F2

What Can Machine Learning Do for Me? Improved Targeting, 3D Modelling, and Resource Estimation: A Case Study from the Castelo de Sonhos Paleoplacer Gold Deposit, Brazil

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As we rapidly increase the speed and volume of data collection in mineral exploration campaigns, mines, and near-mine environments, our data processing methods must become more sophisticated to efficiently deal with this data deluge. Machine learning workflows and machine-assisted modeling will become routine parts of the mining value chain; integrating traditional geoscience knowledge with data science expertise will be critical to successful algorithm deployment.

The most important components of any successful mineral exploration campaign are a robust, reliable geological map and a serviceable geological model. In this case study, the chemostratigraphy of the Esperança South paleoplacer gold deposit of the Castelo De Sonhos (CDS) plateau, Brazil, has been successfully delineated using machine-assisted modeling of geochemical data.

The dominant lithologies at CDS were previously subdivided into four informal units based on granulometry: the lower coarsening-upwards sandstone and pebble conglomerate unit, the middle cobble conglomerate unit, the upper fining-upwards sandstone and pebble conglomerate unit and the top sandstone-dominated unit. The challenge faced when attempting to accurately discriminate stratigraphy at CDS is the textural similarity of the metasedimentary units present across the plateau. Unfortunately, continuity between the four logged lithological units could not be confidently interpreted between drill holes plotted on sections or otherwise mapped in a way to better interpret and predict geology in the area.

This issue was addressed by TriStar Gold and GoldSpot Discoveries Corp. by introducing a four-acid digestion geochemical sampling strategy, which enabled previously unattainable chemostratigraphic definition. The new chemostratigraphy includes seven main lithological units, and four subunits. These were validated spatially (using continuity on cross sections and observations from drilling). Results have been used to create a robust surficial geological map, as well as a 3D geological model to inform exploration and resource domain modeling.

As new data are obtained during resource definition drilling, machine learning classification algorithms assign rock types to new data, and the 3D geological model is quickly and efficiently updated. Resource estimation is enhanced both by the inclusion of more accurate geologically based grade domains and dynamic anisotropy models based on the resulting interpreted erosional surfaces (which are geologically relevant to the placer-style gold mineralisation).

Finally, and perhaps most importantly, incorporation of the chemostratigraphic model almost doubled the indicated resources at CDS because the ranges of the variograms could be extended due to better correlation along the stratigraphy. The project-wide indicated resource estimate (Table 1) has increased from 17.7 Mt in September 2018 to 40.1 Mt in April 2021.

References: Srivastava, M. (2020), “Mineral Resources Update for the Castelo de Sonhos Project, Pará State - Brazil”, TriStar Gold National Instrument 43-101 Technical Report.

Table 1. Comparison of current and previous resources estimates for the Castelo de Sonhos Project

	Classification	Tonnage (Mt)	Grade (g/t Au)	Metal Content (Moz)
Current Project Total	Indicated	40.1	1.2	1.5
	Inferred	22.2	1.0	0.7
Previous Project Total	Indicated	17.7	1.2	0.7
	Inferred	39.8	1.0	1.3