was reported to be 5,99 g/t PGM + Au, with a total reserve to below 1200 m of 125 Mt of ore. The projected output of the mine was 1 920 000 t/y, yielding 8709 kg (280 000 oz) of PGM per year of which platinum constituted 4479 kg (144 000 oz). The Merensky reef is reported to be of low grade, and the rocks are thought to be badly faulted. The Kennedy's Vale property has rights over about 2400 ha, which includes the farm de Goedeverwachting, bought from RPH. The total tonnage of Merensky reef proved to be 48 Mt at a grade of 3,9 g/t PGM + Au, and that of the UG2 — with indicated reserves (600 to 1200 m) of 60 Mt and inferred resources (below 1200 m) of 24 Mt — a total of 84 Mt grading 6,3 g/t PGM + Au. The projected PGM output of the mine was to have been 4666 kg (150 000 oz) per year. For the same reasons as were indicated for Messina, these mines have been mothballed by Impala. However, the closure of the Crocodile River Mine, in September 1991, may be permanent, as all the mining equipment is reported to have been sold. The reason might be not only the low PGM price at that time, but also the many structural disturbances of the UG2 on the property, combined with the fact that the South African tax authorities refused to allow capital expenditure to be offset against profits from Impala's other operations in South Africa. The opencast part of the mine continued production well into 1992 in order to fulfil contractual obligations before the final shutdown.

Another property that eventually could be added to augment Impala's PGM production is the farm Moddergat 389 KQ, located adjacent to the southwestern extremity of the RPH Amandelbult section. This property apparently holds promise; otherwise Impala would not have spent R12 million on drilling the farm, which lies at the border of the so-called 'gaps' in the continuity of the exploitable Bushveld layers, a series of two enigmatic tongues of upper-zone rocks that transgress their footwall right down to the sedimentary floor.

With continued depressed prices of the PGM, Impala has opted for a cautious approach to mining and process developments, and any expansion plans have been shelved for the time being. As at RPM, all the matte is produced from concentrators and smelters at the four main mines but, for the reasons given, the company decided during 1992 to postpone, at least for one year, further expansion to the UG2 concentrator at the mines. Impala has installed a fifth furnace (the 'Gobbler'), and made technical improvements to increase its thermal efficiency and recoveries, capable of handling a feed consisting of 55 per cent UG2 without freezing. It cuts costs by R95 per ton, and savings totalled R50 million in 1992. In March 1994, Impala will start retreating 8 Mt of stockpiled furnace slags, which will yield an extra 71 kg PGM per month. The matte is sent to the Impala refinery at Springs, some 70 km west of Johannesburg. Even at the refinery, technical difficulties were experienced during 1992, with delays in the commissioning of several processing improvements, leading to a build-up of some 1555 kg (50 000 oz) of PGM in the pipeline. While the improvements were in progress and the technical problems were manifest, some of Impala's mine concentrate had to be toll-refined in Europe and the CIS (formerly Soviet Russia).

Impala sells almost all of its PGM production on long-term contracts but, due to the mining and refining problems in 1992, some 2177 kg or 70 000 oz had to be purchased or leased at the end of 1991, and a further 1555 kg or 50 000 oz had to be sought in January 1992. However, the company appeared to have solved its problems by midyear 1992. At the Springs refinery, very pure metals (platinum and palladium 99,95 per cent; other PGM 99,9 per cent) are produced along with sponge and ingot. All the exported products are marketed worldwide by the company's wholly owned subsidiary, Ayrton Metals Ltd. An important contract was recently concluded whereby Impala supplies 1550 kg of platinum per year to the Degussa AG company and three German car manufacturers.

3.1.3. *The Lonrho Group*

Originally named the London Rhodesia Company, the enigmatic Lonrho Plc was established by its founder, Mr R. W. ('Tiny') Rowland in 1962. The company is involved in an extraordinarily diverse range of activities, including producing, manufacturing, trading, publishing, and services, through about 800 subsidiary and affiliated companies in some 60 countries of the world. Specific activities include cattle ranching; tea, tobacco, sugar, and other food-crop growing; PGM- and gold-mining; and even petroleum production in the USA; while manufacturing includes paints and textiles, publishing and printing, industrial plants, agricultural equipment, vehicle fabrication, manufacture and assembly of building products, construction, and brewing. Service activities include hotels in many countries.

Geographically, some 66 per cent of Lonrho's business is in the UK and Europe, but Africa provides the bulk of the profit — 41 per cent in east, central and west Africa and 31 per cent from southern Africa (1991). For the past three years (1990 to 1992), the company's mining activities represented a steady average of 7,16 per cent of group turnover, but an equally steady average of some 37 per cent of the group's gross pre-tax profit. As will be shown, all Lonrho's mining activities are confined to Africa. On the basis of one British pound equalling 4,5 South African rand, the group's net assets on 31st March 1992 amounted to about R8000 million. Net profit on 30 September totalled R670 million for 1990 and R333 million for 1991; and for the six months ending on the last day of March 1992, R194 million. Lonrho South Africa's PGM interests increased turnover by 10,1 per cent to R913,7 million, and income after tax by over 100 per cent to R56,1 for the financial year ended September 1993.

Lonrho owns a 73 per cent share in both Western and Eastern Platinum Ltd, the group's main PGM producers, and a 66 per cent share in Duiker Exploration, which is involved in gold and coal mining in South Africa. The group also owns 45 per cent of the Ashanti mines in Ghana, and 52 per cent of Corsyn Consolidated and 100 per cent of Independence Mining, which are involved in gold mining and exploration in Zimbabwe and Mozambique.

According to Farquhar (1986), Lonrho commenced its initial drilling programme on its holdings in September 1968, while underground development started in July 1970. The first ore was stoped in March 1971 at the oldest of the Lonrho mines, Western Platinum Ltd. Farquhar gauged the *in situ* 'reserves' of the Merensky reef at Western Platinum to be 161 Mt at an average PGM + Au grade of 5,67 g/t (probably overestimated), with 0,16 per cent nickel and 0,10 per cent copper. Unfortunately, his estimates provide neither the vertical depth component nor the farms involved (likely to be Middelkraal 466 JQ and Wonderkop 400 JQ). Original production is thought to have been 1866 kg (60 000 oz) per year, but by 1988 Western Platinum Ltd had, on its own, increased production of PGM + Au to 9390 kg (301 895 oz). This mine now works both the Merensky reef and the UG2 layer. There are now four shafts — the newest (No. 4) reached its final depth of 949 m and started raising ore (total mine capacity 350 000 t/month) in October 1991. Two UG2 concentrators (capacity 80 000 t/month each) were completed in January 1988 and November 1990. The Merensky and UG2 ores are kept separate up to the smelting stage. The smelter and base-metal refinery at the shaft are both currently being expanded to accommodate the output of Eastern Platinum and Karee mines.

From 1985 to 1987, an extensive drilling programme was completed on the Turffontein 642 JQ and Mogales Location, both in Bophuthatswana. Subsequently, late in 1987, three inclined shafts were established to exploit the UG2 chromitite layer, and a new company, Eastern Platinum Ltd, was formed. In November 1989, opencast exploitation of the UG2 outcrop on Turffontein provided oxidized ore for Eastern Platinum's newly established mill and concentrator. Eastern Platinum Ltd has now completed this initial phase, and the opencast operations have now been abandoned — future ore will be hoisted by shafts from deeper stopes. Eastern Platinum also has two UG2 concentrators, and a total milling capacity of 160 000 t/month, but the products are sent to Western Platinum for smelting and refining.

On 22 October 1978, Impala announced the establishment of the Karee mine on the farm Rooikoppies 297, adjacent the Middelkraal farm, on which the main operations of Western Platinum Ltd are based. The reserves of Karee on the Merensky reef were reported to be 130 Mt grading 5,5 g/t PGM + Au, and initial production was to have been 3110 kg (100 000 oz) rising to 9330 kg (300 000 oz) eventually. However, on 1 October 1989, Impala reached an agreement with Lonrho whereby the former ceded ownership of Karee and its portion of the Middelkraal property to Western and Eastern Platinum Ltd, in return for a slightly higher than 25 per cent equity share in the combined properties and 27 per cent of their profits. The Karee mine also had a rather disappointing start, owing to the oxidation of the Merensky and UG2 layers near surface; which caused not only lower grades, but also much dilution of the ore and lock-up of metals in the metallurgical plant. Currently, mining is still carried out from a series of shallow inclined shafts, but a No. 3 vertical shaft was fully commissioned for hoisting in January 1993 to exploit the central and western portions of the property. Stoping of the Merensky reef commenced in the second quarter of 1993. The eastern side of Karee is already being mined at depth from the old No. 2 vertical shaft on Western Platinum. By the second half of 1993, stoping was underway at the No. 4 UG2 surface incline. At Karee, the Merensky and UG2 ores are combined at the start of the metallurgical process, following the method established at Impala, but extensions of the smelter and refinery facilities at Western Platinum are being geared to treating Karee's output. However, Western Platinum Ltd pioneered the metallurgical technology for treating the UG2 layer, which it has successfully been exploiting since 1982. The contribution from this higher-grade source to the total tonnage milled was over 74 per cent in 1993.

Much of Lonrho's PGM output is treated at its refinery at Brakpan on the Witwatersrand. Pure metals are produced, along with ingot and sponge. The exported products are marketed by the parent company, but part of the metal production from the refineries goes to PGM Chemicals (Pty) Ltd, which produces platinum-group-metal chemicals near New Germany in Natal.

The information in Table 3.1. was gleaned from the annual report of Lonrho South Africa Ltd of 30 September 1993, as well as the annual reports of the two mines that make up the division. These consist of Eastern Platinum Ltd (EPL) and Western Platinum Ltd (WPL) which operates Western Platinum and Karee. The noble metals in matte include platinum, palladium, ruthenium, rhodium, iridium, and gold.

The beneficial effects of establishing Eastern Platinum Ltd in 1989 and the contribution of the Karee mine are clearly discernable. Platinum and rhodium output (from another source) were respectively 10 762 kg and 746 kg in 1989; 15 116 kg and 933 kg in 1990; 19 440 kg and 1182 kg in 1991. From these data it appears clear that the PGM millhead yield is about 3,6 g/t. The total annual ore-production target for all these mines is said to be more than 8,0 Mt by 1994, yielding 15 552 kg (500 000 oz) of platinum and 1866 kg (60 000 oz) of rhodium by 1994 but it is possible that this had already been achieved by 1993, although labour unrest has already been manifest at EPL.

3.1.4. *The Gold Fields Group*

The farms Kaalvlakte 416 KQ, Kopje Alleen 422 KQ, Zondereinde 384 KQ, Middeldrift 379 KQ, and Grootkuil 376 KQ lie north-east of Northam and on the south-eastern down-dip side of RPM's Amandelbult section. Before 1981, the mineral rights were obtained by a Panamanian- and Swiss-controlled company, Hong Kong Investments SA. The farms cover the economic layers over a strike of some 20 km, cut off on the south-