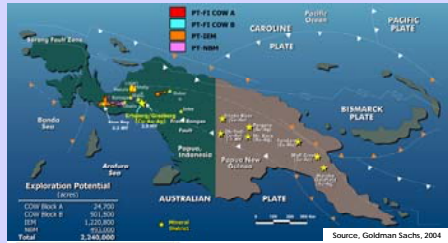


# Extreme Mapping: Supporting PT Freeport Indonesia's Copper and Gold Operations in Papua, Indonesia



The island of New Guinea lies just south of the Equator between the Asian and Australian continents straddling the so-called ring-of-fire. Geologically young, this island was born some 10 to 20 million years ago when two of the earth's plates collided. The collision and subduction of one plate beneath the other thrust the ocean floor upwards over time creating the second largest island on the globe. The ocean floor gave birth to mountains towering as high as 6000 metres, the highest of them capped by glaciers. The island continues to grow in size as heavy equatorial rains wash sediments from the highlands towards the sea, building new land near the coast.

It is in this setting, millions of years ago, that volcanoes unleashed molten material deep within the earth, and as the molten material intrude into the mountains it leaves behind minerals that contain copper, gold and silver.

The Grasberg mine in the Indonesian province of Papua is the engine that drives gold and copper production for PT Freeport Indonesia. The complex includes open pit and underground operations and contains one of the biggest copper and gold reserve in the world.

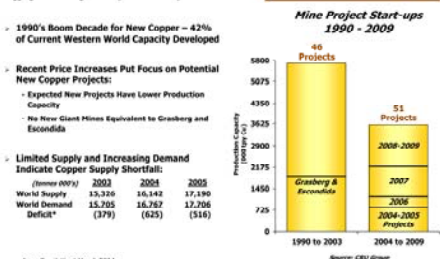
Ertzberg, the copper mountain, was discovered by Mr. Jean Jacques Dozy in 1936, and re-discovered by an expedition led by Mr. Forbes Wilson from Freeport Sulphur Company in the 1960's. This was followed by the development of the Ertzberg Mine in 1968, and in 1988 the discovery of the world-class Grasberg deposit resulted in accelerated and increased production ([www.fx.com](http://www.fx.com)).

- Continuous Production Since 1972
- Discovered Grasberg in 1988
- Development Completed in 1998

Grasberg Complex Expanded to Over 3 Billion Tonnes of Ore\*

- 68.4 Billion lbs Copper\*
- 85.2 Million ozs Gold\*

\* Appropriate remaining reserves plus cumulative production since 1988



Current analysis show that in spite of the decrease in copper use by the telecommunications industries, global copper consumption exceeds demand and this deficit needs to be addressed to meet the requirements of the power distribution, housing, and water supply industries, particularly in the growing economies of the Far East.

To-date, there are no new giant mines equivalent to Grasberg in Indonesia and Escondida in Chile ([www.fx.com](http://www.fx.com)).

The safe, efficient and sustainable operation of exploration, engineering and mining operations depend on accurate, precise and timely delivery of data and information on the economy, weather, geology, hydrology, culture, ecology and engineered structures. Remote Sensing, Photogrammetry, Satellite Positioning, Geographic Information Systems and Project Management are the key technologies that are used to support these operations.

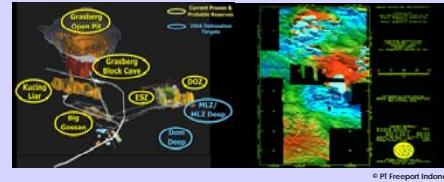
Extraction of minerals from rocks result in the production of tailings. The Grasberg operation produce on average 223 thousand tonnes of tailings per day and these require management under the tailings management programme. These programmes aim to detain and re-use the tailings for horticulture and agriculture, production of building materials, land reclamation, and for the construction of transport infrastructures.

The Landsat Enhanced Thematic Mapper satellite image, covering approximately 60 kilometers by 60 kilometers, shows the ModADA or Modified Aikjwa Deposition Area. This demonstrates the efficiency of the design of the tailings management structures for detaining the tailings generated at the mill facility located at Grasberg, 5000 meters above sea level.

The flow of the sediments into the Arafura Sea, colored light brown, is due to the presence of minerals and organic matter in suspension in the water. Over time, these sediments accumulate and give rise to vast marshy plains. The delta gradually fills up and widens. Mangroves then develop in these areas where the freshwater and salt water mix.

In the region's interior, the dark green color indicates the density of the tropical forest which is home to about 500 species of trees.

The small rounded patches of white represent clouds located over the scene during image acquisition.



Aerialgeomatics have been supporting PT Freeport Indonesia's exploration and site mapping activities in Irian Jaya since 1999. This collaboration has provided training to ground and aircrew and delivered to job-site aerial photographic and navigation systems for capturing high resolution digital images for reconnaissance, environmental audits, emergency response, map production, elevation model generation and exploration.

Finding bodies of ore in this vast virgin territory is the challenge of a lifetime. It begins on paper and through intensive computer and spatial analysis dozens of Remote Sensors, Photogrammetrists, Geologists and Soil & Water Engineers review physical data and scan maps for evidence of mineralization. This is followed by intensive field surveys and exploration drilling.

Continuous in-situ education and training in remote sensing, air survey navigation, photogrammetry, geographic information data and systems maintenance ensure that the team can meet all of the organisations decision-support requirements.

These teams are educated, motivated professionals who constantly demonstrate technical knowledge, perseverance, a sense of adventure and teamwork.

The acquisition of these skills, by the local community, has resulted in highly trained teams who are able to perform safely and efficiently in one of the most inhospitable and uninhabited environments on earth.

These highly trained and dedicated workforces have enabled the discovery of new ore bodies, identified geohazards, prevented environmental degradation, provided security of plant and workforce, and ensured sensitive and appropriate development of the Papua region.

Three Bell -12 helicopters, three DHC-6 Twin Otters and one Grumman Mallard seaplane form the basis of all aerial remote sensing, surveying, mapping, transportation, logistics support, exploration and medical evacuation roles.

Typical operational statistics over an eighteen month period show:

Helicopter Hours Flown	8 122 Hours
Fixed-wing Hours Flown	6 451 Hours
Personnel Moved	64 235 Persons
Cargo Moved	16 781 447 Kilogrammes
Jet Fuel Used	1 560 000 Kilogrammes

Aerialgeomatics have designed, integrated, built and installed digital mapping cameras, and space based survey navigation systems into the nose cones of the helicopters.

The systems consist of 16 million pixel panchromatic near infrared and colour digital cameras that have been calibrated to meet exacting photogrammetric specifications. These sensors are mounted on purpose built mounts that compensate drift and pitch. The system is designed to level, to within ±5°, for image tip and tilt. Reduction of these errors significantly increases the accuracy and precision in planimetry and heighting of the resultant orthophotographic map and elevation model.

Navigation of the helicopter is conducted using dual frequency Global Positioning Systems augmented by satellite based differential corrections. This configuration delivers on-the-fly position accuracies of ±10 centimetres at a data rate of 20 Hertz.

The integrated systems ensure safe navigation, accurate and precise image positioning and orientation, and enhanced on-demand mapping capabilities.

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