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Selection of bioindicators in coal-contaminated soils of Dhanbad, India

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Environmental Earth Sciences, OCT, 2011, Vol. 64(4), pp. 1107-1115.

Coal handling, crushing, washing, and other processes of coal beneficiation liberate coal particulate matter, which would ultimately contaminate the nearby soils. In this study, an attempt was made to determine the status of soil bio-indicators in the surroundings of a coal beneficiation plant, (in relation to a control site). The coal beneficiation plant is located at Sudamudih, and the control site is 5 km away from the contaminated site, which is located in the colony of Central Institute of Mining and Fuel Research Institute, Digwadih, Dhanbad. In order to estimate the impact of coal deposition on soil biochemical characteristics and to identify the most sensitive indicator, soil samples were taken from the contaminated and the control sites, and analyzed for soil organic carbon (SOC), soil N, soil basal respiration (BSR), substrate-induced respiration (SIR), and soil enzymes like dehydrogenase (DHA), catalase (CAT), phenol oxidase (PHE), and peroxidase (PER). Coal deposition on soils improved the SOC from 10.65 to 50.17 g kg(-1), CAT from 418.1 to 804.11 mu g H(2)O(2) g(-1) h(-1), BSR from 8.5 to 36.15 mg CO(2)-C kg(-1) day(-1), and SIR from 24.3 to 117.14 mg CO(2)-C kg(-1) day(-1). Soils receiving coal particles exhibited significant decrease in DHA (36.6 to 4.22 mu g TPF g(-1) h(-1)), PHE (0.031 to 0.017 mu M g(-1) h(-1)), PER (0.153 to 0.006 mu M g(-1) h(-1)), and soil N (55.82 to 26.18 kg ha(-1)). Coal depositions significantly ($P < 0.01$) decreased the DHA to 8.8 times, PHE to 1.8 times, and PER to 25.5 times, but increased the SOC to 4.71 times, CAT to 1.9 times, SIR to 4.82 times, and BSR to 4.22 times. Based on principal component analysis and sensitivity test, soil peroxidase (an enzyme that plays a vital role in the degradation of the aromatic organic compounds) is found to be the most important indicator that could be considered as biomarkers for coal-contaminated soils.
10.1007/s12665-011-0927-x

Relation between hydrogeological setting and swelling potential of clay-sulfate rocks in tunneling

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Engineering Geology, Oct, 2011, Vol. 122, pp. 204-214

In this study, an approach to estimate the swelling potential of clay-sulfate rocks in tunneling is presented. Swelling of clay-sulfate rocks leads to damage in tunnels that is difficult and costly to repair. Swelling is caused by the transformation of the sulfate mineral anhydrite into gypsum, which involves an increase in rock volume in a system open to water flow. Knowledge of the hydrogeological situation and the groundwater flow systems at the tunnel is essential to better understand the swelling processes. The present study was conducted for the Chienberg tunnel in Switzerland. It investigates the hydrogeological situation of four zones in this tunnel crossing the Triassic Gipskeuper formation. In two of them, heavy swelling occurred after tunnel excavation, while in the other two no swelling occurred. In addition, the groundwater flow systems before and after tunnel excavation are investigated based on numerical flow modeling. The findings suggest that in certain situations after tunnel excavation, depending on geological and changing hydraulic conditions, the excavation damaged zone around the tunnel provides a "hydraulic short circuit" between the weathered Gipskeuper and the anhydrite-bearing strata of the unweathered Gipskeuper. As a result, water from the weathered Gipskeuper gets in contact with anhydrite, triggering its transformation into gypsum and, thus, rock swelling. The results of the study may also contribute to improved swelling experiments in the laboratory and a more reliable planning of restoration measures in tunnels that are damaged by rock swelling. 10.1016/j.enggeo.2011.05.009

Variations in the building site categories in the underground mining region of Doubrava (Czech Republic) for land use planning

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Engineering Geology, Oct, 2011, Vol. 122, pp. 169-178

In terms of demands and needs of ground investigation and foundation engineering, the engineering-geological conditions in the underground mining territories represent anthropogenically influenced areas in the most complicated manner, since they suffer the impacts from the underground mining of mineral resources. The subjects of observation are the so-called building site categories, which represent a certain risk factor that must be taken into consideration during foundation engineering and engineering-geological studies in the undermined territories. It is necessary to realise that underground mining is an anthropogenic geodynamic process which significantly varies over time due to mining change, and consequently with variations in the position, shape and size of subsidence in a subsidence basin. All the above mentioned variations should be mandatory knowledge for land use planners, engineering geologists, geotechnicians, foundation engineers and designers because of the evident logicality of these needs. This work presents a case study (Ostrava-Karvina Coal District in the north-east of the Czech Republic) of variations in the building site categories over time,

and the results show that the chronology of the changes has a very significant influence in this area of interest. The results of the building site category evaluation imply that the majority of the interest area falls within relatively good conditions for founding all kinds of structures. However, it was then necessary to consider variations over time in the surface area of less suitable building site categories. A trend certainly confirmed the existence of the previously presumed mutual relationship between building site categories and subsidence size distribution. It is apparent from the analytic results of the relationship between building site categories and planned development that the negative impacts of mining have been only partly considered, or completely disregarded, in the development planning process. Consequently, future land use planners should carefully consider these particular building site categories as the most important and significant factors in the undermining of a region. In this manner, development can be successfully planned for present and future safety.
10.1016/j.enggeo.2011.05.008

Environmental impact of sunscreen nanomaterials: Ecotoxicity and genotoxicity of altered TiO2 nanocomposites on Vicia faba

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Environmental Pollution, OCT, 2011, Vol. 159(10), pp. 2515-2522

Mineral sunscreen nanocomposites, based on a nano-TiO2 core, coated with aluminium hydroxide and dimethicone films, were submitted to an artificial ageing process. The resulting Altered TiO2 Nanocomposites (ATN) were then tested in the liquid phase on the plant model Vicia faba, which was exposed 48 h to three nominal concentrations: 5, 25 and 50 mg ATN/L Plant growth, photosystem II maximum quantum yield, genotoxicity (micronucleus test) and phytochelatins levels showed no change compared to controls. Oxidative stress biomarkers remained unchanged in shoots while in roots, glutathione reductase activity decreased at 50 mg ATN/L and ascorbate peroxidase activity decreased for 5 and 25 mg ATN/L. Nevertheless, despite the weak response of biological endpoints, ICP-MS measurements revealed high Ti and Al concentrations in roots, and X-ray fluorescence micro-spectroscopy revealed titanium internalization in superficial root tissues. Eventual long-term effects on plants may occur.
10.1016/j.envpol.2011.06.020

Investigation of the potential for mineral carbonation of PGM tailings in South Africa

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Minerals Engineering, OCT, 2011, Vol. 24(12), pp. 1348-1356

Increasing atmospheric CO(2) concentration is currently of considerable concern in terms of global warming. A possible technology that can contribute to the reduction of CO(2) emissions is its sequestration by mineral carbonation. In this study, tailings from several different platinum mines in South Africa will be mineralogically characterised and their potential for mineral carbonation reviewed. Mg and Ca-rich minerals (plagioclase, olivine, orthopyroxene, clinopyroxene) present in the tailings are good candidates for mineral carbonation, which mimics natural weathering processes in which these minerals react with gaseous CO(2) to form Ca or Mg carbonates. Since the reaction is influenced by particle surface area, the ultra fine grained nature of the PGM tailings provides another reason for the promise of PGM tailings for mineral carbonation. A preliminary ranking of the tailings samples and their efficacy for mineral carbonation has been developed according to whether the samples showed harzburgtic (e.g. Northam Platinum mine), pyroxenetic (e.g. BRPM) or noritic mineral assemblages. This information and understanding will assist in identifying opportunities and guiding the development of engineered facilities for the sequestration of CO(2) by means of mineral carbonation. 10.1016/j.mineng.2011.07.005

The contributions of geometallurgy to the recovery of lithified heavy mineral resources at the Namakwa Sands mine, West Coast of South Africa

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The Namakwa Sands heavy mineral deposit is located at Brand-se-Baai along the West Coast of South Africa and is a world class producer of premium quality zircon (ZrSiO(4)), ilmenite (FeTiO(3)) and rutile (TiO(2)) concentrates from mainly aeolian sands. Superimposed on the coastal clastic Cainozoic ore-bearing sequence is a calcium-magnesium-rich pseudo-stratigraphy locally referred to as cemented hard layers that effectively lithify the mineralised sands to various degrees of hardness, rendering it unsuitable for routine treatment by wet spirals. Namakwa Sands has recently completed an expansion programme, inclusive of a SAG mill and screen installation, which allows the processing of the cemented hard layers, the first ever in the mineral sands industry. Operationally, the SAG mill and screen are performing well in tandem and are helping to improve mineral resource utilisation to levels not previously possible. Contained zircon output has increased, but at the cost of marginally lower recoveries as predicted from pilot studies. This paper reports on the systematic geometallurgical approach to improve mineral resource utilisation by successfully processing lithified ore.
10.1016/j.mineng.2011.07.011

Understanding the influence of HPGR on PGM flotation behavior using mineralogy

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Due to the very fine grained nature and complexity of the platinum bearing ores from the Bushveld Complex in South Africa, numerous processing operations have investigated alternate comminution devices that can be used to liberate the platinum group minerals of the Merensky and UG2 ores at a coarser grind, at reduced energy consumption and increased throughput. In this study, the mineralogy and flotation performance of product from the high pressure grinding rolls (HPGR) was evaluated and compared to a conventional ball mill product with the aim of determining whether the HPGR product could be used for flotation without any further grinding. Results show that for both the Merensky and UG2 platinum ores, the HPGR product showed more fines and less coarse content compared to the ball mill product. No conclusive evidence of preferential liberation was observed for samples prepared by particle bed breakage. The best flotation results were obtained from the ball mill product. The results from this study have shown the definite need for an integrated approach for the interpretation of the results that extends beyond just measurements of valuable mineral liberation.
10.1016/j.mineng.2011.07.015

Use of X-ray computed tomography to investigate crack distribution and mineral dissemination in sphalerite ore particles

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Minerals Engineering, OCT, 2011, Vol. 24(12), pp. 1249-1257.
As the trends in mineral processing move towards the beneficiation of finer grained and more complex ore bodies, so too do the methods needed to understand and model these processes. During the heap leaching of low-grade ore bodies, the crack distribution and mineral dissemination in ore particles are important characteristics that determine the performance of sub-processes, such as the diffusion of reagents in and out of particle pores. Recent developments in X-ray computed tomography (a) as an advanced diagnostic and nondestructive technique have indicated the potential for the technology to become a tool for the acquisition of 3-D mineralogical and structural data. The spatial distribution of cracks and mineral dissemination in particles derived from a sphalerite ore in the Northern Cape, South Africa, was characterized using a high-resolution industrial X-ray CT system. This paper describes the use of image analysis techniques including image segmentation, which uses a combination of thresholding and other methods to characterize and quantify crack and mineral dissemination in the sphalerite particles. The results are validated with those obtained using traditional techniques such as physical gas (with N(2)) adsorption, mercury intrusion porosimetry, SEM and QEMSCAN. A comparison

of the effect of different comminution devices (HPGR and Cone crusher) on crack generation is also given. 10.1016/j.mineng.2011.04.008

Particle damage and exposure analysis in HPGR crushing of selected copper ores for column leaching

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In mining operations, jaw and gyratory crushers are generally used for primary crushing, and cone crushers are used for secondary crushing. During the past decade, however, high-pressure grinding rolls (HPGR) are being considered due to potential processing benefits such as energy savings, improved exposure/liberation and particle weakening. At this time there is no detailed quantification of particle damage and downstream benefits from HPGR crushing are uncertain. In the present research, copper ores (copper oxide ore and copper sulfide ore) were crushed by a jaw crusher and by HPGR and the products were evaluated for particle damage and copper grain exposure by X-ray computed tomography. Column leaching was done to determine the rate and extent of copper recovery. X-ray computed tomography analysis and laboratory column leaching experiments for copper oxide ore revealed that products from HPGR crushing have more particle damage and higher copper recoveries when compared with products of the same size class from jaw crusher crushing. Generally the copper recovery from column leaching of the oxide ore was found to be dependent on the extent of grain exposure, which increases with a decrease in particle size. In the case of the copper sulfide ore, copper recovery was found to be independent of the crushing technique despite the fact that more particle damage was observed in products from HPGR crushing. This unexpected behavior for the copper sulfide ore might be due to the high head grade and strong leach solution. Column leaching results also show that about 80-90% of the copper was recovered from the copper sulfide ore in a relatively short leaching time irrespective of crushing technique. As expected, copper recoveries improved with a decrease in the particle size of the copper sulfide ore as exposure of copper mineral grains increased.
10.1016/j.mineng.2011.07.010

Application of process mineralogy as a tool in sustainable processing

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The observed behaviours of mineral particles in mineral processing operations have been exploited in the past to model comminution and concentration processes. In this work this concept has been taken a step further, exploiting the mineralogical characteristics of particles to link comminution, concentration and smelting. This

approach is demonstrated using a laboratory-based case study of a Ni-Cu sulphide ore. The case study focused on the effect of shifting energy between the comminution and smelting stages on the overall energy consumption for the metal production process. To model this effect the mineral composition of the particles was linked to the behaviour of the ore particles in the primary grinding, regrinding and flotation stages. This application of process mineralogy provides a methodology to minimise energy use across mineral concentration and smelting processes, an important aspect of sustainable processing. 10.1016/j.mineng.2011.03.017

Hydrogeochemical processes governing the origin, transport and fate of major and trace elements from mine wastes and mineralized rock to surface waters

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Applied Geochemistry, NOV, 2011, Vol. 26(11), pp. 1777-1791.

The formation of acid mine drainage from metals extraction or natural acid rock drainage and its mixing with surface waters is a complex process that depends on petrology and mineralogy, structural geology, geomorphology, surface-water hydrology, hydrogeology, climatology, microbiology, chemistry, and mining and mineral processing history. The concentrations of metals, metalloids, acidity, alkalinity, Cl, F and SO42- found in receiving streams, rivers, and lakes are affected by all of these factors and their interactions. Remediation of mine sites is an engineering concern but to design a remediation plan without understanding the hydrogeochemical processes of contaminant mobilization can lead to ineffective and excessively costly remediation. Furthermore, remediation needs a goal commensurate with natural background conditions rather than water-quality standards that might bear little relation to conditions of a highly mineralized terrain. This paper reviews hydrogeochemical generalizations, primarily from US Geological Survey research, that enhance our understanding of the origin, transport, and fate of contaminants released from mined and mineralized areas. Mobility of potential or actual contaminants from mining and mineral processing activities depends on (1) occurrence: is the mineral source of the contaminant actually present? (2) abundance: is the mineral present in sufficient quantity to make a difference? (3) reactivity: what are the energetics, rates, and mechanisms of sorption and mineral dissolution and precipitation relative to the flow rate of the water? and (4) hydrology: what are the main flow paths for contaminated water? Estimates of relative proportions of minerals dissolved and precipitated can be made with mass-balance calculations if minerals and water compositions along a flow path are known. Combined with discharge, these mass-balance estimates quantify the actual weathering rate of pyrite mineralization in the environment and compare reasonably well with laboratory rates of pyrite oxidation except when large quantities of soluble salts and evaporated mine waters have accumulated underground. Quantitative mineralogy with trace-element compositions can substantially improve the

identification of source minerals for specific trace elements through mass balances. Post-dissolution sorption and precipitation (attenuation) reactions depend on the chemical behavior of each element, solution composition and pH, aqueous speciation, temperature, and contact-time with mineral surfaces. For example, little metal attenuation occurs in waters of low pH (<3.5) and metals tend to maintain element ratios indicative of the main mineral or group of minerals from which they dissolved, except Fe, SiO2, and redox-sensitive oxyanions (As, Sb, Se, Mo, Cr, V). Once dissolved, metal and metalloid concentrations are strongly affected by redox conditions and pH. Iron is the most reactive because it is rapidly oxidized by bacteria and archaea and Fe(III) hydrolyzes and precipitates at low pH (1-3) which is related directly to its first hydrolysis constant, pK(1) = 2.2. Several insoluble sulfate minerals precipitate at low pH including anglesite, barite, jarosite, alunite and basaluminite. Aluminum hydrolyzes near pH 5 (pK(1) = 5.0) and provides buffering and removal of Al by mineral precipitation from pH 4-5.5. Dissolved sulfate behaves conservatively because the amount removed from solution by precipitation is usually too small relative to the high concentrations in the water column and relative to the flow rate of the water. Published by Elsevier Ltd.
10.1016/j.apgeochem.2011.06.002

Confined particle bed breakage of microwave treated and untreated ores

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The effect of microwave treatment on the processing of mineral ores was investigated through simulations of microwave heating, thermal damage and confined particle bed breakage test on bonded-particle models. The simulations were undertaken on two-phase mineral ore consisting of a microwave-absorbing mineral in a non-absorbing matrix. The microwave heating was simulated by dissipating a volumetric heat source in the absorbent phase. The progeny size distribution and degree of liberation for the untreated and microwave treated ores after breakage tests were determined by undertaking image analysis of the model outputs. It was shown that microwave treatment at high power density considerably changed the progeny size distribution and enhanced the degree of liberation in confined particle bed breakage tests. It was also found that crushing velocity has a significant effect on both progeny size distribution and liberation, particularly for the ore treated at high power density.
10.1016/j.mineng.2011.08.020

On the comparison between measured and calculated stresses in large SAG mills

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A study of the structural design of large SAG mills is presented. Stress ranges from strain gauge measurements are compared with those calculated using finite element models for two mills. The agreement between measurement and calculation for one mill is substantially better than it is for the other. The cause of the discrepancy in agreement between measurement and calculation for the two mills is determined to be the relative percentage of ball charge to total charge. For lower total charge to ball charge ratios, the pressure on the heads or end walls of the mills reduces dramatically. As this ratio increases, the pressure on the heads increases to approach a hydrostatic load. The problem of poor agreement between mill finite element models and fatigue design codes is thus partially resolved. 10.1016/j.mineng.2011.08.022

Selective separation of U(VI) from its solutions using amine modified silica gel produced from leached zircon

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International Journal of Mineral Processing, Volume 101, Issues 1–4, 23 November 2011, Pages 81-88, http://dx.doi.org/10.1016/j.minpro.2011.07.010.

A solution of sodium silicate produced from the alkali fusion of Egyptian zircon mineral as a waste was used to prepare silica gel in the pH range 6–7. The surface of the obtained silica was functionalized with diethylenetriamine (DET) and tetraethylenepentamine (TEP) to give triamine modified silica (TAMS) and pentamine modified silica (PAMS), respectively. The success of functionalization process was confirmed by means of FT-IR, energy dispersive X-ray analysis (EDX) and elemental analysis. The surface properties of the modified silica obtained were also investigated. The uptake behavior of the modified silica towards U(VI) ions at different experimental conditions of pH, time, concentration and temperature was studied. The maximum uptake values at 25 °C were found to be 90.3 and 112 mg/g for TAMS and PAMS, respectively. Kinetics and thermodynamics studies showed an endothermic pseudo-second order adsorption process. Regeneration of the loaded silica was performed using 1 M HNO3. The investigated silicas have successfully been applied for extracting of U(VI) obtained from alkaline leaching of Egyptian monazite sand.

Analysis of the state of the art of blast-induced fragment conditioning

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Research conducted over the last few decades have acknowledged the importance of blast-induced fragment conditioning on the comminution and concentration stages. These studies demonstrate that blast-induced conditioning can be considered as a highly relevant factor in the value chain of the mining industry. Despite the significant benefits awarded to this phenomenon, there are few

comprehensive studies about the topic and, in contrast, many questions have been asked regarding the mechanisms of generation and extension. This paper presents a critical review on microfracturing induced by blasting which intends to summarise the current knowledge by presenting the key identified factors related to the phenomenon and discussing its impact on downstream processes. 10.1016/j.mineng.2011.08.012

Reducing the greenhouse gas footprint of primary metal production: Where should the focus be?

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The mineral processing and metal production sector is endeavouring to identify opportunities to improve the sustainability of its operations and reduce its greenhouse gas footprint, with improved energy efficiency receiving increased attention. However, if truly sustainable outcomes are to be obtained it is essential that a life cycle approach be adopted in evaluating these opportunities. In this paper, life cycle assessment methodology is used to indicate where in the metal production life cycle this focus on energy efficiency should be and to evaluate a number of potential opportunities for reducing the greenhouse gas footprint of primary metal production. Results from life cycle assessments of the main primary metal production processes, together with current and predicted global metal production rates, ore grades and grind or liberation size, have been used in a broad analysis to indicate that endeavours to improve the energy efficiency of primary metal production should focus mainly on the metal extraction stage, particularly for steel and aluminium. Declining ore grades and more complex ore bodies anticipated in the future can be expected to significantly increase the energy required for comminution of the main metal ores and will present opportunities for improving the energy efficiency of primary metal production. However, these opportunities will still be appreciably less than potential energy efficiency improvements in the extraction stage for these metals. 10.1016/j.mineng.2011.08.007

Extraction of lithium from micaceous waste from china clay production

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The granites of South-West England are a potential source of lithium which is generally found within the mica mineral, zinnwaldite. It is mainly found in the central and western end of the St. Austell granite. When kaolin extraction occurs in these areas a mica-rich waste product is produced which is currently disposed of in tailings storage facilities. In this study a tailings sample containing 0.84% Li(2)O was

upgraded by a combination of froth flotation, using dodecylamine as the collector, and wet high intensity magnetic separation (WHIMS) to 2.07% Li(2)O. The concentrate was then roasted with various additives, including limestone, gypsum and sodium sulphate, over a range of temperatures. The resulting products were then pulverised before being leached with water at 85 degrees C. Analysis of these products by XRD revealed that the water-soluble sulphates, KLiSO(4) and Li(2)KNa(SO(4))(2), were produced under specific conditions. A maximum lithium extraction of approximately 84% was obtained using gypsum at 1050 degrees C. Sodium sulphate produced a superior lithium extraction of up to 97% at 850 degrees C. In all cases iron extraction was very low. Preliminary tests on the leach solution obtained by using sodium sulphate as an additive have shown that a Li(2)CO(3) product with a purity of >90% could be produced by precipitation with sodium carbonate although more work is required to reach the industrial target of >99%. 10.1016/j.mineng.2011.08.013

The long term operation of a biologically based treatment system that removes As, S and Zn from industrial (smelter operation) landfill seepage

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Passive treatment systems have a long history in the remediation of mining impacted water. The functioning of these systems is poorly understood, in particular the microbial processes that underpin metal removal. A biologically based engineered wetland treatment system that has operated in Trail, B. C. to treat seepage from a historic Pb and Zn smelter landfill, was investigated. The system has functioned for more than a decade, an unusually long life span for a passive bioreactor design. The study focuses on the 5a of operation from 2003 until 2007. Arsenic is a major contaminant in the ore that is processed in Trail, which has caused high As concentrations in the seepage. In addition to As, Zn and Cd removal were investigated. During the 5-a period, the system sequestered 2990 kg of As, 7700 kg of Zn and 85 kg of Cd. Nearly 90% of these elements were removed in two biochemical reactors (BCRs) that comprise the first two components of the six cell system, with the remainder removed in plant-based polishing cells. Average input concentrations over the 5-a period were 2.3 and 4.1 mM for As and Zn, respectively and 0.45 mu M for Cd. Final output concentrations were reduced to 0.01 mM for As, 0.05 mM for Zn and 0.18 mu M for Cd. Sulfur removal averaged 34% of input concentration. Analysis of mineral formation in the system using X-ray diffraction and scanning electron microscopy indicated kottigite (Zn(3)(AsO(4))(2)center dot 8H(2)O) and sphalerite (ZnS) as the major mineral phases controlling As and Zn sequestration; Cd appears to be immobilized as CdS. Evidence for orpiment was obtained from X-ray absorption spectroscopy (XANES) studies, and arsenopyrite was not detected. Although microbial activity dominates the removal of Zn, As and Cd from the soluble phase, abiotic removal mechanisms contribute including sorption of As and Zn to biosolids and filtration of metal precipitates by the solid

matrix. The removal of toxic elements over the period appeared to be relatively consistent. Seasonal fluctuations, a large spike in input element concentrations over a 2-month period, and removal of the two biochemical reactors during a period of reconstruction appeared to have relatively little impact on the system as a whole.
10.1016/j.apgeochem.2011.06.012

Ecological perspectives in restoring mine waste management areas

Kalin, M; Wheeler, WN
ECOLOGICAL ENGINEERING: FROM CONCEPTS TO APPLICATIONS, PARIS 2009 International Congress on Ecological Engineering - from Concepts to Applications (EECA), DEC 02-04, 2009, Paris, FRANCE, Vol. 9, 2011, pp. 90-95.

Ecological Engineering (EE) in mining waste restoration aims to apply knowledge of natural biological systems known to be present on rocks or minerals, and in sediments to practically and beneficially achieve human and industrial objectives in a natural self-sustaining way. Omitting or discarding ecological processes in the engineering of the mine waste management areas severely prolongs the longevity of current mining practices, when chemical treatment must be provided for hundreds of years. The potential biological controls on contaminant generation and the biological strategies available to reverse sulphide oxidation in mine wastes provide pathways toward less expensive, more energy-efficient and ecologically more acceptable strategies for mine waste management. The application of EE to mining has been demonstrated in several field projects and numerous publications, where the relevant bio-mineralization processes have been well-documented. Unfortunately, the EE approach has not been widely accepted, not because of its lack of a scientific foundation or successful implementation, but due to the challenge of effectively communicating the importance of ecosystem function and the associated geochemical and biological processes to the engineering fraternity. The mining industry needs to adapt to the values and aims of contemporary environmental engineering, to develop systems, structures, methods, tools and infrastructures to protect human and environmental health. The progress made in our EE projects has been brought about through the enhancement of ecosystem function. We will here briefly describe the transformation of an acid mine drainage dump into a productive, biologically-active polishing lake. (C) 2011 Published by Elsevier Ltd. Selection and/or peer-review under responsibility of Laboratory "Biochemistry and ecology of continental environments.
10.1016/j.proenv.2011.11.015

Precipitation of Magnesium Carbonates as a Function of Temperature, Solution Composition, and Presence of a Silicate Mineral Substrate

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Environmental Engineering Science, DEC, 2011, Vol. 28(12), pp. 881-889

Precipitation of carbonate minerals can play important roles in geological carbon sequestration and engineered processes for mineral carbonation. Influences of temperature, solution composition, and the presence of a solid substrate on the nucleation and precipitation of magnesium carbonate minerals were examined in a set of batch experiments. Conditions studied are relevant to full-scale geological carbon sequestration systems. Aqueous phase analysis by inductively coupled plasma mass spectrometry quantified the extent of precipitation. X-ray diffraction analysis was conducted to identify solids. Temperature significantly affected the identity of the solid obtained. At 25 degrees C and 60 degrees C the solids were magnesium carbonate minerals, and at 100 degrees C the solid phase was identified as brucite [Mg(OH)(2)]. Although magnesite (MgCO3) was predicted to be the most thermodynamically stable magnesium carbonate phase, no magnesite precipitated and instead metastable magnesium carbonate phases formed. Evolution of dissolved concentrations was consistent with precipitation of these metastable phases. Presence of the magnesium silicate forsterite had no measurable effect on the rate or extent of precipitation. Mineralization in geological systems is likely to also be controlled by ionic strength, pressure, and mineralogy of the host formation.
10.1089/ees.2010.0341

Controlled struvite precipitation from belt press filtrate of anaerobic digester in a CSTR

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Struvite (MgNH4PO4 center dot 6H(2)O) is known to precipitate and clog pipes and pumps, causing operational difficulties and expenses downstream of the anaerobic digester in wastewater treatment plants around the world. This work focused on determining the most appropriate reactor operational conditions (focus on hydraulic retention time and aeration rate) required for attaining the most homogeneous controlled struvite precipitation in order to reduce pipes and pumps clogging downstream of the digester. To this end a continuous laboratory-scale completely stirred tank reactor aerated (for CO2 stripping) reactor was operated at different hydraulic retention times and aeration rates and precipitate composition was determined. A minimum pH of 8.0 was calculated and experimental observed as necessary to attain struvite precipitation to its maximum potential to prevent clogging. To reach this pH value a minimum HRT of 0.5 hours with aeration flow rate of 11.2 m(3)/h/m(3) and/or 15-min HRT with an air flow of 46.7 m(3)/h/m(3) was necessary for the reactor studied. Struvite precipitation kinetics was observed to be much faster than other minerals that can precipitate and a decrease in HRT promoted a precipitate richer in struvite. However, for all HRT and air flows studied the precipitate obtained can be considered to be poor in struvite and can hardly be

reused in agriculture. (C) 2011 American Institute of Chemical Engineers Environ Prog, 2011. 10.1002/ep.10561

A preliminary investigation into magnetic separation process using CFD
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Minerals Engineering, DEC, 2011, Vol. 24(15), pp. 1651-1657

The performance of magnetic separation units relies on the interaction between magnetic, hydrodynamic, gravitational, and inter particle forces. These forces are controlled by process as well as design parameters. In order to get a better understanding of the separation process we have developed a mathematical model using a computational fluid dynamics framework to follow the separation behavior of particles as in a wet high intensity magnetic separator. A three-dimensional, Eulerian-Eulerian model has been developed to predict the flow profile, as well as the concentration profile of solid particles between two parallel plates. The Navier-Stokes equations are used to predict the flow profile for the liquid phase. The model equations have been solved using the finite volume solver available in the commercial computational fluid dynamics (CFD) software, Fluent, to estimate the volume fraction of magnetic particles captured by the plates. Simulation results show that most of the magnetic particles are trapped on the magnetic plate which has also been observed experimentally.
10.1016/j.mineng.2011.08.021

SELECTIVE ABSTRACTS

Full-text Papers available in NML Eprints (http://eprints.nmlindia.org)

Agarwal, Sanjay and Sahu, K K and Godiwalla, K M and Jana, R K (2011) *Studies on the Production of Ferro-Silico-Manganese Alloy in Arc Furnace from Polymetallic Sea Nodule.* In: XII International Conference on Mineral Processing Technology (MPT-2011), 20-22 October, 2011, Udaipur, India.

Polymetallic sea nodule contains 1.1% Cu, 1.15% Ni, 0.076% Co, 5.4% Fe, 22.3% Mn & others. World-wide research is progressing on sea nodules as an alternative future source of minerals. The current Indian program of work considers direct smelting of sea nodules to recover manganese, Cu, Ni and Co for better process, economic viability & environmental consideration. The processes developed so far are mainly based on hydrometallurgical methods which generate very dilute leach solution and

the downstream processing becomes difficult. In such a scenario direct reduction smelting process is proposed in this paper to recover manganese as Fe-Si-Mn alloy from sea nodule. The ferro-silico-manganese alloy is extensively used in the steel industry as deoxidizer. The direct smelting of nodules was carried out on 1 kg scale in electric arc furnace to have Cu, Ni and Co alloy and Mn rich slag. The slag obtained during smelting has MnO: 45%, SiO2: 27%, FeO: 2%, CaO: 4%, some Al2O3 & MgO. This manganese rich slag was further treated in 50 kVA arc furnace to produce Fe-Si-Mn alloy. A number of experiments were carried out with charge consisted of first stage Mn rich slag, coke and dolomite with holding time 15-45 minutes, temperature of melt ranged from 1450 - 1550oC.The composition of Fe-Si-Mn alloy obtained is in the range of Mn: 60-65%, Si: 13-17%, C: 1-2%, S: 0.003% and balance iron which is acceptable grade for industrial use. A manganese recovery of about 78% was achieved. http://eprints.nmlindia.org/5972/

Agrawal, A and Pathak, Pankaj and Mishra, D and Sahu, K K (2011) *Recovery of metal values from spent nickel-cadmium rechargeable batteries by solvent extraction route.* In: Proceedings of the XII International Seminar on Mineral Processing Technology (MPT-2011), Oct 20-22, 2011, Udaipur, India.

Spent Nickel cadmium batteries are classified as hazardous waste due to the presence of toxic cadmium in high concentration. Recycling of metal value by environmentally friendly process is the best option to obtain economical advantage and prevent environmental pollution. In the present investigation, a metal separation scheme is proposed for recovery of cadmium, nickel and cobalt from the leach solution of Ni-Cd battery electrode materials. After removal of the external case, the electrodes were washed with water to remove adhered alkali and dissolve in sulphuric acid in presence of a suitable additive. The iron from the leach solution was removed by selective precipitation and the iron free leach solution of composition: Ni:18.63 g/L, Cd:17.24 g/L, and Co:1.89 g/L was subjected to solvent extraction for separation of cadmium, cobalt nickel using phosphoric acid based extractants. Initially di-(2-ethyl hexyl) phosphoric acid (D2EHPA) and cyanex 302 were used to extract cadmium selectively, followed by cobalt and nickel separation using PC 88A, Cyanex 272 of suitable composition. Effect of different parameters such as equilibration time, pH aqueous feed, solvent concentration, organic to aqueous phase ratio were studied to determine the optimum conditions for extraction, scrubbing and stripping of cadmium, cobalt and nickel. Requirement of number of stages were determined from Mc-Cabe-Thiele plot for complete extraction and stripping of specific metal and subsequently validated by counter current simulation study. http://eprints.nmlindia.org/4109/

Agrawal, A and Perween, M and Pramanick, Shubhajit and Sahu, K K (2011) *Recovery of copper from PCB leach solution by solvent extraction.* In: XII International

Conference on Mineral Processing Technology (MPT-2011), Oct 20-22, 2011, Udaipur, India.

Discarded computers, mobiles and other consumer electronics (e-waste) are the fastest growing portion of the present day waste stream and are considered hazardous wastes due to the presence of several toxic metals. However such waste can be considered as valuable resource several valuable metals like copper, silver, gold etc. In the present study attempts have been made to recover copper from the leach solution of electronic wastes particularly from PCBs of computers and mobile phones. The metal rich concentrate obtained from the beneficiation circuit is leached in sulphuric acid to dissolve different metals such as copper, zinc, nickel, aluminium, iron etc. The leach liquor obtained contained 23.98 g/l Cu, 0.26 g/l Ni, 0.003 g/l Co, 1.7 g/l Zn, 0.0035 g/l Cd, 0.9 g/l Fe. This solution was further subjected to solvent extraction using LIX 84IC and Acorga M 5640 for the separation and recovery of Cu selectively from the leach solution. Various parameters were studied to optimize the conditions for maximum extraction of copper by both the solvents and their extraction efficiency has been compared. The Mc-Cabe Thiele plot shows the requirement of three stages with O/A ratio of 2:1 for quantitative extraction of copper from the leach liquor at pH 1.7 with 25% LIX 84IC. The counter current simulation studies with O/A ratio of 2:1 up to six stage shows almost complete extraction of copper along without co-extraction of other metals. Finally stripping of copper from the loaded organic phase was performed at different concentration of H2SO4 (2.5–15%, v/v). The stripping efficiency is increased with increasing sulphuric acid concentration. http://eprints.nmlindia.org/4108/

Anjali, Kumari and Pandey, R K (2011) *Clean coal technology—a technical response to the environmental challenges.* In: XII International Conference on Mineral Processing Technology (MPT-2011), Oct 20-22, 2011, Udaipur, India.

Coal occurs in 70 countries of the world. Total proved reserve of coal in the world is about 909 billion tonnes. India contributes about 105 billion tonnes of proven coal reserves and ranks fourth in the world after USA, Russia and China. India is also the third largest producer of coal in the world, producing about 400 million tonnes annually. Jharkhand has 39480 million tonnes of proved coal reserve and ranks first in the country. Coal produces 40% of the world's electricity and around 70% of the world's steel. Coal is used in cement, paper, chemical, pharmaceutical industries and also used as liquid fuel in transportation and electricity. Coal is mined in over 50 countries and 7 million people are employed in coal mining sector. In developing countries the coal industry is export oriented and is a major source of foreign currency. Thus, coal makes a significant contribution to global economic development. Beside above facts mining of coal and its uses in different industries have a number of adverse environmental impacts. Use of coal causes emissions of oxides of nitrogen and sulphur, ash, trace elements and carbon dioxide. Ash from coal combustion can effect people's respiratory systems and it also impacts local

visibility. This ash also causes environmental pollution. Emissions of trace elements like selenium and arsenic can be harmful to human health and the environment. During the combustion process NO2 and SO2 gas formed and it can increase ground level ozone, acid rain, green house effect, smog and acidic aerosols. Similarly, coal mining, particularly surface mining, also raises a number of environmental challenges like soil erosion, dust, noise and water pollution etc. which has an impact on local biodiversity. http://eprints.nmlindia.org/4107/

Baruah, B P and Khare, Puja and Rao, P G (2011) *Management of acid mine drainage (AMD) in Indian coal mines.* In: XII International Conference on Mineral Processing Technology (MPT-2011), Oct 20-22, 2011, Udaipur, India.

Mining practices, present and past, contribute towards environmental degradation affecting the ecosystems and human health. The unscientific coal mining in the tertiary North Eastern Region (NER) Indian coal mines poses a serious threat to the environment. Dumping of waste rocks including mine rejects generated during mining adds to the problem by aqueous weathering and discharge of acidic effluents. The coal mining in Meghalaya causes large-scale destruction and degradation of the environment. Coal extraction in the state is done by primitive sub-surface mining methods commonly known as 'rat hole' mining. The indiscriminate and unscientific mining, absence of post mining treatment and management of mined areas are making the fragile ecosystems more vulnerable to environmental degradation and leading to land use changes. The main problems in Meghalaya are the production of Acid Mine Drainage (AMD) in nearby areas by continuous leaching of acidic waste from the coal mining sectors. An Environmental Management Plan (EMP), has been developed for management of AMD in high sulphur coalmines by simulation of AMD from weathered coals and mine rejects. Sequential alkalinity producing (SAP) coupled with biological processes found effective in controlling AMD and reducing TDS, Conductivity, SO4 and toxic elements. In this paper, the state of art for AMD and the processes suitable for the management of AMD are discussed. http://eprints.nmlindia.org/4093/

Bhagat, R P (2011) *Improvement in Quality Parameters of Super-Fluxed Sinter from Indian Iron Ores: NML's Experience.* In: XII International Conference on Mineral Processing Technology (MPT-2011), Oct 20-22, 2011, Udaipur, India.

The various studies at NML report that the quality parameters of sinter could be improved by modifying the physical characteristics of the sinter mix and improving the thermal efficiency. The studies have shown that increasing the solid fuel consumption was not a viable solution to improve TI and RI simultaneously. The mineralogical and morphological compositions of sinter do affect its qualities : A higher amount of calcium ferrites improved the reduction-degradation index and reducibility of sinter. The reducibility was well correlated with the ratio of micro-pores to total pores in sinter. Grain size of the mix did affect the sintering speed and

quality parameters. The studies also show that significant improvement in reduction properties could be achieved by narrowing down the flux size and that of coke as well as optimizing the process variables. The RDI also improved with the addition of polymer in the mix, however, sinter productivity decreased. http://eprints.nmlindia.org/4584/

Bhagat, R P (2011) *Inter-influencing factors in affecting BF coke rate – statistical approach.* In: Proceedings : Inter. Conf. on Energy Efficiency in Steel Industry (EESI-2011), Org. by SAIL-RDCIS Ranchi, Bureau of Energy Efficiency Min. Of Power, Gov. of India New Delhi, Indian Institute of Metals, Ranchi Chapter, December 14-16, 2011, Ispat Bhawan, Ranchi.

A blast furnace (BF) is a multivariate system which is subjected to a large number of inter-influencing variables affecting its performance: productivity and coke rate. It is important to isolate the inter-influence before drawing any conclusions. It is essential to support the parameters' effect (on the responses) through theoretical consideration. . The explanatory variables affecting the coke rate have been statistically analysed in case of typical BF at Bhilai Steel Plant, SAIL and discussed in the present paper. The results (sixteen years' monthly average data points) show that some variables are not orthogonal which have been explained in terms of (a) natural cause and effect relationship amongst the variables and (b) apparent inter-relationship amongst the explanatory variables and masking the effect. The inter-influences of the variables have been isolated and their effect on coke rate has been discussed which are substantiated by the theoretical consideration. The study shows that the variable, burden rate was the most significant one followed by temperature of hot blast. A change in burden rate has been mainly reflected by a change in weight of raw limestone in the burden.. The adverse effect of the variables, ash content of coke was inter-influenced by the variable, limestone consumption. However, analysis shows the variable, ash content in coke affected the coke rate, though marginally when the inter-influence was isolated. The range studied against this variable during the period was quite high: 12 to 554 kg/ THM which indicates that lump ore constituted high proportion in the burden with nearly zero sinter consumption during some period. The empirical equation, established through the analysis of more recent data shows that an increase in ash content of coke (range 21.5- 26.6%) increased the carbon rate and the correlation coefficient was similar to those observed previously. The study indicates that an equation developed need to be modified when the value of an independent variables deviates from the range of data considered in the analysis. http://eprints.nmlindia.org/4582/

Bhattacharyya, P and Singh, Ratnakar (2011) *Generation of Value Added Product by Beneficiation of Barite Waste.* In: XII International Conference on Mineral Processing Technology (MPT-2011), October 20-22, 2011, Udaipur, India.

One of the largest indigenous manufacturing plants of barium chemicals is located at Cuddapah in Andhra Pradesh. During production of Barium carbonate, two types of rejects (flue ash and sludge) have been generated and accumulated for the last few

decades at Cuddapah plant. Earlier, briquetting of charge was suggested to restrict physical losses of material as flue ash. Afterwards, to generate product, having >90% barium sulphate which could be reused, studies have been carried out with currently produced rejects. Detail investigations suggested separate treatment of sludge because the flue ash sample was found to be suitable as feed to the reduction circuit. Both gravity and flotation processes were found to generate product meeting specifications. It was also found that more than 55% of the combined rejects currently generated at Cuddapah plant could be used again for the production of barium carbonate. In the process, recovery of barite value could be more than 65%.
http://eprints.nmlindia.org/6124/

Das, Suchandan K and Bhattacharyya, K K and Singh, Ratnakar (2011) *Optimized Neural Network Model to Characterize the Effects of Process Parameters on the Separation Efficiency of Iron Ore by a High Intensity Magnetic Separator.* XII International Conference on Mineral Processing Technology (MPT-2011), October 20-22, 2011, Udaipur, India.

An improved and optimized multi-input-multi-output (MIMO) neural network model has been developed to predict the output parameters e.g. grade and recovery to characterize the separation behavior of a high intensity magnetic separator for processing iron ore in the particle size range of 75~300 μm. The input parameters in the Neural model comprises of feed composition, % Fe, % SiO2, %Al2O3 and process parameters such as particle size, pulp density and magnetic field intensity. The effect of process parameters on the separation efficiency was characterized by conducting a sensitivity analysis. The neural network architecture has been optimized using an efficient gradient based network optimization algorithm to minimize the training error rapidly. The model is based on the data generated from WHIMS experimental investigations. There has been an excellent agreement between the optimized model predictions with the measured values pertaining to recovery and grade for magnetic separation. This is depicted by the regression fit generated between the predicted and measured values.
http://eprints.nmlindia.org/4185/

Dey, Shobhana and Mohanta, M K and Mohanty, Sunati and Goswami, M C and Bhattacharyya, K K (2011) *Amenability to Processing of Maganiferous Iron Ore.* In: XII International Conference on Mineral Processing Technology (MPT-2011), October 20-22, 2011, Udaipur, India.

Manganiferous iron ore from Karnataka state was investi-gated to upgrade the iron content with lowering of mang-anese in concentrate. Mineralogical studies show that it is comprised of microplaty hematite, martite, goethite, pyrolusite, cryptomelane and minor amount of quartz and kaolinite. The sample contains about 51.4% Fe, 4.75% Mn with 8.5% SiO2 and 2.8% Al2O3. The crushed to 1mm and 3mm samples

were subjected to reduction roasting using producer gas. The reduction roasting converts the hydrated iron oxide mineral into more magnetic materials which facilitates the magnetic separation at low intensity leaving manganese minerals in non-magnetic. The reduced products were subjected to magnetic separation at very low magnetic field to recover magnetite. The final concentrate contain-ing 64.1% Fe and 2.3% Mn is achieved with a yield of 73.5% from -1mm sample. This product can be blended with the low Mn- hematitic concentrate with 65% Fe to generate a pellet feed. http://eprints.nmlindia.org/5991/

Dey, Shobhana and Pani, Santosh and Sharma, Mamta and Das, Avimanyu (2011) *Advanced Coal Cleaning Technology for Challenges in near future.* In: XII International Conference on Mineral Processing Technology (MPT-2011), October 20-22, 2011, Udaipur, India.

Beneficiation potential of a high ash (36%) medium coking coal to a low ash (12%) level is investigated. Characterization studies indicated that the coal must be processed after reducing the size to 1.18 mm in order to accomplish substantial yield of the clean coal. A gravity based flowsheet for the -1.18+0.5 mm fraction is developed to generate clean coal at 12% ash with 9.2% overall yield. Mechanical cell flotation circuit for the -0.5+0.15 mm size fraction resulted in additional 3.5% yield at the desired ash level. A flotation circuit for the fine fraction (-0.15 mm) is developed using Jameson Cell only that added further 3.0% yield in the overall mass recovery at 12% ash. Thus, a total of 15.7% yield of the clean coal with 12% ash is achieved by treating various size classes separately. Recycling of some of the intermediate product streams is recommended for continuous operation to enhance the overall yield of the clean coal significantly. http://eprints.nmlindia.org/5979/

Vidyadhar, A and Srivastava, A and Singh, R K and Nayak, B and Rao, K V and Das, Avimanyu and Bhattacharyya, K K (2011) *Development of Processing Technology for Beneficiation of Lean Iron Ore Fines from GOA.* In: Proceedings of the XII International Seminar on Mineral Processing Technology (MPT-2011), Oct 20-22, 2011, Udaipur, India.

Because of the fast depletion of high grade iron ores and increased industrial demand, low grade iron ores which have hither to been unused, have become a focus of interest in recent years. Thus, the objective of the present study is to beneficiate lean iron ore fines from Goa for utilization in metallurgical plants. The feed sample assayed 44.25% Fe, 29.42% silica and 2.81% alumina. It is apparent from the petrographic observations that the primary ore consisted mostly of magnetite with goethite and quartz; both mineral occurring in granular form and in alternate bands. It was observed from the liberation data that reasonable degree of liberation is achieved only below 210 micron size. Several beneficiation techniques such as scrubbing, jigging, spiralling, hydrocycloning, and magnetic separation are

being employed to develop a suitable process flowsheet as a step to enhance the quality of the iron ore and to reduce the gangue content. The developed process flowsheet gives the desired enrichment of the lean iron ore fines to a grade suitable for sinter feed and pellet feed at reasonable yield and discussed in the light of our experimental results. http://eprints.nmlindia.org/4269/

Vidyadhar, A and Kumari, Neha and Bhagat, R P (2011) *Role of Mixed Cationic/Anionic Collector Systems on Hematite Flotation.* In: XII International Conference on Mineral Processing Technology (MPT-2011), 20-22 October, 2011, Udaipur, India.

The adsorption mechanism of mixed cationic alkyl diamine and anionic sulphate/oleate collectors was investigated on hematite through Hallimond flotation studies. The flotation response of hematite independently with cationic and anionic collectors and with mixed cationic/anionic collector systems is assessed. The Hallimond flotation response of hematite as a function of pH and collector concentration was investigated. The study revealed that hematite flotation recovery is maximum at acidic pH with sulphate, neutral pH 6-7 with oleate, and at basic pH about 9.5 with diamine. It is the first time that the hematite flotation results show increased adsorption of cationic collector in the presence of anionic collector apart from its own co-adsorption. The presence of oleate increased the diamine adsorption due to a decrease in the electrostatic head-head repulsion between the adjacent surface ammonium ions and thereby increasing the lateral tail-tail hydrophobic bonds. The increase in oleate concentration beyond diamine concentration leads to the formation of soluble 1:2 diamine-oleate complex or precipitate and the adsorption of these species decreased the flotation since the alkyl groups of these adsorbed species are randomly oriented at the surface. http://eprints.nmlindia.org/4270/

Sinha, Manish K and Sahu, S K and Meshram, Pratima and Pandey, B D and Kumar, Vinay (2011) *Processing of a Waste Stream for Separation and Recovery of Copper and Zinc.* In: International Conference on Mineral Processing Technology (MPT – 2011), 20-22 Oct 2011, Udiapur.

Solvent extraction studies of copper and zinc have been carried out using Cyanex 272 and LIX 984N separately from a model waste stream of brass pickling. Various parameters for the extraction and separation of copper and zinc such as effect of pH, extractant concentration, phase ratio etc. have been optimized. The results show that extraction of copper and zinc from solution after acid extraction increased with increase in pH and their pH0.5 values were found to be 3.5 and 4.6, and 2.5 and 5.5 with Cyanex 272 and LIX 984N, respectively; LIX 984N showed greater selectivity for copper compared to zinc. By McCabe Thiele diagram number of stages required for the counter current extraction of copper and zinc has been determined for each of the solvents. The stripping study showed that 1 mol/L H2SO4 was sufficient to strip metal ions from both the extractants. An attempt was made to prepare high value

products such as copper powder and zinc oxide from the loaded or stripped solution which could be imminently suitable for various P/M and other applications. http://eprints.nmlindia.org/5978/

Hore, S and Das, Suchandan K and Bhattacharyya, K K and Singh, Ratnakar (2011) *Data-Based Performance Modelling of Hydrocyclone for Processing Iron Ore Fines.* In: XII International Conference on Mineral Processing Technology (MPT-2011), October 20-22, 2011, Udaipur, India.

In this study, a data driven performance characterization model of hydrocyclone has been developed using multiple experimental data set collected from the published literature pertaining to processing of iron ore fines. The cut size, d50, has been determined for a given cyclone operating conditions using Lagrangian interpolation technique. A reduced efficiency curve has been constructed to map the performance and the functional behaviour has been modeled employing three typical distribution functions, namely, Rosin-Rammler, Exponential and Logistic. All pertinent model parameters have been estimated in accordance with the experimental data sets. It has been observed that all these functions fairly mimic the performance of cyclone for processing iron ore in the particle size range 25-300 μm. Rosin-Rammler distribution found to be a better function for fitting the experimental data set in comparison to Exponential and Logistic functions to characterize the performance.
http://eprints.nmlindia.org/4186/

Lee, Jin-Young and Jha, Amrita Kumari and Kumari, Archana and Kumar, J. Rajesh and Jha, Manis K and Kumar, Vinay (2011) *Neodymium recovery by precipitation from synthetic leach liquor of concentrated rare earth mineral.* Journal of Metallurgy and Materials Science, 53 (4). pp. 349-354.

The demand of high purity metals and continuous depletion of high grade ores has made an important global issue for the selective recovery of metal values from minerals/ waste resources. To extract Nd from mineral or waste resources, initial studies were made using synthetic leach liquor of Nd containing 27.77 g/L Nd and 8.36 g/L Fe(pH 0.33). The solution was prepared by dissolving metal alloy of composition 30.10% Nd, 68.00% Fe, 1.07% Ni and 0.83% B in sulfuric acid. A double salt complex of Nd was precipitated from this synthetic solution using 50% NaOH. The 95.89% of Nd was precipitated out at pH 1.83. Further increase in pH of solution, showed the precipitation of Fe along with Nd. Leaching of this double salt using 20% HF (v/v) solution, resulted in the formation of pure neodymium fluoride (NdF3) salt. These optimum parameters will be helpful to the scale up studies for the selective selective extraction of Nd from the actual leach liquor of minerals or solution containing Nd. http://eprints.nmlindia.org/4798/

Mehta, K D (2011) *Role of Pyrite in Selective Bioleaching of Metals from a Complex Sulphide Concentrate.* In: Conference Proceedings on XII International Conference on Mineral Processing Technology MPT - 2011, October 20-22, 2011, Udaipur, India.

The copper concentrate is a kind of complex sulphide material containing minerals such as chalcopyrite, pyrite, pentlandite, pyrrhotite, etc. with valuable metals like 14% Cu, 10% Ni, 0.33% Co and 0.71% Mo. Bioleaching of copper concentrate was carried out in presence of Acidi-thiobacillus ferrooxidans and Acidithiobacillus thiooxi-dans isolated from the copper mine water to optimise the parameters. In order to understand the role of pyrite, selective bioleaching of 90% Ni and 61% Co was observed in presence of 10% pyrite in 60 days at 308K and 2pH with the particles of size < 50 μm with unadapted culture. While recovery of 81% Ni, 45% Co and 5% Cu were achieved with the mixed size particles of ≤200 μm in 60 days time under the above conditions. The selective bacterial dissolution of nickel and cobalt as compared to copper is governed by galvanic interaction between chalcopyrite and pentlandite-/pyrrhotite which is accelerated by the addition of pyrite in the concentrate. http://eprints.nmlindia.org/6075/

Nayak, B and Sri, Damayanthi and Sharma, Mamta (2011) *Mineralogical Constraints on Beneficiation of Low-grade Iron Ores: Case Studies from Jharkhand and Goa.* In: Proceedings of the XII International Seminar on Mineral Processing Technology (MPT-2011), Oct 20-22, 2011, Udaipur, India.

Due to increasing demand of iron ores in India, much emphasis is given on beneficiating low-grade iron ores with a cut-off of +52% Fe instead of the traditional cut-off grade of +58% Fe. In such an attempt we have characterized bulk low-grade iron ores from two different sectors namely, Gua area in the state of Jharkhand and iron ore mines from southern Goa. An integrated instrumental method of characterization using optical microscope (OM), scanning electron microscope (SEM, +EDAX), and X-ray diffraction (XRD) reveal that while the Goan low-grade ores are mineralogically simple consisting primarily of martite and quartz, the ores from Jharkhand are complex consisting of hematite, goethite, clay, quartz, and gibbsite. The tenor/grade of the Goan ore is much less (~43% Fe) compared to the ore of Jharkhand which contains ~54% Fe. Alumina (Al2O3) which is the main problem in the low-grade ores of Jarkhand or generally in Eastern India is found to occur associated with clay, gibbsite and as adsorption in goethite. Textural evidences indicate that while it may be possible to remove these gangue phases from the inter-granular pore spaces it will be quite difficult to liberate the intra-granular impurities that are bound within hematite and goethite in micron levels. On the contrary, these problems do not occur in the studied Goan ores where the iron-bearing phases are not chemically contaminated and are liberated well by comminution. These mineralogical studies indicate that though the Goan ores are low in Fe content, these can be beneficiated to get a higher grade (+63% Fe) with a

high recovery while it will be difficult to improve the Jharkhand ores to similar grade with higher yield. http://eprints.nmlindia.org/6049/

Pani, Santosh and Singh, Siddharth and Paramanick, Subhajit and Dey, Shobhana and Das, Avimanyu (2011) *Prospects of Utilization of Low Grade Iron Ore from Kiriburu.* In: Proceedings of the XII International Seminar on Mineral Processing Technology (MPT-2011), Oct 20-22, 2011, Udaipur, India.
In the present investigation low grade iron ore containing around 54% Fe, 5%SiO 2 and 8% Al 2 O 3 was taken up. It was observed that in the coarser fraction (-30+10 mm) the Fe content is 60% while the finer fractions in the size range of -10+0.15 mm contain around 54% Fe. The -0.15mm fraction contains less than 35% Fe and was rejected. No significant enrichment was observed for the -30+10 mm fraction using gravity concentration. However, magnetic separation of this fraction in permroll resulted in the generation of a concentrate with 19% yield at 62.75% Fe. In all size fractions ranges between -10 to 0.15 mm gravity concentration techniques were found to be ineffective. Therefore, for further recovery of iron values, the tailings from the magnetic separation of -30+10 mm fraction and the original finer material (-10+0.15 mm) were ground to - 0.15mm and subjected to wet high intensity magnetic separation after desliming to obtain pellet grade concentrate. http://eprints.nmlindia.org/5989/

Rath, R K and Kar, A K and Mohanta, M K and Singh, Ratnakar and Kumar, Anil (2011) *Surface Chemical and Settling Studies on Hematite, Quartz and Kaolinite in Presence of Organic Reagents.* In: International Conference on Mineral Processing Technology (MPT – 2011), 20-22 Oct 2011, Udaipur.

The industrial practice of beneficiation of iron ores produces substantial amount of slimes which causes loss of iron values and environmental pollution. Slimes consists of extremely fine grained iron bearing minerals, impurities and poses problem in processing by conventional beneficiation techniques. The present study aims to develop flocculation technique for selective separation of iron bearing mineral from slimes. Initial experiments were directed towards understanding surface chemical properties of constituent minerals viz. hematite, quartz and kaolinite with or without organic reagents such as tannic acid, starch and polyacrylamide-co-acrylic acid (m.w.-150 lakh). In this paper, the results of flocculation-dispersion experiments on individual samples of hematite, quartz and kaolinite are discussed as a function of different process parameters such as pH, flocculation time and dosages of reagents. Based on the studies, conditions were established for selective separation of hematite from quartz and kaolinite. The results of flocculation-dispersion of individual minerals were applied to ternary synthetic mineral system. http://eprints.nmlindia.org/4274/

Sahu, Ashvani Kr and Dey, Shobhana and Bhattacharya, S and Bhattacharya, K K (2011) *Comparative Performance Analysis of Collectors in Flotation.* In: Proceedings of the XII International Seminar on Mineral Processing Technology (MPT-2011), Oct 20-22, 2011, Udaipur, India.

Choice of collector in coal flotation worldwide has been limited to kerosene and diesel oil. For various reasons, mostly related to reagent properties, the latter has been traditionally used in coal flotation in India. In a recent development, commercial synthetic collectors are being launched in the market. Objective of the present work is to compare between the performance of two collectors, diesel oil and one such commercial synthetic collector for the size fractions; -0.5+0.1mm &-0.1mm. These are the typical feed sizes in split feed coal flotation. The comparison was done on the basis of a flotation performance evaluation parameter called "Separation Efficiency Rate (SER)" and also the reagent cost.
http://eprints.nmlindia.org/5994/

Sharma, P and Hue, K and El-Shall, H and Powers, K and Moudgil, B (2011) *Nano, bio and mineral technologies—mutual leveraging for product and process innovations.* In: Proceedings of the XII International Seminar on Mineral Processing Technology (MPT-2011), Oct 20-22, 2011, Udaipur, India.

Particle engineers, primarily trained in disciplines such as mineral, chemical, materials, and mechanical engineering, have made important contributions to basic and applied nanotechnology advances, especially involving nanostructured particulate materials. These include flotation chemistry inspired reagent schemes for selective polishing in microelectronic manufacturing, multifunctional particles for diagnosis and therapies for cancer, nanocomposites for enhanced photocatalysis, functional nano particles for odor control. At the same time, concepts from other technologies such as nano and bio technologies are being adapted for advances in mineral and materials processing technologies. Notably among them are the new measurement and characterization tools that involve sensors and robots. For example, high throughput or combinatorial methodologies employed for screening of chemical/biological/drug have the potential of identifying potential surface active chemical or biological entities for advanced separation purposes. Similarly targeted drug delivery platforms could be adapted for delivering microencapsulating leachants on specific sites on mineral surfaces for extracting the desired metal component. These developments may not only decrease processing costs, but also waste disposal costs. In order to achieve these goals, researchers with interdisciplinary expertise and technology integration skills are needed for developing disruptive solutions to long standing challenges in mineral and materials processing. This paper illustrates attempts for adapting technological innovations across industry sectors. http://eprints.nmlindia.org/4123/

Singh, Harish and Dey, Shobhana and Bhattacharya, S (2011) *Release Analysis of Coal.* In: Proceedings of the XII International Seminar on Mineral Processing Technology (MPT-2011), Oct 20-22, 2011, Udaipur, India.

Washing of fines is more problematic than the washing of coarse coal. One of the perceived barriers in large scale application of flotation in the cleaning of Indian coking coal is the absence of benchmarking. Release analysis is the counterpart in froth flotation to float and sink analysis in the gravity concentration of coal. Thus it provides a benchmark for the coal flotation actually carried out in plants. The present work has been carried out with a LVC coal following the BS 7530 procedure of release analysis. Reagents used include MIBC as the common frother and n-dodecane and a synthetic collector, as the two collecting agents. Current published research indicates that with LVC coal only about 20- 30% yield at 18-19% ash content could be obtained. However, in the present work yields, up to 62% at about the same ash content could be obtained. http://eprints.nmlindia.org/5947/

Singh, R K and Mehta, K D and Sharma, Mamta and Bhattacharyya, K K (2011) *Performance Evaluation of Magnetic Field Intensity on Iron ore slimes.* In: Proceedings of the XII International Seminar on Mineral Processing Technology (MPT-2011), Oct 20-22, 2011, Udaipur, India.

Iron ore industries facing a problem of huge slime generation, dumping causing not only environmental issues but prime natural resources are wasted also. A detailed characterization followed by beneficiation of two different slimes of iron ores generated during processing of ROM and dump fines was studied using hydrocyclone followed by wet high intensity magnetic separator to recover the valuables and as these are already in fine state can be converted to pellets for DRI or blast furnace application. Slime sample-I, generated from ROM through scrubbing and sizing for coarse lump as well as fines and classification assayed 59.25% Fe, 5.14% Al2O3, 4.11% SiO2 , and 4.83% LOI. The Slime sample-II generated from dump fines after classification assayed 58.4% Fe, 5.27% Al2 O3, 4.67% SiO2 , and 5.22% LOI. Although the slimes chemical composition is different, XRD analysis shows that hematite and goethite are major phase whereas gibbsite, kaolinite and quartz are minor gangue minerals phases. One interesting aspect of the observation is that Slime –I indicated higher percentage of goethite compared to low grade slime –II. Multi-stage processing has been done at different magnetic field intensity for two different slimes. Detailed characterization of product sample has been carried out to study the performance of field intensity on separation efficiency. http://eprints.nmlindia.org/6052/

Singh, Ratnakar and Rath, R K and Nayak, B and Bhattacharyya, K K (2011) *Development of process for beneficiation of Low-grade iron ore samples from Orissa,*

India. In: International Conference on Mineral Processing Technology (MPT – 2011), 20-22 Oct 2011, Udiapur.

The paper deals with the results of characterisation and beneficiations studies undertaken on two low-grade Indian iron ore samples (IO-1 and IO-2) with a view to develop process for beneficiation of composite of the two samples to a high-grade concentrate, suitable for iron making through pelletisation. Indian iron ores contain relatively high iron but cost effective reduction of alumina within the specified limits has been a challenging task. Characterisation of the samples revealed the ore to be laminated and fine grained with hematite as the major mineral. Clay is the dominating gangue in most of the ore pieces followed by silica. Occasionally goethite and quartz/jasper were recorded. Clay occurs either as patches within the hematite mass or as cavity/fracture fillings. Liberation studies on the representative samples crushed to 2 mm indicated that around 95 per cent of the grains are liberated below 105 micron. Beneficiation of the two individual samples and their composite based on gravity and magnetic separation techniques resulted in products with varying yield and grade of the products. The effects of various process parameters were studied. Granulometry of the feed was observed to be important for improving quality of concentrate. The results of bench-scale studies were validated through pilot-scale continuous trials. Based on the studies undertaken a suitable process was developed for beneficiation of the composite sample, comprising 60 per cent IO-1 and 40 per cent IO-2, to a high grade product assaying over 65 per cent Fe and material balance was computed. A commercial plant for beneficiation of low-grade iron ore to produce DRI pellet grade concentrate is proposed to be installed.