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Origin of convex tetrads in rare earth element patterns of hydrothermally altered siliceous igneous rocks from the Zinnwald Sn–W deposit, Germany

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Geochimica et Cosmochimica Acta, *Volume 71(2)*, *15 January 2007*, *Pages 335-353*

The chondrite-normalized rare earth element (REE) patterns of whole rock samples from evolved granitic systems hosting rare metal deposits sometimes show a split into four consecutive curved segments, referred to as tetrads. In the present contribution, a rigorous statistical method is proposed that can be used to test whether geological significance should be attributed to tetrads that are only of limited size. The method involves a detailed evaluation of element and sample specific random and systematic errors that are constrained on the basis of independent repeated preparations and analyses of sample and reference materials. Application of the proposed method to samples from the granite-hosted Zinnwald Sn–W deposit, Germany, revealed that at least two tetrads in normalized whole rock REE patterns have to be analytically significant to rule out that fractional crystallization led to the unusual behavior of the REEs. Based on the analysis of altered albite granite and greisen samples from the endocontact of the Zinnwald granite massif, it is demonstrated that the lanthanide tetrad effect is responsible for the formation of the convex tetrads. Geological and petrological evidence suggests that the tetrads in the samples developed prior to greisenization and related cassiterite precipitation. In contrast to the endocontact samples, the rhyolitic wall rocks are typified by normalized REE patterns having tetrads that are variable in size and frequently close to the limit of analytical significance. The sizes of the tetrads apparently correlate with the intensity of albitization, but show no relation to subsequent alteration processes including greisenization and low-temperature argillization. This observation proves that curved segments in normalized whole rock REE patterns can be introduced during hydrothermal fluid–rock interaction.

Slag cleaning in crossed electric and magnetic fields

Author(s): A. Warczok, G. Riveros

Minerals Engineering, Volume 20, Issue 1, January 2007, Pages 34-43

Slags from smelting of copper concentrate contains from 2% to 20% of copper and are directed to slag cleaning operation carry out in electric furnaces or other slag cleaning reactors with injection of carboneous reductant. Ionic structure of liquid slags points out the possibilities of utilization of slag electrolysis in reduction of magnetite and precipitation of dissolved copper as well as electrokinetic phenomena in acceleration of removal of metal or matte inclusions from the slag. Analysis of physico-chemical phenomena, mathematical and fluidodynamic modeling of slag reduction and cleaning allowed for development of a new concept of slag cleaning in crossed electric and magnetic fields. Results of slag cleaning in a large laboratory scale confirmed expectations, showing the possibilities of very intensive slag reduction and copper recovery.

Geochemical modelling of hardpan formation in an iron slag dump

Author(s): Jeannet A. Meima, Simona Regenspurg, Andrea Kassahun, Dieter Rammlmair

Minerals Engineering, Volume 20, Issue 1, Pages 16-25 (January 2007)

The geochemical processes underlying hardpan formation in an alkaline iron slag dump containing up to 30 cm thick hardpans were investigated. A modelling approach has been developed to simulate mineral precipitation sequences upon pore water evaporation with PHRQPITZ and PHREEQC. This modelling approach follows the thermodynamic reaction path in which reaction products, except for calcite, may react again with the aqueous phase and form new products as evaporation proceeds. Phases that were allowed to precipitate include am-SiO_2, am-$Al(OH)_3$, ferrrihydrite, calcite, and salts that are known to occur in natural evaporites. The predicted results were compared with the observed mineralogy of evaporites and hardpans as analysed by XRD, FTIR-spectroscopy, and/or SEM–EDS. The evaporites precipitating from relatively unweathered iron slag were found to consist mainly of sodium salts (mirabilite, trona, glaserite) and to a smaller extent of calcite and gel-like phases of in particularly Si, but also Al and Fe. After 10 years of weathering, amorphous Si-gels and calcite were found to be most abundant. These results are based on model predictions as well as on observations. This silica gel phase, which actually consists of heterogeneous Ca- and Fe-rich silica gels, covers particles and fills micropores and -cracks in the hardpan. Hardpans formed by gel-like phases may hold rain water by their swelling properties.

A potential method for arsenic removal from copper concentrates

Author(s): Ivan Mihajlovic, Nada Strbac, Zivan Zivkovic, Renata Kovacevic, Mirjana Stehernik

Minerals Engineering, Volume 20, Issue 1, Pages 26-33 (January 2007)

This paper presents results for a project demonstrating a new technology for arsenic removal from copper concentrates. The problems concerning pyrometallurgical processing of copper concentrates with high arsenic content are presented in the first part of the paper. Possible solution of the problem by leaching of natural enargite crystals with sodium hypochlorite, under alkaline oxidizing conditions, with enargite converted into crystalline CuO and the soluble arsenic forming AsO_4^{3-} AsO43- was experimentally investigated and results presented in the second part of the paper. Kinetic parameters were calculated for both isothermal roasting and enargite leaching. According to the Arrhenius diagrams, the activation energy of the process, under isothermal conditions was calculated. The kinetic equation for desulfurization during isothermal roasting was found to be: $\left[1-(1-\alpha)^{1/3}\right]^2 = k \cdot t = 5.0593 \cdot \exp\left(\frac{-4571}{T}\right) \cdot t$ 1-1-α1/32=k·t=5.0593·exp-4571T·t, with activation energy of 38 ± 3 kJ/mol. Kinetic equation describing arsenic removal, during same process, was: $(1-2/3\alpha)-(1-\alpha)^{2/3} = k \cdot t = 2.7322 \cdot \exp\left(\frac{-4330}{T}\right) \cdot t$ 1-2/3α-1-α2/3=k·t=2.7322·exp-4330T·t, with activation energy 36 ± 5 kJ/mol. For the process of enargite leaching kinetic equation was: $(1-2/3\alpha)-(1-\alpha)^{2/3} = k \cdot t = 837.87 \cdot \exp\left(\frac{-3608}{T}\right) \cdot t$ 1-2/3α-1-α2/3=k·t=837.87·exp-3608T·t, with activation energy of 30 ± 1 kJ/mol.

New Models of Sustainability for the Resources Sector: A Focus on Minerals and Metals

Author(s): J. Petrie

Process Safety and Environmental Protection, *Volume 85, Issue 1*, *2007*, *Pages 88-98*

The role of the resources sector in sustainable development is indisputable. A world without water, energy, agriculture and minerals is impossible to envisage. Increasingly, however, these same sectors are disconnected from the social fabric of life in countries with developed economies—the consumer society demands instant gratification, with scant regard to the resources which underpin supposed quality of life. In developing countries, however, the picture is distinctly different—these same sectors are the lifeblood of the economy, and their role is obvious to all. The ‘disconnect’ between these two perspectives is real (and growing). On a different level, chemical engineers understand mass conservation, the guiding principles of thermodynamics and their combined role in defining sustainability—but whether policy makers, business strategists, and consumers do is a moot question. This paper explores these two dichotomies using the minerals and metals sector as an example. It suggests new operational models which could position the resources sector at the heart of materials value chains, focusing on the role of networks and partnerships in enhancing the contribution of this sector to sustainability. Such partnerships have the potential to help heal the ‘north-south’ divide between resource extraction and resource consuming economies. Discussion is offered on desirable futures for the sector, and the implications of such for strategic planning and decision support—both for public policy and business practice; the operation of existing operations, and broader societal stewardship of primary resources. Specific consideration is given to the role of chemical engineering in both structuring and analysing problems in this realm of complex systems, and to points of engagement with cognate approaches from the behavioural and management sciences.

Assessment of the mineral industry NORM/TENORM disposal in hazardous landfills

Author(s): Pontedeiro, E. M.; Heilbron, P. F. L.; Cotta, R. M.

Conference: 1st International Conference on Engineering for Waste Treatment
Location: Albi, FRANCE Date: MAY 17-19, 2005
Sponsor(s): Ecole Mines Albi-Carmaux; Paul Sabatier Univ Toulouse; CNRS PROMES Ctr; Tsinghua Univ; New Jersey Inst Technol ; Source: JOURNAL OF HAZARDOUS MATERIALS Volume: 139 Issue: 3 Special Issue: SI Pages: 563-568 DOI: 10.1016/j.jhazmat.2006.02.063 Published: JAN 31 2007

The main objective of this paper is to describe the assessment methodology utilised in Brazil, to foresee the performance of industrial landfills to disposal solid wastes containing natural radionuclides arising from milling and metallurgical installations that process ores containing NORM. An integrated methodology is utilized and issues as risk, exposure pathways and the plausible scenarios in which the contaminant can migrate and reach the environment and human beings are addressed. A specific example of the procedure is described and results are presented for actual situations. The model consists of an engineered depository constructed of earthen materials which minimise costs and maintain integrity over long-term. In order to define the landfill characteristics and the potential consequences to the environment, an impact analysis is carried out, considering the engineering aspects of the waste deposit and the exposure pathways by which the contaminant can migrate and reach the environment and human beings. Analytical solutions are used in the computer program in order to obtain fast results. (c) 2006 Elsevier B.V. All rights reserved.

Adsorptive removal of arsenic from river waters using pisolite

Author(s): P.A.L. Pereira, A.J.B. Dutra, A.H. Martins

Minerals Engineering, Volume 20, Issue 1, Pages 52-59 (January 2007)

This work presents the experimental results for arsenic removal from aqueous solutions using pisolite as a natural inorganic sorbent, a waste mineral product from Brazilian manganese ore mines. A pisolite sample was submitted to physical and chemical characterization; particle size analysis by screening, X-ray diffractometry, X-ray fluorescence, surface area determination by the Brunauer–Emmett–Teller (BET) method and atomic absorption spectrophotometry (AA) for the determination of the species concentration in the pisolite and in the aqueous solution samples from the experiments.

Column and batch tests to contact pisolite and aqueous feed solutions were carried out for evaluation of the pisolite's performance as a natural sorbent for arsenic removal. Experiments using activated pisolite and aqueous feed solutions prepared with Velhas River water were also performed. In the column system, 1.0 g of pisolite removed 1.41 mg of As (4.05% As extraction) from 630 ml of the aqueous feed solution and 1.0 g of activated pisolite extracted 3.51 mg of As (11.6% As extraction). Results for the batch tests with 100 ml of aqueous feed solution and 1.0 g of pisolite removed 1.29 mg of As (24.7% As extraction) and 1.0 g of activated pisolite extracted 3.17 mg (58.2% As extraction).

Recovery of copper powder from copper bleed electrolyte of an Indian copper smelter by electrolysis

Author(s): Archana Agrawal, Sarita Kumari, D. Bagchi, V. Kumar, B.D. Pandey

Minerals Engineering, Volume 20, Issue 1, Pages 95-97 (January 2007)

Copper bleed solution generated from an Indian Copper smelter contains high amount of copper and nickel along with several impurities. Attempts have been made to develop a new process for the production of pure copper powder from such streams. The purity of the electrolytic copper powder produced from such bleed streams was found to be 99.93%. Properties such as compact density of the annealed copper powder, flow-ability, particle size, etc. were evaluated and were found to be suitable for the powder metallurgical applications.

Chemistry and mineralogy of titania-rich slags. Part 1 - Hemo-ilmenite, sulphate, and upgraded titania slags

Author(s): Gueguin, Michel; Cardarelli, Francois

Source: MINERAL PROCESSING AND EXTRACTIVE METALLURGY REVIEW Volume: 28 Issue: 1 Pages: 1-58 DOI: 10.1080/08827500600564242
Published: JAN-MAR 2007

Titania-rich slags with 80 mass percent TiO2 are produced in the electric arc furnaces of QIT-Fer & Titane, Inc., by the continuous smelting of hemo-ilmenite ore with anthracite coal. Titania slag represents an important feedstock for the manufacture of titanium dioxide pigment by the sulphate process. Moreover, part of the production of the titania-rich slag is further acid-leached under a high-pressure and mode rate-temperature hydrometallurgical process to yield an upgraded titania slag with 94.5 mass percent TiO2, which is used in the chloride process. After describing in detail the beneficiation, chemistry, and mineralogy of the hemo-ilmenite ore, this article reviews the unique crystallochemistry and mineralogy of the titanate phases with pseudobrookite-karrooite structure and to a lesser extent silicates and oxides present in these titania-rich feedstocks, focusing on the chemical reactions occurring at each step of the pyro- and hydro-metallurgical processes. The behavior of major elements such as titanium, iron, magnesium, calcium, aluminum, and silicon along with that of minor elements such as vanadium, chromium, and manganese are particularly detailed. A general discussion of the methods specifically developed for the study of the synthetic minerals present in these materials is also presented.

A new synthetic chelating collector for the flotation of oxidized-lead mineral

Author(s): Yongkai Zhu, Chuanyao Sun, Weiguo Wu

Journal of University of Science and Technology Beijing, Mineral, Metallurgy, Material, *Volume 14, Issue 1*, *February 2007*, *Pages 9-13*

A new synthetic reagent DPTUHP [diphenyl α-(3-phenylthioureido) hexylphosphonate] containing a hydrocarbon chain nonpolar group, a thioureido, and a phosphonate easter chelating group, has proven to be an effective collector for the flotation of cerussite mineral. The synthetic method utilized the Mannich-type reaction of an N-monosubstituted thiourea, an aldehyde, and triphenyl phosphate in glacial acetic acid solution. The experimental results of flotation of the cerussite mineral show that the collector has stronger collecting ability and higher selectivity in a neutral and a slightly alkaline medium, especially in the pulp of pH=8. Using the measurements by infrared spectroscopy (IR) and X-ray photoelectron spectroscopy (XPS) of the cerussite mineral, the collector, as well as the cerussite treated with the collector, the flotation mechanism of cerussite has been discussed. It is concluded that the adsorption of collector on cerussite is a chemical adsorption through the electron donor atoms of the collector chelating the Pb (II) of cerussite to form chelate.

DAF-dissolved air flotation: Potential applications in the mining and mineral processing industry

Author(s): Rodrigues, Rafael Teixeira; Rubio, Jorge

Source: INTERNATIONAL JOURNAL OF MINERAL PROCESSING Volume: 82(1), Pages: 1-13 DOI: 10.1016/j.minpro.2006.07.019 Published: FEB 2007

Conventional and non-conventional flotation for mineral processing and for water (and wastewaters) treatment and reuse (or recycling) is rapidly broadening their applications in the mining field. Conventional flotation assisted with microbubbles (30-100 mu m) finds application in the recovery of fine mineral particles (< 13 mu m) and flotation with these fine bubbles is being used as a solid/liquid separation to remove pollutants. The injection of small bubbles to conventional coarse bubbles flotation cells usually leads to general improvements of the separation parameters, especially for the ultrafines (< 5 mu m) ore particles. Results obtained are believed to occur by enhancing the capture of particles by bubbles, one of the main drawbacks in fine ore flotation. It is believed that by decreasing the bubble size distribution (through the injection of small bubbles), increases the bubble surface flux and the fines capture. DAF or dissolved air flotation with microbubbles, treating water, wastewater and domestic sewage is known for a number of years and is now gradually entering in the mining environmental area. This technology offers, in most cases, advantages over settling, filtration, precipitation, or adsorption onto natural and synthetic adsorbents. The targets are the removal of oils (emulsified or not), ions (heavy metals and anions) and the reuse or recirculation of the process waters. Advantages include better treated water quality, rapid start up, high rate operation, and a thicker sludge. New applications are found in the mining vehicles washing water treatment and reuse, AMD (acid mining drainage) neutralization and high rate solids/water separation by flotation with microbubbles. This work reviews some recent applications of the use of microbubbles to assist the recovery of very small mineral particles and for the removal of pollutants from mining wastewaters. Emphasis is given to the design features of innovative devices showing the potential of conventional and unconventional DAF flotation. (c) 2006 Elsevier B.V. All rights reserved.

Hydrocarbon removal from industrial wastewater by hollow-fibre membrane bioreactors

Author(s): Alberti, Federica; Bienati, Barbara; Bottino, Aldo; et al.

Conference: 5th Conference on Desalination Strategies in South Mediterranean Countries (EuroMed 2006) Location: Montpellier, FRANCE Date: MAY 21-25, 2006 Sponsor(s): European Desalimat Soc; Univ Montpellier II ; Source: DESALINATION Volume: 204 Issue: 1-3 Pages: 24-32 DOI: 10.1016/j.desal.2006.05.010 Published: FEB 5 2007

Membrane bioreactors have been extensively studied for the treatment of domestic wastewater. In this paper we describe the application of membrane bioreactors for the depuration of non-civil wastewater coming from the washing of mineral oil storage tanks. Microfiltration hollow-fibre membranes were submerged in the bioreactor where the biomass used the hydrocarbon as a substrate. The performance of the submerged membrane bioreactor was analysed in terms of COD and hydrocarbon removal during different experiments that showed the high efficiency of the system. Particular care was taken in carrying out the operations in the sub-critical flux region. The reactor performance was very high, with removal efficiencies ranging between 93% and 97%, also when the concentration of hydrocarbon was very high. Moreover, the hydraulic retention times used in this work were lower compared to those used in an activated sludge process. Some kinetic parameters for the COD and the hydrocarbon removal were assessed.

Bio-beneficiation of multimetal black shale ore by flotation

Author(s): Langwaldt, Jorg; Kalapudas, Reijo

Source: PHYSICOCHEMICAL PROBLEMS OF MINERAL PROCESSING Issue: 41 Pages: 291-299 Published: 2007

Within the framework of the EU co-funded Bioshale project the bio-benefication of multimetal black shale ore was studied. The EU-co-funded Bioshale project aims to define innovative biotechnological processes for "eco-efficient" exploitation of black shale ores. The ore sample was. from the Talvivaara deposit in Finland. In the black shale ore sample, the total amount of sulphides was 31.5% of which the Ni-minerals pentlandite and altered pentlandite is 0.52%. Nickel is distributed into pyrrhotite and oxidized pyrrhotite, 32.5%, and pentlandite and altered pentlandite, 66.0%. Other sulphides are chalcopyrite (Cu), sphalerite (Zn), pyrite (Co) and alabandite (Mn). The ore sample contanied 12.3% graphite as a fine mixture with other minerals. In standard flotation, a low grade sulphide concentrate with 0.67 % Ni and nickel recovery of 74 % was obtained from the studied black shale ore. The mass of concentrate was then 34.5% of the ore feed. The recoveries of copper and zinc were 91%, of cobalt 89% and of manganese 53%. The content of carbon in the concentrate was 11.3% as graphite represents a naturally floating harmful mineral in the ore. The bioflotation tests showed that collector chemicals, i.e xanthates, had to be supplied to achieve reasonable flotation results. Out of the three tested. bacterial strains, Staphylococcus carnosus, Bacillusfirmus and Bacillus subtilis, the minor hydrophobic strain S. carnosus yielded the best test results. However, results of bioflotation tests failed to substantially improve the product recovery or grade.

Vitrification of copper flotation waste

Author(s): Alexander Karamanov, Mirko Aloisi, Mario Pelino

Journal of Hazardous Materials, Volume 140(1–2), 9 February 2007, Pages 333-339

The vitrification of an hazardous iron-rich waste (W), arising from slag flotation of copper production, was studied. Two glasses, containing 30 wt% W were melted for 30 min at 1400 °C. The first batch, labeled WSZ, was obtained by mixing W, blast furnace slag (S) and zeolite tuff (Z), whereas the second, labeled WG, was prepared by mixing W, glass cullet (G), sand and limestone. The glass frits showed high chemical durability, measured by the TCLP test. The crystallization of the glasses was evaluated by DTA. The crystal phases formed were identified by XRD resulting to be pyroxene and wollastonite solid solutions, magnetite and hematite. The morphology of the glass–ceramics was observed by optical and scanning electron microscopy. WSZ composition showed a high rate of bulk crystallization and resulted to be suitable for producing glass–ceramics by a short crystallization heat-treatment. WG composition showed a low crystallization rate and good sinterability; glass–ceramics were obtained by sinter-crystallization of the glass frit.

Analysis of mineral surface chemistry in flotation separation using imaging XPS

Author(s): Mark C. Biesinger, Brian R. Hart, Russell Polack, Brad A. Kobe, Roger St.C. Smart

Minerals Engineering, *Volume 20, Issue 2*, *February 2007*, *Pages 152-162*

The Inco Bessemer Matte Processing Plant (IBMPP) suffers a loss of chalcocite selectivity in flotation separation from heazlewoodite down the rougher bank. Energy dispersive X-ray spectroscopy (EDX) analyses of the feed, concentrate and tail samples reveal a decrease in Cu and corresponding increase in Ni recovery through the primary rougher banks; tail samples can contain on the order of 7% Cu. The aim of this work was to examine any loss of selectivity through the primary flotation stream due to surface chemistry. Mechanisms suggested have included inadvertent activation and depression by the dissolution and solution transfer of Cu and Ni ions, lack of collector selectivity and possible requirement for reaction of the chalcocite surface prior to collector adsorption. The combination of information from SEM/EDX, X-ray photoelectron spectroscopy (XPS) analysis and XPS imaging has clarified the following aspects of the surface chemical mechanisms and control factors in the rougher flotation separation: (1) chalcocite in the feed to the rougher circuit appears to be unoxidized, i.e., all Cu(I) surface species, whereas the surfaces of the heazlewoodite appear to be entirely oxidized to hydroxide species; (2) chalcocite in the tails from the rougher circuit appears to be more oxidized with evident precipitates corresponding to $Cu(OH)_2$ in both composition and morphology adhering to their surfaces; (3) the primary adsorption of diphenylguanidine (DPG) appears to be to Cu(I) sites on the unoxidized chalcocite surface; (4) adsorption of the DPG collector to chalcocite surfaces appears to be inhibited by the formation or concentration of fine Cu(II) hydroxide precipitates in the later rougher cells; (5) the crystalline morphology of some of the discrete, attached Cu(II) hydroxide precipitates may suggest formation in recycle water streams rather than by surface oxidation of the chalcocite through the circuit although this may not be the only form of Cu(II) hydroxide on chalcocite surfaces in cells *C* and *D*; (6) heazlewoodite flotation appears to be associated with the attachment or locking of fine unoxidized chalcocite rather than any direct adsorption of DPG; heazlewoodite fines are also found attached or locked to some chalcocite particles in concentrates contributing to loss of grade (i.e., heazlewoodite is not completely liberated); (7) heazlewoodite particles in tails have relatively high surface concentrations of attached more-oxidized chalcocite fines contributing to loss of recovery.

An overview of utilization of slag and sludge from steel industries

Author(s): B. Das, S. Prakash, P.S.R. Reddy, V.N. Misra

Resources, Conservation and Recycling, *Volume 50, Issue 1*, *March 2007*, *Pages 40-57*

Significant quantities of sludge and slag are generated as waste material or byproduct every day from steel industries. They usually contain considerable quantities of valuable metals and materials. It is generally possible to recover some values by physical or chemical mineral processing techniques such as crushing, grinding, classification, hydrocyclone, magnetic separation, flotation, leaching or roasting. Transforming these solid wastes from one form to another to be reused either by the same production unit or by different industrial installation are very much essential not only for conserving metals and mineral resources but also for protecting the environment. This paper analyzes the characterization, beneficiation and utilization aspects of blast furnace flue dust, blast furnace sludge, LD sludge and LD slag generated at modern steel plants.

Influence of biogenic Fe(II) on the extent of microbial reduction of Fe(III) in clay minerals nontronite, illite, and chlorite

Author(s): Deb P. Jaisi, Hailiang Dong, Chongxuan Liu

Geochimica et Cosmochimica Acta, Volume 71(5), 1 March 2007, Pages 1145-1158

Microbial reduction of Fe(III) in clay minerals is an important process that affects properties of clay-rich materials and iron biogeochemical cycling in natural environments. Microbial reduction often ceases before all Fe(III) in clay minerals is exhausted. The factors causing the cessation are, however, not well understood. The objective of this study was to assess the role of biogenic Fe(II) in microbial reduction of Fe(III) in clay minerals nontronite, illite, and chlorite. Bioreduction experiments were performed in batch systems, where lactate was used as the sole electron donor, Fe(III) in clay minerals as the sole electron acceptor, and *Shewanella putrefaciens* CN32 as the mediator with and without an electron shuttle (AQDS). Our results showed that bioreduction activity ceased within two weeks with variable extents of bioreduction of structural Fe(III) in clay minerals. When fresh CN32 cells were added to old cultures (6 months), bioreduction resumed, and extents increased.

Thus, cessation of Fe(III) bioreduction was not necessarily due to exhaustion of bioavailable Fe(III) in the mineral structure, but changes in cell physiology or solution chemistry, such as Fe(II) production during microbial reduction, may have inhibited the extent of bioreduction. To investigate the effect of Fe(II) inhibition on CN 32 reduction activity, a typical bioreduction process (consisting of lactate, clay, cells, and AQDS in a single tube) was separated into two steps: (1) AQDS was reduced by cells in the absence of clay; (2) Fe(III) in clays was reduced by biogenic AH_2DS in the absence of cells. With this method, the extent of Fe(III) reduction increased by 45–233%, depending on the clay mineral involved. Transmission electron microscopy observation revealed a thick halo surrounding cell surfaces that most likely resulted from Fe(II) sorption/precipitation. Similarly, the inhibitory effect of Fe(II) sorbed onto clay surfaces was assessed by presorbing a certain amount of Fe(II) onto clay surfaces followed by AH_2DS reduction of Fe(III). The reduction extent consistently decreased with an increasing amount of presorbed Fe(II). The relative reduction extent [i.e., the reduction extent normalized to that when the amount of presorbed Fe(II) was zero] was similar for all clay minerals studied and showed a systematic decrease with an increasing clay-presorbed Fe(II) concentration. These results suggest a similar inhibitory effect of clay-sorbed Fe(II) for different clay minerals. An equilibrium thermodynamic model was constructed with independently estimated parameters to evaluate whether the observed cessation of Fe(III) reduction by AH_2DS was due to exhaustion of reaction free energy.

Model-calculated reduction extents were, however, over 50% higher than experimentally measured, indicating that other factors, such as blockage of the electron transfer chain and mineralogy, restricted the reduction extent. Another important result of this study was the relative reducibility of Fe(III) in different clays: nontronite > chlorite > illite. This order was qualitatively consistent with the differences in the crystal structure and layer charge of these minerals.

A review on hydrometallurgical extraction and recovery of cadmium from various resources

Author(s): M. Sadegh Safarzadeh, M.S. Bafghi, D. Moradkhani, M. Ojaghi Ilkhchi

Minerals Engineering, Volume 20, Issue 3, March 2007, Pages 211-220

Cadmium is a toxic metal, which is primarily produced as a by-product from mining, smelting and refining of sulphide ore concentrates of zinc. Secondary cadmium is recovered from spent Ni–Cd batteries. Some cadmium is also recovered from zinc sinter plant fume, EAF dust, cadmium containing alloys, cadmium containing fluorescent materials, etc. In all cases cadmium is associated with some other impurities depending on the source. The hydrometallurgical processing is very effective for treating such materials because it can control the different levels of impurities. The most common lixiviant used to dissolve the desired metals is sulphuric acid. In the present paper, the hydrometallurgical processes have been described for the recovery of cadmium from various resources using sulphuric acid as the main lixiviant. The leach solution obtained has been purified using cementation or solvent extraction methods. The metal is then produced from the purified solution by electrowinning or precipitation with zinc dust and melting.

Activation of high-iron marmatite in froth flotation by ammoniacal copper(II) solution

Author(s): Xiong Tong, Shaoxian Song, Jian He, Feng Rao, Alejandro Lopez-Valdivieso

Minerals Engineering, *Volume 20, Issue 3*, *March 2007*, *Pages 259-263*

Froth flotation of high-iron marmatite particles activated by ammoniacal copper(II) solution has been studied in this work. This study was performed on single marmatite mineral of 76–125 μm in size and 20% iron content by using micro-flotation. The results have shown that ammoniacal copper(II) solution effectively activated high-iron marmatite particles in the flotation with xanthate as the collector, being much better than copper sulfate, a traditional activator for sphalerite and marmatite flotation. Also, the maximum activation by ammoniacal copper(II) solution in the flotation appeared around pH 9, compared with pH 13–14 by copper sulfate. Therefore, the substitution of ammoniacal copper(II) solution for copper sulfate in high-iron marmatite flotation would increase the separation efficiency and would allow large savings on the consumptions of lime.