

An aerial photograph of a port facility, likely Port d'Ehoala. The image shows a large, curved pier extending into the ocean, with a ship docked at the end. The water is a deep blue, and the surrounding land is green and hilly. The sky is clear and blue. The port facility includes several buildings and a paved area. The overall scene is a well-developed maritime infrastructure.

RioTinto

Transport and Export of Rare Earth Concentrates

Frank Harris

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Where does the Rare Earth Concentrate Come From?

- As part of normal mineral sands extraction, the rare earths are separated as a magnetic reject
- Because the thorium containing monazite mineralisation also follows this same path the material has enhanced levels of radiation in comparison to both the feed stock and the desired products from the mineral sands operation
- Because of the radioactivity this side stream is often disposed of as part of the normal operation (often either in its own waste disposal area or preferentially at depth and covered by lower density sand)
- This can have a radiological benefit as the rehabilitated landform may have a lower radiological signature than the pre-mining background
- However, disposal means the inherent value of the rare earths cannot be realised

Mine location and products (QMM)

Currently mining is only occurring in the Mandena concession about 5km northeast of Tolagnaro (Fort Dauphin).



TiO₂
Titanium dioxide
slag

QMM mines ilmenite from the sands to produce Titanium dioxide, a mineral used in a range of industrial and commercial products.

Rare earths concentrate is also produced in smaller quantities.



Madagascar full satellite image source: Mapsland.com

Mandena operations



** Note satellite imagery from Google Earth may not accurately represent current state or position of the mine ponds, mine infrastructure, or areas under rehabilitation.* Google

Mining process (ore separation and concentrating)

The mining process uses mechanical, magnetic and electrostatic methods of separating ilmenite from the sands – no chemical agents are utilized – and 95 per cent of the material mined by the dredge is returned to the environment.

Dredging at front of the pond



Ilmenite ore separation in wet plant



Sand returned to back of the pond



Further concentration



Truck transport to Port d'Ehoala



Export from Port d'Ehoala

Why Dispose of the Material Containing Rare Earths

- **RADIATION!!!**
- The inherent radioactivity in the material means significant difficulties in all aspects of the handling of the Rare Earth Concentrate
- This includes:
 - Enhanced worker exposure
 - Regulatory issues
 - Land transport issues
 - Export issues
 - Import issues
 - Basically a lot of difficulties to realise any return on the value

Regulatory Issues

Past (Present??) Status



Desired Future State



How To Realise the Value in Compliance with Regulations

- It is not easy
- It took over three years (and maybe twice this if looking at the start of the idea to recover rare earths) to overcome all the hurdles and obstacles in the way
- Obstacles included
 - Need everyone to accept the radioactivity (including the desire to ignore it)
 - Need to stay firm to only looking at options which are in compliance with regulations and also which represent good practice
 - Lack or variable regulatory approaches
 - There is REAL radiological risk
 - Perceptions around radiation (Public, regulator, workers, ports, etc.)
- Even when you have done it once does not mean it is easy from then on

How QMM Packages the Rare Earths Concentrate

- Material transported as UN2912 LSA I material (NOT UN2910)
- Only accept a minimum of two levels of protection for the material
- Material packaged in IP-1 bulka bags (~two tonne per bag)
- Each bag measured for Transport Index and appropriately labelled
- Ten bags per 20 foot shipping container
- Container measure for Transport Index and appropriately placarded (TI between 5 and 10)
- NOTE: Make sure you include the multiplier due to size of the container when determining the TI
- Containers are stored either in designated areas on the mine site or at the company owner port in a area remote from worker or public occupancy
- Between 400 and 500 containers are stored awaiting shipment

The Bulka Bags and the Shipping Container Loading



How QMM Transport the Material

- Loading occurs at a company owned port
- Dedicated container ship for the cargo going direct from port to port (no transshipping)
- Use a shipping company experienced in transporting radioactive material
- Transport under exclusive use (sum of TIs for an individual hold exceeds 200)
- Need to monitor radiation exposures in all ship area and ensure doses are ALARA

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Loading Containers into the Dedicated Ship



How the Material is Unloaded and Imported

- Lots of consultation
- Stay firm in ensuring the material is acknowledged as a radioactive material
- Need to separate the real concerns from the perceived or historical concerns and action appropriately

Conclusion

- The realisation of the value in rare earth concentrates is not easy
- Need to accept the radioactive nature of the material and handle and transport according
- Avoid temptations to not follow the appropriate practices
- It can be done in full compliance with regulations but will require a long term view and a strong commitment to doing the right thing

Any Questions?