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Appraisal of Sri Lanka's Exporting Industrial Minerals Using Publicly Available Mineral Databases

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Abstract
Sri Lanka possesses a diverse portfolio of industrial minerals, yet systematic evaluations of their export performance and competitiveness remain limited. This study analyzes the export trends of graphite, quartz, mica, and mineral sands between 2000 and 2023 using data from UN Comtrade, World Integrated Trade Solution (WITS). The analysis incorporates trade quantities, inflation-adjusted unit values, and Revealed Comparative Advantage (RCA) Analysis to assess Sri Lanka's competitiveness in global markets. Results show that graphite exports, despite increasing unit prices (US$ 373–2,250/MT), have declined in volume since 2015 due to supply constraints and rising competition from synthetic and flake graphite. Quartz emerges as the most stable performer, with consistent growth in both export volume and value, supporting electronics and solar industries. Mica exports peaked in 2014 but declined sharply, though recent increases in mica powder exports highlight niche potential. Mineral sand displayed volatility: titanium concentrates surged to 87.4 KMT in 2021 and collapsed in 2023 to 2.4 KMT, while zirconium concentrates recorded a strong recovery in 2023. RCA analysis confirms Sri Lanka's strong comparative advantage in graphite and quartz, moderate advantage in mica, and mixed performance in mineral sands. The findings suggest that while value-added processing has improved long-term competitiveness, Sri Lanka must balance policy restrictions on raw exports with market realities. Modernization of mining technologies, strengthening value chains, and flexible export strategies are recommended to sustain growth and enhance global competitiveness.

Keywords: Export mineral, HS code, RCA Analysis, UN Comtrade, Value Addition

1 Introduction

Sri Lanka's mineral exports generate nearly US$500 million annually [1]. While global demand rises, systematic evaluations of Sri Lanka's competitiveness remain limited. This study fills that gap by analyzing 2000–2023 trade data from UN Comtrade/WITS, assessing export volumes, unit values, and revenues alongside Revealed Comparative Advantage (RCA) measures. Findings provide insights into Sri Lanka's competitive position and guide policies on value addition, modernization, and sustainable mineral resource management.

2 Methodology

This study is a quantitative analysis based entirely on secondary trade & Quantity data. All data were obtained from reputable public databases and cross-checked against national sources (Geological Survey & Mines Bureau, GSMB) where possible.

2.1. Data Sources

The United Nations (UN) Comtrade database [2] and the World Bank's WITS platform [3] were used to retrieve Sri Lankan export data. Detailed Commodity level trade statistics were provided by these databases using Harmonized System (HS) and standard international trade classification (SITC) coding. Contextual information for the mineral commodity summaries was obtained from the USGS Mineral Yearbooks [4]. Limited national export summaries (2014-2023) were provided by GSMB and were used to validate trends.

2.2. Commodity Selection

Industrial minerals explicitly exported by Sri Lanka under primary processing were focused on. Precious gemstones and major metal ores (e.g., iron, copper) were excluded. Using the HS system, seven 6-digit codes covering four key commodities were identified:

- **Graphite:** HS 250410 - natural graphite powder or flakes and HS 250490 - other natural graphite
- **Quartz:** HS 250610 - vein quartz
- **Mica:** HS 252510 - crude mica rifted into sheets or split and HS 252520 - mica powder
- **Mineral Sands:** Ilmenite & Rutile sands - HS 261400 (Titanium ores and concentrates), Zircon sand - HS 261510 (Zirconium ores and concentrates)

Sri Lanka's major export mineral categories under the Mines and Minerals Act are covered by these codes.

2.3. Data Extraction & Processing

Export quantities and values (2000–2023) for selected HS codes were extracted from UN Comtrade and WITS in CSV format, with "world" as the trade partner. Data consistency was verified by cross-referencing both databases, prioritizing Comtrade for higher resolution.

Annual metrics included trade volume (Metric ton-MT) and value (US$), with unit values (US$/MT) calculated as price proxies. All values were inflation-adjusted to 2023 US$ using Consumer Price Index (CPI) indices.

2.4. Analysis Methods

Descriptive trend analysis: Mean, standard deviation, and long-term export trends were evaluated. Line charts with polynomial trendlines (third order) and R^2 values quantified export dynamics.

Correlation analysis: Pearson correlation coefficients were calculated between trade value and quantity to assess whether price or volume was the main driver of trade performance.

Revealed Comparative Advantage (RCA):
RCA was computed using Balassa's index:

$$\mathrm{RCA_i} = \frac{X_i^c / X_{total}^c}{X_i^w / X_{total}^w}$$

where X_i^c = Sri Lanka's exports of mineral i, X_{total}^c = Sri Lanka's total exports, X_i^w = world exports of mineral i, and X_{total}^w = world total exports. This allowed export specialization to be linked with observed price & quantity dynamics.

Limitations: Price trends may reflect global supply-demand shocks (e.g., COVID-19 disruptions, energy transition demand) beyond Sri Lanka's control. Thus, RCA and correlation were combined with descriptive analysis to minimize bias from exogenous factors.

2.5. Software

Data analysis was performed using spreadsheet tools (Excel/Google Sheets) and Python Libraries such as Matplotlib, Plotly, Seaborn, Pandas. This structured approach enabled a systematic appraisal of export patterns and market behavior were interpreted in the context of known events.

3 Results & Discussion

3.1. Overview

Sri Lanka's industrial mineral export sector displays mixed performance shaped by global demand shocks and domestic value-addition policies. High exports such as quartz, titanium & zircon concentrates experienced volatility, while low exports like graphite and mica reveal a sharper impact from regulatory changes (Figures 1–4).

A structural break occurred after the 2009 policy restricting non-value-added exports, fully enforced in 2012 [5]. This shift is visible in the collapse of crude mica and other natural graphite exports; both fell by over 70% in quantity and value by 2023. The policy objective was to promote processed forms, yet adaptation has been uneven: natural graphite(powder/flakes) stabilized at ≈2.5 kMT/year but showed rising trade value, while mica powder remained modest in scale despite recent growth. This suggests that while value-addition raised per-unit returns, it didn't fully compensate for loss of raw export volumes.

Correlation (Table 1) highlights important dynamics. For quartz, crude mica and mica powder near-perfect correlations ($r \approx 0.98$) between trade value and quantity indicate volume-driven revenues Sri Lanka's role is as a price-taker where competitiveness depends on scale. In contrast, natural graphite flakes show a negative correlation ($r = -0.198$), meaning prices rose even as volumes declined (Figures 2 & 4).

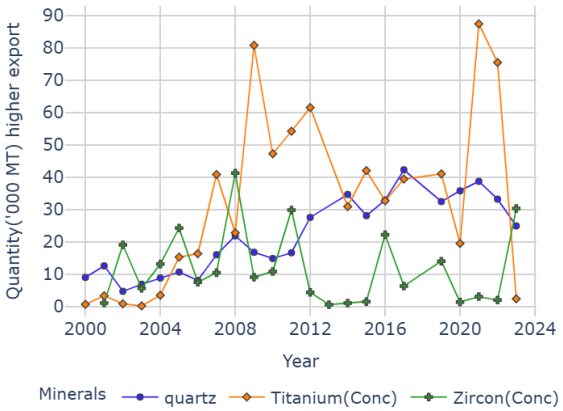

Figure 1: Quantity of Highly Export Industrial Mineral against Year

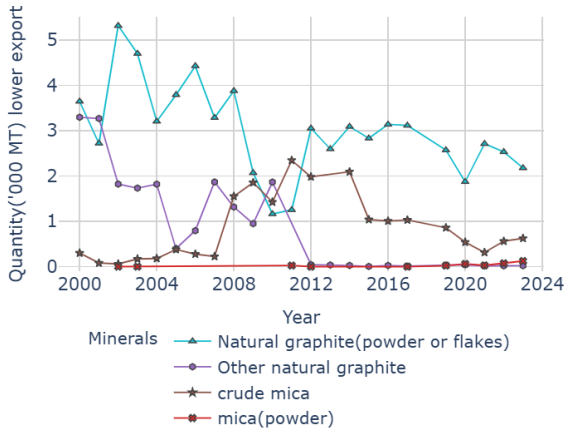

Figure 2: Quantity of Low Export Industrial Mineral against Year

This reflects global demand for high-purity graphite, where Sri Lanka benefits from quality-driven niche markets rather than volume.

High-value minerals show contrasting fortunes. Titanium concentrates recorded the most significant growth in revenue, rising from US$ 5.1M in 2009 to US$ 29.4M in 2022 (Figure 3), aligning with global demand for titanium dioxide in pigments and aerospace alloys. Zircon however, remained erratic, peaking at 30 kMT in 2023 but collapsed in earlier years, pointing to vulnerability to global supply shifts from Australia and Africa.

Overall, the overview suggests two key insights: (1) Sri Lanka's value-addition policy has succeeded in raising per-unit values but not in stabilizing volumes, and (2) competitiveness differs by mineral, graphite benefits from niche purity-driven demand, while quartz and mica rely on bulk scale exports. These findings justify integrating RCA analysis to assess where Sri Lanka genuinely holds export advantage.

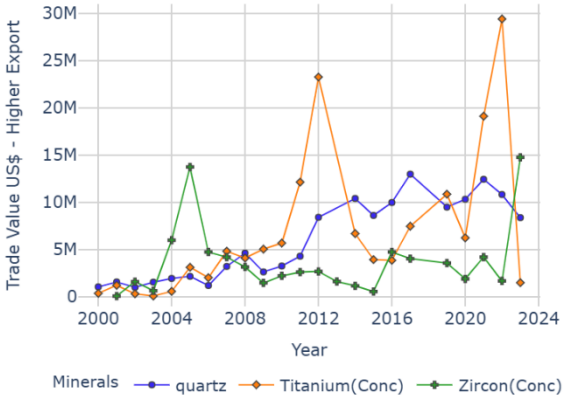

Figure 3: Trade Value of High Value Mineral Exports against Year

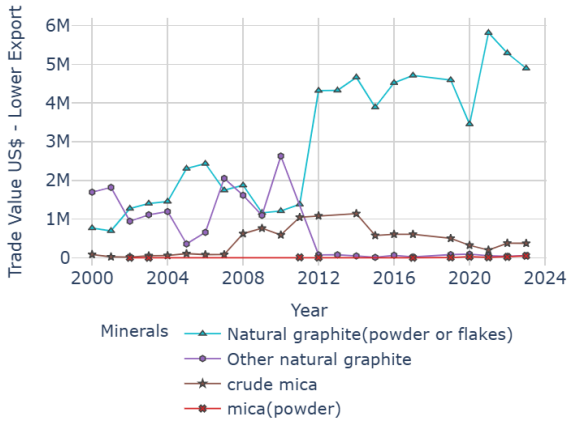

Figure 4: Trade Value of Low Value Mineral Exports against Year

Table 1: Correlation between Trade Value and Quantity for Each Mineral Product

Mineral Product	Correlation between Trade Value and Quantity
Natural Graphite powder or flakes	-0.198
Other Natural Graphite	0.867
Crude Mica	0.970
Mica Powder	0.982
Quartz	0.984
Titanium Conc.	0.774
Zircon Conc.	0.528

3.2. Graphite

Accordingly, Sri Lanka's Natural Graphite (in powder or flakes) exports reveal a divergence between export volumes and trade values. Export volumes peaked in 2002 at over 5,300 MT but have since trended downward, falling

below 3,000 MT after 2012 (Figure 2). By contrast, the inflation-adjusted unit value has steadily increased, ranging from US$ 373/MT to over US$ 2,250/MT (Figure 5). This weak negative correlation (–0.198; Table 1) highlights Sri Lanka's shift toward quality-driven niche competitiveness rather than volume.

Several external shocks explain the volatility. Civil conflict and the global financial crisis (2007–2009) curtailed mining and exports. Limited mine mechanization and reliance on just two operating mines (Kahatagaha, Bogala) constrained production, while competition from China and Brazil depressed Sri Lanka's market share. Post-war recovery and the reopening of Ragedara mine in 2011 revived output temporarily, coinciding with rising global demand for flake graphite in lubricants, electrodes, and biomedical products [6].

The post-2015 period aligns with global Electric Vehicle (EV) adoption and surging demand for battery-grade graphite. Yet Sri Lanka's volumes stagnated despite global demand quadrupling, partly due to weak investment and rising competition from Madagascar, which captured the market for high-purity flake graphite [7]. This underlines a missed opportunity: although Sri Lanka's vein graphite is uniquely high in purity, exports remain small-scale and under-optimized for battery markets.

Thus, Natural Graphite (in powder or flakes) represents a paradox for Sri Lanka: strong per-unit values and global relevance (especially in EV batteries and graphene applications), but declining competitiveness in volume terms. Unlocking value requires targeted investment in mine expansion, mechanization, and refining into Active Anode Material (AAM) to capture high-growth battery markets [8].

In other hand, Other natural graphite products, excluding powder and flake varieties, have vanished in 2012 onwards by the 2009 policy over the years (Figure 2). The strong positive correlation between trade value and quantity (0.867) (Table 1) indicates that higher export volumes drove higher trade values, particularly in the early 2000s.

Despite the rise in demand for high purity graphite, the vein graphite produced in Sri Lanka is still predominantly used in the production of carbon brushes, brake linings, and lubricants [9] with an average price of US$ 2500/MT whereas battery Active Anode Material (AAM) graphite sells at an average price of about US$ 4000 - 6000/MT for crystalline flake (95% TGC) and US$ 6000- 10000/MT for synthetic graphite [10]. For a potential revival, leveraging Sri Lanka's unique high-quality vein graphite, as noted in industry reports, could align with growing demand in battery applications.

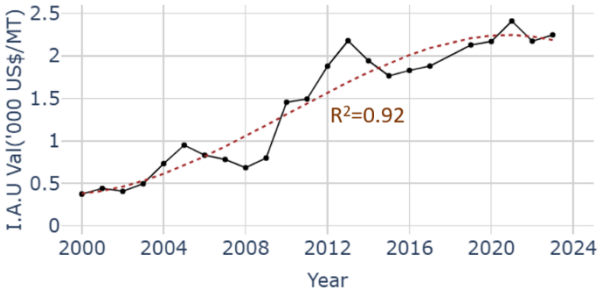

Figure 5: Inflation Adjusted Unit Value (I.A.U. Val) against year for Natural Graphite in Powder or in Flakes

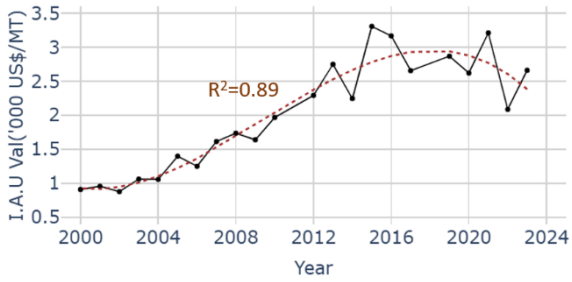

Figure 6: Inflation Adjusted Unit Value against year for Other Natural Graphite

3.3. Quartz

Quartz exports grew steadily from 9 kMT in 2000 to 42 kMT in 2017, with trade values rising from US$ 1.06M to nearly US$ 13M (Figure 1 and Figure 3). Since then, volumes fluctuated but remained significantly above early-2000s levels, showing sustained global demand. The inflation-adjusted unit value averaged US$ 327/MT, within a narrow band (US$ 207–405/MT), confirming price stability (Figure 7). The strong correlation (r = 0.984) between value and quantity indicates Sri Lanka's revenues depend on export scale rather than premium pricing.

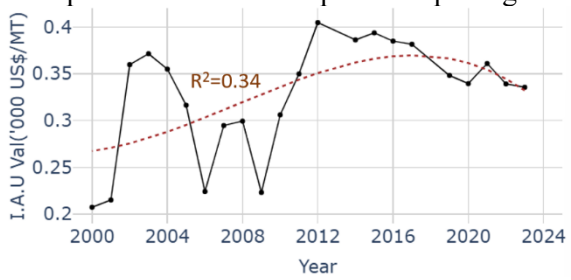

Figure 7: Inflation Adjusted Unit Value against year for Quartz

This stability reflects quartz's role as a bulk commodity for high-tech industries. Global solar and semiconductor expansion in the 2010s boosted demand, especially in Asia (China, Taiwan, India), which rely on high-purity quartz for oscillators, filters, and photovoltaic cells [11]. Sri Lanka, though a minor exporter by volume, benefits from its high-purity vein quartz, positioning it as a niche supplier to electronics and solar markets.

The post-2020 decline (to ≈25 kMT in 2023) likely reflects both global oversupply and Sri Lanka's internal constraints logistical disruptions from the 2022 economic crisis, limited investment in quartz processing, and competition from Brazil and India. Thus, while quartz has demonstrated steady long-term growth, future competitiveness depends on scaling processing capacity to move beyond raw export.

3.4. Mica

Mica exports peaked during 2011–2014, with crude mica earning over US$ 1.1M and volumes above 2 kMT (Figure 2 and Figure 4). Since 2015, exports collapsed by over 70%, falling to just 0.3 kMT and US$ 0.2M in 2021. This decline aligns with Sri Lanka's 2009–2012 policy restricting non-value-added exports, as well as rising global substitution by synthetic mica in electronics and cosmetics.

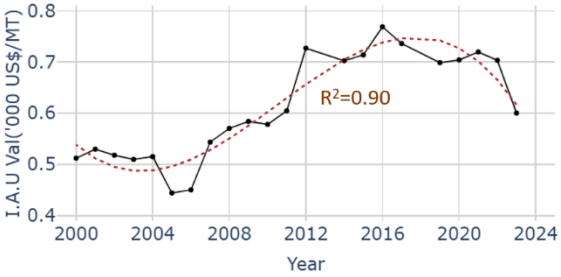

Figure 8: Inflation Adjusted Unit Value against year for Crude Mica and Mica Rifted into Sheets or Split

Figure 9: Inflation Adjusted Unit Value against year for Mica Powder

Crude mica's unit prices remained stable (≈US$ 700/MT) after 2012 with the strong correlation (r = 0.970) between volume and value, showing it is volume-driven and lacks premium potential (Figure 8). By contrast, mica powder though sporadic and small in volumes showed recent growth, reaching its highest value in 2023. Its correlation (r = 0.982) indicates volume is again the main driver, but higher unit values suggest scope for value-added applications in cosmetics and coatings.

Globally, India and China dominate mica production. Sri Lanka's high-quality phlogopite mica has niche appeal but is constrained by low production scale and substitution pressure. For competitiveness, Sri Lanka must pivot toward processed mica powder and specialized applications, rather than attempting to revive bulk crude mica exports.

3.5. Mineral Sands

Sri Lanka's mineral sands exports show extreme volatility. Titanium concentrates surged to US$ 29.4M in 2022 (75 kMT) but collapsed by over 90% in 2023 (to US$ 1.5M, 2.4 kMT) (Figures 1 and Figure 3). Inflation-adjusted unit values fluctuated widely (US$ 88–915/MT; mean US$ 356/MT), reflecting ore quality variation and unstable demand (Figure 10). The moderate correlation (r = 0.774) confirms volume plays a role, but not consistently. This volatility reflects global pigment and aerospace demand cycles, coupled with Sri Lanka's small production base vulnerable to shocks.

Figure 10: Inflation Adjusted Unit Value against year for Titanium Ores and Concentrates

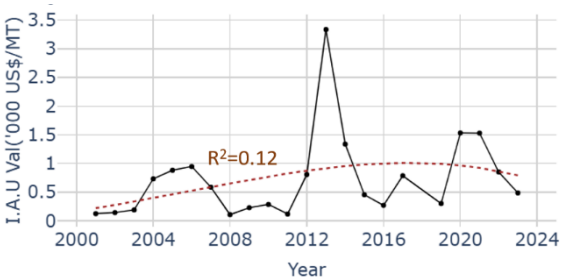

Figure 11: Inflation Adjusted Unit Value against year for Zirconium Ores and Concentrates

Zircon exports followed a different trajectory, with long-term fluctuations but signs of recovery in 2022–2023. The average unit value (US$ 605/MT) and one-off spike in 2013 (>US$ 3,300/MT) point to niche but unstable demand (Figure 11). Zircon's use in ceramics and refractories links it to construction cycles in Asia, explaining periodic booms.

Overall, Sri Lanka's mineral sands exports are constrained by scale, ore quality, and competition from Australia and Africa. Titanium's collapse post-2022 shows vulnerability to market shifts, while zircon's resilience suggests niche potential [12]. Competitiveness depends on upgrading processing and improving supply reliability, as raw export volatility undermines long-term revenue stability.

4 Revealed Comparative Advantage Analysis

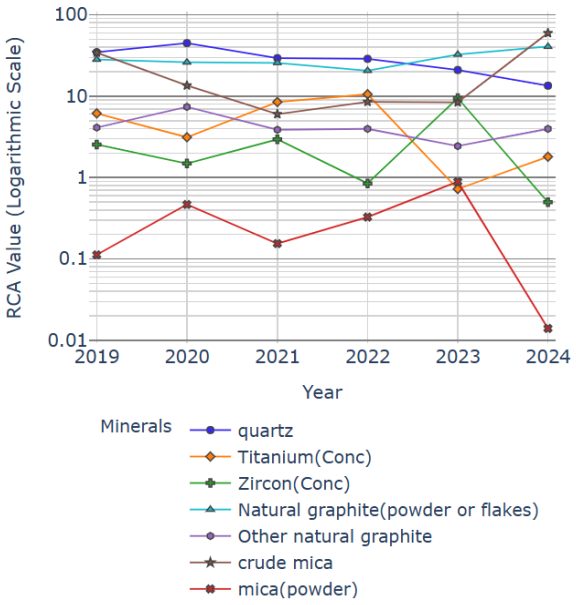

Figure 12: RCA Values by HS Code against year

Revealed Comparative Advantage (RCA) is used to measure whether a country is more specialized in exporting a particular product relative to world trade patterns. Values above 1 indicate a comparative advantage, while values below 1 signal a comparative disadvantage. RCA therefore provides a lens to interpret Sri Lanka's mineral trade performance beyond raw price and quantity trends. (Figure 12).

Natural Graphite (powder/flakes) consistently record RCA values above 10 (Figure 12), highlighting Sri Lanka's strong niche specialization. This strengthens the earlier finding (Section 3.2) that even as export quantities declined, rising unit values reflected real competitiveness rather than temporary price spikes. Other natural graphite products also maintain RCA ≈ 5 (Figure 12), though they are more volatile. Together, these results underscore graphite as Sri Lanka's clearest comparative strength and confirms that Sri Lanka's vein graphite maintains a global market edge, particularly for high purity uses such as batteries and graphene derivatives, despite emerging competition from Madagascar and China.

Quartz also demonstrates RCA values consistently above 10 (Figure 12), confirming Sri Lanka's unique advantage in exporting high-purity vein quartz. As shown in Figure 1, export volumes peaked in 2017 before moderating, but RCA confirms the country still occupies a specialized position in global supply chains for electronics and solar industries. Importantly, the near stable unit prices (US$ ≈350/MT) combined with high RCA indicate that quartz competitiveness is based on quality niche specialization rather than cost leadership. However, the gradual RCA decline since 2020 may reflect domestic production and logistics constraints, highlighting the need for sustained investment.

About Mica products, crude mica shows RCA values near and above 10 (Figure 12), confirming Sri Lanka's strong global position but Section 3.4 showed that exports collapsed after 2014, and RCA validates this as structural uncompetitiveness rather than temporary market fluctuation. Mica powder performs even worse, with RCA near or below 0.1 in most years (Figure 12). This indicates an almost negligible role in global trade, the RCA shows these gains lacked meaningful competitiveness. Together, mica products confirm that Sri Lanka cannot rely on this sector for sustained export strength.

Mineral sands display volatile RCA dynamics. Titanium concentrates occasionally reach RCA ≈10 (e.g., 2021–22) (Figure 12), aligning with the temporary export surges noted in Section 3.5. However, the collapse in 2023 pushed RCA well below 1 then rebuilt immediately in next year, showing that Sri Lanka's titanium exports remain opportunistic and highly exposed to global demand swings. Zircon, by contrast, maintains RCA values closer to 1 and reached up to 10 (Figure 12), suggesting a marginal but unstable competitiveness. The drastic RCA drop ≈10 to ≈0.5 in 2023–24 contrasts with titanium's uptrend, hinting that Sri Lanka's mineral sands

portfolio is reorienting toward ilmenite/rutile rather than zircon. However, the overall trend shows that mineral sands lack the structural competitiveness observed in graphite and quartz but still competitive.

Thus, RCA analysis not only confirms earlier price/quantity findings but also explains why Sri Lanka must prioritize graphite and quartz for future value-added strategies while recognizing mica and mineral sands as structurally weaker sectors.

5 Conclusions

This study demonstrates that Sri Lanka's mineral export sector is economically important but unevenly competitive across its main commodities such as graphite, quartz, mica, and mineral sands.

Graphite shows the clearest long-term strength. Natural graphite (flakes and powder) achieved sustained comparative advantage, with rising trade values despite declining quantities. This indicates that Sri Lanka competes on the quality and purity of vein graphite, relevant for advanced uses such as lithium-ion batteries and graphene derivatives. However, competition from synthetic graphite and emerging producers like Madagascar underscores the need for investment in battery-grade processing and technology upgrades.

Quartz maintains stable prices and strong revealed comparative advantage, confirming its role as a niche export for electronics and solar industries. Yet, post-2017 fluctuations suggest exposure to domestic constraints production bottlenecks, logistics challenges during the 2022 crisis, and rising competition from India and Brazil. To retain competitiveness, Sri Lanka must sustain processing capacity, purity certification, and integration into high-tech supply chains.

Mica has become structurally weaker. Crude mica exports peaked in 2011–2014 but collapsed thereafter, and mica powder remains negligible in global trade. Despite modest recent growth, RCA results confirm that Sri Lanka's mica cannot sustain long-term competitiveness against synthetic substitutes and large-scale Indian and Chinese producers. The sector's future contribution is therefore limited to small, specialized markets rather than bulk exports.

Mineral sands (titanium and zircon) remain volatile. Titanium ores recorded export booms in 2021–22 but collapsed in 2023, highlighting opportunistic rather than structural competitiveness. Zircon shows slightly steadier demand but only marginal comparative advantage. These dynamics imply that mineral sands cannot form the backbone of Sri Lanka's export strategy but could provide short-term windfalls if managed with flexible policies.

From a policy perspective, Sri Lanka's push for value addition has clearly reshaped the industry, prioritizing processed, higher-margin exports over raw material shipments. While this has boosted long-term profitability especially in graphite and titanium, it has also created tensions where global buyers still demand raw inputs, such as crude mica. A rigid ban risks leaving value unrealized, while unregulated raw exports undermine the shift to higher-value processing. A balanced approach is therefore required:

- Tighten value-addition enforcement for strategic commodities like graphite and titanium.
- Allow conditional or quota-based raw exports in weaker sectors (e.g., mica), to capture short-term demand while incentivizing processors.
- Support small-scale processors with subsidies or credit access to ease compliance and improve competitiveness.

Looking ahead, Sri Lanka's mineral sector faces both opportunities and risks. Global demand for battery-grade graphite and high-purity quartz is expected to expand, driven by clean energy and semiconductor growth, presenting clear niches for Sri Lanka. At the same time, structural weaknesses outdated mining technology, economic instability, and limited downstream industries could erode these advantages. To ensure sustainable growth, Sri Lanka must modernize operations, strengthen quality certification, and align export strategies with global clean-tech value chains.

In conclusion, Sri Lanka's mineral exports will remain relevant if policy makers adopt smart, adaptive strategies: prioritize value-added graphite and quartz, treat mineral sands as opportunistic exports, and manage mica as a declining niche. Success depends not only on enforcing bans but also on balancing regulation with market flexibility, enabling Sri Lanka to

leverage its unique high-purity resources for long-term competitiveness in global mineral markets.

Acknowledgements

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