immediate noritic or anorthositic footwall, almost as if the still-molten low-temperature sulphide droplets had migrated into the footwall by gravity settling through the interstitial liquid, after the main cumulus silicates had already solidified. Needless to say, the full width of the viable portion of the Merensky reef, in all its variations, is stoped, usually over about a meter in width. In the case of the thinner reefs, parts of the hanging- or footwall may also be stoped.

2.1.2. *The UG2 Chromitite Layer*

Exploitable chromitite layers occur exclusively within the critical zone of the main Bushveld Complex. Following an old tradition, initiated by Cousins and Feringa (1964), the chromitite layers are sequentially numbered in groups from the bottom upwards. The lower group usually consists of seven layers, with a relatively high (1,65) chromium-to-iron ratio, which decreases upwards in all the chromitite layers. These occur in pyroxenites (bronzitites) of the lower critical zone, and are numbered LG1 to LG7, the LG6 being the thickest and most commonly mined for its chromium content all around the Complex. The middle group usually consists of four layers occurring at the contact of the pyroxenitic lower part and the felspathic upper part of the critical zone, and are labelled MG1 to MG4. The upper critical zone is characterized by rock layers exhibiting remarkably persistent differentiated cyclicity, of which the Merensky unit is a prime example. The chromitite layers within the upper critical zone are designated the upper group, UG1 and UG2, although a UG3 layer is also present in the eastern Bushveld. The chromitites, with a chromium-to-iron ratio of 1,3, usually occur at the base of a cyclic unit.

The UG2 chromitite occurs at varying distances below the Merensky reef (MR). In the western lobe, the least distance is 30 m below the MR, in the northern sector, up to roughly 140 m below the MR at its southern extremity while, in the eastern lobe, the separation may reach 400 m. As noted, the chromitite layer occurs at the base of a cyclic unit, grading upwards through a series of leader chromitite layers into a felspathic pyroxenite, a norite, and even an anorthosite, although the latter is not always represented (in which cases the cycle is termed 'beheaded'). In many areas, the UG2 layer is underlain by a coarse felspathic pegmatoid, reminiscent of that of the Merensky reef, although the pegmatoid may also contain thin, lower-chromitite leaders.

Detailed sampling (Viljoen and co-workers, 1986; Mossom, 1986) shows that maximum PGE values occur at the base of the UG2 chromitite, with progressively lower values upwards, although a lesser peak may occur at the top contact. The upper leader chromitites also show elevated PGE values, but certainly lower than those within the main layer.

A very curious layer, known as the 'boulder bed' occurs some 60 m above the UG2 chromitite. It consists of ellipsoidally rounded 'boulders' of coarse dark pegmatoid with a basal chromitite stringer within anorthosite. It forms the lowest of the Merensky marker layers, and occurs from Impala Platinum to Western Platinum mines, a distance of at least 50 km. The layer has been described in detail (Vermaak, 1976) but its origin remains enigmatic. Owing to the chemistry of the 'boulders' a theory advocating a resorbed layer is untenable.

2.1.3. *Resources of the Merensky Reef and the UG2 Chromitite*

Table 2.1. shows estimates of the various vital parameters for the Merensky reef and the UG-2 chromitite. The strike distances and dips were measured, as accurately as possible, from available geological maps, and the measurements were later confirmed on 1: 50 000 topographic sheets. The individual outcrop farms utilized for each of the sections dealt with are listed in Table 2.2. Grades were calculated, particularly from the old literature that is available, as noted in the references, although all modern sources (also listed in the references) were also used. It would naturally be impossible to list the references for each of the farms for which grades were calculated. Where no grades were available for a given farm, these were estimated from those for the adjoining farms. From these data, the tonnages of the Merensky reef and the UG-2 chromitite layer were calculated on a sector basis for the entire Bushveld. The millhead grades, as opposed to the *in-situ* grades, reflect mining losses due to potholes, replacement pegmatoids, faulting, and grade losses due to the friable nature of the chromite stringers or layers and of their contained base-metal sulphides, which also contain the PGE as discrete minerals, alloys, or in solid solution. All of these losses have been roughly estimated, and are assumed to vary between 20 to 30 per cent, depending on knowledge of the areas concerned. Millhead grade is the grade of ore that will be delivered to the mill, where further extraction losses occur. It should be stressed that, throughout this report, gold values have been ignored, and only PGE grades are presented.

The distributions of the individual PGE in the Merensky reef in various sectors of the Bushveld Complex are shown in Table 2.3, and those for the UG-2 in Table 2.4. All of these data are based on averages, weighted according to strike length, of data published for farms or mines within the sector. Only those for the Rooderand sector were estimated, based on adjoining sectors. The distributions and grades for the Middellaagte sector were calculated from the average values for that sector and the adjoining Northam sector (downdip of the Middellaagte sector). The Northam sector, which will be described later, is currently a producing mine, mostly below 1000 m depth and planned to mine down to 2500 m — its published tonnage has thus *not* been included in the reserve estimates that follow.

Some rather curious phenomena are apparent from Table 2.3. Apart from the eastern extremity of the northern sector of the western Bushveld, the percentage distribution of the individual PGE in the Merensky reef appears to change towards all the other extremities of the Bushveld lobes, that is the Hartebeestpoort, Dwarsrivier, and Naboom sectors. The percentage of palladium increases, probably at the expense of platinum, and the Merensky reef appears to be depleted in rhodium in those areas. No logical explanation can be offered for this anomaly. The same phenomenon does not apparently apply to the UG2 layer. It is also curious that the platinum values of the eastern Bushveld are depleted (Table 2.4), while those of the palladium are enhanced when compared with the western Bushveld — all the other PGE remain at roughly the same level (Table 2.4). Again, there is no explanation, apart from the possibility that the values may be fortuitously biased, although this seems unlikely.

To save space, the actual tonnages calculated are omitted. The density of the Merensky reef was assumed to be 3,2, and that of the UG2 4,3, in keeping with the values used by von Gruenewaldt (1977) in his tonnage calculations. Table 2.5 therefore shows only the *in-situ* and millhead reserves of the individual PGE in the various Bushveld sectors.

2.1.4. *The Potgietersrus Limb*

This limb has a north-trending outcrop length of 110 km, excluding the Villa Nora extension, which appears from under cover as an east-west extension in the northern extremity of the limb. The limb (Figure 2.6) is truncated by faulting in the south, and is overlain by younger (Waterberg) sediments and lavas in the north. The floor rocks consist of a wedge of Transvaal sediments and their metamorphic equivalents (quartzites, shales, hornfelses, leptites, tuffs, dolomites, limestones, and banded ironstones).

The Bushveld rocks progressively transgress these formations; from the Magaliesberg quartzites in the south, across the quartzitic-to-argillaceous Pretoria

Table 2.1

Estimates of strike, dip, thickness, and PGE grade for the Merensky reef and the UG2 chromitite layer in various sectors of the Bushveld Complex

Sector	Strike km	Dip degrees	Merensky reef Thickness m	Merensky reef *In-situ* g/t	Merensky reef Mill-head g/t	UG2 Thickness m	UG2 *In-situ* g/t	UG2 Mill-head g/t
Western BC — northern portion								
Middellaagte	20,60	20	1,00	7,88	5,92	0,70	6,25	5,00
Northam	–	20	1,00	9,49	6,25	0,70	6,53	5,22
Swartklip	9,60	23	1,30	7,38	5,55	0,78	5,28	3,89
Rooderand	9,00	30	1,50	6,58	3,94	0,70	4,95	3,25
Totals/av.	**39,20**	**23**	**1,19**	**7,88**	**5,46**	**0,72**	**5,79**	**4,38**
Western BC — southern portion								
Boshoek	23,52	10	0,40	8,48	5,51	0,75	4,81	3,69
Kroondal	29,30	10	0,40	8,53	5,50	0,78	5,00	3,83
Middelkraal	21,65	11	0,50	4,50	3,60	1,00	5,87	4,50
Hartebeespoort	33,50	12	0,69	3,54	2,76	1,28	5,78	4,33
Totals/av	**107,97**	**11**	**0,51**	**6,16**	**4,27**	**0,97**	**5,38**	**4,09**
Western BC	**147,17**	**14**	**0,69**	**6,62**	**4,59**	**0,91**	**5,48**	**4,17**
Eastern BC								
Dwarsrivier	47,20	14	0,62	5,47	4,10	1,24	4,51	3,38
Maandagshoek	34,85	11	0,36	5,83	4,37	0,60	7,98	5,98
Klipfontein	39,50	21	0,65	6,75	5,00	0,60	6,72	5,04
Naboom	33,40	65	0,80	4,75	3,80	1,10	5,00	3,75
Eastern BC	**154,95**	**26**	**0,61**	**5,72**	**4,33**	**0,90**	**5,96**	**4,47**
Main BC	**302,12**	**20**	**0,65**	**6,16**	**4,45**	**0,91**	**5,73**	**4,32**

Note: The *in-situ* and millhead grades are calculated over a standard stoping width of 90 cm for both the Merensky reef and the UG-2