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Abstract: In the Lac de Gras area, geochemical composition and field relationships characterize five Proterozoic diabase dyke swarms and provide data for the development of a tectonic model of dyke emplacement that has implications for kimberlite exploration. Patterns in dyke characteristics (age, orientation, geochemical composition, paleomagnetism) divide the dykes into populations, whose spatial relationship to known kimberlite pipes is tested using GIS and Bayesian techniques.

Three Paleoproterozoic dyke swarms (Malley, MacKay, Lac de Gras), both individually and combined as a single population, have a moderate to strong spatial association with known kimberlite bodies. No apparent spatial association exists between younger dyke swarms (Mackenzie and 305°) and known kimberlite bodies.

The oldest dyke sets are subparallel to known faults and/or joint sets. The evaluation of the role of early structures in controlling the orientation of Paleoproterozoic dykes requires a better understanding of the age of these faults.

Résumé : Dans la région du lac de Gras, la composition géochimique et les relations de terrain caractérisent cinq essaims de dykes de diabase du Protérozoïque et fournissent des données pour l'élaboration d'un modèle tectonique de la mise en place des dykes qui a des répercussions pour la recherche de la kimberlite. Le regroupement des caractéristiques des dykes (âge, orientation, composition géochimique, paléomagnétisme) permet de répartir les dykes en populations, dont la relation spatiale avec les pipes de kimberlite connus est vérifiée à l'aide du SIG et des techniques bayesiennes.

Trois groupes de dykes du Paléoprotérozoïque (Malley, MacKay, Lac de Gras), pris à la fois individuellement et regroupés en une population unique, montrent une relation spatiale modérée à forte avec les pipes de kimberlite connus. Cependant, il n'existe pas de relation spatiale apparente entre les essaims de dykes plus récents (Mackenzie et 305°) et les pipes de kimberlite connus.

Les ensembles de dykes plus anciens sont presque parallèles aux ensembles de failles et de diaclases connus. L'évaluation du rôle des structures anciennes dans le contrôle de l'orientation des dykes du Paléoprotérozoïque nécessite une meilleure connaissance de l'âge de ces failles.

INTRODUCTION

The Slave Province (Fig. 1) has been the focus of intense diamond exploration since 1991. The area boasts the operating Ekati diamond mine, with a second diamond mine, Diavik, slated to open in 2003. Although the Lac de Gras diamond field contains over 150 reported kimberlite pipes (Armstrong, 1998; J. Armstrong, pers. comm., 2000), limited public domain access to data means that a regional exploration model for kimberlite pipes remains elusive. However, a noted common feature of many kimberlite fields is the tendency for pipes to align along a preferred orientation, suggesting that pre-existing, deep-seated structures (e.g. dykes, faults, terrane boundaries) may be important factors in the distribution of kimberlite magmatism (Dawson, 1971; LeCheminant and Kjarsgaard, 1996; Cookenboo, 1999). This paper explores dykes as potential structural controls on the emplacement of kimberlite pipes.

In the Lac de Gras area, petrography, geochemical composition, and field relationships characterize five Proterozoic diabase dyke swarms and provide baseline data for the development of a tectonic model of dyke emplacement that has important implications for kimberlite exploration. Dyke characteristics (age, orientation, geochemical composition, paleomagnetism) group the dykes into separate populations, whose spatial relationship to known kimberlite pipes is tested using the Bayesian 'weights of evidence' (WofE) technique (Bonham-Carter, 1994) within a GIS environment. The prior probability of finding a kimberlite in any given location in the study area is calculated by dividing the area of known kimberlite by the total study area (i.e. the current spatial density of pipes). The probability of finding a kimberlite in a favourable area, such as within a given distance of a dyke, is calculated using WofE methods. Results of the WofE analysis provide a measure of the strength of spatial association.

This study is part of Project #81, 'Understanding the diamondiferous Lac de Gras kimberlite field, Northwest Territories', of the Geological Survey of Canada and is run jointly by the Mineral Resources and Continental Geoscience divisions of GSC-Ottawa and by GSC-Calgary. Other government partners include Indian and Northern Affairs Canada, Canada Centre for Remote Sensing, and the Government of the Northwest Territories. Industry partners include Monopros, BHP, Kennecott, and Diavik. As a multi-agency and multidisciplinary effort, this project is aimed at improving the baseline for kimberlite exploration in the Lac de Gras area, hopefully for application to other regions of Canada and the world.

STUDY AREA

The Lac de Gras region is in the Archean Slave Province (Fig. 1), in an area dominated by Yellowknife Supergroup metasedimentary rocks and deformed granitoid rocks (McGlynn and Henderson, 1972; Padgham and Fyson, 1992). Mafic and ultramafic volcanic rocks are rare. Plutonic rocks ranging in age from 2.70 to 2.58 Ga (Villeneuve et al., 1997) intrude Yellowknife Supergroup rocks. With the exception of some of the youngest granitoid rocks, all these rocks have been variably folded, faulted, and metamorphosed. High-strain zones parallel regional lineaments and are associated with fold limbs (Kjarsgaard and Wyllie, 1994). Proterozoic dykes ranging in age from 1.27 to 2.23 Ga (LeCheminant et al. 1996) intrude all rocks in the Lac de Gras area (Kjarsgaard and Wyllie, 1994; Kjarsgaard et al., 1994a, b, 1999).

More than 150 Eocene to Cretaceous kimberlite pipes (Kjarsgaard and Heaman 1995; Davis and Kjarsgaard, 1997) intrude the Precambrian rocks (Fig. 1, 2). A sub-area of NTS 76 D was chosen for the initial WofE statistics (Fig. 1).

FIELD RELATIONSHIPS

The compilation of diabase dykes in the Lac de Gras area identified five unique Proterozoic swarms using field and aeromagnetic data (Kjarsgaard et al., 1994a, b, 1999; LeCheminant, 1994). Ages for the swarms range from 1.27 to 2.23 Ga (LeCheminant et al., 1996). The source region for the Mackenzie swarm (and possibly the 305° dykes) is over 700 km northwest of Lac de Gras beneath the Beaufort Sea (Ernst and Baragar, 1992; Baragar et al., 1996; LeCheminant et al., 1996). The suggested source of the Lac de Gras swarm is beneath the Kilohigok basin (*see* Fig. 1), near the coeval Booth River intrusive complex (Roscoe et al., 1987), about 300 km north of Lac de Gras. Potential source regions for the Malley and MacKay dykes have not been positively identified. However, it has been suggested that these swarms relate to the 2.2 Ga breakup of an Archean craton (LeCheminant et al. 1996).

Proterozoic diabase dykes in the Lac de Gras area are undeformed, recessive, linear features typically 10 to 50 m wide (LeCheminant, 1994). Swarms are characterized by distinct orientation, spatial distribution, age, abundance, paleomagnetism, and magnetism (Table 1). Ernst et al. (1996) provide a list of references for each dyke swarm.

Figure 2 shows the distribution of mapped diabase dykes in the Lac de Gras area, as well as the location of known kimberlite pipes. We assume that any dyke is indicative of potential structural features that allow the ascent of kimberlite magma. The total dyke population can be tested to determine whether a spatial relationship exists between the location of kimberlite pipes and distance from a dyke. Figure 2 also shows that, although the Mackenzie dykes are a relatively uniformly distributed, the other dyke swarms are more localized. The possible role of dyke abundance in providing favourable sites for kimberlite emplacement can also be evaluated by testing the spatial relationship between known kimberlite bodies and areas of dyke concentration. Likewise, it is possible that dyke intersections may provide favourable sites for kimberlite emplacement and this spatial relationship can also be tested using WofE.

Several interesting features are apparent in Table 1. Although there are five mapped swarms, there are two clusters of ages, a 2.2 to 2.0 Ga range that includes the Malley,

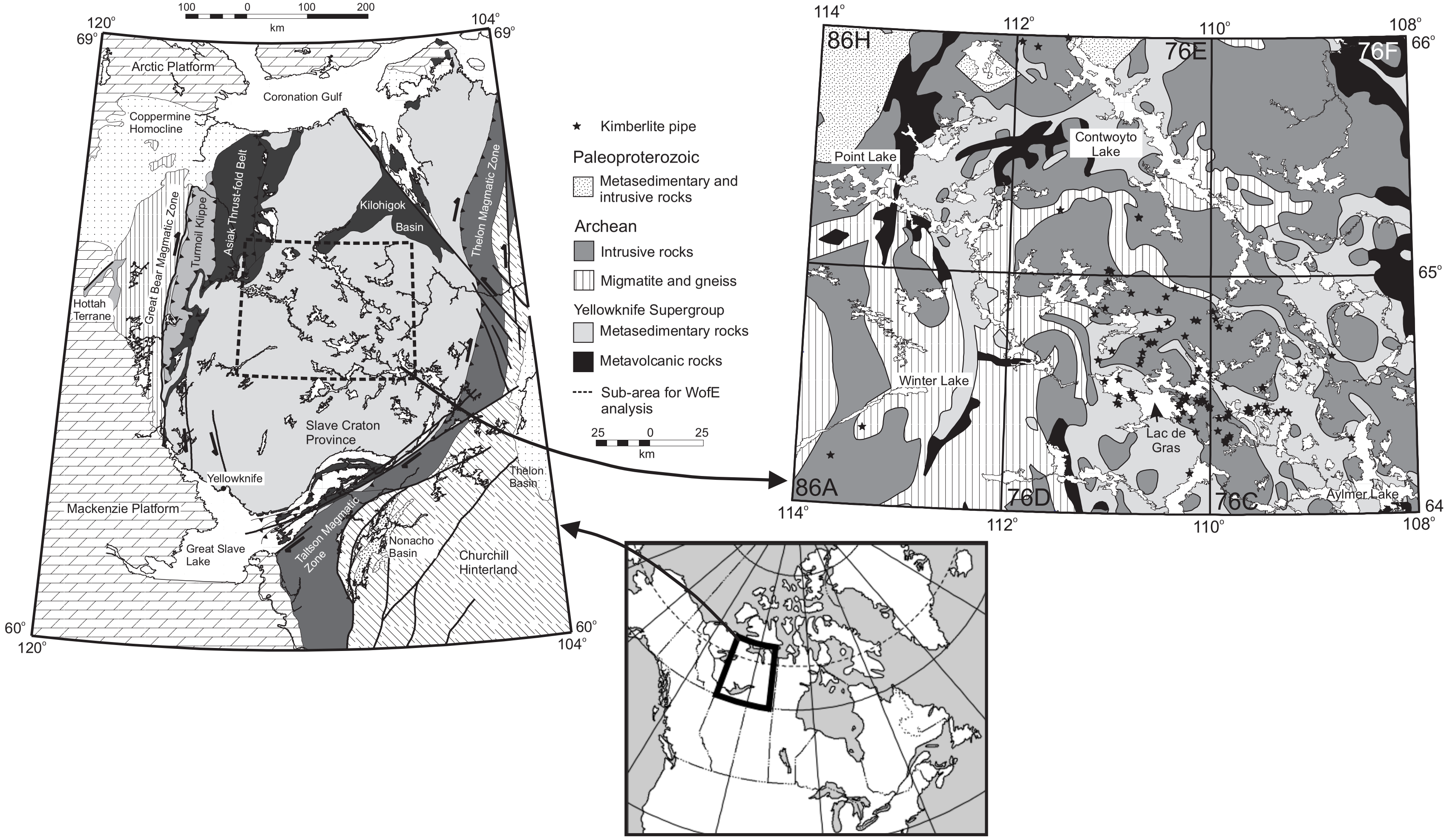


Figure 1. *Study area location map. Tectonic province map after Hoffman and Hall (1993). Generalized bedrock geology of the central Slave Province after Kirkham et al. (1995). Kimberlite locations after Armstrong (1998).*

MacKay, and Lac de Gras swarms, and a 1.27 Ga Mackenzie age that possibly includes the 305° swarm. This corresponds to a general north-northwest trend for the younger Mackenzie and 305° swarms and an east-northeast–north-northeast trend for the older Malley, MacKay, and Lac de Gras swarms (Fig. 3), and suggests that dykes in the Lac de Gras area may be treated as two separate populations on the basis of age. This genetic hypothesis can be evaluated by testing the spatial relationship of kimberlite to distance from old versus young dykes, intersections between old dykes versus intersections between young dykes, and the concentration of old dykes versus the concentration of young dykes.

Lastly, the five swarms can be treated as five separate populations. This allows for the possibility that despite similarities in age, each swarm may have a unique origin and may provide a unique tectonic control.

Table 1. Summary of dyke swarm characteristics in the Lac de Gras area. Data summarized *after* LeCheminant (1994), LeCheminant et al. (1996), and this study.

Trend	Age	Orientation	Magnetism	Total length of dykes[1]	Typical widths
Malley	2.23 Ga	045°-striking	strong	963 km (46)	10–40 m
MacKay	2.21 Ga	080°-striking	weak	758 km (37)	40–50 m
Lac de Gras	2023–2030 Ma	010°-striking	strong	3179 km (131)	20–40 m
305°	(?)1.27 Ga	305°-striking	strong	788 km (25)	15–30 m
Mackenzie	1.27 Ga	NNW-striking Radiating	strong	10 363 km (234)	20–50 m

[1] Total length is based on the total length of dykes for each swarm in the sub-area selected for WofE statistics. The number of mapped segments for each swarm is indicated in brackets.

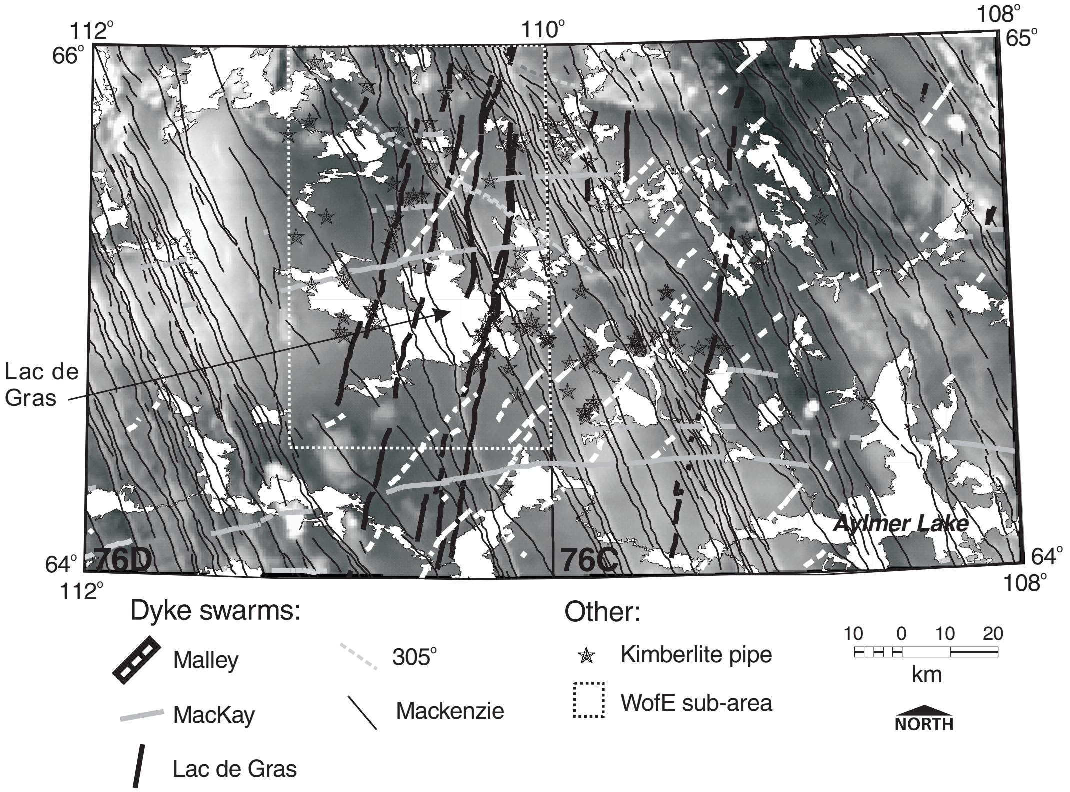


Figure 2. Distribution of kimberlite and dyke swarms in the central Slave Province. Aeromagnetic data obtained from the Geophysical Data Centre, Geological Survey of Canada.

GEOCHEMICAL COMPOSITION

Fifty diabase dyke samples were analyzed for major elements by fused disc X-ray fluorescence, and for trace elements by ICP-MS (analytical work performed by Acme Analytical Labs, Vancouver). A minimum of five samples were analyzed from each of the five dyke swarms.

Whole-rock geochemical analyses for samples from each dyke swarm provide similar results. On the total alkalis-silica (TAS) variation diagram (LeMaitre, 1989), all dyke samples plot within the basalt field (volcanic rocks) or the gabbro field (plutonic rocks) (Fig. 4). Samples from the Lac de Gras swarm, however, are distinct on the TAS plot, due to high total alkalis, whereas samples from all the other swarms are subalkalic or tholeiitic in character (Fig. 4). The alkalic character of the Lac de Gras dykes is also evident from their higher light rare-earth element (LREE) contents and much steeper rare-earth element (REE) patterns as compared to dykes from the other swarms (Fig. 5). On a Pearce (1982)

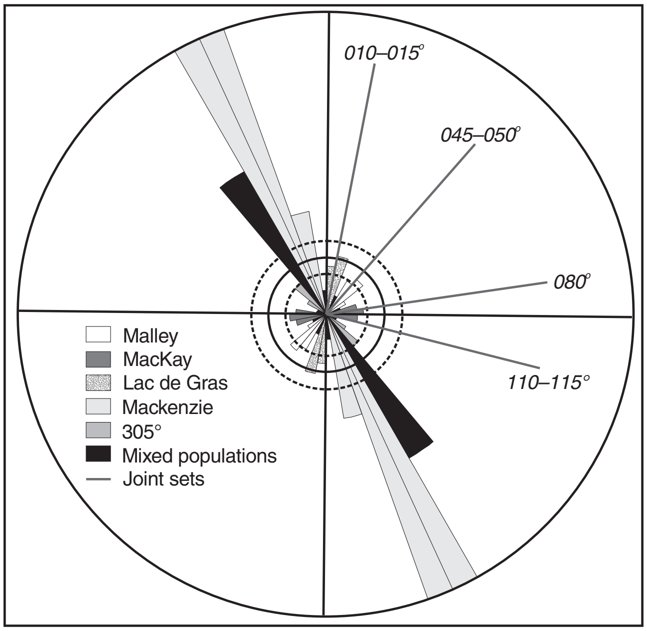


Figure 3. Rose diagram showing mapped dyke orientations by swarm. Mixed populations occur between clusters of each swarm and represent orientations at which dykes of the two adjacent swarm clusters have similar orientations.

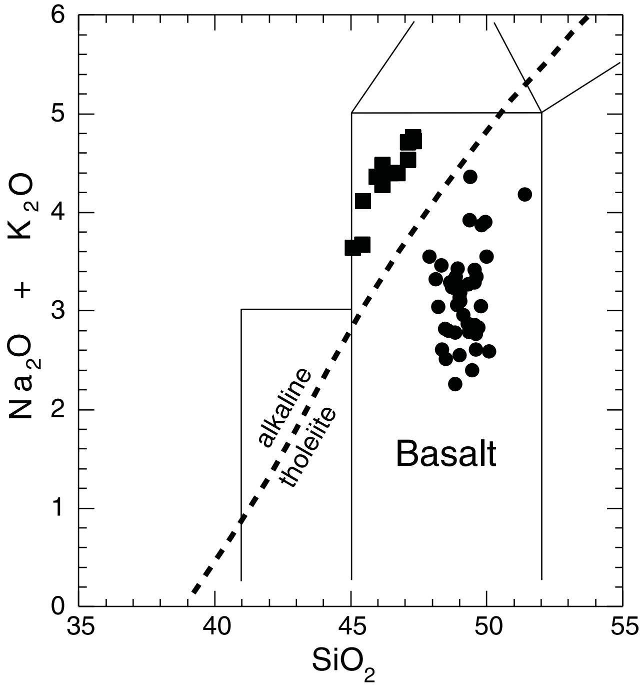


***Figure 4.** Total alkalis-silica (TAS) variation diagram (LeMaitre, 1989). Filled squares = samples from the Lac de Gras diabase dyke swarm; filled circles = samples from the MacKay, Malley, Mackenzie, and 305° diabase dyke swarms.*

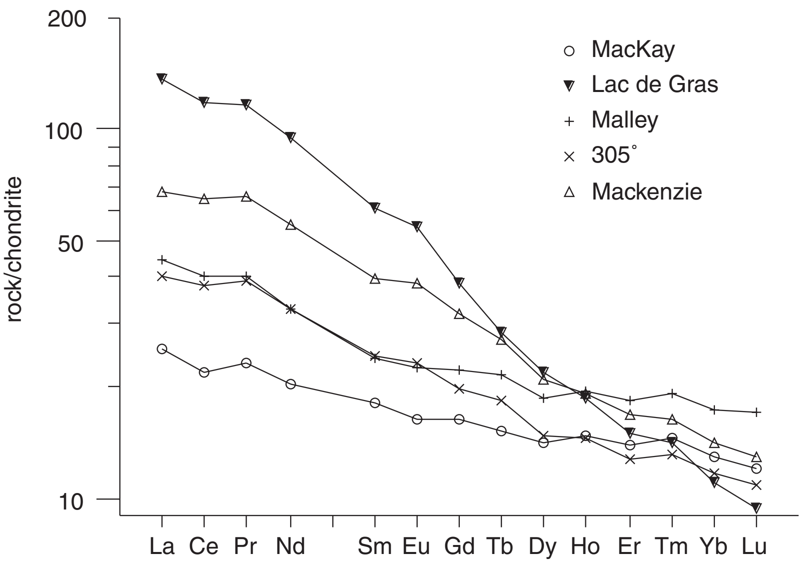


Figure 5.

Chondrite-normalized rare-earth-element (REE) plot for each of the five dyke swarms (mean analysis). Normalization values after *Nakamura (1974).*

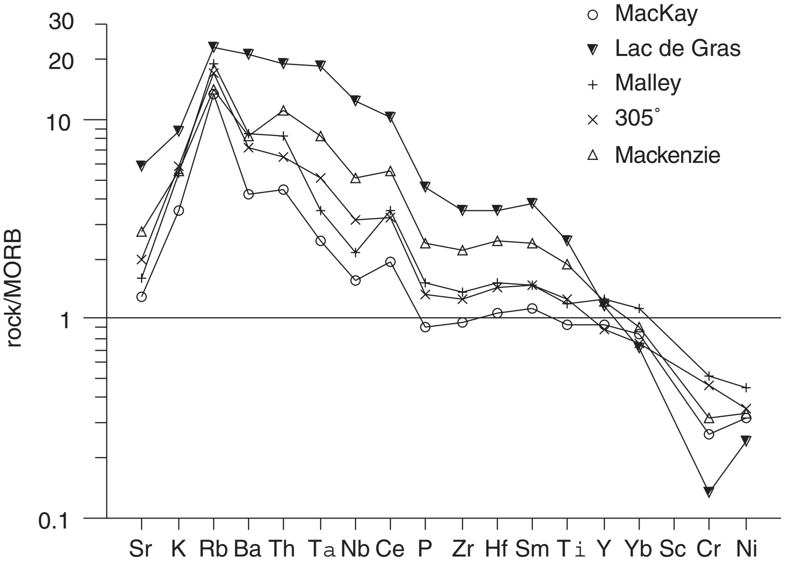
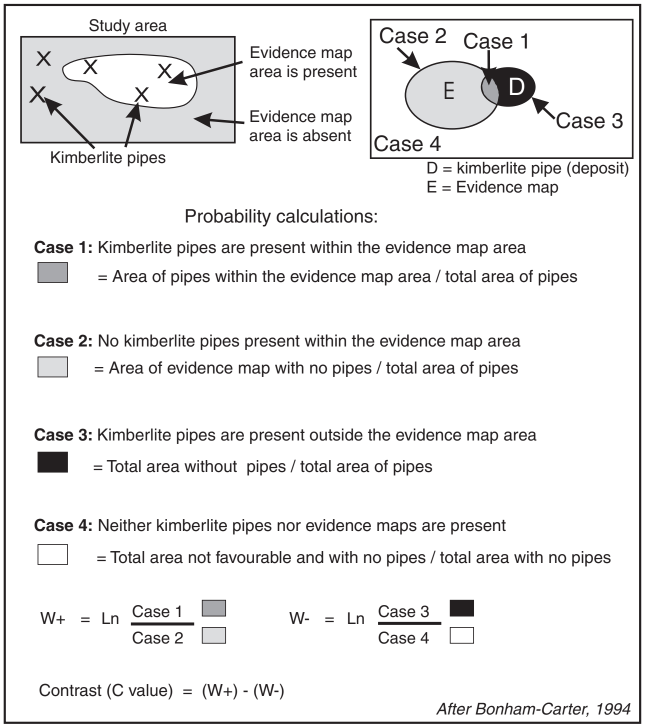


Figure 6.

Mid-ocean-ridge basalt-normalized Pearce (1982) plot for each of the five dyke swarms (mean analysis).

mid-ocean-ridge basalt (MORB)-normalized plot (Fig. 6), the enriched trace-element signature of the Lac de Gras dykes is distinct, as are the discrete differences between the other dyke swarms.

The geochemical composition of the Lac de Gras diabase is consistent with alkalic intraplate basalt magmatism. In contrast, MacKay dykes are MORB-like, with a relatively flat REE pattern (La/Yb_{cn} = 2) and the lowest trace-element enrichment. The Malley dykes also have a relatively flat REE profile (La/Yb_{cn} = 2.5), but have higher total REE and other trace elements (Fig. 5, 6) than the MacKay dykes. The three oldest dyke swarms (Malley, MacKay, and Lac de Gras) thus each have a diagnostic geochemical signature. The younger 1.27 Ga Mackenzie and 305° dykes can further be separated from each other, as well as from the Paleoproterozoic dykes, on the basis of their geochemical composition (Fig. 4, 5, 6) and have a signature typical of continental tholeiite magmatism.



Probability calculations:

Case 1: Kimberlite pipes are present within the evidence map area

▨ = Area of pipes within the evidence map area / total area of pipes

Case 2: No kimberlite pipes present within the evidence map area

░ = Area of evidence map with no pipes / total area of pipes

Case 3: Kimberlite pipes are present outside the evidence map area

■ = Total area without pipes / total area of pipes

Case 4: Neither kimberlite pipes nor evidence maps are present

□ = Total area not favourable and with no pipes / total area with no pipes

$$W+ = Ln \frac{\text{Case 1 } ▨}{\text{Case 2 } ░} \qquad W- = Ln \frac{\text{Case 3 } ■}{\text{Case 4 } □}$$

Contrast (C value) = (W+) - (W-)

Figure 7. *Schematic representation of WofE calculations.*

METHODOLOGY

Weights of evidence analysis

The WofE calculations are schematically represented in Figure 7. The prior probability of finding a kimberlite pipe in any location of the study area is simply the total area of known kimberlite bodies divided by the total study area. In this study, there were 51 known kimberlites (extracted from Armstrong, 1998), each of which was given an arbitrary surface area of 250 m^2, within the total study area of 4396 km^2, defining a prior probability of 0.0029, or less than 1%.

Evidence maps are then constructed and tested to determine whether a spatial association between the evidence map (favourable area) and known kimberlite bodies exists. Four calculations are required for WofE analysis, as follows:

- area of pipes that fall within the evidence map area / total area of pipes (kimberlite pipes are present within the evidence map area);
- area where evidence map is present, but deposits are not / total area of kimberlite (no kimberlite pipes are present within the evidence map area);
- total area without kimberlite / total area of kimberlite (kimberlite pipes are present outside the evidence map area);

- total area not favourable and with no kimberlite / total area with no kimberlite (neither kimberlite nor evidence map areas are present).

A positive spatial association, measured by a calculated weight (W^+), occurs when the probability of kimberlite occurring within the evidence map area is higher than the probability of an evidence map area existing in which no kimberlite occurs.

Similarly, a negative spatial association, measured by a calculated weight (W^-), occurs when the probability of kimberlite occurring outside the evidence map area is much higher than the probability of finding no kimberlite and no evidence map areas. The contrast (C value) measures the difference between the positive and negative spatial associations. Thus, the C value reflects the strength of the spatial association between the given evidence map and known kimberlite pipes.

Data processing for WofE calculations

The processing methodology is represented schematically in Figure 8. As indicated in the previous section, the dykes were treated as 1) a single population, 2) two populations based on age, and 3) five populations based on swarm. In all cases, data processing and applied WofE calculations were identical.

Distance to dykes

To assess the possible spatial relationship between known kimberlite bodies and dykes, evidence maps were made consisting of areas representing increasing distance from dykes, in 50 m increments, to a total of 1000 m. Weights of evidence calculations were performed cumulatively. Thus, the area representing a distance of 150 m from a dyke includes the areas representing 0 to 50 m and 50 to 100 m from a dyke. The strongest spatial association is indicated by the highest C value. However, a second peak in C values commonly occurs at greater distances. More pipes fall within this distance than within the distance identified within the highest C value. Lastly, a third distance is sometimes identified at which there is also a high spatial association with kimberlite and at which more pipes again occur. These peaks in C value can be considered as conservative, moderate, and liberal thresholds, respectively. Each threshold represents a possible maximum distance at which a spatial association exists between dykes and kimberlite.

Dyke abundance

A dyke abundance map that reflects the spatial density of dykes was constructed within the GIS by converting the dyke distribution map to an image and by counting the number of dykes within a defined circular neighborhood around each pixel or cell (*see* Fig. 8). The map was then classified into regions on the basis of standard deviations from the mean. These regions were tested for spatial relationship to the known kimberlite pipes.

Dyke intersections

Dyke intersections were digitized as discrete points. As for dykes, maps were made consisting of 50 m distance intervals to a total distance of 1000 m. Cumulative weights were then calculated. The identification of C value thresholds followed the procedure outlined for the distance to dykes.

RELEVANCE TO KIMBERLITE EXPLORATION

Weights of evidence results

Weights of evidence calculations for evidence maps with a positive spatial association to known kimberlite pipes are summarized in Table 2. Threshold values in Table 2 refer to the exploration criteria (represented by an area) of each evidence map found to be spatially correlated with the known kimberlite pipes. For example, the area within 50 m of Malley dykes totaled 14.7 km^2 and contained two kimberlite pipes,

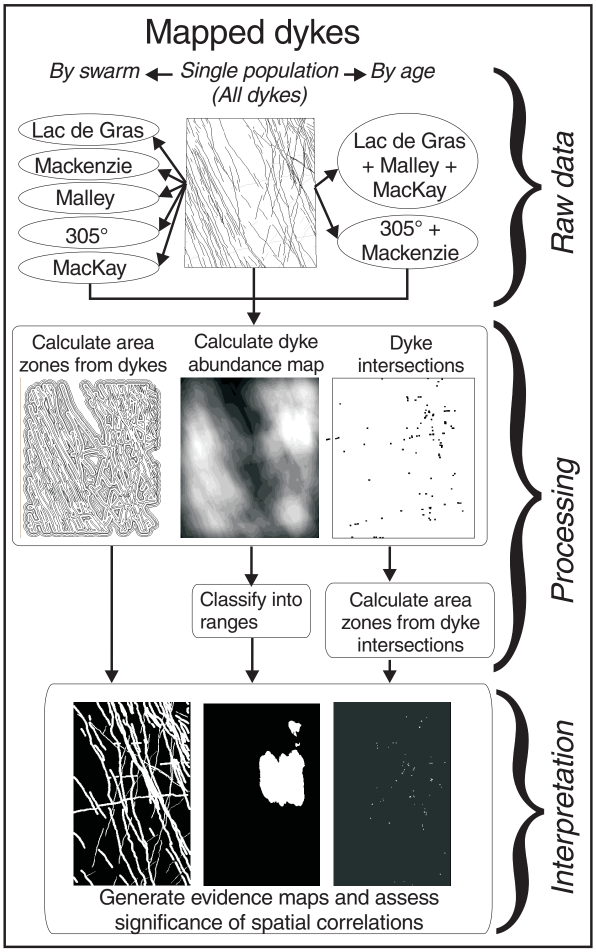


Figure 8. *Flow chart outlining dyke data-processing methodology.*

Table 2. Weights of evidence (WofE) results for spatial relationship between known kimberlite occurrences and evidence maps. Ranks are based on C values.

Evidence map	Area (km²)	No. of pipes	W^+	W^-	C	C/SD*	Rank	Threshold
Best correlation — (shortest distance, high C) conservative thresholds								
Malley dykes	14.7	2	2.49	-0.04	**2.53**	3.44	1	50 m
Dyke intersections	11.3	1	2.05	-0.02	**2.07**	2.02	2	200 m
MacKay dykes	35.7	2	1.59	-0.03	**1.62**	2.23	3	200 m
Older dykes only [1]	76.3	3	1.23	-0.04	**1.27**	2.13	4	50 m
Lac de Gras dykes	242.9	6	0.76	-0.07	**0.83**	1.90	5	350 m
Second best correlation (longer distance, high C) — liberal thresholds								
MacKay dykes	52.6	3	1.60	-0.05	**1.65**	2.76	1	300 m
Malley dykes	58.6	3	1.49	-0.05	**1.54**	2.57	2	250 m
Older dykes only [1]	373.2	12	1.02	-0.18	**1.20**	3.64	3	350 m
Dyke intersections	125.3	4	1.02	-0.05	**1.07**	2.05	4	700 m
Lac de Gras dykes	590.9	15	0.79	-0.20	**0.99**	3.32	5	900 m
Third best correlation (most number of pipes found, high C) — very liberal thresholds								
MacKay dykes	69.8	4	1.61	-0.07	**1.67**	3.19	1	400 m
Older dykes only [1]	915.6	25	0.86	-0.44	**1.30**	4.64	2	900 m
Malley dykes	206.5	7	1.08	-0.10	**1.18**	2.88	3	850 m
Dyke intersections	177.1	5	0.89	-0.06	**0.96**	2.02	4	850 m

[1] Older dykes are the Lac de Gras, Malley, and MacKay dyke swarms only.

* C/SD refers to the contrast divided by its standard deviation (C value is measured at every pixel) and is a measure of uncertainty (*see* Bonham-Carter, 1994).

producing a high C value of 2.53. Extending the distance from the Malley dykes to 250 m finds one additional pipe, but also increases the total area to 58 km^2, resulting in a lowered C value of 1.65. The increased distance represents a relaxed threshold from the more restrictive (in area) conservative threshold, defined by the highest C value.

All three older dyke swarms, individually and when combined into a single population, have a moderate to strong spatial association with known kimberlite pipes. Of these, the Malley dykes show the strongest spatial association, indicated by the highest C value of 2.53. When all older dykes are considered together, the area within 50 m of the Lac de Gras, Malley, or MacKay dykes increased to 76.3 km^2. The C value was lowered due to the increase in search area, but remained strong because an extra pipe was found within this increased area.

Conservative threshold distances (smallest distance with the highest C value) vary from 50 m to 350 m, with six pipes the maximum number found (Lac de Gras dykes) in any one of the evidence maps. Allowing the distances from the dykes to increase (second best correlation, Table 2) produced thresholds in the range of 250 m to 900 m and resulted in a maximum of 15 pipes found in any one evidence map (Lac de Gras dykes). The C value remained high and, in the case of Lac de Gras dykes, it even increased. The population consisting of the oldest dykes also shows a strong spatial association with known kimberlite pipes, with 25 pipes found within the area representing 900 m from the dykes (915.6 km^2) (*see* third best correlation, Table 2).

There was no spatial association of the younger dyke swarms (Mackenzie, 305°), when tested separately by swarm or together as a set of younger dykes, with known kimberlite pipes. In addition, although dyke intersections (all swarms) were spatially related to known kimberlite pipes, there was no spatial association between intersections of only older dykes or only younger dykes and known kimberlite pipes. There was also little spatial association between areas of dyke concentration and known kimberlite pipes with the exception of the Lac de Gras and Malley swarms, which had moderate, uncertain C values of 0.64 and 0.81 respectively, for areas of dyke concentration (>3 standard deviations from the mean) (*see* Bonham-Carter, 1994, for a discussion of uncertainty).

DISCUSSION

A moderately strong spatial association exists between the older dykes (both as a set and as individual swarms), and all dyke intersections with known kimberlite pipes, based on WofE analysis. Although six kimberlite bodies are found within 300 m of a Mackenzie dyke, this number is less than expected for the total evidence map area (C value of -0.30 for area within 300 m of a Mackenzie dyke — 668.1 km^2). The spatial statistics indicate that the likelihood of finding additional kimberlite pipes near the Mackenzie dykes is the same as anywhere else in the test area. In contrast, two kimberlite pipes occur within 300 m of a Malley dyke. However, the small area (due to the number of dykes) represented by the 300 m distance (52.6 km^2) results in a strong spatial correlation between Malley dykes (300 m) and known kimberlite bodies (Table 2). More kimberlite bodies are found along Malley dykes than would be expected from the spatial density of known pipes. Since Malley dykes are much less abundant than Mackenzie dykes, the odds are higher that additional kimberlite pipes may occur along these dykes. From an exploration point of view, older dykes may be a better exploration target. Significant thresholds for the older set of dykes range from 50 m to 350 m, but can be as much as 900 m (*see* Table 2).

To assess the spatial relationship between kimberlite pipes and diabase dykes, it is necessary to assess the influence of 'early' structures (e.g. faults) on both diabase dykes and subsequent kimberlite intrusions. The role of such structures on dyke emplacement is under debate and two main models have emerged (Delaney et al., 1986). One model suggests that dykes use pre-existing fracture sets in the crust, whereas the second model suggests that during emplacement, dyke tips propagate fractures, which the magma then invades. This latter model finds support in the work of Ernst and Baragar (1992) for the giant radial Mackenzie dyke swarm. Vertical injection of magma occurs within 500 km of the focal point of the swarm, followed by fanning lateral flow, reaching distances of at least 2100 km. Uplift associated with a large mantle plume directly beneath the focal point produces a radial stress field that is used by the basic magmas during vertical and lateral flow. Propagation of fractures from the advancing dyke tip can also generate multiple, parallel joint sets. Delaney et al. (1986) observed parallel fracture sets at up to 5 km from dykes, although most occur at distances less than 10 times the dyke width (i.e. a 50 m wide dyke typically has fracture sets no more than 500 m from each side of the dyke). Maximum dyke width in the Lac de Gras area is 50 m (Table 1) and suggests that liberal threshold should be no more than 500 m. However, given the strong spatial association between kimberlite pipes and dykes at up to 900 m, deep structures may exist in this area at distances greater than 10 times the dyke width.

The Paleoproterozoic dykes (Lac de Gras, Malley, and MacKay) form nearly parallel swarms. Interestingly, the MacKay dykes are somewhat arcuate along their length, and the Lac de Gras dykes are interpreted as slightly radial, with a focus about 300 km north of Lac de Gras. The alkalic nature of the Lac de Gras swarm suggests possible minor uplift and/or radial stress field associated with an intraplate plume beneath the Kilohigok basin. The parallel nature of the Malley and MacKay dykes could be consistent with a plume or rift, but these dykes are likely far removed from magma source regions and associated stress fields.

Card et al. (1999) have suggested that periodic reactivation of early structures, in a response to arch-style uplifts, results in a release of pressure and emplacement of mantle-derived magmas in dykes parallel to the arch axes. Although a number of lineaments are apparent on topographic maps and satellite images, evidence for faulting in the Lac de Gras area is limited (Kjarsgaard et al., 1994a, b, 1999). Strike measurements on steeply dipping and often hematized joint sets suggest that faulting is associated with the following trends: 010° to 015°, 045° to 050°, 080°, 110° to 115° (*see* Fig. 3). The structural observations suggest possible fault sets exist at the same orientation as the three older sets of dykes (010°, 045°, 080°). It is thus possible that the Malley, MacKay, and possibly Lac de Gras swarms used pre-existing structures in the crust. Similar relationships have been observed between kimberlite dykes, diabase dykes, and regional joint sets in a detailed study of structural control on Lesotho kimberlite bodies (P.H. Nixon, unpub. report, 1973). However, although the three older dyke swarms in the Lac de Gras area all follow fault trends (Fig. 3), no direct evidence has been found that magma intruded along these faults sets, and no constraint exists on the age of these faults.

CONCLUSIONS

From an exploration point of view, effort should be focused along structures related to the older dyke swarms as these have a moderately strong spatial association with known kimberlite pipes.

The oldest dyke sets are oriented in a direction similar to that of known faults and/or joint sets. An evaluation of the role of early structures in controlling the orientation of Paleoproterozoic dykes requires a better understanding of the age of these faults.

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