Geochemistry, Geochronology and Metallogeny of Pre-Katangan and Post-Katangan Granitoids of the Greater Lufilian Arc, Zambia and Namibia

A. Lobo-Guerrero S.*
LOBO-GUERRERO MINERIA S.A., Calle 126 No 43-76, Off. 309, Bogota, Colombia

**ageo@iname.com; ageo@logemin.com*

The Greater Lufilian Arc is a curvilinear belt of Neoproterozoic Katangan sediments that was deformed during the Pan African orogeny in Zambia and the Democratic Republic of Congo, and the westward extension of similar rock sequences into Botswana, Angola and Namibia. The mobile belt of the Greater Lufilian Arc also comprises a dominantly Paleoproterozoic basement of deformed granitoids, and a diverse suite of Pan-African granitoids that intrude the Katangan sequences.

Sixty percent of the 508 intrusive rocks analyzed from the Arc had midalkaline character; 33% were subalkaline and 7% were alkaline. Mafic rocks are closely associated to felsic rocks in most Arc domains; 2/3 of the gabbroids were midalkaline, 1/6 alkaline and 1/6 subalkaline. The average rock type distribution for the entire Arc closely resembles that of the Zambian Hook Granite Batholith.

A recurrent feature observed in most outcrops of the study area is the presence of three or more contrasting plutonic rock types, including mafic, ultramafic and alkaline plugs and dikes. That multiplicity of rock types in small areas seems to be a characteristic of continental extension anorogenic environments.

Another frequent field observation is persistent clustering of small bodies of red-altered granitoids, gabbroids, hydrothermally-emplaced massive magnetite-hematite, quartz pods and round-pebble hydrothermal breccias. These features occur often in and around iron oxide-copper-gold (IOCG) systems throughout the Arc.

The main granitoid periods of emplacement present in the Arc are listed on Table 1. Several more restricted events occurred at 1700, 1600, 880 and 460 Ma.

The Zambian Lufilian Arc and Damara region of Namibia behaved as independent entities from 2200 to 2000 Ma. They also behaved significantly different from 1400 to 850 Ma. Geological history of the two main portions of the Greater Lufilian Arc is consistent from *circa* 800 Ma to the present, and especially during the last 600 Ma.

Most areas studied in the Arc show polycyclic geological histories. Repeated anorogenic intrusive events are a common denominator. Prolonged crustal histories have resulted in superimposition of events.

Granitoid rock suites with closely matching chemistry and macroscopic features have been found to form two or three times in the same region, with up to a billion years of age difference. These features preclude lithological or detailed geochemical correlation of plutonic rocks.

At least ten clusters of ring complexes were identified in the Arc. Clustering of multiple anorogenic ring complex intrusions can form batholithic size bodies. Clusters are made by amalgamation of multiple ring complexes of varying chemical composition and size. Most of their rocks are midalkaline. Volcanic and plutonic rocks of roughly the same composition occur together. Total duration of ring complex cluster cycles averages 110 Ma, and their plan view geometry is roughly that of an isosceles triangle.

Table 1 Main Granitoid Terranes in the Greater Lufilian Arc

Age (Ma)	Rock Types	Location	Environment of Emplacement	Notes
550 ±50	Granite, alkali granite, quartzmonzonite, syenite, gabbroids	Otjiwarongo, central Namibia, Kaokoland, Damaran intrusives (Namibia), Hook Granite, NW Zambia (Zambia)	Continental epeirogenic uplift	Period may be broken into 3 discrete events.
750 ±50	Granite, alkali granite, syenite, gabbroids with felsic and mafic volcanics	Copperbelt, Kalengwa-Kasempa, NW Zambia (Zambia); Khorixas Inlier, Summas Mountains (Namibia)	Rift-related and continental epeirogenic uplilft.	Intrude Roan and Nguba Lithologies; overlain by Kundelungu and equivalent sediments.
1100 ±50	Granitoids and felsic to mafic volcanics	South of the Copperbelt, West of Lusaka (Zambia); around Omitiomire, Kaokoland, Witvlei area (Namibia)	Continental rift-related environments	Surrounds Kapvaal Craton from Namaqualand to Irumide Belt in Zambia
1900 ±100	Foliated alkali granite, quartzmonzonite, granite	Copperbelt basement, Mkushi-Serenje, NW Zambia, Domes region (Zambia); Kaokoland, central Namibia, Kamanjab Batholith, Grootfontein Inlier (Namibia)	Not well defined; probably formed in an anorogenic continental extension environment	Period can be broken into 4 discrete events

Information currently available on geophysics, geochronology, rock distribution and geochemistry from the Hook Granite Batholith, Nchanga Granite (Zambia), and the Kamanjab Batholith (Namibia) fit quite well with intracontinental, anorogenic, ring complex cluster origins.

Complete Wilson cycles were not identified in the Arc study areas. The dominant magmatic process, as evidenced by the volume of extruded rock, is anorogenic continental epeirogenic uplift, closely-followed in time by rift-related granitoid emplacement. Environments of emplacement for most Arc granitoids could not be identified by traditional geochemical means.

Anomalous thorium content in some Arc granitoids induced and maintained long-lived, large convective cells of hydrothermal fluid flow.

E-W-trending regional fracture systems, that run parallel to the elongation of Arc, play an important role in the location of magmatism and IOCG mineralization. Those structures are generally parallel to the main Arc trend, and could have been normal syn-rift faults reactivated multiple times during geological history.

At least eight discrete periods of mineralization were identified in the Greater Lufilian Arc. There is a wide-spread series of mid-alkaline intrusions emplaced around 750 Ma that produces a variety of mineral deposits. Another event took place around 540±40 Ma. Five less well defined events occurred at ~1970, ~1930, ~1866, 1097-1059

and ~460 Ma. The dominant deposit type is IOCG mineralization, but other types of mineral deposits are present in the Arc. At least two distinct events of disseminated copper mineralization associated to midakaline granitoid intrusives were defined in the Kamanjab Batholith; the first took place around 1975 Ma, the second around 1928 Ma.

The main IOCG events that have been identified in the Arc took place during eight time periods. Rocks of many IOCG deposits and prospects in the Arc are pristine. There is no significant deformaton involved. Hydrothermal brecciation and other mineralization features are un-deformed.

Three discrete time periods show IOCG mineralization in close temporal spatial association with sedimentary-hosted copper deposits. The first took place around Witvlei, Namibia (1108-1059 Ma). The second and third ocurred in the basement to the Zambian Copperbelt (882-725 Ma and 607-500 Ma). This idea may generate a new concept for the origin of sedimentary-hosted copper and cobalt deposits.