

MINERAL SANDS

Introduction

Western Australia's vast stretches of coastal plains offer much more than meets the eye.

In certain areas below the topsoil lie deposits of heavy mineral sands, some of which are rare earths and part of the leading edge of new technology.

The vast importance of heavy mineral sands has only been identified in the past 50 years. Initially mined for paint pigmentation, the minerals are now recognised as being of strategic importance for exciting developments in industrial and scientific technology.

Nobel prizes in physics have been awarded for developments in mineral sand science and application. Indeed, heavy minerals are now bringing technological advances which only a

few years ago were viewed as "21st century dreams."

Properties of mineral sands

There are four main heavy minerals that are extracted from mineral sand mining. The first of these is rutile. Rutile is a naturally occurring titanium dioxide. The mineral is commonly red or black in colour, with a specific gravity of about 4.25 (that's 4.25 times heavier than water). It is the high quantity of titanium (60%) in rutile that makes it such a desirable heavy mineral for use in a wide range of high technology applications.

Ilmenite is another heavy mineral and like rutile it has a significant titanium content (31%). Ilmenite is black with a specific gravity that varies from 4.5 to 5.0. Ilmenite can be slightly magnetic.



Δ A dredge for heavy mineral sands scoops the ore from a flooded basin and then despatches it to a separation plant.

The third mineral property in mineral sands is zircon. Zircon is the principal ore of zirconium. The mineral has no strong coloration and appears off-white or cream as a sand concentrate. The specific gravity of zircon is 4.6 to 4.7.

The rarest mineral, monazite, exists as a rare earth phosphate. Its principal component is thorium (30%). It is the presence of thorium that makes monazite a mildly radioactive mineral. Monazite grains are yellowish to brown with a specific gravity of 4.6 to 5.4.

Formation of mineral sands

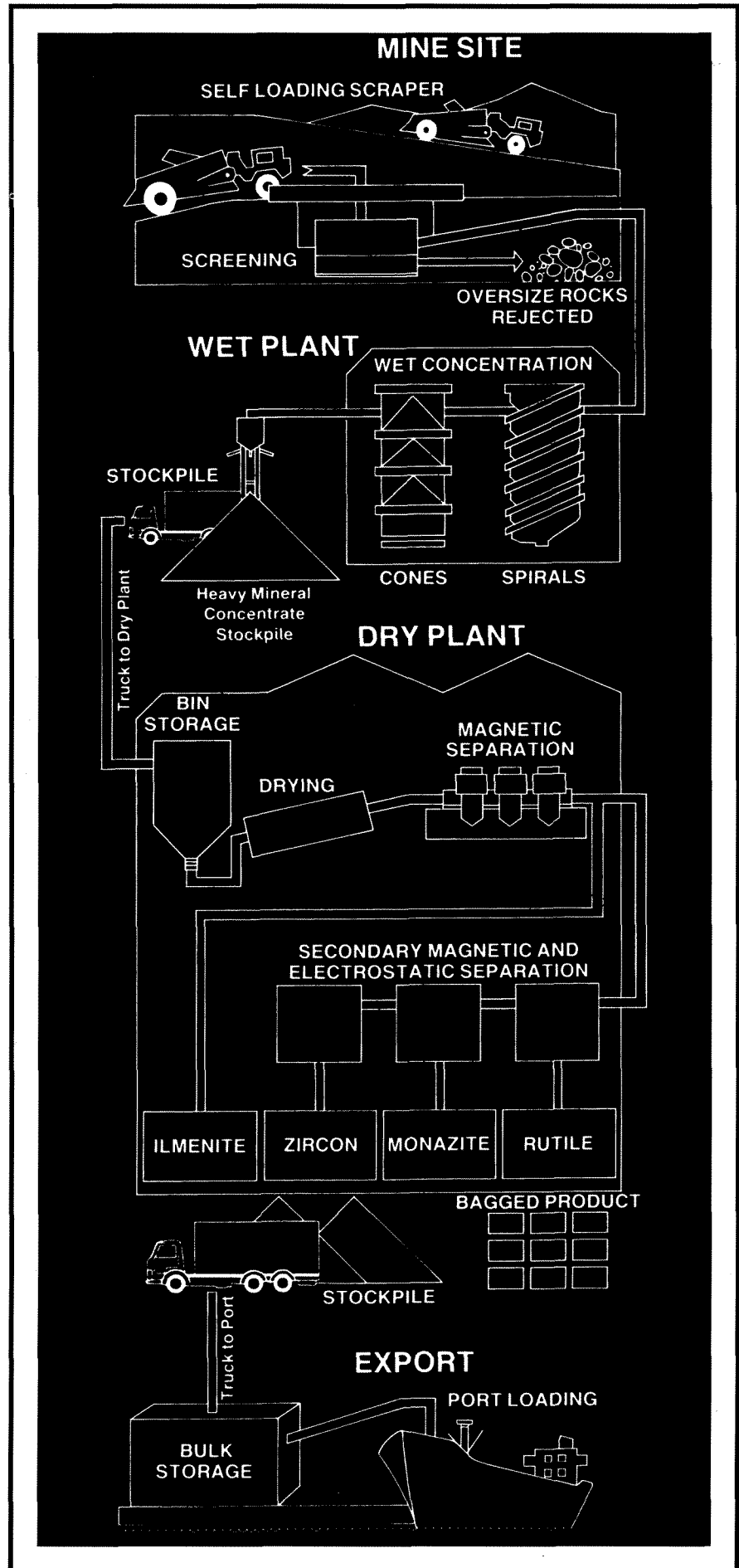
Mineral sand deposits are formed from the erosion and weathering of pre-existing igneous rocks. Over 60 to 200 million years the combinations of wind and water from ancient rivers and seas have leached the minerals from their past rocks and concentrated them into beach and dune deposits. The result is that, today, mineral sand deposits can occur at varying levels above the present sea level. Some deposits have been located up to 35km inland.

Uses of mineral sands

Many of today's richest man-made colours owe their high quality to the heavy minerals found in WA's sandy coastal plain. Rutile and Ilmenite are the major raw materials for the world's paints and dyes.

Because rutile and ilmenite produce a superior titanium dioxide pigment they are also used to enhance colour in plastics. Some ilmenite is used in the steel industry for furnace linings and foundry moulds due to the mineral's ability to withstand extreme temperatures.

The high titanium content in rutile and ilmenite is extracted to produce titanium alloy metals. The titanium is used in high-technology aerospace design. Primarily used for airframe parts, space-craft and guided missile components, titanium is extremely useful due to its strength-to-weight ratio. As a non-reactive metal it is used extensively in making artificial joints in modern surgery.



Zircon is used as the raw material for making refractory bricks and furnace linings due to its melting point of over 2 500 degrees Celsius. It is also used widely in the ceramics industry as a speciality glaze and foundry medium.

A small percentage of zircon is used in its purest form to make nuclear fuel containers.

Television colour and screen luminescence are dependent upon the production and separation of rare earths from monazite. Video monitors and high-efficiency lights all require rare earths for their continued production. The computer, electronic and medical industries all look towards monazite processing as a beginning for future technological developments.

Production

Australia is one of the world's largest producers of heavy mineral sands. Rich deposits in Western Australia make it the nation's leading producer. With such vast heavy mineral sand deposits, WA produces 46% of the world's zircon.

▷ *A flow-chart of a typical mineral sands mining operation, plus the processing and export phases.*

▽ *An artist's impression of how dredge mining and land rehabilitation are carried out.*

Industry analysts have predicted that within a few years WA will be producing up to 70% of global requirements for synthetic rutile. In 1993, WA produced more than 1.6 million tonnes of ilmenite, representing over 90% of Australia's total production. Monozite production in WA ceased in 1994.

Historical background

Heavy mineral sands were first mined in Australia at Byron Bay, New South Wales in 1934. In the 1940s, mining had extended into Queensland as rutile was being used in electrodes for radios in World War II. The post-war mining industry continued to grow and in the mid-1950s ilmenite mining began near Bunbury in Western Australia.

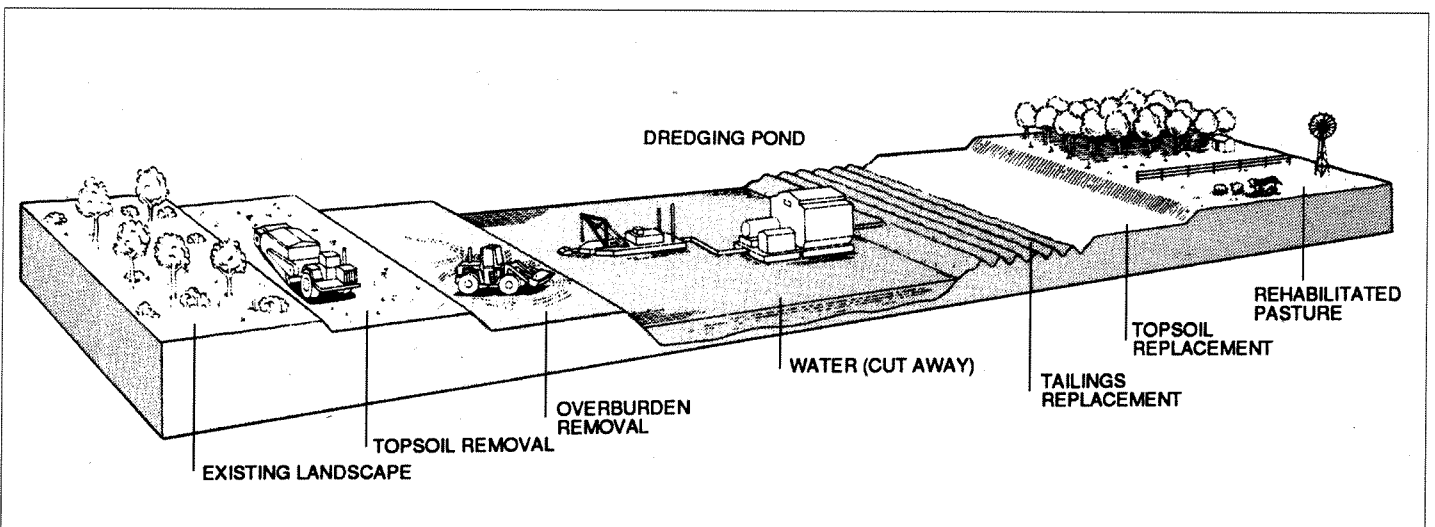
Throughout the late 1950s and 1960s demand increased for titanium dioxide pigment which comes from rutile and ilmenite.

Australia quickly became the world's leading producer of mineral sands. The 1970s saw WA begin full-scale production and the State rapidly became the primary national producer for all heavy mineral sands. This trend continues to now make WA a leading international mineral sands producer.

In mid-1994, production started from Cable Sands' new Jangardup mine, which rates at the first major mineral sands project completed anywhere in the world over the past four years. The mine will produce predominately ilmenite and it has a design capacity of 236 000 tonnes a year.

Mining and treatment

Before mining begins all timber and topsoil is removed from the minesite. The topsoil is stockpiled for later rehabilitation after the mining operation has ceased.



Actual mining methods are moderately simple. There are three main methods:

1. **Suction dredging:** Floating on an artificially made pond the dredge digs up sand which is carried by pipes to a separating plant. The dredge continues to slowly advance while clean sand tailings are spread behind the pond where they will be revegetated at a later date. At the separating plant heavy mineral sands are extracted by using a system of gravity and magnetic separators. These are then pumped into a nearby concentrator and held for final separation and treatment.

2. **Open-cut mining:** Using scrapers and bulldozers the face of the mine is progressively worked. The ore taken from the mine face is then placed into a hopper for screening. The objective of the screening plant is to break the ore down into grains no larger than 2mm. The screened ore then proceeds through an intricate series of spirals to remove tailings and excess slime. The final concentrate is stockpiled for separation and treatment.

The separation and treatment process begins with gravity separation using shaker tables and water fed spirals. The concentrate is then heated to remove all remaining moisture. Finally, the concentrate passes through a series of high tension and magnetic separators to produce the final consistent products —rutile, ilmenite, zircon and monazite.

3. **Hydraulic mining:** With this technique the ore body is washed down using a water cannon. The ore is then pumped as a slurry to a wet concentrator which separates the valuable minerals from the waste material.



Δ Exploration drilling for mineral sands.



Δ Protection and rehabilitation of the environment are important considerations for mineral sands mining companies. Here, officers check the quality of water in a stream near a mining site.