

## **Developing the Next-Generation Mining Geologist: Integrating Fundamental Geology, Data Analytics, and Decision Frameworks Through Apprenticeship-Based Training**

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Preparing the next generation of geologists requires equipping them to leverage the vast body of available knowledge and analytical tools while cultivating skill sets needed to address both known challenges and uncertainties inherent in mineral exploration, resource development, and mineral extraction. While today's geologists have access to an unprecedented range of geological data, analytical tools, and computational methods, many professionals lack the guidance and experience in determining which tools to apply, when to apply them, and how to integrate outputs into decisions. The industry requires these same geologists to make contextual, integrated decisions.

Foundational geologic competencies remain central to this process. Skills such as geologic field mapping, mineralogy and lithology identification, and rigorous geologic reasoning form the basis for effective interpretation of mineral systems. At the same time, the modern mining workforce must integrate emerging analytical approaches, including exploratory data analytics, geostatistical evaluation of datasets, high-level resource estimation (data validation, domaining, classification, and uncertainty), and generation of mineable shapes through optimization tools and conceptual mine design. Early awareness of these downstream considerations can significantly improve geologic interpretations and project outcomes.

This work presents practical case studies of how structured mentorship and real-world applications can bridge the gap between academic training and professional practice through an apprenticeship-style approach. Although advanced tools, like machine learning, are becoming more accessible, the successful application requires thoughtful change management, structured onboarding, and mentorship. Integrating these skills into traditional academic programs presents challenges, but stronger collaboration among academia, exploration groups, mine operators, and technology providers can help develop training pathways that prepare geologists for real-world decision making. By combining apprenticeship-style mentoring with exposure to modern analytical tools, the industry can cultivate a workforce capable of integrating fundamental geology with advanced technologies to ethically and responsibly characterize increasingly complex mineral deposits.