

Article

Implicit Geomodelling of the Merensky and UG2 Reefs of the Bushveld Complex from Open-Source Data: Implications for the Complex's Structural History

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Received: 28 September 2020; Accepted: 29 October 2020; Published: 1 November 2020



Abstract: The Bushveld Complex (BC) is the world's largest source of platinum group metals. Extensive studies on the complex have focused on its geochemistry, magma and platinum group mineral genesis, mineral characterization and intrusion mechanisms. However, relatively little work has been undertaken on the overall 3D geometry of the complex, which detracts from the adequate contextualization of such studies. Furthermore, the absence of a broader 3D model of the complex does not permit the identification of structural trends and mineralization patterns. This contribution details the construction of 3D implicitly-modelled Merensky and UG2 Reefs across the Rustenburg Layered Suite of the BC, using Seequent's Leapfrog software. Multiple open-source and public-domain data sources and modelling workflows were explored to account for disparities in data resolution, data spacing and clustering, and the resolution of model outputs. Key outcomes are (1) a representative, fully-implicit, dynamic geological model of the Merensky and UG2 Reefs over the main chamber of the BC; (2) identification of modelled features that augment the current understanding of the BC's kinematic history and cumulative deformation; and (3) identification and analysis of subtle geometrical trends and patterns, such as inter-reef spacing and modelled depths, as well as structural domains that may not have been apparent from numerous, more focused or isolated petrological or geochemical studies. It is anticipated that this baseline 3D model will form the foundation for future, possibly localized, dynamic updates as further information becomes available. The addition of proprietary (*viz.*, non-open-source) data, such as 2D seismic sections and 3D seismic surveys, would enhance the overall resolution and quality of such a model and resulting interpretations.

Keywords: Bushveld Complex; 3D implicit modelling; open-source data; structural analysis; implicit modelling

1. Introduction

The Bushveld Complex (BC) represents the world's largest source of platinum group metals (PGM), which are critical for multiple industrial applications, from automotive catalysts to components in medical equipment. The BC has been the focus of numerous studies, predominantly on whole rock geochemistry and mineralogy, which seek to develop models for PGM genesis and intrusion mechanisms [1–5]. The majority of these studies examine the cumulate layering across various mines and exploration projects, albeit with limited or only very local contextualization within the overall