

## Rare Metal and Rare Earth - bearing Mineral Resources in Different Geological Environments of India – A.K. Rai, Director, Atomic Minerals Directorate for Exploration and Research

Commercially viable deposits of rare metals (RM) & rare-earth elements (REE), so far identified in India, are associated with a wide range of geological environments, which may be grouped together into two broad categories, one relating to 'primary deposits' of igneous and hydrothermal origin and the other 'secondary deposits' concentrated by sedimentary processes and weathering. In India, Atomic Minerals Directorate for Exploration and Research (AMD) is engaged in exploration of specific rare metals, such as, lithium (Li), beryllium (Be), niobium (Nb) and tantalum (Ta) besides rare earth elements (REE), especially from sedimentary sources. Monazite has been the principal resource of REE in India. In fact, significant resources of REE have been established in India in the form of monazite bearing heavy mineral sands (HMS) in beach sand placers, which account for a vast resource base of LREE (~7Mt REO). In addition, Y and HREE enriched inland riverine placers are established in Chhotanagpur Granite-Gneiss terrain, wherein minerals like xenotime & monazite could well be an answer to the 'balancing problem' faced by REE operations. Valuable REEs including Y can be recovered from such inland placers. Primary sources for RMRE elements have never been a priority resource in India. Globally, carbonatites and alkaline intrusive complexes, as well as their weathering products, are major resources of Nb & REE. In this context, significant primary REE±Nb mineralization recently established in Ambadongar carbonatite (Gujarat), Kamthai carbonatite and Siwana Ring Alkaline Complex (Rajasthan) and Pakkanadu carbonatite (Tamil Nadu) in India is being evaluated. Moreover, considering the present demand-supply scenario, exploration for primary resources especially hosted by carbonatites and alkaline rock complexes needs to be augmented judiciously.

Considering the global production of Li from brines, commercially viable Li-rich brines are yet to be identified in India. Li-mineral, lepidolite, is described from major mica fields of Bihar, Rajasthan and Andhra Pradesh, whereas both lepidolite and amblygonite are reported from Bastar-Koraput pegmatitic belt. Spodumene, most sought after Li-mineral, occurs in Marlagalla-Allapatna pegmatites in Mandya district, Karnataka. Most of the Be in India is recovered as beryl from different pegmatites. In fact, lithium and beryllium minerals were

obtained as a co-product/by-product from different pegmatite fields during mica mining and columbite-tantalite recovery operations. The primary resources of Nb-Ta, especially columbite-tantalite, have been exploited in pegmatitic environment in different mica belts of India (viz., Rajasthan, Bihar and Nellore Mica Belts) and rare metal pegmatites derived soil/gravel fields (Bastar, Chhattisgarh, Odisha and Karnataka) in the secondary environment (eluvial, colluvial and alluvial). The recovered RMRE minerals are stockpiled by AMD. Nevertheless, appreciable resources of Nb especially pyrochlore have been established in carbonatites of Sevattur (Tamil Nadu), Sung valley (Meghalaya) and Samchampi (Mikir Hills, Assam) areas. However, these are not yet exploited due to constraints in beneficiation. It may be worth mentioning that tailings and by-products from related mining activities hold significant amount of REE and research projects are to be initiated to optimize the extraction process of rare earth metals from such sources. More such potential sources of REE, which need to be explored in India, include:

- (i) Tailings from mining and milling of Pb, Zn, Cu and sulphur ores.
- (ii) Tailings from processing of phosphate ore (phosphor-gypsum)
- (iii) Tailings from processing of alumina ore (red mud) and waste rock from mining of other deposits.
- (iv) Sn slags after recovery of metal. Sn slags are enriched in REE; For instance, pegmatites in Bastar and Chhattisgarh are known for Sn, Nb and Ta mineralization and from the large scale availability of such tin slags, a good amount of valuable REEs can be recovered.
- (v) Blast furnace slags of steel plants. The blast furnace slags of many steel plants are also the potential sources of REE, particularly LREE.
- (vi) Coal fly ash derived out of thermal power plants and other coal based industries contains significantly high REEs.

Resource position in the country, with respect to rare metals, is adequate for the ongoing nuclear applications. In nutshell, there is no dearth of geological resources for RM and REE in the country; however, there is a need to highlight the potentiality of multi-commodity primary RMRE projects in India.

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