Ore-Sand: A circular economy solution to the mine tailings and sand sustainability crises

Arnaud Vander Velpen
Senior Research Associate, University of Geneva
Sand industry & Data analytics officer, UNEP/GRID-Geneva
Setting the scene
What is ore-sand?

Ore-sand (o-sand) is a type of processed sand sourced as a co-product or by-product of mineral ores. Typically, it is a result of mechanical crushing and grinding, different physical and physicochemical beneficiation processes for mineral concentrates recovery, including optimization of these processes and additional processing stages to achieve the required properties of sand.
What are the markets for sand?

Source Material  Sector  Application

- Marine
- Riverine
- Lacustrine
- Recycled
- Re-used on site
- Rock quarries (crushed rock)
- Terrestrial (non-marine, non-riverine)
- Industrial (co-)product

Sand and Gravel

- Construction (aggregates)
- Land reclamation
- Industrial uses

Buildings
Infrastructure
Landscaping (e.g. sport fields)
Glassmaking
Electronics
Construction related (e.g. Ceramics)
Energy (e.g. fracking)

50,000,000,000 t

Source: Peduzzi, Unpublished, analysis conducted with USGS data in 2018
The Vale sand case-study
Iron ore and sand co-recovery

Ore crushing, milling, and classification

+1-8 mm
Gravity separation

+0.15-1 mm
Magnetic separation

-0.15 mm
Flotation

Ore crushing, milling, and classification

Ore crushing, milling, and classification

Gravity separation

Magnetic separation

Flotation

Classified to +0.15 mm

Thickening

Milling/ mag. separation

Filtering

Sinter feed

Milling/ mag. separation

Filtering

Pellet feed

Thickening

Filtering

Pellet feed

Thickening

Filtering

Sand

Dry-stacking

Mag. separation

Classification

“coarse”

Filtering

“fine”

Filtering

Thickening

Filtering

Residual tailings

Iron ore flows

Sand flow

Residual tailings

ultrafine
Vale Sand: standard and unique features

**Very fine quartz-based sand**

Vale Sand vs ASTM 33 grading envelope

- **Residual iron oxides, very low trace elements**
- **Very angular shape**

\[ D_{10}: 60\mu m; \ D_{50}: 134\mu m; \ D_{90}: 271\mu m \]
Vale Sand: current and potential applications

Note: based on min SiO₂ and max Fe₂O₃ content; compliance with other requirements may be also needed.
What is the potential to scale up ore-sands?

Note: The potential supply points of ore-sand (red) are shown as points with a radius of 50 km, a typical distance over which transporting sand is economic. The weight of the pixels is proportional to the estimated potential supply at that point, capped at 200 kt. The weight of the blue pixels is proportional to the estimated demand at each location, capped at the same value.
Where ore-sands could be close to markets?

**Diagram:**
- Chile: 16.2 Mt
- South Africa: 6.7 Mt
- Ghana: 947.8 Mt
- Peru: 6.1 Mt
- China: 15.2 Mt
- Philippines: 16.7 Mt
- Mexico: 5.8 Mt
- D. R. Congo: 10.9 Mt
- Turkey: 7.6 Mt
- Brazil: 10.9 Mt
- Russia: 9.3 Mt
- Indonesia: 13.3 Mt
- India: 13.3 Mt
- USA: 9.3 Mt

Countries with total potential > 5 Mt/yr:
- Armenia
- Fiji
- Jamaica
- Cyprus
- Sierra Leone
- Tajikistan
- Zimbabwe
- Guinea
- Togo
- Bulgaria

Countries with total potential > 0.5 Mt/yr:
- Burkina Faso
- Ireland
- Dominican Republic
- Nicaragua

Substitution potential within 50km of prospective sources, Mt.
Conclusions

• **Ore-sand is a product by design, not repurposed waste**
  Adjustments in mineral processing can create a marketable sand product.

• **Current limitations and opportunities**
  Full replacement currently limited by grain size. Coarser ore-sands possible e.g. via coarse particle flotation.

• **Sand markets align with tailings risks**
  Sites close to urban centres present both a sand market and a rationale for tailings reduction.

• **Safeguarding sustainable and just transitions**
  Wider adoption of ore-sands must address potential presence of contaminants, management of residual tailings, and broader effects on the market.

• **Future markets**
  Almost a third of mine sites in the world can find at least some demand for ore-sand within a 50 km range, with at least 10% reduction in tailings. From a consumer point of view, about half of the global sand market is in the vicinity of a potential local source of ore-sand.
Thank you

For more information email: Sand@unepgrid.ch