https://doi.org/10.31705/BPRM.v2(1).2022.13

EXPLORATION FOR RARE EARTH ELEMENTS (REES) IN DIFFERENT GEOLOGICAL FORMATIONS OF SRI LANKA AND THEIR RECOVERY POTENTIAL

Rare earth elements (REEs) are widely attracting global attention due to their crucial role in the modern lifestyle, especially in the industrial advancement towards a green economy through renewable technologies. This particular group of metals consists of the 15 lanthanides, yttrium (Y), and scandium (Sc). There are two subgroups, namely light rare earth elements (LREEs) from lanthanum (La) to europium (Eu) and heavy rare earth elements (HREEs) from gadolinium (Gd) to lutetium (Lu) and Y (Fig. 1a). Generally, LREEs are more abundant in the mineral deposits when compared to more priced HREEs [1].

Currently, the global demand for REEs is skyrocketing, owing to their immense consumption in the advancement of modern high-tech and green technologies. Global demand for rare earth oxides (REOs) has increased approximately from 156 to 208 thousand metric tonnes over the period 2017 to 2019, and it is forecasted to increase to over 304 thousand metric tonnes by the year 2025 [2] (Fig. 1b). However, the global REE supply is unstable and uncertain due to the inadequacy of REE resources and various geopolitical issues. Therefore, exploring new and alternative REE resources worldwide is extremely important to maintain a reliable and steady REE supply.

“Currently, the global demand for REEs is skyrocketing, owing to their immense consumption in the advancement of modern high-tech and green technologies.”

In this context, Sri Lanka has a prominent potential for REE resources considering its favorable geological setting, and previous geochemical studies disclose clear evidence of high REE concentrations in different geological formations [3]. Therefore, the present study explores the REE potential in various geological formations of Sri Lanka, including intrusive rocks, placer deposits, and gem mining wastes. Amongst the studied geological bodies, Eppawala Phosphate Deposit, Pulmoddai mineral sand, and gem mining waste are the most potential REE resources in Sri Lanka (Fig. 2). In addition, downstream lake sediments at Eppawala are also a prospective source for REEs due to the accumulation of REEs via transportation of weathered materials by Jaya-Ganga that flows across the Eppawala phosphate deposit. Table 1 presents the total REE contents and average REO grades of these resources.

Table 1: The total REE contents and average REO grades of the most potential REE resources in Sri Lanka.

Resource	Total REE Content (mg/kg)	Average REO grade (wt%)
Eppawala Phosphate Deposit	2676-6486 (Avg. 4185)	0.49 – 0.91
Eppawala lake sediments	323-2590 (Avg. 1011)	0.18
Pulmoddai monazite	10,640 – 33,011 (Avg. 18,504)	3.4
Gem mining waste	12,786-25,766	1.5

Since the bulk tonnage of the Eppawala Phosphate Deposit is about 60 million tonnes of P_2O_5 [3], its estimated that the average REE reserve is approximately 0.29 million tonnes of REOs. However, the average tonnage of REOs of the other resources remains unknown due to the lack of volume calculations. Therefore, we need to carry out further detailed sampling, geochemical evaluations, mineralogical analyses, and volume calculations before determining the true potential of these resources.

Based on the average REO grade and the feasibility of REE extraction, we selected three resources: Eppawala Phosphate Deposit, Eppawala lake sediments, and gem mining wastes for the development of suitable extraction techniques to recover REEs. Despite the highest REO grade, REE extraction from Pulmoddai monazite is complex and environmentally damaging due to the high concentration of radioactive components like Uranium and Thorium [3]. So far, we have been able to leach out REEs under optimized conditions from the Eppawala Phosphate Deposit, Eppawala lake sediments, and Gem mining wastes with 81%, 78%, and 78%, respectively (Fig. 3a). After completing the optimization of the leaching process, we expect to proceed with the selective separation of rare earth elements with the solvent extraction technique.

In the case of the Eppawala Phosphate Deposit, phosphate mining produces two types of phosphate fertilizers: Eppawala Rock Phosphate (ERP) and High-Grade Eppawala Rock Phosphate (HERP). When applying these ERP and HERP to the crops in their raw forms, a considerable amount of this valuable commodity, REEs, is wasted. Therefore, we need to recover REEs as a by-product during the fertilizer production flow at the Eppawala Phosphate deposit. We are currently at the stage of the leaching optimization of Eppawala HERP and ERP. However, we expect to proceed with the production of REOs and the selective separation of REEs using the solvent extraction technique. Figure 3b illustrates the proposed production flow of REOs and selective extraction of REEs from the ERP and HERP at the Eppawala Phosphate Deposit.

Recovering REEs from ERP and HERP could contribute to the growth of the Gross Domestic Product in Sri Lanka, which would ultimately improve the Sri Lankan economy. When it comes to Gem mining wastes and Eppawala lake sediments, they also contain valuable critical metals like REEs, and we must develop suitable extraction techniques to recover them as well. There have been no previous attempts to explore the potential of REE sources in Sri Lanka and recover REEs from these sources. Therefore, developing novel extraction techniques to extract REEs from the above resources would be helpful for the establishment of the REE industry in Sri Lanka.

Acknowledgements

The authors wish to acknowledge the financial support provided by the Accelerating Higher Education and Development (AHEAD) Operation of the Ministry of Higher Education of Sri Lanka, funded by the World Bank (AHEAD/DOR/6026-LK/8743-LK).

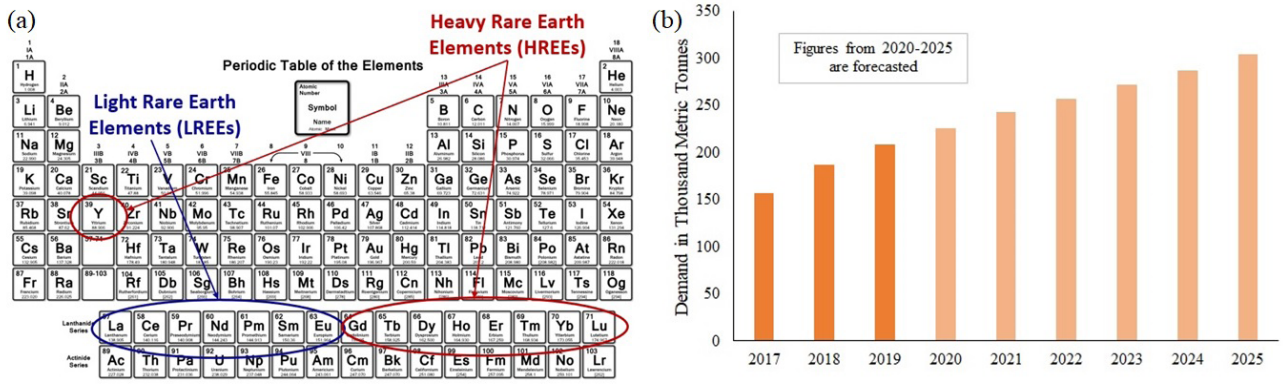

Figure 1: (a) The subgroups of rare earth elements; (b) The global demand for REO from 2017 to 2025 (Source: [2]).

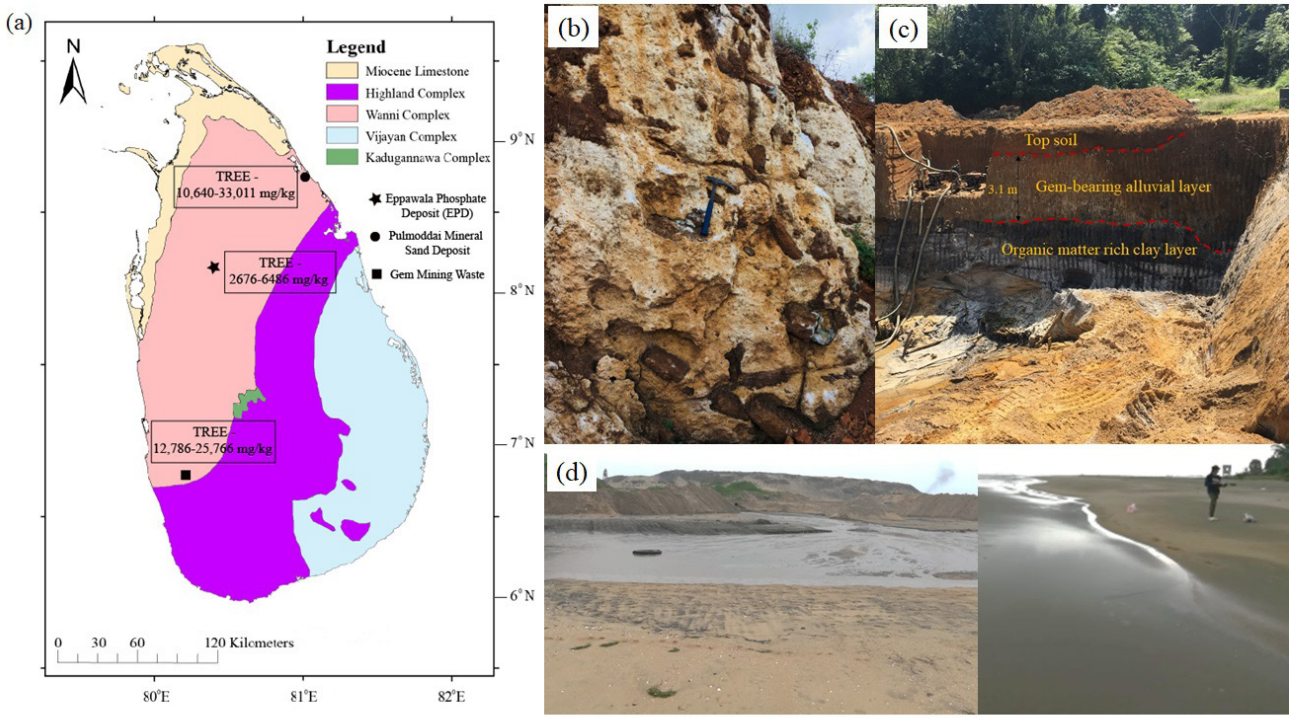

Figure 2: (a) The most potential REE sources in Sri Lanka; (b) Eppawala phosphate deposit; (c) A gem mining site at Wagawatta, Horana; (d) Pulmoddai mineral sand deposit.

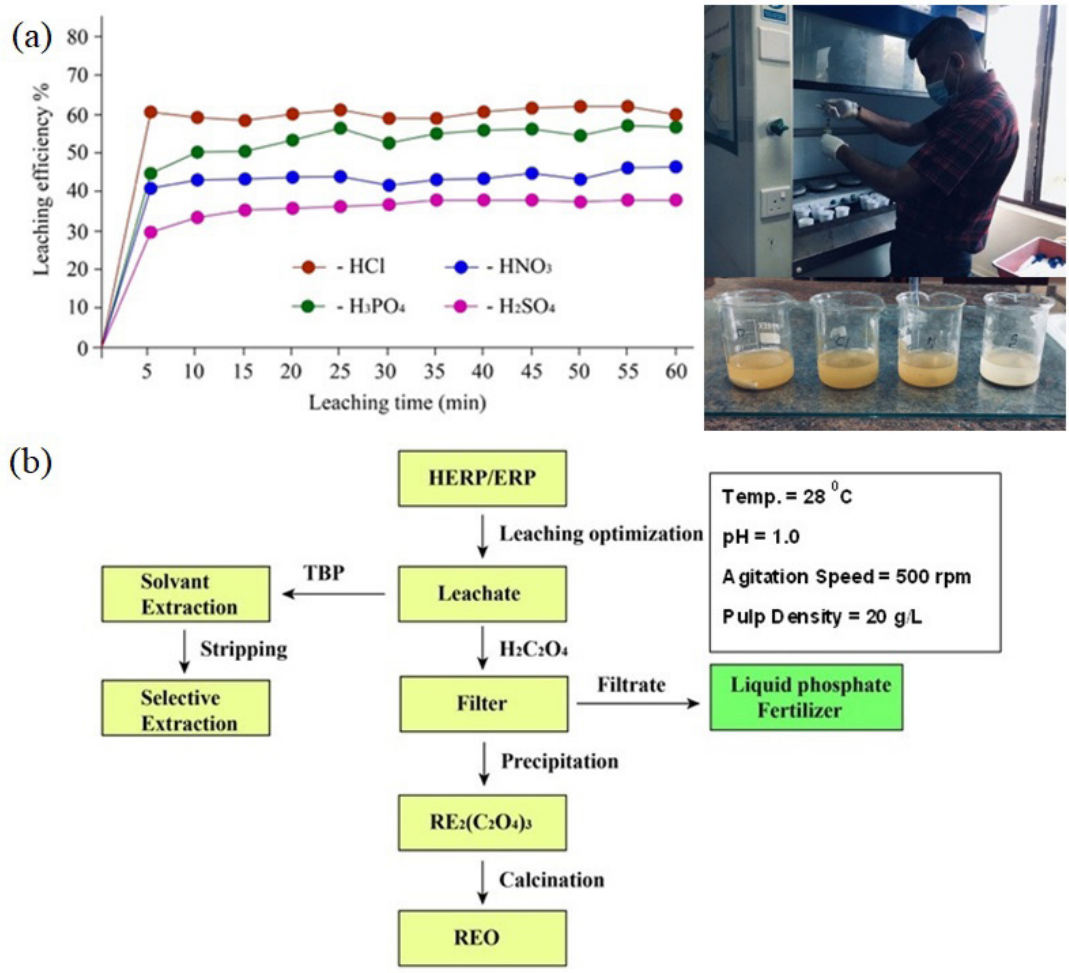

Figure 3: (a) Leaching optimization of REEs from the Eppawala apatite; (b) The proposed REE production flow of REOs and selective extraction of REEs from the Eppawala Phosphate Deposit.

References:

[1] N. Dushyantha et al., "The story of rare earth elements (REEs): Occurrences, global distribution, genesis, geology, mineralogy and global production," Ore Geology Reviews, vol. 122, p. 103521, 2020.

[2] Statista, "Rare earth oxide demand worldwide from 2017 to 2025," 2020.

[3] N. M. Batapola et al., "A comparison of global rare earth element (REE) resources and their mineralogy with REE prospects in Sri Lanka," Journal of Asian Earth Sciences, vol. 200, p. 104475, 2020.

Article by

Nadeera Batapola[1], Nalin Ratnayake[1], Bandara Abeysinghe[1], Ranjith Premasiri[1], Sudath Rohitha[1], Nimila Dushyantha[1], Saman Ilankoon[2], Kithsiri Dissanayake[1], Pannipitiye Dharmaratne[1]

[1]Department of Earth Resources Engineering, Faculty of Engineering, University of Moratuwa, Sri Lanka

[2]Discipline of Chemical Engineering, School of Engineering, Monash University Malaysia, Malaysia