Mineralogical and petrographic study of copper deposits Kibutu and Kajuba (Democratic Republic of Congo) and slags generated after smelting processes.

Marta Wróbel, MSc., Eng.

Democratic Republic of Congo (DRC) is the second largest country in Africa, located in its central part, in the Congo basin. The word "congo" means "*hunter*", and comes from the Bakongo people. The capital of Congo is Kinshasa, situated in the north of the country, on the Congo River, with a population of more than 9 million people. Katanga, province in the southern part of the country, is most abundant in deposits, and the most important city is Lubumbashi, inhabited by 2 million people. The area covered by this research paper is located in this province, north and north-east of Lubumbashi. Studies conducted as part of this research paper were aimed at presenting comprehensive mineralogical and petrographic characteristics of copper deposits near Lubumbashi and slag produced in the process of raw materials recovery, as well as at analysing environmental aspects associated with, among others, extraction and refining of raw minerals. The paper was based on samples brought by Prof. Maciej Pawlikowski, PhD, Eng., collected during two visits to the Democratic Republic of Congo that took place in 2011.

The doctoral dissertation was completed by verifying the following theses:

- A wide range of different minerals is present in the area of Lubumashi due to the complicated genesis and composition of copper deposits.
- Mineralogical, petrographic, and geochemical recognition of ore and rocks will make it possible to refine them in a more efficient way.
- Phase composition of slag after remelting copper ore is varied.
- Determination of the phase composition of slag will be the basis for determining the optimal storage process minimizing negative environmental impacts.
- Mineralogical, petrographic, and geochemical recognition of slag will determine whether the content of copper remaining in waste is high enough to be recovered with profit.
- Mineralogical and geochemical studies will be the basis for the preparation of a simplified analysis of the state of the environment.

Achieving these assumptions required carrying out field research to collect samples for

further studies, as well as numerous analyses. The following have been accomplished:

- Mineralogical and petrographic characterises of ore and rocks from three excavations located in the area of Lubumbashi.
- In situ geochemical measurements, made with DELTA Mining and Geochemistry Handheld XRF analyzer.
- Mineralogical, petrographic, and geochemical characteristics of slag from the process of copper ore remelting.
- The phase composition of slag from the process of copper ore remelting was identified,
- Associated minerals of copper ore were identified.
- Basic environmental analysis was made on the basis of mineralogical and geochemical research results, and information on the state of the environment and its changes.

Based on the analysis of literature, mineralogical and petrographic research of copper deposits in Kibutu, Kajuba, Renzo, and Lubumbashi area and slag generated in the process of their remelting, as well as the environmental analysis, we can draw the following conclusions:

- Deposits in Lubumbashi region consist of two parts.
- Subsurface deposits resulting from the oxidation of copper sulphides and reaction of by-products with carbonates - purely malachite deposits.
- Older deposits occur as dolomite sulphide mineralisation, with large variations of minerals: cuprite, bornite, chalcopyrite, pyrite, and chalcocite.
- Copper ore from the subsurface (malachite) area can be remelted in furnaces, with the addition of haematite or magnetite.
- Copper present in the sulphide portion is not directly suitable for smelting process and should be enriched with flotation method, chemical method with acids, or other method.
- The copper content in the sulphide portion is up to 3%.
- Studies have shown that the covered deposits are small and are on the verge of profitability when it comes to extraction and processing.
- The phase composition of slag has been identified, the following have been distinguished:

-glass
-metal separation (copper, iron)
-silicate phases
-oxygen phases

- When analysing microscopic images, it was found that secondary formed crystallites, oxidized metals, and metallic ore residues are found in slag more often than glass.
- Glass in slag behaves differently, depending on the age of waste.
- Slag alloy is subject to cooling only in certain weather conditions, which are not conductive to rapid cooling in the region of Central Africa. The slower the cooling, the lower the amount of glass, but e.g. silicate phases are formed in larger amounts.
- Economically valuable elements, such as gold, silver, were not detected in the test samples.
- Debris containing metallic copper constitutes about 3% of the researched material, and it should be returned for remelting during the technological process. When applying additional technological processes, it seems possible to use copper slag for construction process (e.g. as a filler for concrete) and road construction (ballast used for paving roads).
- The following threats to the environment of the Democratic Republic of Congo have been identified: excessive deforestation, soil erosion, improperly stored mining and metallurgical waste, poaching, and water pollution.