5. Geochemistry of Rooiberg Felsite and Stavoren Granophyre.

5.1. Major element geochemistry.

The similarity in the geochemistry of Rooiberg Felsite and Stavoren Granophyre and their proposed co-magmatic origin (Walraven, 1982) is the reason why these rock types are considered together.

The major element analyses of felsites, metafelsites and granophyres are tabulated in Appendix 2.

The major oxides were plotted against the Thornton-Tuttle Differentiation Index (Thornton and Tuttle, 1960). All the diagrams display a trend for the felsites, whereas the granophyres are characterized by a cluster of points around a D.I. of 90 to 93. This relationship is clearly shown in Figure 5.1., where CaO is plotted against the D.I.

Samples of granophyres were taken in different localities throughout the area, from stratigraphically high positions, underlying the felsites, as well as from stratigraphically low positions, overlying the Nebo Granite. No differentiation trend of the Stavoren Granophyre magma could be observed. A difference in the geochemistry of major elements between the micro-granophyres and normal granophyres was not observed. Figure 5.1, however, shows some lower values of CaO for the micro-granophyres compared to the granophyres, and may be due to a higher content of plagioclase phenocrysts in the normal granophyres.

The felsites and granophyres were also plotted in the Qz-Ab-Or diagram (Fig.5.2.). The Stavoren Granophyre occupies the same compositional area as the Nebo Granite (Fig.7.5.), corresponding to the field of hypersolvus granites of Luth et al. (1964). The felsites are characterized by a larger compositional area compared to the granophyres.

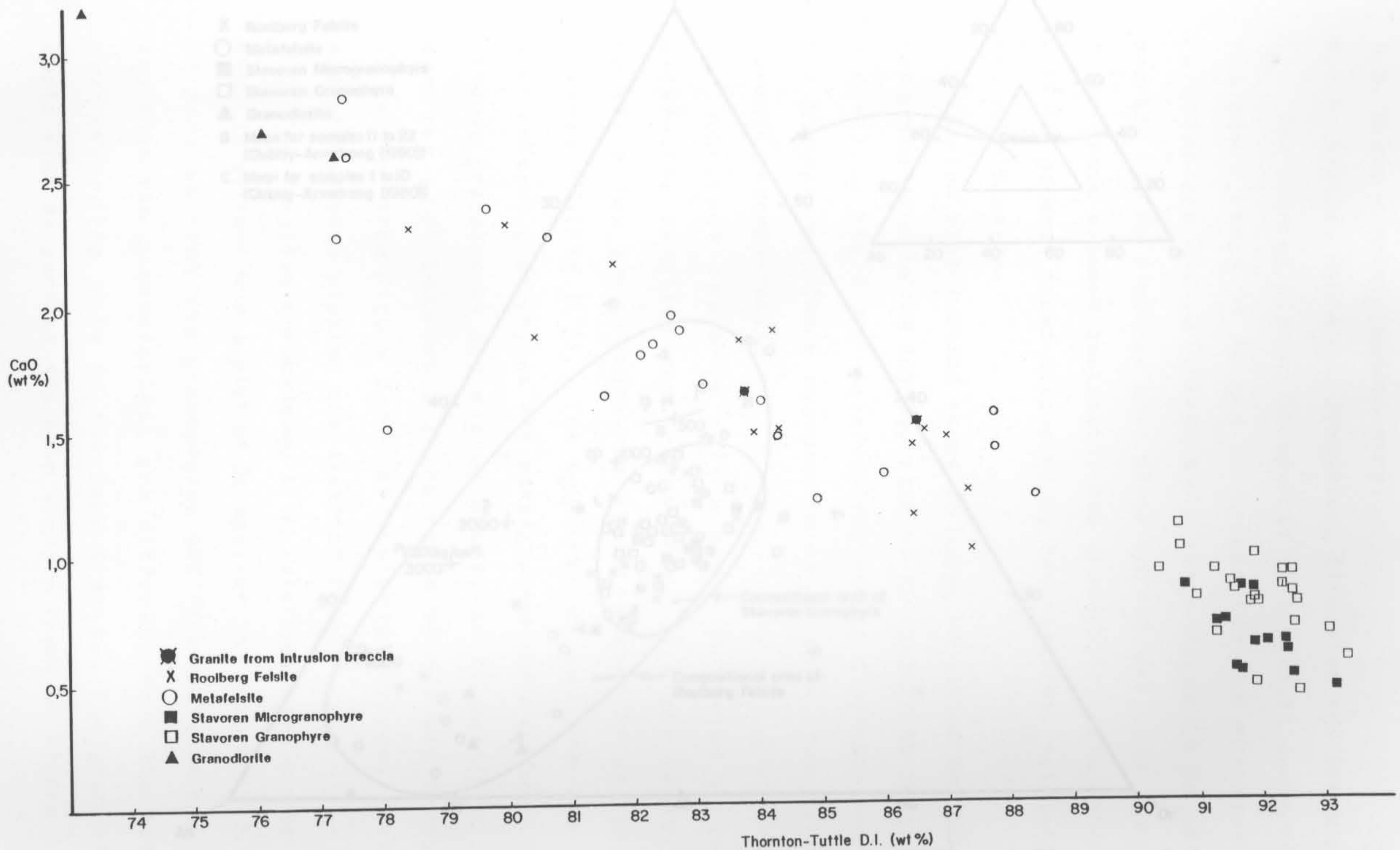

Fig. 5.1.: Plot of CaO against the Thornton-Tuttle D.I. for Rooiberg Felsite, metafelsite, granodiorite and Stavoren Granophyre.

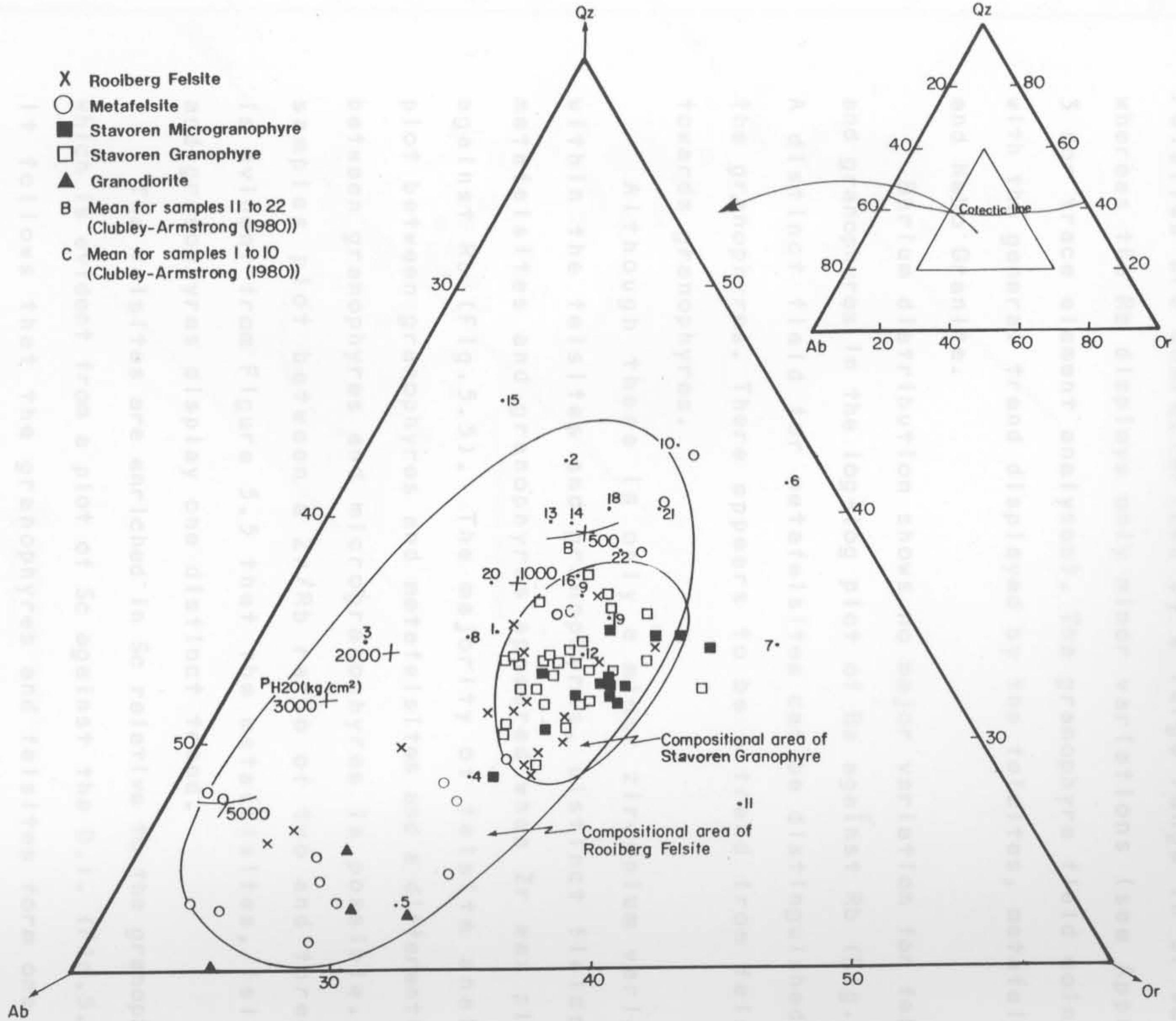

Fig. 5.2.: CIPW normative compositions of Rooiberg Felsite, metafelsite and Stavoren Granophyre in the Qz-Ab-Or diagram. The pressures indicated are in kg/cm^2 and taken from Tuttle and Bowen (1958) and Luth, Jahns and Tuttle (1964). The numbered samples are from Clubley-Armstrong (1981).

5.2. Trace element geochemistry.

5.2.1. Barium, Rubidium, Strontium, Zirconium and Scandium.

The log-log plot of Sr against Rb (Fig.5.3) demonstrates the small range in Rb and Sr values for the granophyres. Felsites are characterized by a large range in Sr values, whereas the Rb displays only minor variations (see Appendix 3 for trace element analyses). The granophyre field coincides with the general trend displayed by the felsites, metafelsites and Nebo Granite.

Barium distribution shows no major variation for felsites and granophyres in the log-log plot of Ba against Rb (Fig.5.4). A distinct field for metafelsites can be distinguished from the granophyres. There appears to be a trend from felsites towards granophyres.

Although there is only a minor zirconium variation within the felsites and granophyres, distinct fields for metafelsites and granophyres appeared when Zr was plotted against Rb (Fig.5.5). The majority of felsite analyses plot between granophyres and metafelsites and a differentiation between granophyres and micrographophyres is possible. Most samples plot between a Zr/Rb ratio of two and three. It is evident from Figure 5.5 that the metafelsites, felsites and granophyres display one distinct trend.

The felsites are enriched in Sc relative to the granophyres, which is evident from a plot of Sc against the D.I. (Fig.5.6). It follows that the granophyres and felsites form one trend and that the granodiorites are different from the latter, corresponding more to the Nebo Granite. The granophyres could also be part of the Nebo Granite trend on Figure 5.6.

5.3. Discussion.

Despite its distribution and volume the Stavoren Granophyre forms a very homogeneous suite of rocks. This was also noted

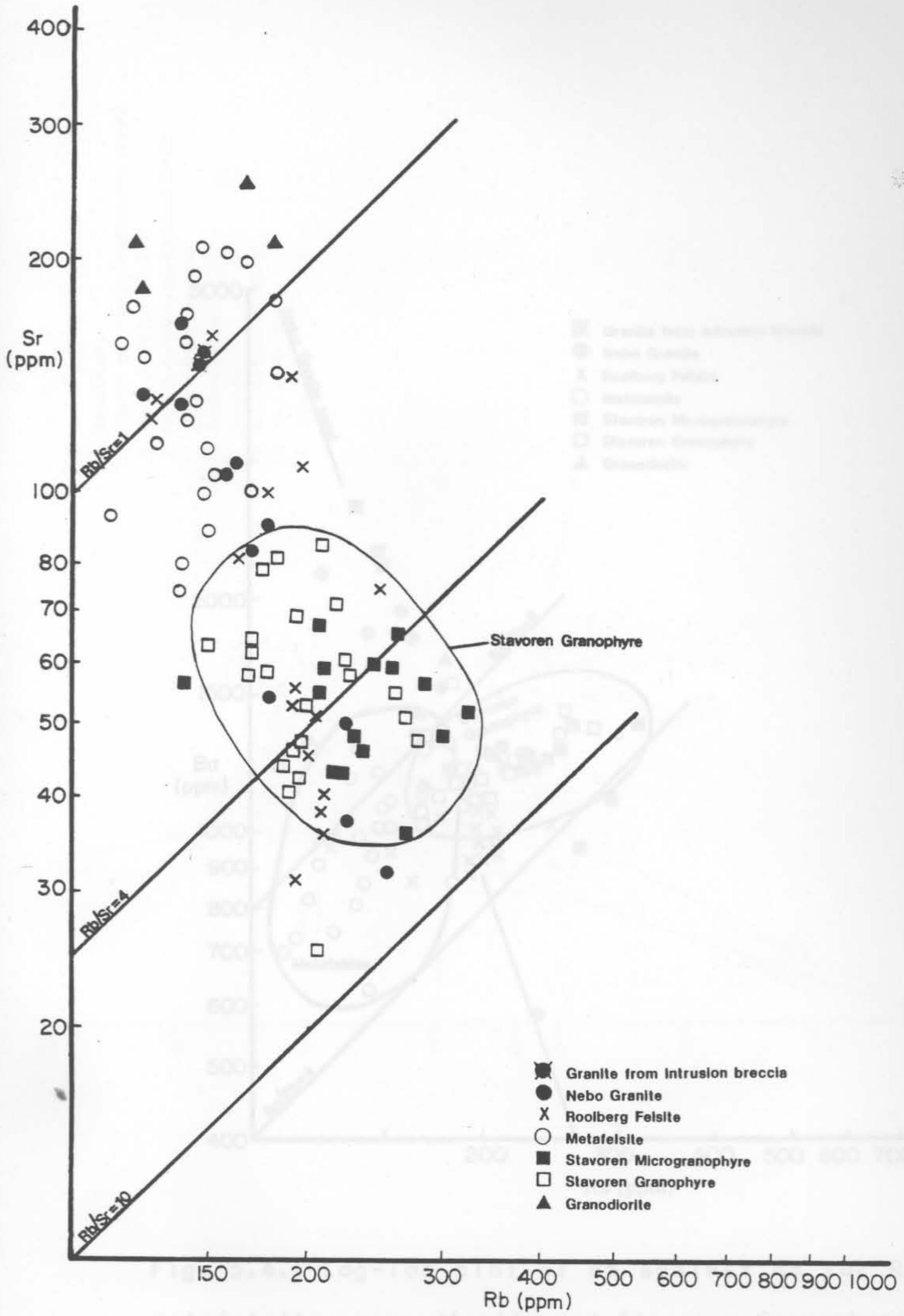

Fig. 5.3.: Log-log plot of Sr against Rb for Rooiberg Felsite, metafelsite, granodiorite and Stavoren Granophyre.

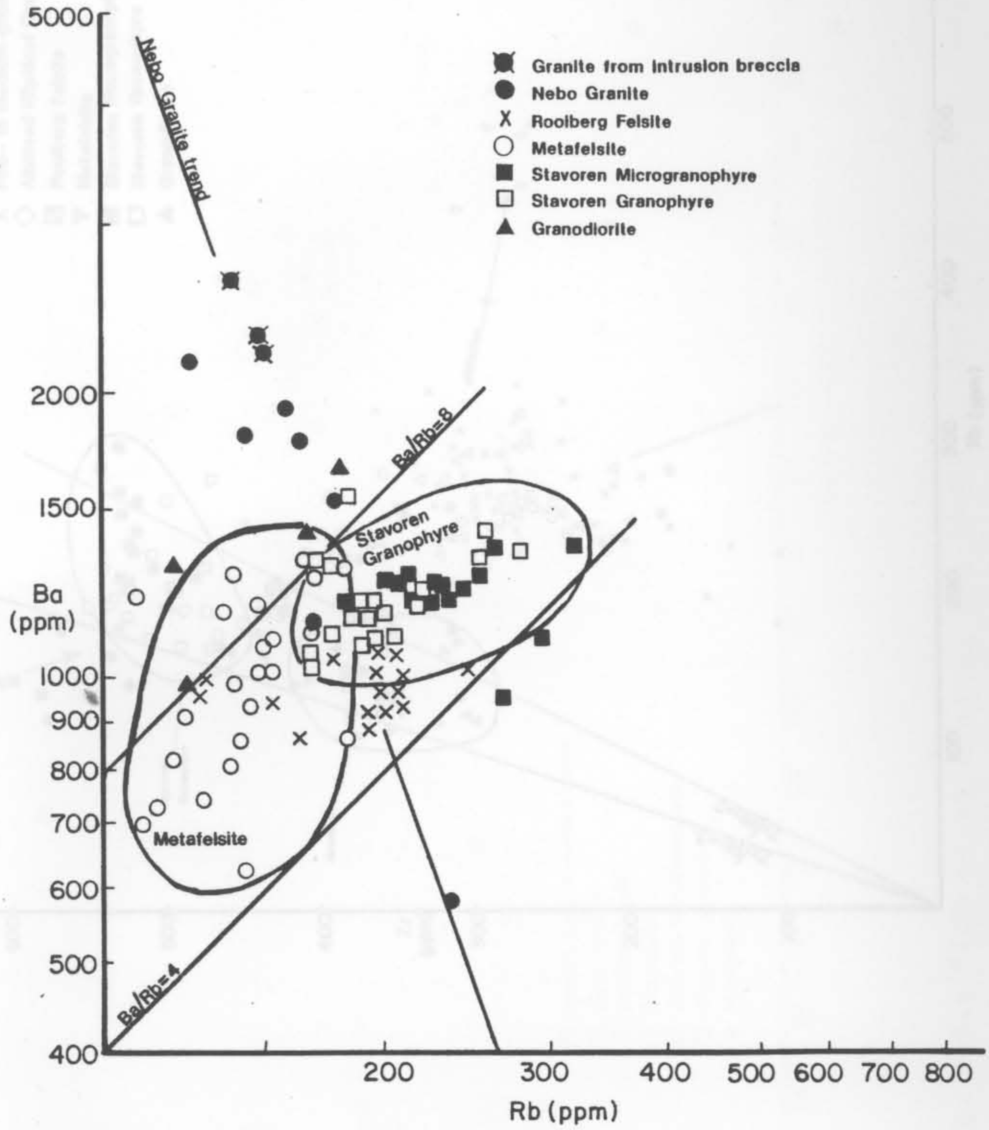

Fig. 5.4.: Log-log plot of Ba against Rb for Rooiberg Felsite, metafelsite, granodiorite and Stavoren Granophyre.

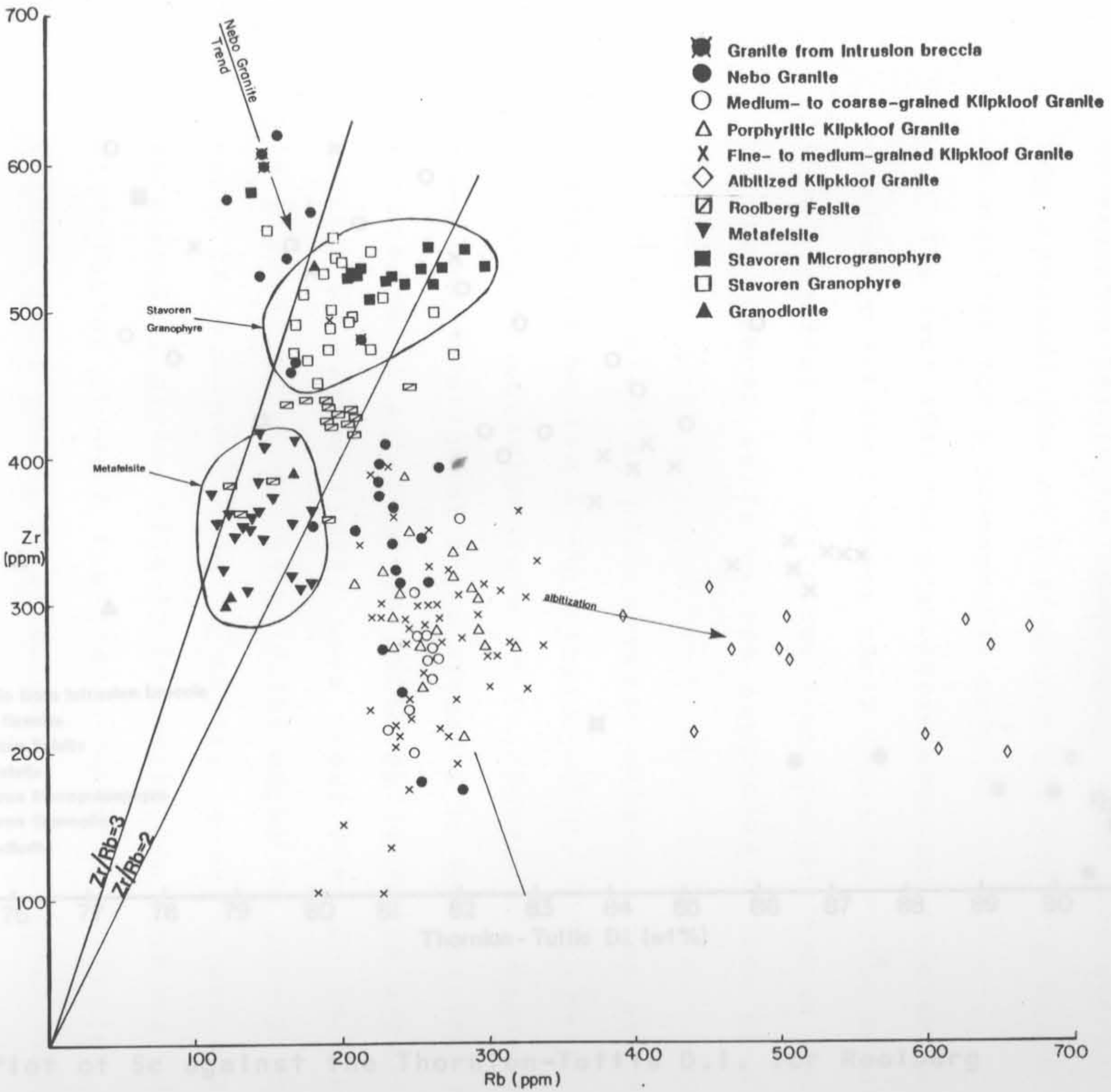

Fig. 5.5.: Plot of Zr against Rb for Rooiberg Felsite, metafelsite, granodiorite, Stavoren Granophyre, Nebo and Klipkloof Granite.

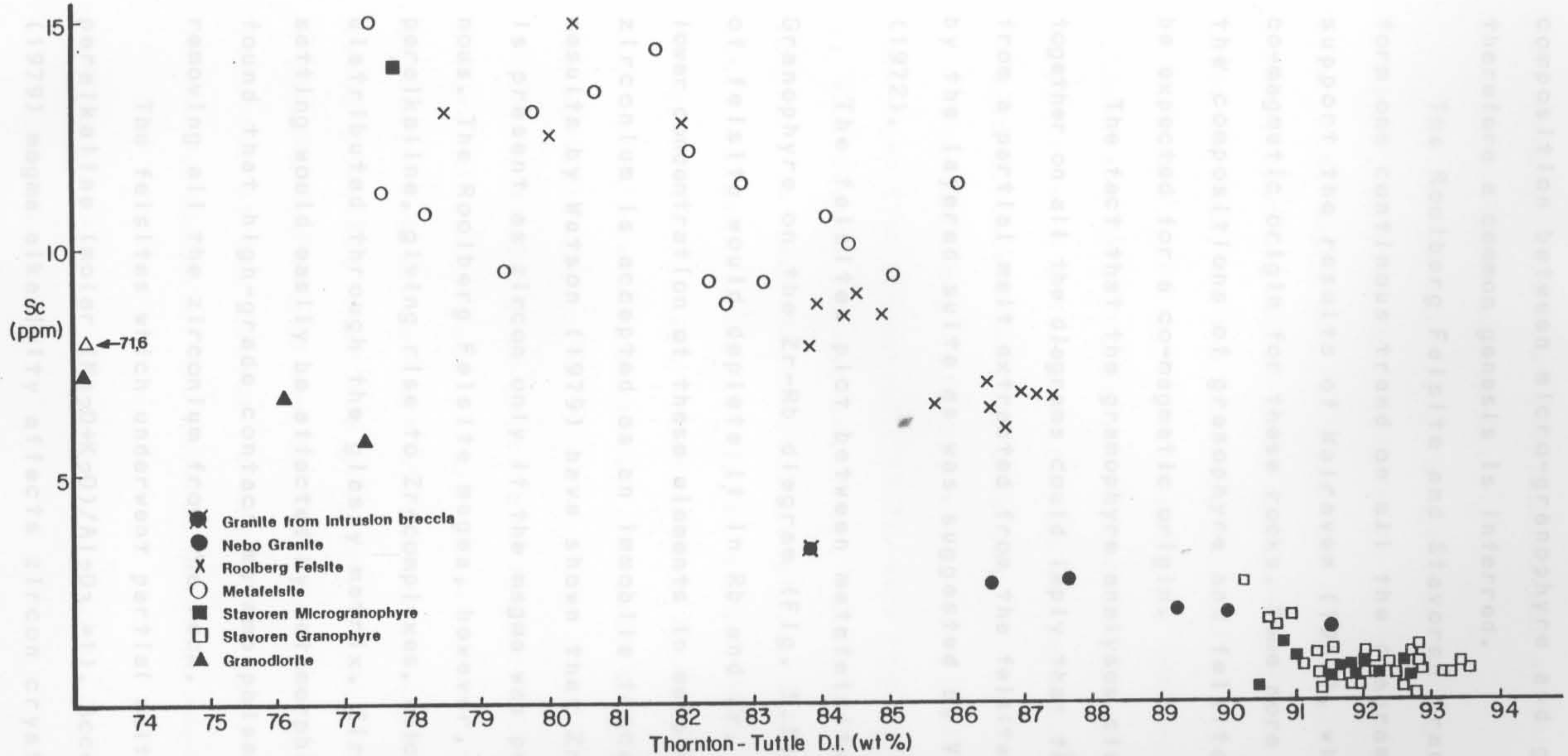

Fig. 5.6.: Plot of Sc against the Thornton-Tuttle D.I. for Roolberg Felsite, metafelsite, granodiorite, Stavoren Granophyre and Nebo Granite.

by Walraven (1982). There is only a slight difference in composition between micro-granophyre and granophyre and therefore a common genesis is inferred.

The Rooiberg Felsite and Stavoren Granophyre seem to form one continous trend on all the diagrams, which could support the results of Walraven (1982), who postulated a co-magmatic origin for these rocks. Some more overlap between the compositions of granophyre and felsite would however be expected for a co-magmatic origin.

The fact that the granophyre analyses cluster so closely together on all the diagrams could imply that they crystallized from a partial melt extracted from the felsites on metamorphism by the layered suite as was suggested by Von Gruenewaldt (1972).

The felsites plot between metafelsites and Stavoren Granophyre on the Zr-Rb diagram (Fig. 5.5). Metamorphism of felsite would deplete it in Rb and Zr, explaining the lower concentration of these elements in metafelsite. However, zirconium is accepted as an immobile trace element. But, results by Watson (1979) have shown that Zr in a rhyolite is present as zircon only if the magma was per- or metaluminous. The Rooiberg Felsite magma, however, was marginally peralkaline, giving rise to Zr-complexes, which are uniformally distributed through the glassy matrix. Zirconium in this setting would easily be affected by metamorphism. Nell (1984) found that high-grade contact metamorphism is capable of removing all the zirconium from the rock.

The felsites which underwent partial melting were slightly peralkaline (molar $(Na_2O+K_2O)/Al_2O_3 = 1$). According to Watson (1979) magma alkalinity affects zircon crystallization. He found that zircon becomes unstable due to an increase in peralkalinity, which is possible if only plagioclase crystallizes, removing the CaO from the system. This is termed the plagioclase effect by Bowen (1945). It is known from petrographic work that plagioclase was an early crystallizing mineral in the granophyres.

Due to the high temperature (850°C) and moderate pressure (2 kbar), melting of the felsite will take place after the upper zone magma was intruded (Von Gruenewaldt, 1972). Walraven (1982), also proved by heat-modelling that the mafic magma could have melted the Rooiberg Felsite.

From Figure 5.5 it follows that the Stavoren Granophyre is enriched in Zr relative to the Rooiberg Felsite and the metafelsite. A difference between microgranophyre and granophyre is also obvious from this diagram.

The Rooiberg Felsite, which were melted by the upper zone magma (Von Gruenewaldt, 1972), were rhyolites and rhydacites of the Damwal Formation. These felsites are different in composition from Stavoren Granophyre. The melting process would however, only partially affect the rock, giving rise to restite which was incorporated in the upper zone magma and which was subsequently intruded as granodiorite into the metafelsites.

It is also important to note that only very few minute zircon crystals were observed in the granophyres, although the Zr content of the rock is high. It therefore seems possible that the granophyric magma, representing a peralkaline liquid was derived from the marginally peralkaline felsites of the Damwal Formation by partial melting due to the intrusion of the Layered Sequence magma.