Heavy metal contamination of agricultural soils around a chromite mine in Vietnam

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Abstract: In Vietnam, the Co Dinh mine is the largest chromite mine in the country. Mining, ore dressing and disposal of the tailings provide obvious sources of heavy metal contamination in the mine area. The present study examined the influence of chromite mining activities on the adjacent lowland paddy field by investigating heavy metal and As levels in the mine tailings, sediments, paddy soils and water. At paddy fields located near the mine tailings, the total contents of Cr, Co and Ni were 5,750, 375 and 5,590 mg kg^{-1}, and the contents of their water-extractable form were 12.7, 1.16 and 32.3 mg kg^{-1}, respectively. These results revealed severe contamination of lowland paddy soils with Cr, Co and Ni as a result of mining activity, suggesting serious health hazards through agricultural products, including livestock in this area. The principal source of the pollution was sediment inflow owing to the collapse of the dike, which was poorly constructed by heaping up soil. Moreover, water flowing out from the mining area was also polluted with Cr and Ni (15.0-41.0 and 20.0-135 μg L^{-1}, respectively). This might raise another problem of heavy metal pollution of watercourses in the area, indicating the need for further investigation and monitoring of fluctuations of water quality with seasonal changes.
Author Keywords: Contamination; Heavy metal; Mine; Soil; Vietnam

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References:

- Abollino, O., Aceto, M., Malandrino, M., Mentasti, E., Sarzanini, C., Barberis, R., Distribution and mobility of metals in contaminated sites. Chemometric investigation of pollutant profiles (2002) Environ. Pollut., 119, pp. 177-193
- Adema, D.M.M., Henzen, L., A comparison of plant toxicity of some industrial chemicals in soil culture and soilless culture (1989) Ecotoxicol. Environ. Saf., 18, pp. 219-229
- Adriano, D.C., Introduction. Chromium. Lead. Copper (2001) Trace Elements in Terrestrial Environment: Biogeochemistry, Bioavailability, and Risks of Metals, pp. 22-23. , Adriano DC. Ed, pp, 315-348, 350-403, 500-539, Springer-Verlag, New York
- Bi, X., Feng, X., Yang, Y., Environmental contamination of heavy metals from zinc smelting areas in Hezhang County, western Guizhou, China (2006) Environ. Int., 32, pp. 883-890
- Bowen, H.J.M., Elements in the geosphere and the biosphere (1979) Environmental Chemistry of the Elements, pp. 237-273. , Bowen HJM. Ed, Academic Press, London
- Bueno, P.C., Bellido, E., Rubi, J.A.M., Ballesta, R.J., Concentration and spatial variability of mercury and other heavy metals in surface soil samples of periurban waste mine tailing along a transect in the Almaden mining district (Spain) (2009) Environ. Geol., 56, pp. 815-824
- Chen, N.C., Kanazawa, S., Horiguchi, T., Chen, N.C., Effect of chromium on some enzyme activities in the wheat rhizospere (2001) Soil Microorg., 55, pp. 3-10
- Chopin, E.I.B., Alloway, B.J., Distribution and mobility of trace elements in soils and vegetation around the mining and smelting areas of Tharsis, Ríotinto and Huelva, Iberian Pyrite Belt, SW Spain (2007) Water Air Soil Pollut., 182, pp. 245-261
- Gee, G.W., Bauder, J.W., Particle-size analysis (1986) Methods of soil analysis: Part 1-Physical and Mineralogical Methods, pp. 383-411. , Klute A. Ed, American Society of Agronomy, Soil Science Society of America, Madison
- Gnandi, K., Tobschall, H.J., Heavy metals distribution of soils around mining sites of cadmium-rich marine sedimentary phosphorites of Kpogamé and Hahotoé (southern Togo) (2002) Environ. Geol., 41, pp. 593-600
- James, B.R., Petura, J.C., Vitale, R.J., Mussoline, G.R., Hexavalent chromium extraction from soils: a comparison of five methods (1995) Environ. Sci. Technol., 29, pp. 2377-2382
- Johnson, R.H., Blowes, D.W., Robertson, W.D., Jambor, J.L., The hydrogeochemistry of the Nickel Rim mine tailings impoundment, Sudbury, Ontario (2000) J. Contam. Hydrol., 41, pp. 49-80
- Jung, M.C., Heavy metal contamination of soils and waters in and around the Imcheon Au-Ag mine, Korea (2001) Appl. Geochem., 16, pp. 1369-1375
- Kien, C.N., Noi, V.N., Bang, N.D., Arsenic and heavy metal concentrations in agricultural soils around tin and tungsten mines in the Dai Tu district, N Vietnam (2009) Water Air Soil Pollut., 197, pp. 75-89
- Kim, M.J., Ahn, K.H., Jung, Y., Lee, S., Lim, B.R., Arsenic, cadmium, chromium, copper, lead, and zinc contamination in mine tailings and nearby streams of three abandoned mines from Korea (2003) Bull. Environ. Contam. Toxicol., 70, pp. 942-947
- Kim, M.J., Jung, Y., Vertical distribution and mobility of arsenic and heavy metals in and around mine tailings of an abandoned

mine (2004) J. Environ. Sci. and Heath Part A, 39 (1), pp. 203-222

- Lee, S., Geochemistry and partitioning of trace metals in paddy soils affected by metal mine tailings in Korea (2006) Geoderma, 135, pp. 26-37
- Lee, C.G., Chon, H.T., Jung, M.C., Heavy metal contamination in the vicinity of the Daduk Au-Ag-Pb-Zn mine in Korea (2001) Appl. Geochem., 16, pp. 1377-1386
- McGowen, S.L., Basta, N.T., Heavy metal solubility and transport in soil contaminated by mining and smelting (2001) Heavy Metals Release in Soils, pp. 89-107. , Selim HM, Sparks DL. Ed, Lewis Publishers, Boca Raton
- McGrath, S.P., Smith, S., Chromium and nickel (1990) Heavy Metals in Soils, pp. 125-150. , Alloway BJ. Ed, Blackies, USA and Halsted Press, Canada
- Otero, X.L., Huerta-Diaz, M.A., Macías, F., Heavy metal geochemistry of saltmarsh soils from Ría of Ortigueira (mafic and ultrmafic areas, NW Iberian Peninsula) (2000) Environ. Pollut., 110, pp. 285-296
- Phuong, N.M., Kang, Y., Sakurai, K., Levels and chemical forms of heavy metals in soils from Red River Delta, Vietnam (2009) Water Air Soil Pollut., , DOI: 10.1007/s11270-009-0139-0
- Rhoades, J.D., Cation exchange capacity (1982) Methods of Soil Analysis: Part 2-Chemical and Microbiological Properties, pp. 149-165. , Pace AL, Miller RH, Keeney DR. Ed, American Society of Agronomy, Soil Science Society of America, Madison
- Keys to soil taxonomy (2006), The 18th World Congress of Soil Science, Philadelphia, PennsylvaniaVietnamese standard: water quality-Surface water quality standard (1995), http://khcn.mt.gov.vn/tieuchuannganh/uploads/TCVN_5942-1995.pdf, Vietnamese Ministry of Science and Technology. Available from URL, [cited August 2008] (in Vietnamese)Vietnamese standard: Soil quality-maximum allowable limits of heavy metals in the soil (2002), http://nea.gov.vn/TCVNMT/ToanVan/7209_02.pdf, Vietnamese Ministry of Science and Technology. Available from URL, [cited August 2008] (in Vietnamese)Introduction (2009), http://www.thanhhoatourism.com.vn/index.php?lan=e&id=gioithieu&catalog=37, Available from URL, [cited September 2009]Turner, M.A., Rust, R.H., Effects of chromium on growth and mineral nutrition of soybeans (1971) Soil Sci. Soc. Am. J., 35, pp. 755-758
- Vaselli, O., Bucccianti, A., De-Siena, C., Geochemical characterization of ophiolithic soils in a temperate climate: a multivariate statistical approach (1997) Geoderma, 75, pp. 117-133
- Wu, J.C., The mineral industry of Vietnam (2002) U.S. Geological Survey Minerals Year Book, , http://minerals.usgs.gov/minerals/pubs/country/2002/vmmyb02.pdf, Available from URL, [cited August 2008]
- Wu, J.C., The mineral industry of Vietnam (2004) U.S. Geological Survey Minerals Year Book, , http://minerals.usgs.gov/minerals/pubs/country/2004/vmmyb04.pdf, [cited August 2008]