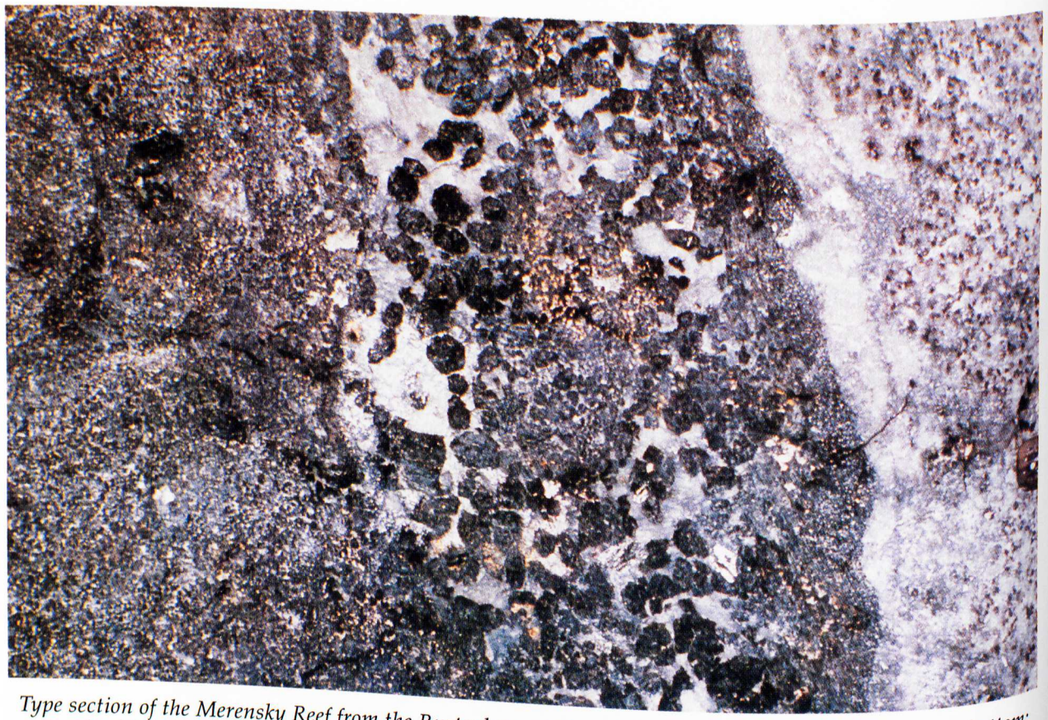
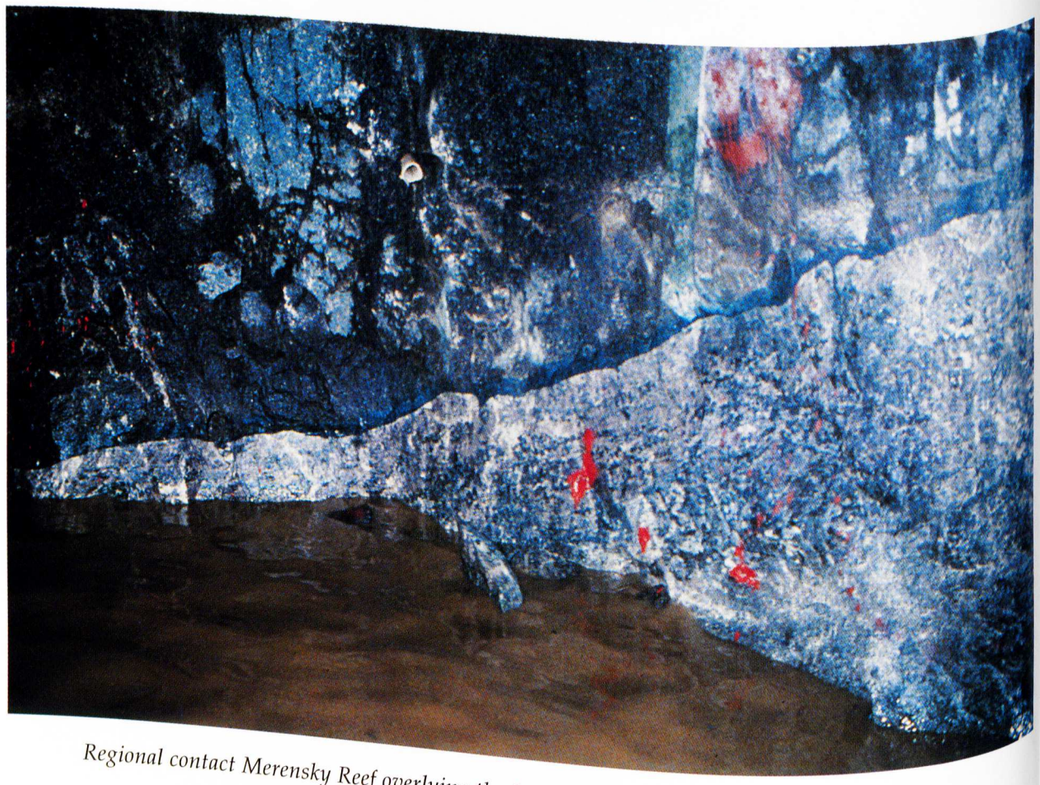


Type section of the Merensky Reef from the Rustenburg section of the Bushveld Complex. From top to bottom: porphyritic pyroxenite, upper chromitite, pegmatoidal reef, lower chromitite, footwall spotted norite. The vertical scale is about 40 cm
(courtesy Dr S.A. Hiemstra)



Regional contact Merensky Reef overlying the footwall marker anorthosite at Zondereinde Mine
(courtesy Gold Fields of South Africa Ltd)

Chapter 1

INTRODUCTION

1.1. Identification

THE elements referred to as the platinum group in the Periodic Table consist of a family of six greyish to silver-white metals, with close chemical and physical affinities. These may be subdivided, according to their relative densities, into three heavier metals — platinum (Pt), iridium (Ir), and osmium (Os), with densities of about 22 g/cm^3; and three lighter metals — palladium (Pd), rhodium (Rh), and ruthenium (Ru), with densities of about 12 g/cm^3. The platinum-group metals belong to the transition elements of Group VIII in the Periodic Table, to which the ferrous metals — iron, nickel, and cobalt — also belong. The chemical consanguinity of all these metals explains their similar geochemical behaviour, and their tendency to be concentrated together as a result of natural geological processes. The high resistance of the platinum-group metals to oxidation and corrosion causes them to be classified as noble metals, together with gold (Au) and silver (Ag), while their exceeding scarcity causes them to be called precious metals, some of them being the costliest of that family.

1.2. Early History

Man's original use of platinum metal, which was probably mistaken for silver at that time, dates back to the Egyptian civilization of the 7th century BC, when the famous 'Thebes casket' was produced. Platinum, being the most common of platinum-group metals in prehistoric and historical times, was the preponderant 'other' metal in gold-placer deposits, which were the main source of the precious metals in those periods. The refractory nature of all the platinum-group metals explains their general scarcity of artifacts from antiquity, although numerous artificial products of platinum and platinum-gold alloys, dating from the first four centuries AD, were located in Ecuador during the 1900s.

During their search for gold on the South American continent, the Spanish conquistadores discovered alluvial black sands in the placer deposits in the coastal strip of the Choco region (now Colombia; near the city of Medellin, north of Bogota, where such placers are still productive), washed down from the surrounding mountains. The silvery platinum grains were regarded as an annoying contaminant, which hindered the successful extraction of gold. Although this problem was overcome either by manual sorting or by mercury amalgamation of the gold, such refining was not considered to be economically viable; consequently much of the 'useless' platinum was discarded. A restricted amount of the metal was nevertheless utilized as small gunshot and as clock weights. In 1707, platinum was referred to as 'Platina del Pinto', the derogatory diminutive of 'plata' (i.e. small silver, also referred to as 'unripe gold') from the Pinto area. This 'platina' was initially used to adulterate gold by alloying to produce 'oroblanco' or white gold and, although this practice was forbidden by decree in 1752, many gilded platinum coins were still being passed off for gold in the 1760s.

The export of platinum from the western regions of South America, referred to as 'New Canada' by the Spaniards, was eventually banned, although early experimental work on material smuggled from these regions indicated a future potential for the metal, one being its ability to assume a high polish for use in mirrors. Such findings inspired studies in England, France, Germany, Spain, and Sweden, where the individual platinum-group metals were eventually 'discovered', and their inextricable mineralogical and chemical links as a metallic group were also established.

Platinum, which was recognized by the Italian academician J.C. Scaliger in 1557 as being 'unmeltable' was formally discovered by Scheffer in Sweden in 1751. It was first used in laboratory apparatus, in glass-melting crucibles, in telescope mirrors, as metric standards, and in decorative porcelain and other *objects d' art* in the later 18th century. The discovery of the other metals of the platinum group then followed — palladium in 1802, named after the asteroid Pallas discovered in the same year; and rhodium in 1804, named after its rose-coloured salts in dilute solution. Both discoveries were the work of the English medical man, Dr W.H. Wollaston. Iridium, named after the rainbow of colours on its surface, was discovered by the chemist Smithson Tennant in the UK in 1804. Finally, ruthenium ('Russia') was isolated by Carl Ernst Klaus at the Kasan university in Russia in 1844. The story behind the eventual melting and refining of these metals is long, and need not concern us here, although it is interesting to note that the catalytic properties of these metals was already known and described in the period 1823 to 1838. In the 19th century their principal uses, especially of platinum, were mainly in sulphuric-acid boilers; in resistance thermometers and thermocouples; as metric standards; in photographic paper; in electrical contacts, lamps, and furnaces; and as spinnerets in glass and synthetic-fibre production. They are still used in many of these applications today.

1.3. Modern Applications

The platinum-group metals characteristically exhibit extraordinary physical and chemical properties that render them indispensable to modern technology and industry. The metals are refractory, with very high