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Mineral exploration in regolith-dominated terrains: Global considerations and challenges

I. González-Álvarez [a,*], M. Boni [b], R.R. Anand [a]

CSIRO, Mineral Resources, Discovery Program, WA, Australia
Dipartimento di Scienze della Terra, dell'Ambiente e delle Risorse, Università di Napoli "Federico II", Italy

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ABSTRACT

Mineral exploration through transported cover is becoming one of the fundamental challenges for the exploration industry in this century. The sharp increase in demand for commodities driven by a growing population and technology-based society is coupled with the decrease in world-class ore deposit discoveries in the last three decades. This is setting the stage for an unprecedented scenario, that is, ensuring that the market supply for critical metals (Ni, Co, Au, PGE, etc.) is satisfied. This situation is becoming the driving force for a restructuring of mineral exploration paradigms. New technologies and methodologies are being developed; and, as a consequence, regions that were considered to be unfavourable for ore deposit exploration are now being reconsidered. Among these areas are vast regions of Regolith-Dominated Terrains (RTD) with basement rock suites buried under thick transported cover and/or deeply weathered profiles.

This Special Issue presents several studies on mineral exploration in RTDs in Brazil, China and Australia, and addresses some of the issues that hinder exploration in these problematic terrains, in the hope of reaching a broad audience, and encouraging researchers from a wide spectrum of disciplines to contribute to this exciting and inspiring exercise.

1. Global considerations

Nearly 25% of the Earth's continental surface area is affected by tropical climatic conditions that result in intense chemical weathering (Fig. 1; Strakhov, 1967). This figure increases when considering regions which experienced these conditions in the past. These areas often display lateritic profiles that may reach considerable depths, up to >100 m (e.g., Anand and Paine, 2002; Bardossy and Aleva, 1990; Goudie, 2004; Thomas, 1994). Similar features are also observed in non-tropical areas, although they are not regionally extensive (Migoń and LidmarBergström, 2001). Deeply weathered regions commonly coincide with major geomorphological features such as cratons and shields, as well as continental lowlands and plateaus (Fig. 1; Taylor and Eggleton, 2001; Twidale and Campbell, 1995), which today are under arid climatic conditions in parts of Australia, Africa and China, and are blanketed by cover and/or dissected landscapes, down to depths of hundreds of metres (Fig. 1). These regions are commonly referred to as regolith-dominated terrains (RTDs). The geological understanding of these regions is problematic due to their lack of fresh bedrock outcrop and complex weathering histories. In fact many of these areas display weathered profiles, which have been developing for millions of years (e.g., Anand and Paine, 2002). Thus many of these regions correspond to ancient, stable and weathered landscapes, as is the case of several regions in Australia, where fossil Palaeogene landscapes (~65–25 Ma; Pillans, 2005 and references therein), and weathered profiles with residual clays dating back to the Late Palaeozoic (>250 Ma; Bird and Chivas, 1988) occur.

Understanding the processes of weathering, erosion and deposition that have formed the thick transported cover over these terrains requires a different approach than applied to their counterparts in recently glaciated and juvenile settings. This is due to the much longer time scales involved and the overprinting by successive weathering events under different climatic environments (Anand and Paine, 2002). These environments are widespread across many continents, but have been largely overlooked for mineral exploration due the risk and cost associated with their exploration. However, increasing mineral resource demand resulting from the exhaustion of world-class ore deposits, and a recent paucity of significant discoveries in the near surface (<50 m), is a compelling motivation to further explore RTDs. Also compelling is the development of new technologies and methodologies that are making mineral exploration in RTDs more economically feasible such as geophysics, and data integration platforms.

Mineral deposits are geochemical anomalies in the Earth's crust due to their local high concentration of one or a diverse suite of trace elements (Ni, Au, Co, Cr, Sc, REE, HFS, etc.), that may develop geochemical footprints. Such anomalies have enormous value when they are

* Corresponding author at: CSIRO, Mineral Resources, Discovery Program, Western Australia, Australia.
E-mail address: ignacio.gonzalez-alvarez@csiro.au (I. González-Álvarez).

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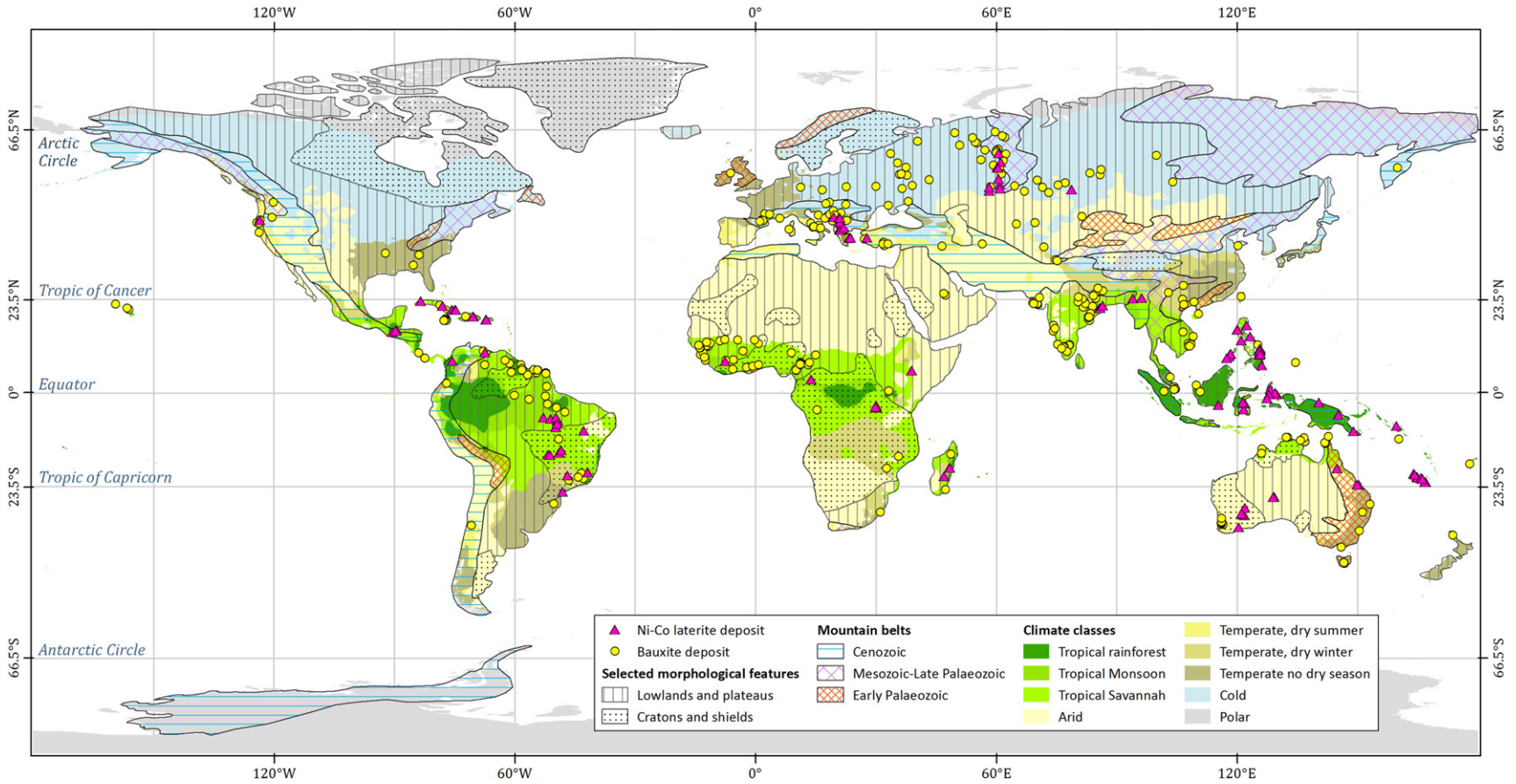

Fig. 1. Main climatic domains based on Köppen's classification and modified after Peel et al. (2007), with the location of the main Ni–Co laterite and bauxite deposits (Schulte and Foley, 2014; USGS, 2015), plotted over selected major morphological features (modified after Taylor and Eggleton, 2001).