

the 'Great Dyke' was rumoured to be too low-grade for successful exploitation. In view of this, I have accepted a 4,0 g/t *in-situ* grade and a 3,2 g/t millhead grade, and used the tonnages of Wilson and Tredoux to calculate the data in Table 2.18.

2.5. The USA

The only PGE-producing mine in the USA at present is in the Stillwater Complex in Montana but, apart from the Goodnews Bay placer deposits, which will be considered separately, the Duluth Complex, the Crillion-La Prouse Complex, and the New Rambler deposit appear to be worth reviewing.

2.5.1. The Stillwater Complex

This 2700 My complex (Figure 2.18) is situated in the Beartooth mountains of Montana, and consists of 48 km of WNW-striking, steeply dipping (50° N), differentially layered rocks with a thickness of 7400 m. Stratigraphically, an arbitrary zero datum has been accepted at the major change from the essentially ultramafic lower part (ultramafic and basal successions) to the plagioclase-dominant upper banded succession. The stratigraphy (thicknesses typical of the so-called 'Dead Tree Section') is shown in Table 2.19.

Intensive exploration of the Stillwater Complex since 1967 has resulted in the discovery of a PGE-bearing layer termed the 'JM reef' in recognition of its discovery by the Johns Manville Corporation in 1970, with value confirmation by 1974 (Conn, 1979). This appears to contain the only consistent exploitable PGE mineralization, and is located between 335 and 450 m above the arbitrary datum in the banded succession. The JM layer apparently persists over the entire 48 km length of the Complex, and has an average thickness of 1,83 m. It is variously positioned near the base of a highly complex sequence of at least nine cyclic units (Todd *et al.*, 1980, 1983) with a generally repetitive lithology of anorthosite, peridotite, and troctolite (Figure 2.19). The layer is recognized by its enhanced base-metal sulphide

content. It usually occurs within a dark magnetite-bearing anorthosite, but tends to wander upwards and downwards in the stratigraphy. The underlying peridotite of the fifth JM cyclic unit is characteristically coarse-grained to pegmatoidal. The successions above and below the reef are complex, and commonly variable and impersistent, with peridotite, bronzitite, websterite, olivine-norite, gabbro, troctolite, and anorthosite layers. This cumulate sequence of the ore-bearing interval has no regular series of fixed traceable layers, as in the Bushveld Complex.

The original exploration indicated two mineralized areas along strike, with a combined length of 12,07 km and an average grade of 4,65 g/t platinum and 14,09 g/t palladium (Pt:Pd ratio 1:3,03). Later grade estimates for the entire strike length are variable, but consistently higher than the original grade. I have accepted the Sutphin and Page (1986) ISMI grade of 20 g/t Pt + Pd, which increases to 20,51 g/t PGE using the total distribution for the individual PGE quoted below. Tonnages to 1200 m would be about 320 Mt of ore, using 42 km strike length, 1,83 m width, a dip of 55°, and a density of 2,87 for the reef. The average percentage distribution of the individual PGE in the JM reef is:

Pt 21,18 per cent
Pd 76,32 per cent
Ru 0,51 per cent
Rh 1,31 per cent
Ir 0,47 per cent
Os 0,21 per cent
Pt:Pd ratio 1:3,60.

I have assumed a mining loss of 20 per cent due to potholes (own observation), faults etc. to provide the millhead grade of 16,41 g/t. The final PGE tonnages for the JM reef in the Stillwater Complex to a depth of 1200 m are provided in Table 2.20.

Much geochemical sampling at Stillwater was undertaken by Page *et al.* (1960), but the analyses failed to reveal any viable mineralization. However, some apparent curiosities became apparent.

Table 2.19
The stratigraphy of the Stillwater complex (Dead Tree Section)

Major division	Subdivision	Lithology
Banded succession	Mega-unit VI 1040 m	Pigeonite gabbro and gabbro
	Mega-unit V 582 m	Troctolite-gabbro and anorthosite
	Mega-unit IV 444 m	Troctolite, troctolite-gabbro, anorthosite
	Mega-unit III 745 m	Troctolite-gabbro, anorthosite
	Mega-unit II 1136 m	Norite and gabbro
	Mega-unit I 515 m	Troctolite-anorthosite (JM reef) Gabbro and norite
Ultramafic succession	Bronzite zone 530 m Harzburgite zone 1135 m	Bronzitite, olivine bronzitite Harzburgites, bronzitites and 13 chromitite layers
Basal succession	Basal bronzitite and norite with xenoliths and sulphides, approx. 100 m thick	

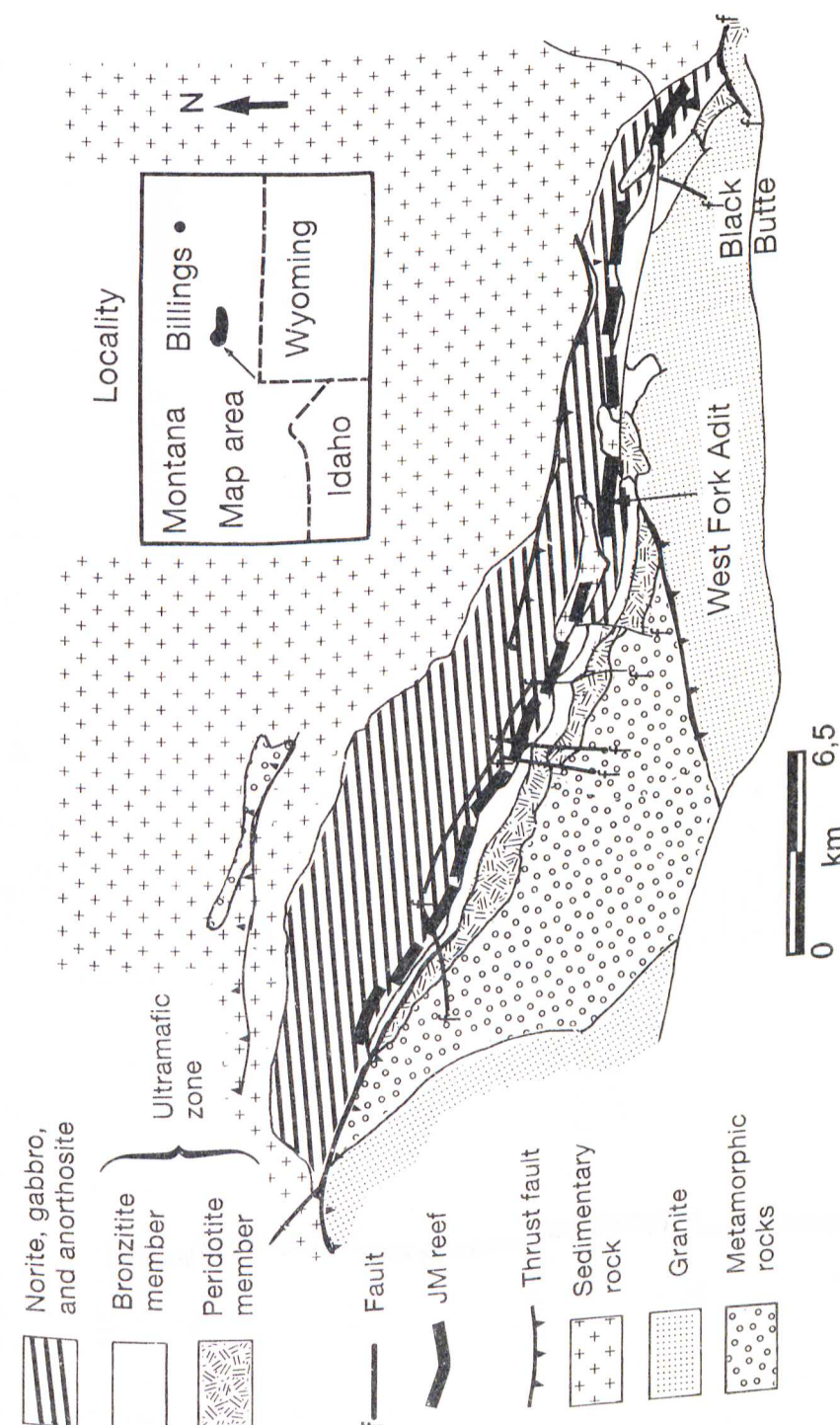


FIGURE 2.18. Geological map of the Stillwater Complex