Rank Statistical Analysis of Gold Endowment in Terranes of Differing Exploration Maturity: Selected Examples from Turkey and Southern Africa

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Zipf's Law is a size-frequency relationship following an inverse power law distribution used to assess the mineral endowment of a metallogenic province and its residual potential. It may also indicate a relative measure of prospectivity to select target areas for mineral exploration. This relationship exists at various scales, from regional to district to camp, and, remarkably, can be shown in some instances to extend across terrane boundaries or even on a craton-wide scale, but does not cross metallogenic zones. The gold deposits of Turkey are represented by a variety of deposit types and geological settings, distributed across a number of micro terranes. They include porphyry, epithermal, VMS, and Carlin-type deposits. With about 98% of the total gold endowment being metallogenically related to the 300 Ma evolution of the Neotethys sensu lato, it permits the application of Zipf's Law to the deposits, broadly all members of one set. Of the expected total endowment of 2,745 tonnes Au, approximately 1,777 tonnes Au has been found, suggesting 35% residual endowment. On the Zimbabwe craton, more than 1,200 tonnes Au was produced between 1897 and 1977 from about 300 mines, with an additional 700 tonnes Au estimated to have been produced in precolonial times. Similar to the example above, most of the gold deposits are epigenetic and related to craton-wide intrusive and metamorphic activity at 2.7 Ga, and can thus be regarded as a single set. Rank analysis of these deposits shows a close fit to their theoretical distribution, with perhaps only a 6% residual potential. The lack of agreement with the expected Zipf distributions for these deposits at the scale of individual greenstone belts suggests that smaller subsets of the data have the effect of underrepresenting the total metal endowment of the system. The Barberton Mountainland has been mined for gold for over 140 years and has produced in excess of 320 tonnes Au. Declared resources contribute an additional 350 tonnes Au. According to Zipf's Law, approximately 60% of theoretical Au endowment is presently unaccounted for. Following this, there should be an additional 22 deposits with sizes in the range of 10 to 30 tonnes Au. By applying Zipf's Law in terranes with different exploration maturity, one can assess the relative prospectivity of a metallogenic province in different geological settings, from craton scale to young orogenic belt. This estimation of the size of undiscovered gold resources is important in prioritizing exploration activity. Calculating residual gold resources at different time intervals can demonstrate the improvement in knowledge of resources and the diminishing residual potential.