



PRODUCT SUITE

OVERVIEW









The mining industry is beset by myriad issues, but some of the biggest of these are related to data.

Mining and exploration companies have mountains of data... the problems come in when that data needs to be reckoned with.

Also, with the advent of Al, much of the industry's data is functionally useless – it's unstructured and non-standardized, and as such is unreadable by machines.

Minerva's TERRA Mining Al suite deploys a suite of tools to help the mining industry with systemic problems such as:

- 1. Unorganized and unstructured data
- 2. Non-standardized data
- 3. Data without interpretation
- 4. Data not "analytics ready" for Al systems



	→ Deep Learning				
Machine Learning	→ Predictive Analytics				
	→ Translation				
NLP	→ Classification, Clustering				
	→ Information Extraction				
6 1	→ Speech to Text				
Speech	→ Text to Speech				
	→ Inference Engine				
Cognitive	→ Knowledge Base				
	→ Reduction				
Optimization	→ Classical				
·	→ Probabilistic, Temporal				
Robotics	→ Reactive Machines				
	→ Limited Memory				
れしかしにしる	→ Theory of Mind, Self-Aware				
nobotics	→ Theory of Mind, Self-Aware				
NODOLICS	→ Theory of Mind, Self-Aware→ Image Recognition				
nobotics	→ Theory of Mind, Self				

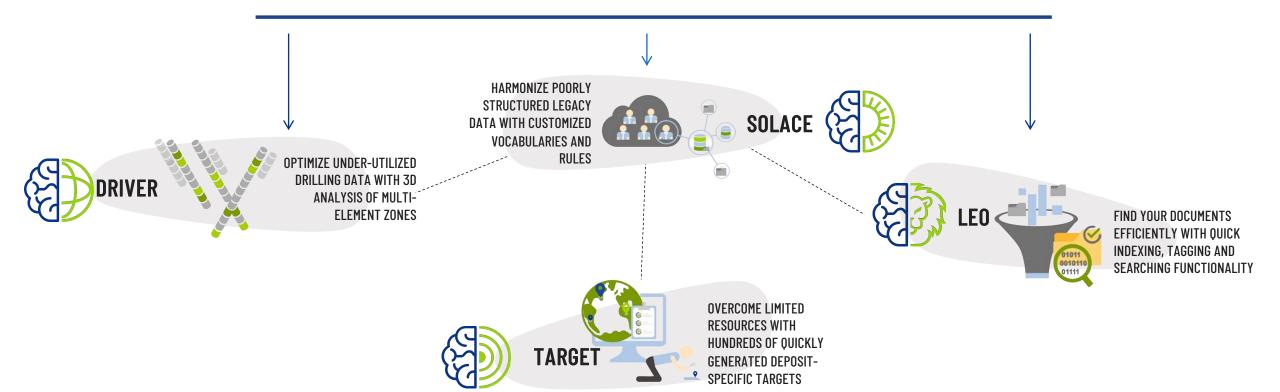
Cognitive AI – Getting a computer to think (and reason) like a human

- We create conceptual models, using ontologies, that describe a specific concept in words, not numbers.
- These models are carefully designed and structured for later use (e.g. a VMS deposit model).
- We then take cohesive datasets that cover a population of data and compare the conceptual models to the datasets where we can make <u>explainable</u> predictions.

Currently Minerva is focused in the mining and natural hazards domains











SOLACE is an integrated service that takes raw domain data and builds an infrastructure to align current and future data to chosen standards and make the data analytics-ready.

- SOLACE is meant for companies that routinely handle streams of poorly controlled data
- Traditionally this data is manually cleaned by employees to a minimum level of quality to suit the use case before being passed on to a centralized database. When data from new projects is acquired or created, this manual and subjective process is repeated, wasting time and effort.
- SOLACE provides organizations the means to choose a standard, define the terms they need to use, convert legacy data to the standard, and implement an alignment process to automatically convert new data.

All of these terms are similar but unique. How can humans or computers handle them?

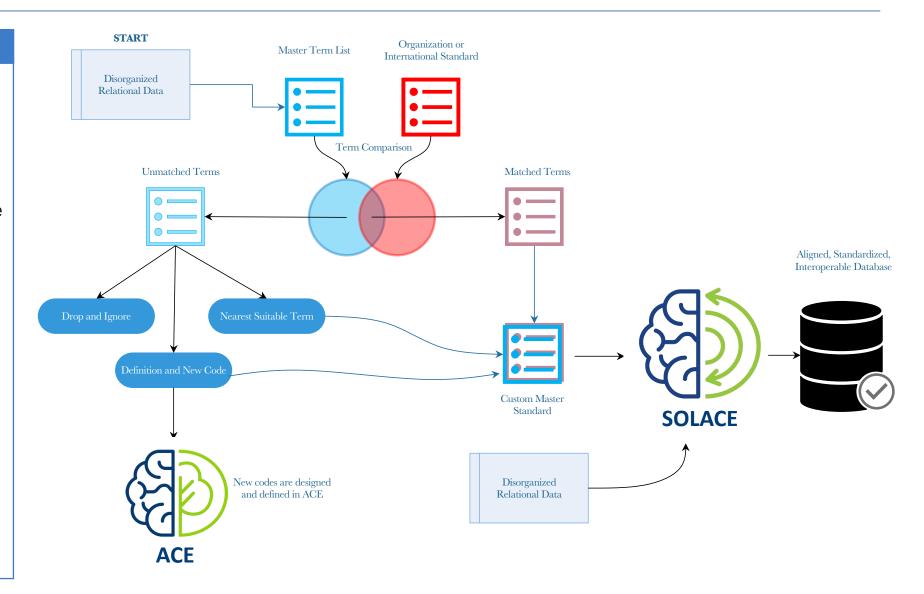


MINERVA SOLACE | Details



Benefits

- Formalizes a necessary process that is often done adhoc
- Produces harmonized streams of data that remove the data cleaning burden from database managers
- The system remembers historic alignments and improves over time
- Individual employees and stakeholders on the data creation stage do not have to change the words they prefer, so long as they continue to use them the same way. This avoids the problem of the topdown imposition of standards, which leads to limited adoption.







LEO uses controlled vocabularies to automatically index, tag, and geotag your files, making document management and searching much faster and more effective

UNSTRUCTURED DOCUMENTS

Can be a single- or multiple-document repository with any MS Office files, PDFs, images, or even non-OCR scans

CONTROLLED VOCABULARIES

LEO uses taxonomies that are built into the system but can be further customized for each client's needs

AUTO-TAGGING

LEO automatically tags documents with relevant words from the taxonomy



DOWNLOAD DOCUMENTS

Once the documents have been found the user can download them

SEARCH FUNCTIONALITY

Basic and advanced search functions in an easy-to-use interface

GEO-TAGGING

LEO automatically tags documents with location data and displays the results on a map

MINERVA LEO | Details



filtered to only display results that contain documents that contain "feasibility study" mining costs ADVANCED FUNCTIONS gold X chalcopyrite X feasibility study X Geographical Bounds. Bulyanhulu Production Detail 2002 2003 ... an increase in direct mining costs and lower • Production for 2004 is expected ... However, we defer and amortize certain mining costs associated with open pit deposits that have diverse ... These mining costs arise from the removal of waste rock at our open-pit mines, and we commonly refer. Capitalized mining costs are an asset that represents the excess of costs capitalized over the related ... The carrying amount of capitalized mining costs is grouped with related mining property, plant and Auto-Classified Tags exploration activity type ore deposit evaluation Mulatos Production Detail December 2005 -feasibility study costs during the start-up period as reported in the fessibility study.... In the table above, fessibility study inting costs per tonne and mining costs per tonne of ore represent ... Year-to-date mining costs per tonne of ore were higher than fessibility study levels due to the following ... average life of mine waste-to-ore ratio as indicated in the feasibility study is 1.4:1 with mining ... costs at \$0.95 per tonne. negative feasibility stud sitive feasibility study Selected Tags: feasibility study mineral resource indicated gold ore deposit waste project silver exposed more... Mulatos Production Detail September 2003 ... On a year-to-date basis, mining costs were \$1.36 in 2007 compared to \$1.25 in 2006, an increase of approximately ... Higher mining costs throughout 2007 have been the result of scheduled maintenance on the Company's equipment ... As a result, the waste-to-ore ratio and related waste mining costs are expected to be significantly lower Selected Tags: mineralized zone gold ore waste core drilling feasibility study project deposit Lime more... La Herradura Production Detail June 2006 ... Page 2 of 24 the second quarter of 2005, \$18 million of mining ... conts were deferred and reduced costs applicable to sales by \$30 per ounce. ... In the second quarter of 2005, \$1 million of mining conts were amortized and increased costs applicable ... In the second quarter of 2005, \$1 million of mining conts were amortized and increased costs applicable ... In the second quarter of 2005, \$1 million of mining conts were amortized and increased costs applicable ... In the second quarter of 2005, \$1 million of mining conts were amortized and increased costs applicable ... In the second quarter of 2005, \$1 million of mining conts were amortized and increased costs applicable ... 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However, EDASIA has made an adjustment for contract mining costs for the Tongolanshan pit based on the ... The overall open-pit unit mining costs for the Numatang pit are higher than those for the underground ... The mining cost parameters used in the pit optimization analysis were based on the unit mining costs ... The overall unit open-pit unit mining costs for the Niumatang pit are higher than the unit underground ... BDASIA has made an adjustment for contract mining costs for the Tongqianshan pit based on the current Selected Tags: open-pit mining underground mining feasibility study mineralized zone Other Metals project ore copper lead more H 4 1 2 3 4 5 6 7 8 9 10 ... » H 1-6 of 160 ness.

Free text search for "mining costs", with the tags "gold and chalcopyrite, not pyrite". Results are then

Link to LEO Live Demo Site

LEO Benefits

- Increase interoperability of unstructured documents
- Increase communication between different operations or groups within operations (Geo-Mine-Met)
- Control over data management setup and workflow (auditable)
- Automatic tagging of documents with user input, controlled approvals of tags, ability to add and customize tags
- Can OCR scan and tag old legacy documents
- On-premise or cloud-based
- Front-end search capabilities using controlled language
- Front end document search capabilities for handing alternative spellings, short forms and misspelled words



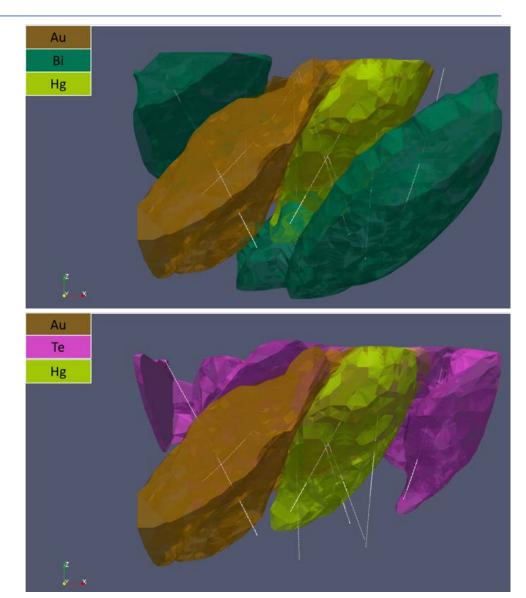


Limited Time, Limited Expertise

- Exploration drilling campaigns spend millions of dollars collecting data, but often focus on only a few key elements
- Resource evaluations spend hundreds of thousands of dollars quantifying the shape and extents of ore bodies for the primary commodities, but rarely apply the same workflow to other elements available in the assays.

3D Analysis Of Multi-Element Zones

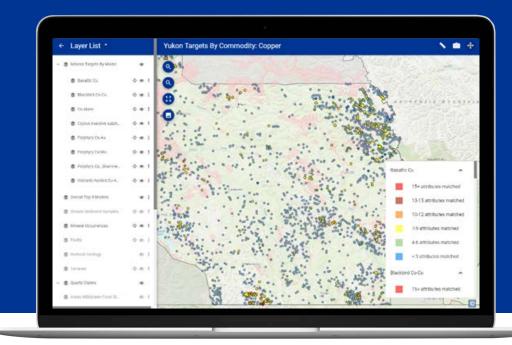
- DRIVER takes multi-element drilling data and applies spatial and geostatistical analysis to produce hundreds of 3D volumes for the full suite of elements
- Used to identify spatial distribution of different element groups for exploration and geometallurgy purposes
- Identifies and indexes key zones and compares DRIVER results to mineral deposit knowledge, explanations and advice (Minerva's core Al system)







A cognitive AI system
that produces
explainable exploration
targets by mimicking the
traditional process of
geological data
evaluation



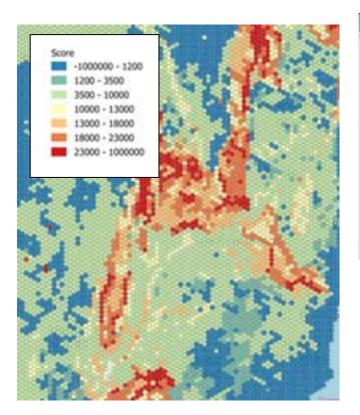
Benefits

- Able to use and interpret large data sets with multiple generations of data
- Combines machine intelligence with human intelligence to reach conclusions faster than geologist
- Provides explanations for individual target points
- Processed datasets reside as a standardized dataset for future Alapplications



Mineral Targets

- Focused on provincial- or state- to country-scale Mineral Target prospectivity maps for mineral exploration but can be applied to smaller claim areas for junior mining companies
- End product is an interactive target map layer that is auditable and provides explanations and advice to users
- Interactive Demo: https://yukonmineraltargets.com/



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H Has Rock Host	tonaite	sometimes	tion inflict entricities		, present	unmatched	-10
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Has Rock Host	granodorite	sometimes				unmatched	-10
Has Rock Host	pyroclastic rock	sometimes				unmatched	-10
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Mas Setting Genetic	arc systems	sumetimes	Has Setting Genetic	arc	present	exact exact opt - exact AKO val	1000
		18831841	Has Rock Host	porphyry	present	unmatched	22570
			Has Rock Host	diorite	present	unmatched	
	-		Has Rock Host	quartz dionte	present	unmatched	
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Has Element Man Enhanced	0	sometimes				unmatched	-10
Has Element Man Enhanced	Sr	sometimes				unmatched	-10
Has Element Man Enhanced	W	sometimes				unmatched	-10
Has Mineral Enhanced To Ore	Molybdenite	usually				unmatched	-10

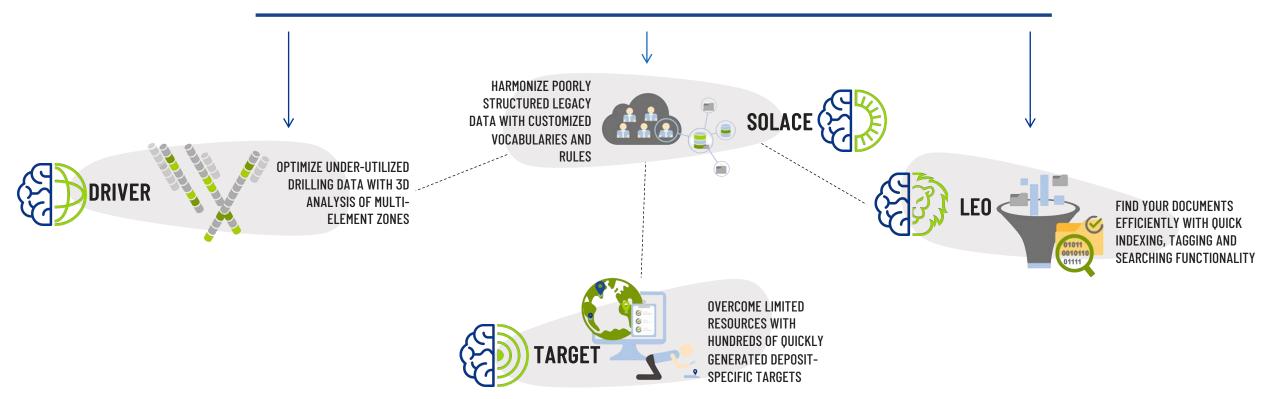
To improve the motch:

To worsen the match:

Rank	Advice	Score	Rank	Advice
4	Check if Molybdenite is present.	9010	4	Check if Cu is absent.
5	Check if Cu is present.	9010	6	Check if Chalcopyrite is absent.



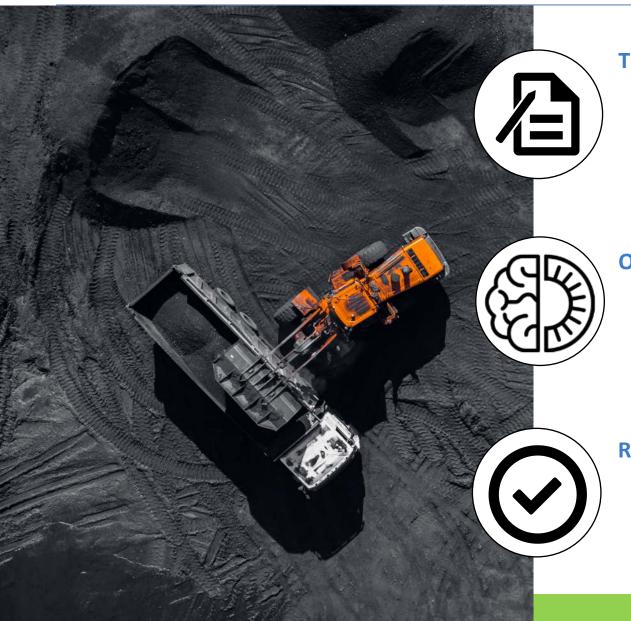
TERRA MINING AI





- **Global Mining Company** Contracted Minerva to complete a SOLACE project on their drillhole database to align terms from all mines, projects and acquisitions to one standard.
- International Exploration Company Completed a TARGET project for the entirety of Brazil for 80+ different deposit models.
- World-Renowned Canadian Exploration Company Geochemical evaluation of over 50,000 soil samples using technology from DRIVER.
- Exploration company After merger of two companies, using LEO to index, tag and search their combined document repositories.
- International Mining Project Used Minerva technology to complete a data audit, interpretation and provided new prospectivity targets to client.





THEIR PROBLEM

A **global mining company** that had multiple mines, projects and acquisition data in different formats and languages

OUR SOLUTION

Minerva's **SOLACE** consulting service and SaaS software solution

RESULTS

A custom master standard and an aligned, standardized interoperable database uniting all their data under one single, auditable standard

CASE STUDY | TARGET





An **international exploration company** exploring in Brazil wanted an efficient way to rank exploration targets.

Minerva's **TARGET** consulting service

An **interactive webmap** displaying **targets** of 80+ deposit models for the entire country of Brazil

CASE STUDY | DRIVER





A world-renowned Canadian exploration company's collected over 50,000 soil samples and wanted additional exploration vectors

Minerva's **DRIVER** 3D metallurgical and geochemical analysis product

Geostatistical analysis resulting in shapefiles displaying exploration vectors

CASE STUDY | LEO





THEIR PROBLEM

Orogen Royalties had tens of thousands of unstructured documents after a merger of two companies

OUR SOLUTION

LEO Intelligent document management system built for the mining and exploration industries.

RESULTS

"With LEO, we are able to quickly search through thousands of documents using keyword searches and obtain a listing of relevant documents along with contextual reference and a listing of other key geological words in the document."

> Dave Groves, P. Geo. VP Exploration Orogen Royalties





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