BOOK REVIEW

MICROBES, MINERALS AND ENVIRONMENT by K.A. Natarajan. Publisher: Geological Survey of India, A.M.S.E. Wing, "Vasudha Bhavan", Kumaraswamy Layout, Bangalore - 78, First Edition 1998. Price Rs.200.

Geological Survey of India, AMSE Wing, Bangalore has published this thematic monograph at an appropriate time when the gold price is so low that we have to necessarily call microbes for help in treating what else other than low grade and refractory gold ore resources dotting different parts of our country and waiting to be fully explored, developed, mined and processed. At a time when an army of Thiobacillus ferrooxidans bacterial biomass is waiting to help the Indian gold industry there are three PSUs as nodal agencies in Madhya Pradesh, Andhra Pradesh and Karnataka trying to defeat the very purpose with which the Central Government, adopted a liberalised mining policy to encourage private investors in this known risky business of gold exploration and mining.

Getting back to the book, the author, Prof K.A. Natarajan is an eminent metallurgist at the Indian Institute of Science, Bangalore. He is an authority in the field of biometallurgy in India and his services have been sought by Hindustan Copper Ltd., Hindustan Zinc Ltd. and Hutti Gold Mines Co. Ltd.

Bioleaching technology is an inexpensive way to extract metal from low-grade gold and copper sulphide ores and also gold locked up in pyrite and arsenopyrite-bearing ores. As the microbes feed on the ore, which has been treated with sulfuric acid to encourage them, the metal is released and concentrated in a solution that is collected into a basin. The metal is extracted and the acid is recycled. The author explains these aspects and many more applications of microbes in this book in a concise yet very informative manner in 12 different Chapters. There are 241 references from world literature which includes 49 works of the author himself and his colleagues from the Indian Institute of Science.

Microorganisms have a role in the formation of bauxite, phosphorite and manganese. Deposits of elemental sulphur are also of biogenic origin. Weathering of iron-bearing minerals is promoted by bacterial action. Sulphate is reduced by bacteria into sulphide minerals, especially pyrite. Microorganisms are also capable of dissolving finely dispersed gold and also aid in its precipitation! These exciting possibilities are introduced in the first Chapter.

The manner in which different microorganisms bring about enrichment of useful mineral constituents (Beneficiation) is described in Chapter 2. The author sees a great promise for bio-catalysed beneficiation of non-sulphidic ores such as bauxite, dolomite, magnesite, phosphates etc. Evolution of biohydrometallurgy from science to technology is traced in Chapter 3 and its commercial applications illustrated with examples in Chapter 4.

Gold ores associated with carbonaceous materials pose a peculiar problem known as 'preg-robbing' which means, even if liberated-gold particles are cyanided, they get adsorbed into carbon, making recovery of gold extremely difficult. Finely disseminated gold particles locked up in pyrite and arsenopyrite can not be processed by direct cyanidation. It requires cost- and energy-intensive and environmentally unacceptable roasting process before cyanidation. Bio-oxidation is the answer for such ores. With two months of biotreatment about 70% of pyrite could be oxidized leading to about 60% recovery. These aspects are dealt with in Chapter 5.

Zinc sulphide ores, galena, nickel sulphides such as millerite and pentlandite, molybdenite, stibnite, cobalt sulphide and polymetallic sulphide ores can all be processed by bioleaching as highlighted in a brief Chapter 6. Use of microorganisms in the beneficiation of coals and petroleum oils is illustrated in Chapter 7.

Biooxidation of sulphide minerals produce acidic waters which is known to cause environmental pollution by contaminating groundwater, rivers, streams and sea coasts which can be prevented again by biological treatment. These are described in Chapter 8. Crisp description of biological methods of treatment of cyanide effluents and other industrial liquid and solid effluents are provided in Chapter 9. The 10th chapter is not of much interest to our readers. It is on Biofouling, Biodeterioration and Biocorrosion.

Questions of the future of biomineral technology is addressed in the last-but-one chapter. In the last chapter the author has presented the "Indian Scenario", listing several opportunities that exist in bioleaching of low grade ores of copper, gold, zinc, cobalt, nickel, molybdenum, manganese and also metal concentrates, mine wastes, and tailings. *To this list can be added carbonaceous shale beds and coal ash which are known to carry high concentration of metals.*

After reading this book, as a geologist, I became curious to know about mining companies in the world who have successfully adopted bioleaching technology for extraction of metals from lean ores. I searched for information over the internet and found one instance worth recording here: The bio-oxidation leaching facility of Newmont Gold Co., at its Gold Quarry has successfully treated low grade refractory ores on commercial basis and produced close to 1.6 Mt (50,000 ounces) of gold with recoveries of 50 to 60 percent. The new process is stated to be $14 to $15 a short ton less expensive than it costs to treat the same type of ore by conventional roasting method.

In the words of Prof Natarajan what is needed to be done "is a mission oriented, dedicated and time-bound national policy devoted to adaptation of Biotechnology in Indian Mining Industries. National organisations such as the Geological Survey of India, State Mines and Geology Departments, Indian Bureau of Mines, National Laboratories and research organisations, Ministry of Mines of the Government of India and the Indian Mining Industries should come together to debate over this issue and chalk out a nationally relevant and time bound programme.

In terms of presentation, the text has a good sense of progression. The writing style is straight forward, and the contents appeal to all categories of people in the mineral and metallurgical industries, professionals of the Geological Survey organizations, earth science institutions and also University students. The book is well produced, with an attractive print style. The price is modest compared to usefulness of this monograph. We heartily congratulate the Geological Survey of India, AMSE Wing, Bangalore for bringing out such a useful and timely book.

Geological Society of India
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V.N. VASUDEV

What is our objective

Our objective is not to blast our way to the Nuclear Club but to awaken the people of the world and work together with all the nations for the liquidation of any such Club along with the immense stock of weapons of mass destruction stored in the cellars of this exclusive Club.

K.R. NARAYANAN
President of India