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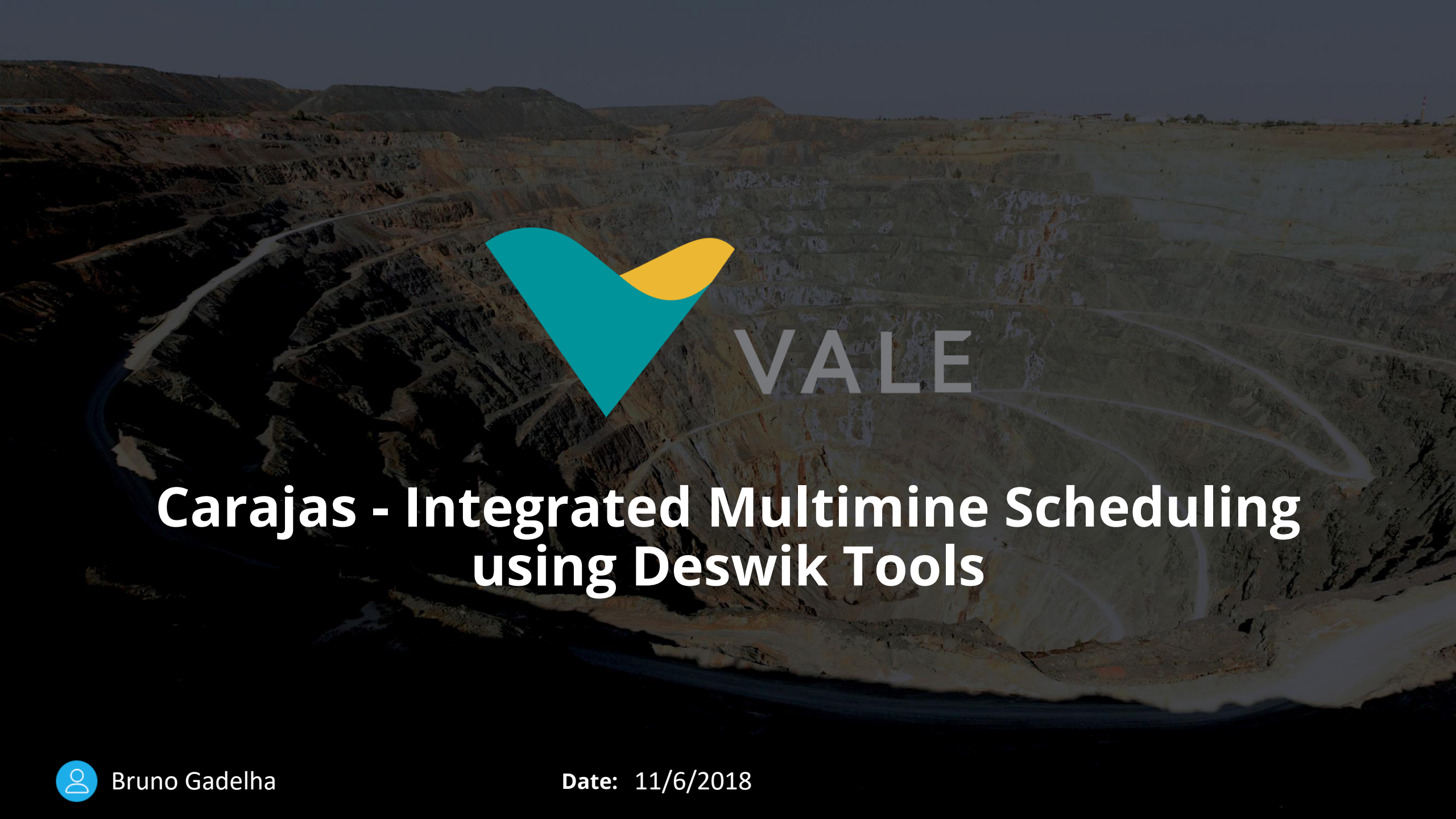


VALE

Carajas - Integrated Multimine Scheduling using Deswik Tools

Bruno Gadelha

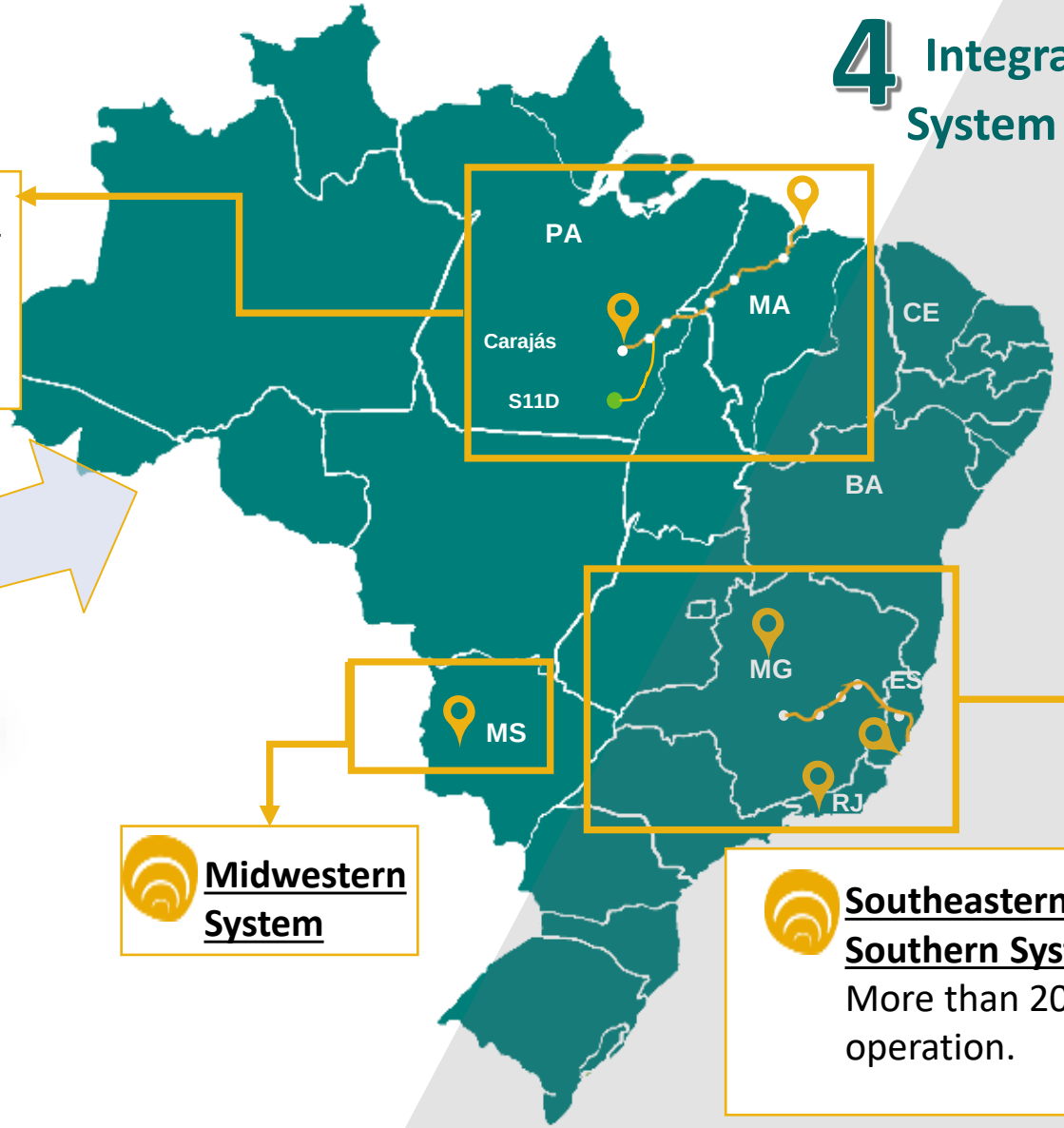
Date: 11/6/2018

OVERVIEW – Vale´s Iron Ore

4 Integrated Ore System in Brazil

Northern System:
Carajás, S11D.

Best Quality Ore

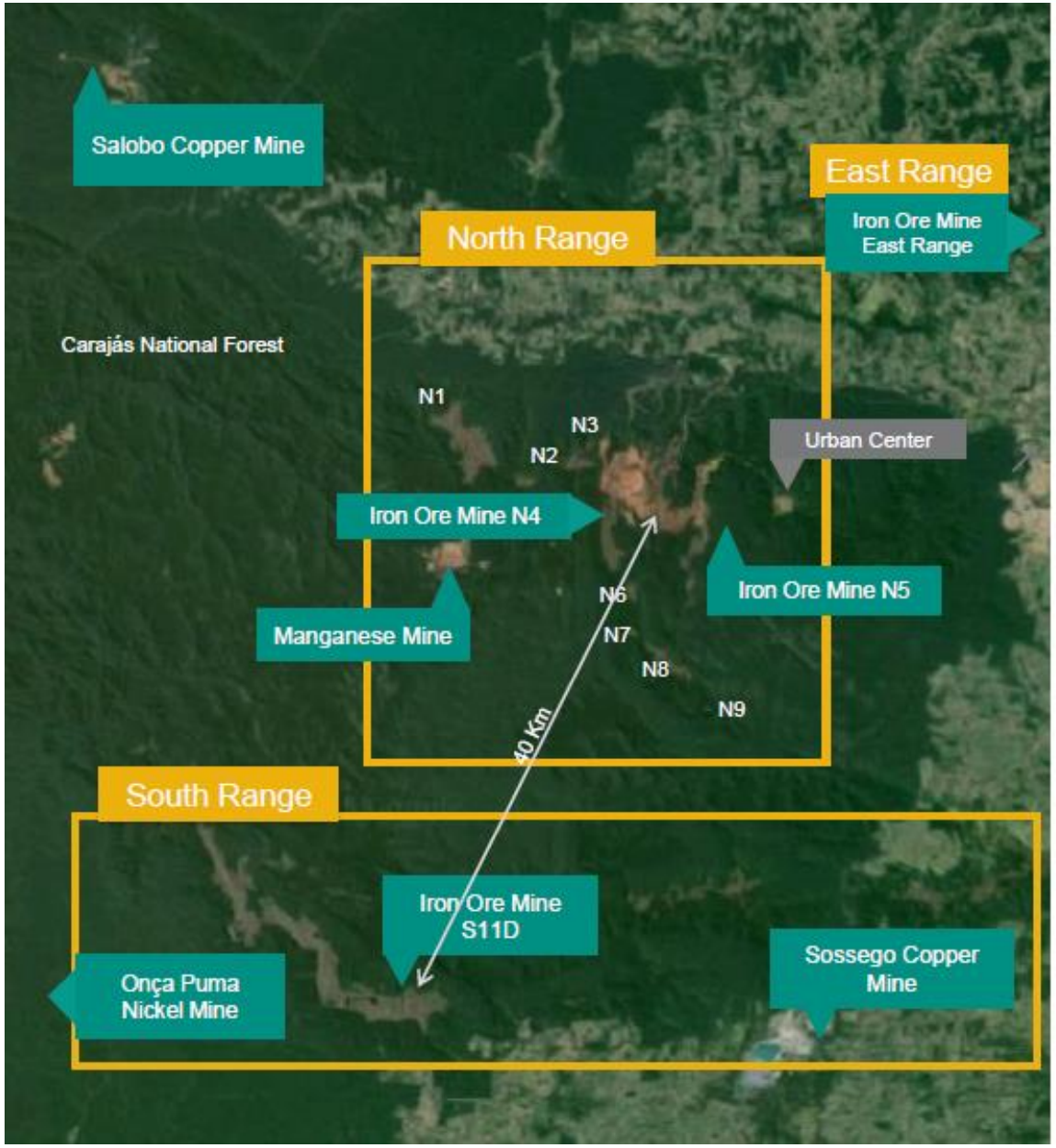


Midwestern System

Southeastern and Southern System:
More than 20 mines in operation.

OVERVIEW – Northern System

OVERVIEW – Northern System



Ore Production Areas

The Iron Ore Geological Reserves in Northern System total 6,622 million tons, divided into:

North Range: 2,169 Mt
East Range: 258 Mt
South Range: 4,195 Mt

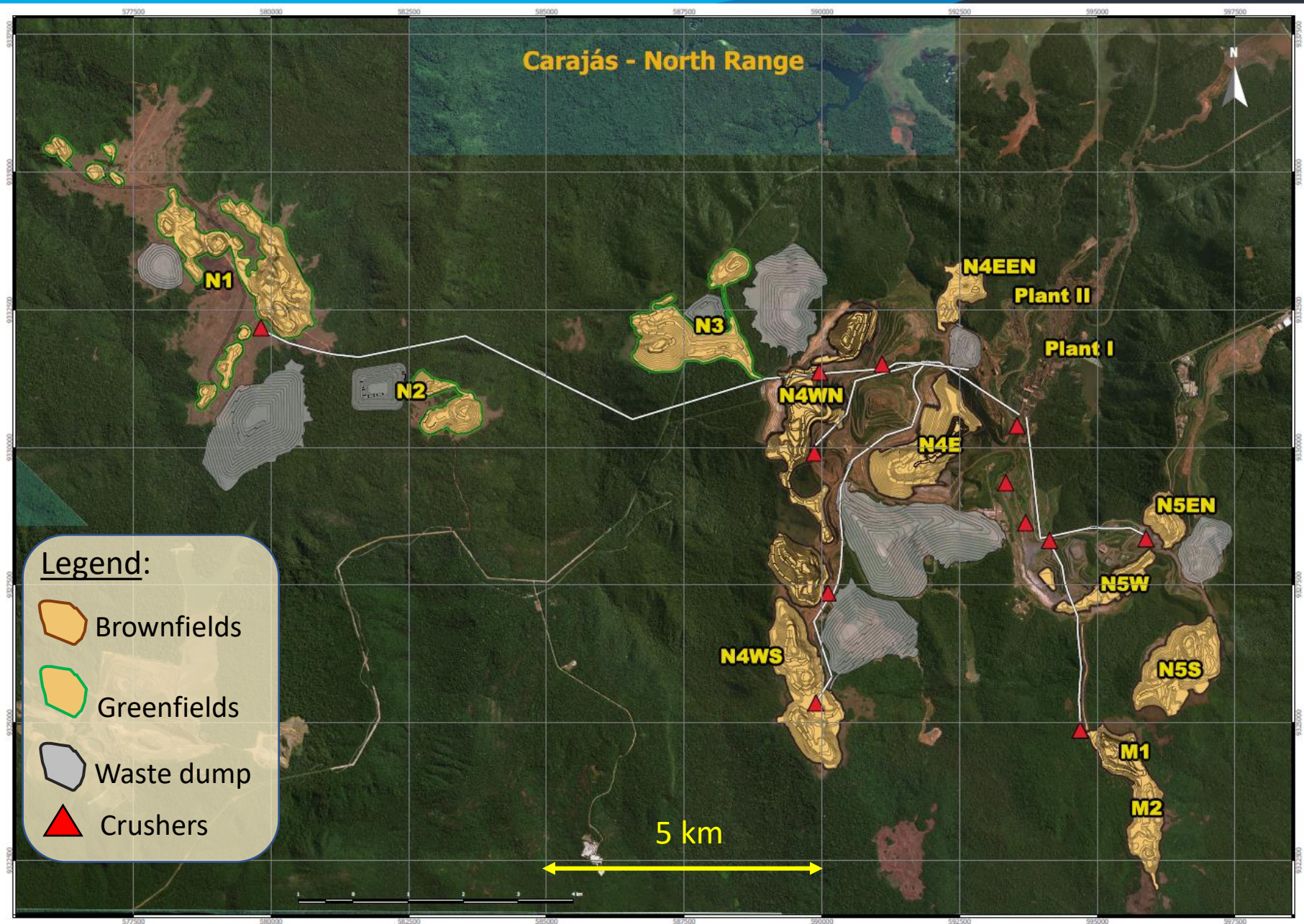
*Form 20-F Vale 2017

OVERVIEW – Carajás: North Range

Carajás´s North Range:

There are currently 6 mines with 8 bottom pits operating simultaneously to feed 3 plants and producing around 140 Mtpy (ROM).

Until 2025 there will be 10 mines in full integrated operation.



Introduction

Deswik.CAD

Deswik.IS

Deswik.Sched

Deswik.Blender

Deswik.LHS

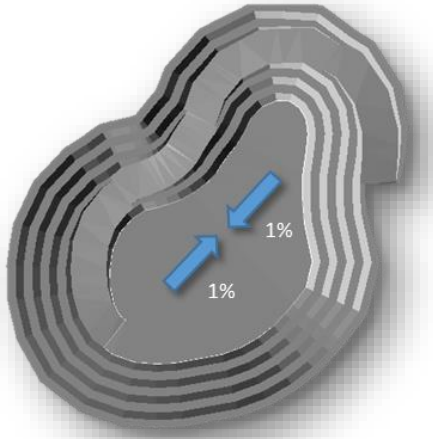
How to do a life of mine plan (LOMP) controlling a huge mining complex with:

- 5 Block models: Over 9.5 millions blocks *(25x25m)*
- 12 Integrated mines
- 74 Stages
- 3 Plants
- 11 Crushers
- 4 Conveyors Systems
- 9 Waste Dumps

CAD Tools

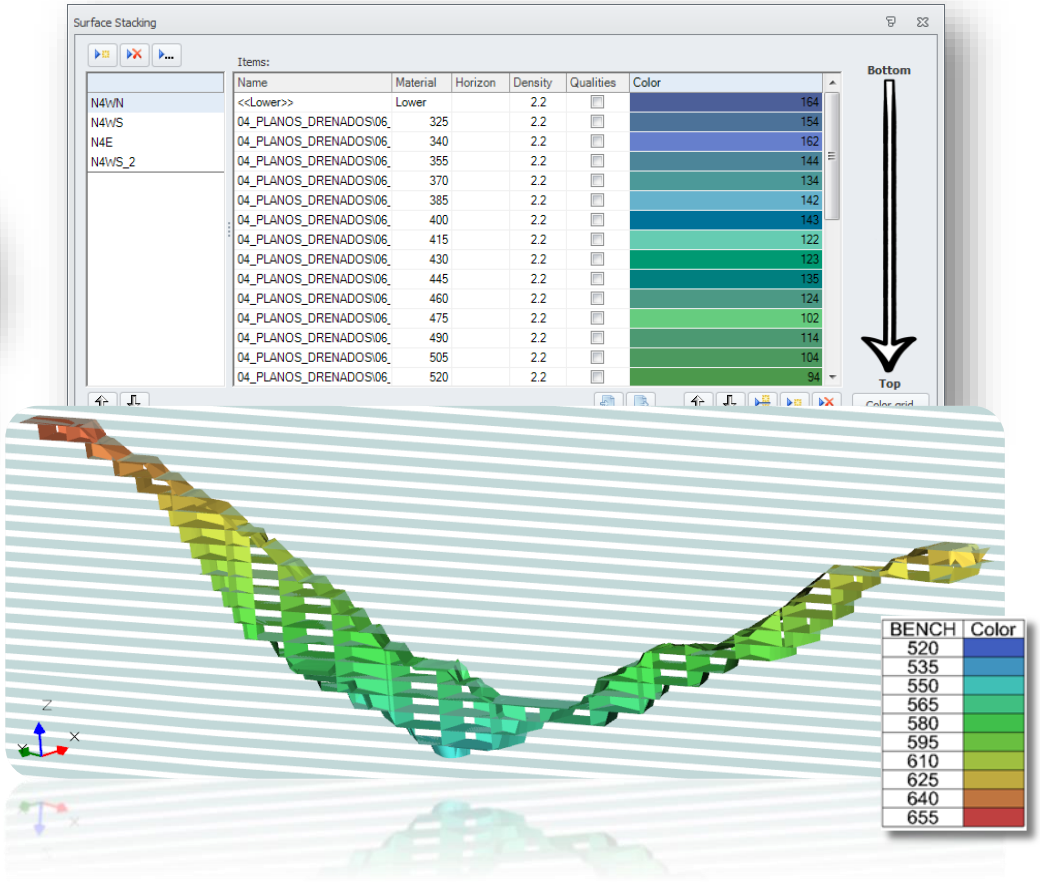
Carajás is a big rainforest with high rainfall rates. Therefore, each mine has the detailed and specific drainage operational plans.

- Pit Design of 74 Stages following the operational drainage plans of each mine.
- Creation and organization of drainage plans in rules per mine (Surface Stacking).
- Use Surface Stacking rules to perform solid bench cutting.
- Creation Over 50.000 tasks solids (50x50m)

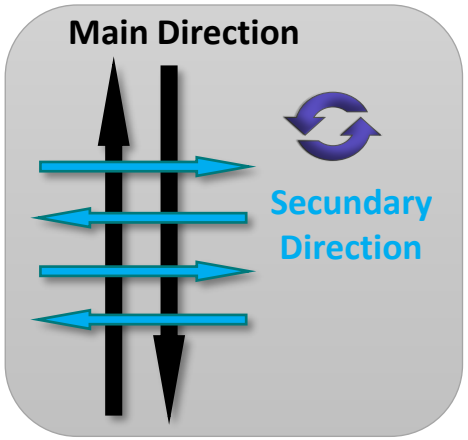


Control of Drainage

Cut benchs solids by Dranage Surfaces



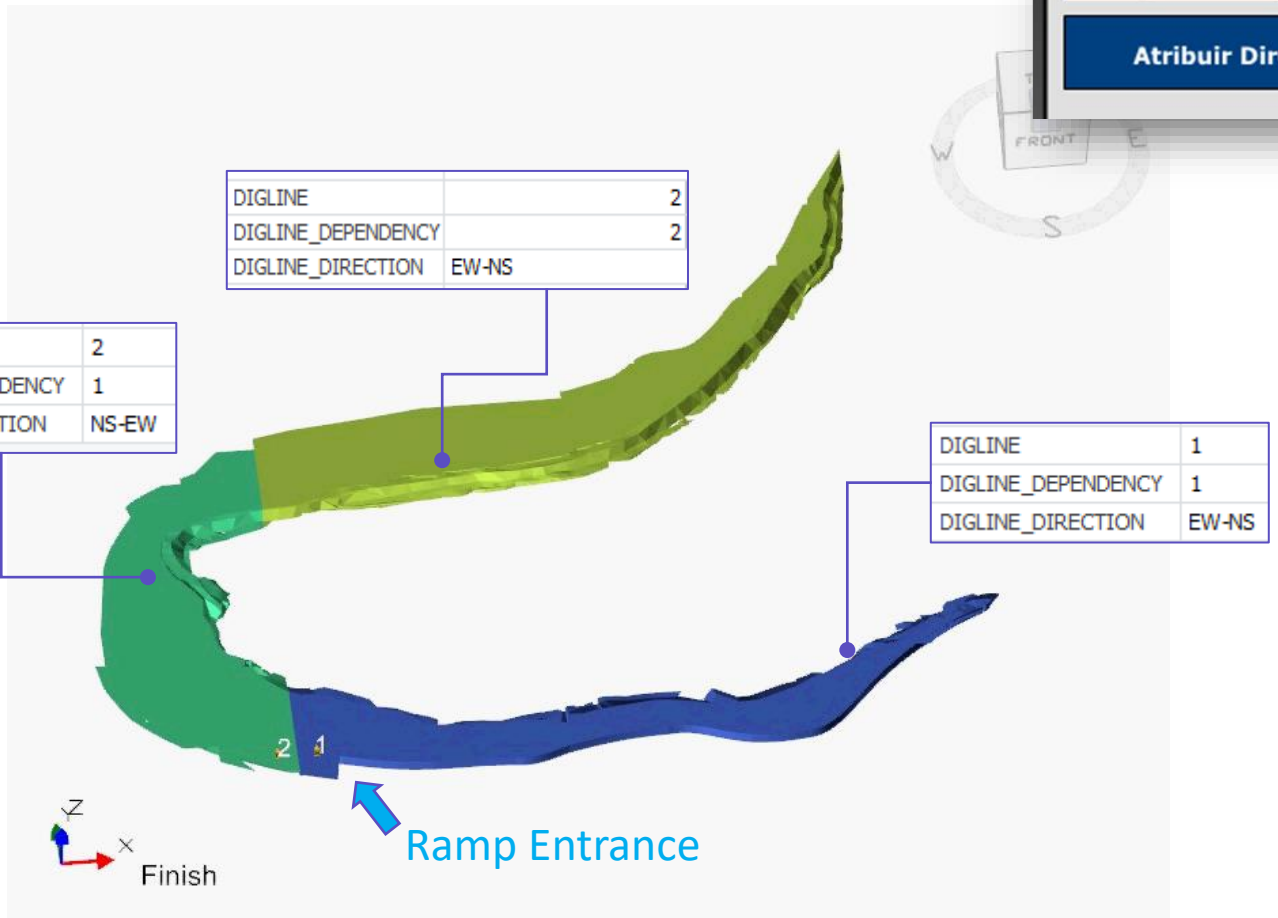
IS – Priorities and Dependencies



The dependency rule MINING DIRECTION was created for tasks when the scheduling using the RAMP PRIORITY (Radius Search) attribute results in a non operational plan, e.g: Horseshoe shape Bench.

MINING DIRECTION Attributes:

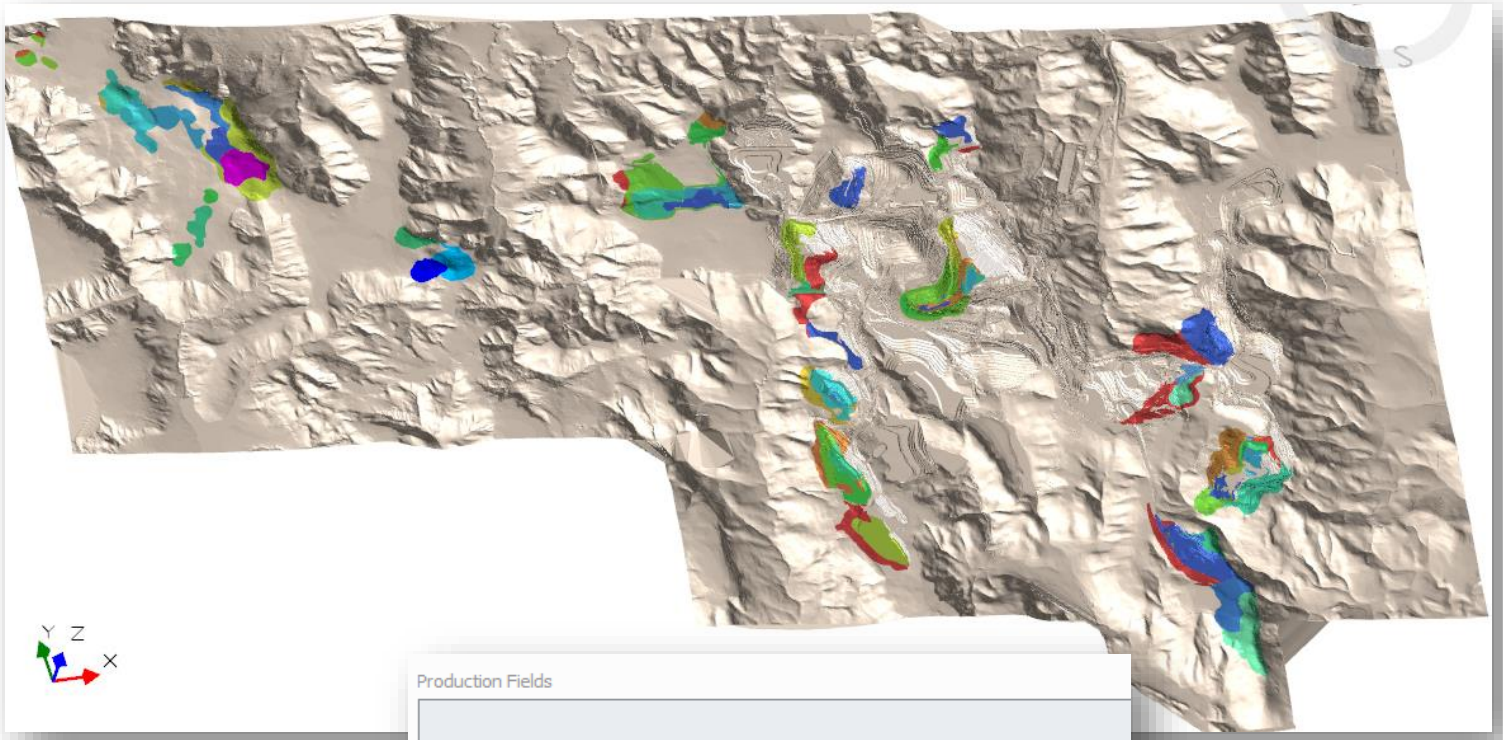
- DIGLINE: different areas with independent mining directions.
- DIGLINE_DEPENDENCY: used to create dependency between DIGLINES.
- DIGLINE_DIRECTION: Sets the Main and Secundary direction, e.g: NS/SN/WE/EW

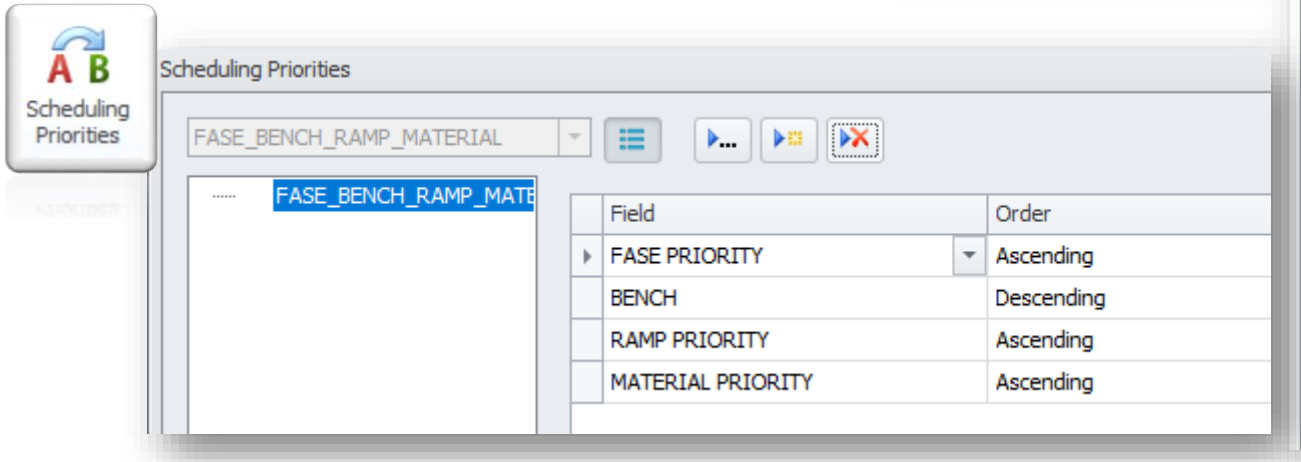


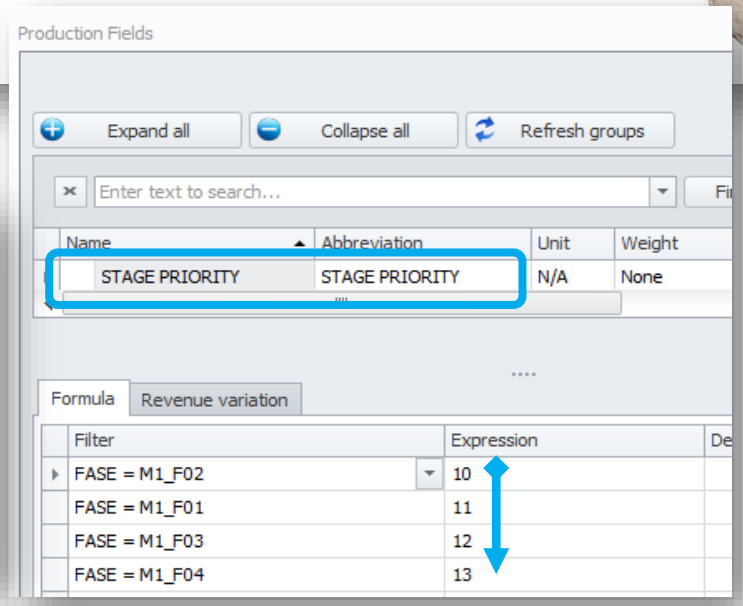
IS – Priorities and Dependencies

Scheduling Priorities Configuration:

- Stage Priority: Sorted by Strip Ratio, Mining Cost or Environmental Restrictions
- Bench: Descending
- Ramp Priority or Mining Direction
- Material: Sorted by Ore Type (1:High Grade, 2: Low Grade, 3: Waste)







Deswik.Sched: Levelling

In the North Range there are three main excavators fleets It matches from 240 to 400u.s. ton trucks, totaling around 30 units.

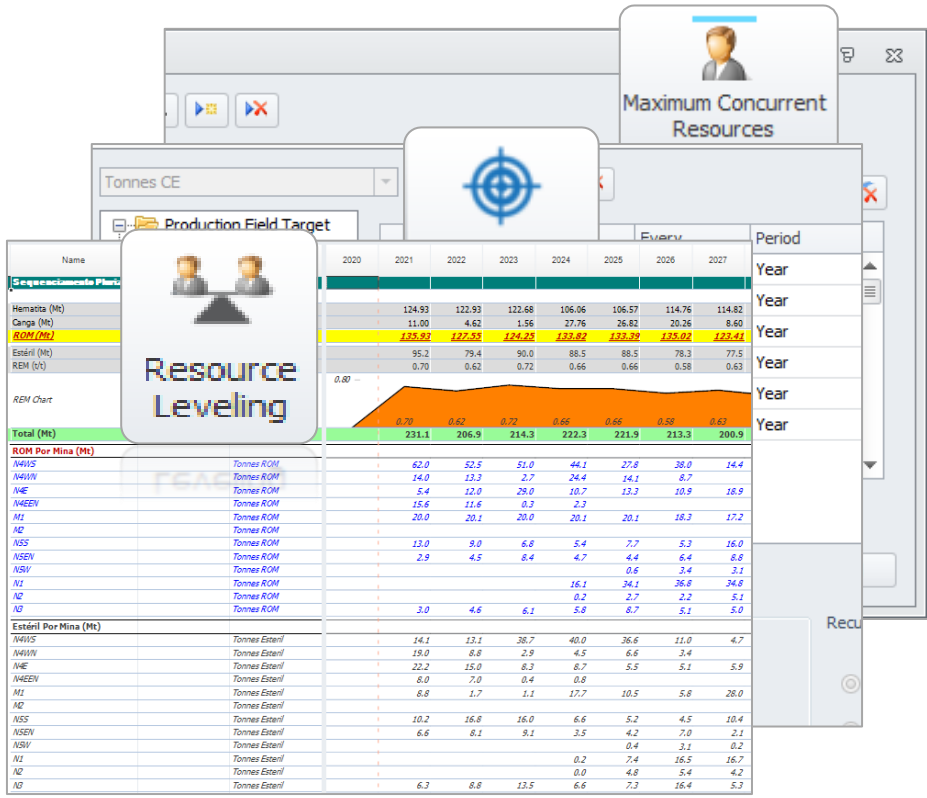
7un. (47yd³) and 4un. (32yd³)

7un. (52 yd³)

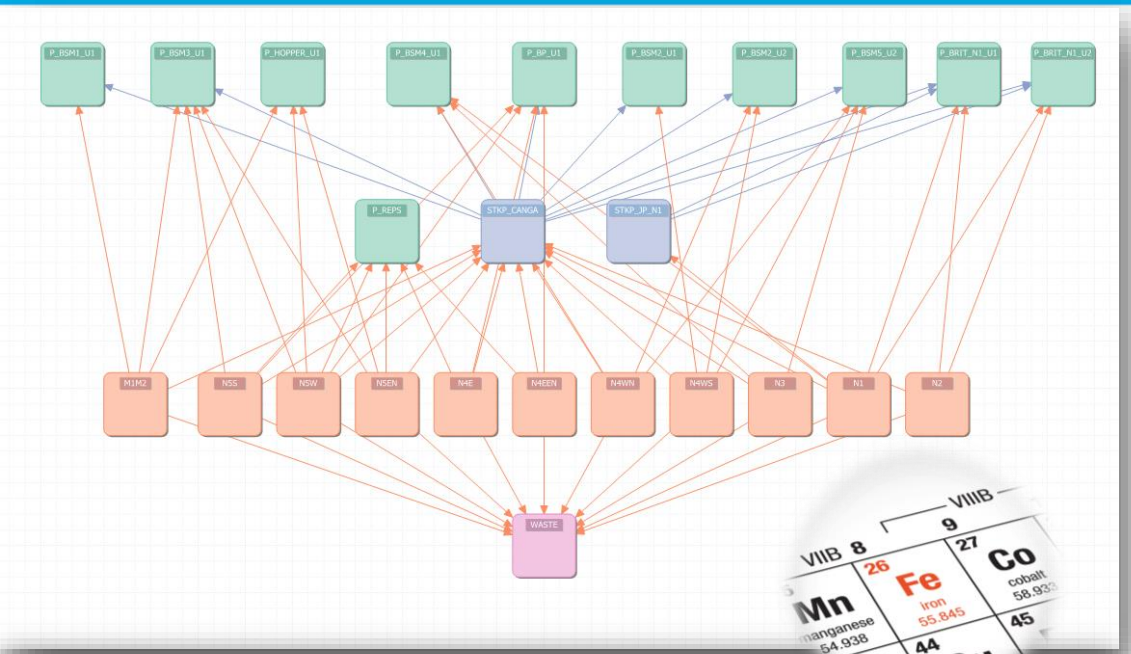
10un. (22yd³)

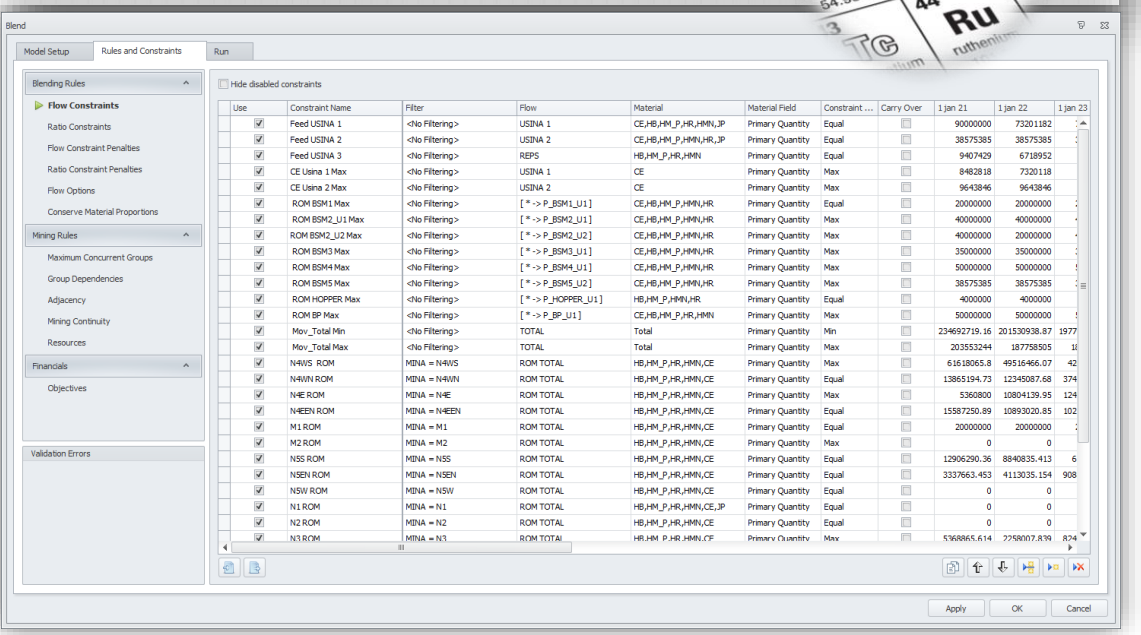
Through the levelling tool we could managed to control each resource and beyond:

- Maximum Concurrent Resources Rules: by (Stage and Bench)
- Productivity Resource Rate by pit: Lookup Table
- Possibility to apply several "targets" by Ore, Waste, Total per mine, etc.
- Standardized reports: improving control of the mine plan



Blender





After levelling, we blend it …

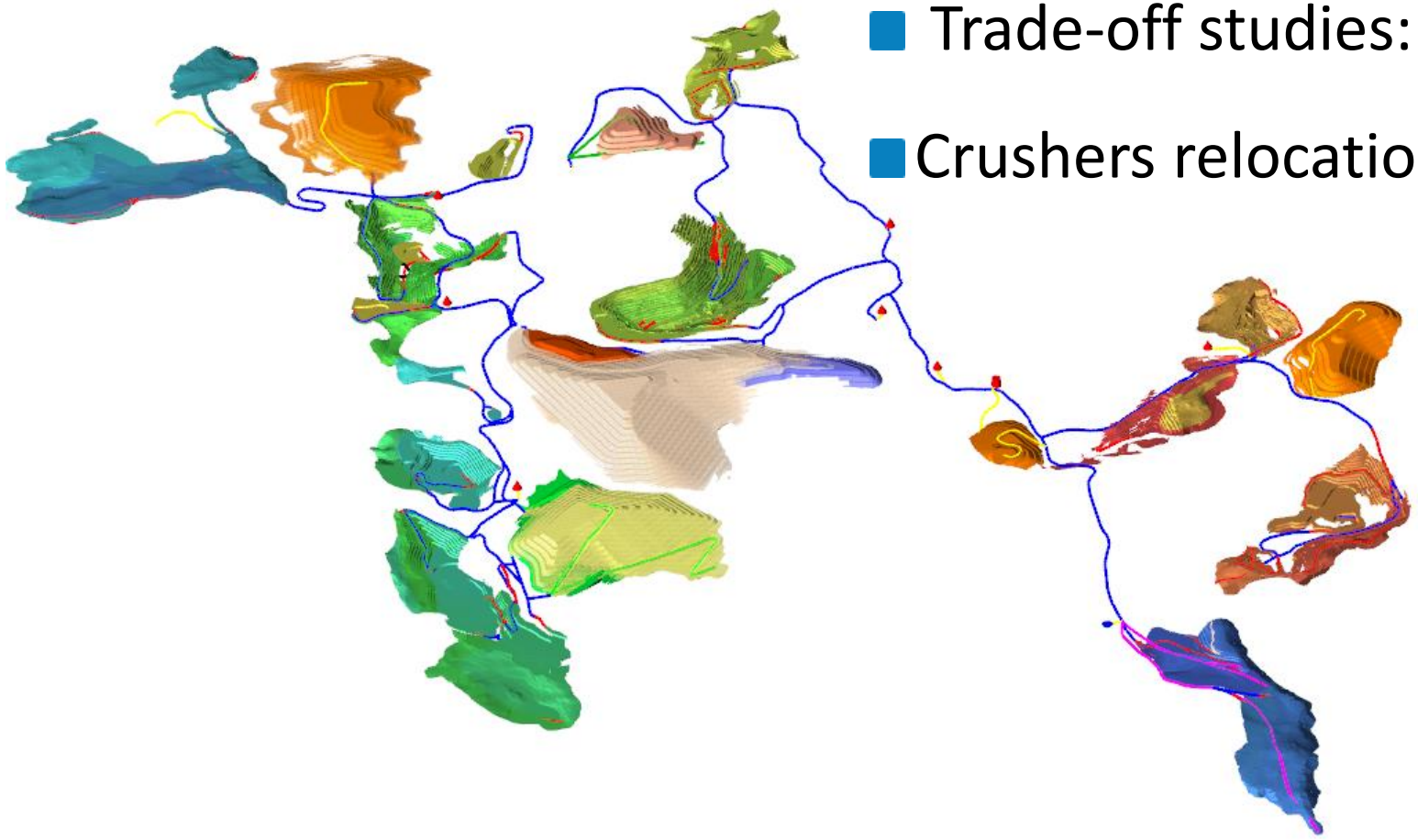
…feeding 3 plants, controlling:

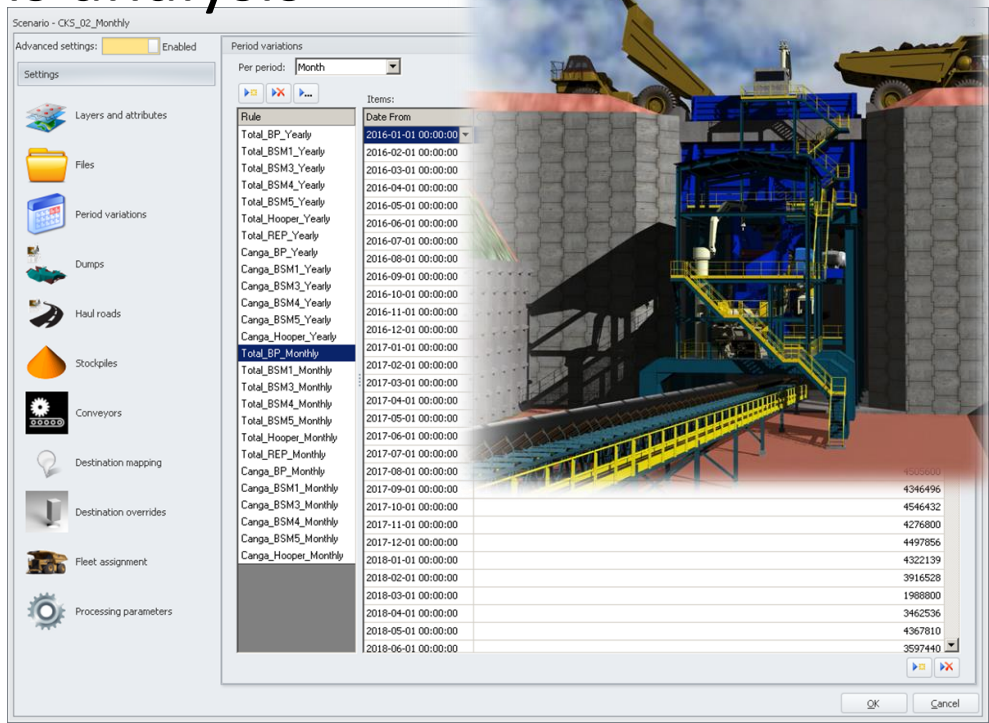
- Capacities
- Averages Grades of: Fe, SiO2, Al2O3, P, Mn
- Material types proportions (Ratio Constraints)

LHS

The integrated scheduler and landform haulage ensures a dynamic analysis for strategic decision making reducing costs and risks.

- Period Variations Rules
- Trade-off studies: (IPCC x Truck and Shovel)
- Crushers relocations analysis





Goals and Challenges Overcome

Integrated Project

Before there were ***9*** *mines projects working seperatedelly.*

Deswik works in an integrated project way, including **All block models.**

Operational Constraints

Optimize design and scheduling of the mines respecting operational aspects such as Drainages and Enviromental Licenses.

Pit Design Tools

Cut Benchs By Surface Stacking Rules.

Constraints dates (Delay Dates)

Scheduler /Blender +LHS

Integrated Mining planning with operational detailed controlling of excavation, haulage and Ore quality.

Scheduler: Resources Levelling

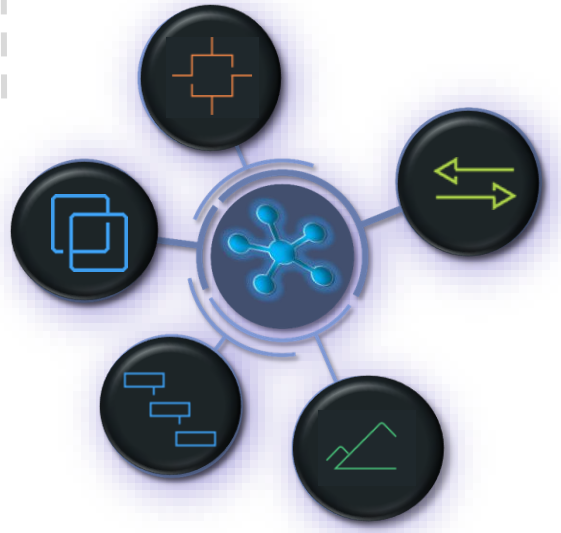
Blender Strategies

Landform and Haulage

Reports And Outputs

Reduction of manual labor work for generation and result analysis.

Dynamic Reports, Pivot Tables and Period Maps



Thank You!

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