MEASUREMENTS OF HEAVY METALS AND NATURAL RADIOACTIVITY LEVELS IN WATER, SOIL AND VEGETATION AROUND THE TITANIUM MINING SITE IN PHU CAT DISTRICT, BINH DINH PROVINCE

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SUMMARY

This study was formulated specifically to provide data of radioactivity of soils, waters and vegetation from two regions: Cat Thanh and Cat Lam in Phu Cat District which earmarked for Titanium mining project. The field survey was done at the beginning of the study. Groundwater samples from 30 wells or boreholes in mining (n = 6) and non-mining areas (controls, n =24), 15 soil samples and 15 vegetation samples were collected. Then, they were analyzed to examine the relationship between community health and characteristics (pH, electrical conductivity, turbidity, total dissolved solids, sulfates, hardness, As, Cd, Fe, Mn, Pb, As, alpha, beta, and gamma radiation). A total number of thirty samples were analyzed for heavy metals using ICP/MS method. Radioactivity levels of the samples were determined using a high purity germanium (HPGe) detector. The results show that there is some points should be considered about radioactivity level in the mining area. Some water samples are detected to contain high concentration of arsenic and disease incidence nearby titanium mines is higher than other areas. Base on the study results, this paper will recommend the solutions to protect community health.

Key words: *Heavy metals, titanium mining, community health, natural radioactivity*

INTRODUCTION

Most titanium mines are located in coastal communes of the two districts Phu My and Phu Cat, and in a part of the Nhon Hoi economic zone, situated in the provincial capital Quy Nhon City. Over 30 enterprises have been granted licenses for titanium exploitation, with a registered capacity of up to 650 tons of titanium ore a year [1]. For many years, titanium mining operations have caused negative environmental impacts. Many research results showed radioactive contamination status in the mining areas [2,3,4,5]. Human beings are continuously exposed to ionizing radiation that stem from both natural and man-made sources. The principal origins of ionizing radiation exposure are natural sources. The main constituents of natural radiation are cosmic rays and gamma ray emitters in soils, building materials, water, food, and air. Natural background radiation, which is equivalent to 2.4 mSv per year, makes up approximately 80% of human exposure in a year [6]. Besides, there is still no water supply system in the study area. People have been using water from wells for drinking. Thus, the assessment of water quality is essential to protect community health.

MATERIALS AND METHODS

Drinking Groundwater Samples

Groundwater samples were randomly collected. Point sources included boreholes (deep drilled wells with hand pumps (> 50m), shallow hand-dug wells (< 30m) with and without hand pumps). Samples from 6 and 24 wells or boreholes in mining and non-mining communities (controls), respectively, were collected for analyses. At each sampling location, physicochemical water quality parameters (pH, electrical conductivity, total dissolved solids and turbidity) were measured in situ using the multi-parameter water quality meter. Samples for metal analysis were acidified with 1 ml of concentrated nitric acid. The collected samples were immediately put into ice chests containing ice cubes (about

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4°C) and conveyed to the laboratory for immediate analysis. The samples were analyzed for sulfates, dissolved solids, and hardness. The laboratory analysis followed standard methods of analysis prescribed for the various elements and parameters (SEWW 2012). Heavy metal concentrations were determined using ICP (Inductively coupled plasma mass spectrometry) method.

Soil sampling and Preparations

Soil sampling was carried out in an area of about 30km long surrounding mine sites (Fig. 1). At each sampling point, dirt and other extraneous (non-soil) materials were first removed to expose the soil. Soil was then collected with hand trowels down to 5 - 10cm depth within a 30 × 30cm area. The soil was homogenized and three samples, each of about 1000cm^3, were packed in clean polythene bags and labeled accordingly. Altogether 15 samples of sandy soil were collected from 15 sampling points. The sample preparation involve oven-drying at 105°C before gamma-ray spectrometric analysis [5].

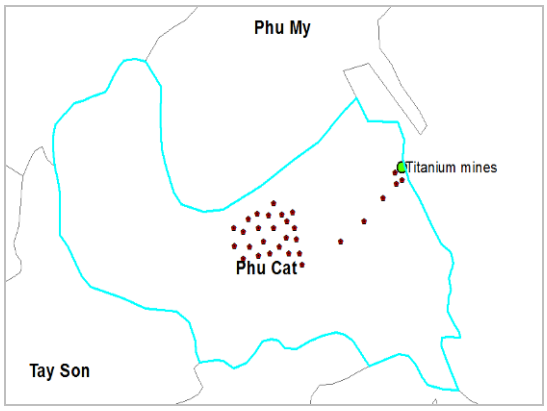

Figure 1. *Map of sampling points*

Vegetation sampling and Preparations

A total of 15 samples were collected. Samples were weighed and then dried in an oven at 105°C overnight and reweighed to find the water content. The samples were crushed and were made to pass through a 0.2-mm sieve. Sieved samples were weighed and a mass of 200g of each sample was placed in a plastic container. The plastic containers were hermetically sealed with adhesive tape for 30 days for secular equilibrium to take place. [7, 8]

Gamma-Ray Spectrometric Analysis

Radioactivity levels of the samples were determined using a high purity germanium (HPGe) detector. The samples were analyzed using a high purity germanium (HPGe) detector of 30% efficiency relative to the standard 3" × 3" NaI (Tl) detector and energy resolution of 1.8 keV (FWHM) at the 1.33 MeV gamma line of ^{60}Co. Detailed description of the gamma-ray spectrometer setup as well as the detector calibration procedures using the IAEA reference materials (RGU-1, RGTh-1, and RGK-1) [5].

Direct interview method

The household's survey was done to get information about community health. 30 questionnaires were used. The interviewees include households living from mining site in different distances where people live crowded such as one, five, ten and thirty kilometers.

RESULTS AND DISCUSSIONS

Soil is the ultimate sink for various kinds of contaminants and it could be an important indicator of environmental pollution [9]. Results of measuring radioactivity in soil samples showed that in distance 1000m, detecting two points should be considered about radioactive environments. But, in residential areas (between 10 and 20 kilometers from titanium mines) meet standard (Fig. 2). It demonstrates the spread of radioactive substances into the soil environment.

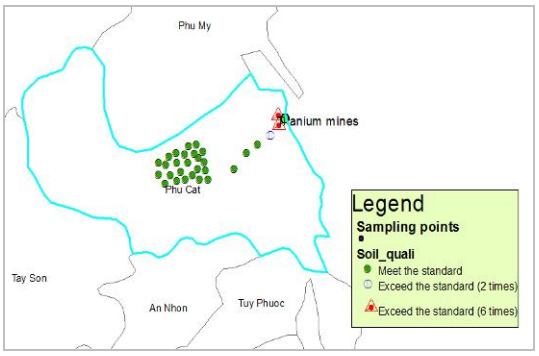

Figure 2. *Radioactivity level in soil samples*

The radioactivity in the vegetation samples are qualified standard (Fig. 3). The average gamma radiation values obtained are higher when compared with the results obtained for normal living areas in the same region.

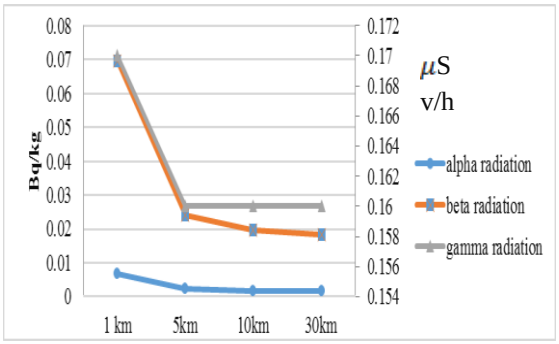

Figure 3. *Radioactivity level in vegetation samples*

The incidence of diseases related to radioactivity and heavy metals such as skin diseases, lung disease, and kidney disease in mining area higher than others. There are groundwater's samples arsenic contaminated (Fig. 4). These areas are mainly agricultural area. The level of radioactivity in environment also dropped sharply. The natural environment is mainly affected by external doses of gamma radiation, judging from results of similar surveys carried out in other parts of mining sites, e.g. Vo Ngoc Anh et al. [1]. This shows that the radioactivity spread in the environment. However, the scope of influence is within one to five kilometers distance (Fig. 5).

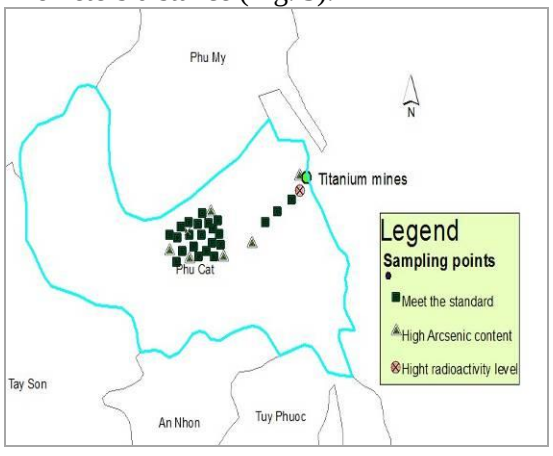

Figure 4. *Heavy metals and natural radioactivity levels in groundwater*

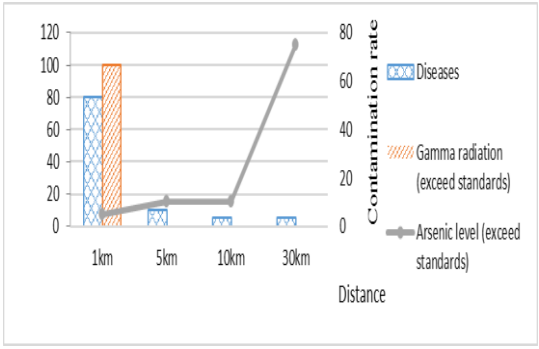

Figure 5. *Contamination rate and incidence of disease*

CONCLUSION

Natural radioactivity levels in water, soil and vegetation around the titanium mining site has been measured using gamma-ray spectrometry with NaI (Tl) detector and flame atomic absorption spectrophotometer. Its findings point should consider the radioactivity in titanium mining area. However, no matter how small radiation exposure could be, it has effect on human being and exposure to this radiation must be reduced.

The results of heavy metal concentrations in the ground water showed the presence of heavy metals with arsenic concentrations above their natural range in the drinking water. At lower concentrations, these metals may be beneficial to the ecosystem but they are regarded to be toxic at higher concentrations. However, heavy metals are potentially toxic with prolonged exposure. Therefore, it is imperative to monitor their accumulation in water samples before inhabitants can use. The local governments should provide the water supply system for local people use.

REFERENCE

1. Vo Ngoc Anh, 2005, "Assess the level of radioactive contamination caused by titanium mining in coastal areas of Binh Dinh province", Department of Science and Technology of Binh Dinh province. (Vietnamese)

2. Le Khanh Phon and Nguyen Van Nam, 2007, "The characteristics of sea water surrounding

titanium mining sites". (Vietnamese) http://www.idm.gov.vn/nguon_luc/Xuat_ban/2007/A300/a1.htm.
3. Dipak Ghosh, Argha Deb and Kanchan Kumar Patra, 2004, "Measurements of alpha radioactivity in arsenic contaminated tube well drinking water using CR-39 detector", *Radiation Measurements*, Volume 38, Issue 1, pp. 19–22.
4. F.P. Carvalho et al., 2007, "Radioactivity in the environment around past radium and uranium mining sites of Portugal", *Journal of Environmental Radioactivity*, Volume 96, Issues 1–3, pp. 39–46.
5. M. Osoro, I. Rathore, M. Mangala and A. Mustapha, 2011, "Radioactivity in Surface Soils around the Proposed Sites for Titanium Mining Project in Kenya", *Journal of Environmental Protection*, Vol. 2 No. 4, pp. 460 - 464.
6. International Atomic Energy Agency, 1996, "Radiation Safety - Regulation for the safe transport of radioactive material", *IAEA Division of Public Information*, IAEA-00725 IAEA/PI/A47E.
7. Mumbai: Atomic Energy Regulatory Board, 2003, "Accreditation of laboratories for measurement of radionuclide content in commodities", Atomic Energy Regulatory Board.
8. Veiga R, Sanches N, Anjos RM, Macario K, Bastos J, Iguateny M, et al., 2006, "Measurement of natural radioactivity in Brazilian Beach sands", *Radiat Meas*, Volume 41(1), pp 89–96.
9. IAEA (International Atomic Energy Agency), 2004, "Soil sampling for environmental contaminants," IAEA-TECDOC- 1415, IAEA, Vienna.

TÓM TẮT

XÁC ĐỊNH NỒNG ĐỘ KIM LOẠI NẶNG VÀ HOẠT ĐỘ PHÓNG XẠ TRONG MẪU NƯỚC , ĐẤT VÀ THỰC VẬT XUNG QUANH KHU VỰC KHAI THÁC TITAN TẠI HUYỆN PHÙ CÁT TỈNH BÌNH ĐỊNH

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Nghiên cứu này cung cấp các số liệu về hoạt độ phóng xạ tại khu vực có khai khoáng titan: xã Cát Thành, Cát Lâm của Huyện Phù Cát, tỉnh Bình Định. Quá trình điều tra thực địa đã được thực hiện khi bắt đầu nghiên cứu. Các mẫu nước ngầm từ 30 giếng đào gồm các mẫu tại khu vực khai khoáng titan (n = 6) khu vực không khai thác (khu vực đối chứng, n =24), 15 mẫu đất và 15 mẫu thực vật đã được thu thập. Sau đó, chúng được phân tích tại phòng thí nghiệm để xác định các thông số hóa lý, phóng xạ và kim loại nặng (pH, EC, độ đục, TDS, sulfates, độ cứng, As, Cd, Fe, Mn, Pb, As, hoạt độ phóng xạ alpha, beta, and gamma). Các kim loại nặng được phân tích bằng phương pháp ICP/MS. Hoạt độ phóng xạ được đo đạt bằng đầu dò HPGe. Kết quả nghiên cứu cho thấy tại khu vực khai khoáng phát hiện các điểm cần lưu ý về hoạt độ phóng xạ. Tỷ lệ mắc bệnh của người dân trong khu vực lân cận mỏ cao hơn các khu vực xa hơn. Bên cạnh đó, phát hiện một số mẫu nước chứa nồng độ As cao hơn tiêu chuẩn cho phép. Dựa trên những kết quả nghiên cứu, bài báo đề xuất các giải pháp bảo vệ sức khỏe cộng đồng.

Từ khóa: *kim loại nặng, khai khoáng titan, sức khỏe cộng đồng, hoạt độ phóng xạ*

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