

Exploring for minerals and metals under cover: the right geophysics at the right scale in the right order

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Summary

The roles of geophysics in mineral exploration should be to: (a) test the existence of a mineral system and its mineral plays under sediment cover, (b) make a success-case exploration model more robust, (c) sequentially target through province/basin, then play, then prospect, then borehole scales, to (d) narrow the uncertainty range of each parameter used to calculate the possible resource sizes of a mineral deposit.

This has been the best practice approach to characterize and target petroleum systems and plays for decades. Each scale of investigation raises different questions about a subsurface accumulation. To answer them, petroleum explorers optimize a testing program with the most useful methods of subsurface geophysical data for each scale, i.e., potential fields at basin scale, reflection seismic for plays and prospects, wireline petrophysics at wellbore scale. The efficiency of this staged targeting approach – with a decision to continue or not after each stage – revolutionized petroleum exploration and its financial and discovery success in the 1990s. This ‘Play-Based Exploration’ is used as standard practice to: Survey prospective regions; Decide which license areas to lease; Estimate the chance of success, confidence, value and risk of districts/plays; Compare the value and favorability of companies’ assets, etc. The benefits returned to petroleum explorers, their investors and global society are evident.

Returning to mineral system and mineral play evaluation, the mineral exploration team hypothesizes where genetically-related clusters of mineral deposits (mineral ‘plays’) could occur if the mineral system’s essential ingredients all coincided. Ideally, the cost:value and risk:reward profile to test the mineral system model is within the company’s failure tolerance. If it is, the exploration team designs a targeting system to efficiently acquire and integrate new geophysical, structural-tectonic, geochemical and lithological data. The geophysical survey should be designed to confirm or disprove the tectonic-structural ‘spine’ of the mineral system hypothesis.

The presentation that accompanies this abstract will summarize how geophysics integrated with structural geology and tectonics is the ‘spine’ of an undercover targeting logic for minerals and metals. To make undercover targeting for minerals and metals more efficient, the optimal survey types should be applied and integrated sequentially through province, then play, then prospect, then borehole scales. A summary of the parallel targeting process for petroleum will be given, to emphasize how alike the petroleum system and mineral system exploration processes are, and how wisdom could be gained from exchanging ideas across petroleum and metals exploration.

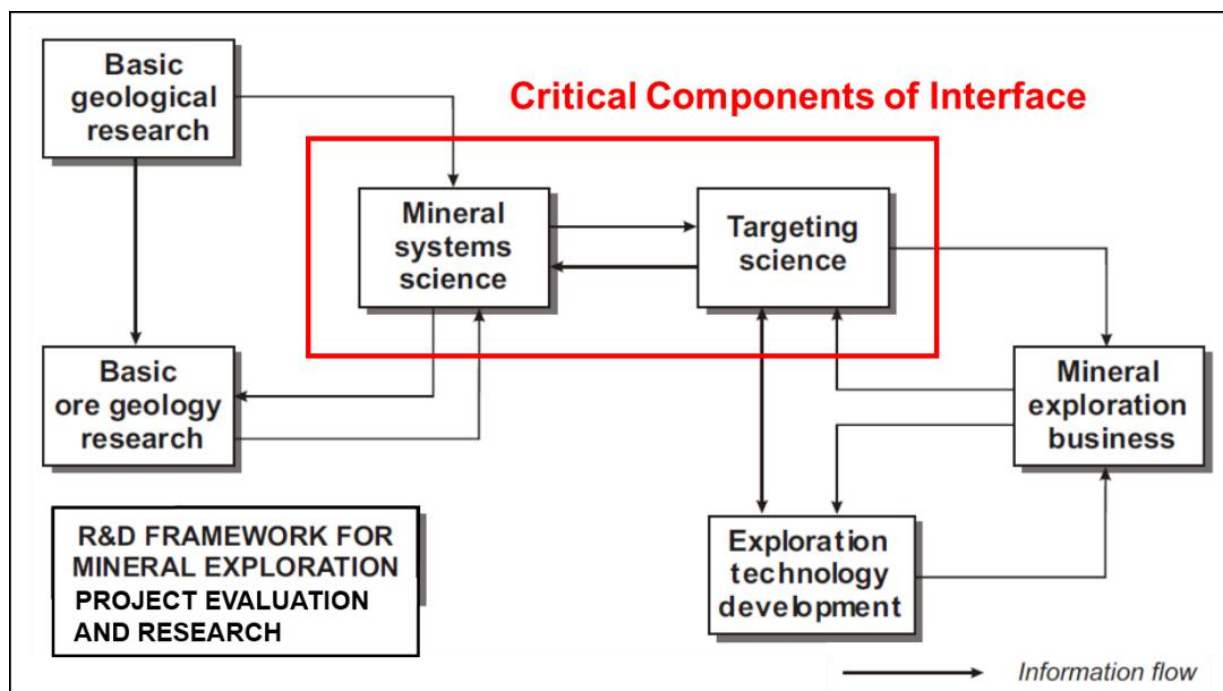


Figure 1. The roles of Mineral Systems Science and Targeting Science to optimize the interface between economic geology and research and the exploration business. Tectonics and structural geology are inputs into mineral system and mineral play analysis. The 'right' combination of and sequence of geophysics methods and equipment should then be deployed to target those mineral system concepts. From Banks et al. (2019), modified after Hronsky (2010).

References

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