Shinkolobwe :
Shinkolobwe and Kasolo

The outcrops of the mineralised R2-banks around Shinkolobwe were already known for hundreds of years and were exploited for copper.
The main hill was named Kasolo.

In 1915 the surveyor Major Sharp "spotted" a yellow spot in the bushes while on a field campaign. This led to the discovery of one of the largest uraniferous deposits in the world. The hill Kasolo was named Shinkolobwe Signal afterwards. Shinkolobwe is a epigenetic stockwork-type deposit that is either mined in open air as underground. Uranium is found together with cobalt- and nickel rich minerals, while there is only very few copper present. The main nickel sulfide found is vaesite.
It is typical for Shinkolobwe that many newfound minerals are discovered on older collected specimens. The original deposit at Shinkolobwe is regarded exhausted.

In the Shinkolobwe vein deposits a nickeliferous carrollite has also been found, but crystals there are exceedingly rare. Alteration of carrollite above the water table and on the dumps has often led to the deposition of sphaerocobaltite on skeletal, etched carrollite.

The Shinkolobwe-Kasolo deposit is genetically related to the stratiform cuprocobaltiferous deposits in the Katanga Crescent, but the intense local tectonics, accompanied by a later remobilization of sulfide minerals and uranium oxides, have given the deposit a typical veined appearance. This characteristic is clearly seen in the geometry of the mineralized body, and in the mineralization itself. The mine was basically exploited for uranium, associated with high grades of cobalt and nickel; copper is not very abundant. It should be remembered that uranium is not unusual in the Cu-Co deposits in the Katanga Crescent (Gauthier et al., 1989). However, although it is generally only a minor byproduct of copper production from the stratiform deposits (with no economic interest, the grade and the quantity being too low), it was the main mineralization in the vein-like deposit of Shinkolobwe, with high levels of cobalt and nickel. The mineralization at Shinkolobwe also contains selenium, as does that of the Musonoi-Extension uranium deposit in the Kolwezi Klippe.
Before taking up the copper sulfide minerals at Shinkolobwe, it is worthwhile to devote a few lines to the history of this great deposit. Shinkolobwe is the name of a small river that has its source at the base of a high hill. The summit of the hill was chosen as a geodesic signal point during the triangulation of South Katanga by the "Comité Spécial du Katanga" (the C.S.K.), the state landlord of the Katanga Crescent. This hill was identified as Shinkolobwe-Signal for reference purposes. It was a protruding outcrop in the eroded area of a Cu-Co deposit, about 3 km east of the native village of Kasolo. In 1915, Major Sharp, one of the U.M.H.K. prospectors, noticed at Kasolo an almost vertical cliff several meters high. It was a steep outcropping of hard, cellular siliceous rock (the RSC Formation, well-known throughout the Katanga Crescent) consi-derably more resistant to erosion than the surrounding sedimentary beds. The
RSC Formation is the great reference mark for finding the stratiform orebodies: at depth, it is the barren massive dolomite separating the two orebodies in the alteration zone, this formation is completely silicified and full of cavities, showing frequently the remnants of the Roan Collenias fossils (stromatoporidae-like algal formations). The big Collenias colonies are the only visible fossils in the formation.

At the foot of this cliff, Sharp identified solid blocks of uraninite associated with curite. But it was not until 1920 that the U.M.H.K. decided to register the deposit at the C.S.K. office in Lubumbashi, under the name "Kasolo deposit" with the mention of "radium" (not uranium!) as the ore metal.

Strangely, this mine was opened by the U.M.H.K. in 1924 under the name of "Shinkolobwe." Logically, it should have been named "Kasolo," or at least "Shinkolobwe-Kasolo," to avoid any confusion with the Shinkolobwe-Signal deposit.
Shinkolobwe

Shinkolobwe is certainly one of the most famous uranium mines in the world. In the course of World War II, it was the only large operational uranium mine in the free world, with rich stockpiles of ore ready for shipment. The richness, diversity and importance of its primary and secondary mineralization make it extraordinary; it yields an assemblage of primary and secondary minerals which exists nowhere else.
Shinkolobwe is not only the type locality for many U-minerals, but also for the cobaltsulfide cattierite and the nickel-cobalt-carbonate comblainite.

Comblainite is a turquoise-blue mineral that is often accompanied by secondary U-minerals.

The description of new Shinkolobwe species based on old samples is still in progress. A mineralogical expedition to explore the old mine dumps and the accessible parts of the ancient quarry and the mine galleries located above the water table would probably result in the collection of additional new species. Of the 28 primary mineral species known in Shinkolobwe , only one is uranium-bearing; while the other 50 uranium-bearing minerals are secondary minerals (of which 28 have are holo types of which 10 are still unique to the deposit).
Although the Shinkolobwe mine is not a copper mine-malachite is very rare - the entire mineraliza-tion remains tied to the existence of cuprocobaltiferous orebodies in the local sedimentary rock series. But the mineralization does not follow the stratification. It occurs as large pockets, as lodes and thin veins more or less entangled. It fills fractures, diaclases, faults and stratification joints in the host beds. Also the mineralization is sometimes disseminated in cellular siliceous rocks and in dolomitic shales and dolomites overlying the upper orebody. The deposit itself is a Mine Group fragment about 300 meters long, enveloped in chlorite-quartz breccia. The whole has been raised from a considerable depth all along a major fault with an extrusive core, a structure seen in some places in the Katanga Crescent.
It seems clear that on the level of the metallogenetic province, the uranium was deposited at the same time as the copper and the cobalt, but more selectively and sparsely. The patches of uranium-bearing ore minerals, when they are found in a copper and cobalt-bearing deposit in the Katanga Crescent, are generally much fewer and smaller than the patches of copper and cobalt. It is now clear that the uranium was deposited locally in the same orebodies as the copper and the cobalt. In this respect, Shinkolobwe is an anomaly: there was practically no copper, there was cobalt, and there was much nickel with some uranium present.

The initial mineralization in Shinkolobwe could have been diagenetic or even syngenetic, but in any case preceded the tectonic movements. During these movements and the raising of the mineralized debris along the length of the extrusive structure, the uranium and the other metals could have been entirely or partially mobilized again, thus giving birth to deposits in lodes and veins.
Some researchers (Audeoud, 1982) have proposed a volcanic origin, not only for the uranium in Shinkolobwe but also the copper and cobalt in all of the deposits throughout the metallogenetic province.
The surface alteration of the Shinkolobwe deposit took place in a relatively recent epoch. The radiogenic lead in the secondary galena is of Tertiary age. The meteoric water bath

affecting a large part of the weathered zone led to the oxidation and decomposition of a part of the primary mineralization, with ions being put into solution and circulation and the episodic re-precipitation of new salts and their hydration according to local conditions. The weathering of the deposit developed under exceptionally favorable conditions; these include the multiplicity of the veins and little seams of uraninite and the primary sulfides all along the upper part of the oxidation zone, the tropical climate, the outcropping of the deposit on the surface (particularly the cellular siliceous rocks, a veritable chimney for channelling the meteoric waters), the very low water table (between 70 and 80 meters), the carbonate nature of the gangues, with many liquid inclusions on certain levels, and the circulation of carbonated and siliceous meteoric waters in the deposit.

It is known that uraninite is readily altered in an oxidizing aqueous environment. Its alteration in situ is accompanied by the transport and precipitation of ions incorporating tetravalent or hexavalent uranium, as a function of the pH of the solutions, their temperature, the range of all of the ions involved, their relative concentration, etc. These ions range from simple ones like the uranyl ion $(UO_2)^{+2}$ and the ion $[(UO_2)(OH)]^{+}$ to complex carbonated, phosphated, silicated and sulfated ions such as $[(UO_2)(CO_3)_2]^{-2}$, $[(UO_2)(CO_3)_3]^{-4}$, $[(UO_2)(SO_4)_2]^{-2}$ and $[(UO_2)(SiO_4)]^{-2}$. In the Shinkolobwe oxidation zone, there was every potential for the combination of the ions mentioned above with the following metallic cations: Ca, Ba, Mg, Cu, Pb, Mo and V, as well as those of the rare earths Ce, La, Y, Gd and Dy.

It will be noted that nickel is never found in the composition of secondary uranium-bearing minerals. Where cobalt is concerned, it is found at Shinkolobwe solely in the secondary deposits in the form of oursinite. Finally, there is the presence of submetallic elements in the mineral deposits in Shinkolobwe: selenium, and in a much smaller proportion, tellurium, and on a trace level, scandium. The lead found in the secondary mineralization is entirely radiogenic.

Comblainite is very rare at Shinkolobwe, and has only been found in a few specimens,

Cattierite in Katanga has been identified only from the Shinkolobwe mine, which is the type locality (Kerr, 1945)

Unlike the carrollite in the stratiform deposits, Shinkolobwe carrollite contains nickel. It is very rare in Shinkolobwe.

The cobalt content of Shinkolobwe siegenite is 26%. Centimeter-size octahedral crystals with brilliant faces are found at a number of points in the Shinkolobwe deposit. In the lower part of the Shinkolobwe oxidation zone, siegenite rich in selenium is also found, in close association with penroseite (described below).

Penroseite was discovered in the oxidation zone of the Shinkolobwe deposit (Deliens, 1975), in association with seleniferous siegenite and molybdenite

Oursenite has been found only in secondary ores at the Shinkolobwe mine (Deliens and Piret, 1983).

Shinkolobwe also produced spectacular cobaltoan calcite in pink hexagonal prisms to several centimeters, with three-faced rhombohedron terminations.
