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Focus paper

Province-scale commonalities of some world-class gold deposits: Implications for mineral exploration

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ABSTRACT

Discovery rates for all metals, including gold, are declining, the cost per significant discovery is increasing sharply, and the economic situation of the industry is one of low base rate. The current hierarchical structure of the exploration and mining industry makes this situation difficult to redress. Economic geologists can do little to influence the required changes to the overall structure and philosophy of an industry driven by business rather than geological principles. However, it should be possible to follow the lead of the oil industry and improve the success rate of greenfield exploration, necessary for the next group of lower-exploration-spend significant mineral deposit discoveries.

Here we promote the concept that mineral explorers need to carefully consider the scale at which their exploration targets are viewed. It is necessary to carefully assess the potential of drill targets in terms of terrane to province to district scale, rather than deposit scale, where most current economic geology research and conceptual thinking is concentrated. If orogenic, IRGD, Carlin-style and IOCG gold-rich systems are viewed at the deposit scale, they appear quite different in terms of conventionally adopted research parameters. However, recent models for these deposit styles show increasingly similar source-region parameters when viewed at the lithosphere scale, suggesting common tectonic settings. It is only by assessing individual targets in their tectonic context that they can be more reliably ranked in terms of potential to provide a significant drill discovery. Targets adjacent to craton margins, other lithosphere boundaries, and suture zones are clearly favoured for all of these gold deposit styles, and such exploration could lead to incidental discovery of major deposits of other metals sited along the same tectonic boundaries.

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1. Introduction

The most up-to-date available statistics on discovery and resource inventories for metals indicate that discovery rates are declining, the cost per discovery is rising steeply, and it takes an increasing amount of time to bring mines into production (Schodde, 2014; Zhang et al., 2015). This is particularly true for the gold exploration industry (Fig. 1; Schodde, 2013). The current exploration and mining industry structure, with largely

acquisition-driven majors and poorly-resourced juniors and a historically low proportion of mid-tier companies, makes this situation difficult to redress (e.g., Groves and Trench, 2014). Several studies have shown that the industry as an entity is a low base-rate situation, with close to zero return. There is little economic geologists can do to influence the overall structure and philosophy of an industry driven by business principles. There is also little that can be done to influence an education system that, from anecdotal evidence, produces graduates less well equipped to deal with the more pragmatic aspects of mineral exploration (Groves and Trench, 2014). What can be done is influence the nature of greenfield exploration, necessary for the next group of significant discoveries required to replenish declining resources. As the oil industry has done over the past several decades, there is a need for the minerals industry to increase the percentage of discovery successes by

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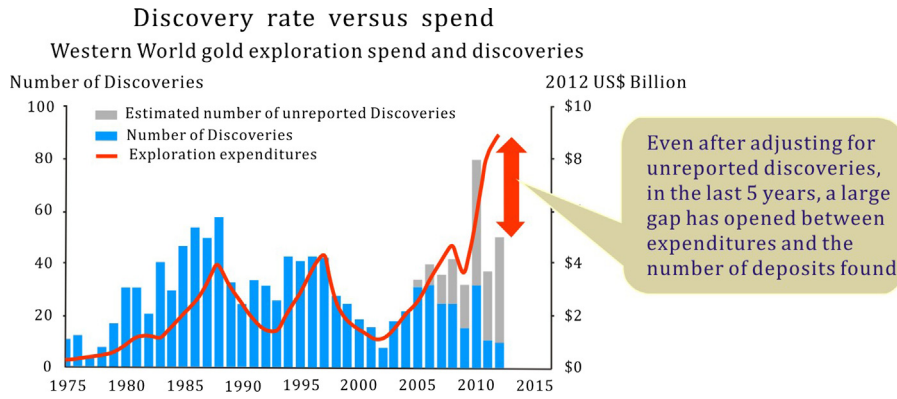


Figure 1. Rate of gold deposit discovery relative to exploration expenditure: number of reported discoveries and estimated unreported discoveries (after Schodde, 2013).

significantly decreasing the number of low-potential targets that are drilled, after careful consideration of their economic potential in terms of a regional geological framework. This paper examines the geological principles behind this type of regional assessment. It follows on from, although takes a more pragmatic approach than, previous studies by Hronsky and Groves (2008) and Hronsky et al. (2012).

2. Importance of scale

Most difficulties experienced in modern society are caused by an inability to view critical issues at an appropriately large scale: to “see the wood for the trees”. Arguably, economic geology also faces the same problem. As a profession, there is a tendency to view and classify mineral deposit types at the deposit scale, at least in part due to the more ready research funding from mining operations, than from regional exploration groups. Despite an increasing emphasis on a mineral systems approach at a variety of scales (e.g., McCuaig, 2013; McCuaig and Hronsky, 2014), a study of the major international economic geology journals of the past two years

shows that about 90% of published papers concern district to deposit to intra-deposit scale research, with less than 5% having obvious global application. As highly anomalous metal concentrations, mineral deposits are not simply formed in specific locations at specific times due to deposit-scale processes, but due to tectonic processes in an evolving Earth (e.g. Groves et al., 2005). This is recognised when the exploration process is viewed theoretically as a logical temporally-staged process at increasingly smaller scales (Fig. 2). Each target, commonly acquired for reasons outside this rigorous framework, should thus be viewed in terms of its larger scale tectonic and temporal setting to access its true potential before an intensive exploration and drilling campaign is mounted.

3. Scale-dependant concepts for gold deposit styles

Orogenic gold, Intrusion-related gold (IRGD), Carlin-type gold, and Iron-oxide copper-gold (IOCG) deposits are classified as separate deposit types (e.g., Lang et al., 2000; Cline et al., 2005; Hedenquist et al., 2005; Williams et al., 2005; Goldfarb et al.,

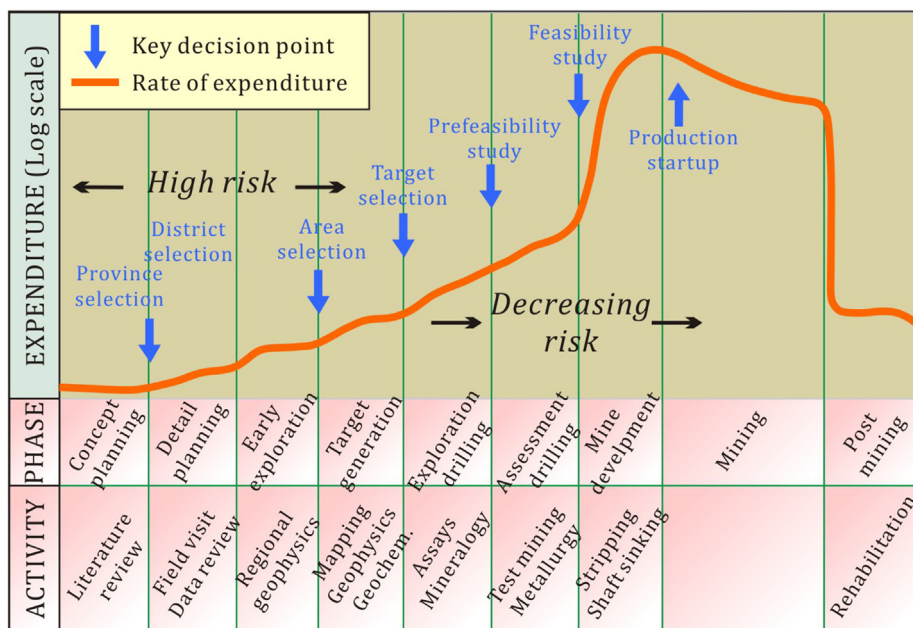


Figure 2. Key stages and decision points in a mineral exploration program. Province selection is a low cost but high geological risk phase. Poor decisions at the global to province scale mean that mineral exploration will never reach the feasibility stage.

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