CHAPTER 7 GEOCHEMISTRY OF THE TALC-RICH PART OF THE UITKOMST COMPLEX

7.1 Introduction

The genesis of the Uitkomst Complex may be divided into to two stages according to Gauert (1998) and de Waal et al., (2001). The first is the conduit stage and consists of the LHZBG, PCR and the MHZBG Units, excluding the top 20 meters (Gauert, 1998; de Waal et al., 2001). The second is the closed-system stage and consists of the upper 20 meters of the MHZBG, the PXNT and GN Units (Gauert, 1998; de Waal et al., 2001). In the conduit stage the parental magma has been determined to most likely be B1-type Bushveld magma that flowed through the conduit. This magma may have been saturated in sulfur and precipitated small quantities of sulfide together with chromian spinel and olivine (de Waal et al., 2001). The small variations in chemical composition in the LHZBG, PCR and MHZBG Units with height, is taken by these authors as supporting the conduit nature of continual replenishment of the magma (de Waal et al., 2001). With the exception of Ti, all the major elements have concentrations closely comparable to B1-magma in the closed-system stage (de Waal et al., 2001). The trace elements Zn, Co, Zr, Y, Sr and Rb show some deviation from the average B1 composition (de Waal et al., 2001). The fractionated trend of the upper part of the MHZBG, the PXNT and GN units was used by de Waal et al. (2001) to confirm the suggested closed-system stage.

In van Zyl's (1996) investigation, the chemical analyses of the primary and secondary silicate minerals associated with the sulphide mineralization show that the complex is enriched in iron towards the base of the LHZBG Unit. The enrichment in iron is interpreted as a combined effect of fractionation and the cooling effect of the country rock on the intruding magma. The sulphide grains also increase in size towards the base of the Lower Harzburgite Unit to >450 microns. The Cu-Ni ratio of the sulphides also increases towards the base of the complex. Van Zyl (1996) also found that there is an increase in the incompatible element content in the bulk rock composition towards the top of the closed system.

Gomwe (2000) determined that there is a decrease in the Na_2O, K_2O, TiO_2 and SiO_2 and an increase in MgO content with increasing height from the base of the complex to the MHZBG Unit. Reflecting the inverse sequence, also observed by Kenyon (1986), the lack of variation with stratigraphic height in the MHZBG Unit indicates that the magma was not differentiated. Gomwe (2000) calculated that the magma contained 20-30% trapped melt, decreasing with height. The Cu-content of >10-20ppm indicate the presence of excess sulphide relative to the trapped melt, which suggest the presence of cumulus sulphide. Gomwe (2000) also noted that the LHZBG and PCR Units have a slightly negative correlation between S and MgO, in that the least Mg- rich rocks are the most S-rich. The negative Sr excursions found in the investigation allude to possible mobilization of Rb during pervasive alteration of the LHZBG, PCR and lower MHZBG Units. Gomwe (2000) also found that the sulphide-bearing rocks have higher values of εNd and lower ratios of [Sm/Ta] than the remainder of the complex, leading to a suggestion of less crustal contamination in these horizons. This could possibly be explained by selective contamination of external sulfur or oxygen from the country rocks, triggering sulphur-segregation. It was also found by Gauert (1998) that Slaaihoek samples showed somewhat higher V/Cr ratios than Uitkomst samples, which may reflect the more evolved nature of the cumulates at Slaaihoek, and higher Zr/Y ratios which may indicate less contamination with dolomitic country rock.

Sakar et al. (2008) indicated that crustal sulphur was assimilated and impacted on the sulphur isotopic signature. It is also deemed to have contributed to the mineralization in the Uitkomst Complex. The sulphur is suggested to have been transported by the fluid derived from pro-grade metamorphism of the country rock. The oxygen isotopes on the other hand indicated country rock derived fluid not to have influenced the signature of the magma, it is suggested to be a result of late-stage meteoric water infiltration.

7.2 Background

In this section the lower units of the Uitkomst Complex are investigated to find out if there is a relationship between mineralogical variation in the LHZBG Unit and the overlying PCR

Unit. Secondly, the possibility that the mineral abundances in the different units may be related to the position sampled in the Complex relative to the inferred margins of the intrusion in the study area. A semi-quantitative approach in the evaluation of the distribution of secondary minerals with height and spatial distribution is used to answer these questions.

As part of the discussion, a mineralogical report compiled for ARM by Moruo Mineralogical Services (Singh and de Nooy, 2003) is also considered. This report was made available for this study by Mr. J. Woolfe of ARM, and refers to Pit 1 and Pit 2, areas outside of the current study area which is confined to Pit 3 area (Figure 7.1). All the lower and central data points in this report refer to the LHZBG, or are assumed to refer to the LHBZG as it is the only unit preserved in that part of the intrusion and no unit indicators are given in the report.

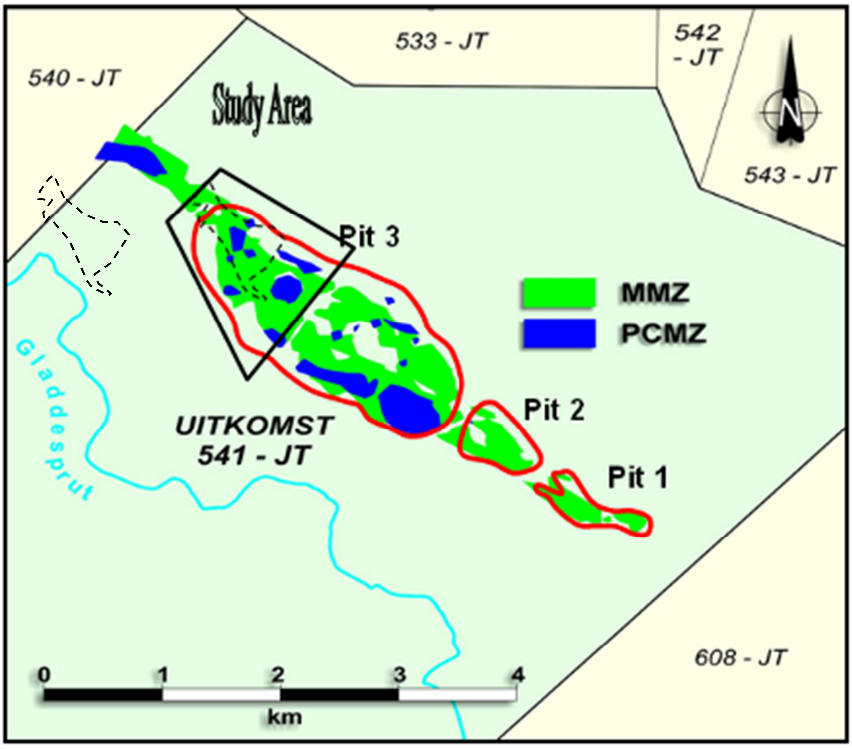


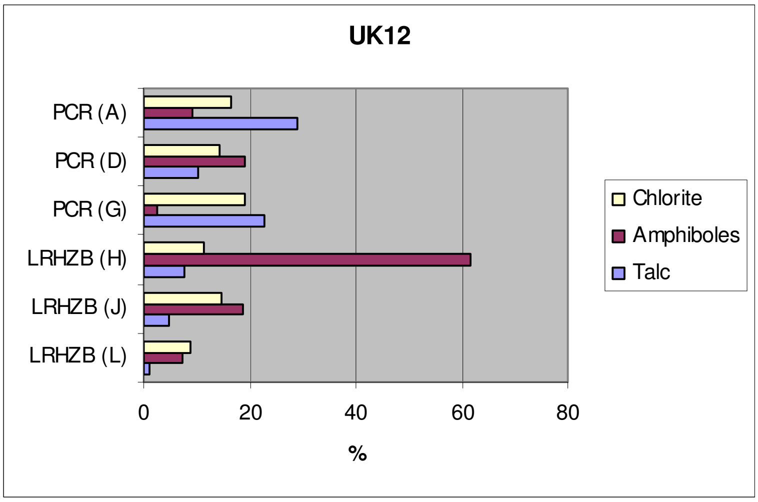
Figure 7.1 Outline of the open pits planned as part of the extension programme. The extent of the study area is indicated. The high alteration mineral assemblage area is indicated by the dashed line. Figure courtesy Nkomati Mine.

7.3 Vertical distribution of amphibole, chlorite and talc

The mineral distribution, based on semi-quantitative mineral abundances determined by XRD, is presented for individual boreholes. The data is presented in such a way to indicate the vertical variation of the secondary minerals. The unit is given with the section number in brackets.

Amphibole, talc and chlorite are grouped together, as these minerals may collectively represent the alteration products of the same primary minerals, i.e. olivine, orthopyroxene and clinopyroxene. The composition of the alteration minerals has already been discussed in the chapters dealing with the petrography and mineral chemistry. Serpentine is not considered a diagnostic mineral as it generally below 5 % occurrence and its presence is solely due to the hydrothermal alteration of olivine at low CO_2 concentrations.

The Loss On Ignition (LOI) is also presented as a separate graph to indicate the presence of volatiles associated with the afore mentioned alteration minerals, with height.



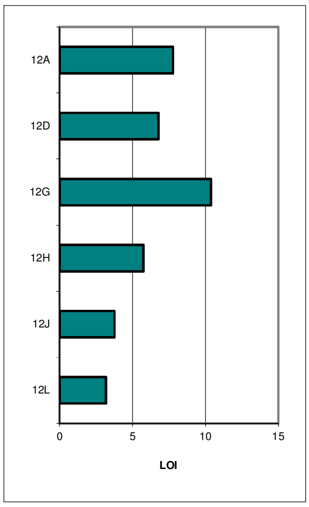


Figure 7.2. Bar-graph indicating the relationship between talc, amphibole and chlorite, as well as the variation of these minerals with height in borehole UK12. The LOI value with height is also presented.

In UK12 (Figure 7.2), there does not appear to be a systematic relationship between the occurrence of talc and amphiboles. The amphibole content increases with height in the LHZBG Unit, between point L and H. The amphibole content in the PCR Unit in contrast shows an almost inverse relationship with talc, with height. The talc content increases with height in the LHZBG Unit and appears to continue the trend into the basal part of the PCR Unit (point L to G) before decreasing and then increasing again with height (point D to A). Talc reaches its highest abundance in the PCR Unit. Talc and amphibole both increase in abundance with height in the LHZBG Unit. There appears to be no systematic variation in the chlorite content with height in either the LHZBG or the PCR Units. In the PCR Unit, chlorite shows a very subtle relationship with talc and shares the inverse relationship of talc with amphibole. The increase of volatiles is demonstrated by the increase in LOI values with height, tapering out near the top of the unit. No specific correlation is made with any of the alteration minerals, but talc show the closest correlation.

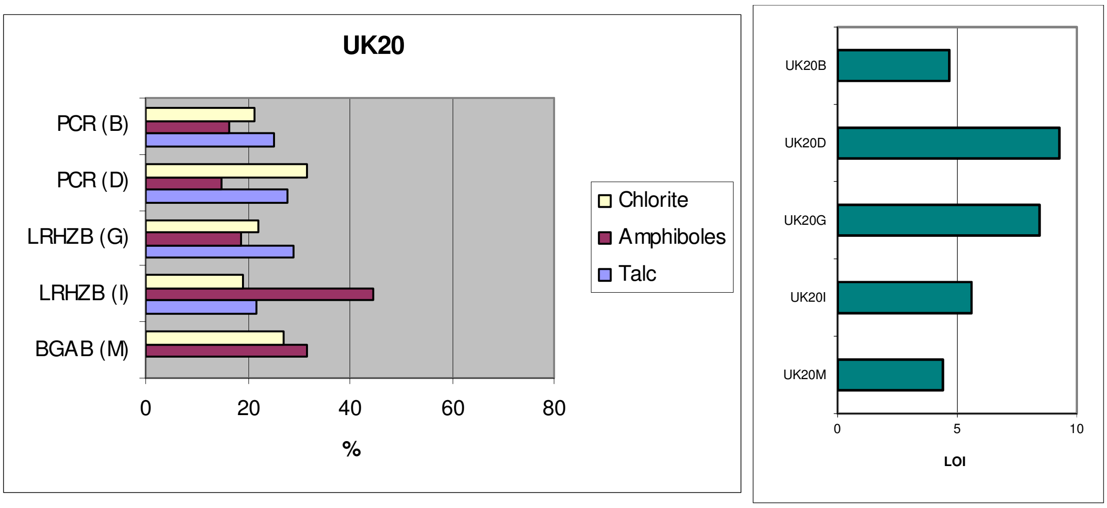
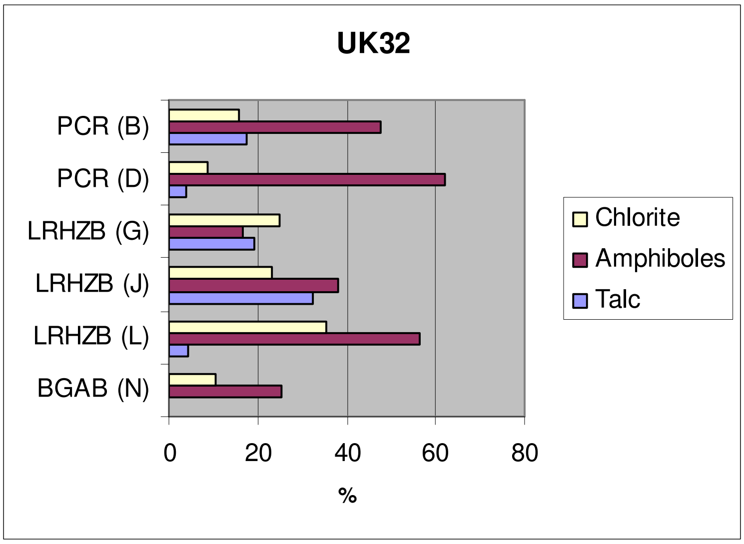


Figure 7.3. Bar-graph indicating the relationship between talc, amphibole and chlorite, as well as the variation of these minerals with height in borehole UK20. The LOI value with height is also presented.

In UK20 (figure 7.3), there appears to be no systematic relationship between the occurrence of amphiboles and talc. There is an increase in the amphibole content from the BGAB Unit to the lower part of the LHZBG Unit, before dropping off and remaining nearly constant in the upper part of the LHZBG and PCR Units. There is no talc present in the BGAB Unit and there is a consistent content of talc from the bottom of the LHZBG Unit through to the top of the PCR Unit. The chlorite content decreases from the BGAB Unit to the base of the LHZBG Unit before steadily increasing to the base of the PCR Unit (point I to D) before decreasing at the top of the PCR Unit. The presence of volatiles increases with height up to the lower contact of the PCR before decreasing again. The closest correlation is with talc.



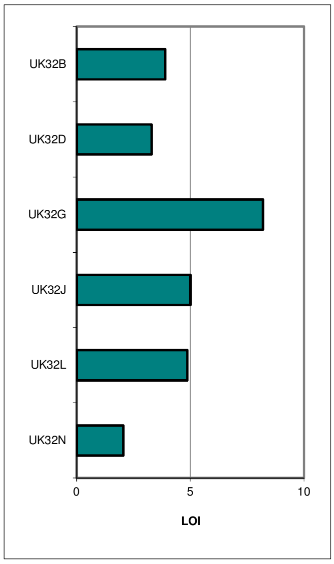


Figure 7.4. Bar-graph indicating the relationship between talc, amphibole and chlorite, as well as the variation of these minerals with height in borehole UK32. The LOI value with height is also presented.

In UK32 (figure 7.4), there again appears to be no relationship between the talc and amphibole content. There is an increase in amphibole content from the BGAB Unit to the lower part of the LHZBG Unit before there is a steady decline in amphibole to the top of the unit (point N to G). The amphibole content then increases in the bottom part of the PCR Unit before decreasing again (point D to B). There does not appear to be a systematic increase or decrease of talc with height. The chlorite content increase from the BGAB Unit to the bottom of the LHZBG Unit then decreases and remains fairly constant to the top of the LHZBG Unit (point N to G). The chlorite content decreases at the bottom of the PCR Unit then increases with height. The LOI increases with height up to the top of the LHZBG, before decreasing in the PCR. The closest correlation is again with the abundance of talc.

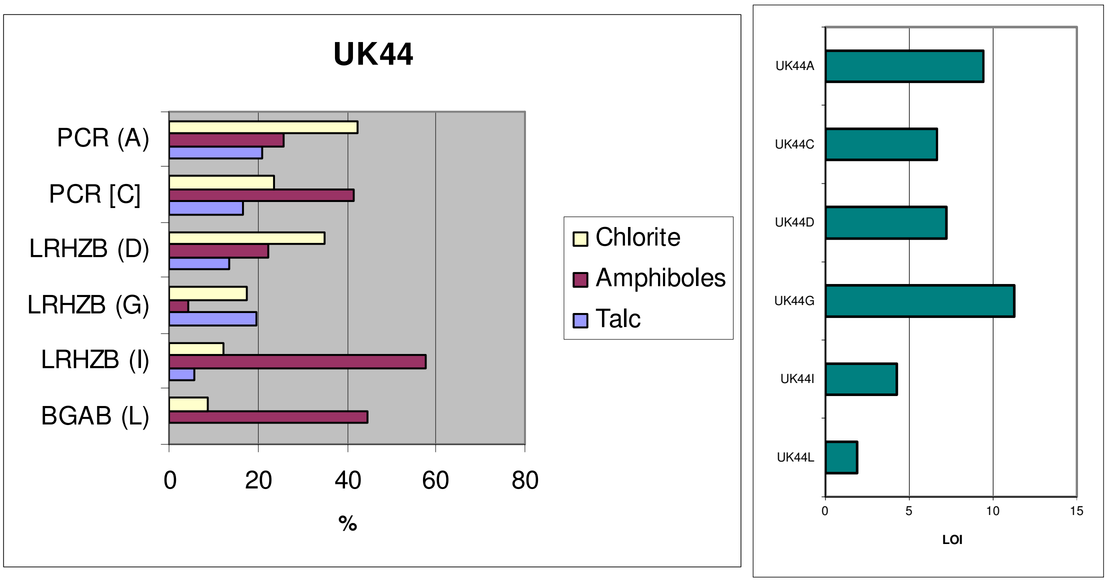
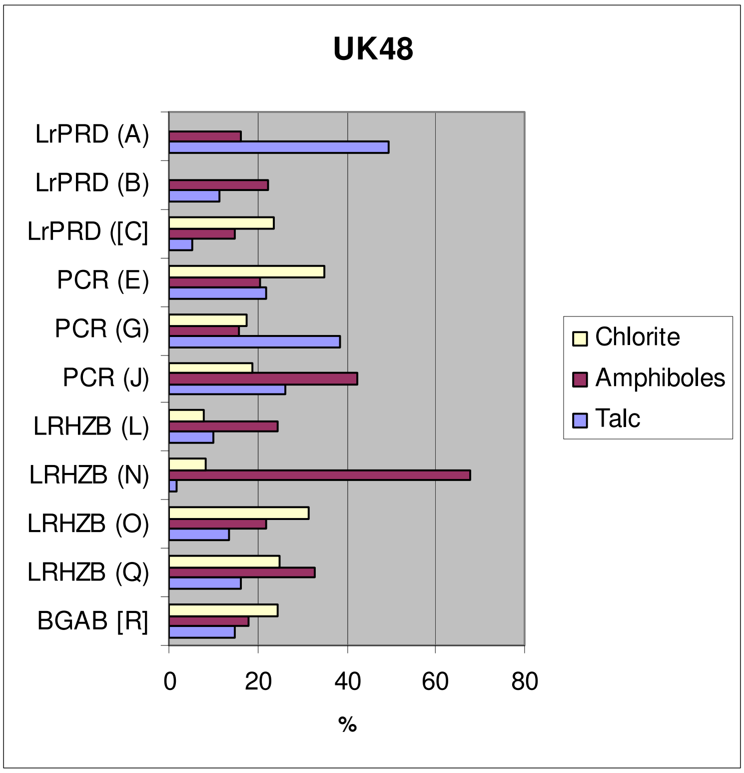


Figure 7.5. Bar-graph indicating the relationship between talc, amphibole and chlorite, as well as the variation of these minerals with height in borehole UK44. The LOI value with height is also presented.

In UK44 (figure 7.5), there appears to be no relationship between the distribution of amphiboles and talc. There is a increase in amphibole content from the BGAB Unit to the lower part of the LHZBG Unit (point L to I) before a rapid decrease and then a steady increase in amphibole with height (point G to C) through the top of the LHZBG Unit to the bottom of the PCR Unit, followed by a decrease of amphibole in the top of the PCR Unit. There is no talc present in the BGAB Unit and the talc content appears to increase with height from point I to G, before decreasing and then steadily in crease from point D (top of the LHZBG Unit) to the top of the PCR Unit. The chlorite content increases steadily from the BGAB Unit to the top of the LHZBG Unit (point L to D) before decreasing in the bottom of the PCR Unit and then increasing again with height (point C to A). The volatile content demonstrated by the LOI values increase from the bottom to the middle of the LHZBG, decreasing before increasing again with height in the PCR. The closest correlation is with the distribution of talc.



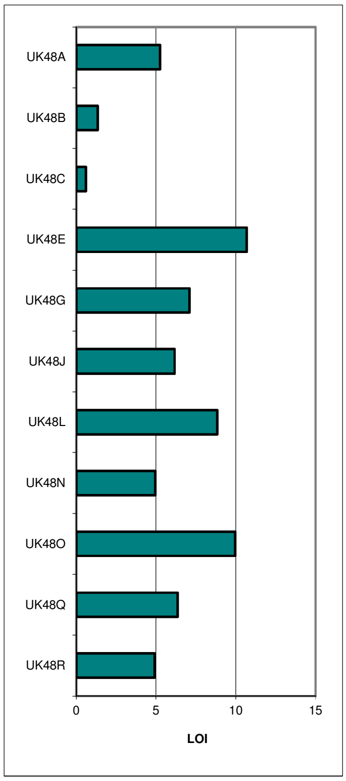
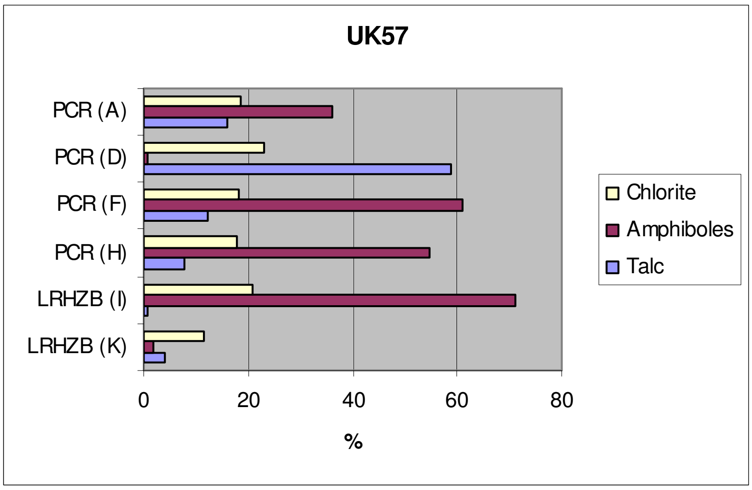


Figure 7.6. Bar-graph indicating the relationship between talc, amphibole and chlorite, as well as the variation of these minerals with height in borehole UK48. The LOI value with height is also presented.

In UK48 (figure 7.6), there does not appear to be a relationship between the occurrence of talc and amphibole. There is no systematic variation in amphibole content with height. The amphibole content is fairly constant with height, with the exception of points J and N. The talc content is fairly constant from the BGAB Unit to the lower part of the LHZBG Unit (point R to O). The talc content then sharply decreases before steadily increasing from the top (point N to G) of LHZBG Unit to the lower PCR Unit. The talc content then steadily decreases from the top of the PCR Unit to the bottom of the LrPRD Sub-unit (point G to C). The talc content then increases with height to the top of the LrPRD Sub-unit (point C to A). The chlorite content slightly increases from the BGAB Unit to the bottom and lower central part of the LHZBG Unit (point R to O). The chlorite content then decreases sharply in the upper central part and top of the LHZBG Unit (point N to L). The chlorite content then increases from the bottom to the top of the PCR Unit (point G to E). The chlorite content then decreases at the bottom of the LrPRD Sub-unit and is completely absent in the upper part of the LrPRD Sub-unit.

The volatile content shows four cycles of increase followed by a sudden decrease. The correlation between LOI values and the percentage talc is again evident.



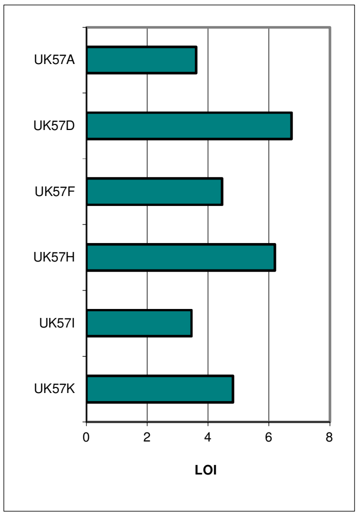
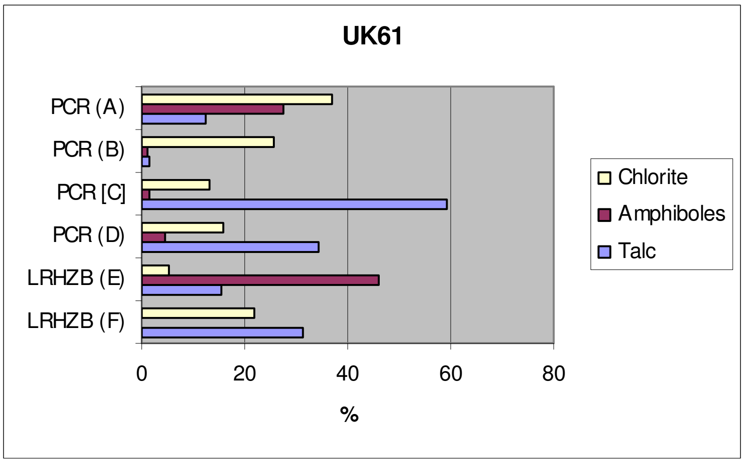


Figure 7.7. Bar-graph indicating the relationship between talc, amphibole and chlorite, as well as the variation of these minerals with height in borehole UK57. The LOI value with height is also presented.

In UK57 (figure 7.7), there does not appear to be a specific relationship between the occurrence of amphibole and talc. The amphibole content steeply increases from the bottom to the top of the LHZBG Unit. The amphibole content decreases at the bottom (point H) of the PCR Unit then increases slightly with height (point F) before a rapid decrease (point D) and increase at the top (point A) of the PCR Unit. The talc content decreases with height in the LHZBG Unit (point K to I) before increasing with height in the PCR Unit (point H to D) before decreasing at the top (point A). The chlorite content increases from bottom of the LHZBG Unit to the top, then decreases at the base of the PCR Unit. The chlorite content of the PCR Unit increases with height (point H to D) before decreasing at the top. The LOI-along with the correlating talc value is erratic with height.



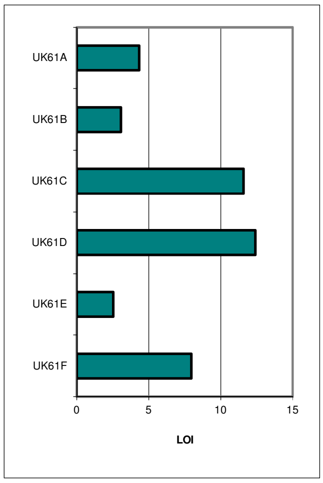


Figure 7.8. Bar-graph indicating the relationship between talc, amphibole and chlorite, as well as the variation of these minerals with height in borehole UK61. The LOI value with height is also presented.

In UK61 (figure 7.8), there appears to be no relationship between the occurrence of talc and amphibole. The amphibole content in the LHZBG Unit goes from being absent in the bottom to maximum in the top. The amphibole content decreases with height in the PCR Unit from point D to B before increasing at the top. The talc content of the LHZBG Unit decreases with height. The talc content of the PCR Unit increases with height (point D to C), before rapidly decreasing (point B) and then increases at the top. The chlorite contents decreases with height in the LHZBG Unit. The chlorite content increases at the bottom to the PCR Unit then slightly decrease and then increase with height (point D to A). In contrast to the other units, the LOI shows cycles of decrease with height, along with talc, although distribution still appears erratic.

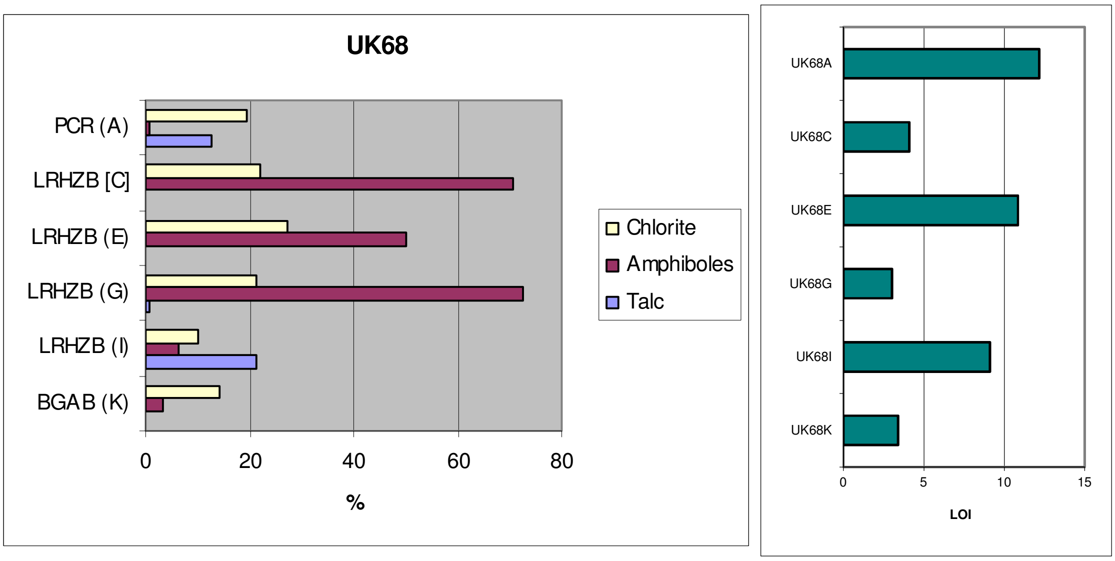


Figure 7.9. Bar-graph indicating the relationship between talc, amphibole and chlorite, as well as the variation of these minerals with height in borehole UK68. The LOI value with height is also presented.

In UK68 (figure 7.9), there appears to be no relationship between the talc and amphibole content. The amphibole content increases with height from the BGAB Unit to the central part of the LHZBG Unit (point K to G) before slightly decreasing and then increasing again towards the top of the unit. The amphibole content then decreases significantly in the PCR Unit. Talc is absent in the BGAB Unit. The talc content decreases with height to absent in the upper part of the LHZBG Unit. Talc is only present again in the PCR Unit. The chlorite content decreases from the BGAB Unit to the bottom of the LHZBG Unit before increasing with height (point I to E) then decrease to the top of the LHZBG Unit through to the PCR Unit (point E to A). The volatile content reflected by LOI values show three increments of increase and decrease with height.

7.4 Lateral distribution of amphibole, chlorite and talc

Only the lateral distribution of the average alteration minerals in the BGAB, LHZBG and PCR Units will be discussed in this section. The aim of this section is to determine the lateral distribution, if any, of the alteration minerals in the study area by looking at the average distribution per mineral per borehole. A summary of the averages, per mineral per borehole, is presented in Tables 7.1, 7.2 and 7.3.

Table 7.1. The average alteration mineral per borehole in the BGAG Unit.

	UK20	UK32	UK44	UK48
Amphibole	30.37	20.23	44.6	5.97
Chlorite	26.86	10.52	8.73	24.61
Talc	0	0	0	14.97

A longitudinal section is given in Figure 7.10, representing the average alteration mineral distribution in the BGAB Unit of the Uitkomst Complex.

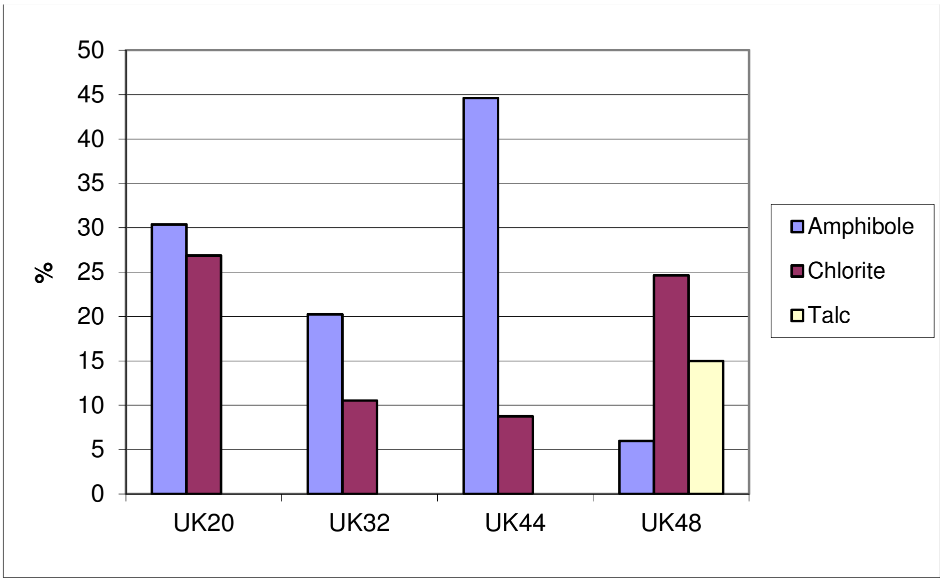


Figure 7.10. The average alteration mineral abundance, expressed in weight percent, in a partial longitudinal section through the Uitkomst Complex in the BGAB Unit. From UK20 (NW) to UK 48 (SE).

From Figure 7.10 it can be seen that the amphibole content varies from the NW to the SE. It can also be seen that the chlorite content decreases from the NW to the SE, before increasing again in the SE corner. Lastly, talc only occurs in the SE portion of the Uitkomst Complex in the BGAB in the study area.

Table 7.2. The average alteration mineral per borehole in the LHZBG Unit.

	UK12	UK20	UK32	UK44	UK48	UK57	UK61	UK68
Amphibole	29.23	31.62	37.18	28.13	36.62	36.46	23.00	49.93
Chlorite	11.63	20.53	27.87	21.60	18.16	16.17	13.47	20.27
Talc	4.56	25.28	18.60	12.99	10.40	2.43	23.40	5.63

A longitudinal section is given in Figure 7.11, representing the average alteration mineral distribution in the LHZBG Unit of the Uitkomst Complex.

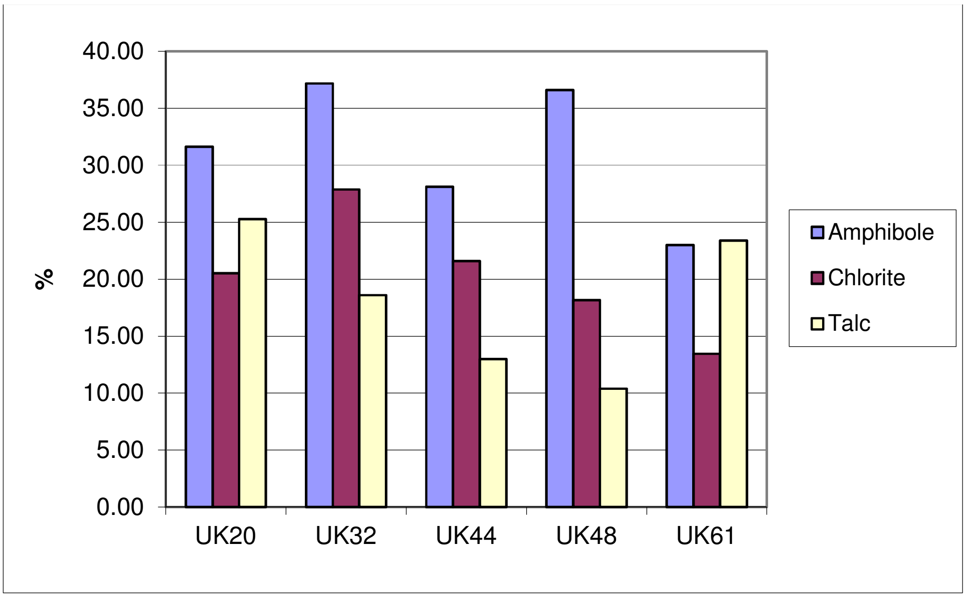


Figure 7.11. The average alteration mineral abundance, expressed in weight percent, in a partial longitudinal section through the Uitkomst Complex in the LHZBG Unit. From UK20 (NW) to UK 61 (SE).

From Figure 7.11 it may be seen that the amphibole content varies from the NW to the SE. It can also be seen that the chlorite content decreases from the NW to the SE in the broad part of the study area. Lastly, the talc content also decreases form the NW to the SE in the study area, before increasing again in the SE corner. A transverse section is given in Figure 7.12, representing the average alteration mineral distribution in the LHZBG Unit of the Uitkomst Complex.

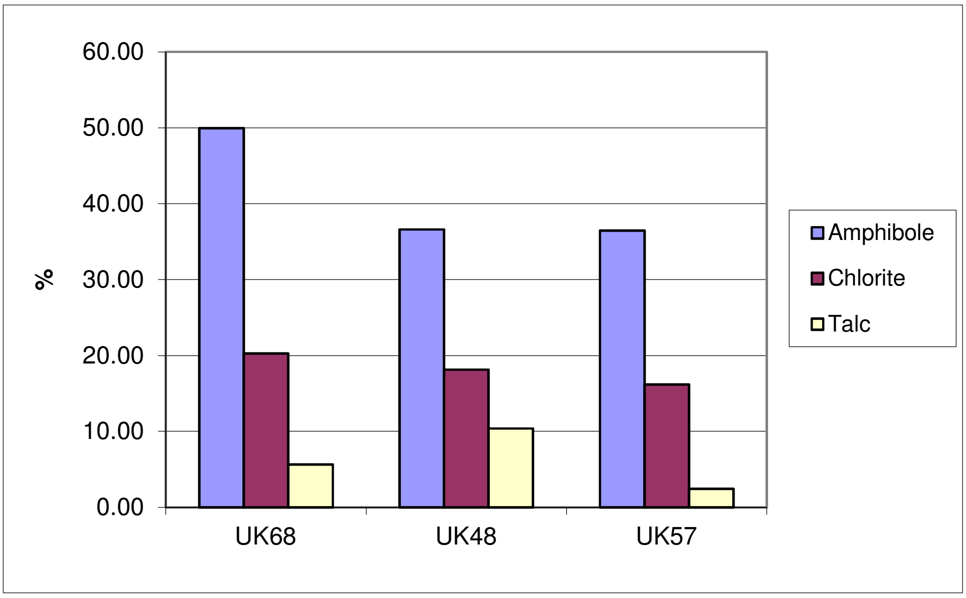


Figure 7.12. The average alteration mineral, expressed in weight percent, in a partial transverse section through the Uitkomst Complex in the LHZBG Unit. From UK68 (N) to UK57 (S).

From Figure 7.12 it can be seen that the amphibole content is higher closer to the inferred margins of the complex and the talc content slightly lower at the edges of the complex. The chlorite content decreases slightly from from the N to the S in the transverse section.

Table 7.3. The average alteration mineral per borehole in the PCR Unit.

	UK12	UK20	UK32	Uk44	UK48	UK57	UK61	UK68
Amphibole	10.34	15.72	54.90	33.58	26.11	38.11	22.17	0.69
Chlorite	16.62	26.44	12.41	33.15	23.71	19.59	22.94	19.32
Talc	20.64	26.41	10.70	18.77	28.87	23.81	26.82	12.72

A longitudinal section is given in Figure 7.13, representing the average alteration mineral distribution in the PCR Unit of the Uitkomst Complex.

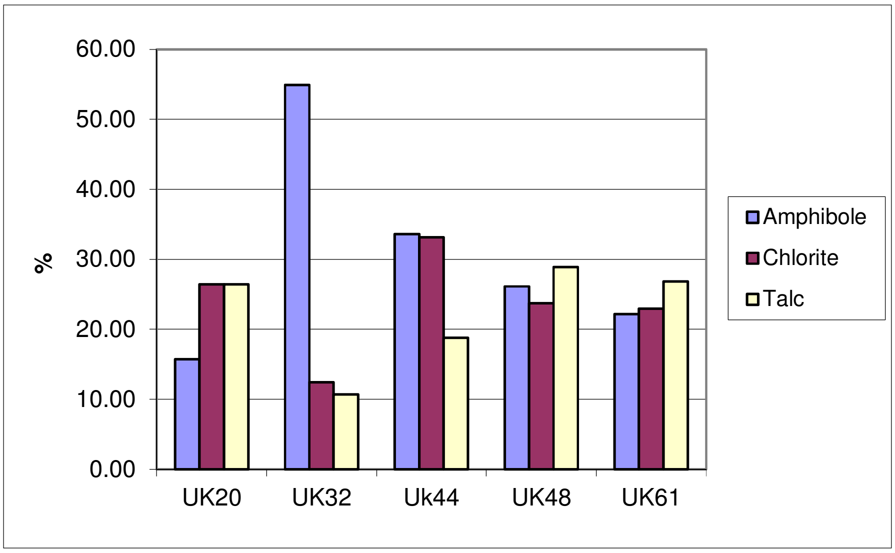


Figure 7.13. The average alteration mineral, expressed in percent, in a partial longitudinal section through the Uitkomst Complex in the PCR Unit. From UK20 (NW) to UK61 (SE).

From Figure 7.13 it may be inferred that the amphibole content decreases from the NW to the SE in the broader part of the study area. The chlorite content first decreases then increase and then decrease again in the NW to the SE in the broader part of the study area. Lastly, the talc contents increase from the NW to the SE in the study area. In Figure 7.14 a transverse section is given through the Uitkomst Complex in the PCR Unit.

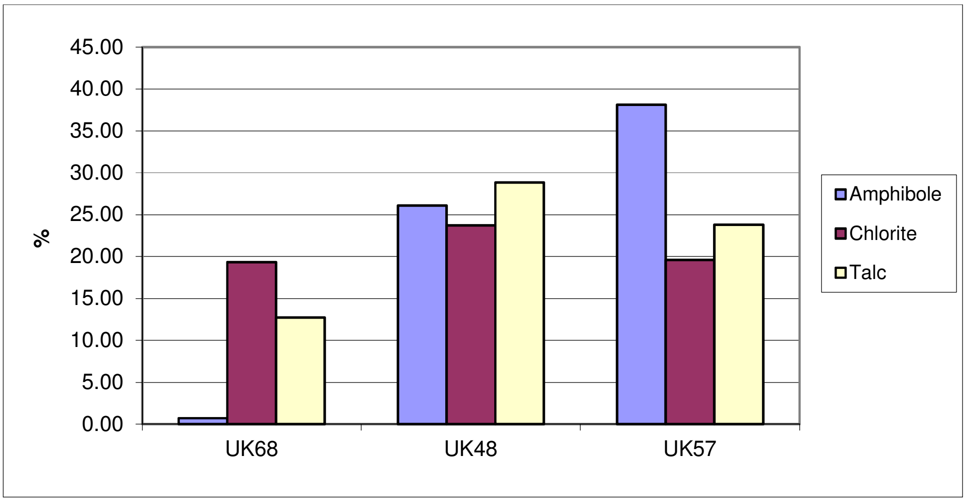


Figure 7.14. The average alteration mineral, expressed in percent, in a partial longitudinal section through the Uitkomst Complex in the PCR Unit. From UK68 (N) to UK57 (S).

From Figure 7.14 it may be inferred that the amphibole content increases from the N to the S in the study area. The chlorite and talc content seem to be lower closer to the inferred margins of the Uitkomst Complex in the PCR Unit.

7.5 Discussion of the distribution of amphibole, chlorite and talc

Decarbonization of dolomite in the presence of a mafic magma should lead to the co-existence of talc and amphibole in the resultant rock (Deer et al., 1992). However, in the profiles of the boreholes through Pit 3, the distribution of talc and amphibole with height indicates no systematic vertical relationship. There also appears to be no consistent increase or decrease of either talc or amphibole with height in any of the lithological units over the spatial distribution of the boreholes sections analysed. The highest occurrence of amphibole is located in the LHZBG Unit either at the top of the unit or near the bottom. The highest occurrence of talc and chlorite is found in the PCR Unit, but not at a consistent stratigraphic height. There appears to be no consistent decrease or increase of chlorite with height in any of the lithological units over the spatial distribution of the borehole sections analysed. There does not appear to be any consistent sympathetic variation between either amphiboles nor talc nor chlorite.

Spatially the vertical distribution of the amphiboles appears to follow a weakly defined mode of occurrence in the LHZBG Unit. Where the highest occurrence of amphibole is near the bottom of the LHZBG Unit, the borehole is positioned further away from the inferred margin of the Uitkomst Complex (UK 20, 32, 44). Where the highest occurrence of the amphiboles in the LHZBG Unit is towards the top of the unit, the borehole is positioned closer to the inferred margin of the Uitkomst Complex (UK12, 48, 57, 61 and 68). There is no apparent vertical spatial distribution pattern for the occurrence of amphiboles in the PCR Unit. The lateral distribution of amphibole in the BGAB Unit and LHZBG Units do not follow a specific trend along the longitudinal section. However, the lateral distribution of amphibole in the PCR Unit is indicated to decrease in a SE-direction. The distribution of amphibole in the LHZBG Unit can not be considered conclusive, but appears to decrease from the S to the N in the PCR along the transverse section.

XRD data from Pit 1 (Singh and de Nooy, 2003) for amphiboles indicates that the presence of amphibole is higher in the upper part of the borehole, where samples were collected further away from the inferred margins of the Uitkomst Complex. In Pit 1 the amphibole content is the highest in the bottom of the borehole, close to the inferred margin of the Complex. In Pit 2 the observed trend is similar to the trend observed in the study area in Pit 3, where the highest occurrence of amphibole is found in the lower part of the borehole, further away from the inferred contact of the Complex. In Pit 2 the highest occurrence of amphibole in the upper part of the borehole, is from samples located closer to the inferred margin of the Complex. The lateral distribution of amphibole in Pit 1 seems highly variable, but the lateral distributions in Pit 2 appear to decrease towards the SE.

It thus appears that conditions favourable for the formation of amphibole prevailed in the NW-part of the exposed Complex, but changed toward the SE. It is also significant to note that the PCR Unit in the form of the PCMZ is not found further towards the SE in association with Pit 1 and Pit 2.

Talc is only weakly tied to spatial location in both the LHZBG and PCR Units. Talc has the highest occurrence in the lower part of the LHZBG Unit where the borehole is located in the wider area to the SE of the intrusion. This is in the part of the study area indicated to have a relative proportion of talc more than 15% (as indicated by Figure 10.1 ; UK48, 68, 57, 61). The highest occurrence of talc in the upper part of the LHZBG Unit is found in the boreholes that fall outside the study area indicated to have a relative proportion of more than 15% talc, in the narrower part of the intrusion in the north-western portion of the study area (UK12 and 20). Talc has the highest occurrence in the central part of the LHZBG Unit between the previously described two areas (UK32 and 44). Talc has the highest occurrence in the upper part of the PCR Unit in the north-western part of the study area (UK12, 20, 32 and 44) and the highest occurrence in the central part of the PCR Unit in the south-eastern part of the study area (UK48, 57 and 61). Talc is found to decrease laterally from the NW to the SE in the LHZBG Unit, but to increase from the NW to the SE in the PCR Unit. Talc does appear to decrease closer to the inferred margin of the Uitkomst Complex relative the central part, in transverse section, in both the LHZBG and PCR Units.

In Pit 1 and Pit 2 the distribution of talc, both vertically and laterally, has been found to be highly variable (Singh and de Nooy, 2003). It was indicated that Pit 1 and Pit 2 has higher talc contents than Pit 3 (Singh and de Nooy, 2003). The highest occurrences of talc in Pit 1 appear near the inferred margins of the Complex and have no discernable lateral distribution pattern. In Pit 2 the talc occurrence increases from the N to the S, with the highest occurrence of talc being found in the boreholes located close to the inferred southern margin of the Complex

Chlorite has a weakly defined mode of occurrence in the PCR Unit where the highest occurrence in the lower part of the unit is found in the boreholes that fall outside the study area indicated to have more than 15% talc (UK12 and 20) in the narrower part of the intrusion. The highest occurrence of chlorite is found in the upper part of the PCR Unit. In the boreholes that falls in the part of the study area indicated to have more than 15% talc, in the wider part of the intrusion (UK32, 44, 48, 61 and 68), with the exception of UK57, where the highest occurrence of chlorite is found in the central part of the PCR Unit. The lateral distribution of chlorite in the BGAB, LHZBG and PCR Units, all seem to indicate a general decrease in abundance from the NW to the SE along the longitudinal section. The lateral distribution of chlorite in the LHZBG Unit seems to decrease from the N to the S in the transverse section, and the distribution in the PCR Unit may not be considered conclusive.

XRD data for Pit 1 (Singh and de Nooy, 2003) indicate the boreholes closer to the inferred margin of the Complex to have the highest occurrence of chlorite in their lower parts. The chlorite content seem to have the highest occurrence in the upper part of the borehole in the samples located furthest from the inferred contact of the Complex. Here the highest occurrence of chlorite is found in the central part of the Complex. In Pit 2 the highest occurrence of chlorite is found in the central part of the Complex. The abundance of chlorite seems to decrease from the NW to the SE. This is the same general trend observed in the study area in Pit 3. As with the amphibole distribution, the process responsible for the formation of the chlorite and distribution pattern, seem to have differed slightly from the NW to the SE in the exposed part of the Complex.

The volatile content, as demonstrated by the Loss On Ignition (LOI) values show cycles of increase and decrease with height. In the NW of the intrusion the LOI values show a correlation with the distribution of talc, but this correlation diminishes progressively toward the SE of the intrusion. The cyclical nature of the LOI values may indicate that the volatiles are linked to a specific fluid migration regime that may have existed in the conduit. It is however not clear whether this reflects a fluid migration that is syn- or post-intrusive or perhaps a combination of both.

7.6 Relationship between mineral content, abundance of xenoliths and the nature of the underlying country rocks

In this section semi-quantitative mineral assemblages as determined by XRD will be considered. The levels of these minerals are above five percent cumulatively, thus having the capability of influencing the froth floatation recovery negatively. A histogram is used in an attempt to determine the relationship between the total abundance of primary magmatic precursor minerals (olivine and pyroxene) and the total alteration minerals (amphibole, chlorite, serpentine and talc), encountered in the LHZBG and the PCR Units. It is placed alongside the percentage of xenoliths in the LHZBG Unit as well as the thickness in meters of the underlying Malmani dolomite and quartzite. The thickness of the MCR Unit is also given. The comparison is presented in Figure 7.15 and 7.16.

It appears that there is a weakly defined similar trend variation between the percentage xenoliths and the percentage of alteration minerals in the PCR Unit, and the thickness of the MCR Unit layer, with the exception of borehole UK48.

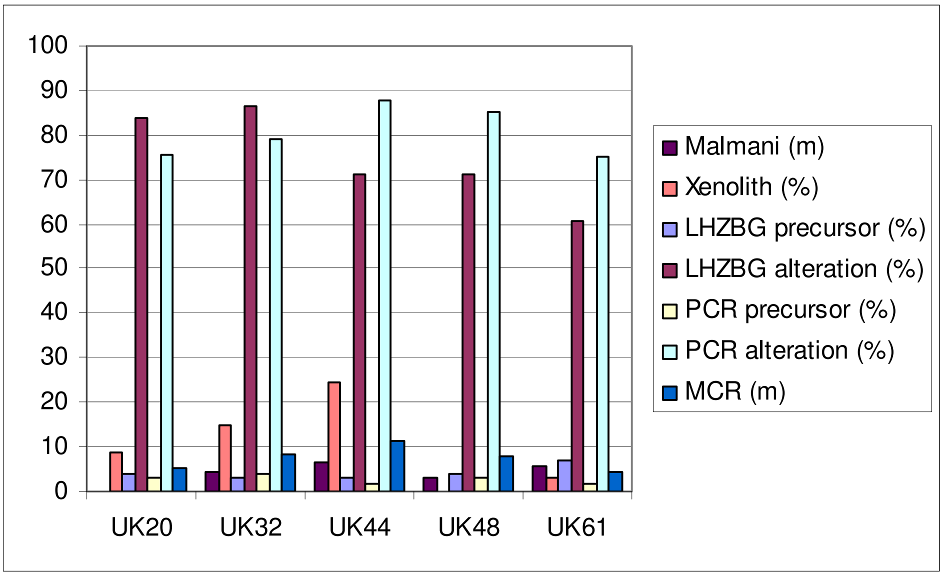


Figure 7.15. A histogram comparison (of a partial longitudinal section) between the percentage primary and alteration minerals in the LHZBG and PCR Units. The percentage xenoliths that forms part of the LHZBG Unit is also presented. The thickness of unassimilated Malmani dolomite and quartzite is also given. The thickness of MCR Unit is also included.

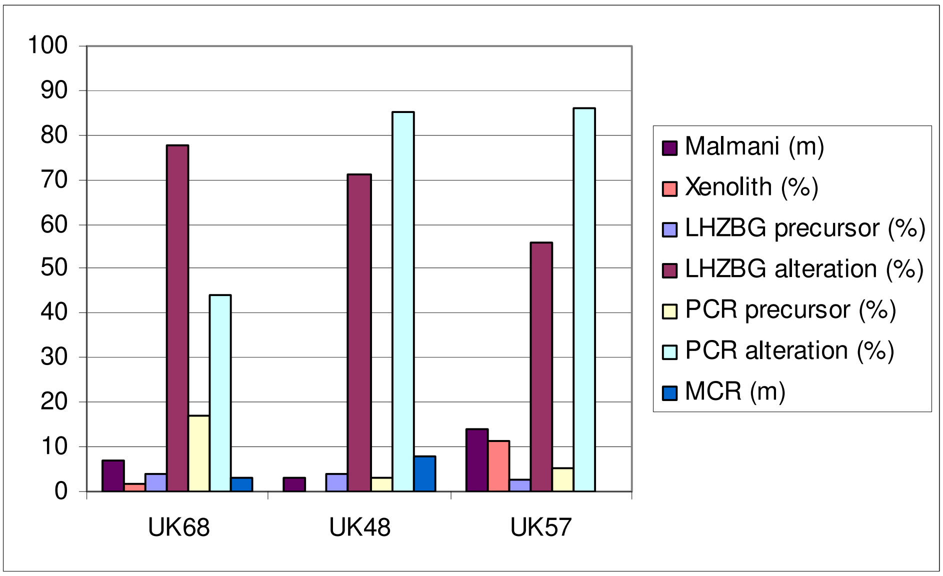


Figure 7.16. A histogram comparison (of a partial transverse section) between the percentage primary and alteration minerals in the LHZBG and PCR Units. The percentage xenoliths that forms part of the LHZBG Unit is also presented. The thickness of unassimilated Malmani dolomite and quartzite is also given. The thickness of MCR Unit is also included.

This comparison indicates that the samples taken from boreholes in the narrower part of the intrusion, and boreholes close to the edge of the Uitkomst Complex, especially in the PCR Unit, suffered less alteration, and therefore a greater preservation of the magmatic precursor minerals, relative to samples taken from boreholes further away from the edge of the Uitkomst Complex and in the broader part of the intrusion.

In general the total amount of alteration minerals in the LHZBG Unit appears to decrease in the broader part of the Uitkomst Complex in the study area, but in contrast appear to increase in the PCR Unit.

7.7 Significant implications of distribution of secondary minerals

The distribution of the secondary minerals may give an indication of the composition of the deuteric fluid(s) that influenced the intrusion. It was shown in the chapter dealing with secondary minerals that some minerals may only exist under certain temperature conditions with a specific X_{CO2}-content in the fluid. Amphibole, the most common secondary mineral in the intrusion, is not useful for delineating the fluid composition as it occurs in over too great a range. Minerals such as serpentine and chlorite will only develop under conditions with low X_{CO2}-content (Winkler, 1974). On the other hand, talc will only develop if the CO_2-partial pressure is high enough to stabilize the formation of it.

The cyclical nature of the LOI values, which is taken to represent the volatile content at the specific location, may give an indication as to the migration pattern of the deuteric fluid. The correlation between the LOI values and talc in the NE of the complex would suggest that it reflects the migration pattern of the CO_2-rich fluid. This fluid would have stabilized the formation of talc a height. The cyclical increase-decrease pattern, not correlating with a specific alteration mineral is noted in the SE of the complex. This may suggest that it represents the last deuteric regime, possibly of a later fluid, to affect that portion of the complex.