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Litho- and Chemo-Stratigraphy of the Critical Zone at Sandsloot, Northern Limb of the Bushveld Complex: A Data Science Approach

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Exploration geoscience practitioners use spatial data to derive insights into the spatial distribution and other characteristics of target geological objects (e.g., an orebody). Data science applications can facilitate information retrieval from existing data while improving performance and reducing bias in interpretation tasks. Despite technical developments [1], exploration geosciences have not yet leveraged these techniques as much as other disciplines.

The Northern Limb (NL) of the Bushveld Complex represents a section of a 2.05 Ga plutonic-volcanic system encompassing mafic to ultramafic cumulate rocks hosting a significant proportion of Platinum-Group Elements (PGE) resources globally[2]. Sandsloot Farm, situated in the centre of the NL, is the largest open pit Pt mine in the world and represents a geological, geochemical and mineralogical data-rich environment, including decades of legacy data. Thus, the Sandsloot area is a prime testing ground where data science applications may be employed to determine key proxies, distil rock and ore classifications, and advance mapping of PGE mineralisation in the NL.

This study uses classic bulk geochemical tools (i.e., CIPW normative mineralogy, Harker plots, down borehole plots and selected precious metals analysis) to identify distinct rock types integrated in a data science approach. The lithological groupings are used to distinguish geological domains at Sandsloot while contextualising their location and correlation with mineralised horizons across multiple boreholes. The comparison of geochemically defined domains with (manually) geologically logged domains produces a clear correlation, indicating the successful nature of this data science derived technique. Further analysis of results provides insight into ore formation, magmatic evolution, magmatic-hydrothermal alteration and contamination processes operating across a range of scales in the NL. Domaining and correlation of large datasets by human interpreters is often highly subjective, but our methodology utilising data science techniques allows a complex and very large database to be handled in a more systematic and robust manner.

[1] Bergen, K. J. et al. (2019) Science 363:1-10.

[2] Kinnaird, J. and McDonald, I. (2018) SEG Spec. Publ. 21:157-176.