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Scale dependence of structural control on gold deposits in Kumasi Basin, Ghana

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The Palaeoproterozoic Kumasi Basin, Ghana formed between 2150 Ma and 2100 Ma initially as a foreland basin [1] that progressively evolved into a back-arc basin that was subducted beneath active volcanic arcs to the west (Sefwi–Bibiani Belt) and to the east (Ashanti Belt) [2]. It contains the Asankrangwa Gold Belt, a NE-SW oriented shear zone, along the central axis of Kumasi. The Palaeoproterozoic evolution of the Western African craton particularly the Eburnean Orogeny played a key role in establishing the structural framework for the orogenic gold deposits in Kumasi [1, 2, 3, 4, 5]. Although the structural architecture of Kumasi evolved throughout the Eburnean orogeny, the most significant gold event took place post-peak metamorphism towards the close of the Eburnean orogeny [2]. Scale-dependent exploratory point-pattern analyses including Fry analyses were carried to identify the key structural controls on localization of gold at different scales of exploration. The results show two dominant orientations, namely, NNE–SSW and NE–SW. At a regional scale (segment lengths 0–300 km), the dominant trends are along NNE–SSW, NE–SW and N–S, whilst there are minor spikes along E–W. At smaller scales of camp- to district (segment lengths 0–50 km), the trend becomes more prominently NE–SW, although significant spikes persist along NNE–SSW. However, new trends along NNW–SSE and NW–SE emerge at this scale and become prominent. At the deposit-scale (segment lengths 0–10 km), predominant spikes occur along NNW–SSE and E–W directions, whilst there are subsidiary spikes along NE–SW and NW–SE. The NNE–SSW trend still persists but becomes insignificant. The prominent NNE–SSW trend at the regional scale possibly relates to ancient crustal-scale structures that could have formed mantle tapping plumbing systems for source processes. The NE–SW trend is likely related to the D2 thrust faults. The N–S trending spike is cryptic — there is no well-defined expression of this trend on the surface. However, like NNE–SSW, this could represent a crustal feature related to gold mineralization that runs through the entire belt. The trends at the camp-to-district scales are noisy, but the major spike along NE–SW persists, with additional spikes appearing along NW–SE and NNW–SSE that can be associated to the flexures caused due to sinistral strike-slip faults generated by reactivation of the D2 thrusts during the D4 deformation event. At the deposit-scale, the NNW–SSE trend becomes predominant, with significant spikes along E–W. This highlights the possible influences of cross faults, splays, jogs and bends along D2 thrust faults associated to the D4 deformation event becomes more discernible as evidenced by the trends along NW–SE and approximately at NNW– SSE directions. The results indicate that the regional-scale exploration should be aligned along the major NNE-SSW and the NE-SW orientations, while the deposit-scale exploration should follow the NW-SE and the NNW-SSE directions that represent flexures along the D2 thrust faults which formed towards the close of the Eburnean orogeny. The significance of these flexures for gold precipitation can be substantiated from the fact that during the D4 deformation event the Kumasi Basin was transformed into a low-stress domain due to strain partitioning between faults and the rock masses and the consequent active deformation along the existing structures and associated secondary structures increased permeability in parts of the Kumasi Basin and created spaces which led to sporadic fluid escape along structures that were actively being deformed and the subsequent physical and chemical reactions eventually triggering gold precipitation.

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