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VARIATION IN THE DISTORTION INDEX OF CORDIERITE EAST OF THE SPARROW LAKE GRANITE PLUTON, DISTRICT OF MACKENZIE

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INTRODUCTION

Miyashiro *et al.* (1955) and Miyashiro (1957) found that cordierite forms a hexagonal polymorph, and that a continuous series exists from the orthorhombic pseudo-hexagonal to a slightly distorted hexagonal structure. The structural state was defined in terms of a distortion index (Δ) which measures the deviation from hexagonal symmetry, and is defined as follows: $\Delta = 2\theta_{131} - (2\theta_{511} + 2\theta_{421}) / 2$. Schreyer & Schairer (1961) subdivided Mg-cordierite into high cordierite ($\Delta = 0.0$), intermediate ($0.0 < \Delta < 0.20$), and low cordierite ($0.20 < \Delta < 0.30$).

The different states of cordierite are generally believed to be due to differences in the degree of ordering of the Al and Si atoms in the *Z* position (Gibbs 1966). These cations are ordered in low cordierite, disordered in high cordierite, and partly ordered in intermediate cordierites.

The distortion index of cordierite is dependent on its Fe and water content (Schreyer & Yoder 1964), Be content (Newton 1966), and temperature of crystallization.

GEOLOGICAL SETTING AND MODE OF OCCURRENCE OF CORDIERITE

The study area (Fig. 1) is in the Yellowknife-Beaulieu region, about 40 km northeast of Yellowknife. The region is underlain by Precambrian rocks of the Slave Province of the Canadian Shield. The rock units of this region consist of metavolcanics and metasediments (Yellowknife Supergroup), granites and granodiorite bodies, and diabase dykes (Henderson & Jolliffe 1941). The Sparrow Lake granite pluton, 9 by 20 km in dimensions, shows an intrusive relationship with the adjacent metasediments.

Cordierite near Sparrow Lake occurs in the metagreywacke and argillite that form a broad aureole about the pluton. Minerals that coexist with cordierite include gedrite, garnet, biotite, cummingtonite, muscovite, oligoclase, andalusite, sillimanite, ilmenite, rutile, pyrrhotite, apatite

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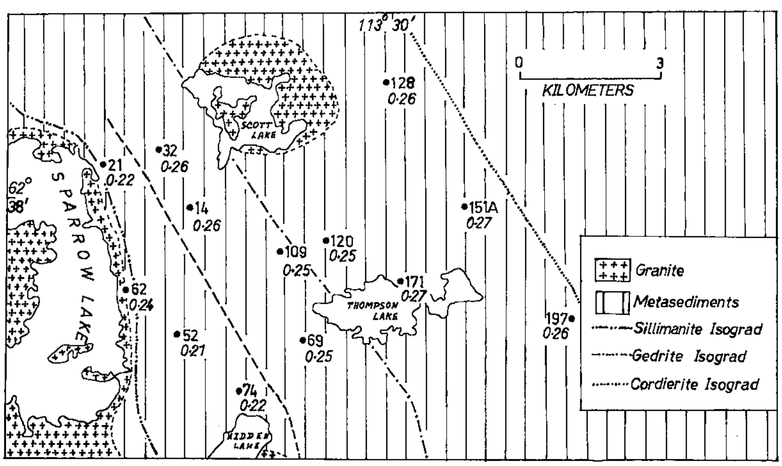

FIG. 1. Geological map showing the sample locations and their cordierite distortion-index values. The line between the sillimanite and gedrite isograds separates values greater than 0.25 and less than 0.25.

and tourmaline. The mineral assemblages of 12 rocks, and partial chemical analyses of the contained cordierite, obtained on an ARL electron microprobe, are given in Table 1. Analytical details and more complete analyses are given by Kamineni (1973).

TABLE 1. PARTIAL CHEMICAL ANALYSES OF CORDIERITES

Sample No.	SiO_2	Al_2O_3	FeO*	MgO	Mineral Assemblage
62	49.60	31.01	7.57	7.50	quartz-cordierite-biotite-andalusite-muscovite-sillimanite-ilmenite
14	49.10	29.95	7.35	8.32	
21	47.50	33.05	8.09	8.54	quartz-cordierite-biotite-garnet-gedrite-ilmenite-pyrrhotite
32	48.94	32.00	7.69	8.45	
52	48.00	32.50	7.20	8.78	
74	48.00	32.02	7.71	8.78	
39	47.60	31.55	8.97	8.26	
69	47.50	31.68	8.61	8.21	
151A	49.05	31.83	8.40	7.01	quartz-cordierite-biotite-oligoclase-ilmenite-pyrrhotite
171	47.68	33.00	8.92	6.95	
197	46.95	31.85	9.15	7.73	
120	48.93	29.66	9.68	7.70	

*Total Fe as FeO

The cordierite porphyroblasts range in size from 0.3 x 0.5 mm near the granite contact to 2.5 x 3.5 cm away from the contact. Cordierite crystals close to the granite show sector twinning. Textural relationships indicate that the cordierite crystals away from the pluton grew mainly under regional metamorphic conditions, whereas the growth near the pluton was influenced by the Sparrow Lake pluton (Kamineni 1973).

Determination of Distortion Index

Cordierite-bearing samples were chosen at different distances from the pluton. Cordierite was separated, purified (70 to 90% pure), and ground to –300 to +400 mesh.

The distortion-index was determined from x-ray diffractograms obtained on a Norelco diffractometer with Ni-filtered $CuK\alpha_1$ radiation. Ratemeter settings were 1 x 8.0 x 10^2 (scale factor, multiplier and time constant respectively), and the scanning speed ¼ inch per minute. The region between 28.5 – 30.5° 2θ was scanned back and forth about six times and an average distortion index was calculated.

Areal Distribution of Distortion Index

It is evident from Figure 1 that the variation of the distortion index around the pluton is somewhat irregular. Nevertheless, cordierites having the highest distortion index are farthest from the pluton. A line drawn to separate the Δ values greater than 0.25 and less than 0.25 approximately follows the metamorphic isograds of the region.

The irregular variation of distortion index on either side of the above-mentioned line can probably be attributed to local heating of cordierites by pegmatites. Pegmatites, up to 60 meters wide in the study area, are very common and extend as far east as the gedrite isograd.

Apart from thermal history, variation in distortion index may be caused by variation in composition. However, Harwood & Larson (1969) showed that the effect is not significant. Plots of MgO/MgO + FeO (mole) and Al_2O_3/Al_2O_3 + SiO_2 (mole) versus distortion index (Figs. 2 & 3) indicate some influence of the former and no influence of the latter on distortion index. In view of small population, the

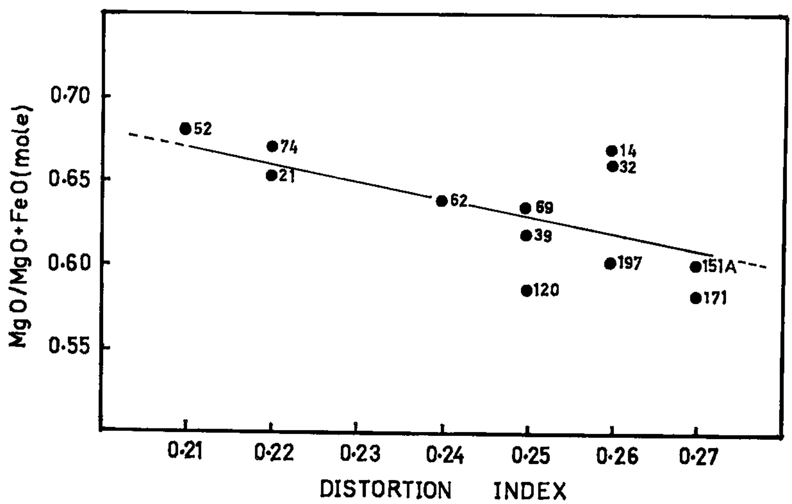

FIG. 2. Plot of the distortion index versus MgO/MgO+FeO in cordierites. The line is the least-squares fit.

significance of the correlation in Figure 2 is not clear. More data are needed to establish confidence levels. Hence, with the present data, it seems that the observed variation of distortion index is due to thermal history.

Acknowledgements

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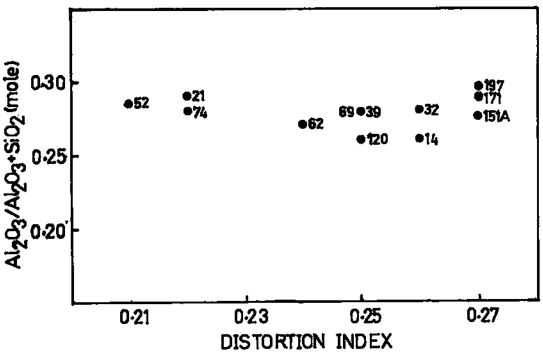

FIG. 3. Plot of the distortion index versus $Al_2O_3/Al_2O_3+SiO_2$ in cordierites.

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