Contamination of steel plant sludge

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In central India, due to huge deposition of the minerals and coal, several steel plants are running using coal as energy. The main potential hazards of steel plants are metals, fluoride, phenol, etc. Among them heavy metals i.e. As, Mn, Cd, Hg, Pb are very toxic. Iron ore is smelted in blast furnace with coke and lime to produce pig iron. The production of steel generates a huge amount of liquid and solid waste. The present studies aim the elemental (i.e. Na, K, Ca, Mg, Al, Cr, Mn, Fe, Ni, Cu, Zn, As, Se, Cd, Hg, Pb, F^-, Cl^-, SO_4^{2-} and PO_4^{3-}) composition of the huge sludge generated by the Asia biggest Bhilai Steel Plant. It is located at the central position of India, which is one of the major iron belts of India, and it is about 20 km away from Raipur, capital of Chattisgarh state, India.

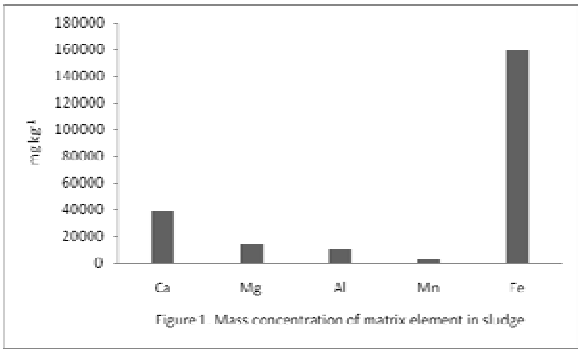

Figure 1. Mass concentration of matrix element in sludge

The production capacity of the plant is 4.0 million ton of steel per year. The liquid effluent is poured in an artificial lagoon, area ≈ 10 km^2. The heavy metal contamination of the wastewater and sludge are investigated. The samples were collected from the nine points of the contaminated area in January 2007. The samples were dried, crushed and particles of mesh size < 0.1 mm was sieved out. The samples were digested with acids using the established methodologies. The content of metals i.e. Na, K, Ca, Mg, Al, Cr, Mn, Fe, Ni, Cu, Zn, As, Se, Cd, Hg and Pb were determined by using technique i.e. ICP-AES and HG-AAS. The mean content of elements i.e. Na, K, Ca, Mg, Al, Cr, Mn, Fe, Ni, Cu, Zn, As, Se, Cd, Hg, Pb, F^-, Cl^-, SO_4^{2-} and PO_4^{3-} were found to be 442, 920, 38209, 13637, 10156, 79, 3005, 159249, 28, 55, 243, 17.4, 1.6, 2.9, 1.1, 115, 2.1, 91, 31.5 and 5.2 mg kg^{-1}, respectively. The mean pH value (n = 9) of liquid effluent was found to be slightly acidic, 6.5. The mean content of elements i.e. Na, K, Ca, Mg, Al, Cr, Mn, Fe, Ni, Cu, Zn, As, Se, Cd, Hg, Pb, F^-, Cl^-, SO_4^{2-} and PO_4^{3-} were found to be 25.4, 11.9, 49.0, 18.3, 0.9, 1.1, 0.3, 0.2, 0.2, 0.1, 0.9, 0.03, 0.02, 2.2, 87 and 31.52 mg kg^{-1}, respectively. The mean mass concentration of the matrix elements in the sludge is shown in Figure 1. Their partition coefficient in the water phase is determined. Their flux, correlation with ions and main potential hazards are discussed.

Compressibility of synthetic glaucophane

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Glaucophane ($Na_2Mg_3Al_2Si_8O_{22}(OH)_2$) is the key index mineral of the bluschist-facies metamorphic rocks, but because of difficulties in making this amphibole the physical properties are not well known. We have recently shown that essentially pure glaucophane can be synthesized if the water content is carefully controlled [1]. Compressibility studies on two synthetic glaucophanes are reported here.

The samples were made from oxide/hydroxide mixtures treated at 750 °C, 2.5 GPa, H_2O contents of 3-4 wt% for durations of 328-660h. Runs were made on samples of GL-10-R5 ($Na_{1.87(14)}Mg_{3.30(14)}Al_{1.95(8)}Si_{7.83(9)}O_{22}(OH)_2$) and FEGL 5-3-4 ($Na_{1.92(11)}Mg_{3.16(19)}Al_{1.98(10)}Si_{7.95(3)}O_{22}(OH)_2$) in a diamond-anvil cell (DAC) using 200 μm inner-diameter stainless steel gaskets pre-indented to 70 μm thickness, a 4:1 methanol:ethanol mixture as the pressure medium, and the shift in the ruby fluoresence lines to determine pressure. The DAC was mounted in line B2 of the Cornell High Energy Synchrotron Source (CHESS) using X-rays of either 18 or 25 keV monochromated by Ge-(111). Transmission powder diffraction patterns were obtained at approximately 1 GPa increments from 0 to 10 GPa by integrating line intensities in diffraction patterns collected with an area detector. Unit-cell dimensions were extracted via Rietveld refinements. Care was taken to note the pressures (7-8 GPa) where significant peak broadening indicated diminishing hydrostaticity.

The Murnaghan equation was used to fit V/V_o data up to 8 GPa with equal precision (r = 0.999) obtained whether K' was derived or fixed to 4. With K' fixed at 4, both samples gave statistically identical values for the bulk modulus K_o, with the average value being 89.5 ± 0.6 GPa. This is larger than the currently accepted value of 88.5 GPa [2], indicating somewhat smaller volume reduction (decreased density) for glaucophane with depth.

[1] Jenkins & Corona (2006) *Amer. Mineral.* **91**, 1055-1068.
[2] Comodi *et al.* (1991) *Eur. J. Mineral.* **3**, 485-499.