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## **Abstract**

Doctoral dissertation: “RARE EARTH, NATURAL RADIONUCLIDES AND SELECTED PRECIOUS METALS IN THE IRON OXIDES, COPPER AND GOLD (IOCG) SINQUYEN DEPOSIT, LAOCAI, NORTH VIETNAM”

The IOCG Sin Quyen deposit is the biggest copper mine in Vietnam, it locates in province Lao Cai, 300 km in the North from Hanoi Capital. The deposit was discovered in the 70<sup>th</sup> years of Last Century by geological and geophysical surveys. The area of Sin Quyen deposit amounts to near 100 ha. Since 2006 IOCG Sin Quyen deposit has been exploited as an open pit mine with annual production of 12 000 tons of copper metal. The yearly excavated ore and spoil rocks amount to more than one million ton and seven millions cubic meters respectively. As well known accompanying with copper metal there are many useful elements such as Au, Ag, REE, U and Th. The two lasted elements are radioactive and their concentrations could be enhanced especially in the dumps and reservoirs. So the contamination of the elements can effect radiological on the environment. Though the deposit in question has been investigated by several scientists from Vietnam, Russia, Australia and Japan (Ta Viet Dung 1975, McLean 2001, Ishihara et al., 2011, Gaskov et al., 2012) but some problems such as mineral compositions, ore origin, contents of REE and precious elements and so on still require to be investigated.

In order to resolve the above mentioned questions the doctoral thesis of title “Rare earth, natural radionuclides and selected precious metals in the IOCG Sin Quyen deposit, Lao Cai, North Vietnam” had been proposed. The aims of the thesis were: i) study of the impact of the natural radionuclides in the environment; ii) to analyze the concentrations and study of the distribution of the copper and the other elements: Au, Ag, REE, U, Th in the ore bodies and host rocks; iii) to find the correlation between the analyzed different chemical compositions; iv) to attempt study the crystallization period happened at the deposit region.

To realize the exercises, on November 2014, author of this thesis together with the groups from AGH UST and Hanoi UMG performed the necessary geological and radioactive surveys on the

field and collected above 50 ore, spoil rocks, semi products and 15 water samples from the deposit and its surround. All the collected samples were transported to AGH-UST and analyzed in the adequate laboratories of this University.

Based on the obtained data author of this thesis states that the main radioactive source is the uranium series, its average concentration in the ores is near 17 times higher than the U average concentration in earth crust and equal to  $690 \text{ Bqkg}^{-1}$ . The  $^{222}\text{Rn}$  in dwelling air is near  $170 \text{ Bqm}^{-3}$ . The absorbed and the effective dose rate resulted from the gamma radiation and radon in dwelling air are equal to near  $200 \text{ nGy/h}$  and  $4.5 \text{ mSv/year}$  respectively. The surface water is contaminated mostly with U isotopes and other chemical elements. The concentration of  $^{238}\text{U}$  isotope in from Red river water amounts to  $50 \text{ mBqL}^{-1}$ , while in dig well water at the waste dump amounts to  $13.1 \text{ BqL}^{-1}$ . There are positive correlations between Cu-U ( $R=0.78$ ), U-Pb ( $R=0.97$ ), Cu-Ag ( $R=0.94$ ), Cu-Au ( $R=0.73$ ), Cu-Pb ( $R=0.82$ ), Cu-Bi ( $R=0.90$ ), Cu-Te ( $R=0.94$ ). The geological data also enabled author described the dynamic geological evolution of the studied region by simplified model. Apart from the mentioned results author collected above 8000 archival data obtained by boreholes well logging, radiometric measurements in tunnels and outcrops and ore samples analyzed in the Vietnam Geological Institute in Hanoi. Using both the archival and the data of the collected samples and the computer program "MineScape 5.12" from the Department of Deposit and Mining Geology Faculty of Geology, Geophysics and Environmental Protection the 3D model of the studied deposit was built up.

The reserves of Cu, Fe, U, Ag and Au were estimated using the 3D model and amount to 539 000; 3 030 000; 188; 24.9 and 19.6 tons, respectively. The Cu reserve calculated by this work is in agreement with that in the Ta Viet Dung report.