

Oxygen Isotope Provenance Study of Gold-Bearing Banket Conglomerate Quartz Pebbles, Tarkwaian Group, Ghana: Implications for Regional Gold Exploration

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The Tarkwaian Group of Ghana hosts the world's second-largest quartz-pebble conglomerate gold system, having produced over 280 tonnes of gold, yet the provenance of its gold-bearing Banket conglomerates remains contentious. Traditional models propose derivation from western Ashanti Belt lode-gold deposits (Obuasi, Prestea, Bogoso) based on pebble morphology and paleocurrent analysis, while recent structural and geochronological studies suggest eastern sources. This controversy has profound implications for regional exploration strategy. We employed oxygen isotope analysis of quartz pebbles from four principal reef horizons at the AngloGold Ashanti Iduapriem Mine to resolve this debate, capitalizing on quartz's resistance to isotopic re-equilibration during low-grade metamorphism. Twenty systematically collected quartz pebbles (covering Reefs A through D, spanning gold grades 0.8-8.5 g/t) yielded $\delta^{18}\text{O}$ values ranging from +8.2 to +13.6‰ (V-SMOW), with a mean of $+10.8 \pm 1.6$ ‰. These values are systematically 3-4‰ lower than ore-stage quartz from western Ashanti Belt deposits (Obuasi +14.1‰, Prestea/Bogoso +14.8‰, Bibiani +14.3‰), with only 10% of Banket samples overlapping the lower range of western source compositions, supporting reinterpretations favoring eastern provenance. No correlation exists between $\delta^{18}\text{O}$ values and gold grades ($r = -0.18$, $p = 0.46$), confirming mechanical rather than chemical controls on ore concentration. Compared globally, Tarkwaian pebbles occupy the lower end of the paleoplacer $\delta^{18}\text{O}$ spectrum (Witwatersrand +13.9‰, Jacobina +11.7‰), potentially reflecting Paleoproterozoic versus Archean source characteristics or post-Great Oxidation Event hydrothermal evolution. These findings challenge conventional provenance models, redirect exploration toward underexplored eastern terranes, and demonstrate the power of stable isotope provenance tracing in polydeformed sedimentary systems within the West African gold province.