APMT

DOMAIN AND RESOURCE MODELING MADE EASY

APMT's mission is to change the way resource and reserve modeling and mine planning, heavily specialized activities, are done in mining companies. This, by bringing together the latest technology with cutting-edge research.

APMT - Consulting Services
Overview

APMT is proud of solving our customer's needs and challenges using deep domain expertise and ingenuity. We have a strong track record of supporting complex and diverse mining operations to unlock the value of their mineral resources.

Advanced Predictive Modeling Technology Ltd (APMT) specializes in strategic consulting services for multiple commodities to mining companies of all sizes, worldwide, throughout their asset's life. We can provide industry-standard services or accommodate very specific customer's requirements.

Our signature is deep domain expertise along with the most advanced software tools, enabling us to provide outstanding results that are also time and cost-effective.

In this brochure, our customers can find a summary of our standard services, team expertise, rates, and examples of our previous work.

We are eager problem solvers and will do what is necessary to provide our customers with the best service possible and robust information for their decision-making.

Contact us to learn more

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Consulting Services

I. Ore Body Modeling

SAMPLING, LOGGING AND QAQC REVIEWS

APMT provides expert services in reviewing sample acquisition and preparation processes, ensuring adherence to best practices for reliable ore body modeling. We specialize in designing robust sampling protocols, conducting heterogeneity assessments to optimize sampling accuracy, and evaluating the consistency of geological logging practices. Additionally, we offer comprehensive reviews of QAQC procedures, including data validation and auditing, to ensure high-quality, reliable inputs for resource estimation and decision-making. We focus on:

- Pierre Gy's theory for sampling of particulate materials
- Heterogeneity tests and sampling and sample preparation protocol design
- Review of quality control and quality assurance procedures and results

GEOLOGICAL MODELING

Ore body modeling is founded in a geological interpretation of the location and extent of geological units. APMT provides advanced services in geological interpretation and modeling, focusing on ensuring accurate and reliable interpretations for ore body characterization. We specialize in reviewing geological interpretations to validate consistency with available data and geological understanding. Our expertise includes:

- Spatial continuity analysis of geological domains
- Application of advanced geostatistical methods and probabilistic models to evaluate and refine geological models
- Assessing consistency with information quality and data density to ensure robust and credible models that support effective resource estimation and decision-making

RESOURCE / RESERVE MODELING

Resource and reserve modeling forms the basis for reliable estimation and planning of mining operations. APMT specializes in creating robust block models using advanced geostatistical tools to accurately represent key geological, mining, and geometallurgical variables. We combine industry-standard practice with cutting-edge methodologies to ensure precise and defensible outcomes. Our expertise includes:

- Development of estimated models to accurately represent resource characteristics
- Selectivity analysis to assess economic potential and optimize extraction strategies
- Uncertainty quantification to address data variability and enhance model robustness
- Confidence assessment to support resource classification and reporting standards
- Transfer of resources into reserves accounting for modifying factors
- Evaluation of model responses under varying scenarios for informed decision-making

II. Geometallurgical Modeling

PROCESS RESPONSE CHARACTERIZATION

Process response characterization identifies the dynamics and quality of outcomes resulting from variations in inputs and process conditions. At APMT, we specialize in modeling geometallurgical outcomes like energy consumption, throughput, reagents consumption and metal recovery using geochemical and mineralogical datasets or operational sensor data. Some of our focus areas include:

- Metallurgical response prediction using machine learning and deep learning
- Construction of Geometallurgical Block Models (Deterministic and Stochastic)
- Forecasting operational KPIs using real-time operational sensor data

SYSTEMIC MODULAR ANALYSIS AND GEOMETALLURGICAL PROGRAM WORKFLOWS

We view mining projects as integrated systems composed of various modules like geology, mining, mineral processing, metallurgy, and logistics/marketing, all within a socio-economic-environmental framework. By constructing predictive models within and across these modules, we capture the intricate dynamics of the mining system. This approach enables us to devise strategies and policies that incorporate and manage the impact of process variability and attribute uncertainty, optimizing the outcomes. At APMT, our goal is to enhance the resilience of the mining value chain, leading to more robust operations. Consequently, we offer:

- Crafting study designs and workflows for geometallurgical programs
- Systemic modular analysis on mine-to-mill, geology-to-port, and mine-to-port systems

We understand that geometallurgical program management necessitates a multidisciplinary team, thus our strategy involves (1) treating unit processes as individual challenges, and (2) considering integrated processes within a comprehensive system.

III. Mine Planning

SHORT-TERM MINE PLANNING

In open-pit mining, short-term planning focuses on creating a dependable production schedule that aligns with the long-term vision. The resulting short-term strategy needs to adhere to mining, processing, and plant limitations while optimizing key objectives such as overall metal yield, net profit, blending, or striping ratio. At APMT, we continually innovate, developing tailored algorithms to offer client-specific solutions on:

- Heuristics and mixed-integer programming (MIP) models
- Blast-hole data assimilation
- Risk-based economic analysis

LONG-TERM PRODUCTION SCHEDULING

In open-pit mining, long-term scheduling determines the extraction timeline for blocks and sets the appropriate cut-off grades, and bench/phase definition. This schedule is optimized to maximize the project's net present value while aligning with corporate strategies, considering mining, processing, and metallurgical constraints, and maintaining balanced stripping ratios. At APMT, we employ advanced algorithms to address and analyze long-term mine planning challenges, including:

- Strategic mine planning
- Stochastic optimization
- Real-options-based strategies under geological uncertainty
- Risk-based economic analysis

MINE SCHEDULING WITH REINFORCEMENT LEARNING

At the frontier between AI research and mining application, we reframe the problem of mine scheduling as a reinforcement learning task for short-term and long-term planning. Using a strategic workflow we provide optimal mine plans accounting for:

- Uncertainties on geological attributes, metal price forecasting, metallurgical responses, and mining costs
- Geometric precedence, open mining faces, and processing capacities

GRADE CONTROL MODEL

Grade Control aims for the integration of data from different sources and supports into the resource models to deliver more accurate local grade and geological attribute estimates. At APMT we focus on delivering:

- High-resolution grade control models
- Data assimilation with different supports
- Robust and reliable data assimilation workflows

IV. Due Diligence

SITE VISIT

Leveraging our hands-on experience in the mining sector, we conduct thorough on-site evaluations. Our experts carefully inspect operations, facilities, and equipment, ensuring that our assessments are grounded in real-world observations and insights.

DOCUMENTATION CHECKS

Our team meticulously reviews all available documentation, from licenses to operational records. This rigorous approach ensures that every aspect of a mining project is considered, validating its authenticity and ensuring compliance with industry standards.

REVIEW OF ACQUIRED DATA AND DATA MANAGEMENT

A mining project's success hinges on data quality. Our experts delve deep into the acquired datasets, scrutinizing their accuracy and relevance. We also assess data management practices, ensuring that data is stored, retrieved, and used effectively to support decision-making.

UNCERTAINTY QUANTIFICATION

Mining is inherently uncertain. Our specialists apply state-of-the-art techniques to quantify the uncertainty associated with mineral resources and reserves, providing stakeholders with a clearer understanding of potential risks.

LOM ECONOMIC RISK ANALYSIS

Leveraging our deep expertise in both mining and finance, we conduct comprehensive Life of Mine (LoM) economic risk analyses. By assessing potential economic scenarios and their likelihoods, we offer stakeholders a robust framework for informed decision-making.
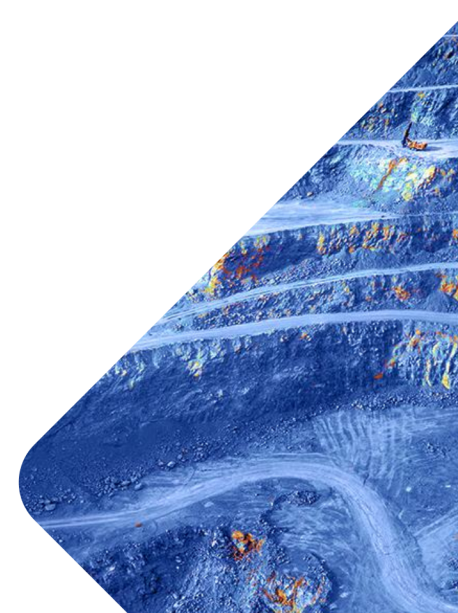
V. Mining Technologies Assessment

BACK-END MINING SOFTWARE CODE REVIEW.

APMT is proud to provide code reviews for industry software, whether in-house developments or software vendor's code. In an age where software drives operations, ensuring that back-end mining software operates flawlessly is crucial. Our technical experts rigorously review the code, ensuring its reliability and robustness, and confirming that it meets the expected results and the highest standards of the mining industry.

TECHNOLOGY IMPACT ASSESSMENT AND BUSINESS CASE

APMT provides assessment of the impact and/or expected outcomes of the implementation of new technologies. This, based on a deep understanding of the technical nature and drivers of the mining business. Among the technologies that we can evaluate are: orebody capture sensors, ore sorting and selectivity, sampling, software, fragmentation measurement, etc.

Once we have understood the impact of the technologies, we can provide an economical assessment and business cases that can inform robust decision-making.

Our Team

APMT

JULIÁN ORTIZ, PHD
CO-FOUNDER, CEO & PRINCIPAL CONSULTANT

Dr. Ortiz is a Mining Engineer from Universidad de Chile and Ph.D. from University of Alberta. Currently, he is Professor and Mark Cutifani / Anglo American Chair in Mining Innovation at University of Exeter - Camborne School of Mines, in the United Kingdom, where he conducts research related to geostatistical ore body estimation and simulation, and geometallurgical modeling using statistical learning. Dr. Ortiz previous roles include Head of Department at Queen's University and Universidad de Chile. He has over 25 years of consulting experience in sampling, ore body modeling, predictive geometallurgy, and technology adoption.

SEBASTIÁN AVALOS, PHD
CO-FOUNDER, CTO & PRINCIPAL CONSULTANT

Dr. Avalos is a Mining Engineer and M.Sc. in Mining from Universidad de Chile and Ph.D. in Mining Engineering from Queen's University. Author of the Annapurna Resource cloud-based mining software solution. He focuses on the application of conventional and advanced predictive modeling techniques in the mining industry. With over 12 years of experience and working on the frontier between deep learning, advanced geostatistics, and mine planning, Sebastian has led and contributed to the realization of more than thirty-eight mining-related projects, published peer-reviewed articles, conference proceedings, and professional training programs.

BERNABE LOPEZ, BENG
DIRECTOR OF BUSINESS DEVELOPMENT

Bernabe Lopez is a Mining Engineer from University of Chile. He has over 15 years of experience developing software for the mining industry as well as a mining operations' and business improvement background. He has successfully led the development of products from ideation to early commercialization that are now used by over 40 Tier 1 operations worldwide. Before joining APMT, he was Lead Product Manager at Hatch Ltd. in Canada and VP of Products at TIMining, Chile.

NELSON MORALES, PHD
SENIOR ADVISOR MINING PRINCIPAL CONSULTANT

Dr. Morales is a Mathematical Engineer from the University of Chile and a Ph.D. in Science from Université de Nice Sophia-Antipolis. He has over 20 years of experience in developing mathematical models and tools for mine planning and design optimization. Throughout his career, he worked for CODELCO-IM2, and for 12 years he was a researcher at the Advanced Mining Technology Center, where he led the Mine Planning and Design group and DELPHOS mine planning laboratory. Currently, he is an associate professor at Polytechnique Montréal. Nelson Morales has authored more than 100 publications in international conferences and journals in mine planning and is the author of several planning software applications for the optimization and simulation of mining operations.

Our Team

PAULA LARRONDO, MSC

**SENIOR ADVISOR GEOLOGY
SENIOR CONSULTANT**

Paula is a Geologist and M.Sc. from Universidad de Chile (Chile) and an M.Sc. in Mining Engineering (Geostatistics) from the University of Alberta (Canada). She worked for 15 years as a geostatistician in various international consulting companies. Paula also founded the geology program at Universidad Mayor (Chile), where she taught geology and geostatistics for seven years. She is a Ph.D. candidate at the Department of Electrical and Computing Engineering of Queen's University, where she is working towards a deep learning model to provide automated feedback to open-ended student work in the context of complex problem-solving in Engineering Education.

NICOLAS AVALOS, MSC

**DEVELOPER, SUPPORT &
PROJECT GEOLOGIST**

Nicolas Avalos is a Geologist and holds a Master's degree in Geology from the University of Chile (Chile). He has two years of experience in prospecting and exploration of natural resources (Au, Ag, Cu, and Mo) at TriMetals Mining Inc and Guanaco Outdoors SpA, and three years of experience in research and development of projects in economic geology. Nicolas specializes in geological modeling, from drill hole description, QA/QC analysis, and database management to generating reports and leading team work.

OSCAR PEREDO, PHD

**ADVANCED RESEARCH &
DEVELOPMENT ADVISOR**

Dr. Peredo is a Computer Scientist and Mathematical Engineer from Universidad de Chile. He holds a Master's degree in Information Technologies with a specialization in Supercomputing and a Ph.D. in Computer Architecture from the Universitat Politècnica de Catalunya, where his thesis focused on the acceleration of large-scale geostatistical applications. With over 15 years of experience in developing high-performance computing and distributed applications, Oscar has contributed to numerous projects utilizing cutting-edge technologies. Currently, he leads the Data Science and Data Engineering teams at a telecom company, focusing on developing large-scale predictive models and applications. He has authored several scientific publications in international conferences and journals, covering topics such as geostatistics, code optimization, and parallel computing.

Experience - Ore Body Modeling and Geometallurgical Modeling

Our team has executed or been part of the following Ore Body Modeling and Geometallurgical-related projects:

1. Las Bambas - Review of reconciliation procedures (Dec 2024) MMG, Peru
2. Eagle - Review of long-term resource model (Feb 2024) Lundin Mining, United States
3. Neves Corvo - Review of long-term recourse model (Jan 2024) Lundin Mining, Portugal
4. Chapada - Review of long-term resource model (Nov 2023) Lundin Mining, Brazil
5. KGHM Victoria - Multivariate conditional simulation (Feb 2023) KGHM, Canada
6. Sorowako - External reserves audit (Dec 2022) Vale, Canada
7. PTVI Bahodopi - Resource model audit 2022 (Dec 2022) Vale, Indonesia
8. Westwood Project - Uncertainty quantification by conditional simulation (Nov 2022) IAMGOLD, Canada
9. Pueblo Viejo - Conditional simulation of quality index for Pico Verde area of the Pueblo Viejo deposit (Aug 2022) Barrick, Dominican Republic
10. Lomas Bayas - Long, medium and short-term resource model audit (Aug 2022) Glencore, Chile
11. Polo Sur - Study of dust generation for Polo Sur Project (Aug 2022) Antofagasta Minerals, Chile
12. Pueblo Viejo limestone quarry resource modeling (Jul 2022) Barrick, Dominican Republic
13. Kay mine resource modeling (Mar 2022) Arizona Metals Corp., USA
14. Amoanda underground study (Feb 2022) Abosso Goldfields Ltd, Ghana
15. Mineralogical composition as a function of particle shape and size (Aug 2021) HZDR, Germany
16. Geometallurgical modeling of mining complexes: testing causal hypothesis to improve plant performance (Aug 2021) ArcelorMittal, Canada
17. Spence growth option - Procedure for evaluating the flotation circuit (Dec 2019) BHP, Chile
18. Nueva Union - Study of scaling factors laboratory-processing plant Nueva Union project (Dec 2019) Teck, Chile
19. Nueva Union - Review of metallurgical projection models (Dec 2019) Teck, Chile
20. Spence Growth Option - Simulation of blending in concentrate stocks for Spence Growth Option (SGO) (May 2019) BHP, Chile
21. Resource review in QBII - Sanction business case (Nov 2018) Teck, Chile
22. Resource estimation - Michilla - La Reina (Oct 2017) Michilla, Chile
23. Resource models, validation, and proposal - Agua de la falda (Aug 2017) Yamana Gold, Chile
24. Resource estimation - Feasibility model (May 2017) Pucobre, Chile

Prior to 2017, team members have participated in over 90 other projects in commodities such as **copper, gold, silver, nickel, zinc, REE, iron ore, nitrates, oil sands and coal**, including statistical and geostatistical analysis, data bases reviews, QAQC reviews, sampling protocol and heterogeneity characterization, domaining, resource models updates, uncertainty quantification, classification, reconciliation, definition of optimum drilling grids, assessments of economic impact of advanced drilling campaigns, full model reviews, multivariate resource and reserve modeling, grade control and short-term planning reviews, characterization and estimation of geometallurgical variables, and exploration potential assessments.

APMT

Our consulting services are powered by Annapurna™ Resource

Learn more