Understanding the structural geology, stratigraphy, and mineralization of the Kibali ‘orogenic’ gold deposit, NE DRC: Key for exploration criteria in complex Neo-Archaean terranes

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The Kibali orogenic gold deposit is the largest gold only project under development in the world today with a total mineral resource 17Moz (Dec 31, 2013). Located in NE Democratic Republic of Congo within the highly prospective Neo-Archaean Kibali granite-greenstone belt, the deposit is atypical in that it shows no association with any large, steeply-dipping crustal scale shear zones, as is typical of orogenic gold deposits. Instead it is spatially related to a series of discrete, subvertical anastomosing shears developed within a major thrust stack.

The regional geology comprises three major terranes: the Neo-Archaean Kibali granite-greenstone belt (2.63-2.64Ga), the West Nile Gneiss thrust onto the Kibali belt along its northern edge and the Upper Zaire Granitic massif (2.62-267Ga) along the southern edge of the greenstone belt. The latter represents a stable domain with a possible E-W strike-slip contact with the Kibali greenstone belt.

The host Kibali Granite-Greenstone terrane is an east-west trending belt composed of thrust stacked volcano-sedimentary units, carbonaceous phyllites, banded iron formations, cherts, and a suite of bi-modal plutons and volcanic rocks. On a deposit scale the litho-stratigraphic units correspond to an intercalation of polymict and quartzose meta-conglomerate, coarse meta-sandstones and/or crystal-rich intermediate-acidic tuffs, carbonaceous phyllites, meta-siltstones, cherts, and banded iron formations intrude by dolerite sills and dikes. Metamorphic grade varies from sub-greenschist facies in the west to amphibolite grade in the east. Mineralization is preferentially hosted within the clastic units and the siliciclastic BIF rocks and is a result of complex interaction between shearing and folding, and competency and chemical contrasts. Geochemical changes across units and proximity to subordinate splays off the principle ‘S2’ shears are key for the mineralization.

Two major NE-SW shortening events are identified that controlled structural evolution and mineralization. Field data suggest that a D1a event generated a series of thrusts, F1 recumbent folds, and an S1a bedding parallel foliation reworked by D1b backthrusts and lateral ramps as part of a continuing shortening event. During D2 a series of NE trending, fault-bounded, sub-vertical corridors (locally termed ‘S2’ structures) characterized by oblique folding (F2) were developed due to transpression. The KCD mineralization spans the late D1b and early D2 events. It is located in an 800m wide high strain NE-trending corridor bounded by two steeply dipping faults which controlled the fluid pathway. Oblique folding generated by left lateral movement across the D2
corridor generated a secondary porosity due to interference folding with F1 fold, as well as en-
echelon folding in which the fluids altered the rocks and precipitated sulfides. Outside of the
corridor, drag folds and reworking of older thrust faults created space for tabular ore bodies. This
complex system controlled the evolution of NE plunging ore lodes with variable geometries.

The world class KCD deposit is an excellent example of a complex deposit developing due to
thrust related shearing and folding in preferential lithological packages. The permit remains highly
prospective with a number of targets identified in similar fault controlled corridors. This model
can be extrapolated outward into the rest of the region.