

Social License to Explore in Legacy Districts: Machine Learning–Driven Stakeholder Analysis at the Deer Trail Project, Utah

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Legacy mining districts exhibit distinct socio-political risks and opportunities compared to greenfield projects, characterized by persistent historical narratives, internal stakeholder politics, environmental concerns, and hopes (and fears) for economic development. Technological innovation in economic geology has traditionally focused on subsurface characterization, geophysical imaging, and mineral system modeling. However, the viability of both new and legacy deposits increasingly depends on above-ground factors, particularly around socio-political risk, which is driven by stakeholder sentiment, network structures, and dominant narratives. This study presents a novel application of machine learning analysis of stakeholder networks and opinions at a historic mining district undergoing renewed exploration at the Deer Trail project in Southern Utah.

Using natural language processing (NLP) and topic modeling (Latent Dirichlet Allocation), the authors were able to identify dominant themes from semi-structured stakeholder interviews across two years. Network analysis techniques were also used to map influence structures, information flows, and potential points of contention within the stakeholder landscape. In the Deer Trail case, there were two distinct groups —the historic community with intergenerational memory, and the recent domestic immigrants who struggle to integrate but are well- connected externally. Combining the topic co-mention network with the stakeholder network, we identify strategies for increasing internal cohesion to address both strategic risks and engagement opportunities.

This aligns stakeholder intelligence with the same rigor applied to geological data, supporting risk-informed decision-making across exploration and development stages.

The Deer Trail case demonstrates that the integration of machine learning outputs with geoscience workflows enables a more quantitative approach to social license assessment. Advanced analytical methods applied to stakeholder systems can unlock value in "old deposits" by reducing uncertainty, improving engagement strategies, and ultimately enhancing project viability and valuation.