

X. SUMMARY AND CONCLUSIONS

Emplacement of the basaltic magma took place along an undulating plane near the top of the Pretoria Group. Absence of sediments of the Smelterskop Formation in their normal stratigraphic position at the present level of erosion indicates that they were lifted up vertically by the intrusion and that they have since been removed by erosion, whereas their presence in the roof, as for instance in the Rooiberg area and in the area mapped by Molyneux (1970a, Plate I) points to their absence at the floor.

Cooling of the magma took place primarily as a result of heat loss through the roof causing recrystallization of the felsite to leptite and microgranite as well as the melting of these rocks to give rise to the large amount of granophyre. Intermittent injection of fresh undifferentiated magma may in part be held responsible for the repetitive stratigraphy and also for the lateral extension of the magma chamber causing progressively higher horizons of the Layered Sequence to terminate against the sediments of the floor.

Crystallization of the Main Zone has probably taken place near the floor of the magma chamber under conditions of slow, continuous convection. Intermittent acceleration of the convection currents may have caused crystallization near the top of the intrusion, i. e. at lower pressures, and may have resulted in accumulation of plagioclase crystals only to form anorthosites. Although crystallization of the magma took place at low oxygen pressures causing an enrichment of iron in the residual magma, the appearance of magnetite in the rocks of the Upper Zone is not only considered to be the result of an increase in the oxygen fugacity, but also to be due to enrichment of iron in the liquid. A periodic increase in the oxygen fugacity enhanced the crystallization of magnetite, which, owing to its higher settling velocity could have assisted in the formation of the magnetite seams. Accumulus growth of crystals by diffusion or while crystals were still in contact with the supernatant magma probably aided the formation of adcumulates.

Postcumulus changes were to a large extent governed by load pressure which had a pronounced effect on the cumulates of the Layered Sequence. A direct result of this is probably the development of reversed zoning, interpenetration and bending of plagioclase crystals as well as the development of myrmekite, symplektite and units of similarly orientated grains of inverted pigeonite. Simul-

taneous compaction of the cumulus pile probably also resulted in the expulsion of large quantities of the intercumulus liquid which could have been concentrated in places to form transgressive pipe-like or sill-like pegmatoids. It is envisaged that, where their movement to higher levels was hampered by ad-cumulus growth of the overlying crystal mush, effectively sealing the intercumulus spaces, these liquids spread out laterally, reconstituting the cumulates to form irregularly shaped pegmatoids often displaying gradational as well as sharp contacts with the country-rocks, as described by Cameron and Desborough (1964, p. 200–223). Where confining pressure on these intercumulus liquids was sufficiently high they could have brecciated the overlying rocks on their way upwards, thus forming the occasional breccia pipe, as for instance on Tweefontein (Ferguson and McCarthy, 1970, p. 74) and near Roosenekal.

Towards the outer margins of the complex, the heat loss was probably more effective, causing lower temperature phases to crystallize simultaneously with higher temperature phases in the central portions of the magma chamber. The lower temperature phases of the ferromagnesian minerals extracted more iron from the fractionating magma where the thickness of the chamber was less, as for instance south of Tauteshoogte, with the result that the magma was depleted in iron, relative to that in the central portions, and prevented the formation of the magnetite seams of Subzone D of the Upper Zone.

Crystallization of apatite and sulphides seems to have been governed by the concentration of phosphorus and sulphur in the magma respectively. The magma reached saturation of both at the base of Subzone D of the Upper Zone, which is indicated by the presence of cumulus apatite crystals and by numerous small droplets of sulphides in the rocks of this subzone.

The appearance of firstly biotite, then cumulus apatite and sulphide droplets and lastly hornblende in the rocks of the Layered Sequence is probably due to a gradual increase of the volatiles in the fractionating magma. Some of the water-rich residual liquids intruded the acid roof rocks and caused additional melting of the leptite to give rise to irregularly transgressive bodies of granodiorite.

The trend of differentiation in layered intrusions can be illustrated graphically by plotting the modified differentiation index or the modified crystallization index against height in the intrusion. Where large amounts of ultramafic rocks are developed, the latter seems to be the more appropriate, whereas the former



is a better parameter to illustrate differentiation of intrusions where not many ultramafic rocks are developed, as in the Bushveld Complex.

REFERENCES

- ATKINS, F. B. (1969) Pyroxenes of the Bushveld Intrusion, South Africa. J. Pet., v. 10, 222-249.
- BARKER, D. S. (1970) Composition of granophyre, myrmekite, and graphic granite. Bull. geol. Soc. Amer., v. 81, 3339-3350.
- BERG, J. J. VAN DEN (1946) Petrofabric analysis of the Bushveld gabbro from Bon Accord. Trans. geol. Soc. S. Afr., v. 49, 155-208.
- BOSHOFF, J. C. (1942) The Upper Zone of the Bushveld Complex at Tauteshoogte. D. Sc. dissertation (unpublished) Univ. of Pretoria, 79p.
- BOWEN, N. L. AND SCHAIRER, J. F. (1935) The system MgO-FeO-SiO₂. Amer. J. Sci., 5th Ser., v. 29, 151-217.
- BROWN, G. M. (1956) The layered ultrabasic rocks of Rhum, Inner Hebrides. Phil. Trans. Roy. Soc. Lond., Ser. B., v. 240, 1-53.
- _____ (1957) Pyroxenes from the early and middle stages of fractionation of the Skaergaard Intrusion, East Greenland. Miner. Mag., v. 31, 511-543.
- _____ (1967) Experimental studies on inversion relations in natural pigeonitic pyroxenes. Carnegie Instn. Wash., Yearb. 66, 347-353.
- BROWN, G. C. AND FYFE, W. S. (1970) The production of granitic melt during ultrametamorphism. Contr. Miner. Pet., v. 28, 310-318.
- BRUYNZEEL, D. (1957) A petrographic study of the Waterfall Gorge profile at Insizwa. Ann. Univ. Stellenbosch, v. 33A, 481-538.
- BUDDINGTON, A. F. (1939) Adirondack igneous rocks and their metamorphism. Geol. Soc. Amer., Mem. 7, 354p.
- BURRI, C., PARKER, R. L. AND WENK, E. (1967) Die optische Orientierung der Plagioklase. Birkhäuser Verlag, Basel und Stuttgart. 334p.
- CAMERON, E. N. (1969) Postcumulus changes in the Eastern Bushveld Complex. Amer. Miner., v. 54, 754-779.
- CAMERON, E. N. (1970) Composition of certain coexisting phases in the eastern part of the Bushveld Complex. Geol. Soc. S. Afr., Spec. Publ. 1, 46-58.
- _____ AND DESBOROUGH, A. (1964) Origin of certain magnetite-bearing pegmatites in the eastern part of the Bushveld Complex. Econ. Geol., v. 59, 197-225.
- _____ AND DESBOROUGH, G. A. (1969) Occurrence and characteristics of chromite deposits - Eastern Bushveld Complex. Econ. Geol., Monogr. 4, 23-40.
- CHAYES, F. (1956) Petrographic Modal Analyses. An elementary statistical appraisal. J. Wiley & Sons, Inc., New York, 113p.
- COERTZE, F. J. (1962) The Rustenburg fault as a controlling factor of ore deposition south west of Pilanesberg. Trans. geol. Soc. S. Afr., v. 65, 253-257.

- _____ (1970) The geology of the western part of the Bushveld Igneous Complex. Geol. Soc. S. Afr., Spec. Publ. 1, 5-22.
- COETZEE, G. L. (1970) The Rooiberg Felsite Series north of Nylstroom. Geol. Soc. S. Afr., Spec. Publ. 1, 312-325.
- COOPER, J. R. (1936) Geology of the southern half of the Bay of Islands Igneous Complex. Newfld. Dep. Nat. Res., Bull. 4, 62p.
- COUSINS, C. A. (1964) The platinum deposits of the Merensky Reef. 225-237, In Houghton, S. H. Ed., The geology of some ore deposits of Southern Africa, v. II. Geol. Soc. S. Afr., Johannesburg. 739p.
- _____ (1969) The Merensky Reef of the Bushveld Igneous Complex. Econ. Geol., Monogr. 4, 239-251.
- CRAIG, J. R. (1966) Appearances of phases during cooling of pyrrhotite-rich Ni-Cu ores. Carnegie Inst. Wash., Yearb. 65, 335-336.
- _____ AND KULLERUD, G. (1969) Phase relations in the Cu-Fe-Ni-S System and their application to magmatic ore deposits. Econ. geol., Monogr. 4, 344-358.
- CRUFT, E. F. (1966) Minor elements in igneous and metamorphic apatite. Geochim. et Cosmochim. Acta, v. 30, 375-398.
- DEER, W. A., HOWIE, R. A. AND ZUSSMAN, J. (1962) Rock-forming minerals. Vol. 2, 371p., Vol. 3, 270p., Vol. 4, 435p., Vol. 5, 370p. Longmans, Green and Co. Ltd., London.
- DESBOROUGH, G. A. AND CAMERON, E. N. (1968) Composition and structural state of plagioclases from the lower part of the eastern Bushveld Complex, South Africa. Amer. Miner., v. 53, 116-122.
- DRESCHER-KADEN, F. K. (1948) Die Feldspat-Quarz-Reaktionsgefüge der Granite und Gneise. Springer Verlag, Berlin. 259p.
- FERGUSON, J. AND WRIGHT, I. H. (1970) Compositional variation of plagioclase in the Critical Series, Bushveld Complex. Geol. Soc. S. Afr., Spec. Publ. 1, 59-66.
- FERGUSON, J. AND McCARTHY, T. S. (1970) Origin of an ultramafic pegmatoid in the eastern part of the Bushveld Complex. Geol. Soc. S. Afr., Spec. Publ. 1, 74-79.
- FORD, W. E. (1955) Dana's textbook of mineralogy, 4th Ed. John Wiley & Sons, Inc., New York, 851p.
- FÖRTSCH, E. (1970) Untersuchungen an Mineralien der Pyromorphit-Gruppe. N. Jb. Miner., Abh., v. 113, 219-250.
- GROBLER, N. J. AND WHITFIELD, G. G. (1970) The olivine-apatite-magnetites and related rocks in the Villa Nora occurrence of the Bushveld Igneous Complex. Geol. Soc. S. Afr., Spec. Publ. 1, 208-227.
- GROENEVELD, D. (1968) The Bushveld Igneous Complex in the Stoffberg area, Eastern Transvaal, with special reference to the magnetitite seams. D. Sc. dissertation (unpublished) Univ. of Pretoria. 172p.

- _____ (1970) The structural features and the petrography of the Bushveld Complex in the vicinity of Stoffberg, Eastern Transvaal. Geol. Soc. S. Afr., Spec. Publ. 1, 36-45.
- GRUENEWALDT, G. VON (1966) The geology of the Bushveld Igneous Complex east of the Kruis River cobalt occurrence, north of Middelburg, Transvaal. M. Sc. thesis (unpublished). Univ. of Pretoria. 104 p.
- _____ (1968) The Rooiberg Felsite north of Middelburg and its relation to the layered sequence of the Bushveld Complex. Trans. geol. Soc. S. Afr., v. 71, 153-172.
- _____ (1970) On the phase-change orthopyroxene-pigeonite and the resulting textures in the Main and Upper Zones of the Bushveld Complex in the Eastern Transvaal. Geol. Soc. S. Afr., Spec. Publ. 1, 67-73.
- HALL, A. L. (1932) The Bushveld Igneous Complex of the Central Transvaal. Geol. Soc. S. Afr., Mem. 28, 560p.
- HAMILTON, D. L. AND ANDERSON, G. M. (1967) Effects of water and oxygen pressure on the crystallization of basaltic magmas, 445-482. In, Hess, H. H. and Poldervaart, A., Editors, Basalts, Vol. 1. Interscience Publishers, New York, 482p.
- HAMMERBECK, E. C. I. (1970) The Steelpoort Park Granite, eastern part of the Bushveld Complex, and the magnetites in the gabbroic country rock. Geol. Soc. S. Afr., Spec. Publ. 1, 299-311.
- HENDERSON, P. (1968) The distribution of phosphorus in the early and middle stages of fractionation of some basic layered intrusions. Geochim. et Cosmochim. Acta, v. 32, 897-911.
- HERZ, N. (1951) Petrology of the Baltimore gabbro, Maryland. Bull. Geol. Soc. Amer., v. 62, p. 979-1016.
- HESS, H. H. (1941) Pyroxenes of common mafic magmas. Part 1 and 2. Amer. Miner., v. 26, 515-535 and 573-594.
- _____ (1949) Chemical composition and optical properties of common clinopyroxenes, Part. 1. Amer. Miner., v. 34, 621-666.
- _____ (1960) Stillwater Igneous Complex, Montana. A quantitative mineralogical study. Geol. Soc. Amer., Mem. 80, 230p.
- HUAN, W. T. AND MERRITT, C. A. (1954) Petrography of the troctolite of the Wichita Mountains, Oklahoma. Amer. Miner., v. 39, 549-565.
- HUBBARD, F. H. (1966) Myrmekite in charnockite from southwest Nigeria. Amer. Miner., v. 51, 762-773.
- HUGHES, C. J. (1970) Lateral cryptic variation in the Great Dyke of Rhodesia. Geol. Mag., v. 107, 319-325.
- Index to the Powder Diffraction File 1970. Joint Committee on Powder Diffraction Standards, Publ. PDIS-20i.
- IRVINE, T. N. (1970a) Crystallization sequences in the Muskox intrusion and other layered intrusions. Part 1, Olivine-pyroxene-plagioclase relation. Geol. Soc. S. Afr., Spec. Publ. 1, 441-476.

- _____ (1970b) Heat transfer during solidification of layered intrusions. I. Sheets and sills. Can. J. Earth Sci., v. 7, 1031-1061.
- _____ AND SMITH, C. H. (1967) The ultramafic rocks of the Muskox intrusion. Northwest Territories, Canada, 38-49. In, Wyllie, P. J., Ed. Ultramafic and related rocks. John Wiley & Sons. Inc., New York, 464p.
- JACKSON, E. D. (1961) Primary textures and mineral associations in the Ultramafic Zone of the Stillwater Complex, Montana. U. S. Geol. Surv., Prof. Pap. 358, 106p.
- _____ (1967) Ultramafic cumulates in the Stillwater, Great Dyke, and Bushveld Intrusions, 20-38. In, P. J. Wyllie Ed., Ultramafic and related rocks. J. Wiley & Sons, New York, 464p.
- _____ (1970) The cyclic unit in layered intrusions - a comparison of repetitive stratigraphy in the ultramafic parts of the Stillwater, Muskox, Great Dyke, and Bushveld Complexes. Geol. Soc. S. Afr., Spec. Publ. 1, 391-424.
- JAHNS, R. H. (1939) Clerici solution for the specific gravity determination of small mineral grains. Amer. Miner., v. 24, 116-122.
- JAMBOR, J. L. AND SMITH, C. H. (1964) Olivine composition determination with small-diameter X-ray powder cameras. Miner. Mag., v. 33, 730-741.
- KULLERUD, G. (1967) Sulphide studies, 286-321. In, P. H. Abelson Ed., Researches in geochemistry, Vol. 2. J. Wiley & Sons, New York, 663p.
- _____ (1968) High temperature phase relations in the Cu-Fe-S system. Carneg. Inst. Wash., Yearb. 66, 404-409.
- KUNO, H. AND NAGASHIMA, K. (1952) Chemical composition of hypersthene and pigeonite in equilibrium in magma. Amer. Miner., v. 37, 1000-1006.
- KUNO, H., YAMASAKI, K., IDIA, C. AND NAGASHIMA, K. (1957) Differentiation of Hawaiian magmas. Jap. J. Geol. Geogr., v. 28, 179-218.
- LIEBENBERG, C. J. (1961) The trace elements of the rocks of the Bushveld Igneous Complex, Part 2. The different rock types. Publ. Univ. Pretoria, No. 13, 65p.
- LIEBENBERG, L. (1970) The sulphides of the Bushveld Complex. Geol. Soc. S. Afr., Spec. Publ. 1, 108-207.
- LOMBAARD, A. F. (1949) Die geologie van die Bosveldkompleks langs Bloedrivier. Trans. geol. Soc. S. Afr., v. 52, 343-376.
- LOMBAARD, B. V. (1932) The felsites and their relations to the Bushveld Complex. Trans. geol. Soc. S. Afr., v. 35, 125-190.
- _____ (1934) On the differentiation and relationships of the rocks of the Bushveld Complex. Trans. geol. Soc. S. Afr., v. 37, 5-52.
- MASKE, S. (1966) The petrography of the Ingeli Mountain Range. Ann. Univ. Stellenbosch, v. 41A, 1-109.

- MENGE, G. F. W. (1963) The Cassiterite Deposits on Doornhoek 342 KR and vicinity, West of Naboomspruit, Transvaal. M. Sc. thesis (unpublished) Univ. of Pretoria. 56p.
- MOLYNEUX, T. G. (1964) The geology and the structure of the area in the vicinity of Magnet Heights, Eastern Transvaal, with special reference to the magnetic iron ore. M. Sc. thesis (unpublished) Univ. of Pretoria, 112p.
- _____ (1970a) A geological investigation of the Bushveld Complex in Sekhukhuneland and part of the Steelpoort Valley, Eastern Transvaal, with particular reference to the oxide minerals. D. Sc. thesis (unpublished) Univ. of Pretoria, 123p.
- _____ (1970b) The geology of the area in the vicinity of Magnet Heights, Eastern Transvaal, with special reference to the magnetic iron ore. Geol. Soc. S. Afr., Spec. Publ. 1, 228-241.
- MORIMOTO, N. AND KULLERUD, G. (1964) Pentlandite: Thermal expansion. Carneg. Inst. Wash., Yearb. 63, 204-205.
- MURTHY, M. V. N. (1958) Coronites from India and their bearing on the origin of coronas. Bull. geol. Soc. Amer., v. 68, 23-38.
- NAKAMURA, Y. AND KUSHIRO, I. (1970a) Compositional relations of co-existing orthopyroxene, pigeonite and augite in a tholeiitic andesite from Hakone volcano. Contr. Miner. Pet., v. 26, 265-275.
- _____ (1970b) Equilibrium relations of hypersthene, pigeonite and augite in crystallizing magmas: Microprobe study of a pigeonite andesite from Weiselberg, Germany. Amer. Miner., v. 55, 1999-2015.
- NALDRETT, A. J. (1969) A portion of the system Fe-S-O between 900 and 1080^o C and its application to sulfide ore magmas. J. Pet., v. 10, 171-201.
- NALDRETT, A. J. AND KULLERUD, G. (1966) Limits of the Fe_{1-x}S - Ni_{1-x}S solid solution between 600^o and 250^o C. Carneg. Inst. Wash., Yearb. 65, 320-326.
- _____ (1967) A study of the Strathcona Mine and its bearing on the origin of the Nickel-Copper Ores of the Sudbury District, Ontario. J. Pet., v. 8, 453-531.
- NEL, H. J. (1940) The basal rocks of the Bushveld Igneous Complex, north of Pretoria. Trans. geol. Soc. S. Afr., v. 43, 37-68.
- NEUHAUS, A. (1951) Orientierte Substanzabscheidung (Epitaxie). Fortschr. Miner., v. 30, 136-296.
- NOCKOLDS, S. R. AND ALLEN, R. (1953) The geochemistry of some igneous rock series. Geochim. et Cosmochim. Acta, v. 4, 105-142.
- OSBORN, E. F. (1959) Role of oxygen pressure in the crystallization and differentiation of basaltic magma. Amer. J. Sci., v. 257, 609-647.
- _____ (1962) Reaction series for subalkaline igneous rocks based on different oxygen pressure conditions. Amer. Miner. v. 47, 211-226.
- PECK, D. L. , WRIGHT, T. L. AND MOORE, J. G. (1966) Crystallization of tholeiitic basalt in Alae Lava Lake, Hawaii. Bull. Volc., v. 29, 629-655.



- PHILLIPS, E. R. (1964) Myrmekite and albite in some granites of the New England Batholith, New South Wales. J. geol. Soc. Austr., v. 11, 49-50.
- _____ AND RANSOM, D. M. (1968) The proportionality of quartz in myrmekite. Amer. Miner., v. 53, 1411-1413.
- PLATEN, H. VON (1965) Kristallisation granitischer Schmelzen. Contr. Miner. Pet., v. 11, 334-381.
- POLDERVAART, A. AND HESS, H. H. (1951) Pyroxenes in the crystallization of basaltic magma. J. Geol., v. 59, 472-489.
- POLDERVAART, A. AND PARKER, A. B. (1964) The crystallization index as a parameter of igneous differentiation in binary variation diagrams. Amer. J. Sci., v. 262, 281-289.
- _____ (1965) Reply to discussion by C. P. Thornton and O. F. Tuttle. Amer. J. Sci., v. 263, 279-283.
- RAAL, F. (1965) The transition between the Main and Upper Zone of the Bushveld Complex in the Western Transvaal. M. Sc. thesis (unpublished) Univ. of Pretoria, 59p.
- REYNOLDS, D. (1947) The granitization controversy. Geol. Mag., v. 84, 209-223.
- ROUX, P. (1968) Die Bosveldkompleks op De Kafferskraal 53 JT en omgewing, noord van Dullstroom. M. Sc. thesis (unpublished) Univ. of Pretoria, 100p.
- SHELLEY, D. (1964) On myrmekite. Amer. Miner., v. 49, 41-52.
- SKINNER, B. J. AND PECK, D. L. (1969) An immiscible sulfide melt from Hawaii. Econ. geol. Monogr. 4, 310-322.
- SMITH, J. R. (1960) Optical properties of low-temperature plagioclase. Geol. Soc. Amer., Mem. 80, 191-219.
- SMITH, J. V. and GAY, P. (1958) The powder patterns and lattice parameters of plagioclase feldspars. II. Miner. Mag., v. 31, 744-762.
- STORMER, J. C. AND CARMICHAEL, I. S. E. (1971) Fluorine-hydroxyl exchange in apatite and biotite: a potential igneous geothermometer. Contr. Miner. Petr., v. 31, 121-131.
- TABORSZKY, F. K. (1962) Geochemie des Apatits in Tiefengesteinen am Beispiel des Odenwaldes. Beitr. Miner. Pet., v. 8, 354-392.
- THORNTON, C. P. AND TUTTLE, O. F. (1960) Chemistry of igneous rocks, I. Differentiation index. Amer. J. Sci., v. 258, 664-684.
- _____ (1965) Discussion of "The crystallization index as a parameter of igneous differentiation in binary variation diagrams" by A. Poldervaart and A. B. Parker. Amer. J. Sci., v. 263, 277-279.
- TILLEY, C. E., YODER, H. S. AND SCHAIRER, J. F. (1963) Melting relations of basalts. Carneg. Inst. Wash., Yearb. 62, 77-84.
- _____ (1968) Melting relations of igneous rock series. Carneg. Inst. Wash., Yearb. 66, 450-457.

- TROGER, W. E. (1959) Optische Bestimmung der gesteinsbildenden Minerale. Teil I, Bestimmungstabellen. E. Schweizerbart'sche Verlagsbuchhandlung, Stuttgart, 147p.
- _____ (1967) Optische Bestimmung der gesteinsbildenden Minerale. Teil 2. E. Schweizerbart'sche Verlagsbuchhandlung, Stuttgart, 822p.
- TURNER, F. J. AND VERHOOGEN, J. (1960) Igneous and metamorphic petrology, 2nd Ed. McGraw-Hill, New York, 694p.
- TUTTLE, O. F. AND BOWEN, N. L. (1958) Origin of granite in the light of experimental studies in the system $\text{NaAlSi}_3\text{O}_8$ - KAlSi_3O_8 - SiO_2 - H_2O . Geol. Soc. Amer. Mem. 74, 153p.
- ULMER, G. C. (1969) Experimental investigations of chromite spinels. Econ. Geol., Monogr. 4, 114-131.
- VULTEE, J. VON (1951) Die orientierten Verwachsungen der Mineralien. Fortschr. Miner., v. 30, 297-378.
- WAGER, L. R. (1956) A chemical definition of fractionation stages as a basis for comparison of Hawaiian, Hebridean and other basic lavas. Geochim. et Cosmochim. Acta, v. 9, 217-248.
- _____ (1960) The major element variation of the Layered Series of the Skaergaard Intrusion and a re-estimation of the average composition of the Hidden Layered Series and of the successive residual magmas. J. Pet., v. 1, 364-398.
- _____ (1963) The mechanism of adcumulus growth in the layered series of the Skaergaard intrusion. Miner. Soc. Amer., Spec. Pap. 1, 1-9.
- WAGER, L. R. AND DEER, W. A. (1939) Geological investigations in East Greenland, Part III. The petrology of the Skaergaard Intrusion, Kangerdlugssuaq, East Greenland. Medd. om Gronland, v. 105, No. 4, 1-352.
- WAGER, L. R., BROWN, G. M. AND WADSWORTH, W. J. (1960) Types of igneous cumulates. J. Pet., v. 1, 73-85.
- WAGER, L. R. AND BROWN, G. M. (1968) Layered Igneous Rocks. Oliver and Boyd, Edinburgh and London, 588p.
- WAGNER, P. A. (1929) The platinum deposits and mines of South Africa. Oliver and Boyd, Edinburgh, 326p.
- WILLEMSE, J. (1953) The mineral potentials of the townlands of Roosenekal. Restricted Report, Peri-urban Areas Health Board, Pretoria, 14p.
- _____ (1959) The "Floor" of the Bushveld Igneous Complex and its relationships, with special reference to the Eastern Transvaal. Trans. geol. Soc. S. Afr., v. 62, xxi-lxxx.
- _____ (1964) A brief outline of the geology of the Bushveld Igneous Complex, 91-128. In, Haughton, S. H., Ed., The geology of some ore deposits of Southern Africa, Vol. II. Geol. Soc. S. Afr., Johannesburg, 739p.
- _____ (1969a) The geology of the Bushveld Igneous Complex, the largest repository of magmatic ore deposits in the world. Econ. Geol., Monogr. 4, 1-22.

- _____ (1969b) The vanadiferous magnetic iron ore of the Bushveld Igneous Complex. Econ. Geol., Monogr. 4, 187-208.
- WILLEMSE, J. AND BENSCH, J. J. (1964) Inclusions of original carbonate rocks in gabbro and norite of the eastern part of the Bushveld Complex. Trans. geol. Soc. S. Afr., v. 67, 1-87.
- WILLEMSE, J. AND FRICK, C. (1970) Stroomroof en die invloed van ver-skuiwings op die geomorfologie in die opvanggebied van die Steel-poortrivier in Oos-Transvaal. Trans. geol. Soc. S. Afr., v. 73, 159-171.
- WONES, D. R. (1963) Physical properties of synthetic biotites on the join phlogopite-annite. Amer. Miner., v. 48, 1300-1316.
- YODER, H. S. AND TILLEY, C. E. (1962) Origin of basalt magmas. An experimental study of natural and synthetic rock systems. J. Pet., v. 3, 342-532.
- _____ AND SCHAIRER, J. F. (1963) Pyroxenes and associated minerals in the crust and mantle. Pyroxene quadrilateral. Carneg. Inst. Wash., Yearb. 62, 84-95.
- YUND, R. A. AND KULLERUD, G. (1966) Thermal stability of assemblages in the Cu-Fe-S system. J. Pet., v. 7, 454-488.
- ZYL, J. P. VAN (1970) The petrology of the Merensky Reef and associated rocks on Swartkop 988, Rustenburg district. Geol. Soc. S. Afr., Spec. Publ. 1, 80-107.
- DALY, R. A. (1928) Bushveld Igneous Complex of the Transvaal. Bull. geol. Soc. Amer., v. 39, 703-768.
- FRICK, C. (1967) The margin of the Bushveld Complex in the vicinity of De Berg, north of Dullstroom. M.Sc. thesis (unpublished) Univ. of Pretoria, 127p.
- ROEDER, P. L. AND OSBORN, E. F. (1966) Experimental data for the system MgO - FeO - Fe₂O₃ - Ca Al₂Si₂O₈ - SiO₂ and their petrologic implications. Amer. J. Sci., v. 264, 428-480.

APPENDIX I

MODAL ANALYSES AND COMPOSITION OF CUMULUS PHASES OF ROCKS FROM THE MAIN AND UPPER ZONES OF THE BUSHVELD COMPLEX

- M. R. Merensky Reef
- I. C. No. Number of identity changes on a 40mm traverse
(Chayes, 1956, p. 77).

Cumulus phases are denoted by asterisks following the volumetric percentage.

Values used in the compositional trend of the plagioclase in Folder III are marked by an asterisk. Where only two values are given they were averaged for construction of the trend.

APPENDIX I. MAIN ZONE, Subzone A.

Sample Number	PB4398	PB4389	PB4284	PB4275	PB4271	PB4254	PB4093	PB40895	PB4076	PB4049	PB3883	PB3832	PB3801	PB3701	PB3573	
Height in metre above M.R.	1	4	35	38	39	44.5	93.5	94.5	99	107	158	173	182	213	252	
Modal analysis (vol. %)																
Plagioclase	84.6*		54.3*	40.6*	88.3*		76.3*	78.8*	80.8*	64.0*	65.8*	69.6*	84.9*	60.9*	74.0*	
Orthopyroxene	8.2*		42.1*	40.1*	9.5*		8.5	13.7*	9.2	23.5*	31.7*	27.4*	6.5*	28.4*	21.5*	
Clinopyroxene	7.1		2.7	18.8	1.7		14.6	5.4	8.9	10.1*	2.5	3.0	4.1	10.7*	4.4	
Biotite	—		0.3	0.2	tr.		tr.	0.2	0.3	1.0	—	—	—	—	—	
K-feldspar	—		tr.	—	—		—	0.1	—	—	—	—	—	—	—	
Quartz	0.1		0.5	0.2	0.4		0.6	1.6	0.8	1.35	—	—	4.3	—	0.1	
Apatite	—		—	—	—		—	tr.	—	—	—	—	tr.	—	—	
Opaque	tr.		tr.	0.1	tr.		—	0.2	tr.	tr.	—	—	0.2	—	—	
I.C. No.	70		61	73	70		52	51	57	68	115	142	37	98	60	
Plagioclase: mol. % An from:																
$2\theta_{131}-2\theta_{1\bar{3}1}(\text{CuK}\alpha)$	76*	74	76	76		76*		69*		68*	72			72*	73	
$2\theta_{241}-2\theta_{2\bar{4}1}(\text{CuK}\alpha)$	—	73	—	74		71		70		68	71*			72	—	
2V	77	76	78	76		81(?)		69		69	70			70	69	
Ext. angles	76	76	77*			77	71									
Orthopyroxene: mol. % Fs from:																
2V	25	25	20	20		23		34		30	25			25	26	
Name of rock and remarks																
	Spotted anorthositic hypersthene gabbro		Spotted norite	Feldspathic pyroxenite, Bastard Reef	Spotted anorthosite	Mottled anorthosite	Hypersthene gabbro Inverted pigeonite	Hyperite Inverted pigeonite	Anorthositic hyperite Inverted pigeonite	Hyperite	Fine-grained norite	Fine-grained norite	Spotted anorthosite	Spotted hyperite	Spotted norite	

APPENDIX I (Continued). MAIN ZONE, Subzone A

Sample Number	PB3549	PB3521	PB3496	PB3448	PB3372	PB33315	PB3245	PB3166	PB3051	PB2951	PB2829	PB2731	PB2633	PB2461	PB2371
Height in metre above M.R.	259	267	276	291	314	326	352	376	411	441	470	515	538	591	618
Modal analysis (vol. %)															
Plagioclase	36.2*		61.8*		63.8*	67.5*	63.7*	58.3*	57.5*	64.5*	61.1*	55.4*	83.5*	61.7*	63.2*
Orthopyroxene	55.3*		28.3*		22.1*	14.8*	12.9*	21.4*	20.4*	16.9*	11.9*	19.9*	13.1*	20.8*	9.4*
Clinopyroxene	8.5		9.3		13.7*	16.9*	22.8*	20.0*	20.2*	18.4*	26.2*	23.8*	2.8	17.0*	24.3*
Biotite	—		0.3		—	—	—	0.1	0.5	—	0.1	0.1	0.2	0.2	0.8
K-feldspar	—		—		—	—	—	—	—	—	—	—	—	—	0.1
Quartz	—		0.3		0.4	0.8	0.6	0.1	1.4	0.2	0.6	0.8	0.4	0.3	2.1
Apatite	—		—		—	—	—	—	—	—	—	—	—	—	tr.
Opaque	—		—		—	—	—	—	tr.	—	0.1	—	—	—	tr.
I.C. No.	128		92		80	75	68	68	53	62	58	64	56	69	52
Plagioclase: mol. % An from:															
$2\theta_{131}-2\theta_{1\bar{3}1}(\text{CuK}\alpha)$		70*		69*	69	68*	68*	68*			68*	66	68		67*
$2\theta_{241}-2\theta_{2\bar{4}1}(\text{CuK}\alpha)$		—		70	—	68	68	68			—	—	—		67
2V		69		67	67	68	68	67			66	68	71		67
Extinction angles											68		69*		
Orthopyroxene: mol. % Fs from:															
2V		26		27	27	27	28	27			28	30	29		30
Name of rock and remarks	Fine grained feldspathic pyroxenite		Hyperite, possibly the needle norite		Hyperite Base of so-called "porphyritic norite"	Hypersthene gabbro Large orthopyroxene crystals	Hypersthene gabbro Large orthopyroxene crystals	Hyperite Large orthopyroxene crystals	Hyperite Large orthopyroxene crystals	Hypersthene gabbro Large orthopyroxene crystals	Hypersthene gabbro Large orthopyroxene crystals	Hypersthene gabbro Top of "porphyritic norite"	Norite Banding	Hyperite	Hypersthene gabbro

APPENDIX I (Continued). MAIN ZONE, Subzone A

Sample Number	PB2276	PB2273	PB2127	PB2015	PB1702	PB1677	PB1651	PB1611	PB1572	PB1281	PB1101	PB942	PB837	PB801	PB717
Height in metre above M.R.	640	642	692	727	821	830	835	848	860	948	1005	1045	1080	1095	1115
Modal analysis															
Plagioclase	72.7*		62.4*	62.3*	69.8*	23.1*	63.8*	64.2*	74.8*	60.3*	68.7*	83.7*	34.8*	69.6*	62.9*
Orthopyroxene	22.7*		26.9*	24.2*	18.5*	31.1*	17.0*	9.4*	14.3*	21.7*	7.3	8.3*	35.1	21.3	30.1
Clinopyroxene	3.9		7.7	10.6	10.5*	42.8*	15.1*	24.9*	8.5*	16.7*	23.5*	6.4*	26.6*	7.9*	6.5*
Biotite	0.2		0.5	0.8	0.4	0.9	1.1	0.1	0.5	0.6	tr.	0.4	0.4	0.4	0.2
K-feldspar	—		—	0.2	—	tr.	0.3	—	0.5	0.1	—	—	—	—	—
Quartz	0.4		2.4	1.5	0.6	2.0	2.6	1.2	1.4	0.6	0.5	1.2	3.1	0.8	0.3
Apatite	tr.		tr.	—	0.1	tr.	—	—	—	—	—	—	—	—	—
Opaque	0.1		0.1	0.1	0.1	tr.	0.1	0.2	—	—	—	—	tr.	tr.	—
I.C. No.	65		43	40	58	72	45	65	52	57	60	54	51	60	52
Plagioclase: mol. % An from:															
$2\theta_{131}-2\theta_{131}$ (CuK α)	68	68		68*	67	67	67	67*	66	65		64*	64*		62
$2\theta_{241}-2\theta_{241}$ (CuK α)	—	—		68	68*	68	68	68	67	67		65	65		66
2V	73	71		69	70	67	66	66	68	66*		64	64		65
Extinction angles	70*										65*				64*
Orthopyroxene: mol. % Fs from:															
2V	29	29		32	33	32	32	33	33	30		34	30		33
Name of rock and remarks	Norite		Spotted norite Large orthopyroxene crystals	Hyperite	Hyperite	Feldspathic pyroxenite	Hyperite	Hypersthene gabbro	Hyperite Cumulus bronzite	Hyperite Cumulus bronzite	Hypersthene gabbro "Ophitic" orthopyroxene	Anorthositic hyperite Large ophitic orthopyroxene crystals	Feldspathic pyroxenite Large ophitic orthopyroxene crystals	Norite Large ophitic orthopyroxene crystals	Norite Large ophitic orthopyroxene



APPENDIX I (Continued). MAIN ZONE, Subzone B

Sample Number	G575	G576	G577	G578	G579	G580	G581	G582	G583	G501	G584	G585	G586	G587	G587X
Height in metre above M.R.	1465	1490	1515	1560	1580	1640	1680	1720	1740	1790	1880	1950	1960	1980	2010
Modal analysis (vol. %)															
Plagioclase	67.0*	77.8*	77.8*	75.0*	61.6*	61.4*	65.4*	77.1*	70.3*	61.0*	61.6*	61.4*	59.7*	47.6*	65.2*
Orthopyroxene	13.6	9.9	9.9	8.1	13.1	19.5	13.7	8.7	13.0*	15.6	14.0*	12.5*	18.8*	13.6*	13.4*
Clinopyroxene	18.9*	11.9*	11.9*	16.2*	24.3*	18.9*	20.1*	13.6*	16.2*	22.0*	21.9*	24.8*	19.7*	35.4*	20.4*
Biotite	tr.	—	—	—	0.1	—	—	tr.	0.2	0.2	0.6	0.4	0.6	0.2	0.2
K-feldspar	—	—	—	—	—	—	—	—	—	—	0.4	tr.	—	—	—
Quartz	0.4	0.4	0.4	0.7	0.9	0.2	0.8	0.6	0.3	1.2	1.5	0.8	1.2	0.5	0.8
Apatite	—	—	—	—	—	—	—	—	—	tr.	—	—	—	—	—
Opaque	tr.	—	—	—	—	tr.	—	—	—	tr.	—	0.1	—	—	—
I.C. No.	59	45	45	48	45	46	44	43	52	45	46	55	57	65	56
Plagioclase: mol. % An from:															
$20_{131}-20_{131}$ (CuK α)		63	62	62*	62	62				62*	60		61*	62*	
$20_{241}-20_{241}$ (CuK α)		65	64	—	65	64				64	63		64	64	
2V	63	67	64	63	63*	63*			63	62	61		60	62	
Extinction angles			63*	62		64			61		61*				
Orthopyroxene: mol. % Fs from															
2V	33	34	36	34	36	35			38	38	38		37	37	
Name of rock and remarks	Hypersthene gabbro. Inverted pigeonite and primary ophitic orthopyroxene Conspicuous bent plagioclase crystals	Hypersthene gabbro. Inverted pigeonite and primary ophitic orthopyroxene	Hypersthene gabbro. Inverted pigeonite and primary ophitic orthopyroxene	Hypersthene gabbro. Inverted pigeonite and primary ophitic orthopyroxene	Hypersthene gabbro. Inverted pigeonite and primary ophitic orthopyroxene	Hyperite. Inverted pigeonite and primary ophitic orthopyroxene	Hypersthene gabbro. Inverted pigeonite and primary ophitic orthopyroxene	Hypersthene gabbro. Inverted pigeonite and primary ophitic orthopyroxene	Hypersthene gabbro. Inverted pigeonite and granular ophitic orthopyroxene	Hypersthene gabbro. Inverted pigeonite and primary ophitic orthopyroxene	Hypersthene gabbro. Inverted pigeonite and granular ophitic orthopyroxene.	Hypersthene gabbro. Inverted pigeonite and granular ophitic orthopyroxene	Hypersthene gabbro. Inverted pigeonite and granular ophitic orthopyroxene	Hypersthene gabbro. Inverted pigeonite and granular ophitic orthopyroxene	Hypersthene gabbro. Inverted pigeonite and granular ophitic orthopyroxene.



APPENDIX I (Continued). MAIN ZONE, Subzone B

Sample Number	G587A	G587B	G587C	G587D	G588	G589	G590	G591	G592	G593	G594	G595	G435	G488	G489
Height in metre above M.R.	2065	2100	2150	2215	2260	2290	2310	2335	2385	2430	2470	2510	2580	2675	2795
Modal analysis (vol. %)															
Plagioclase	59.0*	68.0*	61.5*	68.6*	59.1*	65.4*	68.6*	67.5*	68.2*	56.9*	67.3*	63.7*	77.9*	70.4*	59.6*
Orthopyroxene	17.9*	11.4*	15.7*	13.1*	14.3*	21.7*	22.8*	7.6*	20.5*	21.1*	7.4*	33.4*	8.6*	21.2*	16.8*
Clinopyroxene	23.1*	20.1*	21.7*	18.1*	26.4*	12.8*	7.7*	24.3*	11.3*	22.0*	25.3*	2.9	13.2*	7.3*	23.4*
Biotite	—	tr.	tr.	—	—	tr.	0.2	0.1	—	—	—	—	—	0.3	—
K-feldspar	—	—	tr.	—	—	—	—	—	—	—	—	—	—	—	—
Quartz	—	0.3	1.0	0.2	0.2	tr.	0.6	0.5	—	—	tr.	—	0.3	0.8	0.1
Apatite	—	—	—	—	—	—	—	tr.	—	—	—	—	—	—	—
Opaque	—	0.2	tr.	—	—	tr.	0.1	—	—	—	—	—	—	—	0.1
I.C. No.	74	55	46	57	48	54	49	52	59	48	56	43	46	58	45
Plagioclase: mol. % An from:															
20 ₁₃₁ -20 ₁₃₁ (CuK α)	64*	62*	62*	62*	63*	62*	62*	60*	60*	60*	59	58*	57	57*	57*
20 ₂₄₁ -20 ₂₄₁ (CuK α)	65	64	64	64	64	63	63	62	62	62	61	61	61	61	61
2V	64	61	61	61	61	60	60	60	60	60	60*	58	58	58	58
Extinction angles	63												58*	57	57
Orthopyroxene: mol. % Fs from															
2V	35	38	38	37	38	38	38	37	36	36	37	39	39	42	40
Name of rock and remarks	Hypersthene gabbro. Inverted pigeonite and granular ophitic orthopyroxene Conspicuous myrmekite	Hypersthene gabbro. Inverted pigeonite and granular ophitic orthopyroxene	Hypersthene gabbro. Inverted pigeonite and granular ophitic orthopyroxene Conspicuous bent plagioclase	Hypersthene gabbro. Inverted pigeonite and granular ophitic orthopyroxene	Hypersthene gabbro. Inverted pigeonite and granular ophitic orthopyroxene Conspicuous myrmekite	Hyperite. Inverted pigeonite and granular ophitic orthopyroxene Conspicuous myrmekite and bent plagioclase	Hyperite. Inverted pigeonite and granular ophitic orthopyroxene Conspicuous bent plagioclase	Gabbro. Inverted pigeonite and granular ophitic orthopyroxene	Hyperite. Inverted pigeonite only Conspicuous myrmekite	Hypersthene gabbro. Inverted pigeonite only Conspicuous myrmekite	Gabbro. Inverted pigeonite only Conspicuous myrmekite	Norite. Inverted pigeonite only Conspicuous myrmekite and bent plagioclase	Hypersthene gabbro Conspicuous myrmekite	Hyperite Conspicuous bent plagioclase	Hypersthene gabbro Conspicuous bent plagioclase

APPENDIX I (Continued). MAIN ZONE, Subzone B

Subzone C

Sample Number	G490	G512	G513	G514	G515	G517	G518	G426	G520	G522	G523	G524	G525	G526	G527
Height in metre above M.R.	3020	3170	3175	3185	3200	3220	3245	3250	3260	3270	3280	3295	3335	3350	3365
Modal analysis (vol. %)															
Plagioclase	59.3*	60.9*	60.8*	61.5*	61.4*	68.3*	60.5*	15.0*	65.5*	62.3*	69.7*	64.6*	62.1*	59.1*	58.8*
Orthopyroxene	21.0*	30.4*	33.4*	31.4*	24.9*	28.4*	25.7*	58.7*	28.6*	15.2*	5.8*	4.3*	10.8*	20.0*	18.9*
Clinopyroxene	19.6*	8.7*	5.9*	7.1*	13.7*	3.3	13.8*	26.3*	5.9*	22.4*	24.5*	30.9*	26.9*	20.9*	22.3*
Biotite	tr.	—	—	—	—	—	—	—	—	tr.	—	—	—	—	—
K-feldspar	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Quartz	tr.	tr.	—	—	tr.	—	—	—	—	0.1	tr.	0.2	0.2	—	—
Opaque	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
I.C. No.	59	95	85	95	93	70	83	50	48	61	68	70	65	64	95
Plagioclase: mol. % An from:															
20 ₁₃₁ –20 ₁₃₁ (CuK α)		65*	64	64	62	61	64*	65	69*	68	68*	72	70*		72*
20 ₂₄₁ –20 ₂₄₁ (CuK α)		68	67	65	65	64	66	—	68	68	68	71			71
2V	55	64		64		63*	65	65	71	69		69	70		72
Extinction angles	56*	65			64*	64	64					71*			
Orthopyroxene: mol. % Fs from:															
2V	44	33		32		33	32	27	28	31		31	31		27
Name of rock and remarks															
	Hyperite Conspicuous myrmekite and bent plagioclase	Fine-grained norite Conspicuous myrmekite	Fine-grained norite Conspicuous myrmekite	Fine-grained norite Conspicuous myrmekite	Fine-grained hyperite Conspicuous myrmekite	Fine-grained norite Conspicuous myrmekite	Fine-grained hyperite. Inverted pigeonite Conspicuous myrmekite	Feldspathic pyroxenite. Primary orthopyroxene Conspicuous bent plagioclase and orthopyroxene No myrmekite	Norite Conspicuous bent plagioclase and orthopyroxene	Hypersthene gabbro Conspicuous bent plagioclase	Gabbro Conspicuous bent plagioclase	Gabbro Conspicuous bent plagioclase	Hypersthene gabbro Conspicuous bent plagioclase	Hypersthene gabbro. Conspicuous bent plagioclase Large orthopyroxene crystals	Hypersthene gabbro. Needles of clinopyroxene Large orthopyroxene crystals

APPENDIX I (Continued). MAIN ZONE, Subzone C

Sample Number	G528	G529	G530	G531	G532	G533	G535	G537	G538	G539	G540	G541	G542	G543	G597
Height in metre above M.R.	3380	3395	3410	3435	3445	3450	3475	3505	3535	3565	3585	3600	3620	3650	3715
Modal analysis (vol. %)															
Plagioclase	54.7*	44.2*	55.2*	61.8*	46.5*	79.4*	58.1*	49.1*	53.4*	58.9*	60.0*	81.7*	55.9*	62.7*	68.9*
Orthopyroxene	32.0*	32.6*	30.9*	33.1*	25.2*	6.2*	16.1*	14.8*	23.4*	17.4*	14.3*	12.7*	14.9*	12.1*	9.3
Clinopyroxene	13.2*	23.0*	13.7*	4.9*	28.3*	14.3*	25.8*	36.0*	23.1*	23.5*	24.4*	5.6	28.1*	25.2*	21.4*
Biotite	—	—	—	—	—	tr.	—	—	—	—	0.6	—	0.4	—	0.1
Quartz	0.1	0.2	0.2	0.2	—	tr.	—	0.1	0.1	0.2	0.7	—	0.5	—	0.2
Apatite	—	—	—	—	—	—	—	—	—	—	—	—	0.1	—	—
Opaque	—	—	—	—	—	—	—	—	—	—	tr.	—	0.1	—	0.1
I.C. No.	72	105	94	58	83	63	80	88	62	63	55	63	50	75	46
Plagioclase: mol. %An from:															
2 θ_{131} -2 $\theta_{\bar{1}31}$ (CuK α)		70*	72	70	72	72*	73*	72	70		72	69		72	64
2 $\theta_{\bar{2}41}$ -2 θ_{241} (CuK α)		—	—	70	—	—	—	—	—		70*	—		—	65
2V		71		72		73	73	74		70		71		71	67
Extinction angles				71*					71		69	71*		71*	65*
Orthopyroxene: mol. % Fs from:															
2V		27		28		29	26	28		29		28			36
Name of rock and remarks															
	Hyperite Large orthopyroxene crystals	Hyperite Large orthopyroxene crystals. Fine-grained plagioclase and clinopyroxene	Hyperite Fine-grained plagioclase and clinopyroxene	Norite Conspicuous bent plagioclase	Hypersthene gabbro	Hypersthene gabbro	Hypersthene gabbro	Hypersthene gabbro	Hyperite	Hypersthene gabbro	Hypersthene gabbro Conspicuous bent plagioclase	Hyperite	Hypersthene gabbro	Hypersthene gabbro Primary orthopyroxene	Hypersthene gabbro. Inverted pigeonite and primary ophitic orthopyroxene Conspicuous bent plagioclase

Sample Number	G598	G412	G599	G600	G601	G602	G413	G603	G411	G605	G410	G607	G608	G609	G611
Height in metre above M.R.	3735	3760	3775	3785	3800	3820	3840	3855	3895	3905	3920	3935	3950	3965	3980
Modal analysis (vol. %)															
Plagioclase	60.8*	66.6*	58.2*	64.6*	56.5*	53.0*	56.0*	56.6*	56.3*	62.9*	72.1*	73.0*	88.9*	77.5*	38.7*
Orthopyroxene	14.8	13.6	4.3	6.3	20.9	21.4	15.8	19.3	16.9	18.9*	26.5*	19.6*	—	18.7*	28.0*
Clinopyroxene	24.4*	19.7*	37.5*	29.0*	22.4*	25.4*	28.2*	24.1*	26.5*	18.2*	1.4	7.2	10.9	3.3	31.0*
Biotite	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Quartz	—	0.1	—	0.1	0.1	0.1	—	—	0.2	—	—	—	—	—	—
Apatite	—	—	—	—	—	—	—	—	tr.	—	—	—	—	—	—
Opaque	—	—	—	—	0.1	0.1	—	—	tr.	—	—	0.2	0.2	0.5	2.3*
I.C. No.	64	60	53	63	56	52	57	54	52	53	62	46	48	40	67
Plagioclase: mol. % An from:															
20131-20131 (CuK α)	64*			61		60		60*	60*	60	60*		59	56*	
20241-20241 (CuK α)	65			63		62		62	62	62	61		61	58	
2V	64			64		63		60	61	60			60*	57	
Extinction angles				62*		62*								55	
Orthopyroxene: mol. % Fs from:															
2V	33			36		37		37	37	38	37			41	
Name of rock and remarks	Hypersthene gabbro. Inverted pigeonite and primary ophitic orthopyroxene Conspicuous bent plagioclase	Hypersthene gabbro. Inverted pigeonite and primary ophitic orthopyroxene Conspicuous bent plagioclase	Gabbro. Inverted pigeonite and primary ophitic orthopyroxene Conspicuous bent plagioclase	Gabbro. Inverted pigeonite and primary ophitic orthopyroxene Conspicuous bent plagioclase	Hypersthene gabbro Primary ophitic orthopyroxene Conspicuous bent plagioclase	Hypersthene gabbro Primary ophitic orthopyroxene Conspicuous bent plagioclase	Hypersthene gabbro. Inverted pigeonite and primary ophitic orthopyroxene	Hypersthene gabbro. Inverted pigeonite and primary ophitic orthopyroxene Conspicuous bent plagioclase	Hypersthene gabbro. Inverted pigeonite and primary ophitic orthopyroxene. Conspicuous bent plagioclase	Hyperrite. Inverted pigeonite only Conspicuous myrmekite	Norite. Inverted pigeonite only	Hyperrite Conspicuous myrmekite and bent plagioclase	Mottled anorthosite Conspicuous myrmekite	Norite Conspicuous myrmekite and bent plagioclase	Hypersthene gabbro



APPENDIX I (Continued). UPPER ZONE, Subzone A

Subzone B

Sample Number	G561	G415	G407	G612	G406	G400	G509	G510	G396	G649	G651	G568	G566	G569	G422
Height in metre above M.R.	3990	4005	4030	4050	4070	4083	4087	4110	4175	4200	4205	4275	4286	4290	4375
Modal analysis (vol. %)															
Plagioclase	60.5*	57.5*	65.9*	59.6*	55.4*	88.9*	82.8*	91.4	75.6*	27.5*	34.7*	79.5*	76.7*	59.8*	55.1*
Orthopyroxene	25.6*	14.4*	24.9*	31.7*	30.9*	—	3.9	1.3	4.7*	21.1*	19.2*	5.5*	3.1	6.7*	15.7*
Clinopyroxene	12.8*	17.0*	7.7*	6.3*	13.6*	2.2	0.4	0.9	8.8*	51.1*	41.1*	4.4	10.3*	23.2*	20.4*
Biotite	—	0.6	0.2	—	—	1.3	0.9	1.2	1.1	—	1.2	3.7	0.3	0.8	0.8
K-feldspar	—	—	—	—	—	—	—	—	—	—	—	0.7	—	—	—
Quartz	—	—	—	—	—	0.2	—	0.4	—	—	—	1.5	—	—	0.1
Apatite	—	—	—	—	—	—	—	—	—	—	—	—	—	0.1	—
Opaque	1.1	10.5*	1.3	2.4	0.1	7.4*	12.0*	4.8	9.8*	0.3	3.8	4.7*	9.6*	9.4	7.9*
I.C. No.	41	280	45	43	48	45	40	41	44	55	42	36	55	45	43
Plagioclase: mol. % An from:															
2θ ₁₃₁ –2θ ₁₃₁ (CuKα)			58	58	57	57	57	57				57	58	57*	57*
2θ ₂₄₁ –2θ ₂₄₁ (CuKα)			60	60	59	59	59	58				59	59	59	59
Eulerian angles I					58			57*	56*	59		57		56	56
Extinction angles	56		59*		58*			57	56	59		58*		56	56
2V			60	60	60	59	58	58				58	59	59	57
Orthopyroxene: mol. % Fs from:															
2V			43	42	43		44						44	42	45
nz													42	42	
Name of rock and remarks															
		Hyperite Conspicuous myrmekite and bent plagioclase													
			Very fine-grained hypersthene gabbro												
				Norite Conspicuous bent plagioclase											
					Hyperite Conspicuous bent plagioclase										
						Magnetite anorthosite Conspicuous bent plagioclase									
							Magnetite anorthosite First symplektite								
								Magnetite anorthosite Conspicuous bent plagioclase							
									Magnetite hypersthene gabbro Symplektite present						
										Feldspathic pyroxenite Inverted pigeonite					
											Hypersthene gabbro				
												Magnetite hyperite Conspicuous bent plagioclase			
													Magnetite gabbro Symplektite present		
														Magnetite gabbro Conspicuous bent plagioclase Symplektite present	
															Magnetite hypersthene gabbro

APPENDIX I (Continued). UPPER ZONE, Subzone C

Sample Number	G658	G365	G351	G613	G614	G314	G617	G618	G619	G312	G620	G621	G622	G310	G623
Height in metre above M.R.	4530	4625	4637	4660	4685	4760	4804	4812	4824	4825	4828	4849	4855	4865	4875
Modal analysis (vol.%)															
Plagioclase	60.2*	49.4*	48.0*	63.0*	64.1*	52.7*	87.2*	89.7*	56.9*	57.1*	89.1*	53.7*	56.9*	70.5*	52.6*
Olivine	12.2*	6.4*	4.7*	22.0*	25.9*	3.0*	—	—	—	0.2	—	2.2*	—	12.7*	—
Orthopyroxene	2.8	6.0*	5.3*	—	0.3	32.5*	—	—	33.7*	7.5*	0.2	10.8*	13.9*	4.7	7.9*
Clinopyroxene	15.9*	31.8*	33.2*	0.9	0.9	2.7	—	3.7	3.4	23.3*	0.6	18.0*	20.3*	1.9	30.9*
Biotite	0.9	—	—	0.4	1.4	0.2	3.0	1.5	0.6	0.2	3.6	7.4	0.4	2.8	0.9
K-feldspar	—	—	—	—	—	—	0.2	0.1	—	—	0.3	—	—	—	—
Quartz	—	—	—	—	—	—	3.6	0.1	—	—	1.3	—	—	—	—
Apatite	—	—	—	—	—	—	tr.	0.2	tr.	—	0.2	—	—	—	—
Opaque	8.0*	6.4*	8.8*	13.7*	7.4*	8.9*	6.0*	4.7*	5.4*	11.7*	4.7*	7.9*	8.5*	7.4*	7.7*
I.C. No.	45	69	75	36	53	103	52	43	68	52	38	55	70	47	71
Plagioclase: mol. % An from:															
Eulerian angles l	55	53			54	56	56		56			55			55
Extinction angles	55	54	53		55*	56	56		55			55			55
2V				54	57										
Orthopyroxene: mol. % Fs from:															
2V		44	44			42			46						
nz						41			46				46		
Olivine: mol. % Fa from:															
2V		53		45	50									53	
d ₁₇₄		49		51	52									54	
Name of rock and remarks	Magnetite olivine gabbro Conspicuous symplektite	Magnetite olivine hyperite	Magnetite olivine hypersthene gabbro Clusters of large plagioclase crystals	Magnetite troctolite, Sisal Marker	Magnetite troctolite, Sisal Marker Symplektite present	Magnetite olivine norite Fine-grained	Magnetite anorthosite Conspicuous bent plagioclase	Magnetite anorthosite	Magnetite norite	Magnetite gabbro Symplektite present	Magnetite anorthosite Conspicuous bent plagioclase	Magnetite olivine hypersthene gabbro Conspicuous symplektite	Magnetite hypersthene gabbro Symplektite present	Magnetite Troctolite Conspicuous symplektite	Magnetite gabbro Symplektite present

APPENDIX I (Continued). UPPER ZONE, Subzone C

Subzone D

Sample Number	G309	G624	G307	G625	G626	G630	G642	G641	G271	G640	G639	G636	G635	G279	G634	
Height in metre above M.R.	4924	4949	4975	5015	5104	5125	5180	5270	5350	5370	5415	5455	5490	5510	5540	
Modal analysis (vol. %)																
Plagioclase	49.3*	53.3*	47.2*	41.6*	65.0*	54.5*	55.8*	55.0*	53.3*	45.8*	63.0*	84.1*	63.9*	52.4*	47.0*	
Olivine	—	—	tr.	—	—	—	—	21.2*	16.4*	28.6*	14.7*	—	—	13.4*	18.8*	
Orthopyroxene	1.8*	11.9*	6.2*	34.3*	19.0*	5.8*	11.2*	—	—	—	—	—	—	—	tr.	
Clinopyroxene	41.1*	27.2*	32.2*	22.2*	5.8*	31.9*	24.7*	13.2*	16.7*	15.0*	11.2*	0.7	28.9*	25.2*	19.0*	
Biotite	1.9	0.8	1.1	0.4	0.2	0.4	1.4	tr.	—	tr.	—	0.1	0.7	0.1	0.9	
K-feldspar	—	—	—	—	—	0.4	—	—	—	—	—	—	—	—	—	
Quartz	0.2	—	—	—	0.1	—	—	—	—	—	—	—	—	—	—	
Apatite	—	—	—	—	—	—	—	3.9*	4.4*	4.3*	4.3*	—	tr.	—	6.2*	
Opaque	5.7*	6.7*	13.3*	1.5	9.9*	7.0*	6.9*	6.7*	9.2*	6.3*	6.8*	15.1*	6.5*	8.9*	8.1*	
I.C. No.	58	61	80	85	45	53	50	45	52	58	74	40	42	73	70	
Plagioclase: mol. % An from:																
Eulerian angles I	53		53	54	55	50	51	46		45	46	45	46	45	44	
Extinction angles	54		54	56	54	50		47		45	46	46	46	44	45	
Orthopyroxene mol. % Fs from:																
2V	38															
nz	39	46		45	49		50									
Olivine: mol. % Fa from																
2V								69		71	70			69	69	
d ₁₇₄								69		70	70			70	69	
Name of rock and remarks	Magnetite gabbro	Magnetite hypersthene gabbro Symplektite present	Magnetite gabbro	Magnetite hyperite	Magnetite hyperite Conspicuous bent plagioclase Symplektite present	Magnetite gabbro Bent plagioclase Symplektite present	Magnetite hypersthene gabbro	Magnetite olivine diorite Conspicuous symplektite First cumulus apatite	Magnetite olivine diorite Conspicuous symplektite	Magnetite olivine diorite Conspicuous symplektite	Magnetite olivine diorite Conspicuous symplektite	Magnetite anorthosite Conspicuous symplektite	Magnetite gabbro Conspicuous symplektite	Magnetite olivine diorite Conspicuous symplektite Ovicular diorite	Magnetite olivine diorite Symplektite present Ovicular diorite	Magnetite olivine diorite Symplektite present

APPENDIX I (Continued). UPPER ZONE, Subzone D

Sample Number	G633	G632	G631	G263	G257	G242	G276	G277	G228	G247	G505	G231	G252	G253	G368
Height in metre above M.R.	5560	5605	5670	5715	5735	5795	5804	5810	5835	5850	5870	5890	5950	5960	5990
Modal analysis (vol. %)															
Plagioclase	47.9*	50.7*	53.8*	74.9*	53.0*	69.4*	77.9*	85.2*	84.8*	57.0*	65.0*	79.0*	52.5*	41.2*	49.0*
Olivine	22.1*	20.6*	16.3*	—	16.2*	12.2*	17.2*	1.5	1.3	—	5.7*	—	—	24.9*	16.0*
Orthopyroxene	—	—	—	—	—	—	—	—	—	1.3	2.9	—	6.0	8.8	4.1
Clinopyroxene	12.2*	13.9*	14.6*	13.3*	20.2*	14.0*	0.9	1.2	1.0	34.5*	18.6*	—	29.6*	0.6	13.2
Hornblende	—	—	—	—	—	—	—	—	—	—	—	1.9	0.8	tr.	—
Biotite	0.7	—	—	—	0.4	—	0.6	1.0	1.1	tr.	—	7.2	3.1	5.9	5.5
K-feldspar	—	—	—	—	—	—	—	—	—	—	—	0.3	0.3	—	—
Quartz	—	—	—	—	—	—	—	0.1	0.4	0.1	0.1	5.0	1.0	—	0.2
Apatite	6.7*	5.6*	5.5*	—	3.3*	—	tr.	0.1	—	—	tr.	0.4	0.2	8.5*	3.6*
Opaque	10.4*	9.2*	9.8*	11.8*	6.9*	4.4*	3.4*	10.9*	11.4*	7.1*	7.7*	6.2*	6.5*	10.1*	8.4*
I.C. No.	74	73	71	53	60	97	60	65	75	71	61	37	54	56	72
Plagioclase: mol. % An from:															
Eulerian angles l	44	46	45	43		43	42		44	46		50	50	51	49
Extinction angles	46	45	45	43		43	43		44	46		48	50	52	49
Orthopyroxene: mol. % Fs from:															
2V														56	62
nz													53		
Olivine: mol. % Fa from:															
2V	68	71	71			78	74							78	89
d ₁₇₄		69	69			73	73							70	79
Name of rocks and remarks															
	Magnetite olivine diorite Symplektite present	Magnetite olivine diorite Symplektite present	Magnetite olivine diorite Symplektite present	Magnetite diorite	Magnetite olivine diorite	Magnetite olivine diorite	Magnetite troctolite Conspicuous symplektite	Magnetite anorthosite Intercumulus olivine	Magnetite anorthosite	Magnetite diorite	Magnetite olivine diorite	Magnetite anorthosite	Magnetite diorite	Magnetite olivine diorite	Magnetite olivine diorite

APPENDIX I (Continued). UPPER ZONE, Subzone D

Sample Number	G285	G208	G216	G215	G201	G200
Height in metre above M.R.	6075	6140	6165	6180	6207	6209
Modal analysis (vol. %)						
Plagioclase	56.0*	51.8*	59.4*	49.7	58.1	45.5
Olivine	9.0*	0.4*	2.6*	—	—	—
Orthopyroxene	—	—	—	—	—	—
Clinopyroxene	11.5	9.6	4.8	21.7	7.6	7.7
Hornblende	12.0	24.4	17.1	16.9	12.6	19.9
Biotite	2.3	1.0	2.5	—	—	—
K-feldspar	0.9	0.6	1.8	1.5	6.1	12.5
Quartz	2.1	2.1	3.4	4.9	10.6	12.2
Apatite	2.7*	2.7*	2.2*	1.4	0.3	0.5
Opaque	3.5*	7.4*	6.2*	3.9	4.6	1.7
I.C. No.	76	65	56	65	86	70
Plagioclase: mol. % An from:						
Eulerian angles I	42	45		45		
Extinction angles	43	47		45		
Olivine: mol. % Fa from:						
2V	89					
Name of rock and remarks	Magnetite olivine diorite	Magnetite olivine diorite	Magnetite olivine diorite Partially altered	Diorite Partially altered	Diorite Rock is altered	Diorite Rock is altered

APPENDIX II

Tables of chemical analyses, CIPW norms recalculated to hundred (A), Differentiation Index (DI), Crystallization Index (CI), recalculated norms (B) for the Modified Crystallization Index (MCI) and Modified Differentiation Index (MDI), as well as the names and localities of the samples, and the sources of the chemical analyses.

APPENDIX II. UPPER ZONE

	M55		M282		M281		M280		M279		M278		M51		M276		M274		M272		M63		M269		M268		
SiO ₂	52,42		46,16		39,07		37,41		46,29		44,22		45,97		58,62		41,79		45,99		55,40		44,02		45,61		
TiO ₂	1,38		2,25		3,29		2,83		2,05		2,36		3,04		0,29		2,49		2,64		0,14		2,80		2,43		
Al ₂ O ₃	13,13		15,34		12,30		11,94		18,30		17,15		16,63		24,14		16,43		13,87		24,37		16,34		14,29		
Fe ₂ O ₃	7,11		2,65		2,70		2,43		3,42		3,13		5,23		0,58		2,61		4,20		0,24		5,80		6,16		
FeO	12,16		17,33		24,51		26,10		13,41		16,27		11,09		1,85		17,59		14,80		1,77		12,01		12,21		
MnO	0,38		0,30		0,36		0,36		0,19		0,21		0,18		0,03		0,24		0,24		0,03		0,18		0,21		
MgO	0,27		2,59		4,13		5,40		3,54		5,35		3,48		0,27		3,94		5,84		0,66		5,35		6,55		
CaO	7,41		7,41		7,52		7,08		7,02		7,73		9,48		7,73		8,48		9,24		10,07		9,48		9,00		
Na ₂ O	3,14		2,84		2,35		2,32		3,30		3,10		3,24		4,71		3,04		2,13		4,48		2,28		2,13		
K ₂ O	0,93		0,93		0,59		0,62		0,66		0,33		0,40		0,79		0,33		0,23		0,89		0,17		0,07		
P ₂ O ₅	0,26		0,98		1,85		2,15		0,30		1,64		0,03		0,20		1,71		0,03		0,01		0,00		0,02		
H ₂ O	1,70		1,19		0,89		1,12		1,12		0,85		0,76		1,06		0,96		0,94		1,94		1,47		1,21		
CO ₂	0,10		0,10		0,12		0,11		0,05		0,04		0,06		0,02		0,06		0,04		0,14		0,23		0,16		
	100,39		100,07		99,77		99,87		99,65		100,38		99,59		100,29		99,67		100,19		100,14		100,13		100,05		
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	
Qz	11,89	13,78	—	—	—	—	—	—	—	—	—	—	—	—	10,71	10,91	—	—	—	—	3,51	3,53	—	—	1,05	1,22	
Or	5,57	6,46	5,55	6,20	3,50	4,11	3,69	4,29	3,96	4,39	1,95	2,24	2,39	2,78	4,71	4,80	1,97	2,26	1,37	1,54	5,39	5,34	1,02	1,19	0,41	0,48	
Ab	26,93	31,22	24,27	27,13	20,05	23,55	16,54	19,26	28,34	31,39	26,28	30,18	27,74	32,10	40,13	40,90	25,98	29,75	18,15	20,45	38,63	38,89	99,59	22,76	18,25	21,17	
An	19,25	22,31	26,65	29,79	21,43	25,19	20,54	23,92	33,55	37,16	28,76	33,03	30,03	34,75	37,44	38,16	30,53	34,97	27,83	31,36	44,63	44,92	34,39	39,96	29,63	34,36	
C or Ne							Na	7,8	2,07				c	1,18	1,36												
Di {	Wo	6,87	7,96	1,95	2,18	2,17	2,55	0,90	1,05	—	—	—	—	7,27	8,41	—	—	0,76	0,87	7,59	8,55	2,61	2,63	5,59	6,49	6,47	7,50
En	0,33	0,38	0,41	0,46	0,49	0,58	0,23	0,27	—	—	—	—	3,13	3,62	—	—	0,21	0,24	3,23	3,64	0,97	0,98	2,77	3,22	3,41	3,95	
Fs	7,37	8,54	1,68	1,88	1,82	2,14	0,72	0,84	—	—	—	—	4,12	4,77	—	—	0,58	0,66	4,38	4,94	1,69	1,70	2,70	3,14	2,87	3,33	
Hy {	En	0,34	0,40	4,31	4,82	0,51	0,60	—	4,41	4,88	1,62	1,86	3,48	4,03	0,68	0,69	0,29	0,33	10,11	11,39	0,71	0,71	8,38	9,74	13,11	15,21	
Fs	7,72	8,95	17,66	19,74	1,92	2,26	—	—	9,37	10,38	2,90	3,33	4,56	5,28	2,51	2,56	0,80	0,92	13,76	15,51	1,24	1,25	8,16	9,48	11,02	12,78	
OI {	Fo		1,26	1,41	6,56	7,70	9,35	10,89	3,19	3,53	8,22	9,44	1,51	1,75	—	—	6,59	7,55	0,93	1,05	—	—	1,67	1,94	—	—	
Fa			5,72	6,39	26,67	31,32	32,13	37,41	7,47	8,27	16,16	18,56	2,19	2,53	—	—	19,60	22,45	1,39	1,57	—	—	1,79	2,08	—	—	
Mt	10,45		3,88		4,09		3,55		5,04		4,55		7,67		0,85		3,82		6,14		0,36		8,54		9,05		
Ilm	2,66		4,31		6,35		5,43		3,95		4,49		5,84		0,56		4,78		5,05		0,28		5,40		4,68		
Hm																											
Ap	0,62		2,35		4,42		5,14		0,72		3,89		0,07		0,47		4,09		0,07		0,02		—		0,05		
H ₂ O																											
DI	44,39		29,82		23,55		22,01		32,30		28,23		30,13		55,55		27,95		19,52		47,49		20,61		19,71		
CI	19,87		31,43		29,20		30,05		39,38		38,14		40,44		37,87		37,43		42,38		46,30		47,07		45,60		
MDI		76,47		63,00		65,26		64,61		54,43		54,31		51,66		59,17		56,62		48,36		52,26		41,41		41,91	
MCI		16,49		26,36		26,65		28,06		32,99		33,89		34,40		27,23		32,65		36,51		33,43		41,64		40,71	

APPENDIX II (Continued) UPPER ZONE

	M465		M48		M47		M46		M255		M253		M45		M44		M43		M3		M37		M40		M288		
SiO ₂	51,30		43,81		50,63		39,40		47,19		43,74		45,83		49,14		52,20		48,02		51,79		45,23		41,29		
TiO ₂	0,86		1,94		0,26		2,20		1,41		2,16		1,84		1,09		0,08		0,37		0,44		0,37		3,18		
Al ₂ O ₃	22,55		18,37		22,29		15,08		17,52		19,42		8,44		18,60		18,97		25,70		16,86		20,50		18,01		
Fe ₂ O ₃	0,88		4,00		0,51		2,66		3,64		7,54		4,56		2,25		0,62		1,94		1,19		1,33		8,42		
FeO	5,66		14,98		5,78		23,50		11,84		10,77		16,03		9,01		7,07		3,93		9,46		12,23		12,68		
MnO	0,10		0,18		0,10		0,27		0,19		0,16		0,31		0,15		0,18		0,06		0,20		0,16		0,15		
MgO	1,69		6,42		3,94		9,41		6,55		4,56		10,80		4,83		8,97		0,78		7,95		8,45		6,58		
CaO	7,53		6,40		9,17		4,83		8,21		8,42		9,55		9,87		9,00		11,53		9,00		8,35		6,58		
Na ₂ O	4,18		2,71		3,14		1,88		2,18		2,45		1,03		3,04		2,18		3,60		2,23		2,23		2,58		
K ₂ O	1,62		0,30		0,96		0,10		0,17		0,17		0,30		0,50		0,21		0,53		0,17		0,27		0,14		
P ₂ O ₅	0,18		0,03		0,01		0,02		0,01		0,01		0,01		0,03		0,00		0,01		0,01		0,02		0,01		
H ₂ O	3,12		0,95		2,48		0,92		0,93		0,92		1,29		1,50		0,84		2,76		0,80		1,00		0,87		
CO ₂	0,28		0,07		0,35		0,01		0,10		0,09		0,11		0,16		0,07		0,12		0,09		0,05		0,08		
	99,95		100,16		99,62		100,28		99,94		100,41		100,10		100,17		100,39		100,12		100,19		100,19		99,83		
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	
Qz	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1,04	1,05	—	—	1,76	1,81	—	—	—	—	
Or	9,91	10,27	1,79	1,98	5,86	5,94	0,59	0,64	1,01	1,10	1,01	1,19	1,79	2,00	2,99	3,16	1,25	1,26	3,25	3,37	1,01	1,04	1,61	1,65	0,84	1,03	
Ab	36,60	37,91	23,12	25,58	27,43	27,79	16,00	17,42	18,64	20,27	20,85	24,57	8,82	9,83	26,10	27,61	18,53	18,73	29,66	30,79	18,99	19,50	19,02	19,55	22,06	27,06	
An	37,57	38,93	31,85	35,24	45,35	45,94	24,00	26,12	37,93	41,26	41,74	49,19	17,75	19,78	36,17	38,27	41,57	42,01	54,33	56,39	35,75	36,71	41,65	42,80	32,94	40,41	
C	0,64	0,66	2,04	2,25			3,16	3,44											Ne1,03	1,07			1,42	1,46	1,70	2,09	
Di	Wo	—	—	—	0,66	0,67	—	—	1,32	1,44	0,09	0,11	12,60	14,04	5,57	5,89	1,38	1,40	2,04	2,12	3,82	3,92	—	—	—	—	
	En	—	—	—	0,32	0,32	—	—	0,65	0,71	0,05	0,06	6,57	7,32	2,63	2,78	0,83	0,84	0,59	0,61	2,04	2,09	—	—	—	—	
	Fs	—	—	—	0,33	0,33	—	—	0,66	0,72	0,04	0,05	5,67	6,32	2,87	3,04	0,47	0,47	1,54	1,60	1,65	1,69	—	—	—	—	
Hy	En	2,68	2,78	6,09	6,74	7,90	8,00	3,29	3,58	15,08	16,40	10,20	12,02	16,67	18,58	6,14	6,50	21,62	21,85	—	—	17,88	18,36	4,44	4,56	10,08	12,37
	Fs	5,35	5,54	3,13	8,99	8,02	8,13	5,30	5,77	15,50	16,86	9,24	10,89	14,39	16,04	6,72	7,11	12,26	12,39	—	—	14,49	14,88	4,44	4,56	7,87	9,65
Ol	Fo	1,18	1,22	7,03	7,78	1,34	1,36	14,22	15,48	0,53	0,58	0,82	0,97	2,81	3,13	2,42	2,56	—	—	1,00	1,04	—	—	11,76	12,09	3,24	3,97
	Fa	2,60	2,69	10,34	11,44	1,50	1,52	25,31	27,55	0,61	0,66	0,81	0,95	2,66	2,96	2,91	3,08	—	—	2,90	3,01	—	—	12,97	13,33	2,79	3,42
Mt	1,33		5,85		0,76		3,88		5,34		11,00		6,70		3,31		0,90		2,91		1,74		1,94		12,35		
Ilm	1,69		3,69		0,51		4,21		2,71		4,13		3,55		2,10		0,15		0,73		0,85		0,70		6,11		
Hm																											
Ap	0,45		0,07		0,02		0,04		0,02		0,02		0,02		0,07		—		0,02		0,02		0,05		0,02		
H ₂ O																											
DI	46,51		24,91		33,29		16,59		19,65		21,86		10,61		27,09		20,82		32,91		21,76		20,63		22,90		
CI	39,53		43,43		51,60		41,14		49,95		49,35		45,82		47,82		58,03		55,00		52,25		56,52		43,62		
MDI		56,41		47,99		44,00		51,38		40,24		37,69		42,71		46,68		34,31		40,18		40,41		39,09		41,16	
MCI		30,45		37,20		39,64		36,28		42,06		43,95		41,08		38,14		46,02		41,48		41,75		45,28		40,95	

APPENDIX II (Continued). UPPER ZONE

	M291		M308		1		2		3		4		5		6		7		8		9		10		
SiO ₂	43,56		51,31		46,60		48,00		51,50		49,30		53,2		45,26		46,83		47,14		50,45		53,60		
TiO ₂	2,65		0,67		2,52		2,26		1,41		1,80		1,91		1,70		2,50		2,90		0,10		0,22		
Al ₂ O ₃	16,98		27,14		17,52		13,00		14,64		13,87		12,53		13,42		15,55		21,50		27,40		23,87		
Fe ₂ O ₃	9,44		2,98		4,93		3,03		3,22		2,38		3,29		4,63		5,26		7,96		1,10		1,80		
FeO	9,97		2,28		16,25		16,20		12,85		16,78		14,17		18,35		11,90		5,71		1,55		1,54		
MnO	0,16		0,04		0,21		0,26		0,30		0,43		0,12		0,39		0,30		0,05		0,20		0,05		
MgO	4,89		0,27		5,86		2,88		1,49		1,77		1,08		4,19		3,29		0,30		0,15		3,37		
CaO	8,01		10,12		7,10		7,14		6,40		7,49		6,58		8,50		10,01		8,46		12,90		11,29		
Na ₂ O	2,36		3,84		2,80		3,18		3,23		3,52		2,73		2,97		3,41		4,30		3,85		4,22		
K ₂ O	0,23		0,40		0,33		1,23		1,80		1,17		2,37		0,25		0,40		0,50		0,50		0,25		
P ₂ O ₅	0,00		0,01		0,08		1,06		0,34		0,45		0,16				0,07		0,05		0,03				
H ₂ O	1,39		0,96		0,44		2,05		2,40		1,33		1,68		0,79		0,73		0,85		2,65		0,48		
CO ₂	0,15		0,13																						
	99,79		100,15		99,64		100,29		99,58		100,29		99,82		100,45		100,18		99,74		100,90		100,72		
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	
Qz	2,65	3,27	5,14	5,45	—	—	—	—	4,18	4,68	—	—	7,25	8,11	—	—	—	—	2,83	3,43	—	—	0,81	0,84	
Or	1,38	1,70	2,38	2,52	1,84	2,11	7,36	8,49	10,61	11,87	7,09	7,83	13,77	15,39	1,38	1,55	2,21	2,54	2,79	3,39	2,79	2,92	1,38	1,43	
Ab	20,32	25,10	32,79	34,76	23,57	27,00	26,92	31,05	27,54	30,82	29,69	32,80	23,27	26,02	24,90	27,88	28,80	33,13	36,24	46,96	30,91	32,35	35,55	36,88	
An	35,69	44,09	50,61	53,63	34,57	39,61	17,46	20,14	20,14	22,54	18,60	20,55	15,11	16,89	22,44	25,12	25,91	29,80	38,18	46,32	56,26	58,87	45,07	46,76	
C or Ne			C2,04	2,16																					
Di	Wo	1,98	2,45	—	—	0,02	0,02	4,50	5,19	3,99	4,47	6,61	7,30	7,03	7,86	8,21	9,19	9,82	11,30	1,69	2,05	2,32	2,43	4,27	4,43
	En	1,22	1,51	—	—	0,01	0,01	1,10	1,27	0,69	0,77	0,10	0,11	0,89	0,99	2,32	2,60	3,65	4,20	0,70	0,85	0,35	0,37	3,37	3,50
	Fs	0,64	0,79	—	—	0,01	0,01	3,67	4,23	3,62	4,05	6,18	6,83	6,82	7,62	6,27	7,02	6,36	7,32	—	—	2,18	2,28	0,41	0,43
Hy	En	11,17	13,80	0,68	0,72	—	—	5,60	6,46	3,01	3,37	2,34	2,59	1,77	1,98	1,73	1,94	1,40	1,61	—	—	—	—	4,92	5,10
	Fs	5,90	7,29	0,70	0,74	—	—	18,76	21,64	15,57	17,43	14,17	15,65	13,54	15,14	4,64	5,19	2,43	2,79	—	—	—	—	0,61	0,63
Ol	Fo	—	—	—	—	10,20	11,69	0,28	0,32	—	—	0,75	0,83	—	—	4,39	4,91	2,18	2,51	—	—	—	—	—	—
	Fa	—	—	—	—	17,06	19,55	1,05	1,21	—	—	4,99	5,51	—	—	13,04	14,60	4,17	4,80	—	—	—	—	—	—
Mt	13,93		4,36		7,22		4,39		4,71		3,45		4,86		6,71		7,64		10,00		1,62		2,54		
Ilm	5,12		1,28		4,79		4,33		2,76		3,52		3,67		3,18		4,70		5,48		0,16		0,49		
Hm																			1,12						
Ap	—		0,02		0,27		2,54		0,77		1,17		0,34		—		—		—		—		0,10		
H ₂ O					0,44		2,04		2,41		1,34		1,68		0,79		0,73		0,97		2,66		0,48		
DI	24,35		40,31		25,41		34,28		42,33		37,78		44,29		35,28		31,01		41,86		33,70		37,74		
CI	45,51		51,08		44,79		24,03		23,74		21,25		18,27		33,04		36,94		39,69		57,01		55,79		
MDI		38,85		43,47		48,68		70,34		72,41		74,64		78,99		62,42		57,02		50,78		39,56		40,59	
MCI		42,85		38,10		39,46		20,89		19,32		17,21		14,73		27,81		30,87		33,75		41,82		41,64	

APPENDIX II (Continued). MAIN ZONE

	M306		M305		M303		M299		M296		M294		M226		M224		M221		M219		M216		M213		M94		
SiO ₂	50,71		51,60		52,37		50,99		51,34		53,02		51,96		52,40		52,71		52,31		52,28		52,36		52,53		
TiO ₂	0,15		0,17		0,21		0,21		0,20		0,23		0,67		0,42		0,13		0,13		0,15		0,07		0,08		
Al ₂ O ₃	15,61		18,73		17,38		17,87		18,60		3,63		17,51		18,50		18,77		18,42		16,79		18,99		25,25		
Fe ₂ O ₃	0,95		0,55		0,72		0,60		0,63		0,84		0,39		0,49		0,86		0,62		0,45		1,12		0,38		
FeO	8,79		6,22		6,67		5,30		5,74		13,38		6,58		5,75		5,72		6,43		6,88		6,07		2,55		
MnO	0,21		0,15		0,17		0,14		0,14		0,31		0,17		0,15		0,16		0,17		0,18		0,15		0,06		
MgO	9,70		6,93		8,46		9,36		9,04		21,72		7,57		7,17		6,85		7,71		8,62		7,17		1,55		
CaO	10,07		11,39		10,90		12,37		11,39		5,36		11,39		12,05		11,31		10,72		11,62		9,76		10,35		
Na ₂ O	2,08		2,53		2,38		1,98		2,04		0,60		2,46		2,57		2,88		2,71		2,49		3,03		4,01		
K ₂ O	1,26		0,24		0,22		0,31		0,22		0,07		0,22		0,18		0,24		0,31		0,18		0,22		0,31		
P ₂ O ₅	—		0,01		0,02		0,02		0,02		—		0,01		—		—		0,01		0,01		0,01		0,01		
H ₂ O	0,83		0,97		0,84		1,17		0,85		1,18		0,90		0,65		0,80		0,73		0,73		0,77		2,28		
CO ₂	0,10		0,10		0,05		0,16		0,10		0,14		0,15		0,07		0,07		0,08		0,09		0,11		0,66		
	100,46		99,59		100,39		100,48		100,31		100,47		99,98		100,40		100,50		100,35		100,47		99,83		100,01		
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	
Qz	—	—	0,04	0,04	0,36	0,37	—	—	—	—	—	—	0,58	0,59	0,46	0,47	0,12	0,12	—	—	—	—	—	—	1,95	1,97	
Or	7,47	7,60	1,44	1,46	1,31	1,33	1,85	1,87	1,31	1,33	0,41	0,42	1,31	1,34	1,06	1,08	1,42	1,44	1,84	1,86	1,06	1,07	1,31	1,34	1,89	1,90	
Ab	17,67	17,97	21,72	21,97	20,23	20,54	16,89	17,12	17,36	17,60	5,11	5,20	21,03	21,43	21,80	22,13	24,45	24,82	23,03	23,30	21,13	21,33	25,90	26,37	34,93	35,19	
An	29,68	30,19	39,63	40,09	36,27	36,82	39,29	39,82	41,20	41,76	7,07	7,19	36,47	37,17	38,53	39,12	37,71	38,29	37,35	37,79	34,23	34,56	37,96	38,65	51,50	51,89	
Di	Wo	8,56	8,71	7,37	7,46	7,49	7,60	9,38	9,51	6,48	6,57	8,22	8,36	8,59	8,75	8,95	9,09	7,76	7,88	6,68	6,76	9,83	9,93	4,55	4,63	0,53	0,53
	En	4,97	5,05	4,29	4,34	4,56	4,63	6,24	6,32	4,20	4,26	5,30	5,39	5,14	5,24	5,47	5,55	4,66	4,73	3,98	4,03	5,91	5,97	2,73	2,78	0,25	0,25
	Fs	3,19	3,25	2,73	2,76	2,51	2,55	2,45	2,48	1,85	1,88	2,36	2,40	2,99	3,05	2,98	3,03	2,70	2,74	2,36	2,39	3,40	3,43	1,59	1,62	0,28	0,28
Hy	En	8,31	8,45	13,22	13,37	16,61	16,86	13,50	13,68	17,53	17,77	45,98	46,77	13,91	14,18	12,34	12,64	12,46	12,65	13,46	13,62	12,96	13,09	15,19	15,47	3,73	3,76
	Fs	5,33	5,42	8,41	8,51	9,16	9,30	5,30	5,37	7,75	7,85	20,46	20,81	8,10	8,25	6,79	6,89	7,22	7,33	7,99	8,08	7,46	7,53	8,83	8,99	4,20	4,23
Ol	Fo	7,70	7,83	—	—	—	—	2,63	2,67	0,65	0,66	2,28	2,32	—	—	—	—	1,30	1,32	1,87	1,89	0,09	0,09	—	—	—	—
	Fa	5,44	5,54	—	—	—	—	1,14	1,16	0,32	0,32	1,12	1,14	—	—	—	—	0,84	0,85	1,19	1,20	0,06	0,06	—	—	—	—
Mt	1,39	—	0,81	—	1,05	—	0,88	—	0,92	—	1,23	—	0,58	—	0,71	—	1,25	—	0,90	—	0,65	—	1,64	—	0,57	—	
Ilm	0,29	—	0,32	—	0,40	—	0,40	—	0,38	—	0,44	—	1,28	—	0,80	—	0,25	—	0,25	—	0,29	—	0,13	—	0,15	—	
Ap	—	—	0,02	—	0,05	—	0,05	—	0,05	—	—	—	0,02	—	—	—	—	—	0,02	—	0,02	—	0,02	—	0,02	—	
DI	25,14	—	23,20	—	21,90	—	18,74	—	18,67	—	5,52	—	22,92	—	23,32	—	25,99	—	24,87	—	22,19	—	27,21	—	38,77	—	
CI	53,47	—	57,59	—	57,26	—	64,09	—	62,65	—	52,39	—	56,80	—	58,66	—	56,05	—	56,25	—	57,50	—	54,16	—	53,39	—	
MDI	—	42,63	—	37,17	—	36,34	—	30,18	—	30,64	—	32,08	—	37,35	—	36,27	—	38,86	—	38,58	—	37,58	—	39,81	—	43,82	—
MCI	—	42,54	—	44,02	—	44,62	—	49,71	—	48,82	—	48,29	—	43,91	—	44,66	—	42,85	—	43,44	—	44,31	—	42,22	—	39,38	—

APPENDIX II (Continued). MAIN ZONE

	M209		M202		M189		M188		M186		M182		M179		M177		M174		M172		M169		M166		M165		
SiO ₂	51,95		52,38		51,78		50,09		51,63		51,77		52,18		52,36		52,54		51,45		52,91		52,67		52,69		
TiO ₂	0,15		0,17		0,14		0,14		0,13		0,11		0,13		0,18		0,22		0,06		0,21		0,14		0,17		
Al ₂ O ₃	17,72		19,42		16,27		17,49		21,08		27,09		24,15		16,65		16,77		25,97		17,12		18,19		16,59		
Fe ₂ O ₃	0,51		0,64		0,32		0,48		0,44		0,53		0,53		0,33		0,32		0,36		0,44		0,27		0,45		
FeO	6,43		4,89		7,03		6,04		4,26		1,44		2,18		5,54		6,06		2,02		5,82		5,56		5,30		
MnO	0,17		0,13		0,18		0,16		0,11		0,05		0,06		0,14		0,15		0,06		0,14		0,13		0,14		
MgO	8,46		6,70		10,00		9,11		6,22		1,35		3,33		9,83		9,75		3,41		9,61		9,45		10,08		
CaO	11,23		12,12		11,39		12,20		12,05		12,12		12,45		11,96		10,72		12,45		10,07		10,90		11,78		
Na ₂ O	2,71		2,67		2,08		2,04		3,03		3,53		3,05		2,12		2,04		2,64		2,12		2,04		1,92		
K ₂ O	0,37		0,31		0,18		0,18		0,34		0,46		0,37		0,43		0,46		0,28		0,52		0,31		0,31		
P ₂ O ₅	0,01		0,02		—		0,01		0,01		0,02		0,01		0,02		0,02		0,01		0,04		0,02		0,02		
H ₂ O	0,65		0,92		0,90		1,57		0,95		1,01		0,94		0,74		1,06		0,81		0,98		0,68		0,75		
CO ₂	0,12		0,13		0,10		0,33		0,03		0,08		0,17		0,12		0,30		0,08		0,28		0,07		0,11		
	100,48		100,50		100,37		99,84		100,28		99,56		99,57		100,42		100,41		99,60		100,24		100,43		100,31		
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	
Qz	—	—	0,25	0,25	—	—	—	—	—	—	1,33	1,34	2,07	2,09	—	—	0,43	0,43	2,54	2,56	1,20	1,21	0,81	0,82	0,78	0,79	
Or	2,20	2,22	1,84	1,86	1,07	1,08	1,08	1,09	2,02	2,04	2,76	2,79	2,22	2,24	2,55	2,57	2,75	2,78	1,67	1,68	3,10	3,14	1,84	1,85	1,84	1,86	
Ab	22,98	23,22	22,70	23,00	17,70	17,83	17,61	17,79	25,82	26,05	30,31	30,63	26,37	26,65	18,01	18,17	17,41	17,58	22,62	22,77	18,11	18,32	17,30	17,42	16,33	16,50	
An	35,20	35,57	40,31	40,85	34,75	35,01	38,84	39,24	43,23	43,62	57,60	58,21	51,83	52,38	34,80	35,11	35,58	35,92	58,96	59,35	36,02	36,43	39,68	39,97	35,93	36,30	
Di	Wo	8,60	8,69	8,36	8,47	9,23	9,30	9,56	9,66	7,06	7,12	1,39	1,40	4,52	4,57	10,30	10,39	7,51	7,58	1,48	1,49	5,92	5,99	6,03	6,07	9,48	9,58
	En	5,26	5,32	5,22	5,29	5,74	5,78	6,07	6,13	4,47	4,51	0,81	0,82	2,97	3,00	6,81	6,87	4,85	4,89	0,98	0,99	3,86	3,91	3,94	3,97	6,38	6,45
	Fs	2,86	2,89	2,64	2,68	2,94	2,96	2,88	2,91	2,15	2,17	0,51	0,52	1,24	1,25	2,74	2,76	2,15	2,17	0,40	0,40	1,66	1,68	1,67	1,68	2,37	2,39
Hy	En	9,64	9,74	11,55	11,70	16,04	16,16	11,59	11,71	5,95	6,00	2,60	2,63	5,45	5,51	15,19	15,32	19,65	19,84	7,62	7,67	20,30	20,53	19,67	19,81	18,85	19,04
	Fs	5,23	5,29	5,82	5,90	8,21	8,27	5,50	5,55	2,86	2,89	1,64	1,66	2,28	2,31	6,12	6,17	8,73	8,81	3,07	3,09	8,69	8,79	8,35	8,41	7,02	7,09
Ol	Fo	4,36	4,41			2,29	2,30	3,85	3,89	3,63	3,66					1,81	1,83										
	Fa	2,62	2,65			1,30	1,31	2,01	2,03	1,92	1,94					0,80	0,81										
Mt	0,74		0,94		0,46		0,72		0,64		0,78		0,78		0,48		0,47		0,53		0,65		0,39		0,65		
Ilm	0,29		0,32		0,27		0,27		0,25		0,22		0,25		0,34		0,42		0,11		0,40		0,27		0,32		
Ap	0,02		0,05		—		0,02		—		0,05		0,02		0,05		0,05		0,02		0,09		0,05		0,05		
DI	25,18		24,79		18,77		18,69		27,84		34,40		30,66		20,56		20,59		26,83		22,41		19,95		18,95		
CI	57,29		59,12		60,12		62,89		60,08		60,55		61,46		61,49		59,18		65,86		58,01		61,54		62,44		
MDI		38,81		36,05		34,06		31,93		37,00		37,40		35,64		32,91		33,68		30,85		34,62		31,66		30,74	
MCI		44,21		44,82		46,90		48,86		45,25		43,88		45,10		47,56		46,47		48,47		45,83		47,89		48,53	

APPENDIX II (Continued). MAIN ZONE

	M161		M160		M159		M158		M157		M153		1		2		3		4		5		6		7		
SiO ₂	51,74		52,61		51,54		51,65		51,63		51,86		52,10		53,40		51,66		51,65		51,60		50,40		49,96		
TiO ₂	0,11		0,13		0,10		0,08		0,08		0,17		0,14		0,18		0,14		0,11		0,16		0,17		0,12		
Al ₂ O ₃	19,20		19,34		19,47		22,95		19,30		6,50		18,05		17,51		17,85		23,97		17,49		15,85		24,66		
Fe ₂ O ₃	0,29		0,39		0,39		0,19		0,32		0,83		3,19		1,17		1,37		1,01		0,89		1,87		1,20		
Cr ₂ O ₃											0,85		0,07				0,09				0,02		0,06		0,05		
FeO	5,27		5,11		5,37		3,72		5,32		10,03		4,02		6,12		5,20		3,69		6,95		5,20		3,23		
MnO	0,13		0,13		0,13		0,09		0,13		0,23		0,12		0,20		0,14		0,11		0,20		0,16		0,10		
MgO	10,33		10,00		10,00		6,85		11,47		23,32		8,75		7,10		7,57		4,83		8,23		9,23		6,23		
CaO	9,76		9,68		9,83		11,15		9,02		4,84		11,10		11,60		11,70		10,75		11,15		14,50		11,60		
Na ₂ O	2,08		2,12		2,22		2,57		1,98		0,64		2,19		3,79		2,15		2,45		2,12		1,60		2,00		
K ₂ O	0,24		0,22		0,18		0,16		0,10		0,06		0,21		0,21		0,22		0,25		0,16		0,14		0,21		
P ₂ O ₅	0,01		0,01		0,01		—		—		0,01																
H ₂ O	0,75		0,85		1,12		0,85		0,74		0,96		0,55		0,60		1,21		0,80		0,81		0,73		0,91		
CO ₂	0,13		0,10		0,12		0,10		0,09		0,12																
	100,04		100,49		100,48		100,35		100,18		100,41		100,49		101,88		99,30		99,62		99,78		99,91		100,27		
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	
Qz	—	—	0,86	0,87	—	—	—	—	—	—	—	—	3,23	3,42	—	—	2,54	2,63	3,57	3,66	0,84	0,86	—	—	1,34	1,38	
Or	1,43	1,44	1,30	1,31	1,07	1,08	0,95	0,95	0,60	0,61	0,35	0,36	1,17	1,24	1,15	1,18	1,23	1,28	1,40	1,43	0,89	0,91	0,78	0,81	1,17	1,21	
Ab	17,75	17,87	17,97	18,12	18,92	19,07	21,86	21,95	16,86	16,96	5,37	5,53	18,23	19,27	31,43	32,32	18,24	18,92	20,81	21,33	17,96	18,43	13,66	14,21	16,74	17,26	
An	42,70	42,98	42,71	43,07	42,96	43,30	50,92	51,14	43,76	44,03	14,84	15,27	38,93	41,19	29,87	30,71	38,92	40,37	53,66	54,99	37,93	38,92	35,70	37,13	52,46	59,25	
Di	Wo	2,53	2,55	2,24	2,26	2,55	2,57	1,97	1,98	0,53	0,53	3,87	3,98	6,64	7,03	11,19	11,51	8,21	8,51			7,33	7,52	15,22	15,83		
	En	1,70	1,71	1,52	1,53	1,70	1,71	1,31	1,32	0,36	0,36	2,74	2,82	4,92	5,21	6,69	6,88	5,31	5,51			4,36	4,47	10,41	10,83		
	Fs	0,63	0,63	0,55	0,56	0,66	0,66	0,51	0,51	0,12	0,12	0,81	0,83	1,07	1,13	3,90	4,01	2,34	2,43			2,57	2,64	3,59	3,73		
Hy	En	22,75	22,90	23,45	23,65	20,66	20,82	15,77	15,84	26,31	26,47	47,59	48,97	16,71	17,68	2,59	2,66	13,60	14,11	11,98	12,28	16,08	16,50	12,35	12,84	15,38	15,86
	Fs	8,40	8,45	8,56	8,63	7,98	8,04	6,21	6,24	8,86	8,92	14,05	14,46	3,62	3,83	1,52	1,56	6,02	6,24	6,06	6,21	9,50	9,75	4,26	4,43	4,82	4,97
Ol	Fo	1,04	1,05			1,90	1,92	0,05	0,05	1,45	1,46	5,71	5,87			5,64	5,80							0,13	0,14		
	Fa	0,42	0,42			0,82	0,83	0,02	0,02	0,54	0,54	1,86	1,91			3,28	3,37							0,05	0,05		
Mt	0,42		0,57		0,57		0,28		0,46		1,21		4,61		1,76		2,03		1,43		1,39		2,72		1,86		
Ilm	0,21		0,25		0,19		0,15		0,15		0,32		0,27		0,39		0,27		0,18		0,33		0,36		0,21		
Chr											1,26		0,05				0,07				0,01		0,04		0,04		
Sp.																			0,10						0,07	0,07	
Hz																											
Ap	0,02		0,02		0,02						0,02																
H ₂ O													0,55		0,59		1,22		0,81		0,81		0,73		0,91		
DI	19,18		20,13		19,99		22,81		17,46		5,71		22,63		32,58		22,01		25,78		19,69		14,44		19,25		
CI	62,89		62,01		62,32		64,30		63,96		59,15		61,25		51,76		59,90		66,83		58,56		66,93		63,31		
MDI		29,36		29,98		30,26		30,12		27,26		23,82		29,89		45,97		33,64		32,63		34,92		26,52		24,89	
MCI		49,81		49,07		49,44		48,99		51,41		55,15		49,14		39,58		46,51		47,15		45,60		51,53		52,69	

APPENDIX II (Continued). MAIN ZONE

	8		9		10		11		12		13		14		15		16		17		18		19		20		
SiO ₂	49,96		49,51		50,20		51,11		52,70		48,85		51,48		50,72		52,25		46,60		50,50		51,50		52,00		
TiO ₂	0,17		0,22		0,13		0,16		0,15		0,10		0,26		0,44		0,20		0,06		0,25		0,20		0,20		
Al ₂ O ₃	18,49		18,83		20,05		19,75		21,05		26,45		18,04		16,40		5,35		30,17		6,00		5,40		4,76		
Fe ₂ O ₃	1,86		1,92		1,84		2,14		0,50		0,45		1,82		1,55		1,10		1,12		4,15		2,40		1,59		
Cr ₂ O ₃	0,06		0,04		0,03														0,03		0,55				0,51		
FeO	4,65		4,30		3,80		4,39		5,80		2,15		4,96		6,66		14,25		0,86		9,40		11,00		10,38		
MnO	0,14		0,14		0,13		0,15		-		-		0,04		0,02		0,30		0,04		0,15		0,15		0,24		
MgO	8,95		9,57		7,90		7,05		4,20		4,25		7,40		8,55		18,40		3,81		21,90		21,95		25,20		
CaO	12,83		12,47		12,64		12,64		12,60		14,05		13,35		13,30		6,25		14,60		4,40		5,40		3,03		
Na ₂ O	1,72		2,00		1,80		2,02		2,10		2,10		1,90		2,20		0,55		2,05		1,25		0,90		0,31		
K ₂ O	0,17		0,25		0,17		0,20		0,30		-		0,26		0,20		0,20		0,15		-		-		0,10		
P ₂ O ₅							0,04		0,20		0,05		0,03		0,06						0,10		0,10				
H ₂ O	0,89		0,81		0,84		0,65		0,05		0,25		0,30		0,40		1,05		0,32		0,80		0,85		1,17		
	99,89		100,06		99,53		100,30		99,65		98,70		99,84		100,50		99,90		99,81		99,45		99,85		99,49		
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	
Qz	0,16	0,17	-	-	1,40	1,46	2,35	2,45	5,03	5,10	0,24	0,24	2,10	2,18	-	-	-	-	-	-	-	-	-	-	-	-	
Or	0,95	0,99	1,39	1,45	0,96	1,00	1,11	1,16	1,68	1,70	-	-	1,67	1,73	1,11	1,15	1,11	1,15	0,83	0,85	-	-	-	-	0,58	0,61	
Ab	14,42	15,02	16,79	17,52	15,31	15,91	16,97	17,69	17,90	18,16	18,06	18,29	16,28	16,88	18,29	18,91	4,72	4,87	17,35	17,72	10,57	11,53	7,88	8,31	2,70	2,83	
An	42,36	44,12	41,68	43,49	46,34	48,16	44,20	46,08	47,34	48,02	63,54	64,36	39,57	41,02	34,37	35,54	11,40	11,77	72,52	74,08	10,94	11,94	10,59	11,16	11,37	11,91	
Di	Wo	8,94	9,31	8,43	8,80	6,96	7,23	7,54	7,86	6,13	6,22	2,70	2,74	11,16	11,57	13,18	13,63	8,25	8,52			4,22	4,60	6,40	6,75	1,54	1,61
	En	6,25	6,51	6,09	6,35	4,96	5,16	5,12	5,34	3,04	3,08	1,88	1,90	7,42	7,69	8,38	8,67	5,00	5,16			3,07	3,35	4,40	4,64	1,09	1,14
	Fs	1,92	2,00	1,56	1,63	1,38	1,47	1,83	1,91	2,94	2,98	0,61	0,62	2,91	3,03	3,95	4,09	2,77	2,87			0,75	0,82	1,47	1,55	0,30	0,31
Hy	En	16,03	16,70	11,21	11,69	14,78	15,36	12,37	12,90	7,40	7,51	8,83	8,94	11,12	11,53	8,38	8,67	41,03	42,36	0,04	0,04	45,65	49,80	42,91	45,23	58,49	61,25
	Fs	4,97	5,18	2,88	3,00	4,13	4,29	4,42	4,61	7,13	7,23	2,87	2,91	4,23	4,38	4,21	4,35	22,58	23,31			11,06	12,07	14,25	15,02	16,24	17,01
Ol	Fo			4,53	4,73															6,51	6,65	4,26	4,65	5,10	5,38	2,47	2,59
	Fa			1,28	1,34															1,62	1,67	0,48	0,49	1,14	1,24	1,86	1,96
Mt	2,70		2,83		2,66		3,11		0,70		0,70		2,56		2,08		1,62		1,68		6,08		3,49		2,32		
Il	0,36		0,49		0,24		0,33		0,32		0,15		0,61		0,76		0,46		0,09		0,53		0,46		0,46		
Ap									0,34		0,17										0,34		0,34				
Ch	0,04		0,03		0,03															0,01		0,58		-		0,55	
Sp																				0,17	0,17			-			
H ₂ O	0,89		0,81		0,85		0,65		0,05		0,25		0,37		0,46		1,05		0,32		0,81		0,85		1,18		
DI	15,53		18,18		17,67		20,43		24,61		18,30		20,05		19,40		5,83		18,18		10,57		7,88		3,28		
CI	67,07		67,24		67,40		63,91		59,09		73,79		63,36		61,52		50,94		79,38		53,81		55,25		57,18		
MDI		25,12		26,33		25,35		29,50		37,80		22,61		30,85		33,77		34,71		19,05		26,38		28,21		21,77	
MCI		52,45		53,00		52,32		49,41		43,57		54,25		48,46		47,41		45,74		58,60		52,98		51,92		55,59	

APPENDIX II (Continued).

CRITICAL ZONE

BASAL ZONE

	1		2		3		4		5		1		2		3		4		5		6		7		8		
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	
SiO ₂	49,90		71,70		52,00		50,80		48,90		41,50		53,60		54,50		53,20		55,40		55,40		41,40		45,30		
TiO ₂	0,12		0,20		0,18		0,10		—		0,08		0,12		0,16		0,21		0,10		0,10		0,07		0,17		
Al ₂ O ₃	28,20		13,19		4,82		17,01		30,00		1,16		5,64		1,77		5,05		1,60		2,35		3,16		3,76		
Fe ₂ O ₃	1,46		1,48		1,06		2,01		0,50		2,19		0,46		1,01		1,17		—		—		0,60		4,51		
Cr ₂ O ₃	0,74		0,24		0,27		0,10		—		1,00		0,23		0,43		0,26		0,65		0,60		0,95		0,25		
FeO	0,41		7,00		9,35		5,60		1,30		6,13		8,78		8,90		8,70		9,35		9,65		6,63		6,27		
MnO	0,04		0,20		0,22		0,15		—		0,13		0,22		0,22		0,19		0,15		0,15		0,13		0,15		
MgO	3,57		17,30		27,25		10,97		0,55		45,50		27,20		30,60		26,22		32,45		30,85		42,50		30,60		
CaO	12,98		6,76		3,78		11,10		16,90		0,53		2,26		1,52		3,38		0,45		0,65		0,88		2,98		
Na ₂ O	2,19		1,20		0,27		1,96		1,95		0,22		0,42		0,10		0,61		—		—		0,22		0,62		
K ₂ O	0,09		0,14		0,04		0,11		0,15		0,01		0,08		0,04		0,30		—		—		0,01		0,29		
P ₂ O ₅																			0,20		0,30						
H ₂ O	0,18		1,04		1,18		0,53		0,20		1,67		1,42		1,22		1,13		0,15		0,10		2,86		4,86		
	99,98		100,45		100,42		100,51		100,45		100,12		100,43		100,47		100,42		100,50		100,15		99,41		99,76		
Qu	4,45	4,60	—	—	—	—	—	—	1,52	1,53	—	—	—	—	—	—	—	—	—	—	1,96	1,99	—	—	—	—	
Or	0,50	0,52	0,78	0,81	0,22	0,23	0,61	0,63	0,83	0,84	0,05	0,05	0,44	0,45	0,22	0,23	1,67	1,73	—	—	—	—	0,05	0,05	1,70	1,84	
Ab	18,28	18,89	9,95	10,35	2,31	2,39	16,51	17,16	16,46	16,61	1,79	1,91	3,30	3,44	1,05	1,09	5,28	5,48	—	—	—	—	1,81	1,90	5,66	6,12	
An	64,33	66,46	30,14	31,34	11,78	12,19	37,24	38,70	72,34	73,00	2,29	2,42	11,08	11,47	4,25	4,40	10,10	10,48	1,39	1,41	1,54	1,56	4,41	4,64	6,92	7,49	
Di	Wo	—	—	1,36	1,41	2,92	3,02	7,36	7,65	3,30	3,33	0,17	0,18	—	—	1,40	1,45	2,80	2,91	—	—	—	—	—	—	3,60	3,89
	En	—	—	0,97	1,01	2,14	2,21	5,11	5,31	1,35	1,36	0,14	0,15	—	—	1,05	1,08	2,07	2,15	—	—	—	—	—	—	2,89	3,13
	Fs	—	—	0,26	0,27	0,50	0,52	1,61	1,67	1,97	1,99	0,01	0,01	—	—	0,21	0,22	0,47	0,49	—	—	—	—	—	—	0,27	0,30
Hy	En	7,87	8,13	41,01	42,65	53,40	55,27	18,76	19,49	—	—	10,42	11,09	63,80	65,48	70,46	72,93	54,11	56,16	78,17	79,18	75,25	76,42	13,94	14,66	34,72	37,59
	Fs	—	—	10,88	11,31	12,73	13,18	5,97	6,20	—	—	0,80	0,85	14,85	15,24	14,22	14,72	12,21	12,67	16,25	16,46	17,08	17,34	1,45	1,52	3,45	3,73
Ol	Fo	—	—	0,63	0,66	8,40	8,69	2,27	2,36	—	—	72,19	76,82	2,10	2,16	3,06	3,17	6,11	6,34	1,06	1,07	—	—	64,39	67,69	29,94	32,36
	Fa	—	—	0,18	0,19	2,22	2,30	0,80	0,83	—	—	6,13	6,52	0,53	0,54	0,69	0,71	1,53	1,59	0,25	0,25	—	—	7,39	7,77	3,28	3,55
Mt	0,05		2,09		1,53		3,01		0,70		3,25		0,70		1,42		1,78		—		—		0,94		6,91		
Il	0,21		0,46		0,40		0,15		—		0,12		0,21		0,33		0,47		0,15		0,15		0,10		0,38		
Hm	2,04		—		—		—		—		—		—		—		—		—		—		—		—		
Ch	0,73		0,25		0,27		0,07		—		0,98		0,24		0,42		0,27		0,63		0,60		0,93		0,28		
Sp	1,36	1,40											0,97	1,00					1,35	1,37	2,19	2,22	1,54	1,62			
Hz													0,21	0,22					0,26	0,26	0,46	0,47	0,14	0,15			
Ap																			0,34		0,67						
H ₂ O	0,18		1,04		1,18		0,53		0,20		1,68		1,42		1,22		1,13		0,15		0,10		2,90				
DI	23,23		10,73		2,53		17,12		18,81		1,84		3,74		1,27		6,95		0		1,96		1,86		7,36		
CI	71,21		61,60		62,22		63,68		75,25		82,06		58,81		58,95		58,60		58,58		56,47		79,10		65,57		
MDI		24,01		23,17		19,08		28,41		22,72		9,35		19,67		17,16		22,93		16,71		19,33		11,24		15,80	
MCI		53,07		54,04		59,31		51,17		53,21		86,51		56,79		59,00		56,30		58,51		56,21		82,35		69,54	

APPENDIX II (Continued). CHILL PHASE AND AVERAGE OF SILLS

	1		2		3		4		5		
SiO ₂	50,55		51,45		50,30		52,41		55,06		
TiO ₂	0,66		0,34		2,13		1,03		0,67		
Al ₂ O ₃	15,23		18,67		15,02		13,07		14,63		
Fe ₂ O ₃	1,04		0,28		2,63		2,55		1,84		
Cr ₂ O ₃	0,01		—								
FeO	10,07		9,04		8,64		8,43		6,75		
MnO	0,23		0,47		0,17		0,16		0,18		
MgO	8,30		6,84		7,43		8,28		9,14		
CaO	11,30		10,95		10,49		9,00		7,67		
Na ₂ O	2,24		1,58		2,02		2,09		1,96		
K ₂ O	0,19		0,14		0,28		0,92		0,79		
P ₂ O ₅	0,12		0,09		0,16		0,12		0,22		
H ₂ O	0,24		0,37		0,33		1,66		0,79		
	A	B	A	B	A	B	A	B	A	B	
Oz	—	—	2,93	2,98	3,92	4,29	4,29	4,65	8,40	8,86	
Or	1,12	1,16	0,83	0,84	1,58	1,73	5,69	6,17	4,41	4,65	
Ab	18,91	19,50	13,34	13,56	17,08	18,68	17,76	19,25	16,64	17,55	
An	30,90	31,86	43,35	44,06	31,32	34,24	23,42	25,39	29,01	30,59	
Di	Wo	10,14	10,73	4,29	4,36	8,38	9,16	8,50	9,21	3,42	3,61
	En	5,40	5,57	2,13	2,17	5,04	5,51	5,08	5,51	2,20	2,32
	Fs	4,42	4,56	2,08	2,11	2,88	3,15	2,97	3,22	0,99	1,04
Hy	En	11,28	11,63	14,88	15,12	13,53	14,79	15,53	16,83	20,59	21,71
	Fs	9,25	9,54	14,56	14,80	7,73	8,45	9,01	9,77	9,17	9,67
Ol	Fo	2,77	2,86	—	—	—	—	—	—	—	—
	Fa	2,51	2,59	—	—	—	—	—	—	—	—
Mt	1,51		0,41		3,80		3,72		2,65		
Il	1,25		0,65		4,07		2,03		1,33		
Ch	0,02		—		—		—		—		
Ap	0,28		0,21		0,34		0,34		0,40		
H ₂ O	0,24		0,34		0,33		1,66		0,79		
DI	20,03		17,10		22,58		27,74		29,45		
CI	53,23		58,37		51,67		45,26		48,19		
MDI	41,36		36,15		39,08		45,90		42,69		
MCI	41,76		44,76		42,70		37,92		40,16		

APPENDIX II (continued) Locality of samples and references

UPPER ZONE

Sample No.	Height in m above M. R.	Rock Type
M55	4620	Quartz diorite
M282	4510	Olivine diorite
M281	4420	Olivine magnetite diorite
M280	4330	Olivine diorite
M279	4220	Diorite
M278	4180	Olivine diorite
M51	4130	Magnetite diorite
M276	4115	Anorthosite
M274	4020	Olivine diorite
M272	3870	Hypersthene gabbro
M63	3805	Anorthosite
M269	3740	Magnetite gabbro
M268	3690	Hypersthene gabbro
M465	3670	Anorthosite
M48	3630	Troctolite
M47	3580	Anorthosite
M46	3500	Troctolite
M255	3365	Hyperite
M253	3240	Magnetite gabbro
M45	3205	Pyroxenite (feldspathic)
M44	3180	Magnetite gabbro
M43	3140	Norite
M3	3078	Anorthosite
M37	3070	Magnetite gabbro
M40	3050	Troctolite
M288	3010	Olivine gabbro
M291	2915	Magnetite gabbro
M308	2860	Mangetite anorthosite

APPENDIX II (continued)

All the above samples were collected by Molyneux (1970, Plate III) along a traverse at Magnet Heights and analysed at the Dept. of Geology, University of Glasgow.

1. Troctolite - 1 mile from Magnet Heights on road to Jane Furse
(Sisal horizon) C. J. Liebenberg, 1961, LIEB-26.
2. Diorite - First outcrops on old Tauteshoogte road.
C. J. Liebenberg, 1961, LIEB-7(a).
3. Diorite - 20 ft. below leptite on old Tauteshoogte road.
C. J. Liebenberg, 1961, LIEB-9.
4. Fayalite diorite - Duikerskrans. J. C. Boshoff, 1942, Table 13, No. 85.
5. Syenodiorite - Paardekloof. J. C. Boshoff, 1942, Table 13, No. 10.
6. Olivine diorite - Duikerskrans. J. C. Boshoff, 1942, Table 13, No. 72.
7. Diorite - Duikerskrans. J. C. Boshoff, 1942, Table 13, No. 74.
8. Magnetite bearing anorthositic norite - Luipershoek.
B. V. Lombaard, 1934, Table 5, No. 423.
9. Anorthosite, below Main Magnetite Seam - Mamagalies Kraal.
R. A. Daly, 1928, Table 10, No. 6.
10. Anorthositic gabbro - 1 mile from bridge on road to Magnet Heights.
C. J. Liebenberg, 1961, LIEB-29.



APPENDIX II (continued)

MAIN ZONE

Sample No.	Height in m above M. R.	Rock type
M306	2830	Hyperite
M305	2740	Hyperite
M303	2700	Hypersthene gabbro
M299	2500	Hypersthene gabbro
M296	2340	Hyperite
M294	2270	Pyroxenite
M226	2130	Hypersthene gabbro
M224	2050	Hypersthene gabbro
M221	1970	Hypersthene gabbro
M219	1920	Hyperite
M216	1820	Hypersthene gabbro
M213	1770	Norite
M94	1695	Anorthosite
M209	1670	Hypersthene gabbro
M202	1520	Hypersthene gabbro
M189	1460	Hyperite
M188	1330	Gabbro
M186	1230	Hyperite
M182	1060	Anorthosite
M179	970	Anorthositic gabbro
M177	930	Hyperite
M174	780	Hypersthene gabbro
M172	660	Anorthosite
M169	560	Hypersthene gabbro
M166	505	Hypersthene gabbro
M165	400	Hypersthene gabbro
M161	305	Hyperite
M160	250	Hyperite
M159	170	Hyperite
M158	140	Hyperite
M157	110	Norite
M153	0	Pyroxenite - Merensky Reef



APPENDIX II (continued)

All the above samples were collected by Molyneux (1970, Plate III) along a traverse across the Leolo Mountains, and analysed at the Dept. of Geology, University of Glasgow.

1. Norite - Maandagshoek Missionhospital.
C. J. Liebenberg, 1961, LIEB-52.
2. Gabbro - 3 miles from the Steelpoort bridge along the road to Dwars River.
C. J. Liebenberg, 1961, LIEB-30.
- 3-11. Norite and gabbro - from unspecified localities in the Leolo Mountains.
C. J. Liebenberg, 1961, W1-W9.
12. Norite - Bon Accord. A. L. Hall, 1932, Table 28, No. 1.
13. Spotted anorthosite - Forest Hill, hanging wall of Merensky Reef.
P. A. Wagner, 1929, p. 125.
14. Norite - Uysedoorns. B. V. Lombaard, 1934, Table 5, No. 409.
15. Norite - 0,5 mile east of Roossenekal.
B. V. Lombaard, 1934, Table 5, No. 410.
16. Pyroxenite - Chieftains Plain. B. V. Lombaard, 1934, Table 5, No. 480.
17. Spotted anorthosite - above Merensky Reef, Maandagshoek.
C. J. Liebenberg, 1961, LIEB-51.
18. Pyroxenite - Merensky Reef, Dwars River.
P. A. Wagner, 1929, p. 118.
19. Pyroxenite - Merensky Reef, Winnaarshoek.
P. A. Wagner, 1929, p. 118.
20. Pyroxenite - Merensky Reef, Forest Hill.
C. J. Liebenberg, 1961, LIEB-59.

CRITICAL ZONE

1. Anorthosite - Dwars River. C. J. Liebenberg, 1961, LIEB-31.
2. Norite - Mooihoek. C. J. Liebenberg, 1961, LIEB-45.
3. Pyroxenite - Mooihoek. C. J. Liebenberg, 1961, LIEB-46.
4. Norite - East of Mooihoek pipe. C. J. Liebenberg, 1961, LIEB-50.
5. Anorthosite - Driekop, north of Mooihoek.
A. L. Hall, 1932, Table 38, No. 1.

APPENDIX II (continued)

BASAL ZONE

1. Harzburgite - Aapiesdoringdraai, at Spekboom River bridge.
C. J. Liebenberg, 1961, LIEB-32.
2. Pyroxenite - 0,5 mile east of Steelpoort on road to Burgersfort.
C. J. Liebenberg, 1961, LIEB-34.
3. Pyroxenite - Jagdlust on main road.
C. J. Liebenberg, 1961, LIEB-61.
4. Pyroxenite - above Hendriksplaats norite, Hendriksplaats.
C. J. Liebenberg, 1961, LIEB-36.
5. Bronzitite - Jagdlust, south of Olifants River.
A. L. Hall, 1932, Table 32, No. II.
6. Bronzitite - Bronzitite, southeast of Malipsdrift, north of the Olifants River.
A. L. Hall, 1932, Table 32, No. I.
7. Harzburgite - Borehole on Aapiesdoorndraai.
C. J. Liebenberg, 1961, LIEB-32(a).
8. Picrite - Aapiesdoorndraai. C. J. Liebenberg, 1961, LIEB-32.

MARGINAL GROUP

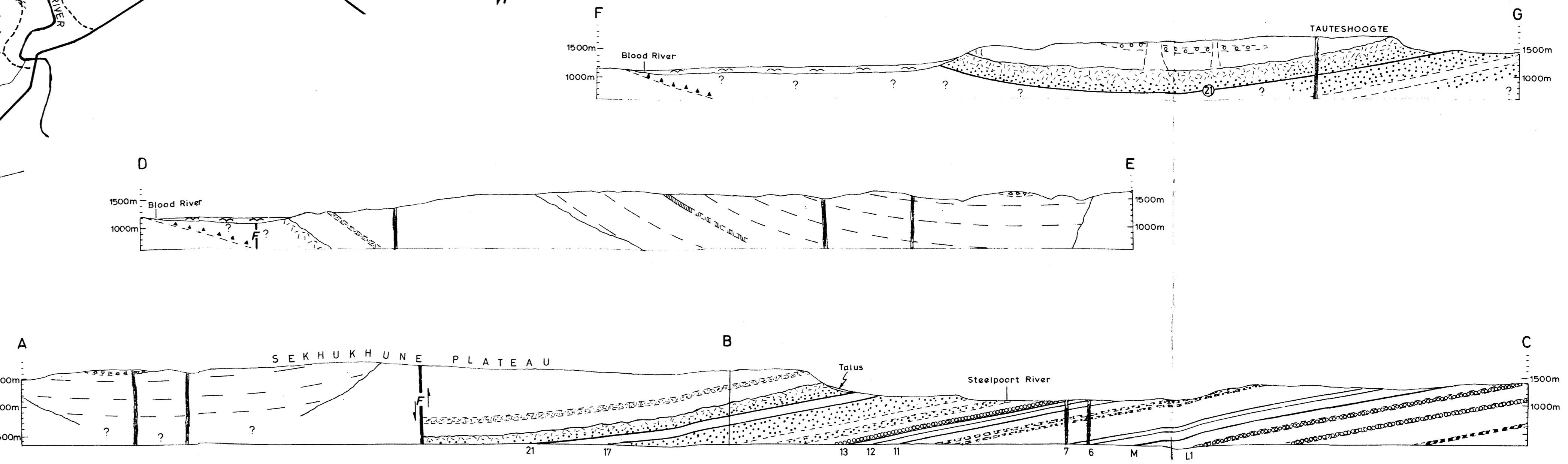
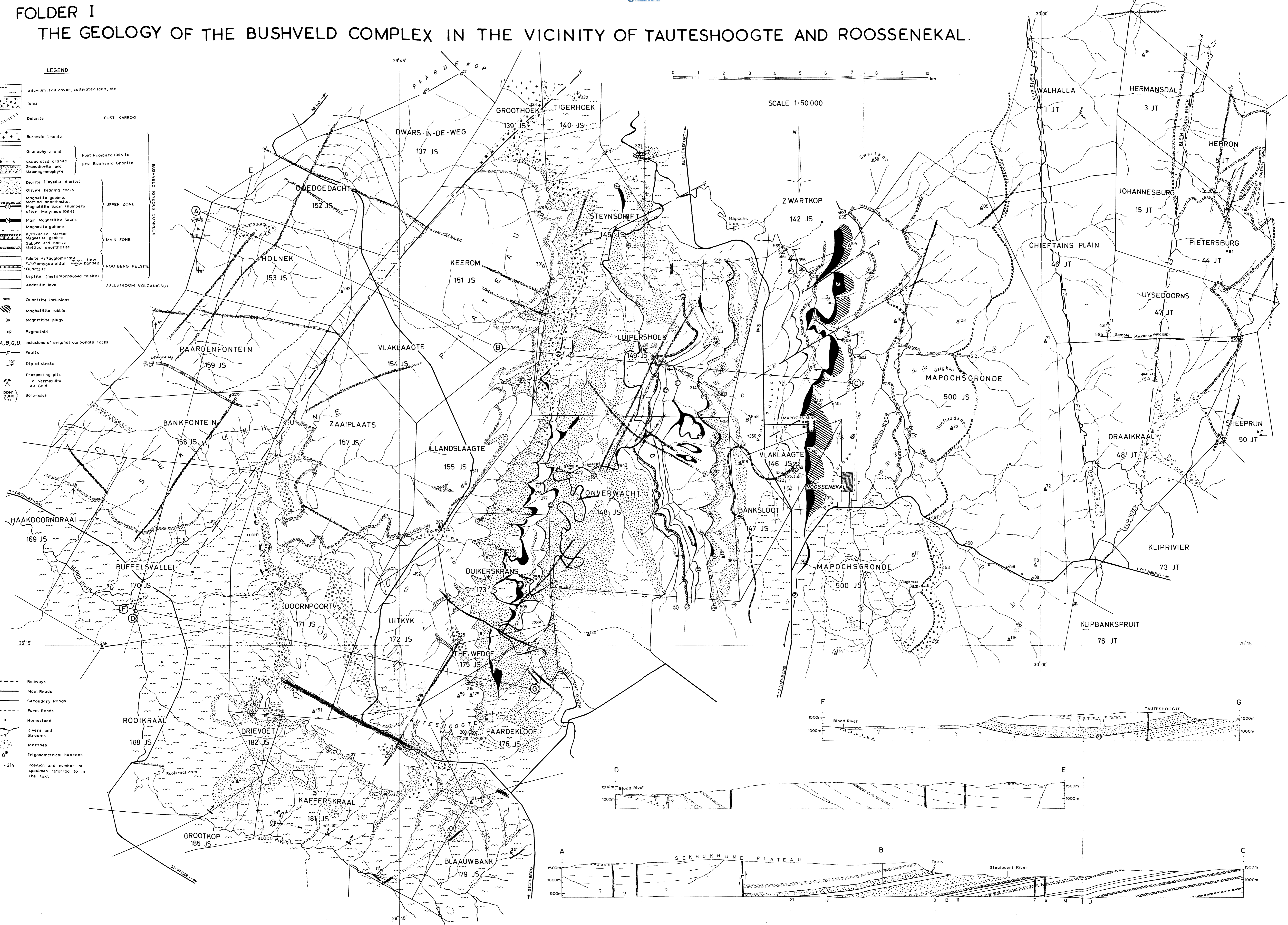
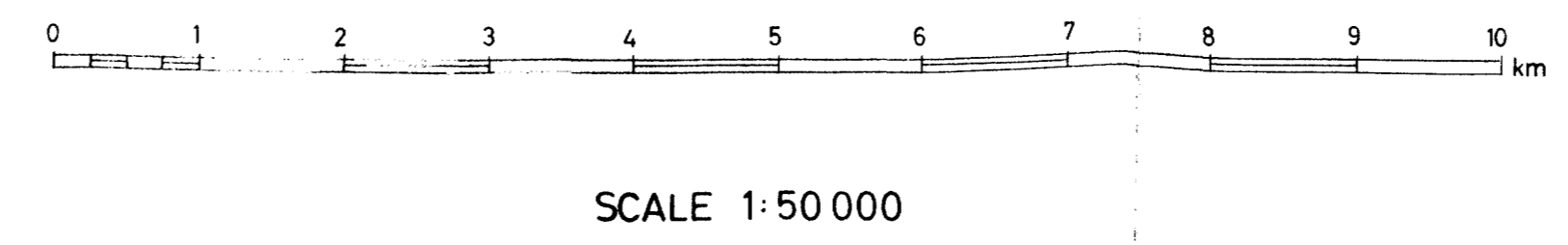
1. Hypersthene gabbro - 4,5 miles east of Klip River along road to Lydenburg. (SA 1087).
L. R. Wager and G. M. Brown, 1968, Table 26, No. 1, p. 355.
2. Hypersthene gabbro - south of Sjambock Railway Station, northwest of Pretoria.
R. A. Daly, 1928, Table 6, No. 6, p. 727.
3. Gabbro - Chilled floor phase, Zilikaatsnek.
H. J. Nel, 1940, Table 5(a), p. 53.
4. Average of 5 Lydenburg type mafic sills.
J. Willemse, 1959, Table 4 and Fig. 5, p. xlv.
5. Average of 9 Maruleng type mafic sills.
J. Willemse, 1959, Table 4 and Fig. 5, p. xlv.

FOLDER I

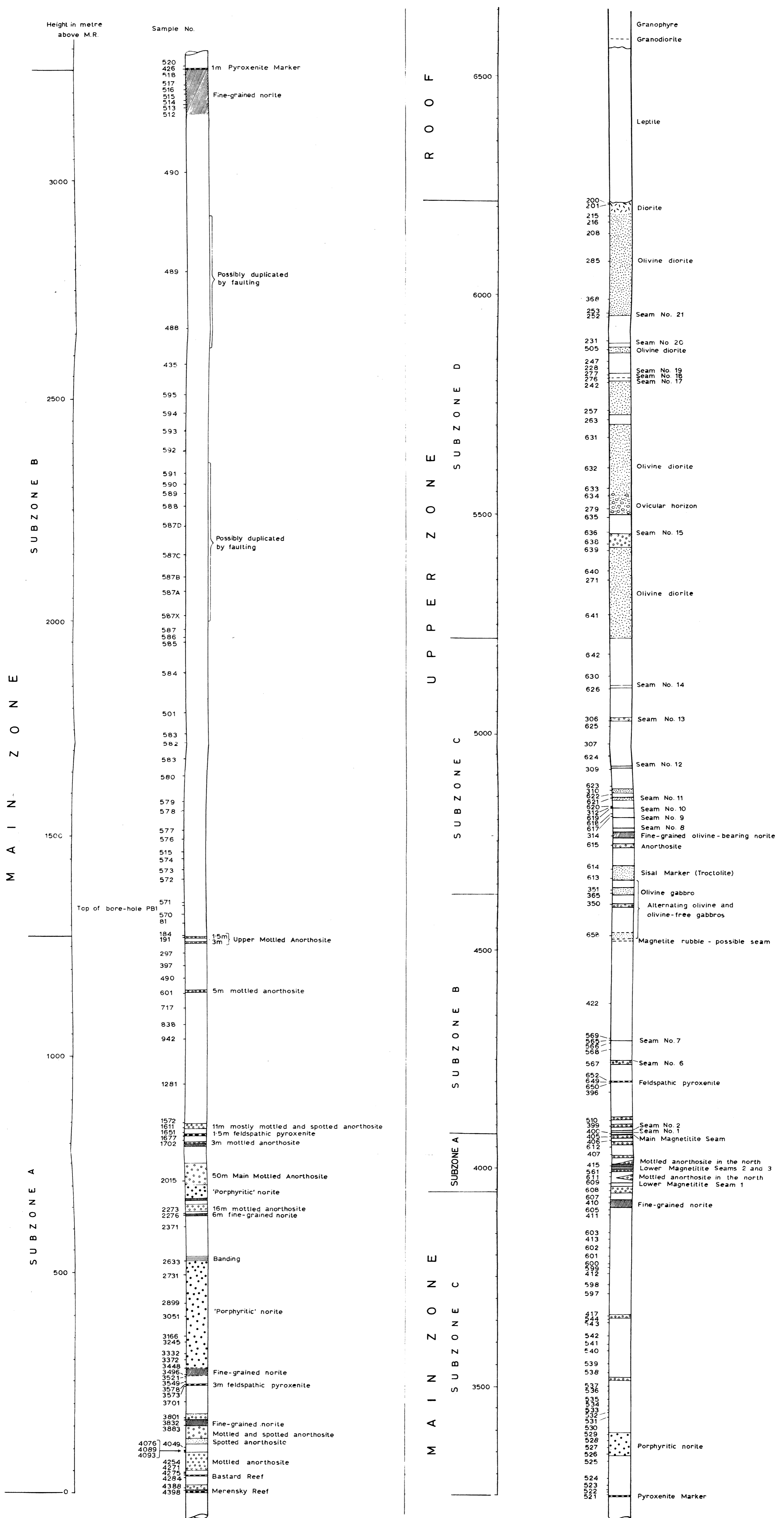
THE GEOLOGY OF THE BUSHVELD COMPLEX IN THE VICINITY OF TAUTESHOOGTE AND ROOSSENEKAL.

LEGEND

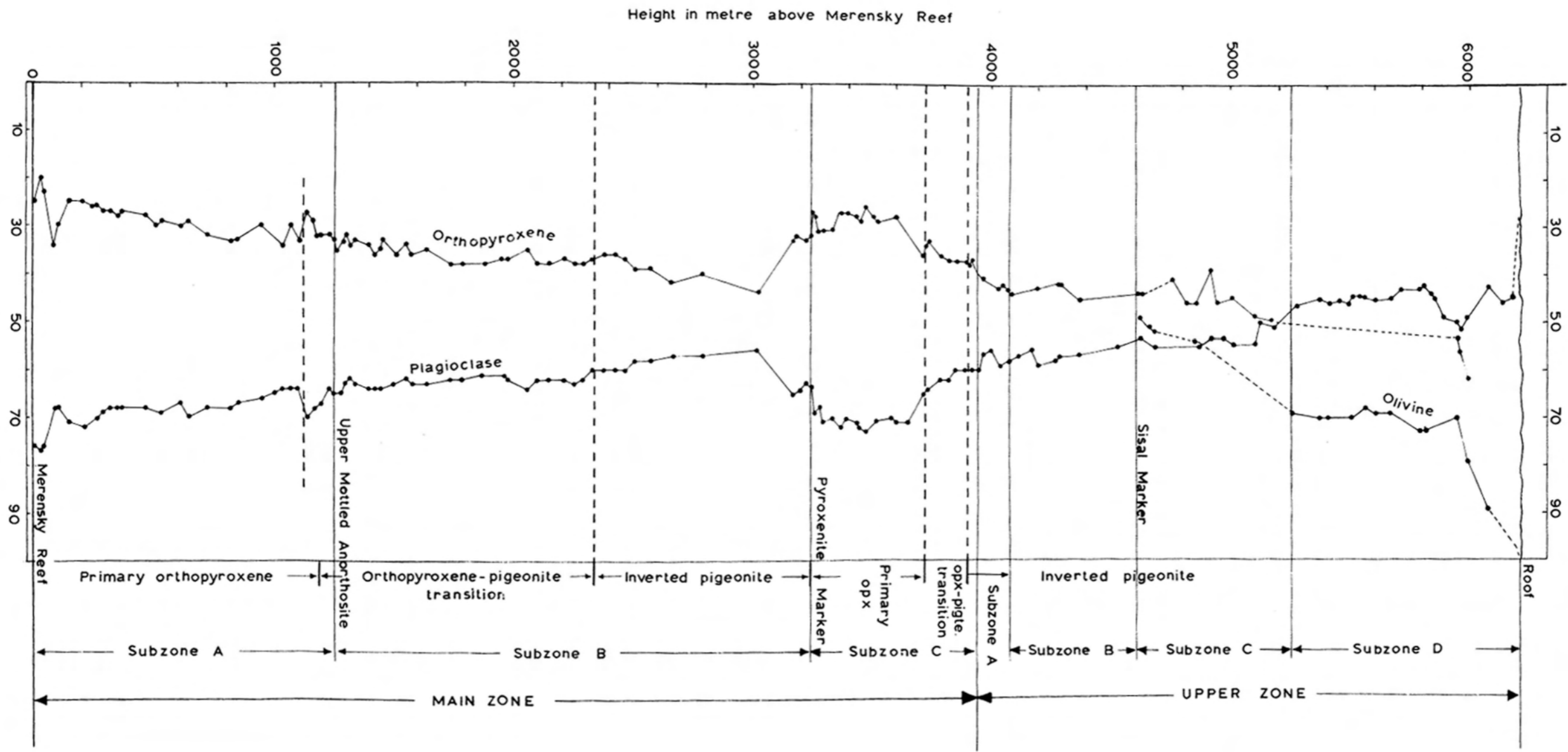
- Alluvium, soil cover, cultivated land, etc.
- Talus
- Dolomite
- Bushveld Granite
- Granophyre and associated granite, etc.
- Diorite (Fayalite diorite)
- Olivine bearing rocks
- Magnetite gabbro
- Mottled anorthosite
- Magnetite Seam (numbers after Molyneux 1964)
- Main Magnetite Seam
- Pyroxenite Marker
- Gabbro and norite
- Mottled anorthosite
- Felsite (agglomerate)
- Felsite (omylaloidal)
- Quartzite
- Leptite (metamorphosed felsite)
- Andesitic lava
- Quartzite inclusions
- Magnetite rubble
- Magnetite plugs
- Pegmatoid
- Inclusions of original carbonate rocks
- Faults
- Dip of strata
- Prospecting pits
- Vanadium
- Au Gold
- Bore-holes



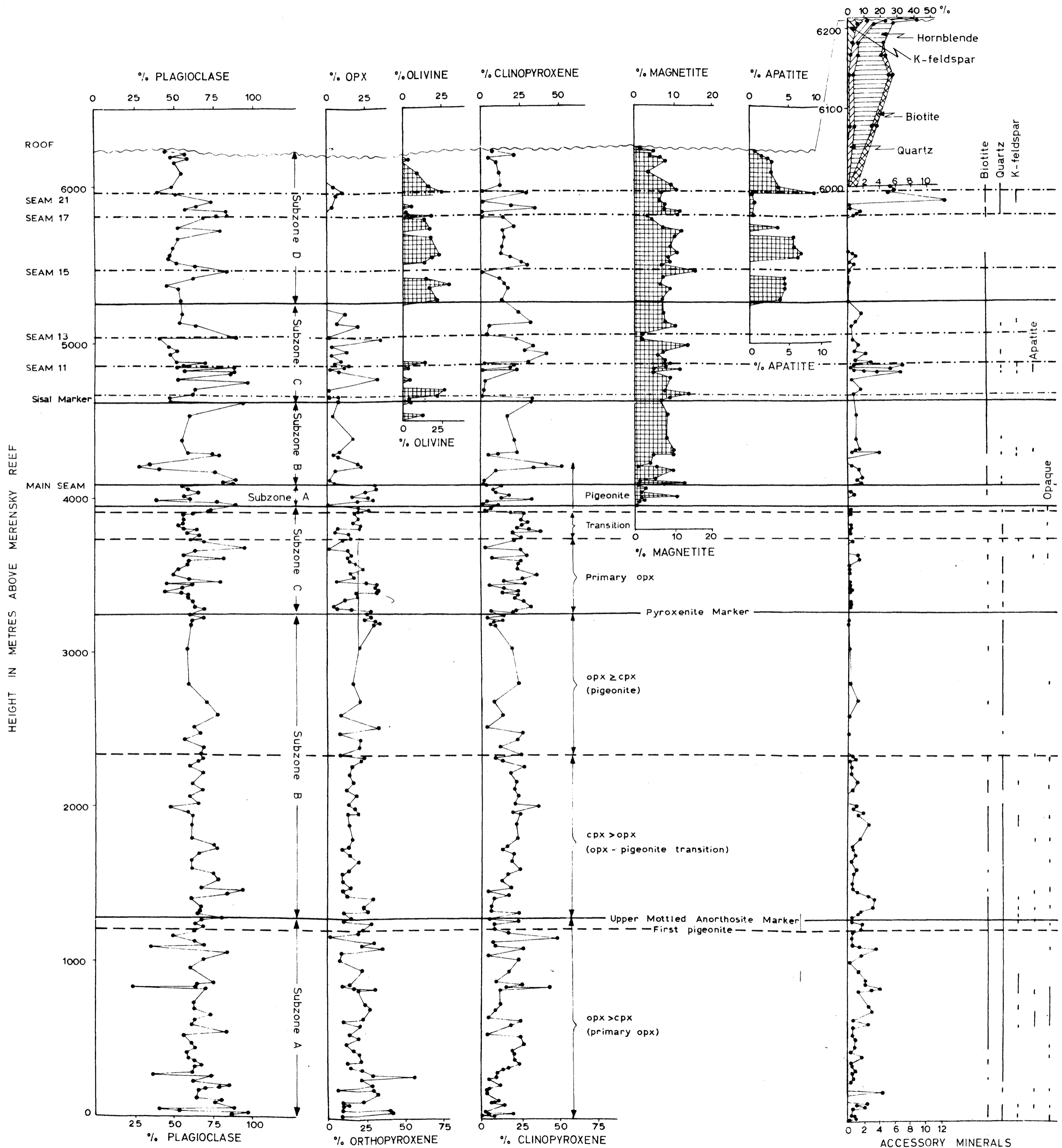
FOLDER II. COLUMNAR SECTION OF THE MAIN AND UPPER ZONES IN THE ROOSSENEKAL AREA



FOLLER III. COMPOSITIONAL VARIATION OF PLAGIOCLASE (MOL. % An), ORTHOPYROXENE (MOL. % Fs) AND OLIVINE (MOL. % Fa) IN ROCKS OF THE MAIN AND UPPER ZONE



FOLDER IV. MODAL VARIATION OF MINERALS IN THE MAIN AND UPPER ZONES OF THE
BUSHVELD COMPLEX IN THE VICINITY OF ROOSSENEKAL





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