Dispersion patterns of kimberlite indicator minerals, West Greenland

Peter W. Uitterdijk Appel

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CONTENTS

ABSTRACT

Twenty seven 50 kg stream sediment samples and two 300 kg stream sediment samples were collected from two streams in the Sarfartôq area, West Greenland. The numerous kimberlite dykes known to outcrop along the two streams carry kimberlite indicator minerals such as pyrope, chromediopside, picroilmenite and chromespinel. Diamonds were not found, but kimberlite indicator minerals such as pyrope, picroilmenite, chromediopside and chromespinel were found in the fine fraction of the stream sediments. The dispersion pattern of the indicator minerals in the streams show that kimberlites can be traced by stream sediment sampling, and that even a few indicator minerals indicate kimberlites upstream.

Two bulk samples of kimberlite dykes were investigated. One 610 kg sample from Sarfartôq and one 195.8 kg sample from Maniitsoq. No diamonds were found in any of the samples. The Sarfartôq dyke proved to be highly micaceous and very low in indicator minerals which were all fine grained. One pyrope from the Sarfartôq sample was of class 3 according to Dawson & Stephens (1975) classification. The Maniitsoq dyke was a low-micaceous kimberlite with an abundance of indicator minerals in grains up to 1 cm. Most pyropes from this dyke were of classes 9, 11 and 12 according to Dawson & Stephens (1975) classification.

Pressure-temperature estimates on pyrope-clinopyroxene equilibrium, general mineralogy and chemical composition indicate that the Maniitsoq kimberlite holds a better potential of being diamondiferous than the Sarfartôq kimberlite.

INTRODUCTION

Kimberlites have been known in Greenland for several decades and some prospecting has been carried out by several companies. Diapros Ltd., Canada carried out stream sediment programmes in the 70s as a result of which one microdiamond was found in a stream sediment collected in the Sarfartôq area. In the beginning of the 90s RTZ carried out a limited stream sediment sampling programme for kimberlite indicator minerals.

In view of the recent "Diamond rush" in Canada it was decided to carry out a pilot project in order to establish the dispersion pattern of kimberlite indicator minerals in West Greenland.

The Canadian kimberlites were primarily found by tracing kimberlite indicator minerals in moraine deposits. This method is, however, not particularly suited for Greenland due to the lack of extensive moraine cover in West Greenland.

The ice free area in West Greenland is fairly rugged with a good degree of exposure, generally well over 50 % of the bed rock is exposed. Thick extensive glacial tills are rare and moraine is generally restricted to small isolated areas. Most of the streams are turbulent and generally do not reach great length before entering one of the numerous lakes which dominate the landscape. The indicator mineral programme in the glacial tills which proved so successful in Canada is thus of limited use in West Greenland. It was decided to carry out a pilot study during which different types of streams which are known to cut kimberlites, were tested for heavy minerals. The aim of the study was to determine whether kimberlite indicator minerals can be found in the streams, how far they travel and in which size fractions most indicator minerals appear.

A second minor project consisted of bulk sampling of a kimberlite from the northern Sarfartôq region. Furthermore a bulk sample from the southern Maniitsoq region previously collected by the Cryolite company, was tested for diamonds and the indicator minerals investigated.

REGIONAL DISTRIBUTION OF KIMBERLITES

Kimberlites have been found in several areas. The Sisimiut-Sarfartôq area where the kimberlites occur in Proterozoic rocks (Fig. 1), the Maniitsoq area within the Archaean craton of West Greenland, and the Paamiut-Ivittuut region in the southern part of the

Archaean craton. Larsen (1991) has made a detailed inventory of known kimberlites to which the reader is referred for further information.

In the Sisimiut-Sarfartôq area kimberlite swarms. The Sisimiut swarm which occurs over an area 60 km long and 15 to 20 km wide. The kimberlites are phlogopite-bearing with ultramafic nodules and macrocrysts of olivine, garnet and ilmenite.

The Sarfartôq kimberlite swarm covers an area of 80 by 80 km on either side of the border between the Proterozoic and the Archaean (Fig. 1). The kimberlites are related to the Sarfartôq carbonatite complex. The kimberlites range in age from 589 to 656 Ma (Larsen, 1991).

The kimberlites in the Maniitsoq area are found within an area of 50 by 50 km, and their age range from 586 to 613 Ma (Larsen, 1991). These kimberlites are dykes up to two metres thick with a variable strike. They contain macrocrysts of olivine, garnet and opaques.

The Paamiut-Ivittuut kimberlites range in age from 193 to 220 Ma (Larsen, 1991). These kimberlites occur mainly as sills, but one dyke traceable for several hundred metres have been found near Paamiut.

KIMBERLITES IN THE INVESTIGATED AREA

The Sarfartôq carbonatite complex is found at the border between the Archaean block to the south and the Proterozoic Nagssugtoqidian mobile belt to the north (Secher & Larsen, 1980). Associated with the carbonatite is a kimberlite swarm, where the kimberlites are found as cone sheets centred on the carbonatite. Some of the kimberlites carry abundant nodules such as nodules of dunite, lherzolite and granulite. Many of the dykes are phlogopitic with macrocrysts of olivine, ilmenite and magnetite. An unfortunate feature from an exploration point of view is the scarcity of garnet macrocrysts and macroscopic garnets in the kimberlite groundmass. Detailed field inspection in 1993 only revealed very few macroscopic garnets, most of them deep slightly purplish red. The kimberlites have been described by Larsen (1991) to which the reader is referred for a brief account on their mineralogy and chemistry.

The kimberlites found in the area adjacent to the Sarfartôq glacier are generally less than a metre wide. Locally, however, a multitude of closely spaced dykes, ranging from a few centimetres to a metre in width, can be found separated by gneiss sheets only tens of centimetres thick; thus yielding a combined width of the kimberlite of a few metres. The dykes occur as sheets and dykes with dips ranging from shallow to vertical. Kimberlites with crosscutting relationships have been found.

Some of the kimberlite dykes are deeply weathered and appear as yellow ground, whereas most of them are quite fresh and appear in depressions as typical hardebank.

"Kimberlite fracturing" is abundant and locally quite spectacular, appearing as sets of fractures on either side of the kimberlites. Even kimberlite dykes down to a few centimetres in width are betrayed by fractures, a feature which greatly facilitates prospecting. Immediately south of the Sarfartôq glacier is a major fracture system in which several kimberlite dykes are found. The fracture system can be traced for kilometres. In the same area flat swampy areas with diameters in the order of a hundred metres are found.

SAMPLING PROGRAMME

During the present stream sediment sampling programme, streams cutting kimberlites in the Archaean block were investigated, since such kimberlites presumably have the best potential for economic contents of diamonds (Clifford, 1966).

The stream sediment sampling was carried out within two parts of the Sarfartôq area (Fig. 2). In the Sarfartôq area an abundance of kimberlite dykes and kimberlite sheets are known to outcrop at or close to the brink of the streams thus shedding material into the streams. One of the investigated streams is fast flowing and turbulent, whereas the other is a slow running meandering river. The selected streams are:

1. The turbulent Sarfartôq stream originating partly from the Sarfartôq glacier and partly from a large lake situated northeast of Sukkertoppen Fig. 2.

2. The upper part of the slow meandering stream of the Paradisdal Fig. 2.

1. The Sarfartôq stream varies in width from a few tens of metres to well over 50 metres (Fig. 3). The water flow is rapid and quite turbulent. In several places the stream has eroded steep canyons which are not accessible and have thus not been included in this survey. The water in the stream is milky grey as a result of suspended fine grained

material. This is a characteristic feature of streams originating from the Inland Ice or from local glaciers.

The sediment in the river bed range in grain size from fine grained to well rounded boulders up to one metre in diameter. The river sediment is dominated by gneiss boulders and pebbles with smaller amounts of amphibolite boulders, locally with an abundance of well rounded kimberlite boulders. The latter are rarely more than 50 cm in diameter. Most of the river gravel originates from the exposed banks on either side of the stream. A good deal of the gravel originates, however, from the area concealed under the Sarfartôq glacier.

The part of the stream from the large lake down to the first steep canyon has been sampled at small regular intervals Fig. 2. The stream has been sampled further down to where it enters the Paradisdal (Fig. 2). The sampling density in the latter part of the stream was governed by accessability, resulting in several large gaps between some sample locations. A total of 13 stream sediment samples have been collected in this stream.

2. The Paradisdal river is a slow running strongly meandering stream with crystal clear water. The stream is situated in the flat expansive densely vegetated Paradisdal where muskox and reindeer graze side by side. The river sediment is dominated by boulders in the order of 30 to 40 cm in diameter with virtually no gravel, but locally some fine grained sediments in the clay size range. A total of 13 stream sediment samples were collected in this stream.

SAMPLE PREPARATION

Most of the stream sediment samples collected (Table 1) consisted of about 20 litres (about 50 kg) of gravel with grain size ranging up to a few centimetres. The samples were collected in the parts of the stream with the quickest water flow. The field treatment of the stream sediment samples is shown in flow sheet 1.

The samples were sieved through three sieves 8 mesh, 12 mesh and 20 mesh. The + 8 mesh fraction was discarded after inspection. The + 12 mesh fraction and the - 12 mesh + 20 mesh fractions were jigged in the respective sieves, producing concentrate that appeared like an "eye" in the sieve (Fig. 4). The central part of the "eye" consisted mainly of garnets and magnetite, rimmed by a black rim of amphiboles. The material from the "eye" was collected with a small spoon and stored in plastic bags. The - 20 mesh fraction was panned in a conical aluminium pan. The panning was stopped before the concentrate changed colour due to high concentrations of either garnet or magnetite. The concentrate was stored in plastic bottles. Upon arrival in Denmark, the samples were dried and split. One quarter was kept in Denmark for reference and three quarters were sent to the Ukrainian State Institute of Mineral Resources, Simferopol, Crimea, Ukraine for processing.

Two "bulk" stream sediments samples were collected. One from the lower part of the Sarfartôq stream and one from the stream of Paradisdal Fig. 2. About 300 kg of sand and gravel from each sample site was passed through an 8 mesh sieve, and the - 8 mesh fraction (about 60 kg) was shipped to Denmark and from there on to Simferopol, Ukraine for processing.

Finally one "bulk" sample of 610 kg of kimberlite (K-2 on Fig. 2) was collected and shipped to the Ukraine for processing. Another "bulk" kimberlite sample collected in the Maniitsoq area (K-1 on Fig. 1) was also shipped to Ukraine and processed.

SAMPLE PROCESSING

In the following description some measures are in mesh and others in metres. The sieves used in the field were bought in the USA and measure in mesh units. 8 mesh is equivalent to a 2.36 mm sieve, 12 mesh is equivalent to a 1.70 mm sieve and 20 mesh is equivalent to a 0.85 mm sieve. The laboratory equipment used was European and thus metric.

The samples coarser than 20 mesh were treated as shown on flow sheet 2. After weighing, the samples were briefly investigated under the microscope. They were then run through an automatic x-ray luminescence analyzer, which separates luminescent minerals from non luminescent minerals. The luminescent fraction was subsequently checked for diamonds. The non luminescent fraction was microscopically investigated for indicator minerals.

The - 20 mesh fraction of the samples were treated as shown on flow sheet 3. First a few grammes of sample were investigated in order to obtain a general idea of the mineralogical composition. The remaining part of the samples were then passed through a magnetic separator. The highly magnetic fraction, mainly magnetite with minor amounts of ilmenite, was stored.

The less magnetic fractions (1.5 and 2.5 A) were mineralogically investigated and selected indicator minerals analyzed by microprobe. The non magnetic fraction was separated in heavy liquid (bromoform), and a split of the heavy fraction was investigated for indicator minerals. Selected mineral grains were analyzed by microprobe. The remaining part of the heavy fraction was thermochemically decomposed by fusion with NaOH at 350-400°C for 30 minutes. After cooling, washing with HCl, HNO_3 and water and then sieving through 0.07 mm sieve, the fine fraction was stored and the coarse fraction checked for diamonds.

The "bulk" sediment samples were sieved in the field through an 8 mesh sieve. The + 8 mesh fraction was discarded and the - 8 mesh was shipped to Simferopol, Ukraine. The processing of the samples is outlined in flow sheet 4. The coarser fractions > 0.5 mm were jigged and then followed by the x-ray luminescence check. The luminescent fractions were tested for diamonds, whereas the non luminescent went through magnetic fractionation. The magnetic component was checked for indicator minerals and these were analyzed on microprobe. The non magnetic fractions thermochemically decomposed and the residue checked for diamonds.

The fraction < 0.5 mm was treated on a shaking table. The heavy fraction went through magnetic separation followed by thermochemical decomposition of the non magnetic part and diamond check. The magnetic fraction was checked for indicator minerals. The light fraction from the shaking table and the light fraction from the jigging of the coarser concentrates underwent flotation. In flotation grains up to 2 mm can be carried by the airbubbles to the surface and thus separated. The concentrate from the flotation was subjected to thermochemical decomposition followed by the diamond check. For further details on the flotation method see Smirnov *et al.*, 1994b.

PROCESSING OF BULK KIMBERLITE SAMPLES

The two bulk kimberlite samples one weighing 195.8 kg and the other 610 kg were processed as outlined in flow sheet 5.

The samples were crushed to - 2 mm. After slime removal the + 0.1 mm fraction was split. About 10 % of the + 0.1 mm fraction was sieved into three fractions. The two coarser fractions > 0.5 mm were jigged. The heavy fractions from the jigging were separated in an automatic x-ray luminescence analyzer. The fluorescent fraction was checked for diamonds. The non luminescent fraction was thermochemically decomposed as described above, and the concentrate was checked for diamonds. The - 0.5 mm fraction from the sieving was treated on a shaking table. The heavy fraction from the shaking table was magnetically separated. The magnetic fraction was visually checked for indicator minerals and the non magnetic fraction was thermochemically decomposed and checked for diamonds. The light fraction from the jigging, the light fraction from the shaking table and the 90 % split was combined and subjected to flotation. The concentrate from the flotation were thermochemically decomposed and checked for diamonds. The tailings from the flotation was crushed and sieved. The fraction < 0.1 mm was discarded. The + 0.1 mm fraction was separated in heavy liquids (bromoform). The light fraction was discarded and the heavy fraction was thermochemically decomposed and the concentrate was checked for diamonds.

RESULTS

A: Stream sediment samples

In the + 20 mesh fractions no kimberlite indicator minerals nor diamonds were found.

A large number of garnets, ilmenites, spinels, pyroxenes and olivines were found in the stream sediments in the - 20 mesh fraction. The minerals microscopically resembling kimberlite indicator minerals were separated from the other heavy minerals. Some grains from each group of suspected kimberlite indicator minerals were selected for microprobe analyses on a Jeol Super 733 microprobe (Smirnov *et al.*, 1994a).

A range of kimberlite indicator minerals were found, namely pyrope garnet, picroilmenite, chromespinel, chromediopside, enstatite and forsterite.

Pyrope garnets occurred in four stream sediment samples, all from the Sarfartôq stream. The chemical composition of the garnets is shown in Table 2. According to the classification of pyrope garnets of Dawson and Stephens (1975) the pyrope from sample 390413 is of class 1 and the pyropes found in samples 390409 and 309415 are class 9 pyropes. It is significant that only very few pyrope garnets have been identified. This is partly due to the fact that the kimberlites in the Sarfartôq area contain precious few indicator minerals. It should also be emphasized that only a few pyropes of red and lilac colours were analyzed. Further microprobe analysis might very well prove additional garnets to be kimberlitic pyropes.

Ilmenite is a common heavy mineral in the area. It is usually fine grained and well worn, thus rendering it quite difficult to identify whether it is an ilmenite or a picroilmenite. A few grains of ilmenite were selected for microprobe analyses and only one (0.30 × 0.25 mm large) grain proved to be picroilmenite (sample 390404 from Sarfartôq stream). The composition of this grain is shown in Table 3.

Chromespinels were even more difficult to identify visually than ilmenite. However, out of 6 suspected kimberlitic chromespinels 4 proved to be kimberlitic in samples 390402, -404, -412 and -423. The three former from the Sarfartôq stream and the latter from Paradisdal stream. The composition of these grains are shown in Table 4.

Pyroxenes are common in the stream sediments. Clinopyroxenes are represented by green diopsides of various colours (Smirnov *et al.*, 1994a). Several emerald green diopsides were analyzed and the group containing more than 0.5 % Cr_2O_3, which is considered kimberlitic, is listed in Table 5. However, when the chromediopsides are plotted in a Al_2O_3 versus Na_2O diagram constructed by Ilupin (1988), some of the chromediopsides plot outside the kimberlite field (Fig. 5).

B: Bulk stream sediment samples

Both bulk samples proved to be very low in indicator minerals and none of them carried diamonds (Smirnov *et al.*, 1994b). Pyropes of Dawson and Stephens' (1975) classes 6 and 9 were found in samples 390411 and 390410 respectively. Only two pyrope grains were analyzed (Table 2).

In sample 390410 four grains of picroilmenite were found (Table 3), all of which were quite small. In the same sample two grains of chromediopside were found (Table 5). Green diopsides were also encountered in sample 390411, but with Cr_2O_3 contents below 0.5 %.

No chromespinels were detected in any of the bulk stream sediment samples. It should, however, be emphasized that all grains in these two samples are very worn and no original surfaces have been preserved. It was therefor very difficult under the microscope both to distinguish picroilmenite from ilmenite, and to identify chromespinel. Future investigations using the scanning electron microscope may reveal further indicator minerals.

C: Bulk kimberlite samples

Two bulk kimberlite samples were investigated. K-1 weighing 195.8 kg was collected from the Maniitsoq area (Fig. 1). K-2 (GGU Sample number: 404007) weighing 610 kg was collected in the Sarfartôq area close to the site where stream sediment sample 390404 was collected (Fig. 2).

K-1 is a low-micaceous porphyritic kimberlite with 65 to 85 percent olivine. The olivine is very fresh. K-2 is a micaceous porphyritic kimberlite with inclusions of kimberlite and xenoliths of lamprophyres. Up to 3.5 cm large nodules of highly serpentinised olivine nodules are seen in K-2. In both samples carbonate is abundant in the matrix ranging from 10 to 50 %. Both samples contain a few percent rhombic pyroxene and 3 to 5 % ore minerals and minerals of the humite-chondrodite group are found in small amounts. Pyrope is generally finegrained (< 0.5 mm). Detailed description of the mineralogy is presented in Smirnov *et al.* (1994b).

Composite samples of K-1 and K-2 have been analyzed for major and selected trace elements (Table 6). The samples are plotted in Fig. 6 where they plot in the kimberlite field.

No diamonds were found in either of the samples, however, kimberlite indicator minerals appeared in both samples. In K-1 the indicator minerals are rather abundant and are found from the fine fraction up to grains more than 10 mm large. In K-2 indicator minerals are virtually found only in the fraction < 0.5 mm, and even here they are very sparse. Apart from the common indicator minerals the bulk samples showed a wide range of minerals such as garnets of pyrope-almandine-grossularite composition, amphiboles, pyrite, galena, sphalerite, cinnabar, chalcopyrite, rutile, perowskite and sphene. Minerals such as magnetite, corundum, moissanite and graphite were rarely found.

Garnets found in the kimberlites are mainly pyropes with high Cr_2O_3 and low CaO content, characteristic of high pressure and temperature formation. Table 2 shows microprobe analysis of the pyrope garnets from the two kimberlites. The pyropes can be classified according to Dawson and Stephens (1975). Unfortunately none of the analysed garnets fall into class 10. Most K-1 pyropes fall into groups 9, 11 and 12. One pyrope from K-2 is a class 3 pyrope (Table 2). Selected pyrope compositions from Table 2 have been plotted in Fig. 7, where most of the pyropes plot in the fields of either wehrlites and lherzolites (Sobolev *et al.*, 1969).

Picroilmenite in up to 1 cm large grains sometimes rounded sometimes angular is seen in K-1. Selected grains have been analyzed on the microprobe, results are listed in Table 3.

Chromediopside was found in abundance in K-1, and a number of grains were analyzed on the microprobe. The analyzed chromediopside grains with Cr_2O_3 > 0.5 % are listed in Table 5.

The chemical composition of co-existing pyrope and chromediopside allows pressure-temperature estimates for the kimberlites. In a subsample from the K-1 Maniitsoq kimberlite the following results show that the kimberlite originated from areas in the mantle where diamonds are stable. In the table below is listed pressure - temperature estimates of the K-1 kimberlite based on different models: (1) Ellis & Green (1974), (2) Saxena (1979), (3) Krogh (1988).

Pressure		Temperature	
(kbar)	(1)	(2)	(3)
10	1105	1031	1086
20	1147	1103	1133
30	1188	1174	1180
40	1229	1246	1227
50	1270	1317	1274
60	1311	1389	1321

CONCLUSIONS

A: Stream sediment sampling programme

The stream sediments in the Sarfartôq area carry only very few indicator minerals. One of the reasons being that the kimberlites in the area only contain very low amounts of indicator minerals, and these are usually finegrained. Another reason for the low indicator mineral content of the stream sediment samples may be due to strong dilution. This is particularly noticeable for example in the Sarfartôq stream which drains an active glacier shedding large amounts of sediments into the stream.

The stream sediment sampling programme in the Sarfartôq area proved, however, that even in areas where kimberlites carry only very few indicator minerals and even with strong dilution, it is possible to determine dispersion patterns of indicator minerals and to trace kimberlites upstream. The fine grained nature of the few indicator minerals make exploration for kimberlites in the Sarfartôq area difficult but not impossible. The coarser grainsize and higher abundance of the indicator minerals in the Maniitsoq kimberlite (K-1) indicate that prospecting for kimberlites in the Maniitsoq area will be easier than in the Sarfartôq area.

Bulk sampling of the two large streams yielded only a few indicator minerals although dozens of kimberlite dykes are known to outcrop upstream. This shows that even small amounts of indicator minerals should be taken into consideration in future prospecting in West Greenland.

B: Bulk kimberlite sampling

During the field programme in Sarfartôq several new kimberlites were discovered, showing that the density of kimberlites in that area must be high. Furthermore, large swampy areas which may host larger kimberlite bodies were encountered. Finally it was found that kimberlite features such as repeated fracturing on either sides of even quite narrow dykes are conspicuous and abundant. This will greatly facilitate future prospecting for kimberlites.

Investigation of the kimberlite bulksamples shows that the Maniitsoq kimberlites hold better potential of being diamondiferous than the Sarfartôq kimberlite.

REFERENCES

Clifford, T. N. 1966: Tectono-metallogenic units and metallogenic provinces of Africa. *Earth Planet. Sci. Lett.* **1**, 421-434.

Dawson J. P. & Stephens, W. E. 1975: Statistical analysis of garnets from kimberlites and associated xenoliths in kimberlite. *Geochim. Cosmochim. Acta* **83**, 589-607.

Ellis, E. G. & Green, E. H. 1974: An experimental study of the effect of Ca upon garnet-clinopyroxene Fe-Mg exchange equilibrium. *Contrib. Mineral. Petrol.* **71**, 13-22.

Ilupin, I. P. 1988: New data on typomorphism of chrome-diopside from kimberlites. Vses. nauchno-issled. geol. -razy. Inst. (VNIGRI) 7-9. (In Russian).

Krogh, E. J. 1988: The garnet-clinopyroxene Fe-Mg geothermometer a partition of existing experimental data. *Contrib. Mineral. Petrol.* **99**, 44-48.

Larsen, L. M. 1991: Occurrence of kimberlite, lamproite and ultramafic lamprophyre in Greenland. *Open File Ser. Grønlands geol. Unders.* **91/2**, 36 pp.

Saxenea, S. K. 1979: Garnet-clinopyroxene termometer. *Contrib. Mineral. Petrol.* **70**, 229-235.

Secher, K. Larsen, L. M. 1980: Geology and mineralogy of the Sarfartôq carbonatite comples, southern West Greenland. *Lithos* **13**, 199-212.

Smirnov, G. I., Chashka, A. I. & Tarasyuk, O. I. 1994a: Report on study of diamondiferousness and mineral composition of gravitational concentrates from alluvium of some streams of the Western Greenland. Simferopol, Ukraine. 72 pp. Unpublished report.

Smirnov, G. I., Chashka, A. I., Tarasyuk, O. N., Fisunova, L. N., Vishnevski, A. A., Bobrievich, A. P. & Fedoroshin, U. I., 1994b: Report on study of diamondiferousness and mineral composition of gravitational concentrates from Alluvium of some streams and kimberlites of West Greenland (Part II). Simferopol, Ukraine. 28 pp. Unpublished report.

Sobolev, N. V., Lavrentyev, Y. G., Pospelova, L. N. & Sobolev, Y. V. 1969: Chromian pyropes form Yakutian diamonds. Dokl. Akad. Nauk. SSSR, 189, 162-165. (In Russian).

Table 1. Sample list of stream sediment samples

	GGU no.	Size + 12 mesh Mass(g)	Size -12 + 20 mesh Mass(g)	Size - 20mesh Mass(g)	
1	390401	735.4	307.5	998.8	
2	390402	111.0	300.4	940.7	
3	390403	1269.8	362.2	1086.3	
4	390404	232.2	337.5	497.3	
5	390405	205.2	215.0	918.9	
6	390406	328.7	296.5	127.0	
7	390407	506.1	409.9	293.1	
8	390408	315.6	374.4	567.5	
9	390409	256.2	67.0	312.8	
10	390412	261.1	326.8	952.6	
11	390413	212.6	174.9	752.5	
12	390414	212.3	36.2	877.4	
13	390415	120.4	150.5	423.6	
14	390416	287.2	193.3	433.5	
15	390417	128.1	212.3	630.8	
16	390418	352.6	392.9	256.3	
17	390419	297.0	215.6	313.1	
18	390420	172.6	123.5	251.6	
19	390421	205.3	274.6	354.9	
20	390422	317.8	336.9	509.0	
21	390423	296.2	548.6	1461.1	
22	390424	205.6	185.3	182.3	
23	390425	294.0	335.6	472.2	
24	390426	257.6	171.6	198.2	
25	390427	181.2	269.1	668.0	
26	390428	433.2	349.3	131.4	
27	390429	288.8	338.4	267.5	
Bulk s.s.	390410				53.3 kg (-8 mesh)
Bulk s.s.	390411				50.5 kg (-8 mesh)
K1	Kimberlite				195.8 kg
K2	Kimberlite				610.0 kg

Bulk s.s.: bulk stream sediment. K1 and K2: bulk kimberlite samples.

Table 2. Microprobe garnet

	413/1	409/2	414/1	415/1	411/7	410/1	K1/23	K1/19
SiO_2	41.99	41.33	40.76	41.93	38.26	42.21	39.93	42.04
TiO_2	0.07	0.49	0.01	0.11	0.03	0.15	0.48	0.6
Al_2O_3	22.22	20.26	20.14	18.11	21.24	21.8	20.86	20.41
Cr_2O_3	1.34	3.88	5.03	7.02	0	2.12	0.11	1.47
Fe_2O_3	1.46	2.00	1.77	0.96	1.38	0.87	4.8	3.13
FeO	8.11	4.58	6.75	5.74	28.00	7.23	7.9	5.72
MnO	0.36	0.27	0.48	0.31	0.94	0.46	0.45	0.25
MgO	20.40	22.17	19.75	20.34	7.64	18.23	14.6	21.6
CaO	3.87	4.39	5.13	5.56	2.81	7.02	11.5	4.28
Sum	99.82	99.37	99.82	100.08	100.03	100.09	100.7	99.5
Si	2.986	2.956	2.945	3.004	2.973	3.029	2.911	3.00
Ti	0.004	0.026	-	0.004	0.002	0.008	0.026	0.032
Al	1.863	1.705	1.716	1.536	1.945	1.844	1.792	1.72
Cr	0.077	0.219	0.287	0.396	0	0.120	0.006	0.083
Fe+3	0.078	0.108	0.096	0.052	0.081	0.047	0.263	0.168
Fe+2	0.482	0.274	0.408	0.344	1.819	0.434	0.482	0.342
Mn	0.021	0.017	0.030	0.017	0.062	0.028	0.028	0.015
Mg	2.162	2.363	2.129	2.169	0.885	1.950	1.587	2.300
Ca	0.329	0.335	0.395	0.478	0.234	0.540	0.904	0.328
Pyrop	71.7	73.3	65.7	65.6	29.49	66.07	52.89	73.79
Alm.	16.7	10.1	13.8	11.5	60.65	14.70	16.06	11.45
Spes.	0.7	0.6	1.0	0.6	2.06	0.95	0.93	0.51
Uvar.	3.8	6.0	8.5	13.1	0.00	6.11	0.32	0.90
Gros.	-	-	-	-	3.68	9.38	15.33	0.00
Andr.	2.8	3.8	4.9	2.6	4.03	2.39	13.17	8.46
Ti-and.	0.1	1.3	-	0.1	0.09	0.41	1.32	1.62
Knorr.	-	4.9	6.1	6.5	0.00	0.00	0.00	3.27
Dawson cl.	1	9	9	9	6	9	6	9

Microprobeanalysis of pyrope garnets from stream sediments and kimberlites. In the sample number e.g. 413/1 the 413 are the last three digits from the GGU sample number listed in Table 1. The digit after the slash is the number of the mineral grain analysed from that particular sample. 413/1 in this table means the first garnet analysed from sample 390413. The same system is used in Tables 3 to 5.

Table 2. Microprobe garnet (continued)

	K1/15	K1/22	K1/16	K1/17	K1/13	K1/11	K1/18	K1/8	K1/1	K1/2
SiO_2	41.38	41.43	41.96	41.69	41.5	42.27	41.47	41.32	41.52	41.56
TiO_2	0.09	0.74	0.41	0.47	0.64	0.59	0.72	0.16	0.12	0.85
Al_2O_3	21.31	19.95	19.98	19.71	18.64	18.74	17.84	19.14	19.09	17.63
Cr_2O_3	2.06	2.61	3.31	4.38	4.48	5.18	5.26	6.21	6.33	6.77
Fe_2O_3	2.5	2.81	2.33	1.66	2.7	2.07	2.55	0.21	0.11	1.24
FeO	7.01	8.06	5.81	6.39	5.62	4.67	4.83	8.38	8.29	6.34
MnO	0.43	0.38	0.24	0.33	0.29	0.32	0.33	0.48	0.48	0.32
MgO	20.79	19.57	21.17	20.93	20.4	10.01	19.77	18.84	18.98	18.98
CaO	4.5	5.2	5.12	4.82	5.93	5.65	6.97	5.54	5.46	6.07
Sum	100.07	100.75	100.33	100.38	100.2	99.5	99.74	100.28	100.38	99.76
Si	2.952	2.973	2.990	2.979	2.985	3.060	3.006	2.992	3.001	3.033
Ti	0.004	0.040	0.022	0.025	0.035	0.032	0.039	0.010	0.007	0.047
Al	1.792	1.687	1.678	1.569	1.580	1.600	1.524	1.633	1.626	1.516
Cr	0.116	0.148	0.186	0.247	0.255	0.296	0.301	0.355	0.362	0.391
Fe+3	0.134	0.152	0.125	0.089	0.146	0.113	0.139	0.011	0.006	0.068
Fe+2	0.418	0.484	0.346	0.382	0.338	0.283	0.293	0.507	0.501	0.387
Mn	0.026	0.023	0.014	0.020	0.018	0.020	0.020	0.029	0.030	0.020
Mg	2.211	2.093	2.248	2.229	2.187	2.159	2.136	2.033	2.045	2.064
Ca	0.344	0.400	0.390	0.369	0.457	0.438	0.541	0.430	0.423	0.475
Pyrop	72.42	66.12	71.31	68.51	66.37	66.74	65.47	63.32	63.58	60.46
Alm.	13.95	16.12	11.54	12.73	11.27	9.75	9.79	16.91	16.71	13.13
Spes.	0.87	0.77	0.48	0.67	0.59	0.68	0.68	0.98	0.98	0.67
Uvar.	4.52	3.74	5.68	6.57	6.20	7.62	9.16	13.32	13.48	10.27
Gros.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Andr.	6.71	7.59	6.25	4.46	7.31	5.83	6.98	0.57	0.30	3.47
Ti-and.	0.24	2.00	1.10	1.26	1.73	1.66	1.97	0.44	0.33	2.38
Knorr.	1.30	3.66	3.64	5.80	6.54	7.72	5.96	4.46	4.62	9.62
Dawson cl.	9	1	9	11	11	11	11	11	11	11

Table 2. Microprobe garnet (continued)

	K1/10	K1/4	K1/5	K2/1
SiO_2	41.54	41.87	41.6	41.34
TiO_2	0.48	0.03	0.00	0.48
Al_2O_3	17.78	18.47	17.23	21.47
Cr_2O_3	7.72	7.73	8.28	0.14
Fe_2O_3	0.36	0.01	1.17	2.37
FeO	6.08	8.09	6.84	10.98
MnO	0.36	0.36	0.42	0.47
MgO	19.4	19.38	18.15	17.19
CaO	5.82	4.09	6.1	4.9
Sum	99.54	100.03	99.79	99.34
Si	3.028	3.042	3.053	3.025
Ti	0.026	0.002		0.026
Al	1.527	1.581	1.490	1.851
Cr	0.444	0.444	0.480	0.008
Fe+3	0.019	0.001	0.056	0.130
Fe+2	0.370	0.492	0.042	0.672
Mn	0.022	0.022	0.026	0.029
Mg	2.107	2.099	1.986	1.874
Ca	0.454	0.318	0.480	0.384
Pyrop	61.79	59.64	56.60	63.64
Alm.	12.54	16.77	14.42	22.70
Spes.	0.75	0.76	0.90	0.98
Uvar.	13.04	10.75	13.15	0.41
Gros.	0.00	0.00	0.00	4.92
Andr.	1.00	0.03	3.33	6.61
Ti-and.	1.34	0.08	0.00	1.34
Knorr.	9.54	11.97	11.61	0.00
Dawson cl.	12	12	12	3

Table 3. Microprobe picroilmenite

Samples NN	404/5	410/4	410/5	410/3	410/2	K1/38	K1/34	K1/22	K1/28	K1/35	K2/2
SiO_2	n.d.	0.06	n.d.	0.05	0.09	0.01	0.01	0.04	0.03	0.08	n.d.
TiO_2	56.65	46.06	48.38	52.49	54.05	46.35	50.42	52.33	55.02	53.77	46.92
Al_2O_3	0.67	n.d.	0.39	0.56	0.60	0.36	0.48	0.22	0.48	0.72	0.56
Cr_2O_3	0.44	0.22	0.12	0.22	0.56	0.17	0.16	1.72	0.84	0.56	0.66
Fe_2O_3	1.16	13.41	11.04	8.35	5.53	16.45	11.28	8.40	4.04	7.78	17.28
FeO	28.43	34.64	31.30	28.56	28.00	25.22	27.15	25.36	26.89	24.18	25.18
MnO	0.25	0.33	0.21	0.29	0.36	0.31	0.24	0.27	0.28	0.24	0.25
MgO	12.53	3.29	6.54	10.26	11.35	9.05	10.06	11.94	12.35	13.00	9.42
CaO		0.03	0.01	0.04	0.01	0.02	0.02	0.03	0.09	0.01	0.04
Sum	100.13	98.04	97.99	99.98	100.55	97.94	99.82	100.31	100.02	100.34	100.31
Si	-	0.001	-	0.001	0.001	-	-	0.001	-	0.001	-
Ti	0.977	0.871	0.893	0.917	0.938	0.844	0.893	0.909	0.953	0.922	0.832
Al	0.018	-	0.012	0.015	0.012	0.010	0.013	0.005	0.012	0.019	0.016
Cr	0.008	0.004	0.003	0.004	0.010	0.003	0.003	0.032	0.015	0.010	0.013
Fe+3	0.020	0.254	0.204	0.146	0.096	0.300	0.200	0.146	0.070	0.134	0.306
Fe+2	0.545	0.254	0.643	0.555	0.541	0.511	0.535	0.490	0.518	0.463	0.497
Mn	0.004	0.008	0.004	0.006	0.007	0.006	0.004	0.005	0.005	0.004	0.004
Mg	0.428	0.124	0.239	0.355	0.390	0.326	0.352	0.411	0.423	0.443	0.332
Ca	n.d.	0.008	n.d.	0.001	n.d.	n.d.	n.d.	n.d.	0.003	n.d.	0.001
$FeTiO_3$	54.5	69.9	53.6	30.5	23.9	26.9	28.1	13.2	16.9	5.0	24.1
$MgTiO_3$	42.8	14.3	31.5	55.7	64.7	8.8	54.6	70.4	73.8	79.7	50.0
$MnTiO_3$	0.4	0.9	0.5	0.9	1.2	0.9	0.6	0.8	0.9	0.7	0.6
Al_2O_3	0.9	-	0.8	1.2	1.4	0.7	1.0	0.4	1.0	1.7	1.2
Cr_2O_3	0.4	0.2	0.2	0.3	0.8	0.2	0.2	2.7	1.3	0.9	1.0
Fe_2O_3	1.0	14.7	13.4	11.4	8.0	22.5	15.5	12.5	6.1	12.0	23.1

Microprobeanalysis of picroilmenite from stream sediments and kimberlites. (See text to Table 2).

Table 4. Microprobe chrome-spinel

Samples NN	402/2	423/5	412/6	404/8
SiO_2	n.d.	n.d.	n.d.	n.d.
TiO_2	4.53	0.20	0.91	0.21
Al_2O_3	5.11	15.65	5.90	9.12
Cr_2O_3	41.08	53.37	59.46	61.70
Fe_2O_3	16.41	2.40	5.99	0.75
FeO	24.66	16.44	17.00	17.16
MnO	0.26	0.30	0.33	0.28
NiO	0.16	0.04	0.07	0.10
ZnO	n.d.	0.06	n.d.	0.02
MgO	7.56	11.67	10.77	10.56
CuO	n.d.	n.d.	n.d.	-
Sum	99.76	100.19	100.43	99.82
Ti	0.12	0.00	0.02	0.01
Al	0.21	0.59	0.23	0.36
Cr	1.13	1.34	1.57	1.62
Fe+3	0.43	0.06	0.15	0.02
Fe+2	0.72	0.44	0.48	0.48
Mn	0.01	0.01	0.01	0.01
Ni	0.00	0.00	0.00	0.00
Zn	-	0.00	-	0.00
Mg	0.39	0.55	0.54	0.52

Microprobeanalysis of chromespinels from stream sediments and kimberlites. (See text to Table 2).

Table 5. Microprobe chrome diopide

Samples NN	409/4	421/1	403/2	413/4	402/1	406/3	404/3	407/2	406/2	417/2
SiO_2	54.81	54.52	55.54	54.24	55.13	54.38	53.68	54.75	55.37	54.99
TiO_2	0.01	0.02	0.01	0.02	0.09	0.03	0.02	0.04	0.05	0.04
Al_2O_3	1.36	1.20	1.41	1.85	1.26	1.49	1.58	1.37	1.55	1.63
Cr_2O_3	0.56	0.56	0.69	0.70	0.72	0.75	0.80	0.81	0.84	0.92
Fe_2O_3	n.d.	0.07	n.d.	n.d.	n.d.	n.d.	-	-	-	-
FeO	4.11	3.24	3.22	4.68	3.24	3.44	3.78	3.09	3.47	4.21
MnO	0.14	0.12	0.17	0.15	0.11	0.10	0.08	0.13	0.01	0.10
MgO	14.62	15.65	18.76	14.46	15.38	15.75	15.23	15.53	15.44	15.27
Cao	23.50	24.28	19.88	23.07	23.25	23.94	23.77	23.45	22.01	22.71
Na_2O	0.63	0.58	0.59	0.58	0.52	0.40	0.54	0.61	0.80	0.62
K_2O	n.d.	0.02	0.01	0.01	n.d.	0.01	0.01	-	-	0.01
Sum	99.74	100.26	100.28	99.76	99.70	100.29	299.49	99.78	99.54	100.50
Si	2.017	1.988	1.996	2.001	2.027	1.991	1.975	2.008	2.036	2.006
Al^{IV}	-	0.012	0.004	-	-	0.009	0.025	-	-	-
T-site	2.017	2.000	2.000	2.001	2.027	2.000	2.000	2.008	2.036	2.006
Al^{VI}	0.060	0.038	0.054	0.080	0.055	0.055	0.044	0.062	0.066	0.070
Ti	-	-	-	-	0.002	-	-	-	-	-
Cr	0.016	0.015	0.028	0.020	0.020	0.022	0.022	0.024	0.024	0.026
Fe^3+	-	0.002	-	-	-	-	-	-	-	-
Fe^2+	0.126	0.099	0.097	0.144	0.099	0.106	0.117	0.90	0.106	0.129
Mn	0.004	0.004	0.004	0.004	0.002	0.002	0.002	0.004	-	0.002
Mg	0.803	0.850	1.004	0.795	0.841	0.860	0.836	0.848	8.46	0.831
Ca	0.927	0.949	0.765	0.911	0.916	0.926	0.938	0.921	0.865	0.888
Na	0.044	0.042	0.041	0.042	0.035	0.013	0.037	0.044	0.057	0.044

Microprobeanalysis of chromediopsides in stream sediments and kimberlites. (See text to Table 2).

Table 5. Microprobe chrome diopide (continued)

Samples NN	412/3	405/3	408/3	414/2	408/2	410/8	410/6	K1/51	K1/53	K1/47
SiO_2	54.05	53.82	54.51	51.20	55.76	54.86	55.75	54.72	55.46	53.79
TiO_2	0.02	0.03	0.06	0.01	0.29	0.01	0	0.25	0.17	0.01
Al_2O_3	1.59	1.52	1.35	0.70	1.11	0.83	0.69	1.7	1.43	0.25
Cr_2O_3	0.95	1.00	1.08	1.81	2.26	0.58	0.95	0.62	0.81	1.26
Fe_2O_3	-	-	-	-	-	0	0	0	0	0
FeO	4.75	3.19	4.31	3.51	2.69	3.32	2.77	3.91	3.43	2.52
MnO	0.13	0.13	0.09	0.06	0.02	0.09	0.05	0.11	0.11	0.08
NiO						0.03	0.06	0	0	0
MgO	14.62	15.56	15.42	17.57	17.42	14.86	14.81	18.15	18.1	17.45
Cao	22.87	24.12	22.51	24.86	19.13	24.27	24.76	19.46	19.27	23.71
Na_2O	0.66	0.76	0.73	0.56	1.63	0.49	0.56	1.43	1.14	1.51
K_2O	0.02	0.01	-	0.02	0.04	0.01	0	0.01	0.03	0
Sum	99.66	100.14	100.06	100.30	100.30	99.35	100.4	100.36	99.95	100.58
Si	1.998	1.964	1.999	1.873	2.008	1.520	1.529	1.473	1.503	1.446
Al^{IV}	0.002	0.026	0.001	0.030	-					
T-site	2.000	2.000	2.000	1.873	2.008					
Al						0.027	0.022	0.054	0.046	0.008
Al^{VI}	0.067	0.040	0.056	-	0.048					
Ti	-	-	0.002	-	0.009	0.001	0			
Cr	0.027	0.028	0.030	0.076	0.065	0.013	0.021	0.013	0.017	0.027
Fe^3+	-	-	-	-	-	0	0	0	0	0
Fe^2+	0.146	0.096	0.132	0.106	0.080	0.077	0.064	0.088	0.078	0.057
Mn	0.004	0.004	0.002	0.002	-	0.002	0.001	0.003	0.002	0.002
Ni						0.001	0.001	0	0	0
Mg	0.806	0.846	0.842	0.944	0.935	0.614	0.605	0.728	0.731	0.699
Ca	0.906	0.942	0.884	0.959	0.738	0.720	0.727	0.561	0.559	0.683
Na	0.047	0.053	0.051	0.039	0.115	0.026	0.030	0.074	0.060	0.079

Table 5. Microprobe chrome diopide (continued)

Samples NN	K1/2	K1/48	K1/54
SiO_2	55.95	55.68	55.32
TiO_2	0.22	0.02	0.16
Al_2O_3	1.29	0.68	3.26
Cr_2O_3	1.47	2.52	3.74
Fe_2O_3	0	0	0
FeO	3.26	2.36	1.68
MnO	0.03	0.03	0.07
NiO	0	0	0
MgO	17.21	15.19	13.71
CaO	19.46	21.36	17.62
Na_2O	1.17	1.98	4.11
K_2O	0.04	0	0.02
Sum	100.1	99.82	99.69
Si	1.522	1.520	1.495
Al^{IV}			
T-site			
Al	0.041	0.022	0.104
Al^{VI}			
Ti	0.012	0.001	0.009
Cr	0.032	0.054	0.080
$Fe^{3}+$	0	0	0
$Fe^{2}+$	0.074	0.054	0.038
Mn	0.001	0.001	0.002
Ni	0	0	0
Mg	0.698	0.618	0.552
Ca	0.567	0.625	0.510
Na	0.062	0.105	0.215

Table 6. Major + trace element composition of the two kimberlites K-1 and K-2

Oxides	K-1	K-2/5	K-2/4	K-2/2	K-2/3	K-2/1
SiO_2	29.15	27.77	27.81	20.71	36.41	39.41
TiO_2	3.53	3.09	3.32	2.01	3.70	0.04
Al_2O_3	1.10	2.11	1.68	1.43	0.69	0.61
Fe_2O_3	2.69	4.60	4.04	4.80	4.01	1.48
FeO	6.54	6.84	7.11	7.34	8.75	6.51
MnO	0.12	0.12	0.11	0.13	0.09	0.05
MgO	35.44	26.52	26.67	21.22	35.01	44.21
CaO	7.80	11.83	11.40	20.65	1.69	0.35
Na_2O	0.06	0.16	0.09	0.17	0.25	0.03
K_2O	0.33	1.91	1.63	1.14	0.75	0.06
P_2O_5	0.30	0.66	0.64	1.40	0.13	0.21
SO_3	0.69	0.50	0.48	0.54	0.57	0.51
CO_2	7.17	9.92	10.03	16.18	2.82	4.25
H_2O+	3.10	4.40	4.28	2.58	3.74	1.67
H_2O-	0.14	0.25	0.40	0.16	0.31	0.57
Sum	98.18	100.68	100.59	100.46	98.92	99.99
Cr	800	320	400	250	1200	500
Ni	1200	320	320	150	630	2500
Sc	n.d.	6.3	5	8	n.d.	n.d.
V	80	50	50	25	63	8
Cu	32	20	20	40	40	25
Zn	32	20	25	20	40	32
Ga	2	4	4	5	n.d.	1.5
Ba	1000	1500	1200	2000	n.d.	n.d.
Sr	n.d.	630	500	1500	100	n.d.
Y	10	n.d.	n.d.	12	n.d.	n.d.
Zr	50	100	100	150	63	63
Nb	20	25	25	20	15	n.d.
La	25	32	32	40	n.d.	n.d.
Ce	n.d.	100	80	100	n.d.	n.d.
Nd	n.d.	50	50	63	n.d.	n.d.
Pb	1.5	8	6.3	6.3	5	3.2
Co	120	50	50	32	63	100
Mo	1.2	0.6	0.6	0.5	2	0.8
Sn	2	2.5	2	1.2	2.5	1
Ge	n.d.	1	1.2	1	1.5	1.2

Major element chemistry and selected trace element contents of the two bulk samples of kimberlite. K-1 is from Maniitsoq. K-2 is from Sarfartôq.

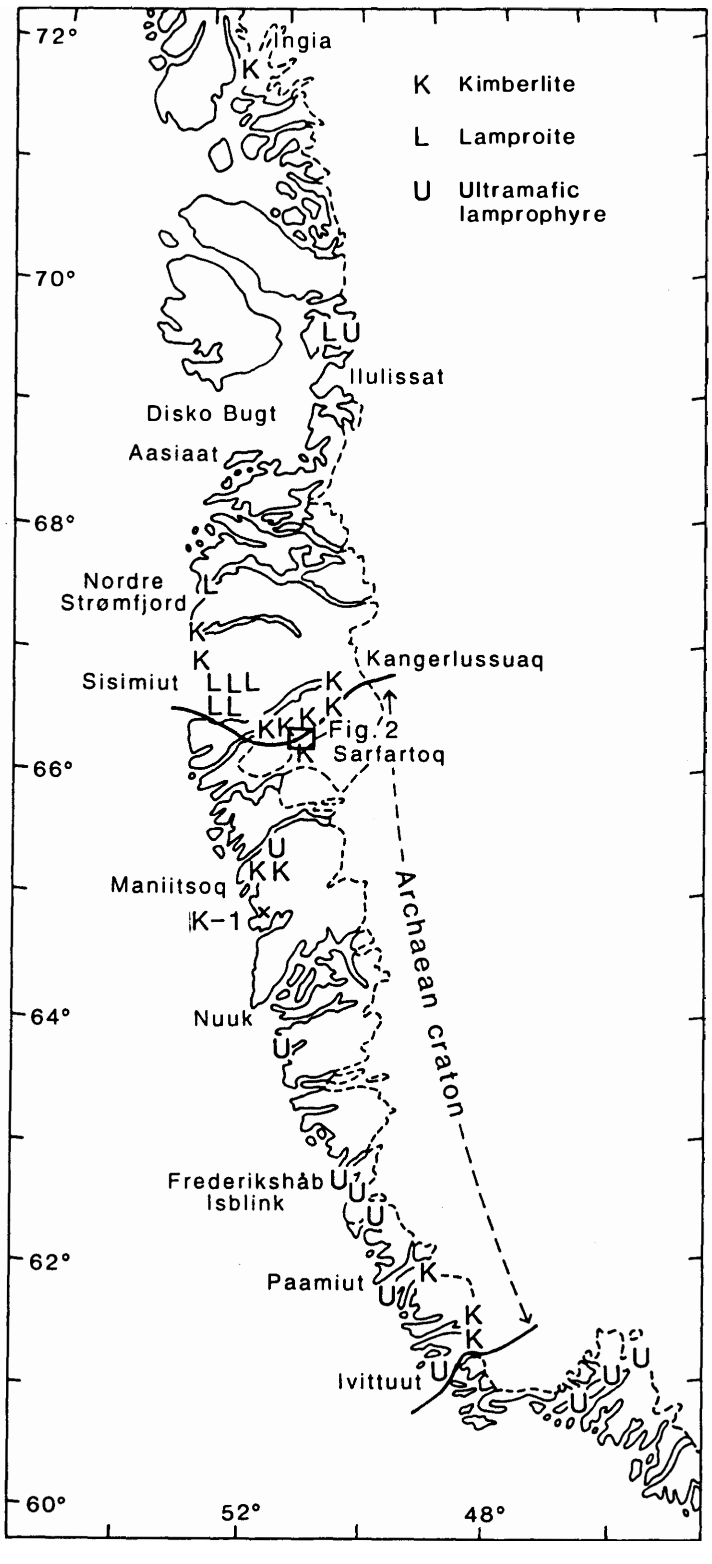


Fig. 1. Index map of Greenland, with Archaean and Proterozoic areas and main kimberlite and lamproite provinces.

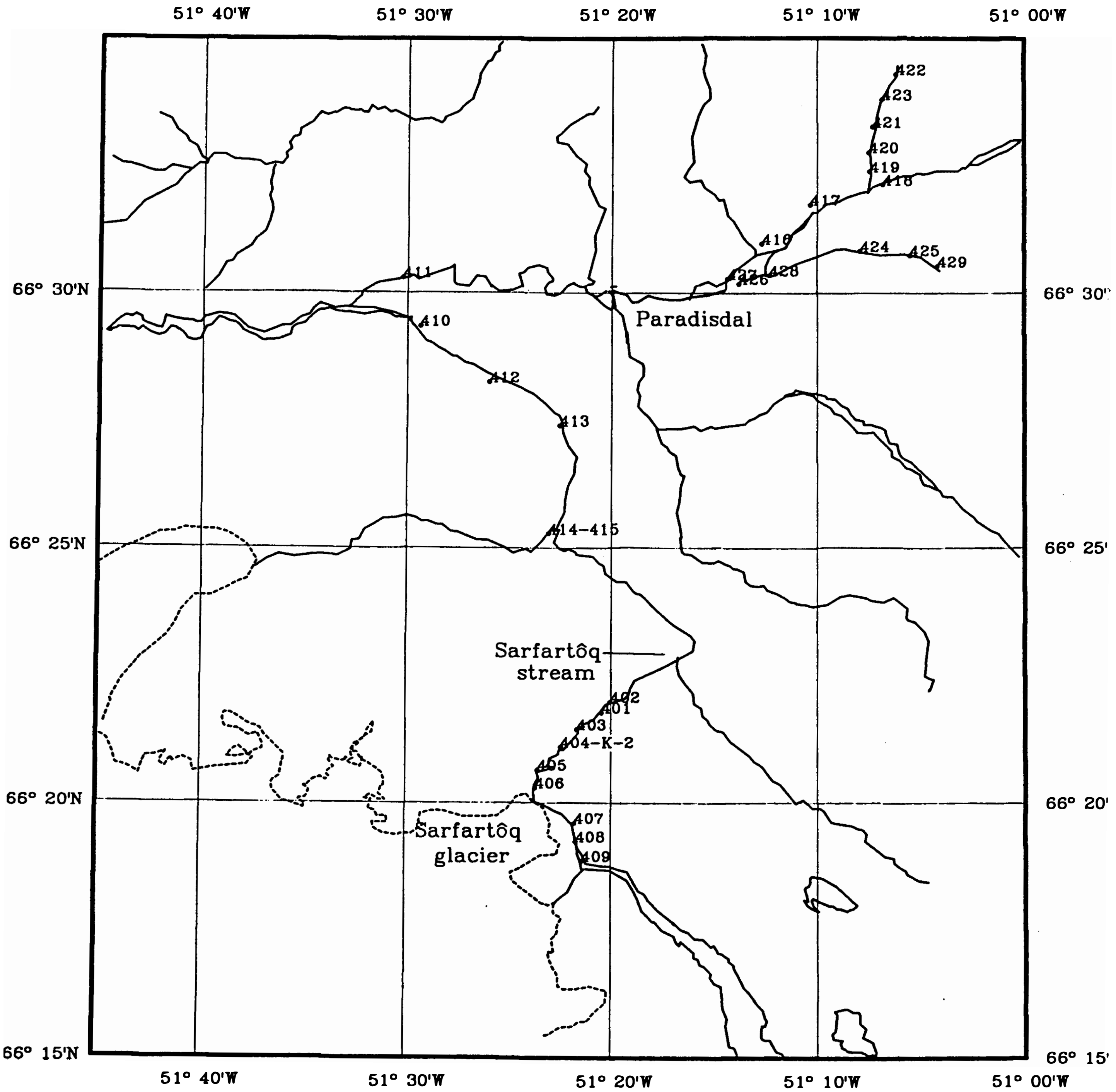


Fig. 2. Detailed map of the Sarfartôq area with the site of stream sediment samples.

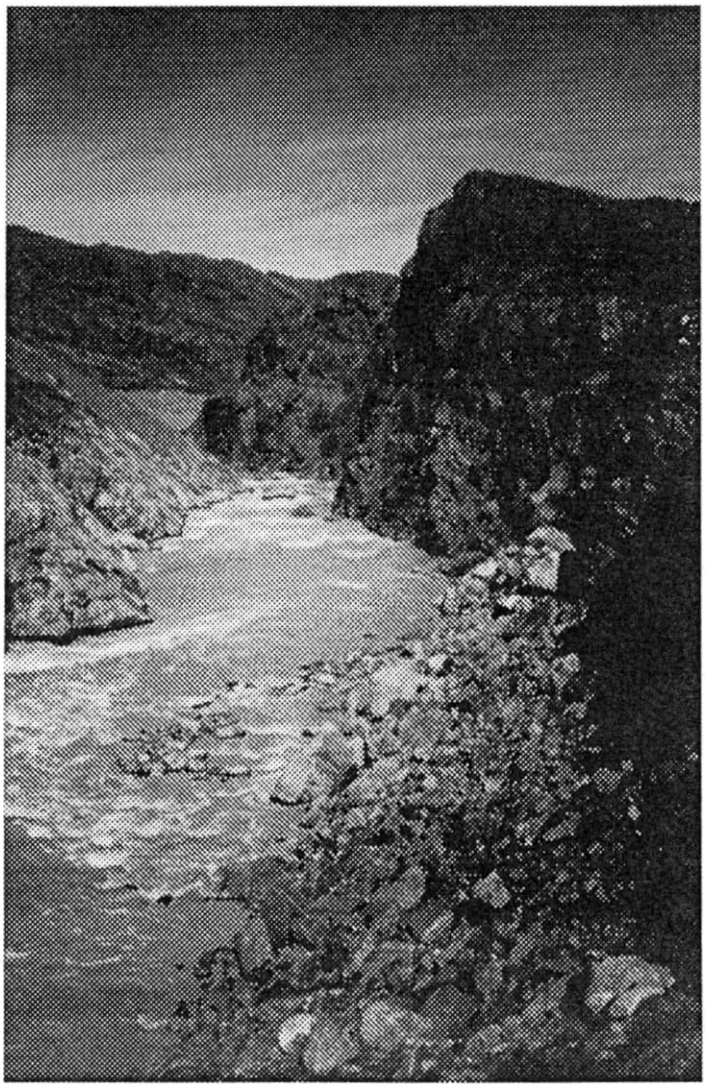


Fig. 3. The turbulent Sarfartôq stream.

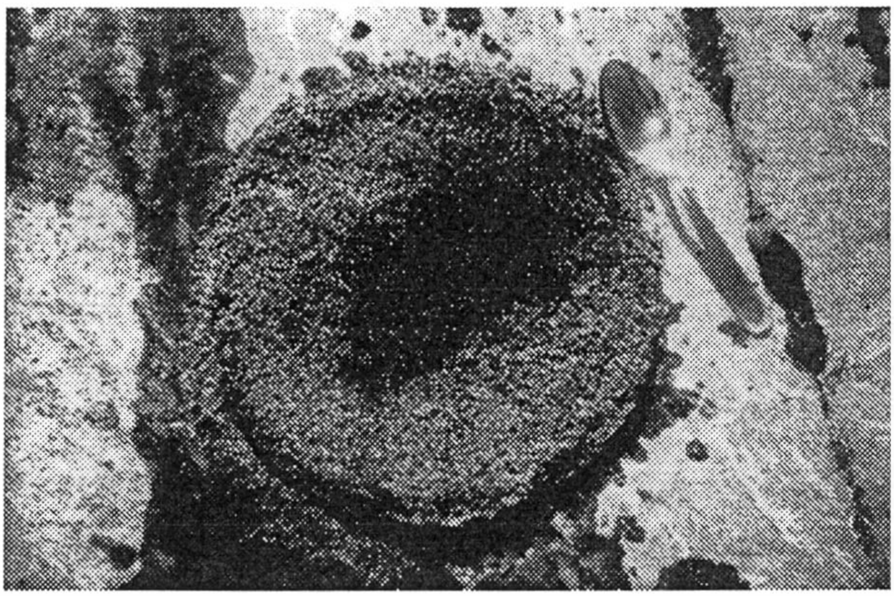


Fig. 4. Jigged sieve contents showing "bulls eye".

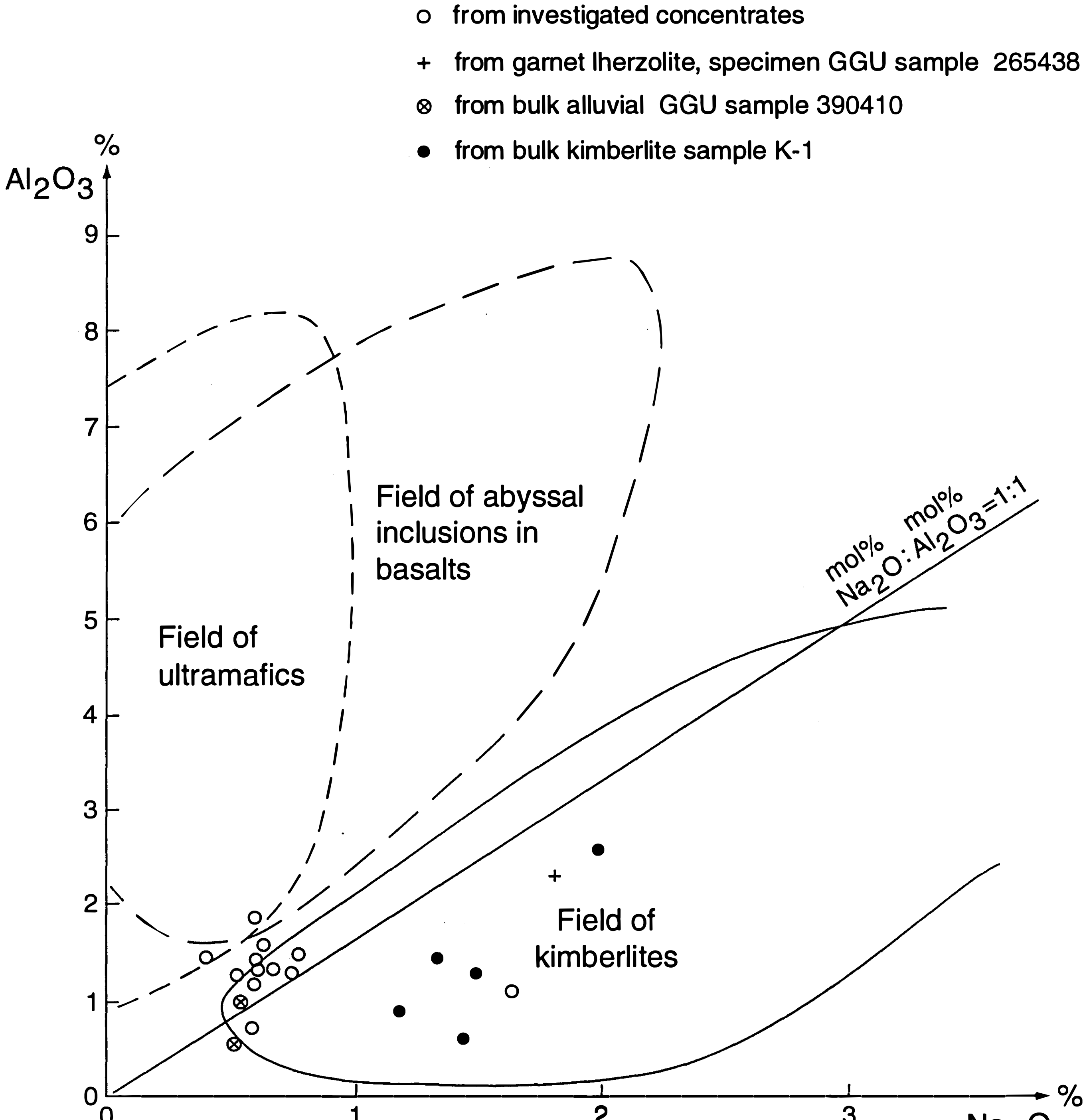


Fig. 5. Al_2O_3 versus Na_2O in chromediopside with Cr_2O_3 0.5 weight % (Smirnov et al. 1994 b).

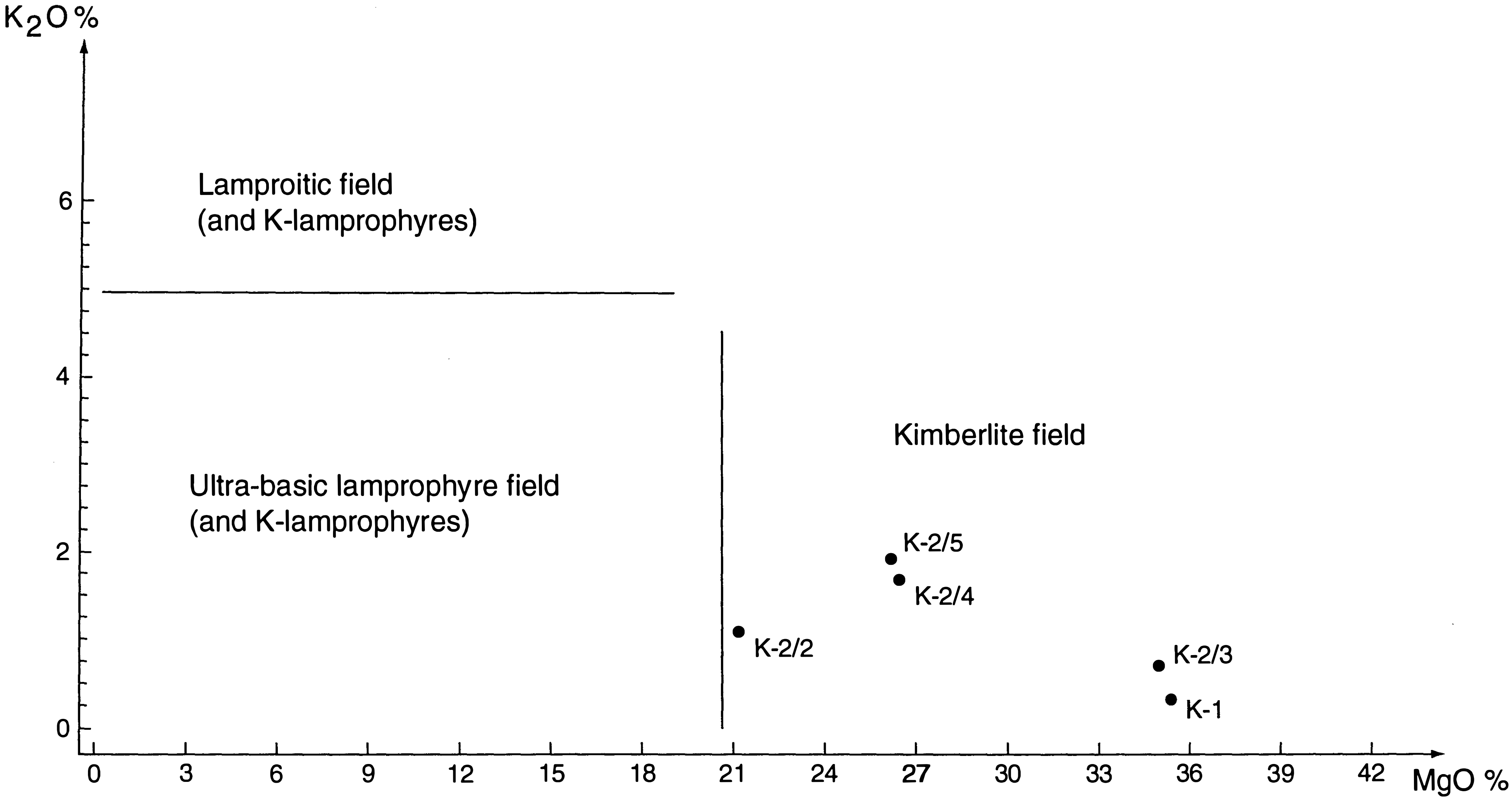


Fig. 6. K_2O versus MgO in weight percent for whole rock composition (Smirnov et al. 1994 b).

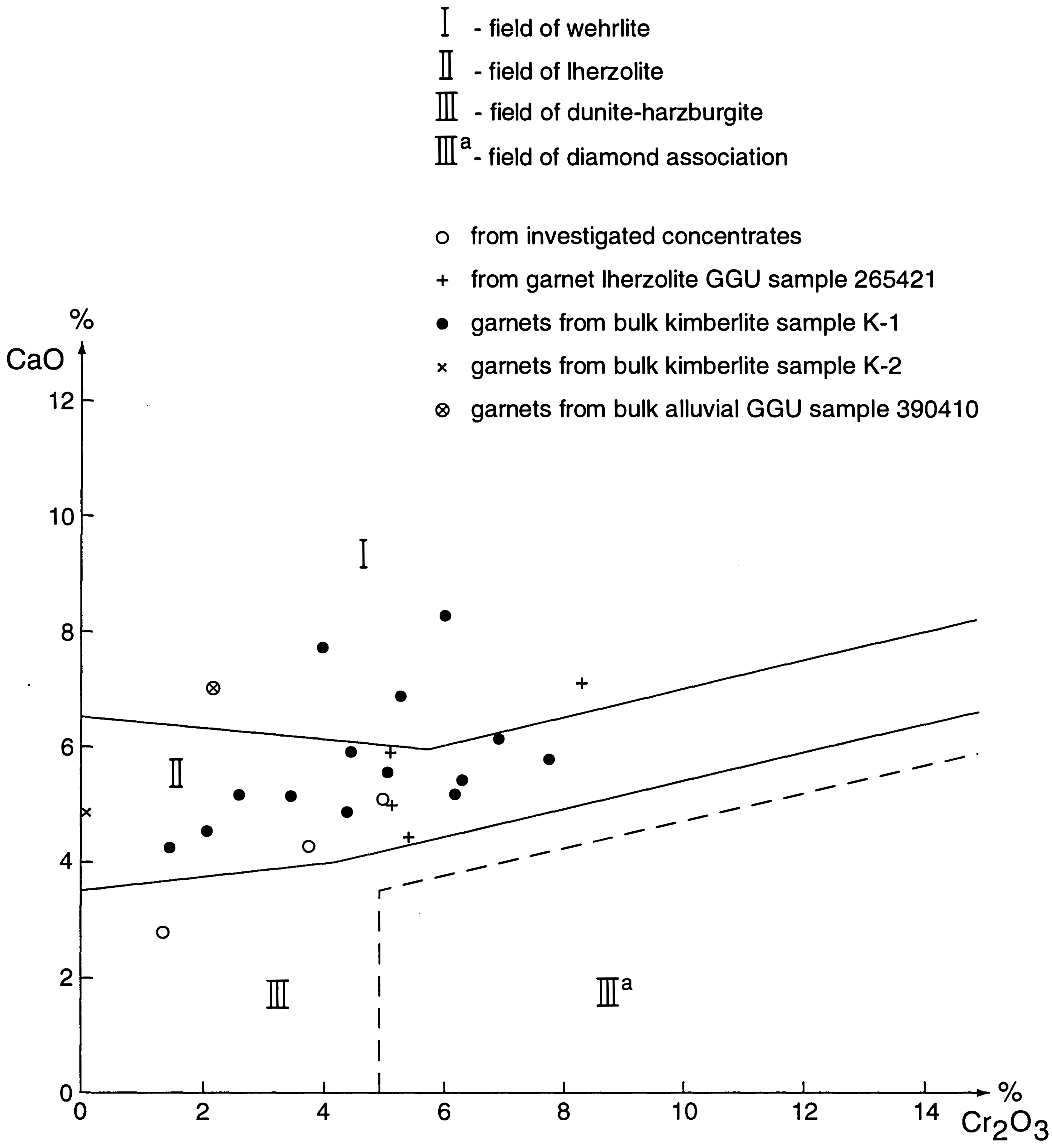
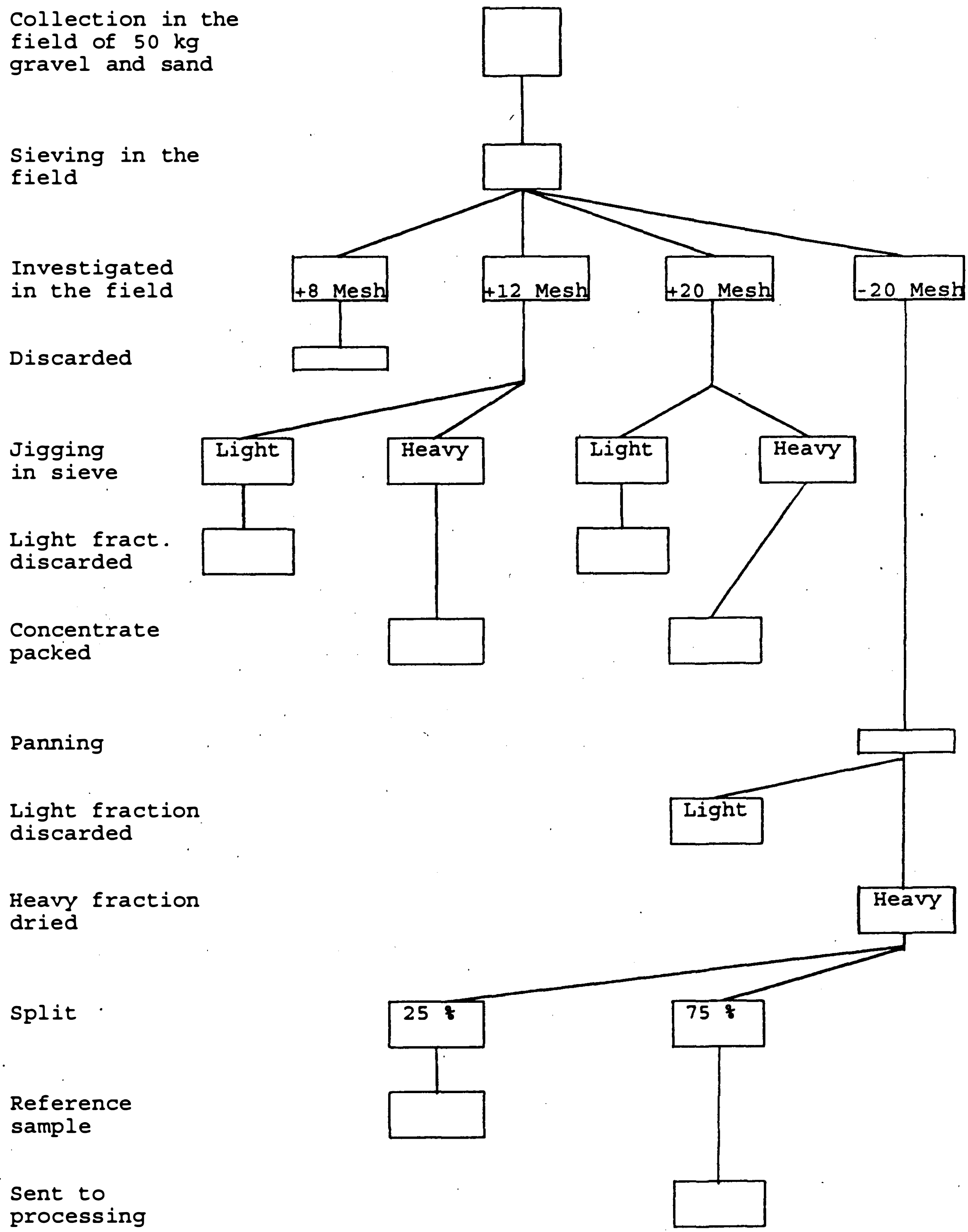
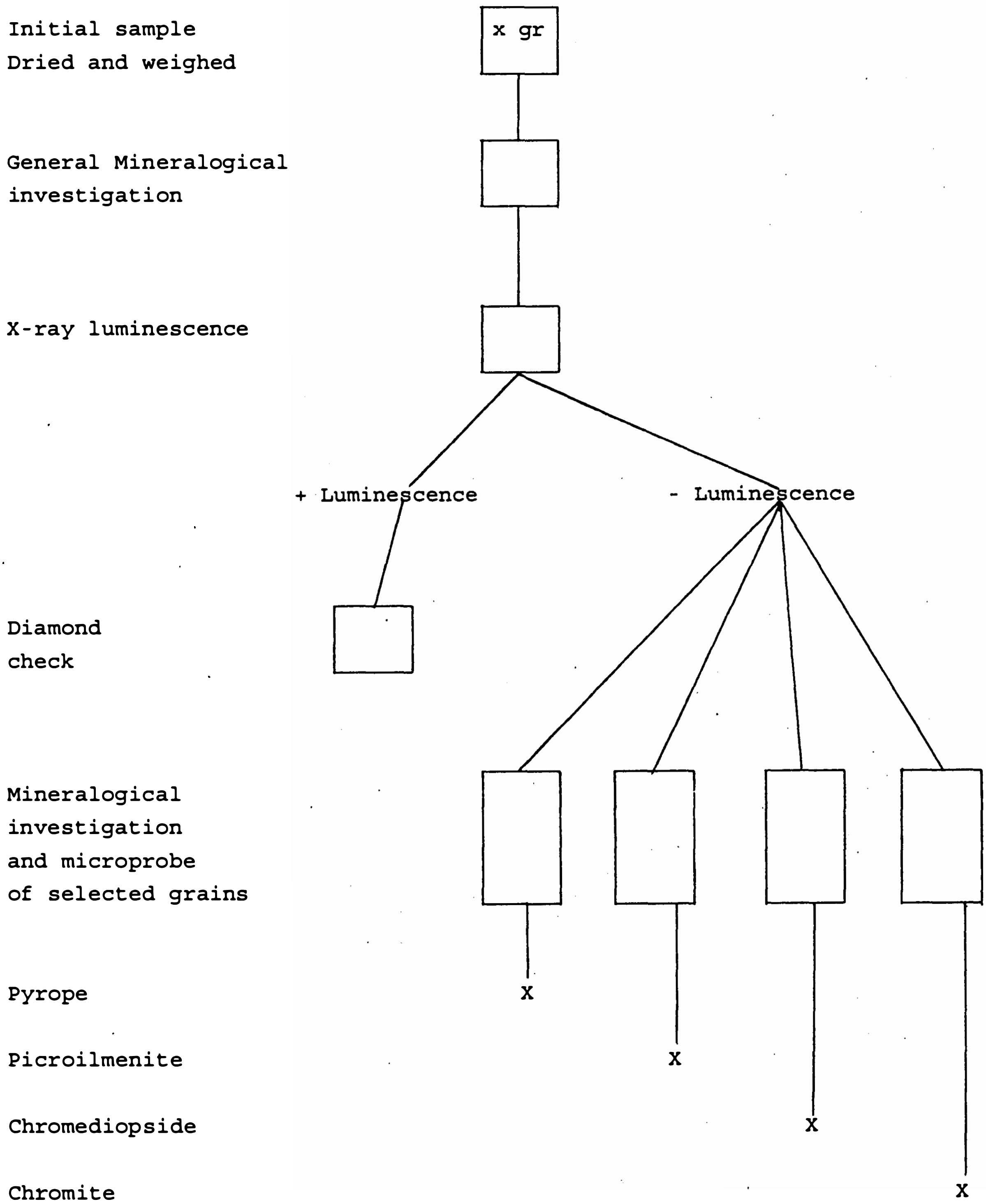


Fig. 7. Relations Cr_2O_3 - CaO in weight percent in pyrope (Smirnov et al. 1994 b).

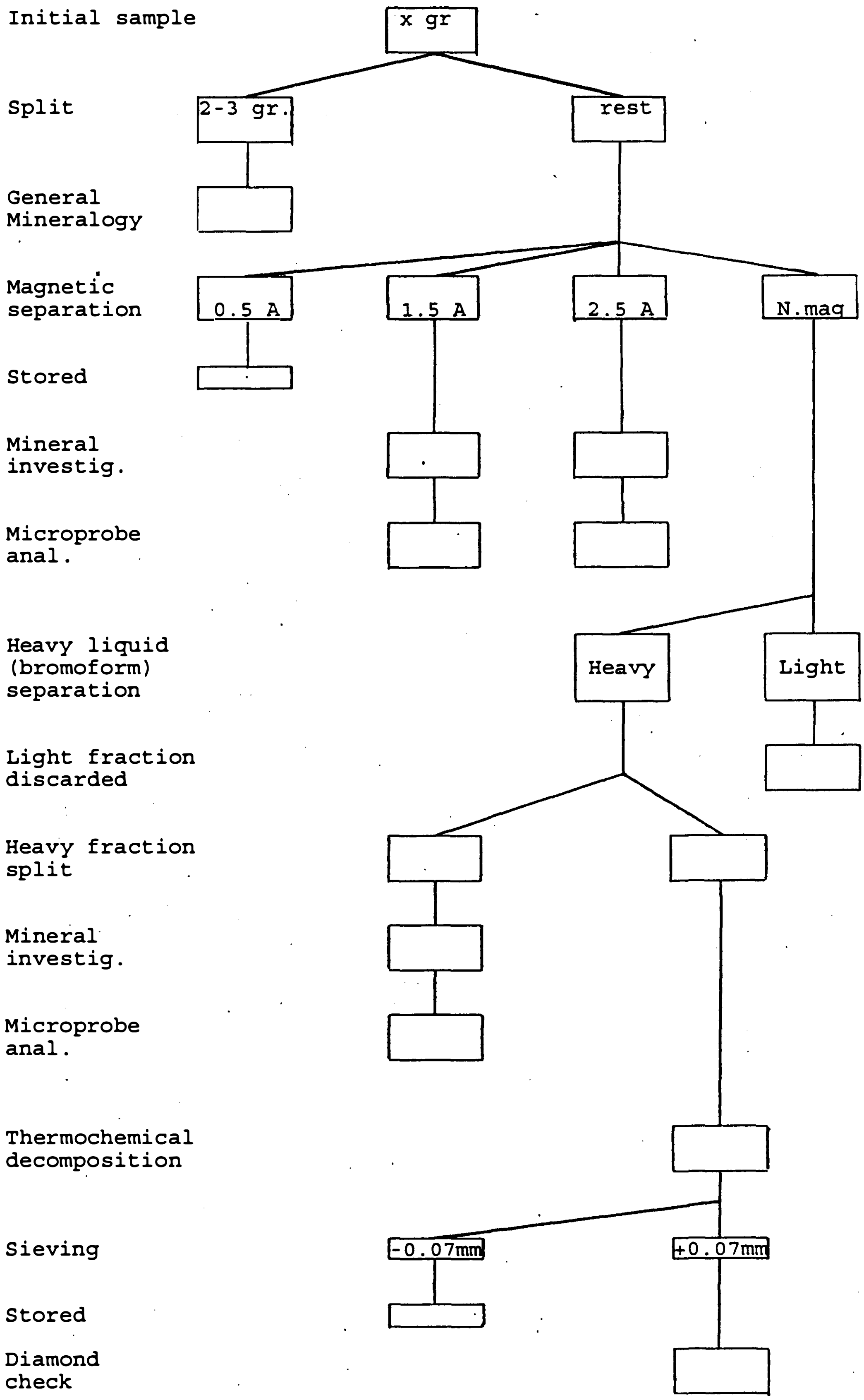
Flow sheet 1 for stream sediment samples



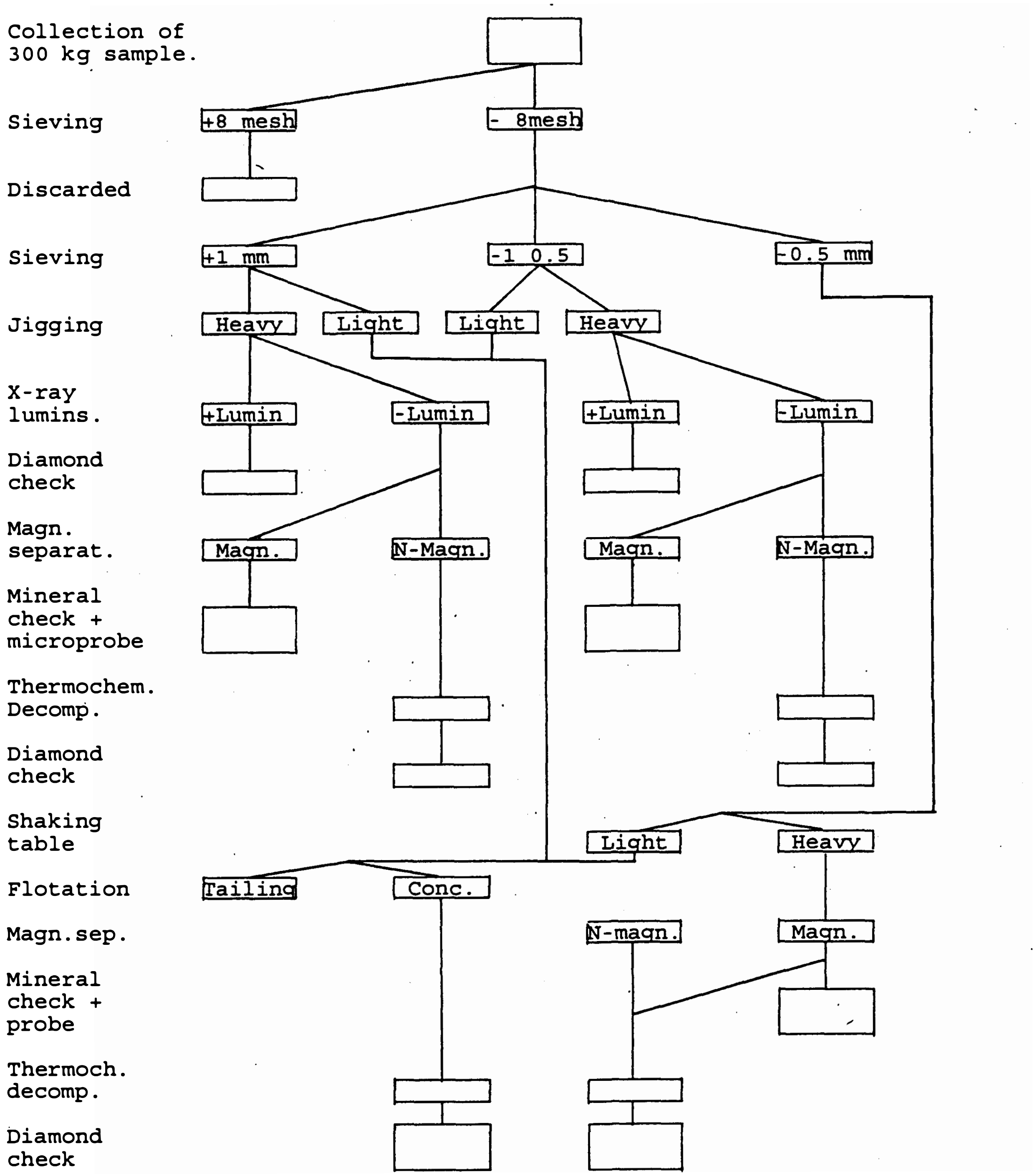
Flow sheet 2 for stream sediment samples coarser than 20 mesh



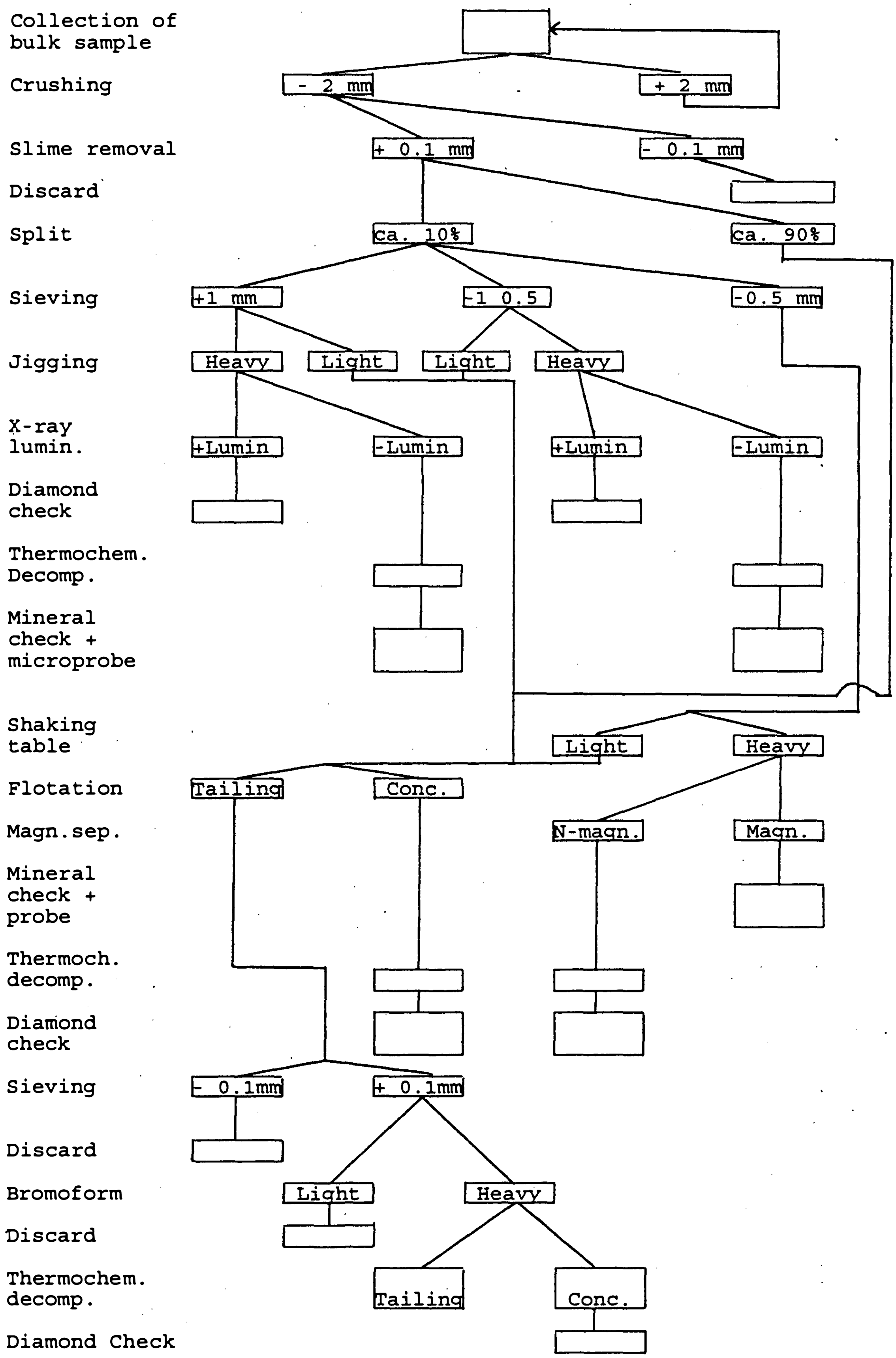
Flow sheet 3 for stream sediment samples finer than 20 mesh



Flow sheet 4 for bulk sediment samples



Flow sheet 5 for bulk kimberlite samples



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