



**FROM VALIDATION IN A GREENFIELD COPPER
PROJECT TO CONTINUOUS TESTING WITH THE
MINPRAXIS TESTER**

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ABSTRACT

This paper presents results from geometallurgical testing campaigns conducted on samples from a large greenfield copper project, where a comminution study was carried out to determine the ore hardness in terms of crushability and mill grindability.

The work provided the opportunity to trial a new comminution testing technology, the Minpraxis Tester (MPT), which can continuously process half-core samples lengthwise, as well as lump samples, providing a more comprehensive rock characterization in comparison to conventional bench-scale methods. The MPT can simultaneously generate crushability, mill grindability, and geotechnical data while functioning within an assay preparation workflow, thereby significantly expanding the data available for orebody modelling and leaving the other half of core available as reference core or further standardized metallurgical test work.

The results demonstrate the validation and applicability of MPT technology in predicting geometallurgical parameters and its ability to generate an extensive dataset, which can be used to enhance orebody characterization, accelerate study progression, and forecast mill productivity. Based on these outcomes, an onsite trial has progressed in which the MPT is applied to half-core samples to obtain both geotechnical strength and comminution parameters. Lump samples are also being processed to expand the comminution dataset.

KEYWORDS

Geometallurgy, Comminution and Rock Mechanics

INTRODUCTION

Improving geometallurgical characterization has become a key priority for enabling efficient mine planning and production forecasting. This study focuses on the rapid and reliable assessment of ore hardness using lump samples to improve resource utilization. Lump samples, which are commonly available during project assessment stages, such as from geotechnical and geometallurgical test campaigns or mine sampling after production blasting or caving, provide valuable material for geometallurgical analysis. The primary objective is to evaluate the performance of the Minpraxis Tester (MPT) in processing lump samples and predicting key geometallurgical comminution parameters, including the Drop Weight Index (DWi), $A \times b$ hardness generated by SMC testing, SAG grindability parameters such as the SAG Grindability Index (SGI), SAG Power Index (SPI), and the SAGDesign Variability Testing (SVT) parameter, as well as the Bond Ball Mill Work Index (BBWi). These parameters can be used for comminution modeling and throughput forecasting.

Background to the Minpraxis Tester

The Minpraxis Tester (MPT) was developed to meet the demand for low-cost geotechnical and geometallurgical tests that can be applied to small sample volumes in large quantities, making it ideal for applications such as resource drilling and grade control (Nadolski, 2019; 2020). Integrated into standard assay preparation workflows, the MPT captures high-resolution compressive strength measurements continuously as well as sample density per piece. It can process half-core samples at approximately 1 cm resolution or test individual lump samples, including broken core fragments and grade control pieces, enabling continuous strength characterization across the rock mass using samples originally collected for metal assay.

Key features of the MPT, shown in Figure 1, include a high-resolution force sensor and roller position sensors, both operating at a 40,000 Hz data sampling rate, a large drivetrain, and an instrumented core feeder for automated size measurement of core samples. The hydraulic system ensures consistent compressive force, maintaining a fixed roll gap throughout testing. For half-core samples, the system records force along the sample length; for lump rocks, it provides particle-level strength measurements suitable for deriving drop weight indices, SAG grindability, and Bond work indices. A proprietary lump sizer, similar in function to the instrumented core feeder, automates the estimation of lump particle shape and volume, minimizing the need for sieving or manual size checks and streamlining geometallurgical workflows. Product sieving is not carried out, which contributes to the quick test turnaround time.



Figure 1 – MPT with automated core sample sizer

METHODOLOGY

Sample Description and MPT Testing

The test campaign included groups of lump samples consisting of rock fragments. Over 200 samples were delivered pre-screened and bagged into several size fractions. The MPT samples were selected near the end of the comminution program, limiting the quantity of rocks available for each size class. Still, MPT tests were performed on various size classes for each orebody to develop the models.

Samples were processed using the MPT, with roll gap settings selected to maintain an appropriate thickness-to-gap ratio for lump samples. Prior to testing, each lump rock was automatically measured by the proprietary lump sizer system, which captured its length, thickness, cross-sectional area, and volume.

Geometallurgical Comminution Program

The objective of the test campaign was to demonstrate the MPT's capability to test lump samples, using existing comminution test results for benchmarking. The comminution indices used for comparison include:

- Drop-weight impact hardness ($A \times b$ or DW_i in kWh/m^3) from SMC testing
- SAG Grindability Index from Aminpro (SGI in minutes)
- SAG Power Index from SGS (SPI in minutes)
- SAGDesign Test hardness (SDT in kWh/t)

- Bond Ball Mill Work Index (BBWi in kWh/t)

The list above includes commonly used indices for comminution flowsheet design and associated equipment sizing.

RESULTS

MPT Model Building

The MPT models for deriving drop-weight test results, originally developed from previous test campaigns, were refined using a subset of half of the dataset provided by the client. These refined models were then applied to the MPT lump testing results to predict Drop Weight Index (DWi) and $A \times b$ values. In this way, a blind testing component was included in the program.

The MPT models for deriving the SPI, SGI and BBWi indices were developed using all the complete dataset provided by the client, which included over 200 calibration samples, to report the predicted values. Finally, the MPT models for deriving the SDT index were developed using the full dataset of nearly 100 SAGDesign calibration samples and applied to predict SDT values.

MPT Impact Breakage Prediction

The MPT impact breakage hardness ($A \times b$) and drop weight index (DWi) results are depicted in Figure 2, with key findings being:

- 78% of the MPT $A \times b$ predicted values have an absolute relative error (Abs. RE) within 15%, with an average of 9.8%.
- 79.6% of the MPT DWi dataset has an Abs. RE within 15%, with an average of 9.8%.

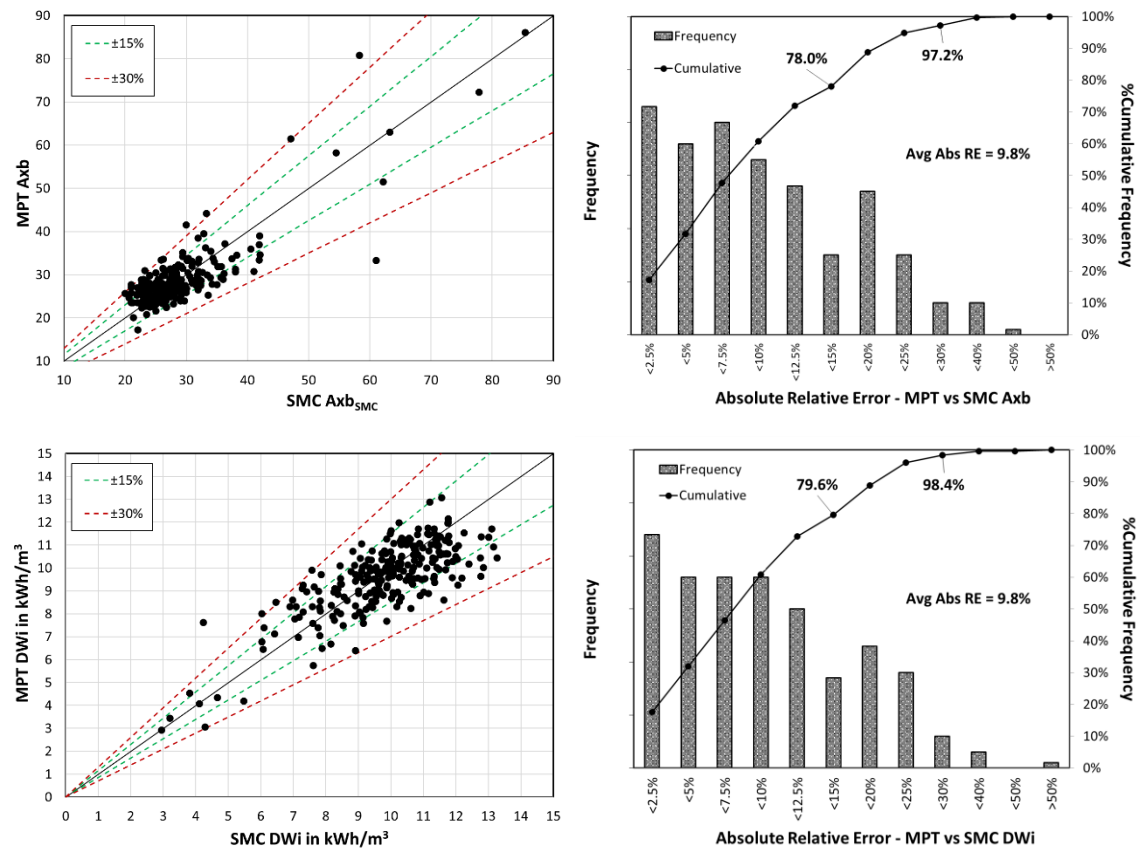


Figure 2 – MPT prediction for the A×b and DWi hardness parameters

MPT SAG Grindability Prediction

The SDT, SGI and SPI tests are tumbling mill tests that focus on predicting SAG mill performance. A comparison of MPT and SAG grindability results is shown in Figure 3. The predictive accuracy varies for each grindability test with the following key findings:

- The best result was obtained with the SDT_MPT dataset, where 82.6% of the dataset has an Abs. RE within 15%, with an average of 9.6%.
- For the SGI, 71.5% of the dataset has an Abs. RE within 15%, with an average of 12.8%.
- For the SPI, 60.6% of the dataset has an Abs. RE within 15%, with an average of 16.3%.

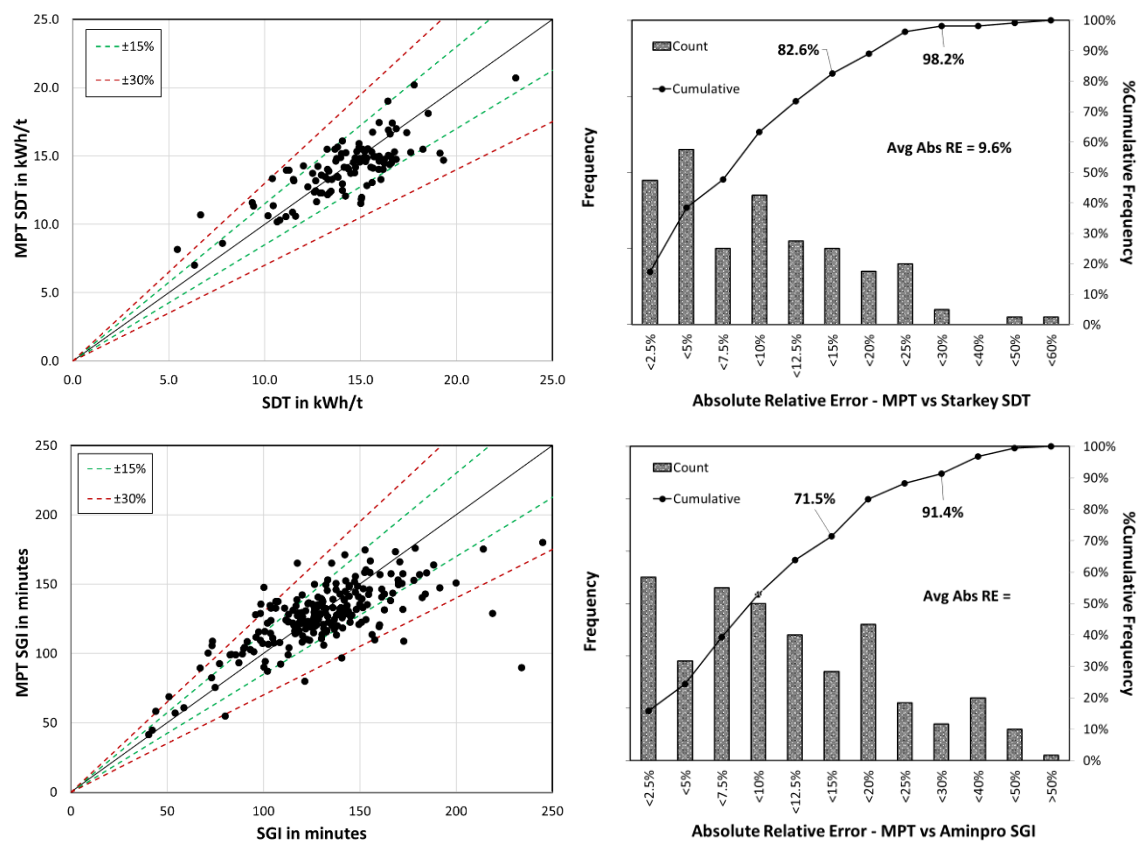


Figure 3 – MPT prediction for the SDT, SPI and SGI SAG grindability parameters

MPT Bond Ball Mill Work Index Prediction

The MPT BBWi (BBWi_{MPT}) results are depicted in Figure 4, with the highest predictive accuracy: 85.3% of the BBWi_{MPT} dataset has an absolute error within 15%, with an average of 8.6%.

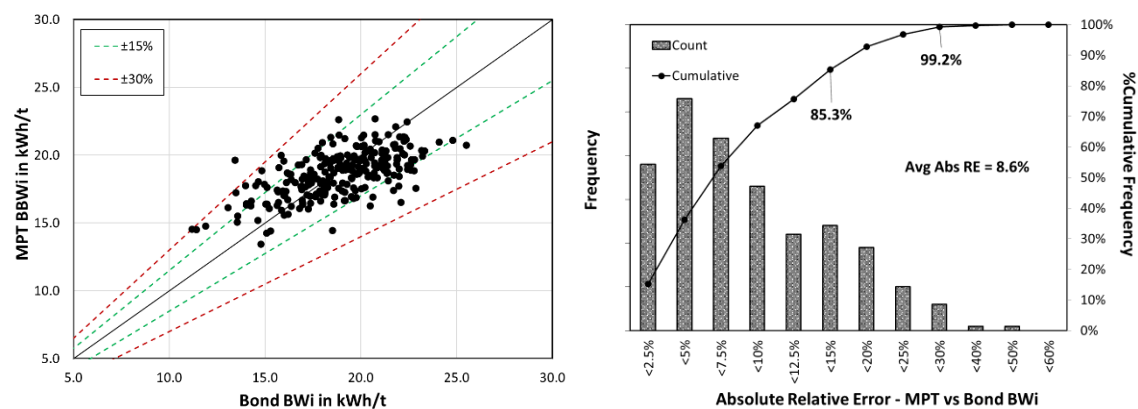


Figure 4 – MPT prediction for BBWi hardness parameters

In summary, Table 1 shows that while the predicted A×b_MPT, DWi_MPT, SDT_MPT and BBWi_MPT values measured by SMC, SAGDesign and Bond Ball Mill grindability tests demonstrate strong predictive performance based on absolute error. However, the results for SPI_MPT and SGI_MPT were less favorable, with lower predictive accuracy. This discrepancy is believed to stem from inherent limitations of the SPI and SGI test methods themselves, particularly in their application to hard materials, as discussed in the next section.

Table 1 – Validation of the MPT predicted comminution parameter values

Description	A×b	DWi	SPI	SGI	SDT	BBWi
Size Class	-	-26.5+22.4	-26.5+22.4	-26.5+22.4	-19+16	-13.2+11.2
(in mm)	26.5+22.4	-22.4+19	-22.4+19	-22.4+19		-13.2+9.5
	-22.4+19		-19+16	-19+16		
%CumF < 30%	97.2%	98.6%	88.9%	91.4%	98.2%	99.3%
%CumF < 15%	78.0%	79.6%	60.6%	71.5%	82.6%	85.3%
Average	9.8%	9.8%	16.3%	12.2%	9.6%	8.6%

DISCUSSION

The test program demonstrated that the MPT achieved strong acceptance levels for A×b, DWi, SDT, and BBWi. Further investigation is needed to understand the limitations of the MPT models for both the SGI and SPI tests in comparison to the SAGDesign test. The reduced performance of these models may be related to the fact that both SGI and SPI tests are reported to struggle with measuring high hardness values when they exceed 150 minutes, as suggested by some sources.

The MPT modeling results for the SVT were not presented, as the SVT is calculated from a regression model based on raw SAGDesign laboratory parameters, including the initial passing at 1.7 mm of the SDT feed sample, revolutions obtained in the third cycle, and the slope of the linear portion of the SAGDesign test when the product percentage passing is less than 60% (Brissette, Mihajlovic, and Sanuri, 2014). Building an MPT model from a modeled value could lead to error propagation and compromise model accuracy.

The MPT models were developed using size classes that differed across the comminution tests. The MPT test samples were selected towards the end of the geometallurgical program and were viewed by the mining company as less optimal in terms of representativeness. Additionally, the samples for each deposit were selected by different laboratories, which may have influenced the results. Ideally, the MPT sample selection would have occurred earlier in the program, alongside the SMC rock selection.

CONCLUSION

To support improved orebody characterization and enhanced production forecasting, lump rock samples were tested using the proprietary Minpraxis Tester (MPT). The test campaign demonstrated that the MPT can rapidly and reliably predict key comminution parameters, including DWi and A×b obtained from SMC testing, as well as SDT and BBWi. Several operational advantages were also observed. The MPT eliminated the need for product sieving, enabled automated size measurement of individual particles, and captured particle-level strength data, allowing for high-resolution hardness characterization not typically achievable through conventional testing.

For any further comparative testing using lump samples, several refinements would help strengthen the alignment between datasets and further enhance MPT predictive modeling:

1. Select MPT samples at the same stage as SMC lump sample selection during comminution sample preparation.
2. Develop MPT models using a consistent size class across all comminution parameters to streamline

- testing and support broader comparability.
3. Carry out additional work on SGI and SPI data to better understand whether observed differences stem from MPT data characteristics or inherent variability in the comminution tests themselves.
 4. Further data collection would allow a more comprehensive evaluation of how MPT-based predictions relate to JK DWT A×b test outcomes.

Following the positive validation outcomes from this program, additional trials were initiated at the client site. The client has since broadened its evaluation of the MPT to include processing of resource half-core for both geotechnical and comminution parameters, along with lump samples selected earlier in the sample preparation workflow. This expanded interest reflects the opportunity to substantially increase data density to support more informed decision-making across mining and mineral processing.

REFERENCES

Amelunxen, P., Berrios, P. and Rodriguez, E. (2014) The SAG Grindability Index, *Minerals Engineering*, Volume 55, January, pp. 42-51, <http://dx.doi.org/10.1016/j.mineng.2013.08.012>.

Brissette, M., Mihajlovic, V. and Sanuri, S. (2014) New Accurate Testwork to Meet Required Accuracies of Mining Project Development, *Proceedings of the XXVII International Mineral Processing Congress (IMPC)*, 20-24 October, Santiago, Chile, Chapter 4, pp. 200-209.

Nadolski, S. (2019). 'Rock Hardness Measurement'. US Provisional Patent. 62910780. United States Patent & Trademark Office.

Nadolski, S. (2020). 'Rock Hardness Measurement'. WIPO International Application. WO 2021/062556 A1. World Intellectual Property Organization.