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Contact us:

Ph: +1 (702) 988-2320

Email: geology@magnusconference.com

Website: https://geology.magnusconferencea.com/

BOOK OF ABSTRACTS

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Lala Behari Sukla*, Archana Pattanaik, Debabrata Pradhan
Biofuels and Bioprocessing Research Center, Institute of Technical Education and Research, Siksha 'O' Anusandhan (Deemed to be University), Odisha, India

Recovery of nickel and cobalt from low-grade Ni-laterite ore of sukinda, Odisha using microorganisms

Nickel principally occurs in two types of deposits i.e. sulfide and laterite ores. About 60% of nickel reserves are in the form of lateritic ores and 40% are in the form of sulfidic ores. However, the high-grade sulfidic ores have been the major source of nickel till date. Interest in low-grade Ni-laterite ores has increased in recent years as high-grade Ni-sulfide deposits are being quickly depleted. The nickel resources in India are estimated at 189 million tonnes of metal content of which Odisha accounts for maximum of 175 million tonnes. The only significant deposit of lateritic nickel ore in India is in the ultra-basic belt of Sukinda, Odisha with a nickel content of 0.15-1.2% along with trace amount of cobalt and manganese which is yet to be commercially exploited. The major occurrence of nickel is in the form of nickeliferous limonite in the overburden of chromite mines in Sukinda valley, Jajpur. A huge amount of overburden (nearly 8 to 10 times that of the ore) is generated during chromite mining in Sukinda chromite deposits of Odisha contains nickel and cobalt as minor constituents (Ni: 0.4%-0.9% and Co: 0.02%-0.05%). These overburdens are dumped nearby and have found a very little use so far. The mineralogical studies indicated that there was no separate nickel bearing mineral phase in the lateritic nickel ore. Goethite is the main iron bearing phase or host, which contains most of the nickel in the raw lateritic ore. However, processing of Ni laterites has proven technically difficult and costly through the conventional methods. Hence, the development of alternative low-cost biotechnologies for Ni solubilization has been encouraged. Bioleaching involves the utilization of microorganisms and their metabolic products to dissolve metals from low grade ores. Both autotrophic and heterotrophic microorganisms possess the potential to recover nickel from its ores. The use of heterotrophic fungi (strains of *Aspergillus* and *Penicillium*) and bacteria (strains of *Bacillus* and *Pseudomonas*) for metal recovery have been extensively studied. However, in case of nickel recovery from lateritic ores, strains of *Aspergillus* and *Penicillium* are the most preferred microorganisms. These microbes produce organic acids such as gluconic, oxalic, citric etc. by their cellular metabolism, which are responsible for metal solubilisation from lateritic ores. Several studies suggest that citric acid and oxalic acid are the two major fungal metabolites to have major role in nickel bioleaching. *Acidithiobacillus ferrooxidans* a chemolithotrophic bacterium has been reported to solubilize nickel from lateritic ore by microbial reductive method. This bacterium reduces ferric iron (Fe^{3+}) in the goethite to ferrous iron (Fe^{2+}) in anoxic condition with elemental sulfur as electron donor, thereby producing sulfuric acid which generates acidity in the medium and is responsible for dissolution of nickel. Recent study reported about the use of DIRB (Dissimilatory Iron Reducing Bacteria) in bio-reduction of lateritic chromite overburden (COB) and enhancement in nickel and cobalt recovery. DIRB have the ability to utilize Fe (III) as terminal electron acceptor during bio-reduction of lateritic mineral. In this process DIRB consortium reduces the goethite phase to hematite and magnetite with the exposure of nickel oxide. Subsequent leaching of DIRB pre-treated ore by H_2SO_4 results in enhanced recovery of nickel and cobalt. However, bioleaching of nickel and cobalt from lateritic ore are in laboratory scale only. Further work is required to better understand the bioleaching process and identification of more efficient microbial strains.

Audience Take Away:

- From this presentation the audience will learn to make use of low grade and secondary resources for the recovery of valuable metals
- They will be able to make use of different microorganisms for various purposes
- They will be able to develop an environmentally sustainable process of metal recovery from low grade deposits and different wastes
- As the environmental safety is an important global concern, the audiences can choose this process of metal recovery from secondary resources for further research and development.
- Yes, this area of research is gaining more attention by the researchers
- The high grade mineral deposits are being depleted very fast along with the rise in demand for various metals
- In the near future these low grade mineral deposits and secondary resources will be the source to meet the growing metal demand

Biography:

Prof. Sukla is at present Director in Biofuels and Bioprocessing Research Center (BBRC), Siksha 'O' Anusandhan (Deemed to be University), Bhubaneswar. He has worked as Chief Scientist and was heading the Bioresources Engineering Department in CSIR-IMMT, Bhubaneswar, India. He has more than 45 years of R&D experience in the area of Bio-mineral Processing, Hydrometallurgy and contributed over 240 papers in International & National Journals. He has published 5 books and 10 patents and seven students have been awarded Ph.D. degrees under his guidance He is a Fellow Institution of Engineers INDIA. Prof. Sukla is the recipient of several prestigious awards.