090123 by F. Holcapek.

ANACONDA EXPLORATION LTD, Mar. 1980. Assessment Report #090552 by C. Roots, K. Baldry and G.G. Carlson.

ANDERSON, R.G., 1988. Plutonic rocks in the Dawson map area, Yukon Territory. In: Current Research, Part A, Geological Survey of Canada Paper 87-1A, p. 689-697.

ANDERSON, R.G., 1988. An overview of some Mesozoic and Tertiary plutonic suites and their associated mineralization in the Northern Canadian Cordillera. In: Recent Advances in the Geology of Granite-Related Mineral Deposits, R.P. Taylor and D.F. Strong (eds); Canadian Institute of Mining and Metallurgy Special Volume 39, p. 96-113.

ARCHER, CATHRO AND ASSOCIATES LTD, Feb. 1979. Assessment Report #090443 for Ukon Joint Venture by A.R. Archer.

ARCHER, CATHRO AND ASSOCIATES (1981) LTD, Oct. 1988. Assessment Report #092674 by W.D. Eaton.

ARCHER, CATHRO AND ASSOCIATES LTD, December 1980. Assessment Report #090708 for Ukon Joint Venture by W.D. Eaton.

ARCHER, CATHRO AND ASSOCIATES LTD, Jan. 1977. Assessment Report #090183 by A.R. Archer and E.P. Onasick.

ARCHER, CATHRO AND ASSOCIATES LTD, Jan. 1977. Assessment Report #090184 by A.R. Archer and E.P. Onasick.

ARCHER, CATHRO AND ASSOCIATES LTD, Dec. 1977. Assessment Report #090271 by A.R. Archer.

ARCHER, CATHRO AND ASSOCIATES LTD, Dec. 1977. Assessment Report #090273 by A.R. Archer.

ARCHER, CATHRO AND ASSOCIATES LTD, Feb., 1980. Assessment Report #090561 by A.R. Archer and E.P. Onasick.

BAKKE, A., November 1991. Update on the Fort Knox Gold Deposit. Presentation and core display at Whitehorse Geoscience Forum.

BERGER, B.R., AND BONHAM, H.F., JR., 1989. Epithermal gold-silver deposits in the Western United States: time-space products of evolving plutonic, volcanic and tectonic environments. Journal of Geochemical Exploration, Vol. 36, p. 103-142.

BURNS, L.E., AND NEWBERRY, R.J., 1987. Intrusive rocks of the Lime Peak-Mt Prindle area. In: Mineral Assessment of the Lime Peak-Mt Prindle Area, Alaska; T.E. Smith, G.H. Pessel and M.A. Wiltse (eds), State of Alaska Department of Natural Resources, Division of Geological and Geophysical Surveys, p. 3-1 to 3-83.

CANADIAN MINERALS YEARBOOK, 1983-1984. Energy, Mines and Resources Canada.

CODY HAWK RESOURCES INC., June, 1983. Assessment Report #092041 by H.J. Hodge.

CROWSON, P., 1991. Minerals Handbook 1990-91. Statistics and analyses of the World's mineral industry. Stockton Press.

DAWSON, K.M., 1990. Regional geological setting of selected mineral deposits of the Northern Cordillera. In: Mineral Deposits of the Northern Canadian Cordillera, J.G. Abbott and R.J.W. Turner (eds), 8th IAGOD Symposium Field Trip Guidebook, Geological Survey of Canada Open File 2169.

EMOND, D.S., 1992. Petrology and geochemistry of tin and tungsten mineralized plutons, McQuesten River Region, Central Yukon. In: Yukon Geology, Vol. 3, Exploration and Geological Services Division, DIAND, p. 167-195.

EMOND, D.S., and LYNCH, T., 1992. Geology, mineralogy and geochemistry of tin and tungsten veins, breccias and skarns, McQuesten River region (115P (North) and 105M 13), Yukon. In: Yukon Geology, Vol. 3, Exploration and Geological Services Division, DIAND, p. 133-159.

ERDMER, P., AND DOWNING, D., 1992. Geological, geochemical and geophysical exploration for diamonds in Yukon. Twentieth Annual Yukon Geoscience Forum, Summary seminar notes, 25 November, 1992.

FAIRBANKS GOLD MINING, INC., August 1992. Project description for the Fort Knox Mine.

GARRETT, R.G., 1974. Mercury in some granitoid rocks of the Yukon and its relation to gold-tungsten mineralization. Journal of Geochemical Exploration Vol. 3, p. 277-289.

GEOLOGICAL SURVEY OF CANADA. Regional stream sediment geochemistry for the Dawson map sheet. Open File 2365.

GOODFELLOW, W.D., AND JONASSON, I.R., 1977. Geochemical distribution of uranium, tungsten and molybdenum in the Tombstone Mountains Batholith, Yukon. Geological Survey of Canada Report of Activities, Part B, Paper 77-1B, p. 37-45.

GORDEY, S.P., AND ANDERSON, R.G., 1993. Evolution of the Northern Cordilleran Miogeocline, Nahanni Map Area (105I), Yukon and Northwest Territories. Geological Survey of Canada, Memoir 428.

GORDEY, S.P., AND THOMPSON, R.I., 1992. Structural styles, Ancestral North America. In: Geology of the Cordilleran Orogen in Canada, H. Gabrielse and C.J. Yorath (eds); Geology of Canada, No. 4. Decade of North American Geology Series, Geological Society of America, Vol. G-2, p. 625-630.

GREEN, L.H., 1972. Geology of Nash Creek, Larsen Creek, and Dawson map-areas, Yukon Territory. Geological Survey of Canada Memoir 364.

GUILBERT, J.M., AND PARK, C.F., JR., 1986. The Geology of Ore Deposits. W.H. Freeman and Company.

HULBERT, L., CARNE, R.C., GREGOIRE, D.C. and PAKTUNC, D., 1992. Sedimentary nickel, zinc and platinum group element mineralization in Devonian black shales at the Nick property, Yukon, Canada: a new deposit type. Exploration and Mining Geology, Vol. 1, p. 39-62.

LIVGARD CONSULTANTS LTD, Nov. 1990. Assessment Report #060246 for J. Hanna by E. Livgard.

MATTAGAMI LAKE MINES LTD AND NORANDA EXPLORATION CO. LTD, August 1979. Assessment Report #090523 by J. Biczok.

MATTAGAMI LAKE EXPLORATION LTD, 1981. Assessment Report #092982 by J. Biczok.

MATTAGAMI LAKE EXPLORATION LTD, December 1980. Assessment Report #090847 by J. Biczok and R. Kemp.

METALSWEEK, 1993. Pricing foldout for the week ending September 3, 1993.

MILCHEM INC., June 1980. Assessment Report #090617 by B.V. Templeton.

MOUNTAIN MINERALS LTD, October 1977. Assessment Report #090221 by S. Wise.

MURPHY, D.C., HEON, D., AND HUNT, J., 1993. Geological overview of Clear Creek map area, Western Selwyn Basin. In: Yukon Exploration and Geology 1992; Exploration and Geological Services Division, Yukon, Indian and Northern Affairs Canada, p. 61-69.

MURPHY, D.C., AND ROOTS, C., 1992. Geology of Keno Hill map area (105M/14). Exploration and Geological Services Division, Yukon, Indian and Northern Affairs Canada, Open File 1992-3, scale 1:50 000.

NEWBERRY, R.J., BURNS, L.E., SWANSON, S.W., AND SMITH, T.E., 1990. Comparative petrologic evolution of the Sn and W granites of the Fairbanks-Circle area, Interior Alaska. In: Ore-bearing Granite Systems: Petrogenesis and Mineralizing Processes; H.J. Stein and J.L. Hannah, eds; Geological Society of America Special Paper 246, p. 121-142.

NORANDA MINES LTD AND MATTAGAMI LAKE EXPLORATION LTD, August 1979. Assessment Report #090522 by J. Biczok.

NORANDA MINES LTD AND MATTAGAMI LAKE EXPLORATION LTD, August 1979. Assessment Report #090638 by J. Biczok.

NORANDA EXPLORATION CO. LTD, 1982. Assessment Report #091432 by J.L. Biczok.

NORANDA EXPLORATION CO. LTD, Jan. 1984. Assessment Report #091506 by J. Biczok.

NORANDA EXPLORATION CO. LTD, Feb. 1985. Assessment Report #091607 by W. Reid.

NORANDA EXPLORATION CO. LTD, 1986. Assessment Report #091814 by S.J. Mackay.

OLADE, M.A., AND GOODFELLOW, W.D., 1978 Lithogeochemistry and hydrogeochemistry of uranium and associated elements in the Tombstone Batholith, Yukon, Canada. In: Proceedings of the 7th International Geochemical Symposium, Golden, Colorado, J.R. Watterson and T.K. Theobold (eds), Association of Exploration Geochemists, p. 407-428.

PARRY, D., 1989. The petrographic analysis of the host rock and vaesite bearing horizon on the Nick property, Yukon Territory. Unpublished B.Sc. thesis, University of British Columbia.

RADIES, B., 1992. Alaska losing its chill at last. The Prospector, July/August 1992, p. 1-3.

READ, H.H., 1980. Rutley's Elements of Mineralogy (Twenty-sixth edition). Thomas Murby and Co., London.

ROSE, A.W., HAWKES, H.E., AND WEBB, J.S., 1979. Geochemistry in Mineral Exploration. Academic Press.

SAWKINS, F.J., 1990. Metal Deposits in Relation to Plate Tectonics. Springer-Verlag.

STANDARD OIL COMPANY OF BRITISH COLUMBIA LTD, July, 1976. Assessment Report #090115 by H.H. Wober.

STANDARD OIL COMPANY OF BRITISH COLUMBIA LTD, July, 1976. Assessment Report #090142 by H.H. Wober.

STRONG, D.F., 1986. A review and model for granite-related mineral deposits. In: Recent Advances in the Geology of Granite-Related Mineral Deposits, p. 424-445.

TEMPELMAN-KLUIT, D.J., 1969. A re-examination of pseudoleucite from Spotted Fawn Creek, West-Central Yukon. Canadian Journal of Earth Sciences, Vol. 6, p. 55-62.

TEMPELMAN-KLUIT, D.J., 1970. Stratigraphy and structure of the "Keno Hill Quartzite" in Tombstone Rive-Upper Klondike River map-areas, Yukon Territory (116B/7, B/8). Geological Survey of Canada Bulletin 180.

THOMPSON, R.I., AND ROOTS, C.F., 1982. Ogilvie Mountains project, Yukon: a new regional mapping program. Geological Survey of Canada, Paper 82-1a, p. 405-411.

TILTON, J.E., EGGERT, R.G., AND LANSBERG, H.H.(EDITORS), 1988. World Mineral Exploration: Trends and Economic Issues. Resources for the Future, Washington D.C.

TOTAL ENERGOLD CORP., Dec/89. Assessment Report #092787 by K. Pelletier and T. Tucker.

UNION MINIERE EXPLORATIONS AND MINING CORP. LTD, December, 1977. Assessment Report #090264 by A.A. Burgoyne.

UNION MINIERE EXPLORATIONS AND MINING CORP. LTD, April, 1977. Assessment Report #090195 on the Rein 7-50 claims by C.V. Dyson.

UNION MINIERE EXPLORATIONS AND MINING CORP. LTD, September 1977. Assessment Report #090375 on the Rein 51-60 claims by C.V. Dyson.

UNION MINIERE EXPLORATIONS AND MINING CORP. LTD, September 1977. Assessment Report #090229 on the Shyne claims by C.V. Dyson.

UNION MINIERE EXPLORATIONS AND MINING CORP. LTD, September 1978. Assessment Report #090375 on the Rein claims by A.A. Burgoyne and R.S. Tolbert.

URANGESELLSCHAFT CANADA LTD, September 1977. Assessment Report #090261 by J. Brophy.

URANGESELLSCHAFT CANADA LTD, June 1978. Assessment Report #062003 by J. Brophy.

URANGESELLSCHAFT CANADA LTD, October 1979. Assessment Report #062003 by J. B. Williams.

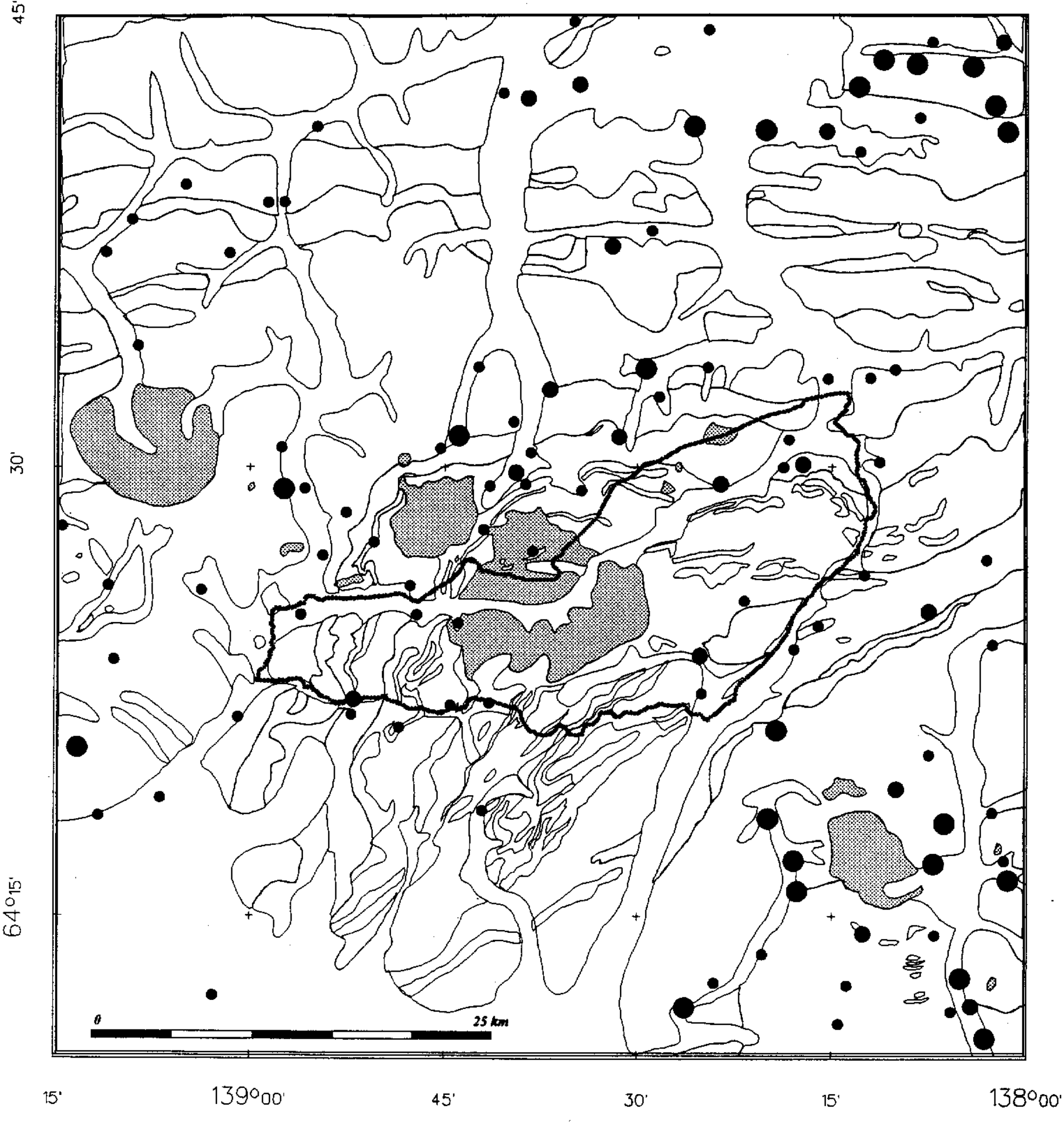
WILKINSON, K., 1987. Geology of a subarctic tin-bearing batholith, Circle Hot Springs, Alaska. MIRL Report No. 74, University of Alaska, Fairbanks.

YUKON MINFILE, 1993 UPDATE. Exploration and Geological Services Division, Indian and Northern Affairs Canada.

APPENDIX A

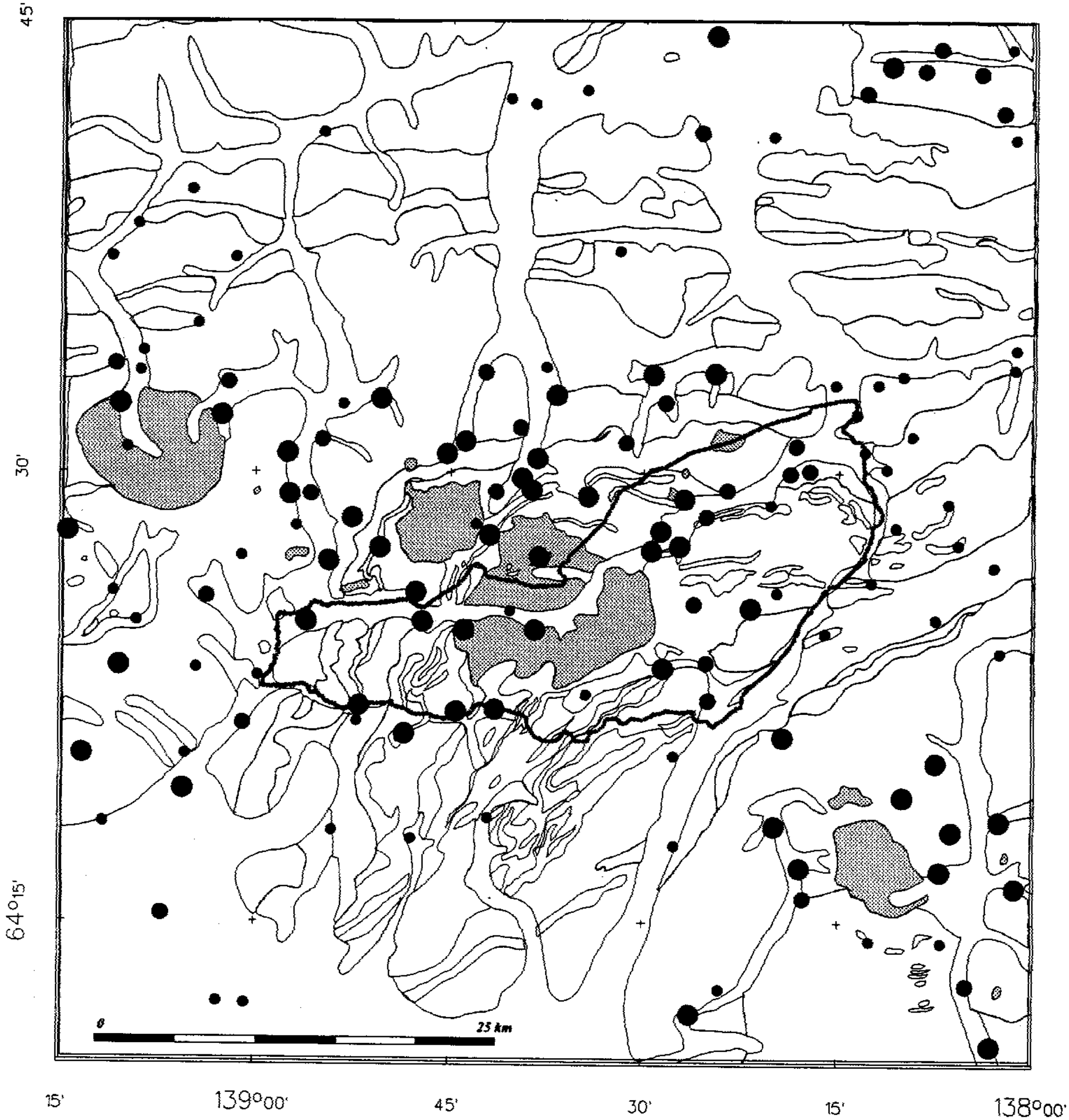
STREAM SEDIMENT GEOCHEMICAL DATA

SILT SAMPLE LOCATIONS (GSC OPEN FILE 2365)



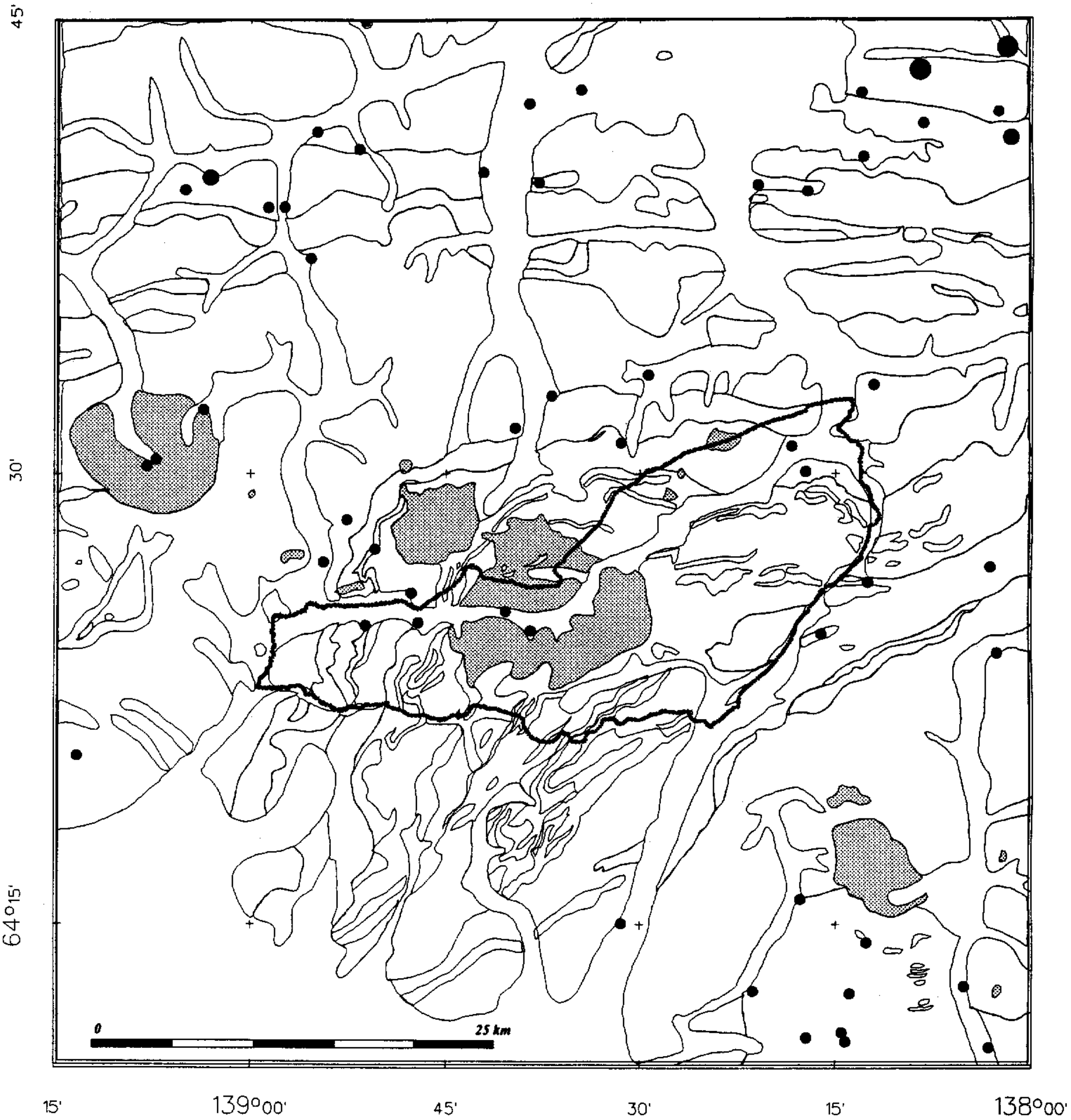
ANTIMONY IN STREAM SEDIMENT

●	*95 to 100th percentile*	*5.2-84 ppm*
●	*90 to 95th percentile*	*3.3-5.2 ppm*
•	*70 to 90th percentile*	*1.6-3.3 ppm*



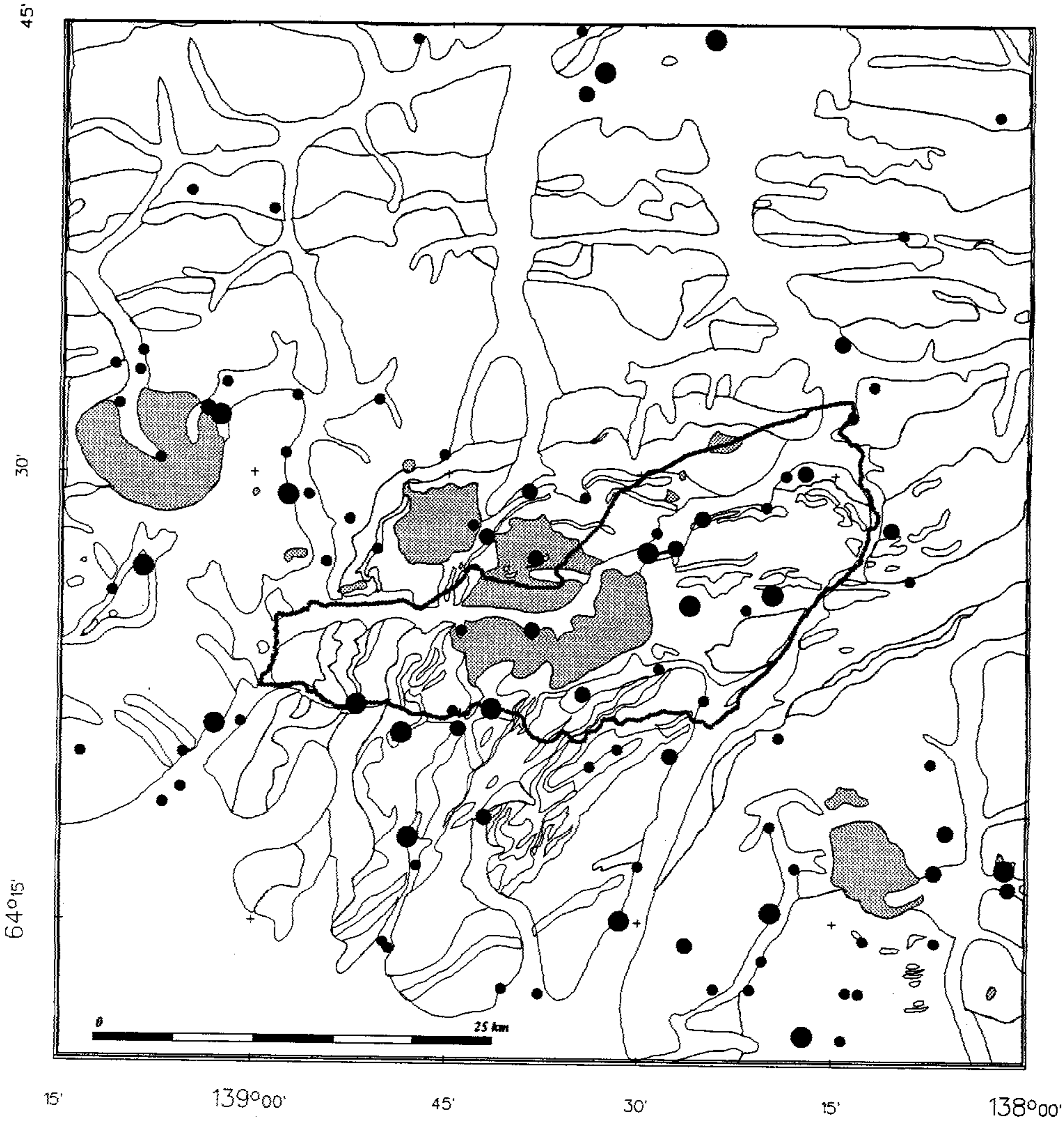
ARSENIC IN STREAM SEDIMENT

●	*95 to 100th percentile*	*34-670 ppm*
●	*90 to 95th percentile*	*23-34 ppm*
•	*70 to 90th percentile*	*14-23 ppm*



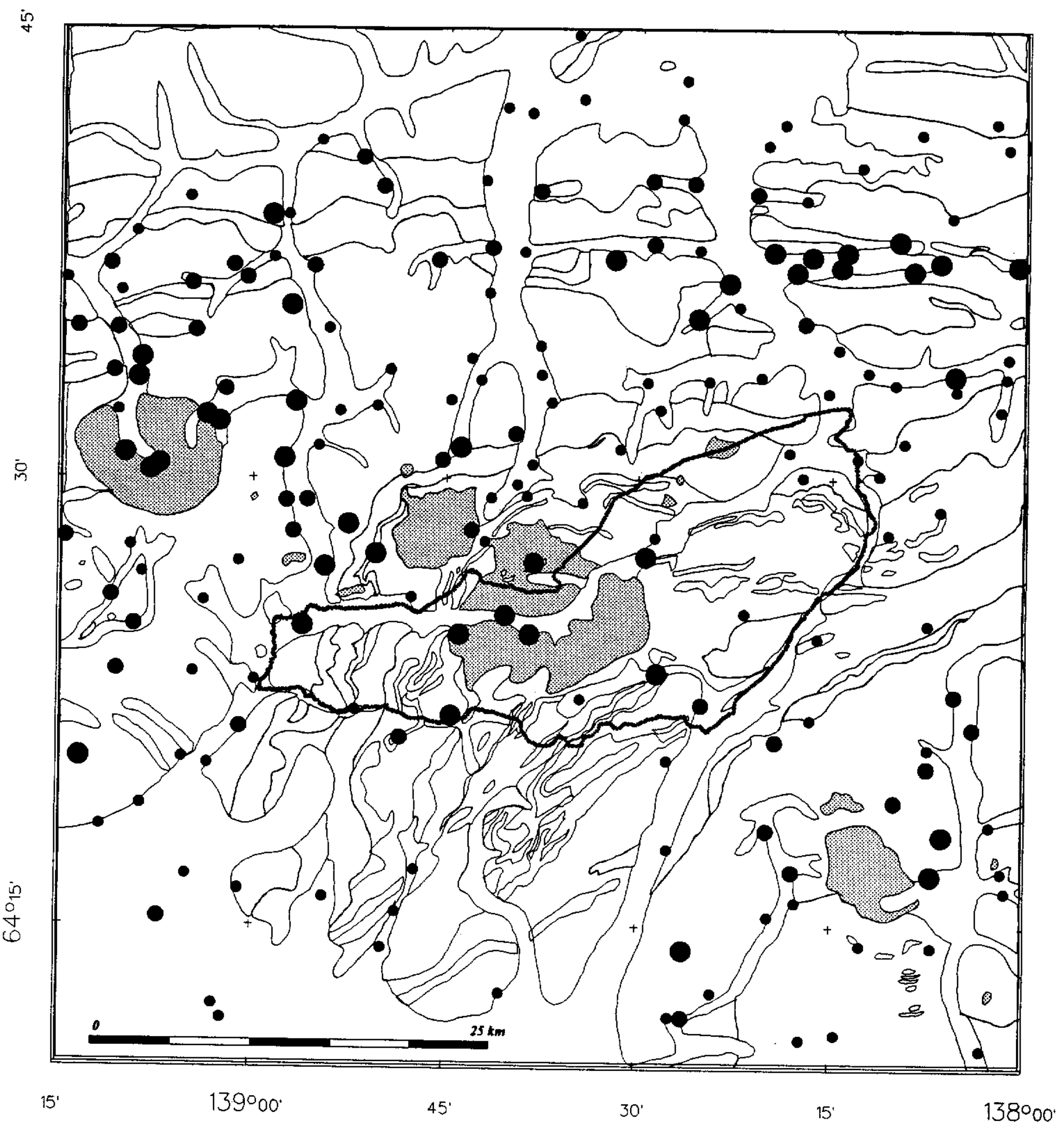
BARIUM IN STREAM SEDIMENT

●	*95 to 100th percentile*	*6299-99999 ppm*
●	*90 to 95th percentile*	*3750-6299 ppm*
•	*70 to 90th percentile*	*1640-3750 ppm*



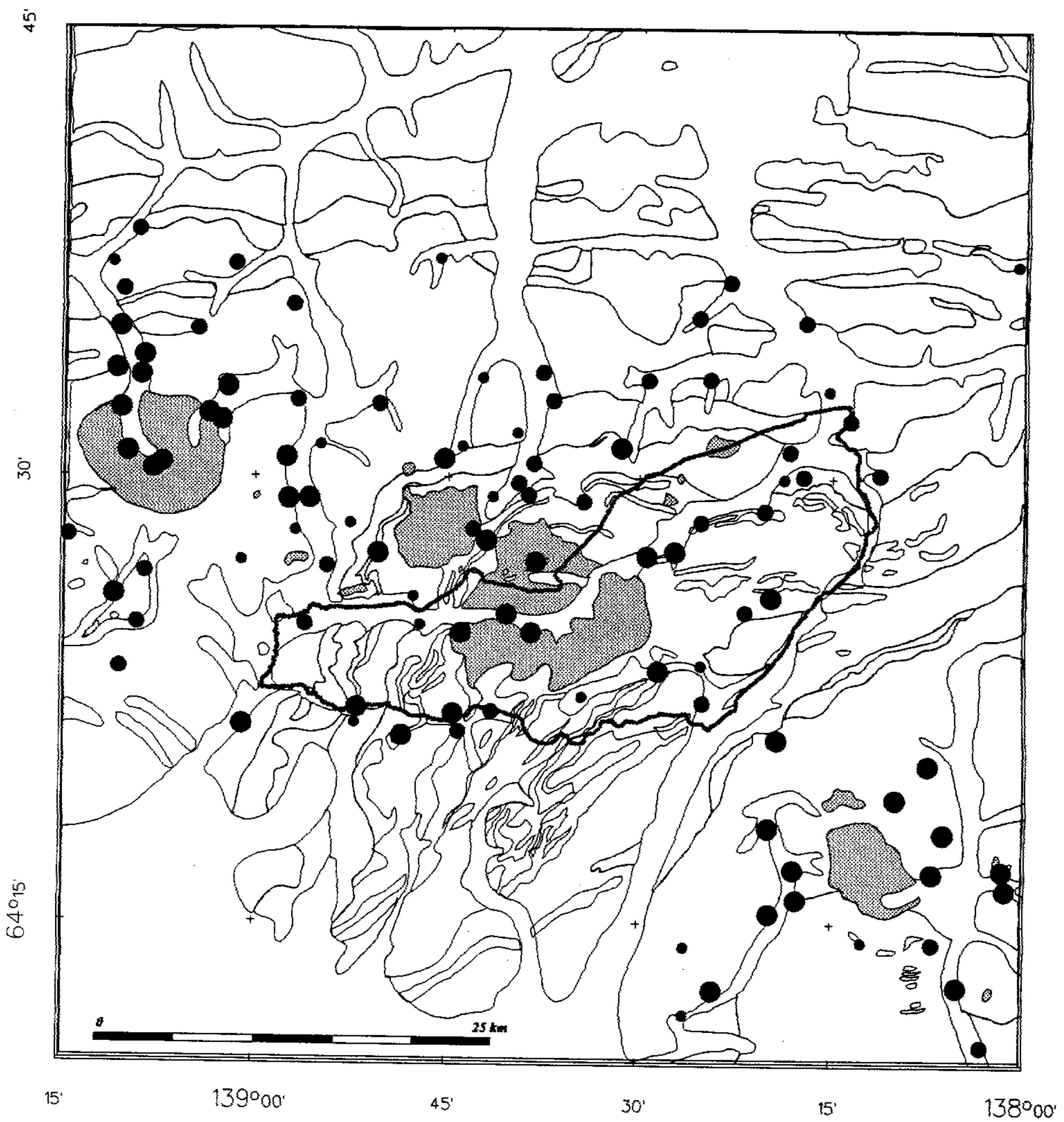
BROMINE IN STREAM SEDIMENT

⬤	*95 to 100th percentile*	*15-210 ppm*
●	*90 to 95th percentile*	*10-15 ppm*
•	*70 to 90th percentile*	*5.3-10 ppm*



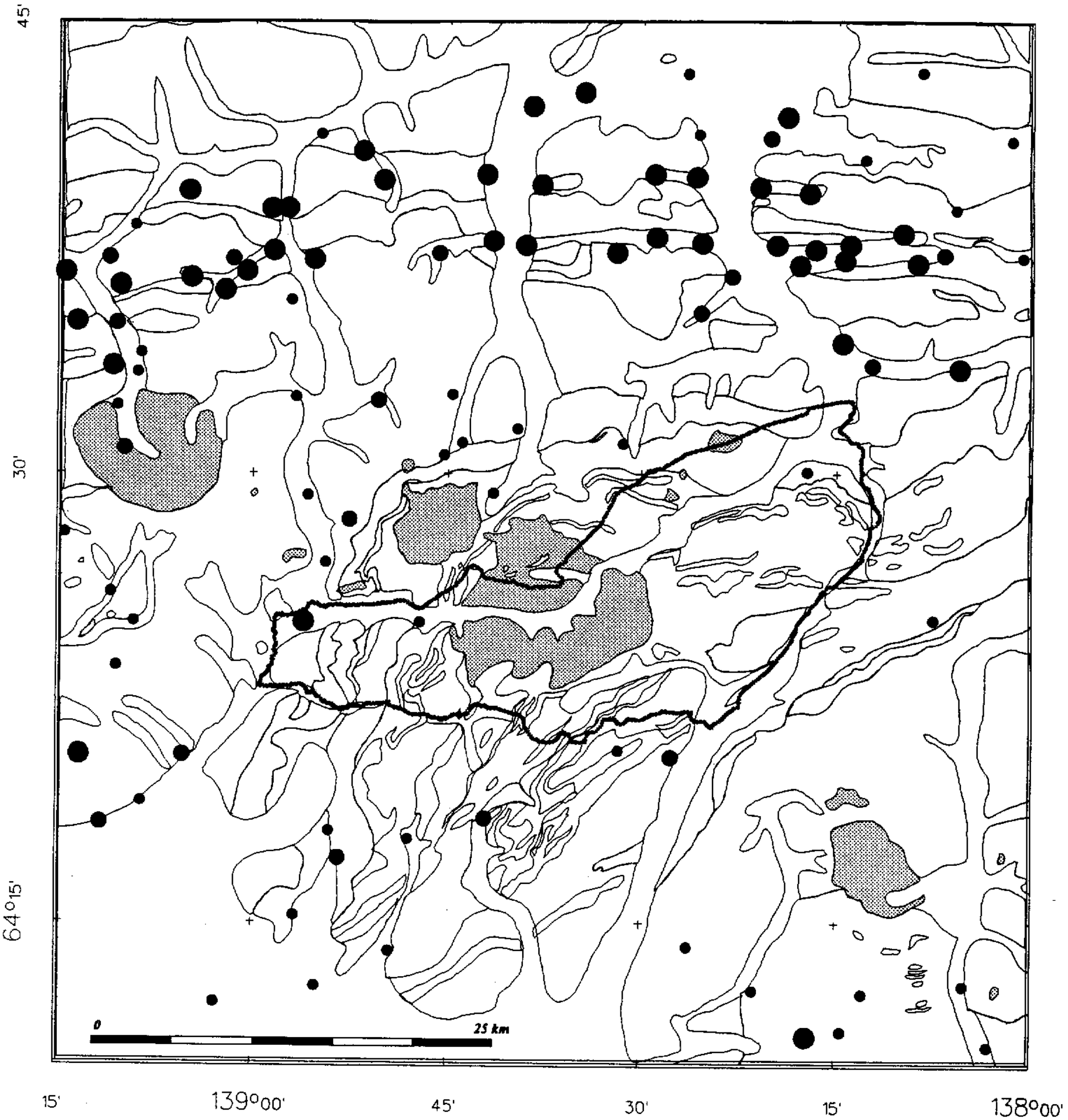
CERIUM IN STREAM SEDIMENT

●	*95 to 100th percentile*	*110-280 ppm*
●	*90 to 95th percentile*	*96-110 ppm*
•	*70 to 90th percentile*	*70-96 ppm*



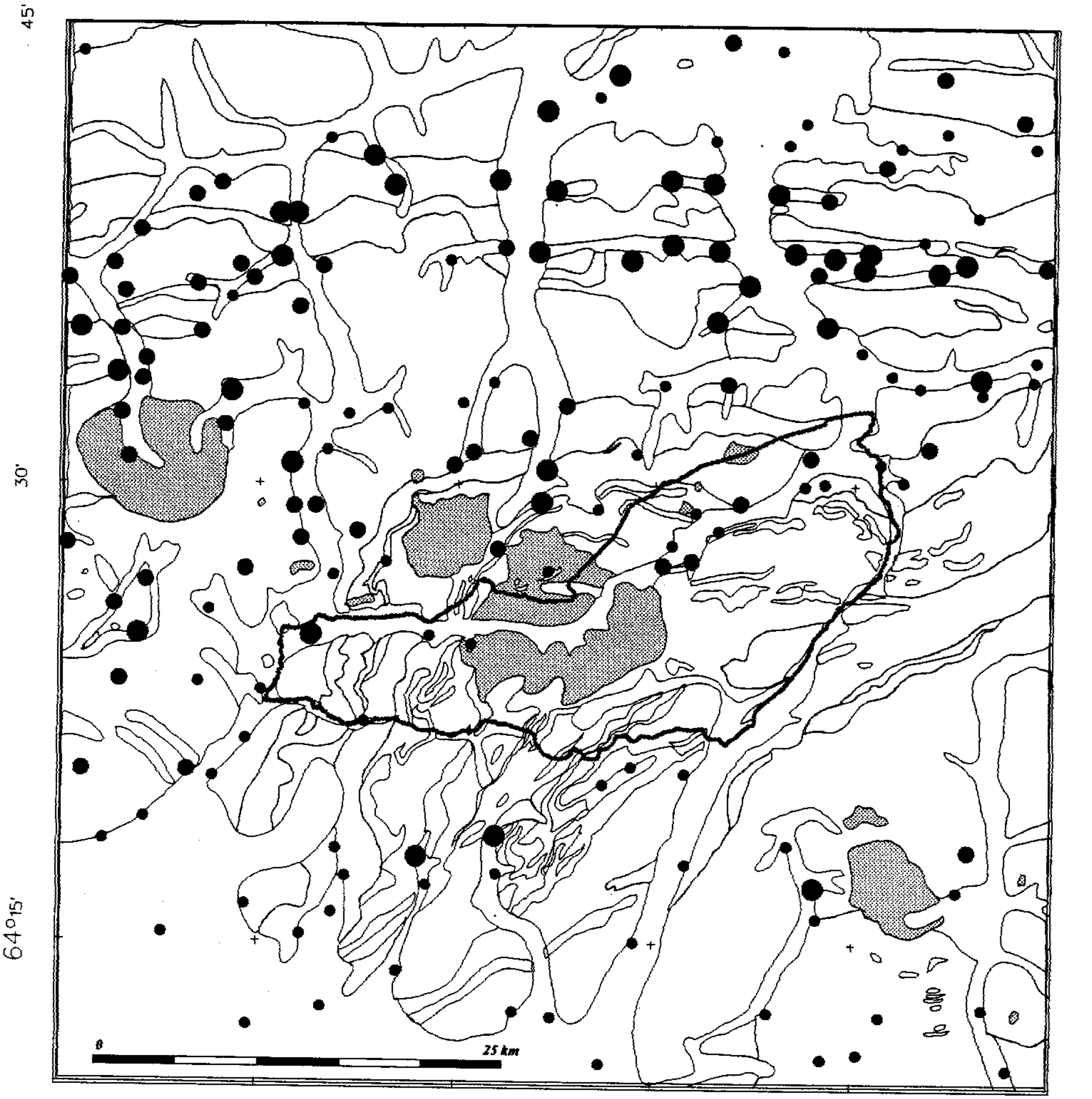
CESIUM IN STREAM SEDIMENT

● (largest)	*95 to 100th percentile*	*9-35 ppm*
● (medium)	*90 to 95th percentile*	*7-9 ppm*
● (small)	*80 to 90th percentile*	*6-7 ppm*



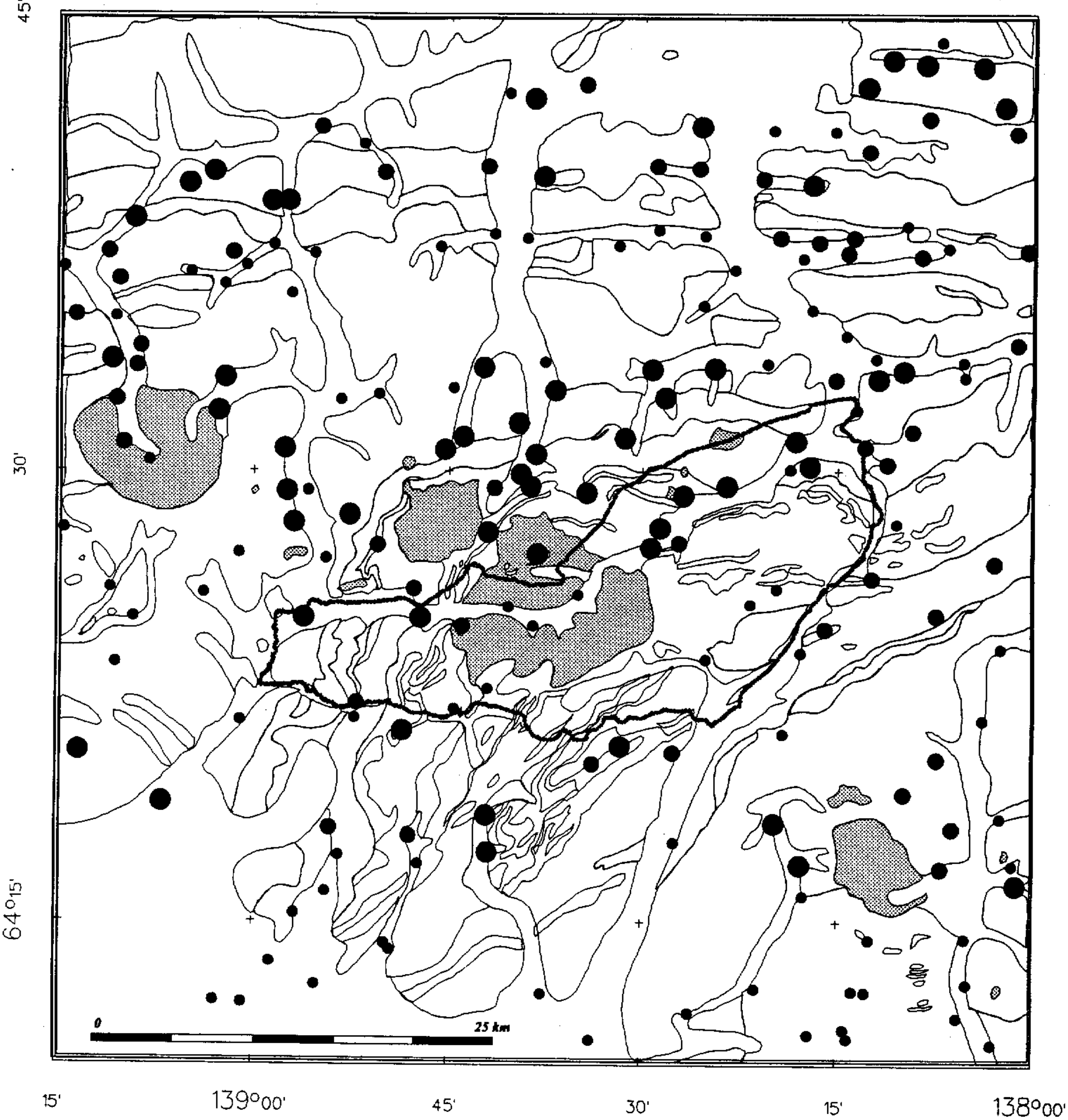
CHROMIUM IN STREAM SEDIMENT

95 to 100th percentile	*260-3000 ppm*
90 to 95th percentile	*200-260 ppm*
70 to 90th percentile	*130-200 ppm*



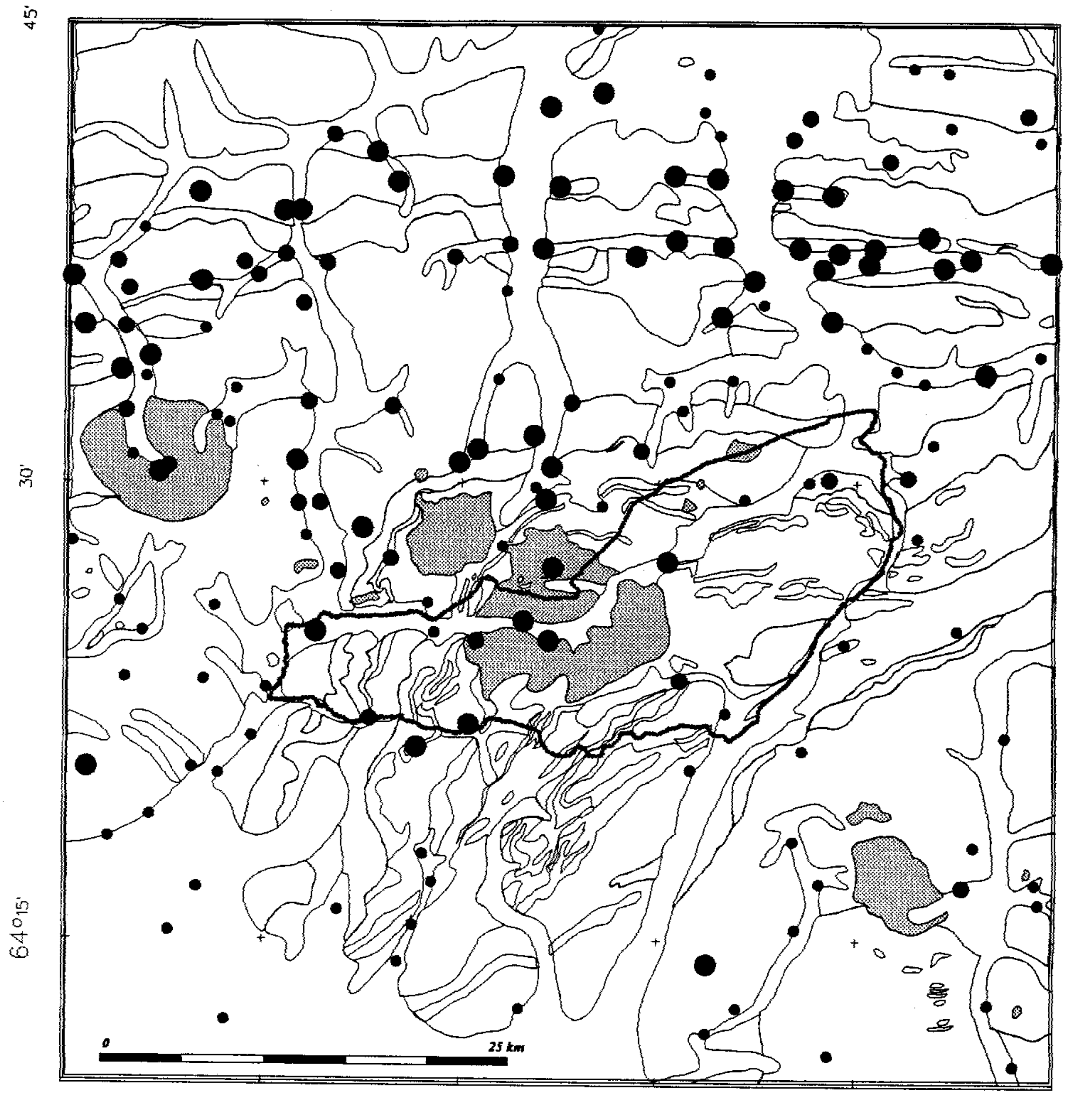
COBALT IN STREAM SEDIMENT

●	*95 to 100th percentile*	*27-420 ppm*
●	*90 to 95th percentile*	*20-27 ppm*
•	*70 to 90th percentile*	*13-20 ppm*



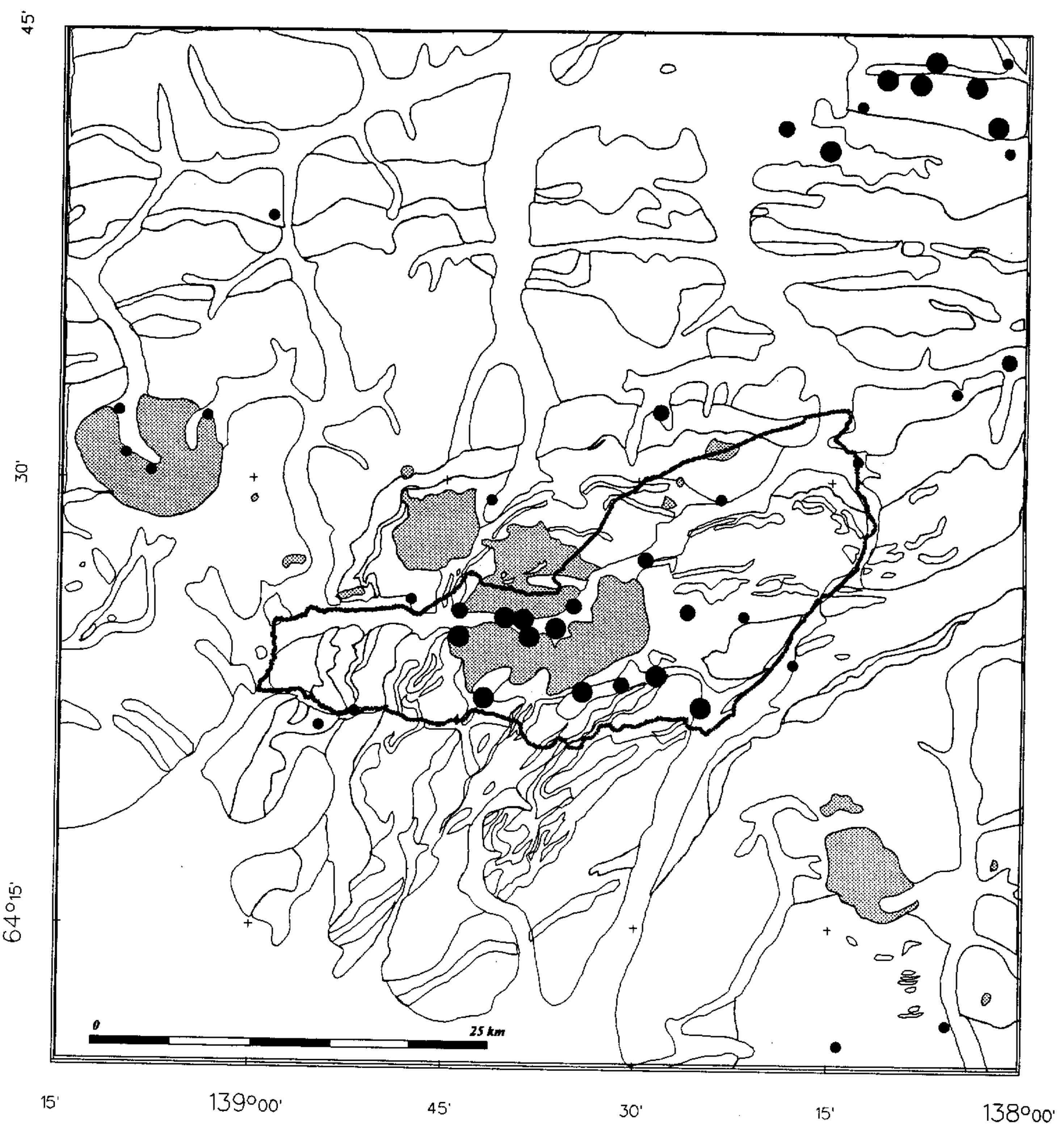
COPPER IN STREAM SEDIMENT

●	*95 to 100th percentile*	*67-228 ppm*
●	*90 to 95th percentile*	*52-67 ppm*
•	*70 to 90th percentile*	*31-52 ppm*



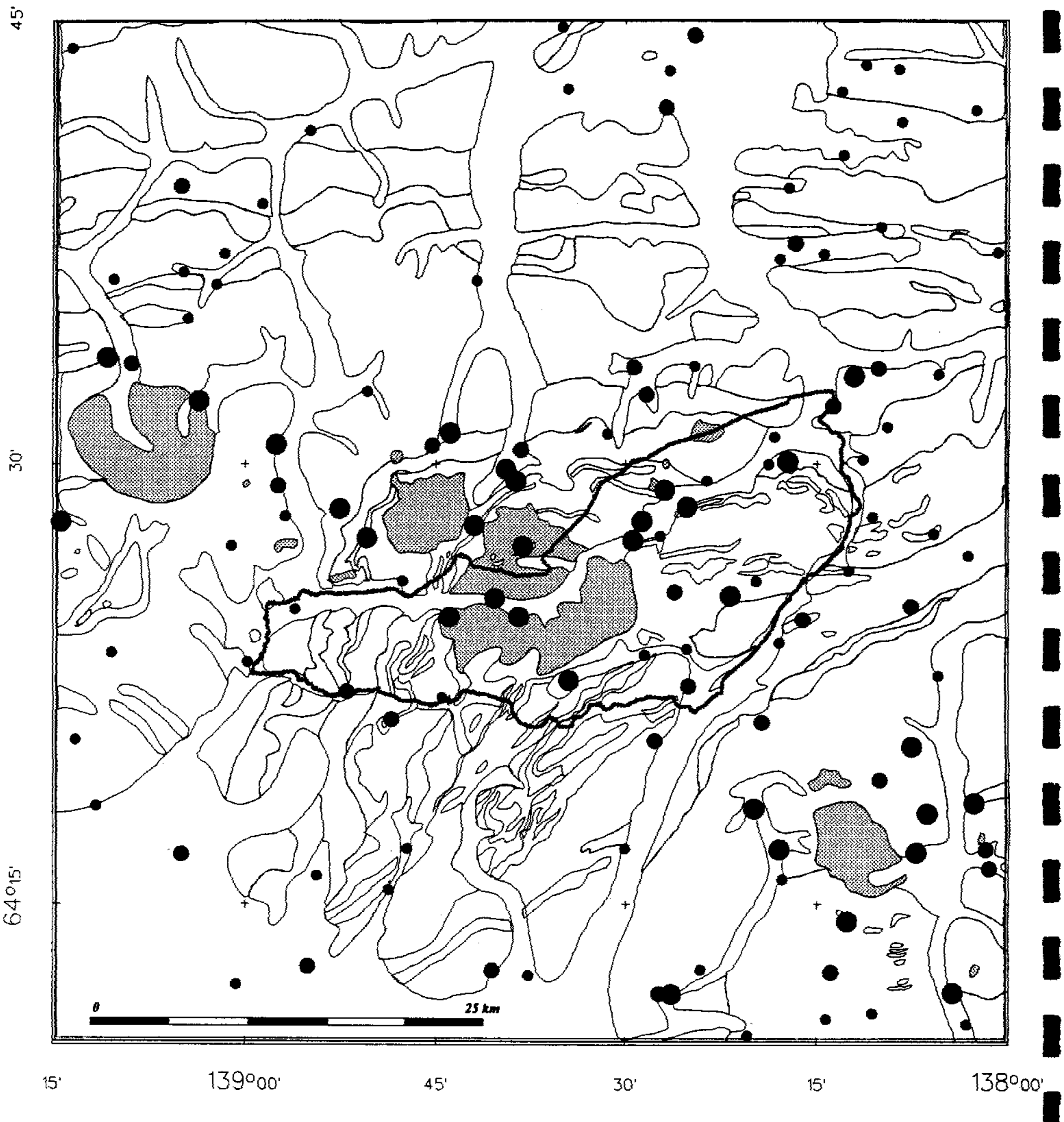
EUROPIUM IN STREAM SEDIMENT

●	*95 to 100th percentile*	*2.1-186 ppm*
●	*90 to 95th percentile*	*1.8-2.1 ppm*
•	*70 to 90th percentile*	*1.4-1.8 ppm*



FLUORIDE IN STREAM WATER

●	*95 to 100th percentile*	*260-9600 ppb*
●	*90 to 95th percentile*	*170-220 ppb*
•	*70 to 90th percentile*	*110-170 ppb*

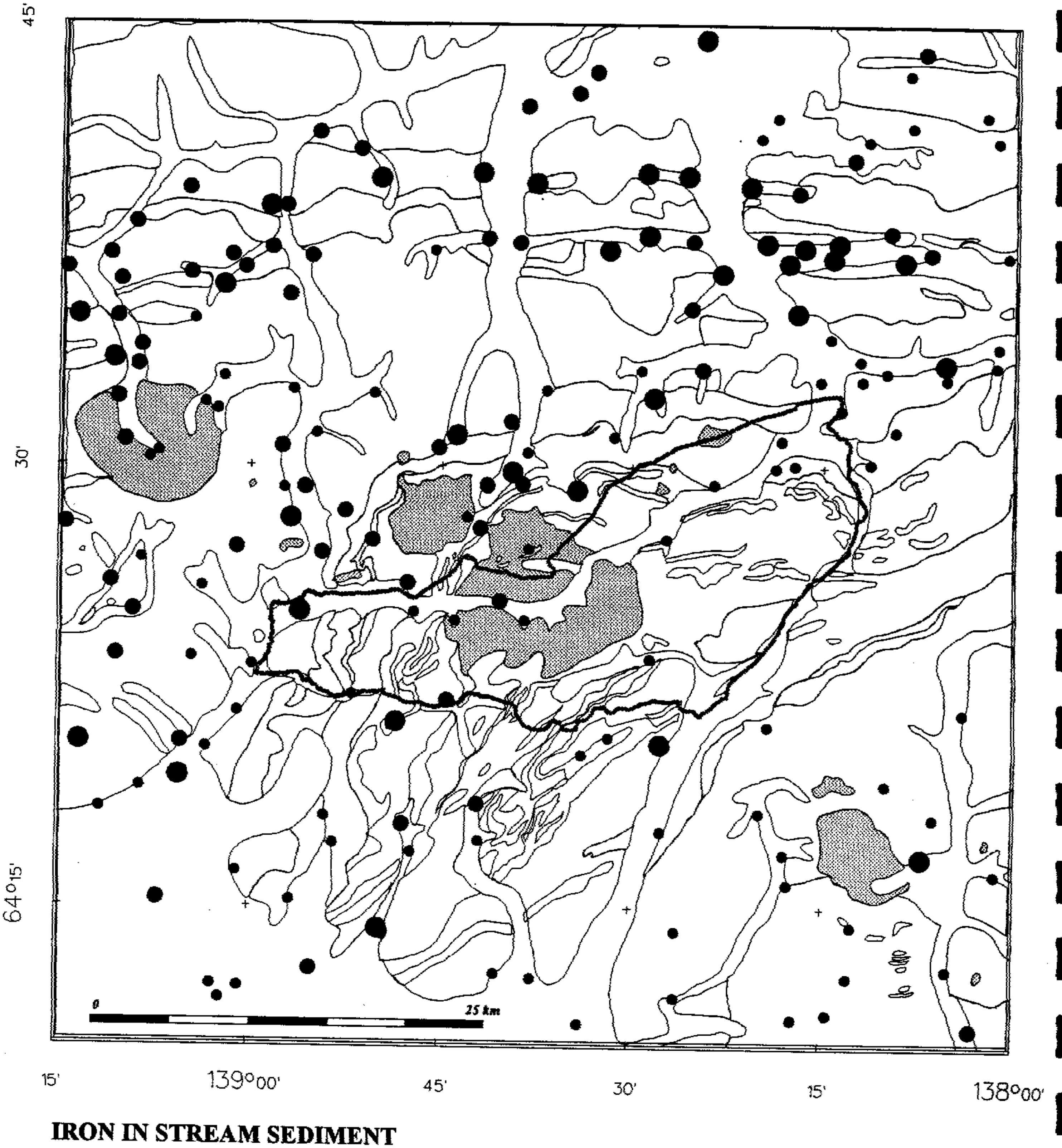


GOLD IN STREAM SEDIMENT

●	*95 to 100th percentile*	*15-1050 ppb*
●	*90 to 95th percentile*	*9-15 ppb*
•	*80 to 90th percentile*	*6-9 ppb*

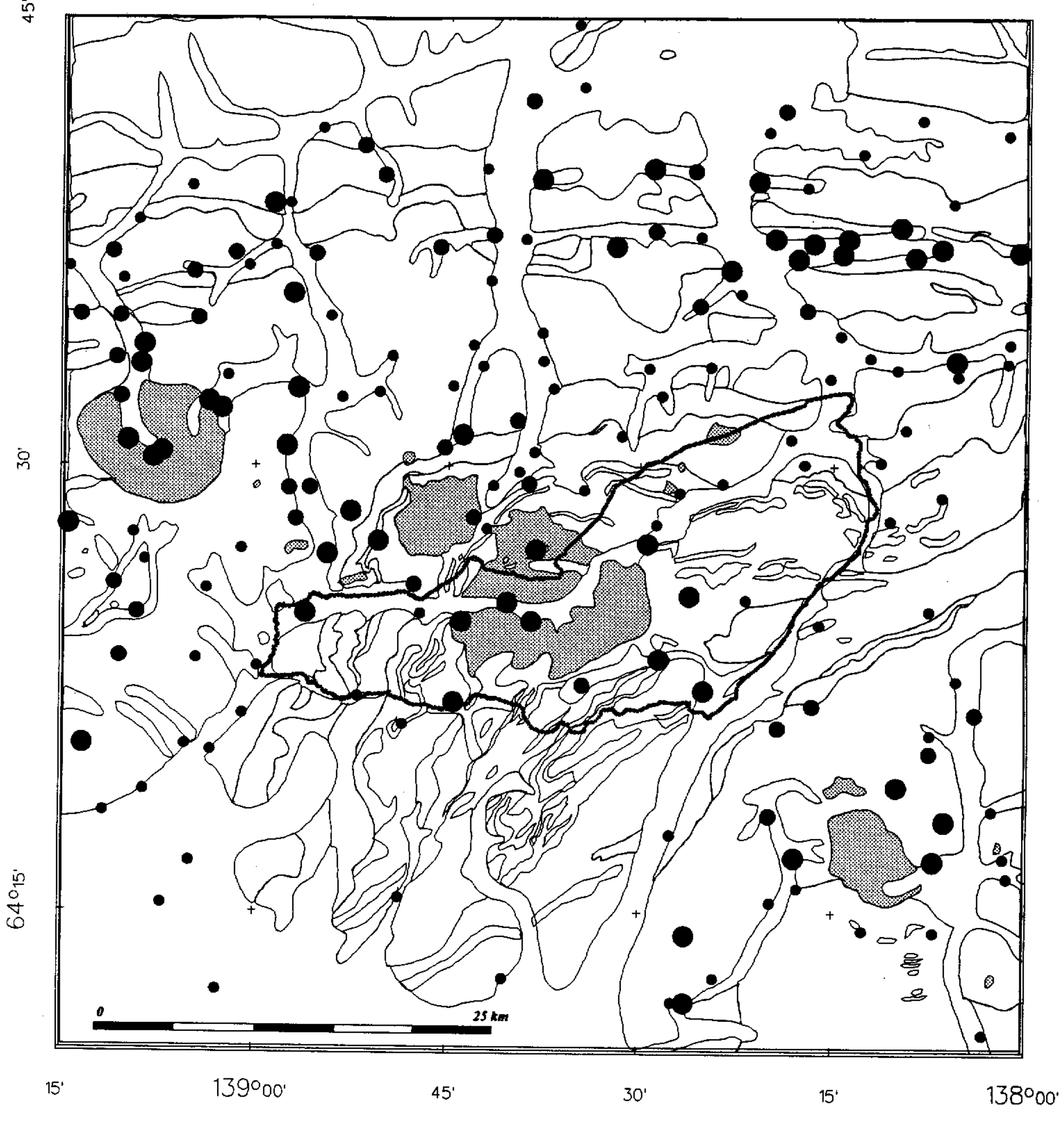
HAFNIUM IN STREAM SEDIMENT

⬤	*95 to 100th percentile*	*11-27 ppm*
●	*90 to 95th percentile*	*10-11 ppm*
•	*80 to 90th percentile*	*8-10 ppm*



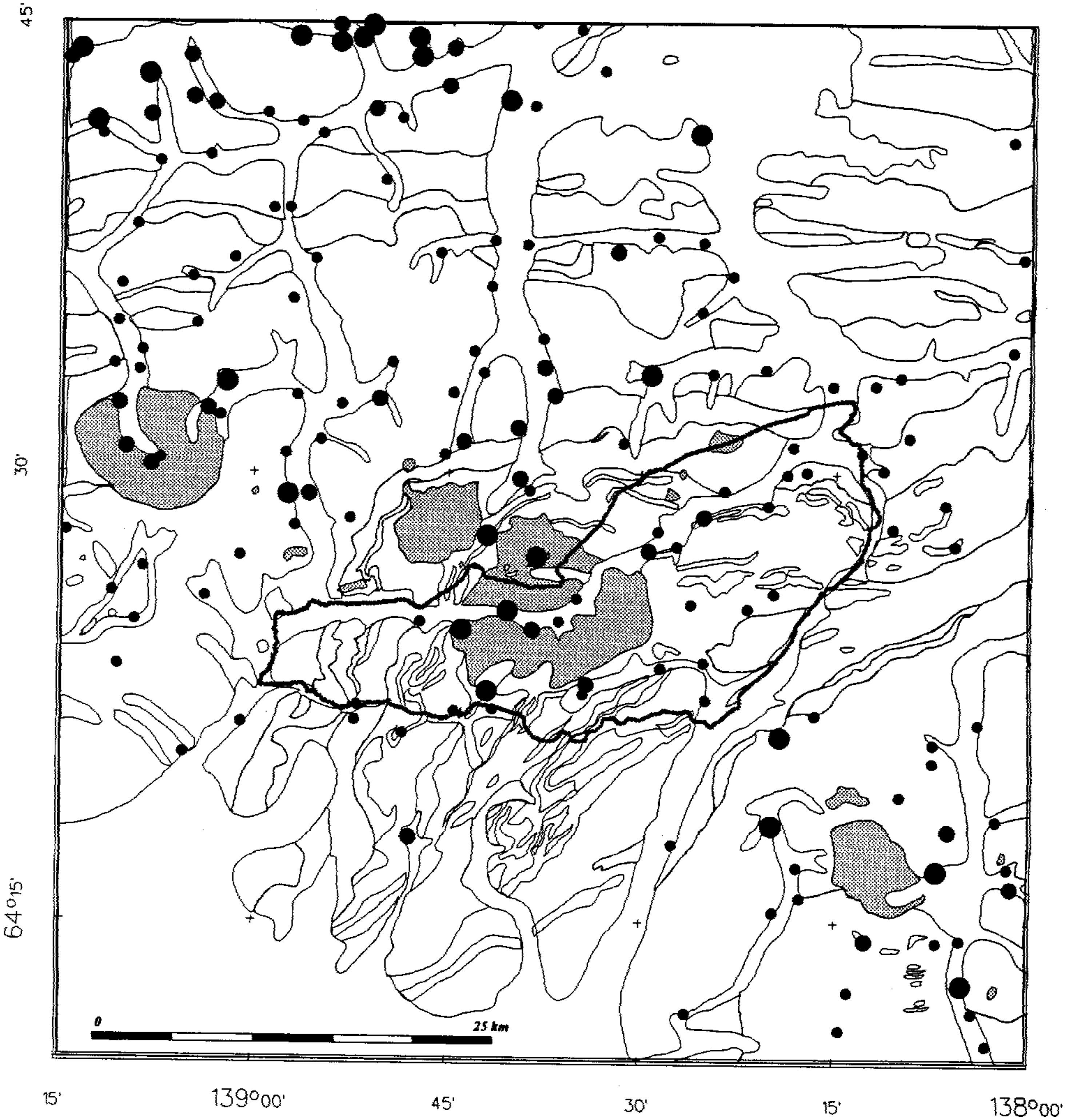
IRON IN STREAM SEDIMENT

●	*95 to 100th percentile*	*6.29-37.3%*
●	*90 to 95th percentile*	*5.25-6.29%*
•	*70 to 90th percentile*	*3.75-5.25%*



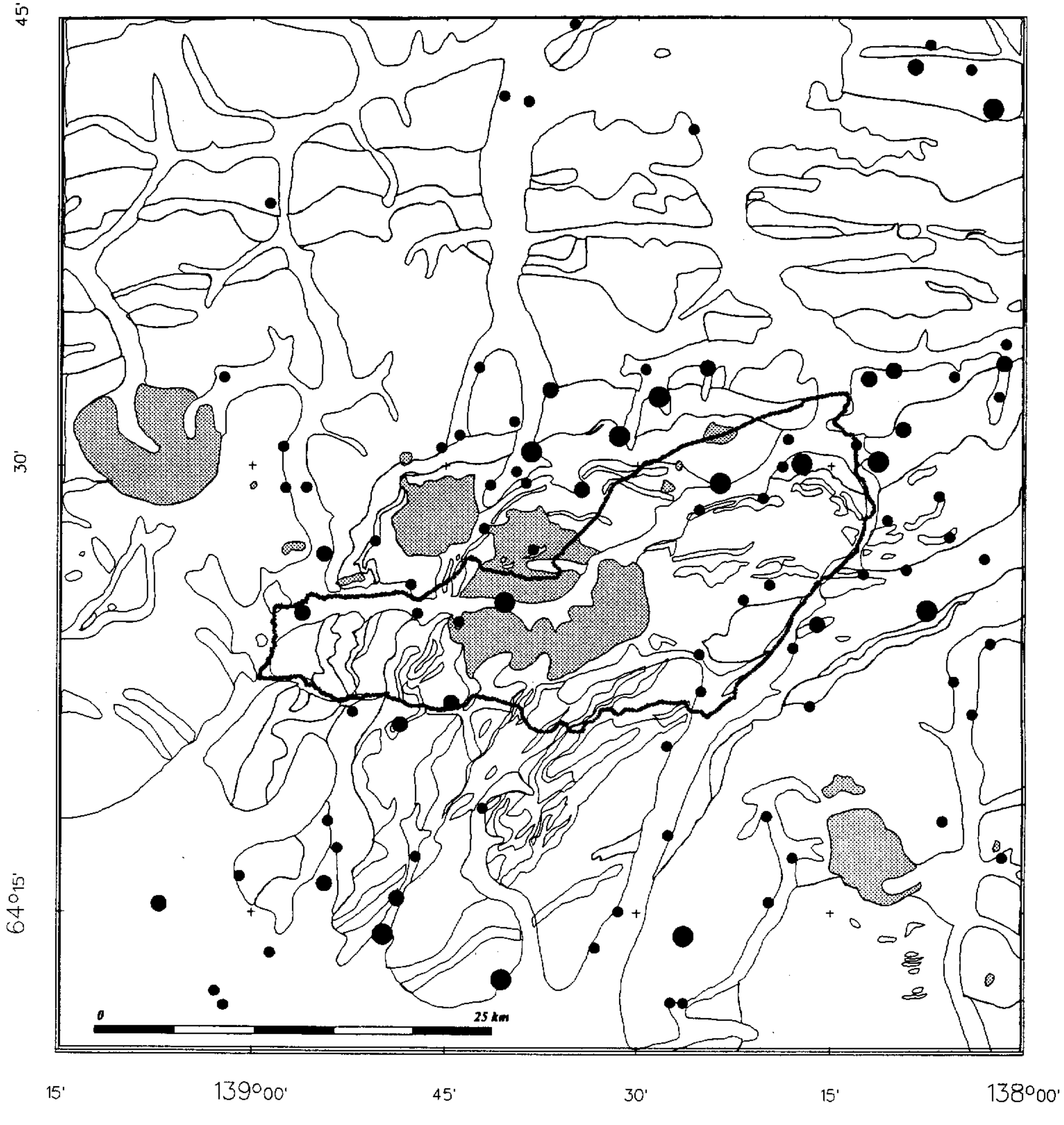
LANTHANUM IN STREAM SEDIMENT

●	*95 to 100th percentile*	*62-190 ppm*
●	*90 to 95th percentile*	*53-62 ppm*
•	*70 to 90th percentile*	*39-53 ppm*



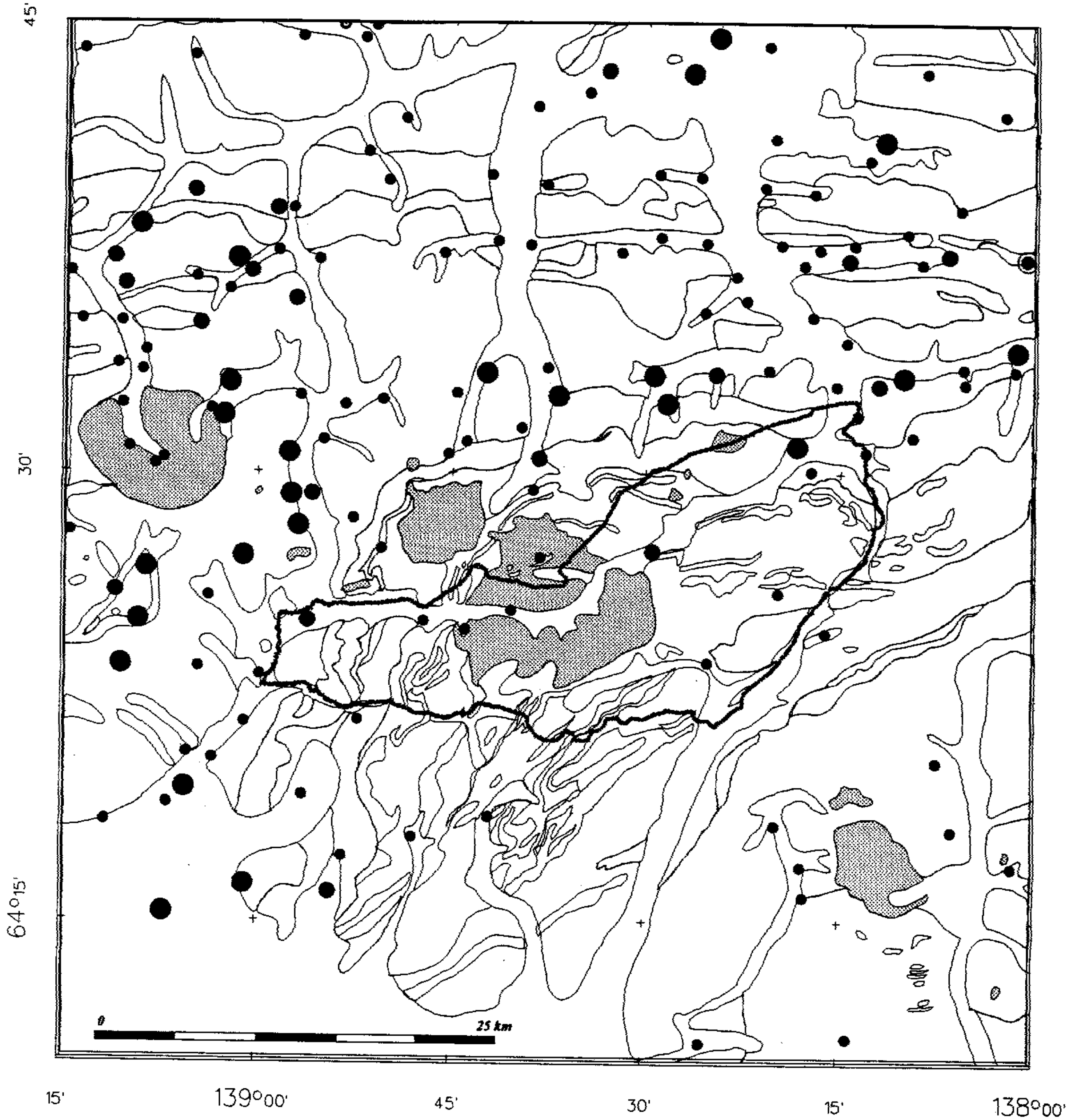
LEAD IN STREAM SEDIMENT

●	*95 to 100th percentile*	*52-680 ppm*
●	*90 to 95th percentile*	*34-52 ppm*
•	*70 to 90th percentile*	*14-34 ppm*



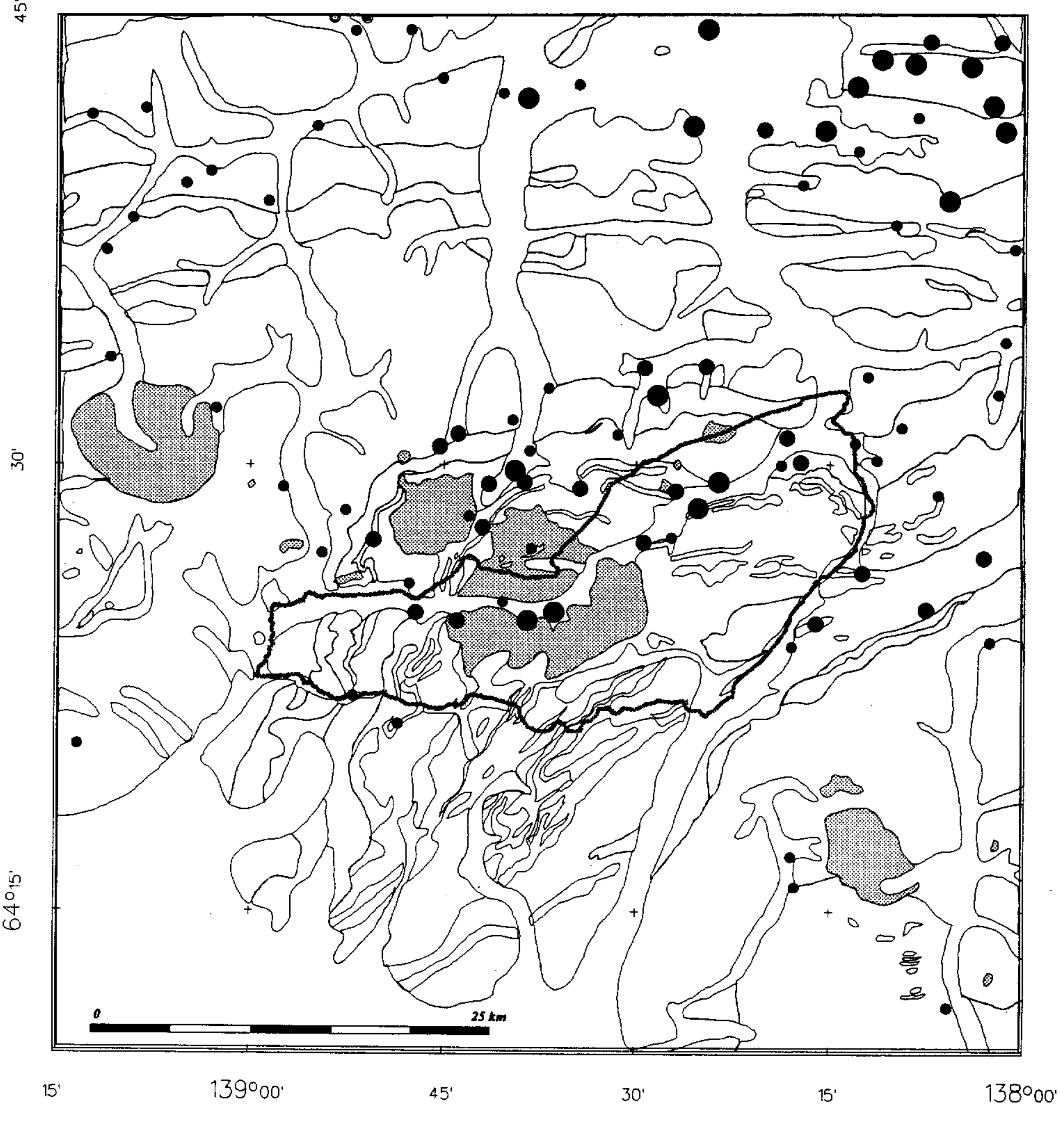
LUTETIUM IN STREAM SEDIMENT

● (large)	*95 to 100th percentile*	*0.68-3.54 ppm*
● (medium)	*90 to 95th percentile*	*0.63-0.68 ppm*
• (small)	*70 to 90th percentile*	*0.52-0.63 ppm*



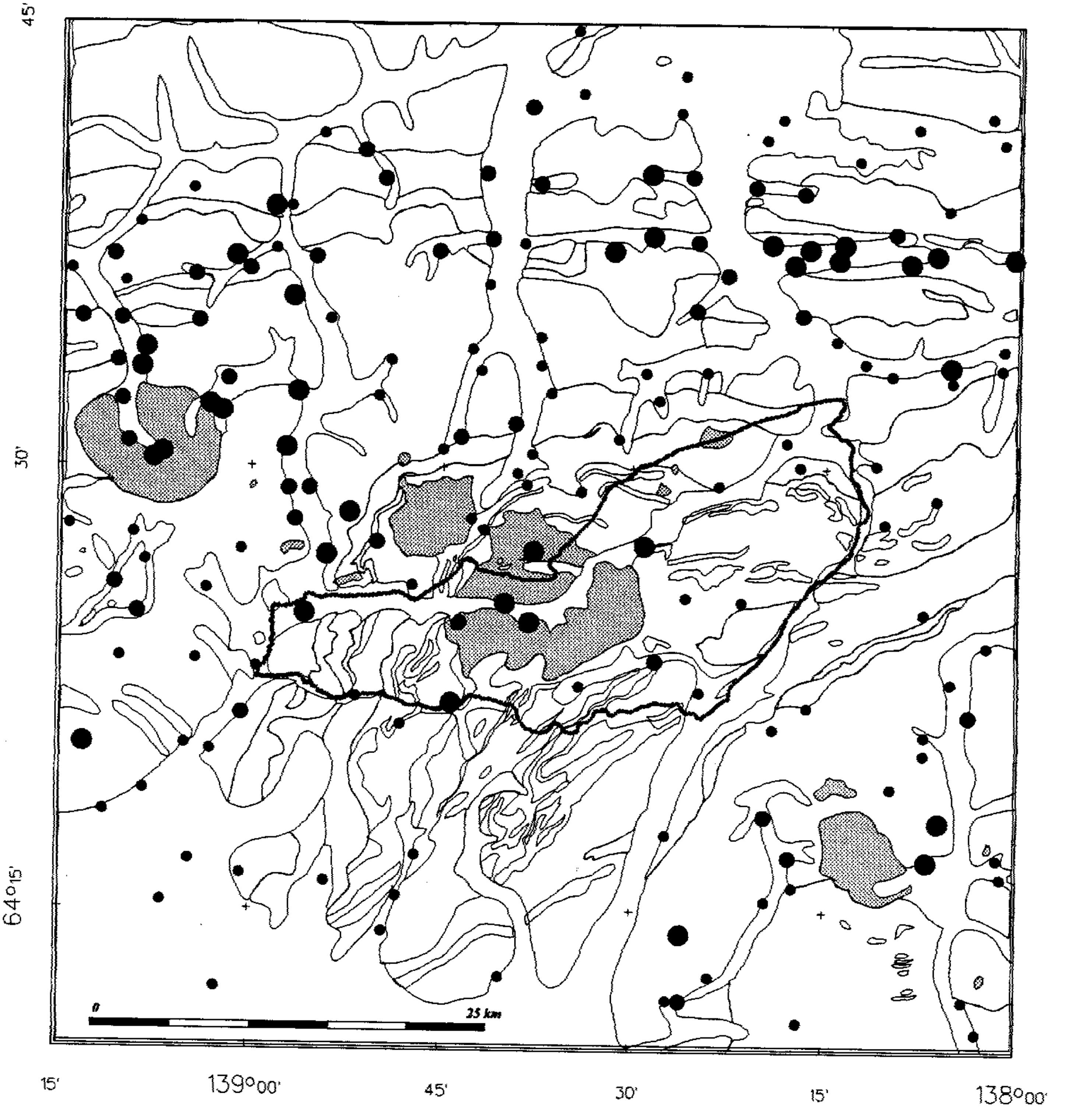
MANGANESE IN STREAM SEDIMENT

●	*95 to 100th percentile*	*1400-75000 ppm*
●	*90 to 95th percentile*	*1040-1400 ppm*
•	*70 to 90th percentile*	*585-1040 ppm*



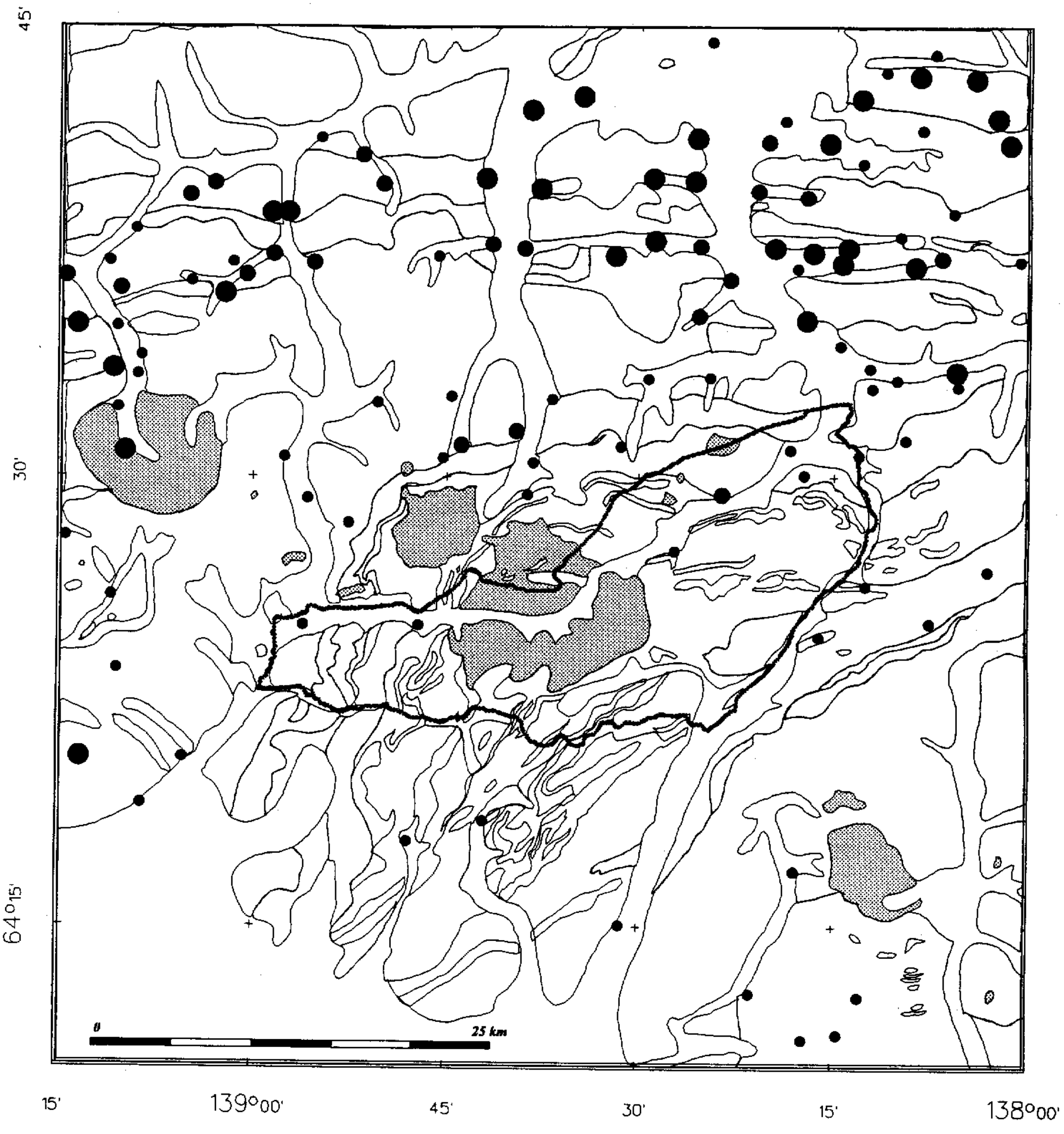
MOLYBDENUM IN STREAM SEDIMENT

● (large)	*95 to 100th percentile*	*12-63 ppm*
● (medium)	*90 to 95th percentile*	*7-12 ppm*
• (small)	*70 to 90th percentile*	*3-7 ppm*



NEODYMIUM IN STREAM SEDIMENT

●	*95 to 100th percentile*	*44-90 ppm*
●	*90 to 95th percentile*	*38-44 ppm*
•	*70 to 95th percentile*	*28-38 ppm*

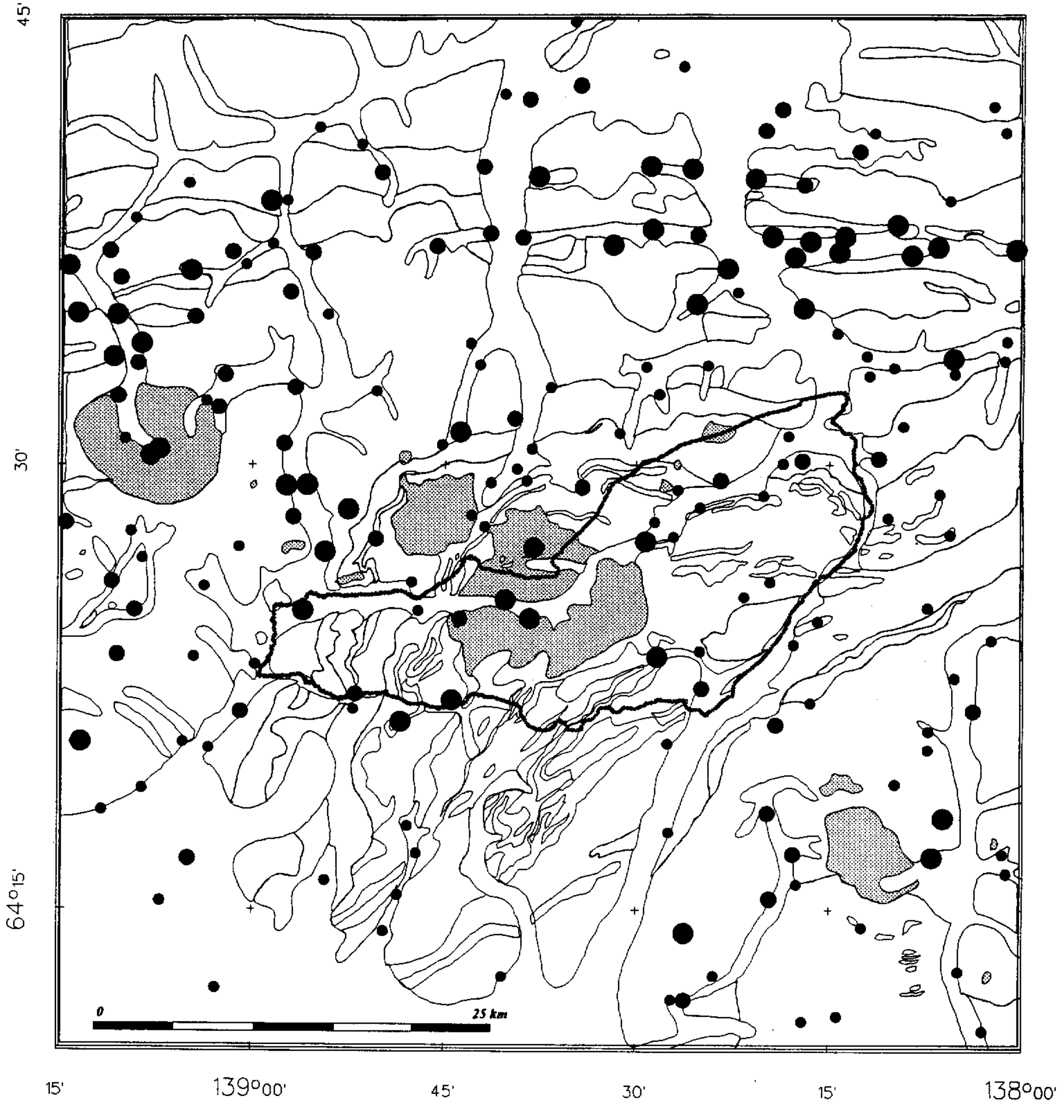


NICKEL IN STREAM SEDIMENT

● (largest dot)	*95 to 100th percentile*	*105-1000 ppm*
● (medium dot)	*90 to 95th percentile*	*76-105 ppm*
• (smallest dot)	*70 to 90th percentile*	*42-76 ppm*

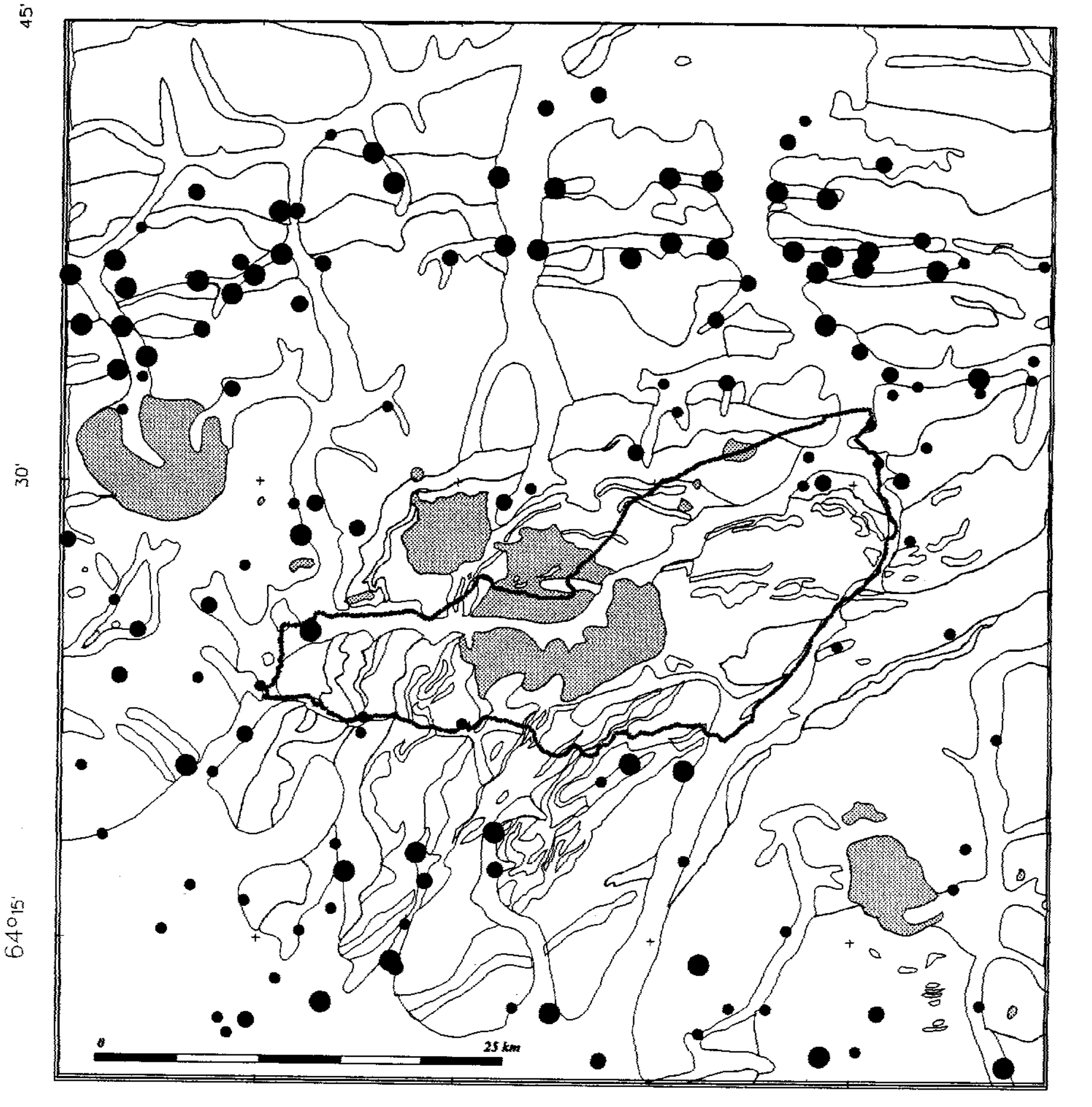
pH IN STREAM WATER

●	*0 to 3rd percentile*	*2.4-6.3*
●	*3rd to 5th percentile*	*6.3-6.7*
•	*5 to 17th percentile*	*6.7-7.3*



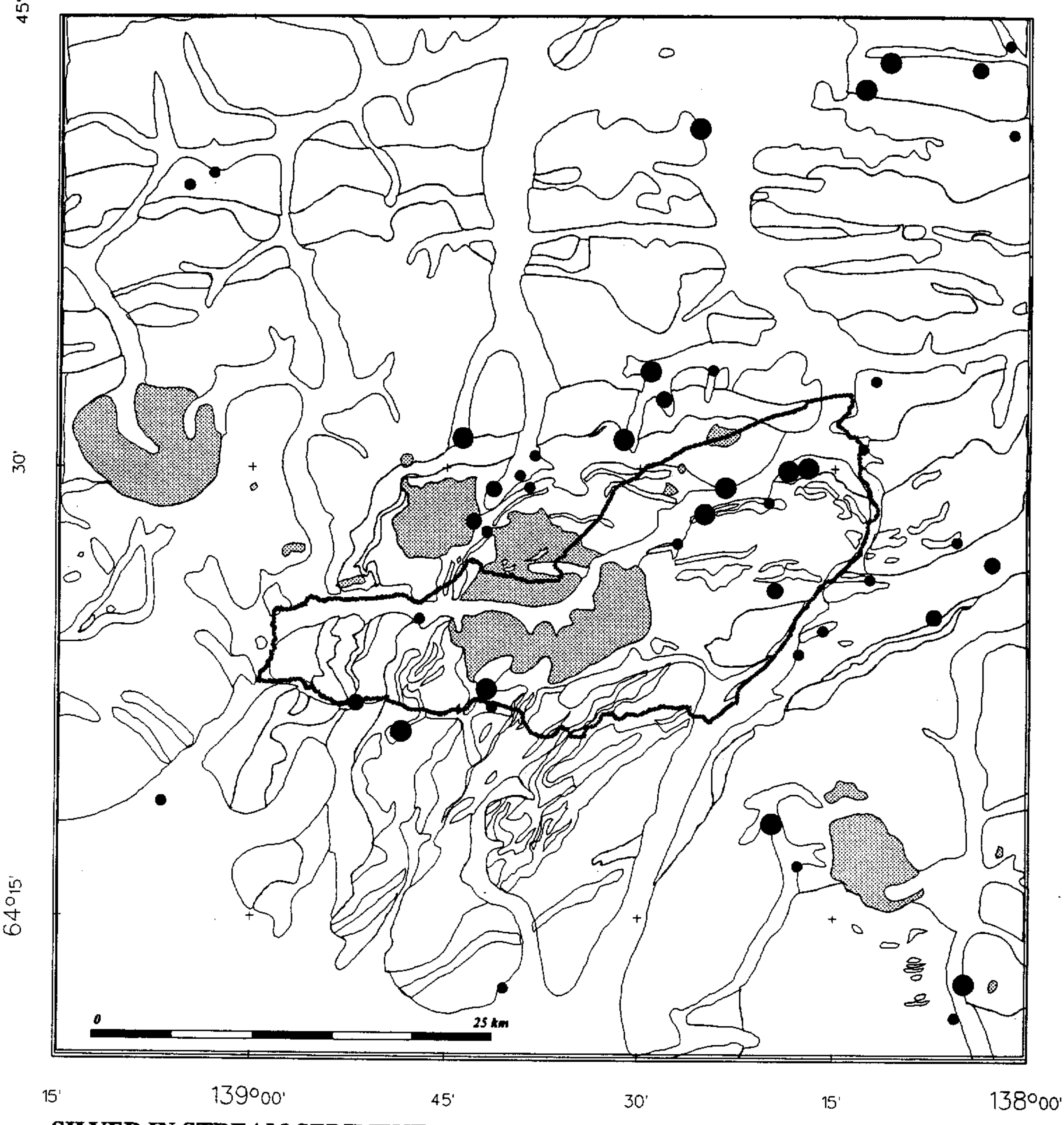
SAMARIUM IN STREAM SEDIMENT

●	*95 to 100th percentile*	*8.4-17 ppm*
●	*90 to 95th percentile*	*7.3-8.4 ppm*
•	*70 to 90th percentile*	*5.6-7.3 ppm*



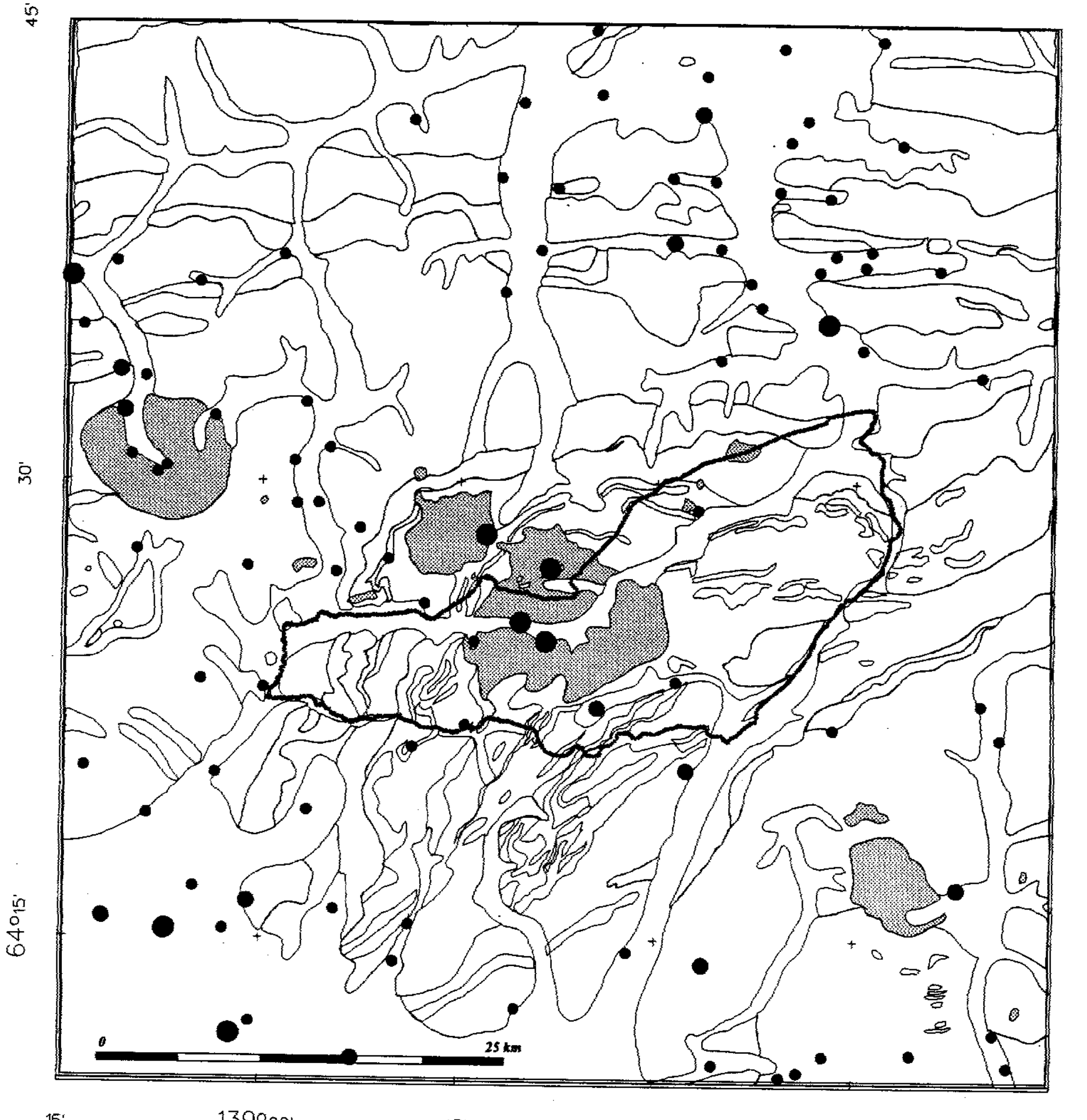
SCANDIUM IN STREAM SEDIMENT

● (large)	*95 to 100th percentile*	*20-38 ppm*
● (medium)	*90 to 95th percentile*	*17-20 ppm*
• (small)	*80 to 90th percentile*	*14-17 ppm*



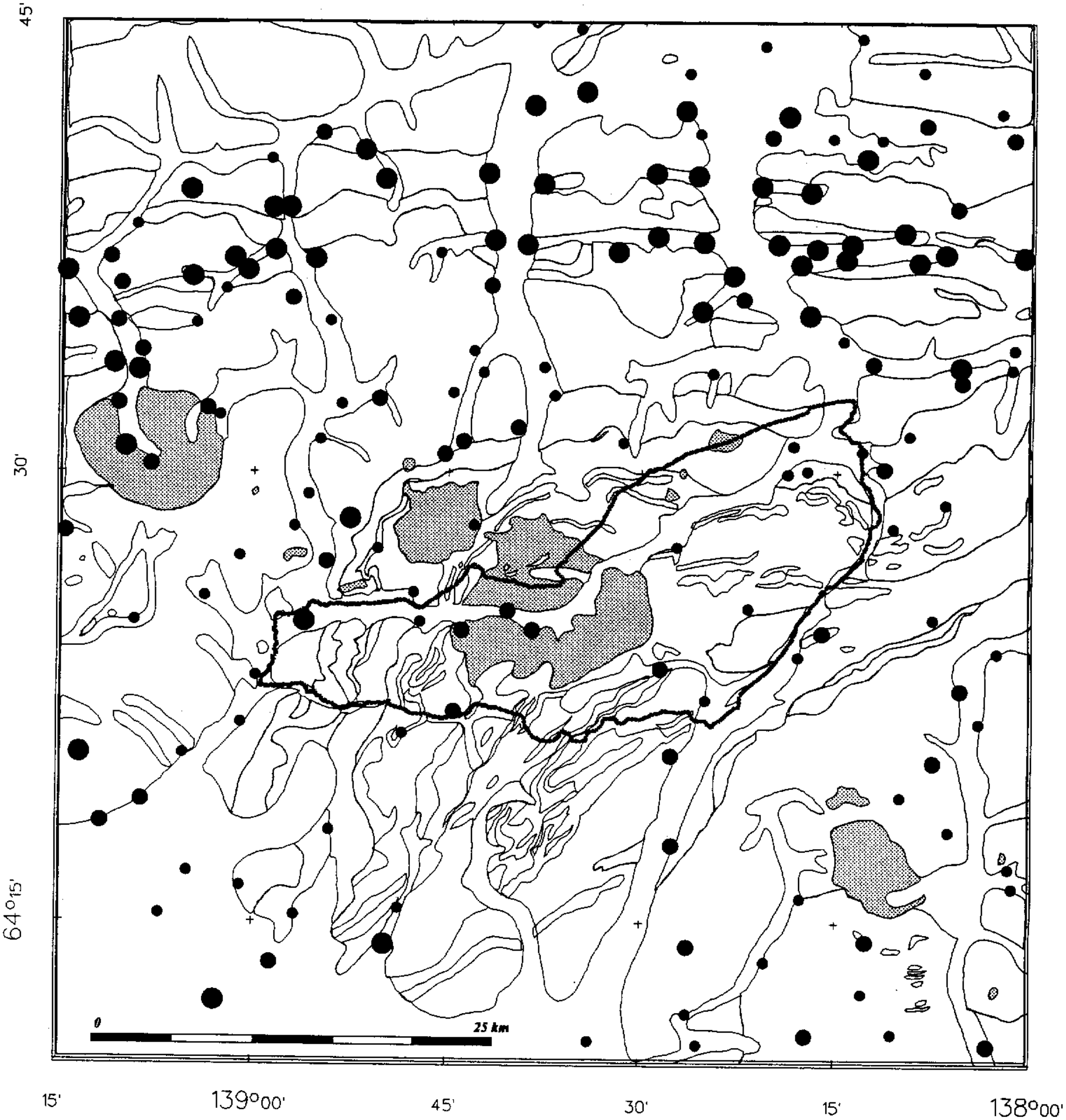
SILVER IN STREAM SEDIMENT

●	*95 to 100th percentile*	*0.7-5 ppm*
●	*90 to 95th percentile*	*0.4-0.7 ppm*
•	*80 to 90th percentile*	*0.2-0.4 ppm*



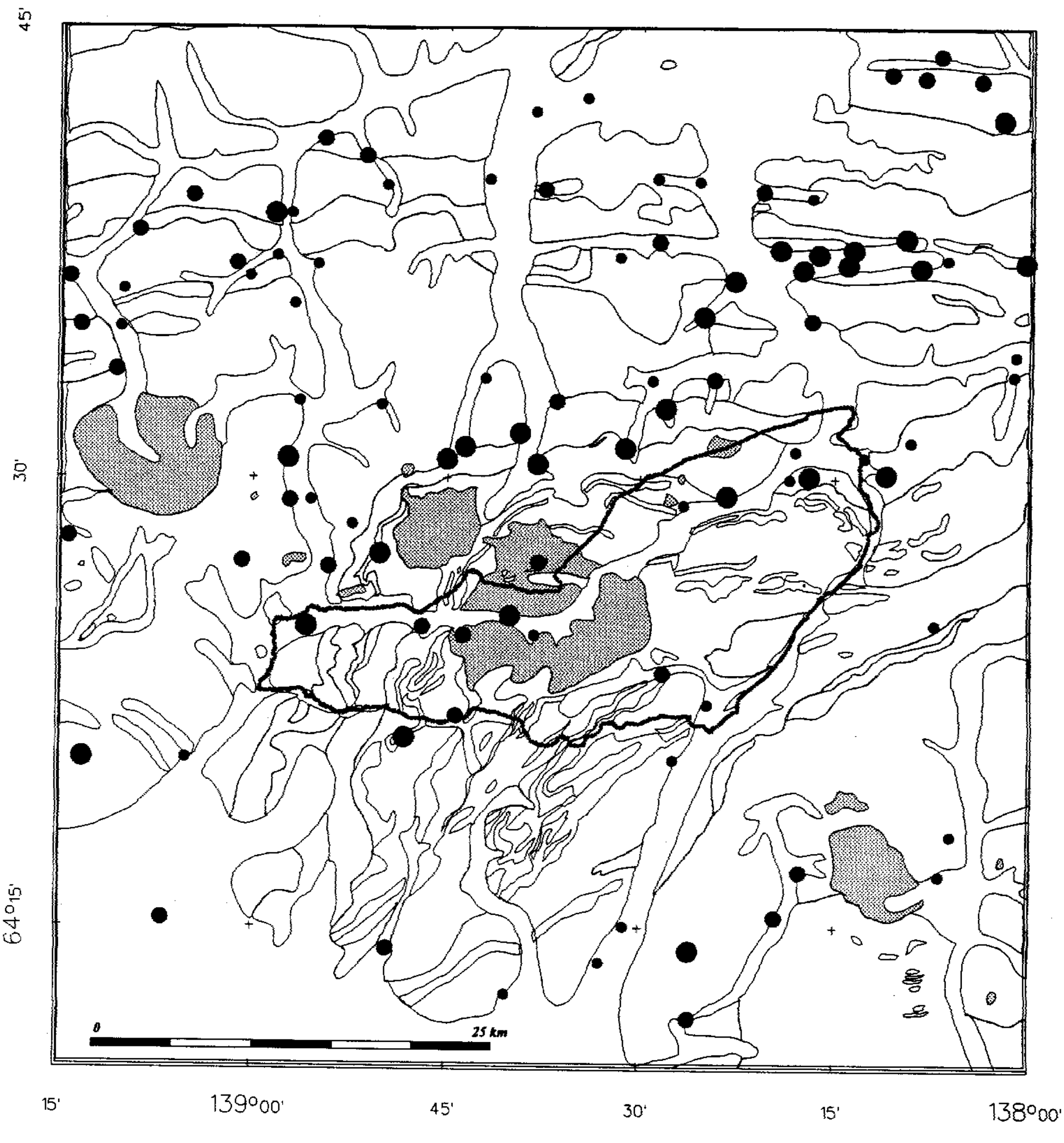
SODIUM IN STREAM SEDIMENT

● (large)	*95 to 100th percentile*	*1.46-100.28 ppm*
● (medium)	*90 to 95th percentile*	*1.28-1.46 ppm*
● (small)	*70 to 90th percentile*	*0.89-1.28 ppm*



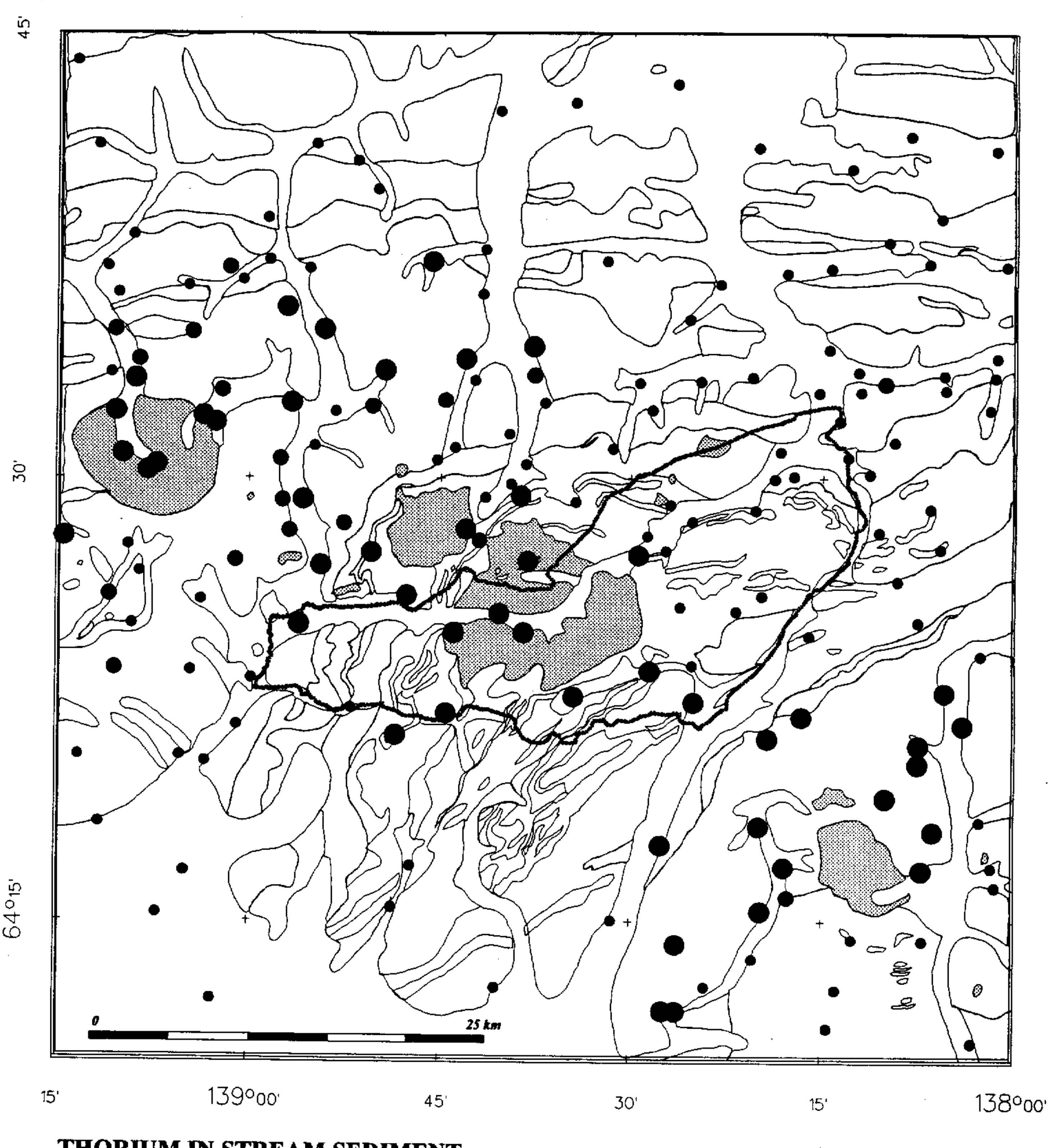
TANTALUM IN STREAM SEDIMENT

● (large)	*95 to 100th percentile*	*2-5.9 ppm*
● (medium)	*90 to 95th percentile*	*1.5-2 ppm*
● (small)	*70 to 90th percentile*	*1.1-1.5 ppm*



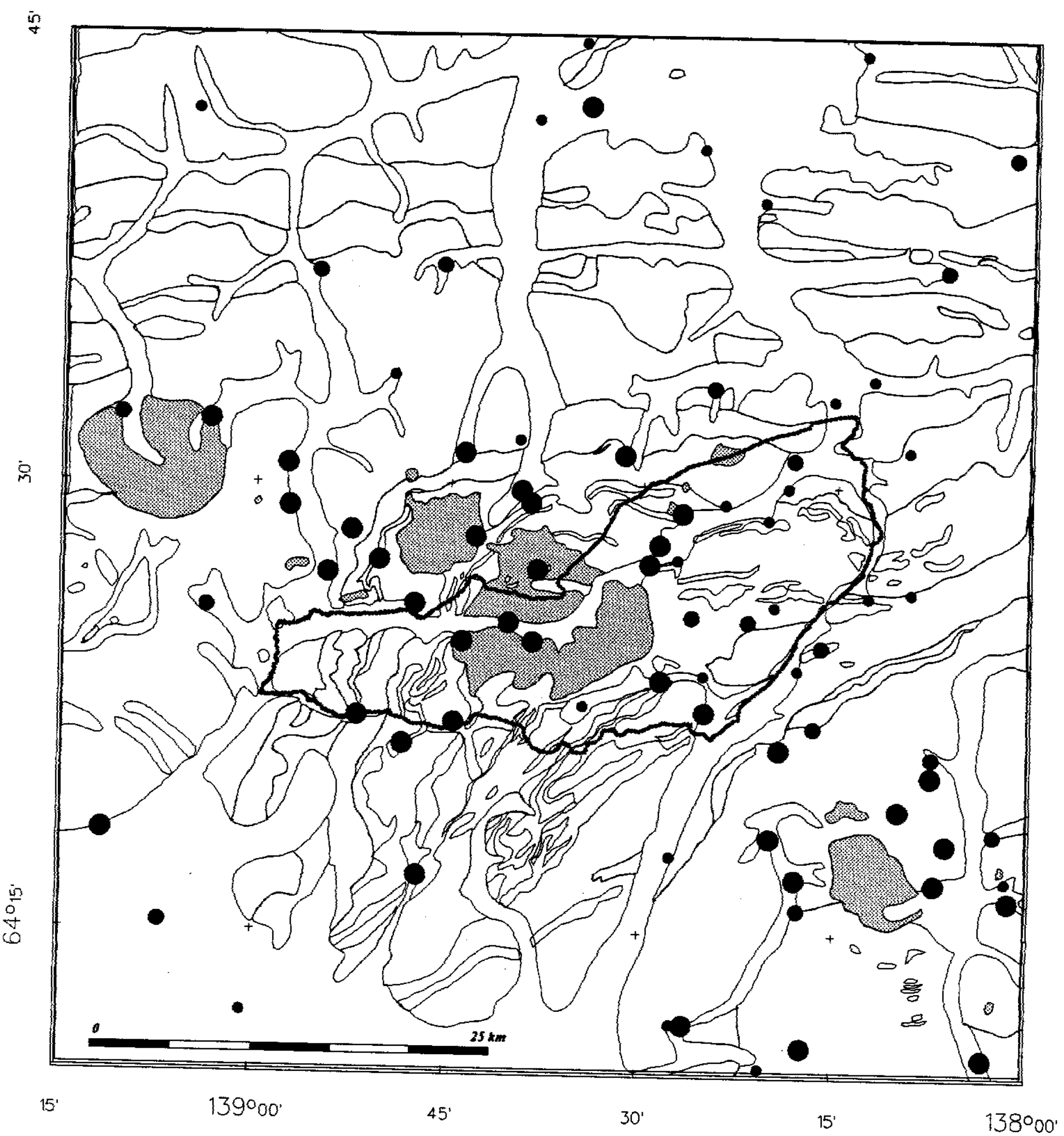
TERBIUM IN STREAM SEDIMENT

● (largest)	*95 to 100th percentile*	*1.2-3.9 ppm*
● (medium)	*90 to 95th percentile*	*1-1.2 ppm*
• (smallest)	*70 to 90th percentile*	*0.9-1 ppm*



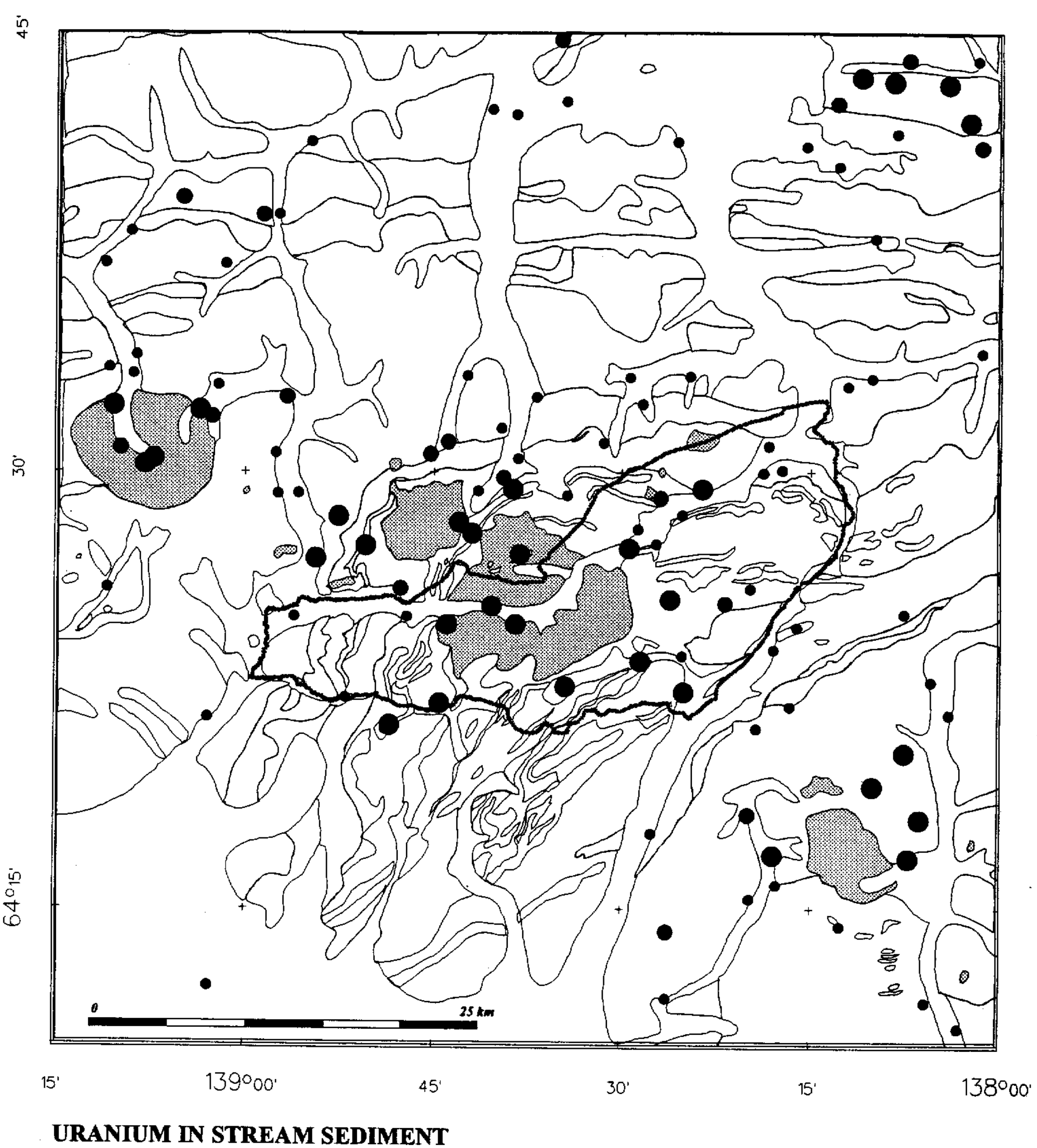
THORIUM IN STREAM SEDIMENT

●	*95 to 100th percentile*	*16-95 ppm*
●	*90 to 95th percentile*	*14-16 ppm*
•	*70 to 90th percentile*	*9.7-14 ppm*



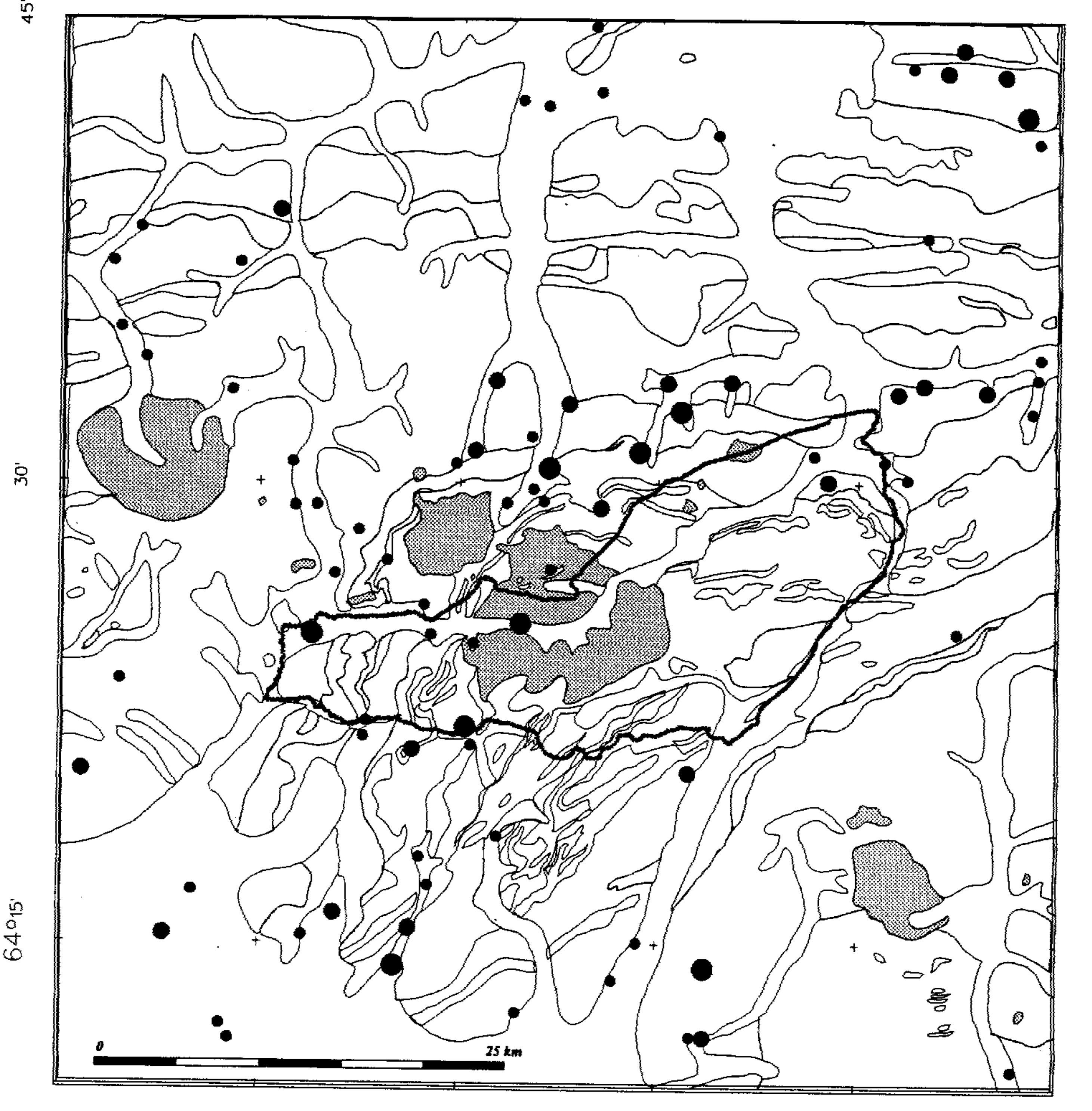
TUNGSTEN IN STREAM SEDIMENT

●	*95 to 100th percentile*	*3.0-29.0 ppm*
●	*90 to 95th percentile*	*2.0-3.0 ppm*
•	*70 to 95th percentile*	*0.9-2.0 ppm*



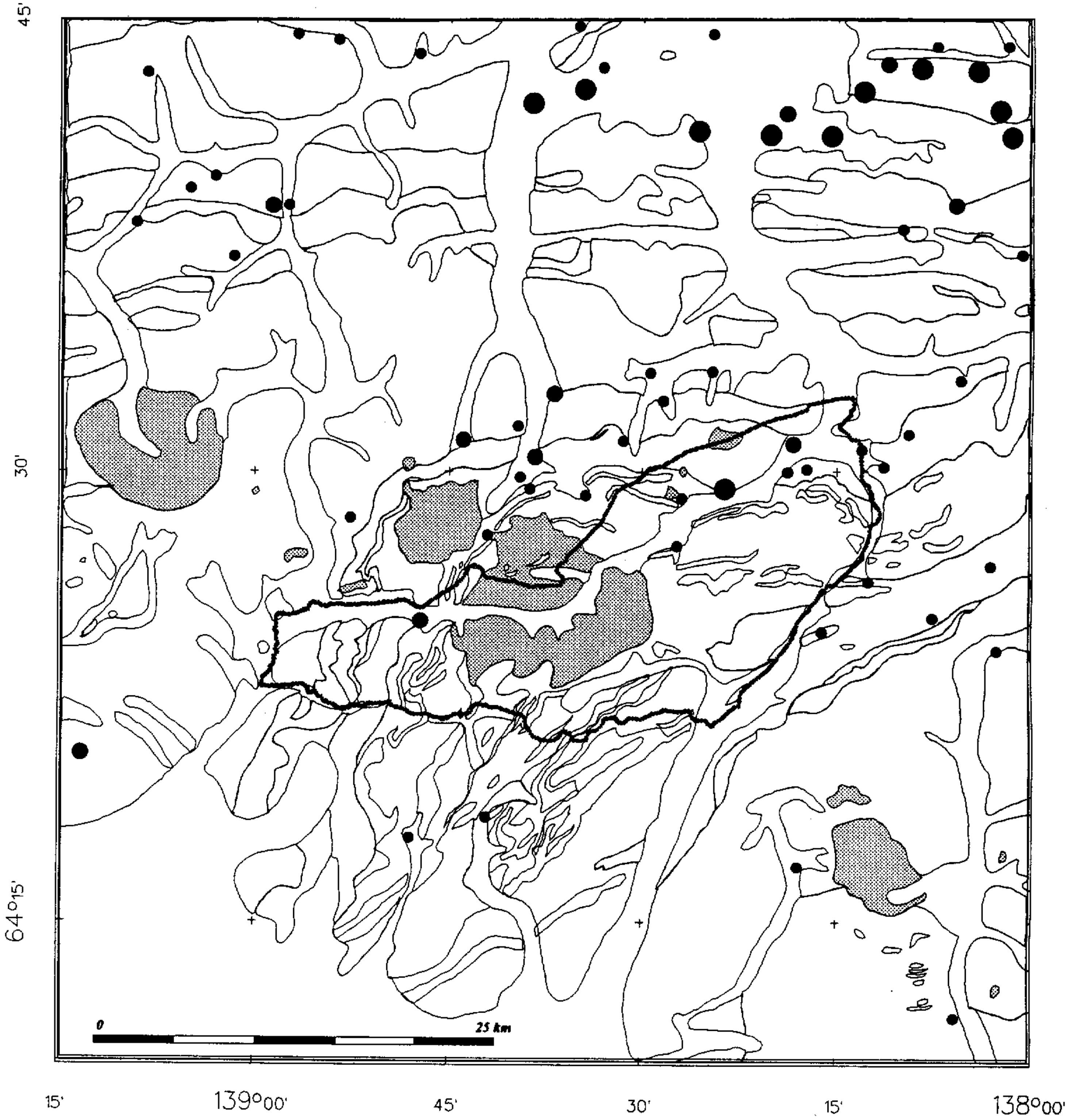
URANIUM IN STREAM SEDIMENT

● (large)	*95 to 100th percentile*	*11-130 ppm*
● (medium)	*90 to 95th percentile*	*7.8-11 ppm*
● (small)	*70 to 90th percentile*	*4.9-7.8 ppm*



YTTERBIUM IN STREAM SEDIMENT

●	*95 to 100th percentile*	*4.1-15.2 ppm*
●	*90 to 95th percentile*	*3.7-4.1 ppm*
•	*70 to 90th percentile*	*3.1-3.7 ppm*



ZINC IN STREAM SEDIMENT

⬤	*95 to 100th percentile*	*630-7600ppm*
●	*90 to 95th percentile*	*390-630 ppm*
•	*70 to 90th percentile*	*188-390 ppm*

PEARSON CORRELATION MATRIX

	ZN	CU	PB	NI	CO
ZN	1.000				
CU	0.357	1.000			
PB	0.051	0.077	1.000		
NI	0.563	0.535	-0.124	1.000	
CO	0.163	0.608	-0.065	0.745	1.000
AG	0.230	0.444	0.303	0.251	0.323
MN	0.039	0.166	0.025	0.190	0.369
BA	0.471	0.380	-0.028	0.419	0.242
MO	0.741	0.433	0.034	0.398	0.081
AS	0.043	0.466	0.225	-0.006	0.169
BR	0.000	0.157	0.067	-0.023	0.143
CR	0.050	0.240	-0.180	0.746	0.592
CS	-0.007	0.435	0.216	0.057	0.287
FE	0.092	0.451	-0.116	0.505	0.686
HF	-0.063	0.093	-0.149	0.032	0.178
NA	0.059	0.257	-0.090	0.264	0.428
RB	0.042	0.296	0.078	0.087	0.266
SB	0.206	0.327	0.244	0.102	0.118
SC	0.026	0.398	-0.212	0.583	0.744
TA	0.103	0.339	-0.171	0.594	0.671
TH	-0.055	0.216	0.184	-0.034	0.156
U	0.128	0.290	0.140	0.036	0.091
W	0.005	0.253	0.179	-0.073	0.051
LA	0.022	0.366	0.057	0.315	0.516
CE	0.005	0.360	0.014	0.360	0.586
ND	0.057	0.429	-0.023	0.443	0.649
SM	0.089	0.459	-0.053	0.471	0.666
EU	0.020	0.113	-0.013	0.064	0.149
TB	0.157	0.489	-0.165	0.428	0.559
YB	0.248	0.458	-0.113	0.323	0.436
LU	0.165	0.353	-0.048	0.255	0.373
AU	0.065	0.315	0.099	0.053	0.149
PH	0.006	-0.188	0.104	0.084	0.066
F	0.227	0.123	-0.032	0.094	-0.090

	AG	MN	BA	MO	AS
AG	1.000				
MN	0.145	1.000			
BA	0.347	0.053	1.000		
MO	0.377	0.109	0.399	1.000	
AS	0.168	0.042	0.037	0.097	1.000
BR	0.197	0.196	0.015	0.053	0.319
CR	0.134	0.107	0.100	-0.032	-0.083
CS	0.385	0.074	0.134	0.094	0.608
FE	0.431	0.564	0.187	0.139	0.172
HF	0.433	-0.019	0.102	-0.044	0.125
NA	0.620	0.146	0.184	0.064	0.143
RB	0.404	0.115	0.216	0.083	0.244

SB	0.275	0.019	0.151	0.196	0.607
SC	0.402	0.163	0.143	-0.030	0.042
TA	0.373	0.118	0.234	0.013	0.053
TH	0.272	0.068	0.117	0.026	0.412
U	0.190	0.009	0.158	0.254	0.465
W	0.200	-0.027	0.069	0.093	0.607
LA	0.346	0.148	0.198	0.033	0.316
CE	0.348	0.183	0.180	-0.018	0.252
ND	0.402	0.182	0.214	0.034	0.240
SM	0.496	0.182	0.223	0.085	0.228
EU	0.097	0.025	0.014	0.052	0.074
TB	0.570	0.117	0.257	0.207	0.179
YB	0.657	0.161	0.303	0.279	0.147
LU	0.725	0.159	0.245	0.214	0.157
AU	0.181	0.045	0.104	0.082	0.588
PH	-0.039	-0.011	0.046	-0.232	-0.103
F	0.103	-0.053	0.074	0.568	0.008

	BR	CR	CS	FE	HF
BR	1.000				
CR	-0.048	1.000			
CS	0.387	0.006	1.000		
FE	0.234	0.486	0.378	1.000	
HF	0.148	0.126	0.389	0.415	1.000
NA	0.195	0.294	0.479	0.650	0.725
RB	0.138	0.052	0.746	0.413	0.524
SB	0.079	-0.017	0.293	0.154	0.131
SC	0.105	0.687	0.312	0.733	0.522
TA	-0.019	0.582	0.345	0.653	0.521
TH	0.345	-0.023	0.761	0.327	0.523
U	0.627	-0.075	0.528	0.145	0.192
W	0.399	-0.098	0.595	0.163	0.296
LA	0.314	0.296	0.696	0.571	0.542
CE	0.203	0.368	0.649	0.626	0.574
ND	0.228	0.426	0.629	0.670	0.584
SM	0.223	0.464	0.609	0.730	0.641
EU	0.074	0.031	0.089	0.120	0.121
TB	0.156	0.373	0.481	0.627	0.684
YB	0.202	0.235	0.496	0.632	0.736
LU	0.245	0.231	0.499	0.622	0.699
AU	0.232	-0.016	0.414	0.167	0.207
PH	-0.053	0.110	-0.118	-0.074	-0.057
F	-0.023	-0.056	-0.046	-0.046	-0.096

	NA	RB	SB	SC	TA
NA	1.000				
RB	0.569	1.000			
SB	0.152	0.198	1.000		
SC	0.687	0.407	0.096	1.000	
TA	0.684	0.464	0.088	0.795	1.000
TH	0.508	0.732	0.195	0.220	0.324
U	0.264	0.314	0.144	0.010	0.073

W	0.269	0.344	0.288	0.056	0.107
LA	0.649	0.718	0.185	0.547	0.666
CE	0.680	0.726	0.165	0.639	0.747
ND	0.717	0.712	0.185	0.718	0.788
SM	0.783	0.674	0.203	0.800	0.821
EU	0.108	0.060	0.015	0.068	0.085
TB	0.797	0.586	0.206	0.747	0.703
YB	0.841	0.638	0.204	0.680	0.611
LU	0.910	0.606	0.194	0.629	0.590
AU	0.178	0.204	0.434	0.085	0.123
PH	−0.028	−0.068	−0.029	0.029	0.072
F	−0.087	−0.049	0.102	−0.128	−0.110

	TH	U	W	LA	CE
TH	1.000				
U	0.683	1.000			
W	0.616	0.654	1.000		
LA	0.852	0.556	0.470	1.000	
CE	0.766	0.386	0.368	0.969	1.000
ND	0.704	0.383	0.333	0.943	0.969
SM	0.622	0.314	0.312	0.883	0.927
EU	0.097	0.131	0.245	0.115	0.110
TB	0.446	0.247	0.248	0.641	0.683
YB	0.440	0.226	0.214	0.581	0.625
LU	0.442	0.248	0.233	0.555	0.580
AU	0.320	0.335	0.459	0.273	0.230
PH	−0.118	−0.151	−0.112	−0.074	−0.045
F	−0.018	0.147	−0.002	−0.051	−0.100

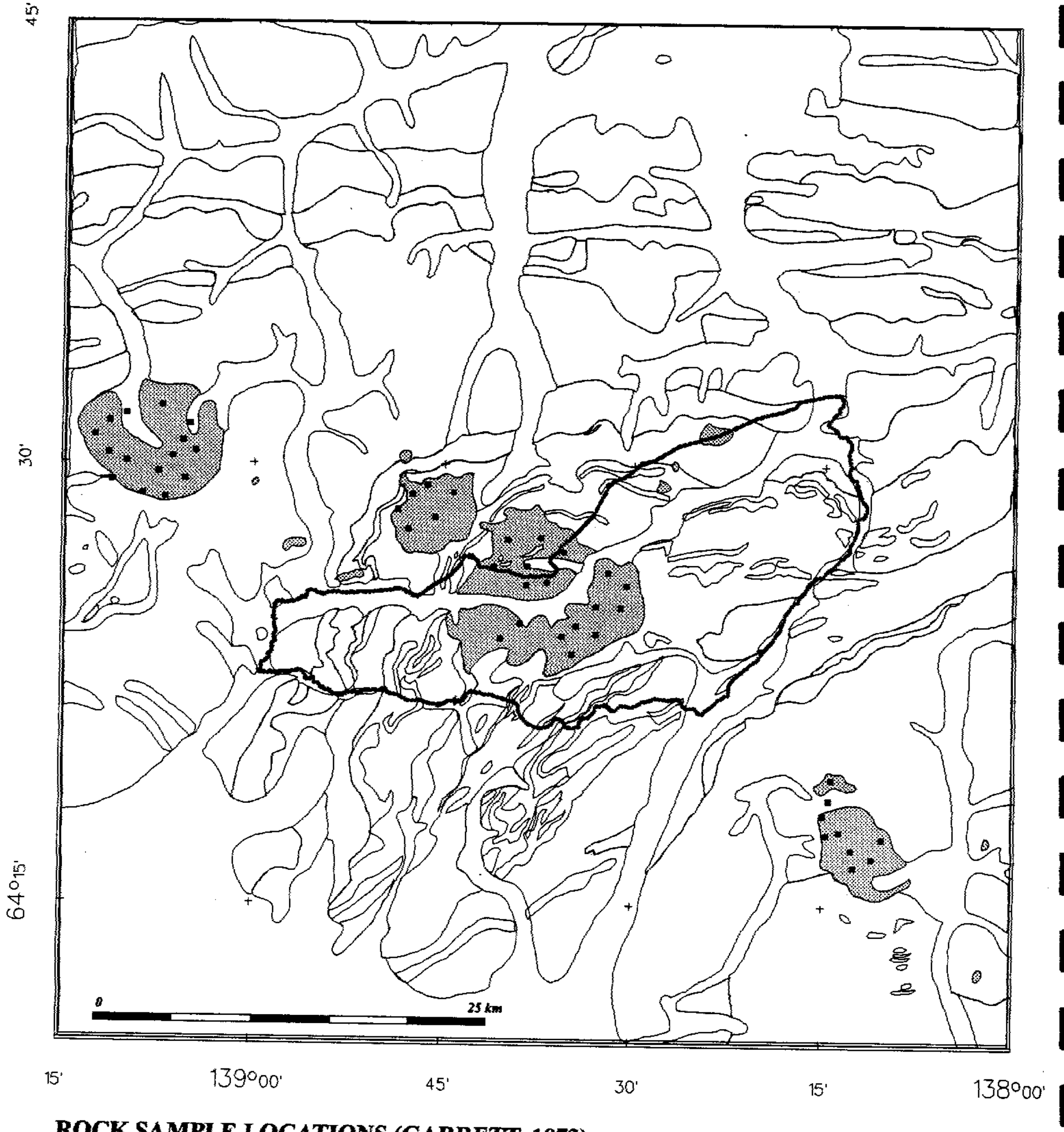
	ND	SM	EU	TB	YB
ND	1.000				
SM	0.962	1.000			
EU	0.116	0.123	1.000		
TB	0.753	0.826	0.114	1.000	
YB	0.697	0.783	0.121	0.871	1.000
LU	0.641	0.738	0.115	0.802	0.922
AU	0.217	0.231	0.342	0.165	0.201
PH	−0.042	−0.038	−0.046	−0.116	−0.124
F	−0.080	−0.068	−0.001	0.033	0.043

	LU	AU	PH	F
LU	1.000			
AU	0.198	1.000		
PH	−0.029	−0.079	1.000	
F	−0.014	−0.005	−0.393	1.000

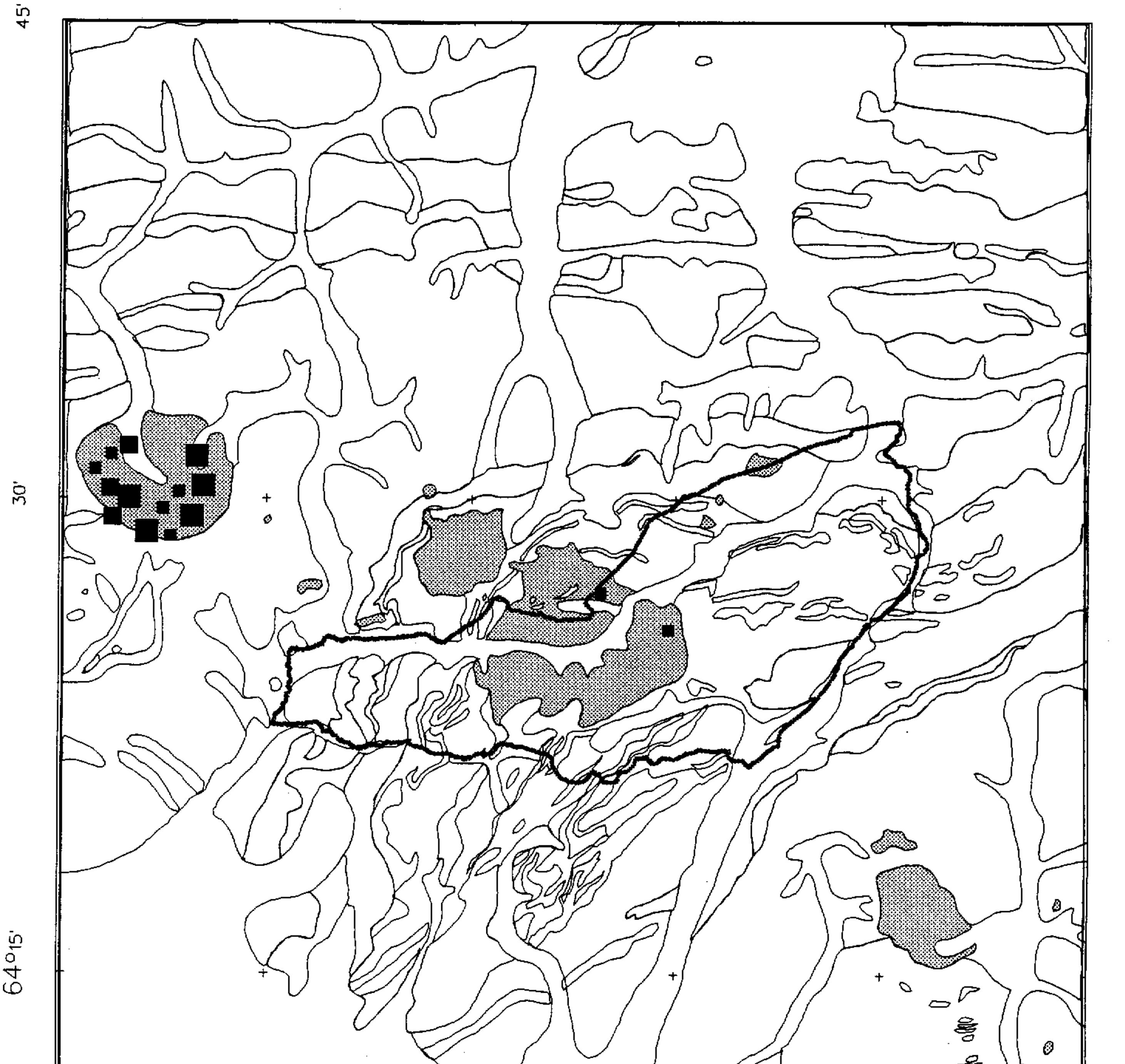
NUMBER OF OBSERVATIONS: 341

APPENDIX B

LITHOGEOCHEMICAL DATA

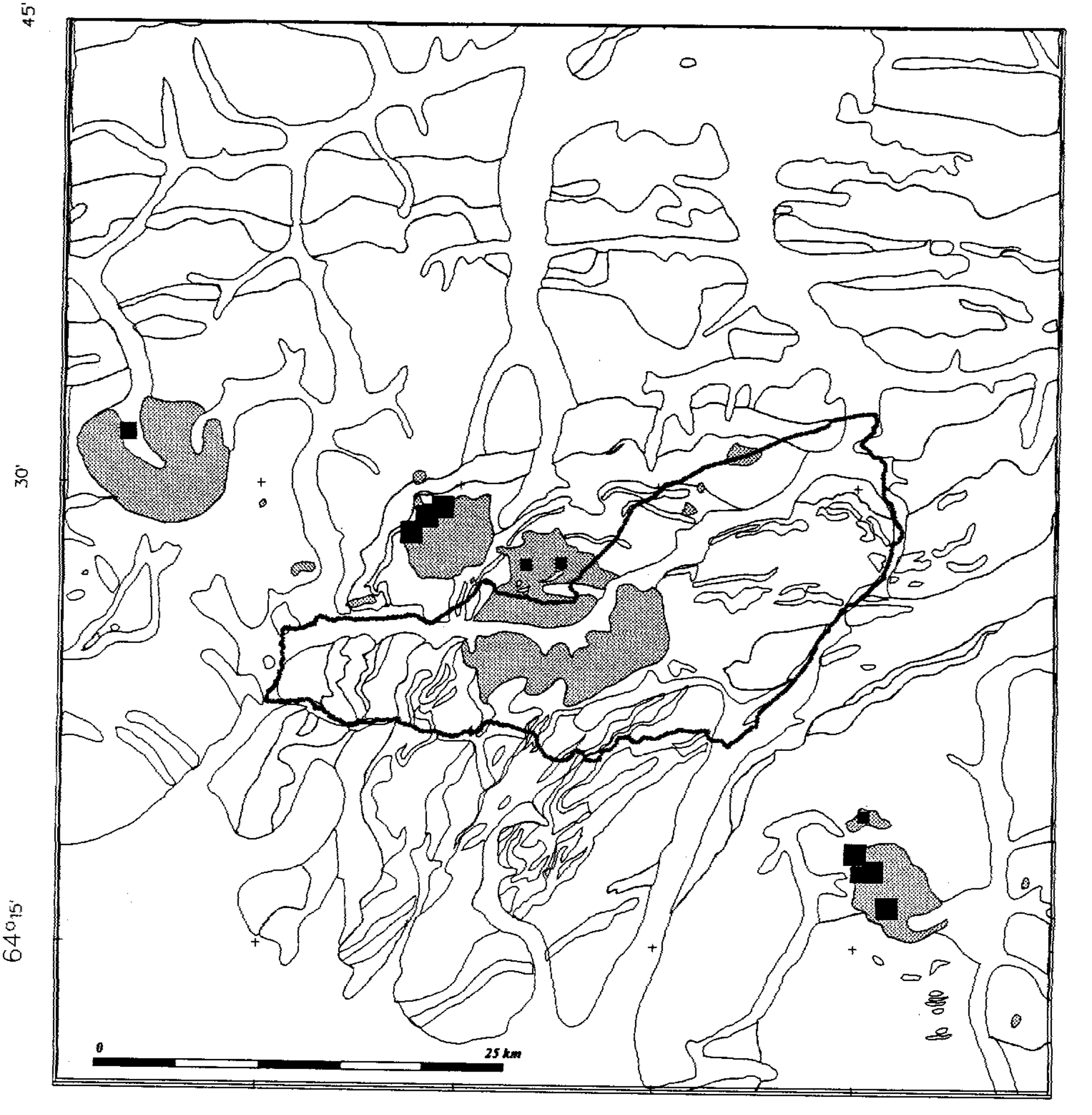


ROCK SAMPLE LOCATIONS (GARRETT, 1973)



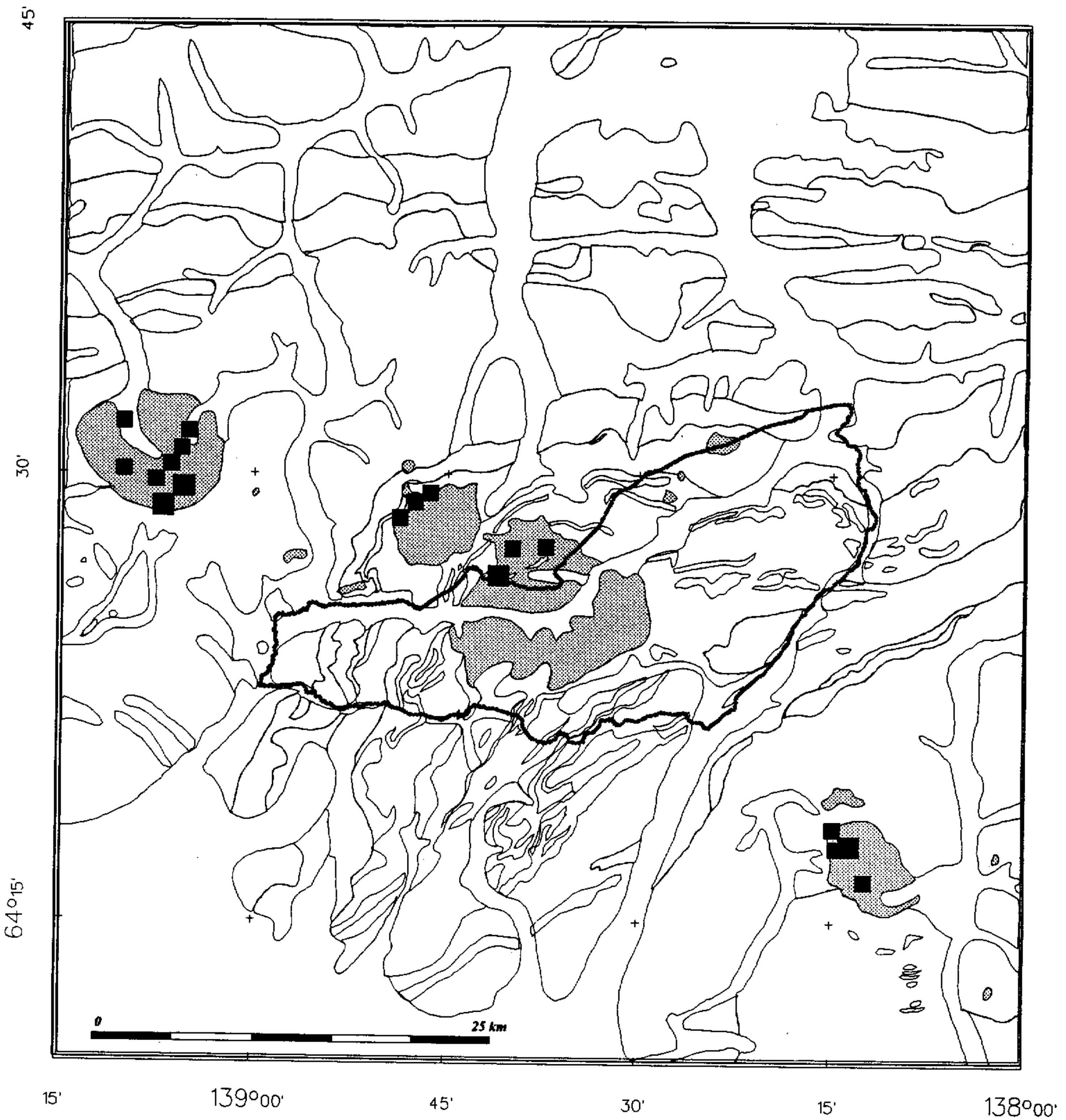
BARIUM IN ROCK

■	*95 to 100th percentile*	*6400-8500 ppm*
■	*90 to 95th percentile*	*5500-6400 ppm*
■	*80-90th percentile*	*3800-5500 ppm*



BERYLLIUM IN ROCK

■	*95 to 100th percentile*	*14-16 ppm*
■	*90 to 95th percentile*	*13-14 ppm*
■	*83 to 90th percentile*	*9-13 ppm*



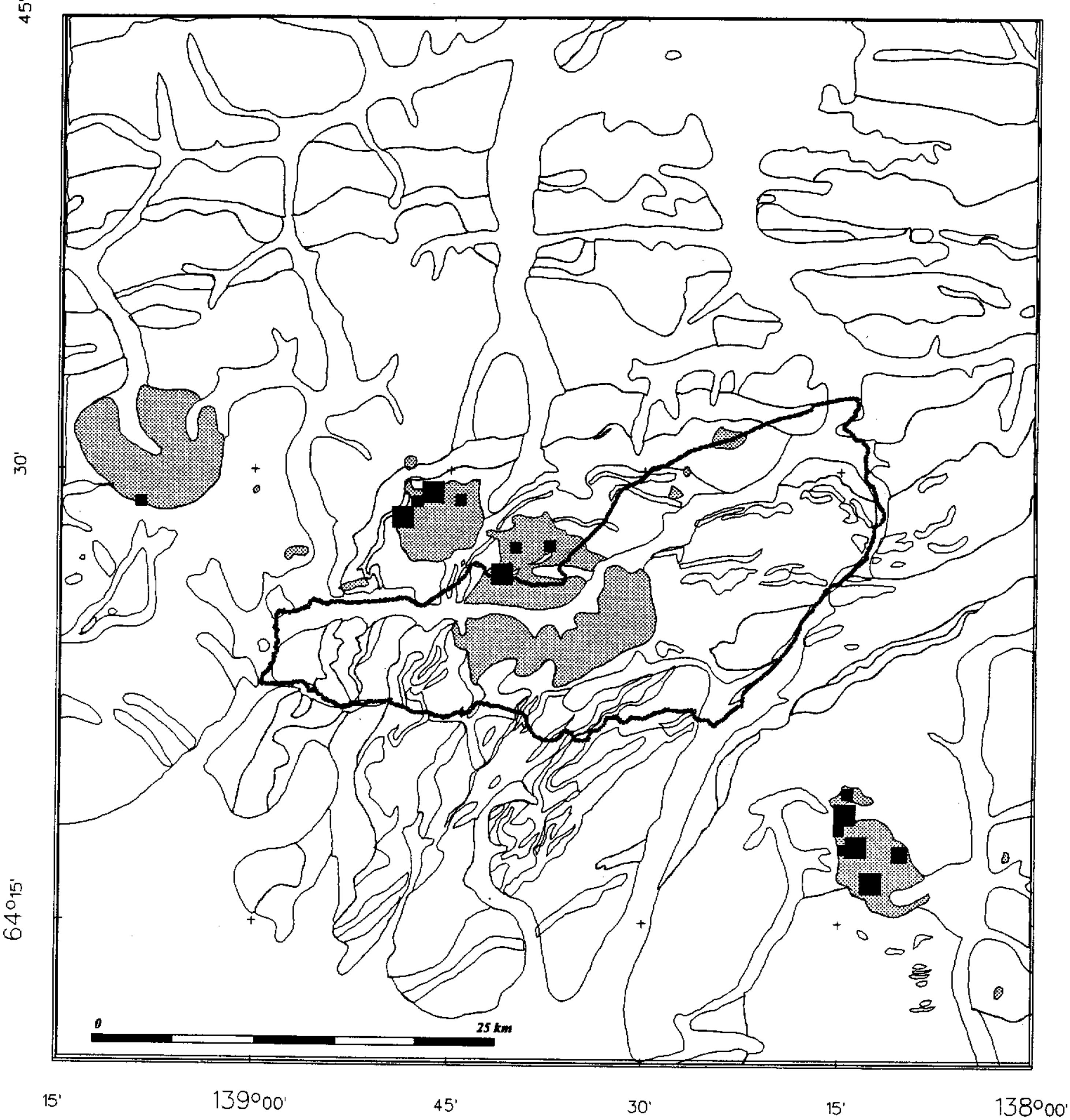
CALCIUM IN ROCK

■ *95 to 100th percentile* *6.0-8.3%*

■ *74 to 95th percentile* *3.6-6.0%*

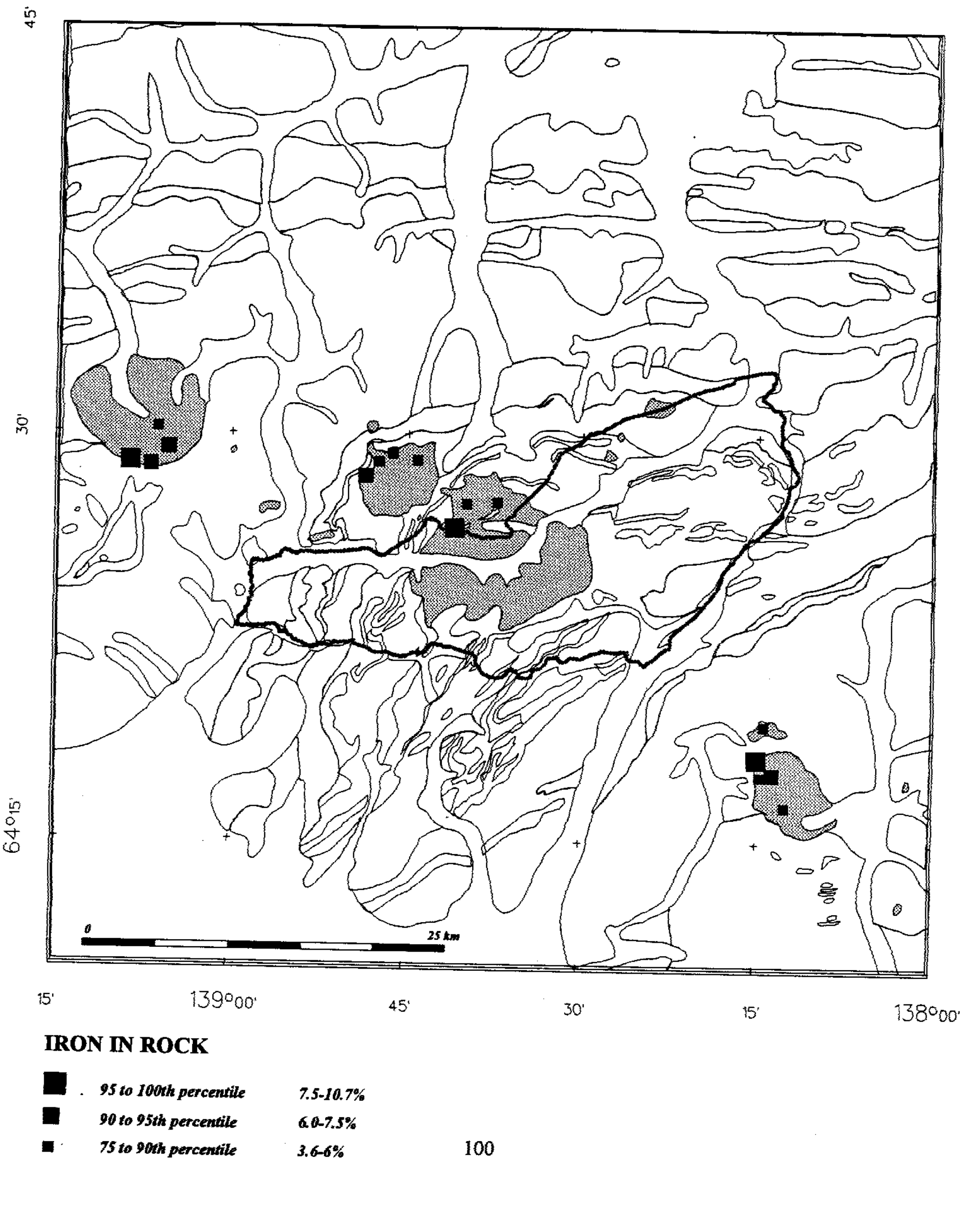
COBALT IN ROCK

■	*95 to 100th percentile*	*22-39 ppm*
■	*90 to 95th percentile*	*19-22 ppm*
■	*77 to 90th percentile*	*8.2-19 ppm*



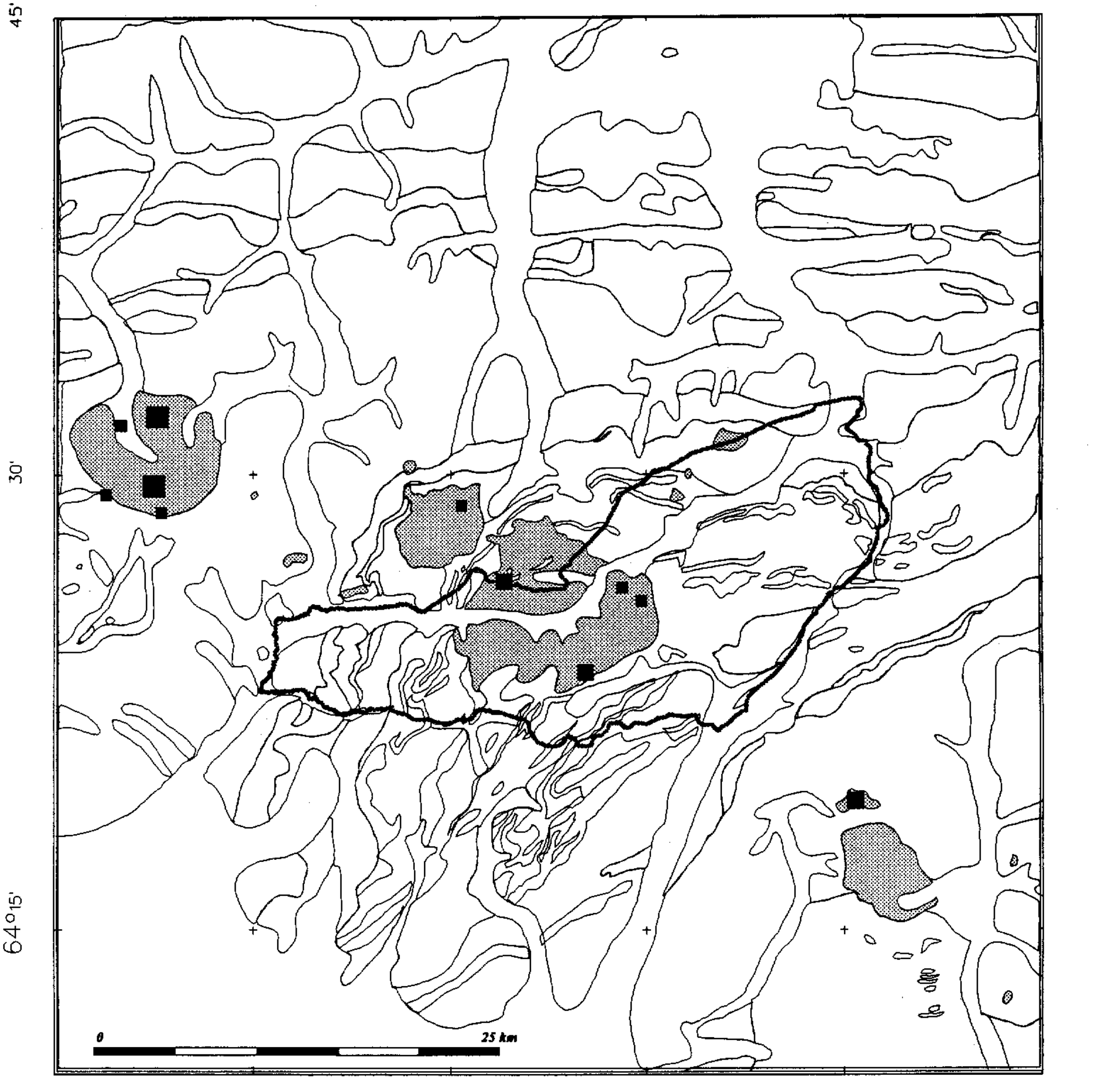
COPPER IN ROCK

■	*95 to 100th percentile*	*44-245 ppm*
■	*90 to 95th percentile*	*38-44 ppm*
■	*75 to 90th percentile*	*18-38 ppm*



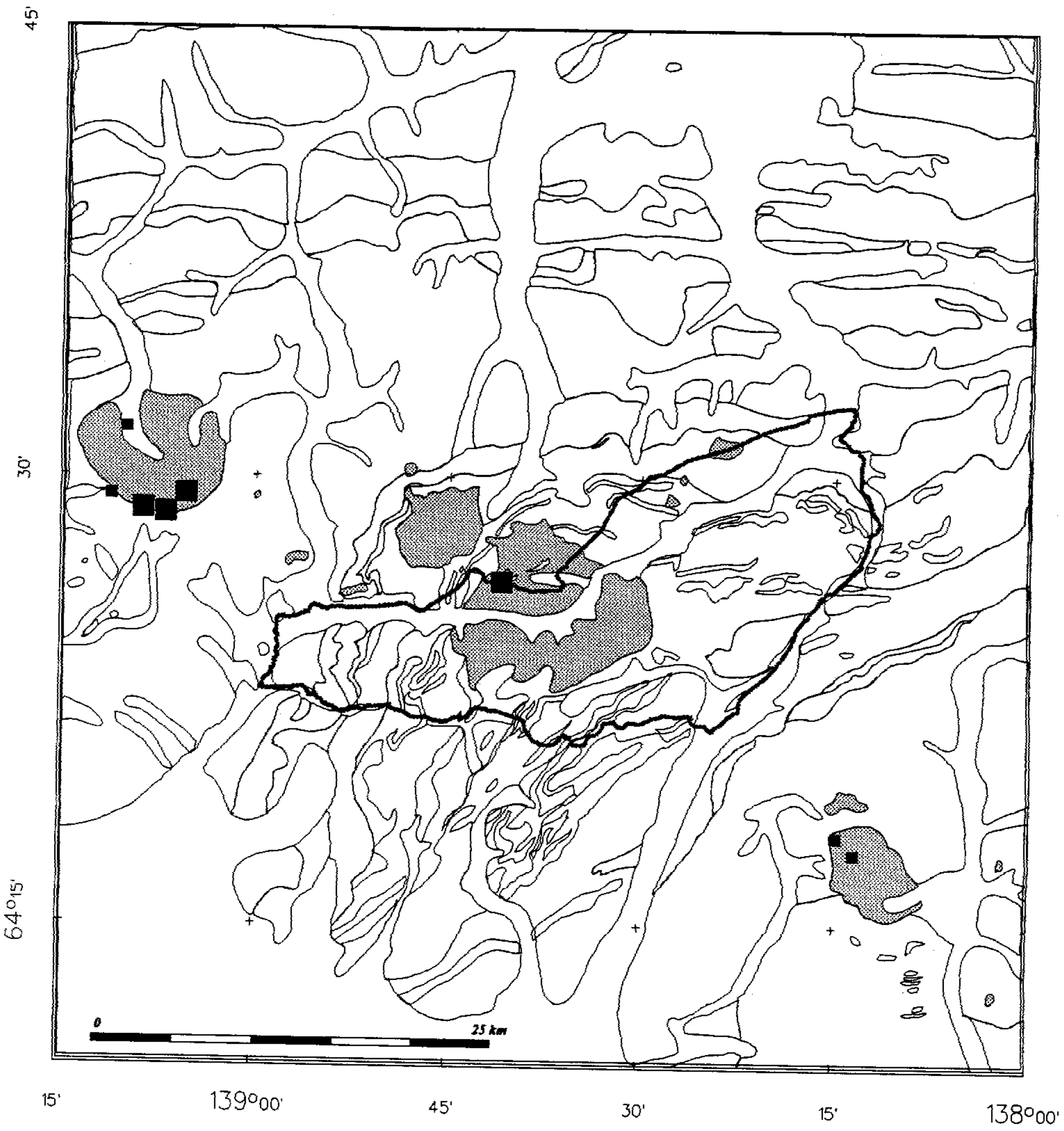
IRON IN ROCK

■ (largest)	*95 to 100th percentile*	*7.5-10.7%*
■	*90 to 95th percentile*	*6.0-7.5%*
■ (smallest)	*75 to 90th percentile*	*3.6-6%*



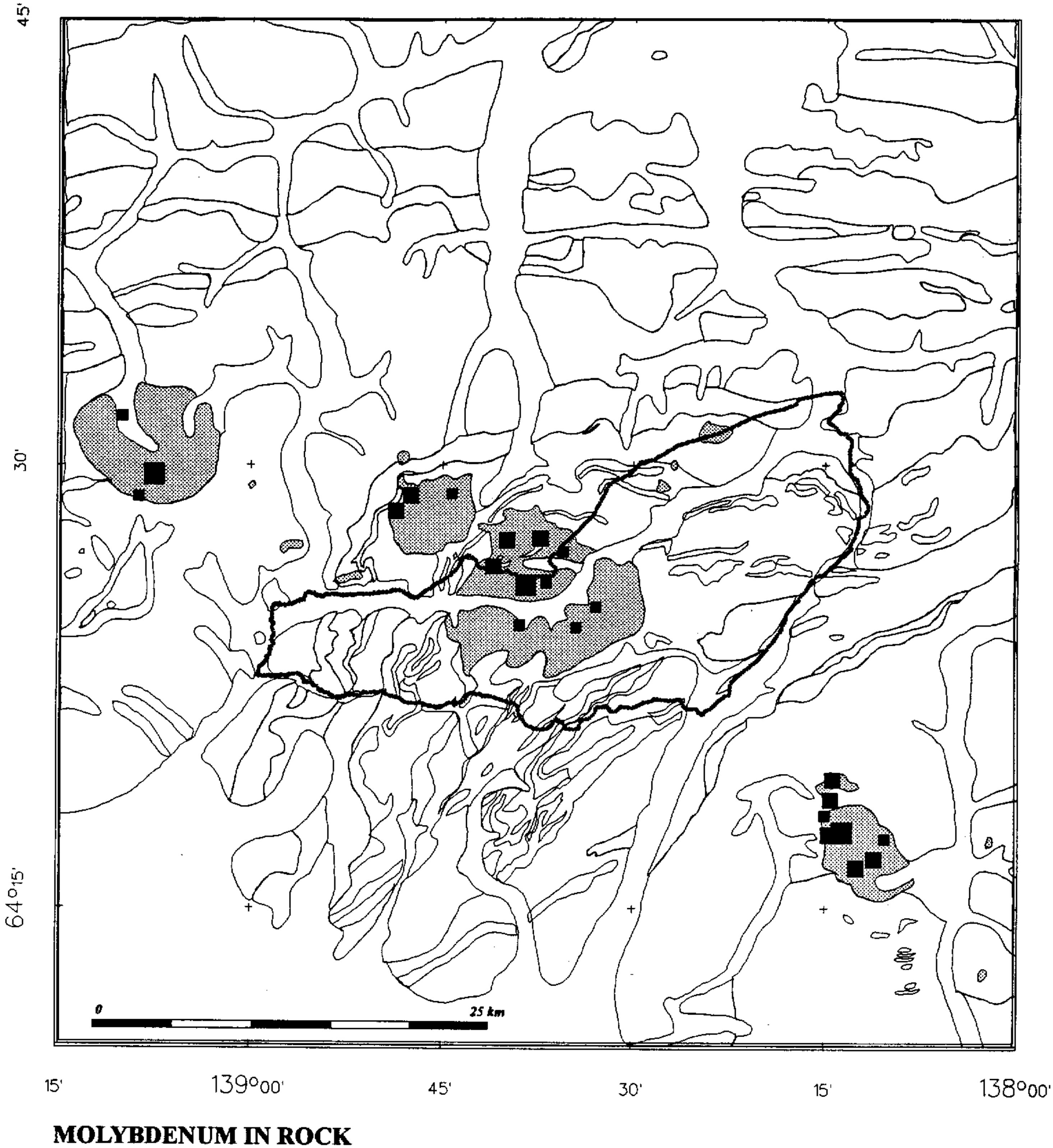
LEAD IN ROCK

■	*97 to 100th percentile*	*116-139 ppm*
■	*90 to 97th percentile*	*97-116 ppm*
■	*80 to 90th percentile*	*76-97 ppm*



MANGANESE IN ROCK

■	*95 to 100th percentile*	*2346-4114 ppm*
■	*93 to 95th percentile*	*1730-2346 ppm*
■	*90 to 93rd percentile*	*1576-1730 ppm*

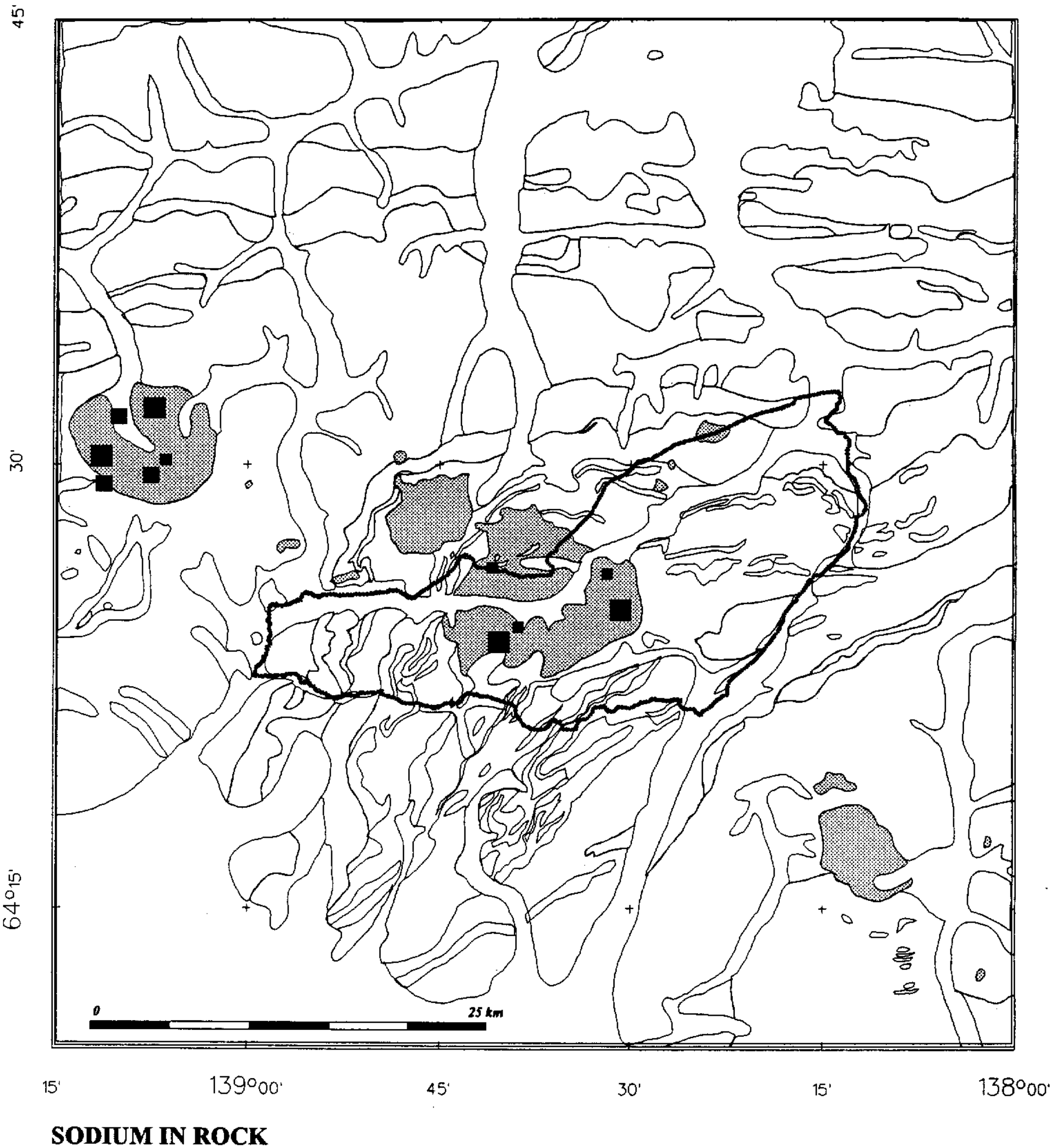


MOLYBDENUM IN ROCK

■	*98 to 100th percentile*	*2-4 ppm*
■	*85 to 98th percentile*	*1-2 ppm*
■	*67 to 85th percentile*	*0.2-1 ppm*

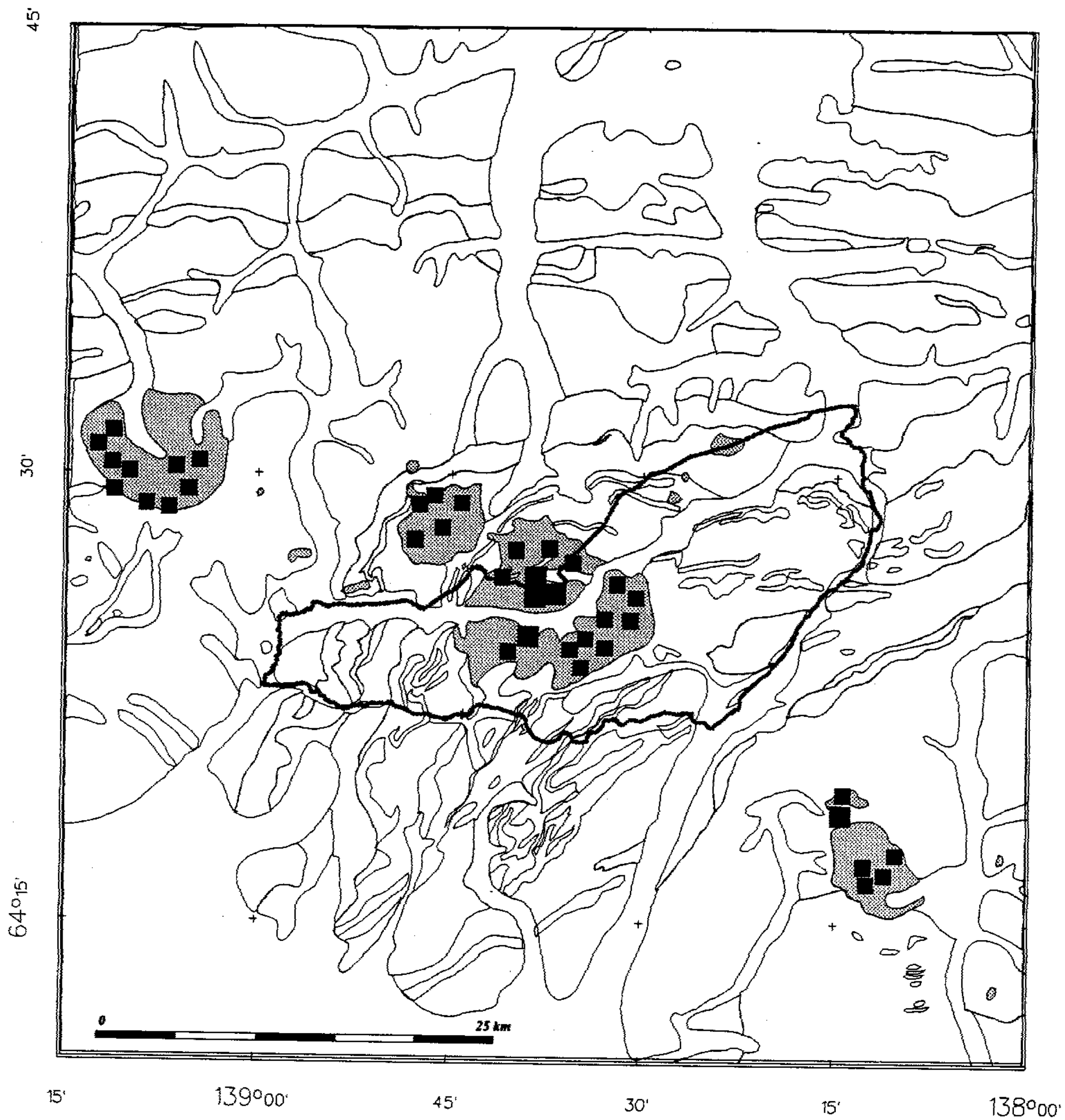
POTASSIUM IN ROCK

■ . *95 to 100th percentile* *9-10%*



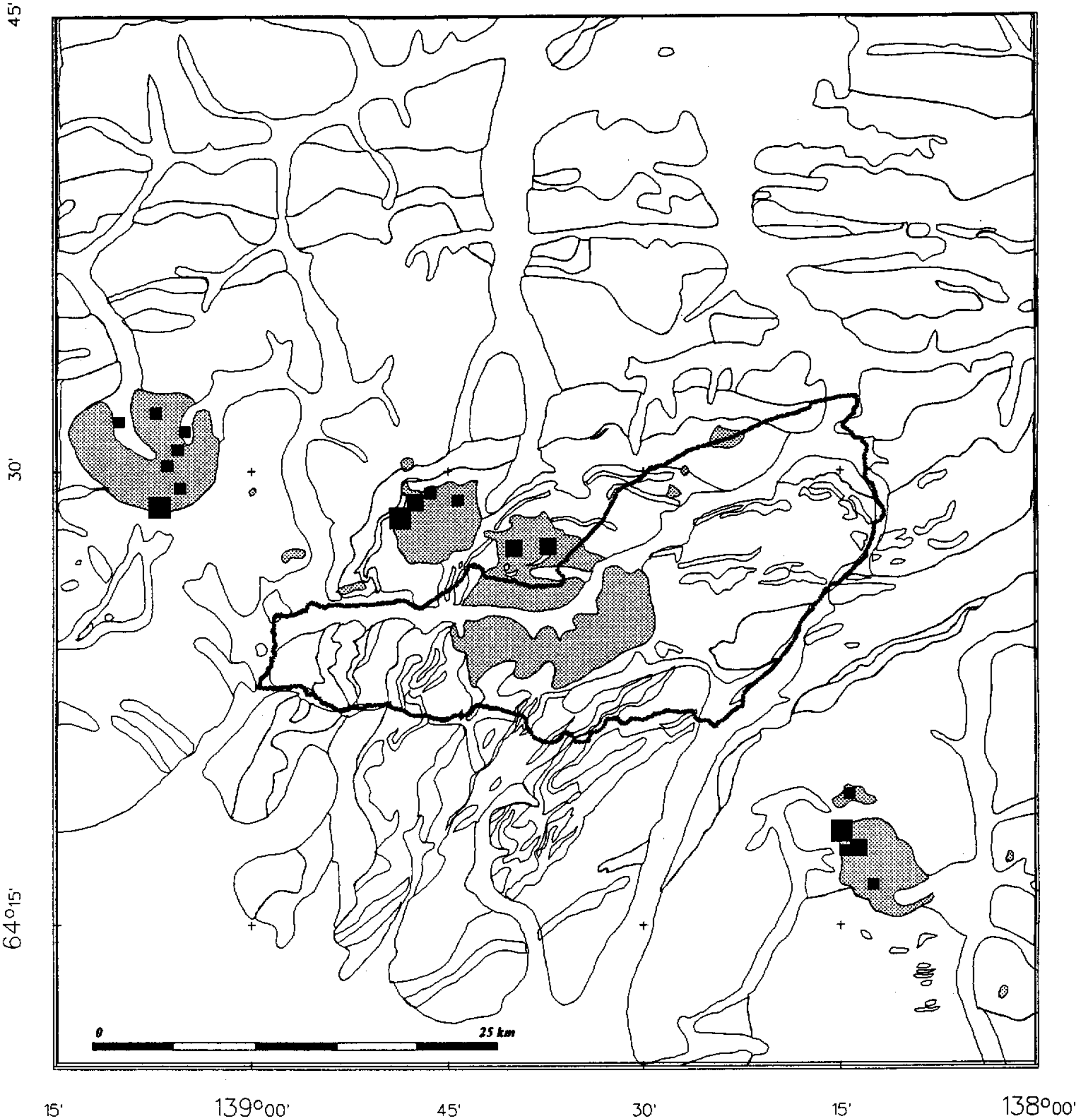
SODIUM IN ROCK

■	*95 to 100th percentile*	*4.1-4.9%*
■	*90 to 95th percentile*	*3.6-4.1%*
■	*80 to 90th percentile*	*3.2-3.6%*



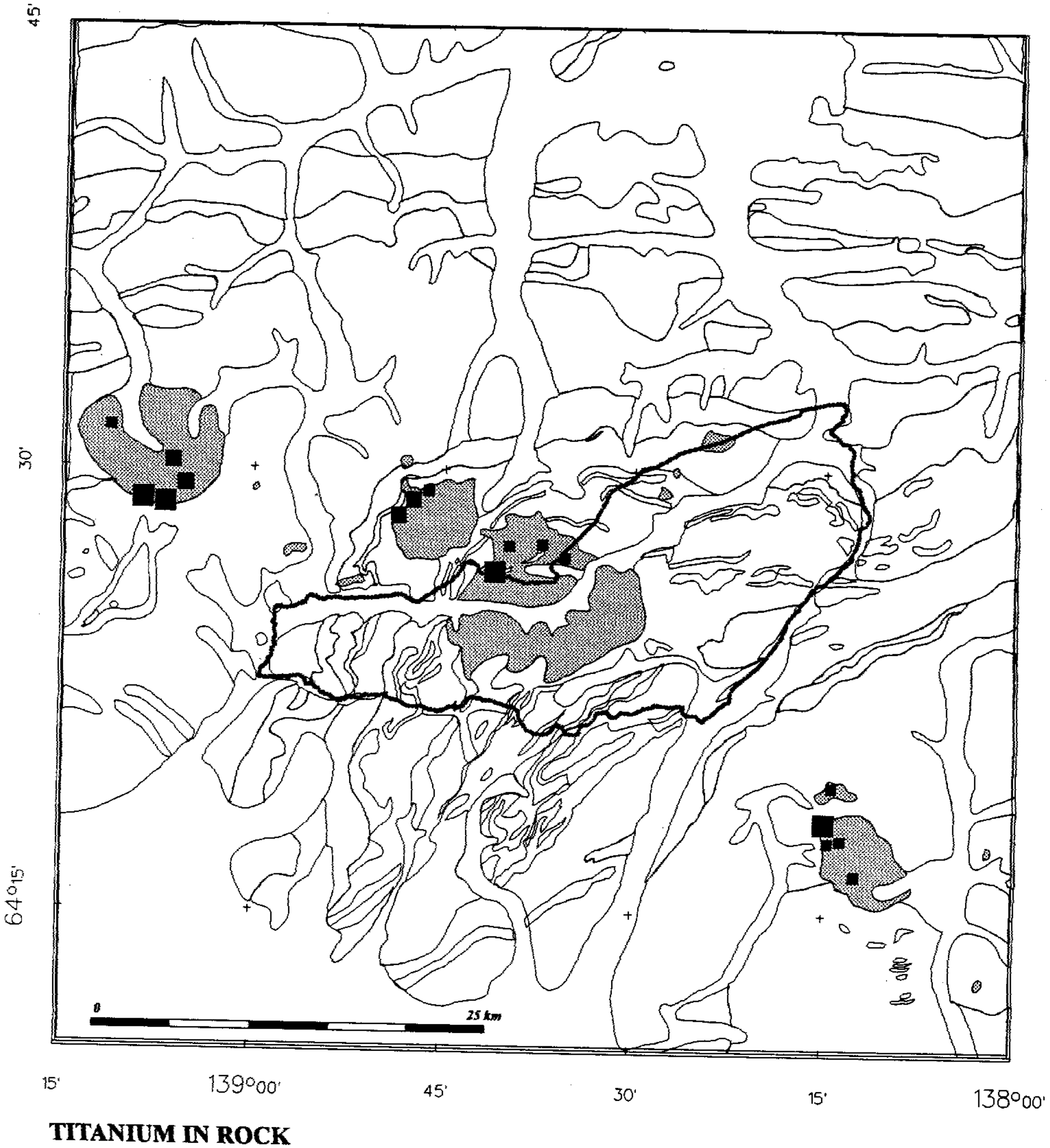
SILICON IN ROCK

■	*95 to 100th percentile*	*31.5-33.4%*
■	*92 to 95th percentile*	*26.5-31.5%*



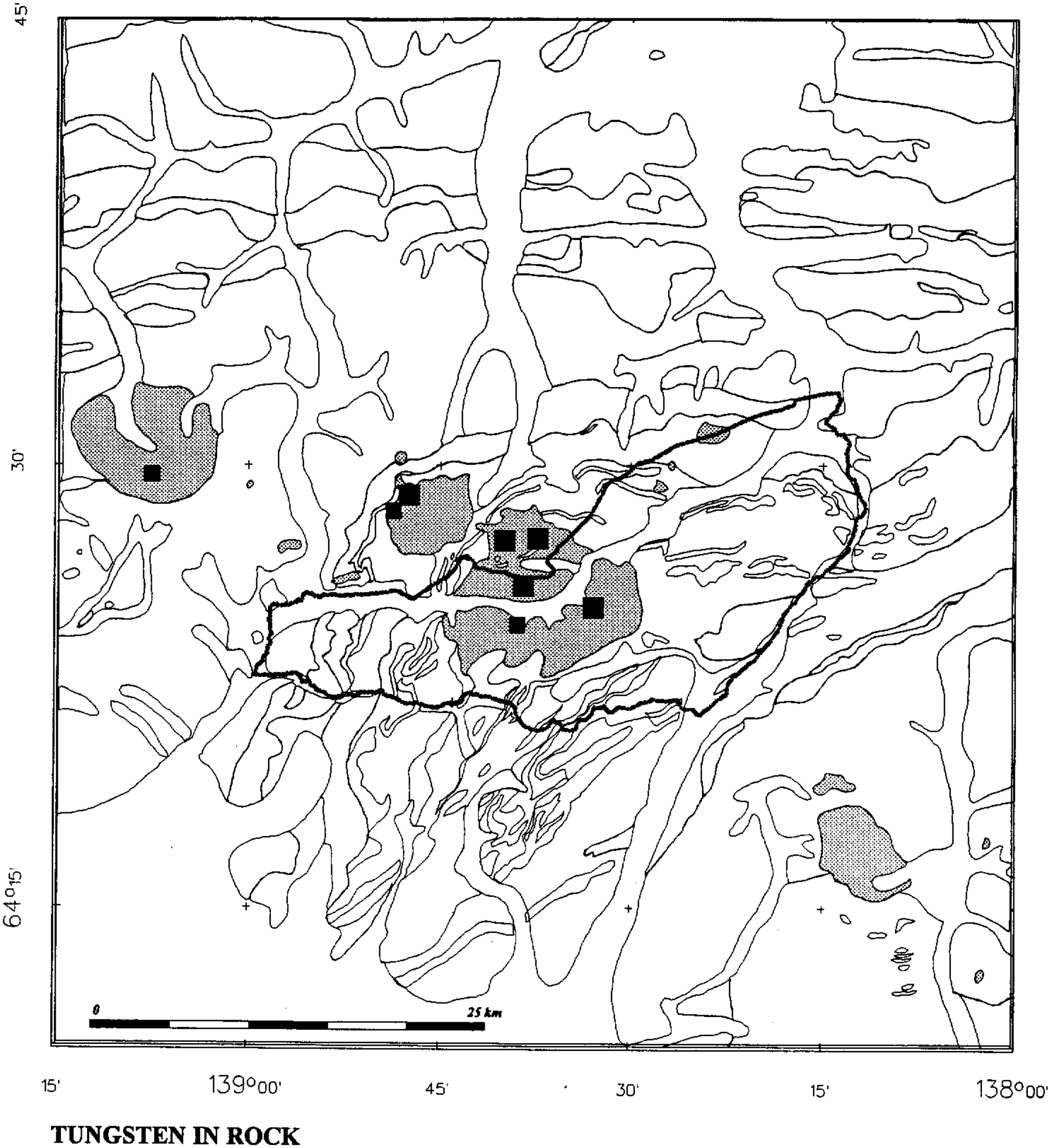
TIN IN ROCK

■	*95 to 100th percentile*	*3.8-4.9 ppm*
■	*90 to 95th percentile*	*2.8-3.8 ppm*
■	*78 to 90th percentile*	*2.1-2.8 ppm*



TITANIUM IN ROCK

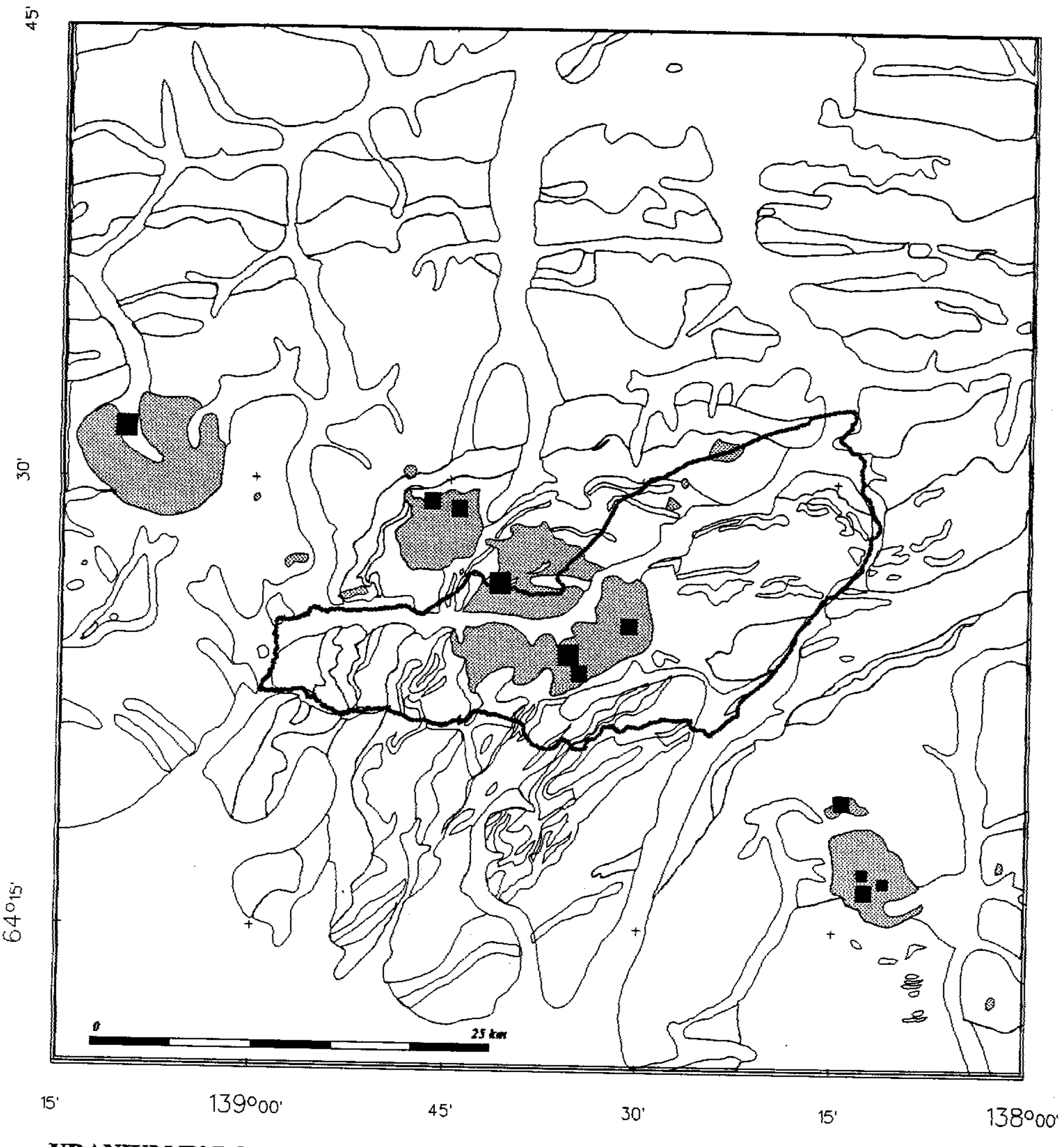
■	*95 to 100th percentile*	*7467-8855 ppm*
■	*90 to 95th percentile*	*5538-7467 ppm*
■	*75 to 90th percentile*	*4114-5538 ppm*



TUNGSTEN IN ROCK

■ 92 to 100th percentile 2-4 ppm

■ 90 to 92nd percentile 1-2 ppm

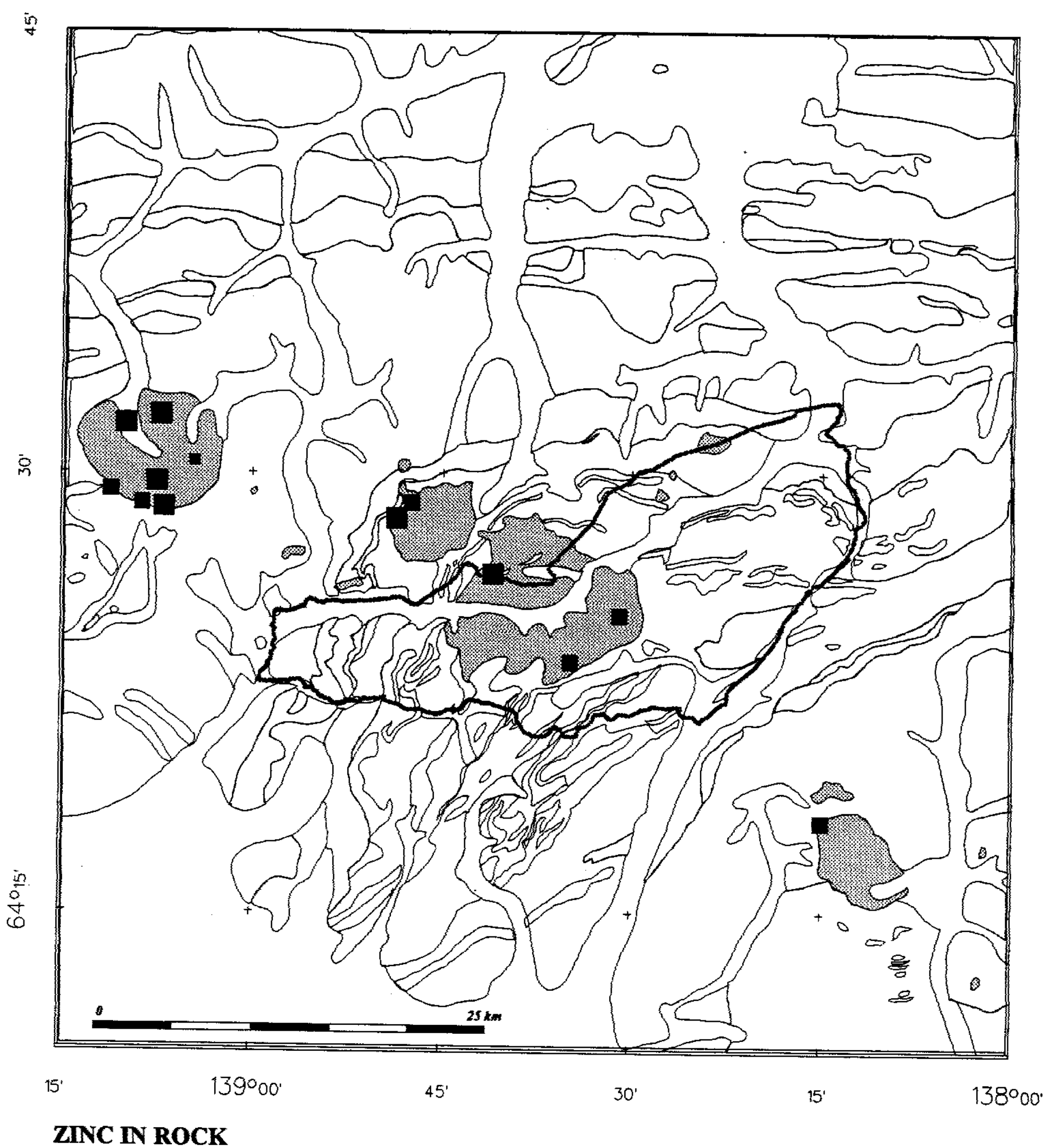


URANIUM IN ROCK

■ (large)	*95 to 100th percentile*	*13.3-18.8 ppm*
■ (medium)	*90 to 95th percentile*	*10.3-13.3 ppm*
■ (small)	*80 to 90th percentile*	*7.8-10.3 ppm*

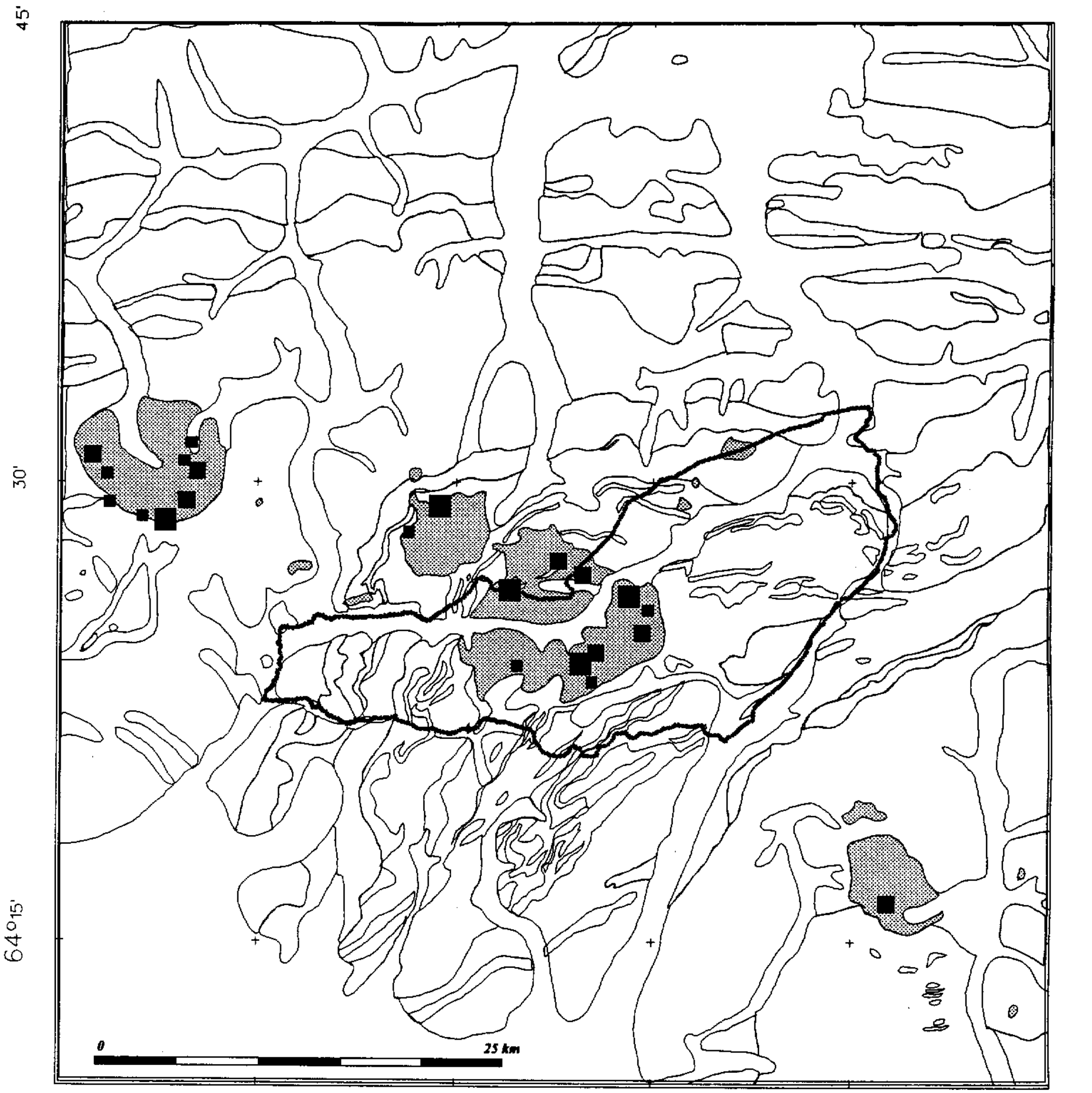
VANADIUM IN ROCK

■	*95 to 100th percentile*	*97-154.6 ppm*
■	*90 to 95th percentile*	*77-97 ppm*
■	*77 to 90th percentile*	*38-77 ppm*



ZINC IN ROCK

■	*92 to 100th percentile*	*155-225 ppm*
■	*83 to 92nd percentile*	*127-155 ppm*
■	*80 to 83rd percentile*	*118-127 ppm*



ZIRCONIUM IN ROCK

■	*95 to 100th percentile*	*112-143 ppm*
■	*80 to 95th percentile*	*80-100 ppm*
■	*75 to 80th percentile*	*65-80 ppm*

PEARSON CORRELATION MATRIX

	SI	AL	FE	MG	CA
SI	1.000				
AL	-0.271	1.000			
FE	-0.698	-0.066	1.000		
MG	-0.441	-0.192	0.813	1.000	
CA	-0.587	-0.439	0.744	0.654	1.000
NA	0.188	0.016	-0.641	-0.580	-0.354
K	0.007	0.121	-0.492	-0.669	-0.397
TI	-0.538	-0.041	0.909	0.735	0.628
MN	-0.723	0.043	0.779	0.398	0.693
BA	-0.293	-0.098	0.101	-0.069	0.363
ZN	-0.699	0.095	0.626	0.368	0.427
CU	-0.150	-0.225	0.367	0.528	0.328
PB	-0.079	0.132	-0.143	-0.118	-0.153
NI	-0.245	0.626	0.423	0.305	-0.142
CO	-0.542	0.049	0.884	0.894	0.524
MO	-0.066	-0.049	0.157	0.350	0.133
W	0.116	-0.115	0.051	0.157	0.094
U	0.006	0.011	-0.069	-0.052	-0.106
BE	-0.301	0.054	0.378	0.587	0.353
V	-0.486	-0.147	0.849	0.900	0.669
SN	-0.372	-0.103	0.368	0.407	0.611
ZR	-0.271	-0.022	0.267	0.039	0.236

	NA	K	TI	MN	BA
NA	1.000				
K	0.402	1.000			
TI	-0.706	-0.459	1.000		
MN	-0.425	-0.229	0.730	1.000	
BA	-0.035	0.138	0.032	0.248	1.000
ZN	-0.146	-0.020	0.573	0.713	0.050
CU	-0.275	-0.360	0.315	0.154	-0.081
PB	0.254	0.235	-0.149	-0.024	-0.226
NI	-0.507	-0.391	0.462	0.281	-0.207
CO	-0.666	-0.618	0.795	0.509	-0.048
MO	-0.157	-0.222	0.097	0.019	-0.124
W	-0.071	-0.193	0.043	-0.048	-0.078
U	0.093	0.146	-0.108	-0.054	-0.306
BE	-0.204	-0.434	0.322	0.150	-0.006
V	-0.609	-0.628	0.813	0.533	-0.041
SN	-0.124	-0.323	0.355	0.379	0.213
ZR	-0.110	0.194	0.304	0.374	0.026

	ZN	CU	PB	NI	CO
ZN	1.000				
CU	0.133	1.000			
PB	0.384	-0.022	1.000		
NI	0.212	0.062	-0.222	1.000	
CO	0.457	0.421	-0.163	0.581	1.000
MO	0.105	0.264	0.152	-0.015	0.238
W	-0.002	0.000	-0.086	0.007	0.112
U	0.066	0.083	0.520	-0.182	-0.082
BE	0.234	0.248	0.206	0.081	0.447
V	0.416	0.466	-0.171	0.335	0.843
SN	0.278	0.120	0.158	-0.143	0.243
ZR	0.315	0.045	0.175	-0.029	0.073

	MO	W	U	BE	V
MO	1.000				
W	0.491	1.000			
U	0.139	-0.112	1.000		
BE	0.476	0.184	0.216	1.000	
V	0.254	0.113	-0.092	0.473	1.000
SN	0.251	0.216	0.082	0.700	0.427
ZR	-0.265	-0.163	0.219	-0.052	0.058

	SN	ZR
SN	1.000	
ZR	0.094	1.000

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