Dynamic models: Time as a critical element in resource exploration

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Exploration in both the mineral and petroleum industries relies on models that define the location, size, and quality of the resource. Ideally, these models are based not simply on description, but on dynamic processes. Concentrations of both metals and hydrocarbons require a source, a mechanism for mobilizing the resource, a pathway for transport, and a process for concentrating the resource. These elements of a dynamic model must be appropriately aligned in time. For example, impediments to mobilization may arise or retreat, dictating allowable transport times. Similarly, the mechanism for mobilization must be operative when pathways are available. Re-Os geochronology is uniquely suited for dating both sulfide minerals and organic matter, providing the fundamental time constraint for exploration models.

Consider, for example, a blind ore body located near both a shear zone and a pluton. Should exploration for additional ore in the same region focus on the shear zone or the pluton? Comparison of the age of the ore with the age of the pluton and/or the timing of deformation in the shear zone can quickly narrow the options. Applying this simple idea requires meticulous sampling for geochronology, and merging of ages with detailed geologic observations and broad geologic constraints. Combined skills in geochronology and economic geology are essential.

Similarly, hydrocarbon system evolution may include tectonic or sedimentologic pulses that trigger maturation or migration, interaction of oils with aqueous fluids, mixing of oils and resultant asphaltene precipitation, biodegradation, or fill and spill among reservoir compartments. With Re-Os geochronology, we can now date kerogen, bitumen, tar mats, and oils in discrete parts of a petroleum system to reconstruct its evolution through time – an invaluable exploration guide.

A key prerequisite for successful partnerships is trust. Academics must earn the trust of industry partners by scrupulously honoring confidentiality, using samples and data wisely, and reporting within the agreed-upon time. In return, industry partners must provide the background needed for reasoned interpretation, and be open to discussion of non-standard models. Profitable industry-academia partnerships bring together multiple data sets and ideas for discussion among scientists with diverse backgrounds and skill sets. We will provide examples of such interactions from our work with both the mineral and petroleum industries.