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The Situation of Titanium Sector in Vietnam

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ABSTRACT: Titanium is a metallic element that plays a role in several key industries, including automotive, aerospace, defense, and medicine. Due to its strategic significance, policymakers around the world have continuously developed and implemented policies aimed at owing titanium-related technologies. Vietnam possesses substantial titanium reserves; however, limitations in extraction and processing technologies have led to the production of low-grade products. This study presents an overview of titanium resources in Vietnam, existing processing technologies, and relevant management challenges. These insights provide a foundation for formulating more effective strategies for technological advancement and sustainable resource management in the titanium sector.

KEYWORDS: Mineral management, titanium processing, Vietnam, ilmenite, beach sand tailing.

I. INTRODUCTION

Titanium is widely recognized as an element with diverse applications, distinguished by its low density, high heat resistance, corrosion resistance, and excellent biocompatibility [1]. In 2024, the global production of titanium-bearing minerals was approximately 9.35 million tonnes, with ilmenite accounting for around 90% of thetotal. China was the largest producer, contributingan estimated 3.3 million tonnes, followed by Mozambique with about 1.9 million tonnes. However, a major concern is the geopolitical and economic in stability in several countries that are key producers of titanium resources [2].

Vietnam, located in Southeast Asia, has a total land area of 331,690 km^2. The country possesses a diverse range of mineral resources, including petroleum, coal, ironore, apatite, titanium, and rare earth elements [3]. The mining sector plays a vital role in supporting key domestic industries such as cement production, metallurgy, thermal power generation, and petroleum processing, contributing approximately 2.48% to the national GDP in 2023 [4]. In 2022, Vietnam attracted 108 FDI-funded projects related to the mineral industry, with a total investment of 19.7 million dollars. This article provides an overview of key issues concerning the management, exploitation, and trade (import/export) of mineral resources in Vietnam, with a particular focus on titanium minerals..

II. OVERVIEW OF TITANIUM SOURCES AND PROCESSING INVIETNAM

Titanium deposits in Vietnam are found in two primary forms: titanium-bearing ores and beach sand tailings. The estimated reserves of titanium- bearing ores amount to approximately 22.2 million tonnes and are distributed across various regions of the country. In contrast, the majority of the remaining titanium resources occur as beach sand tailings, with the largest concentration located along the coastal area of Lam Dong Province, estimated at around600milliontonnes(**Figure1**).The titanium-bearing ores with potential for extraction include ilmenite, rutile, zircon, and monazite [5]. Among these, ilmenite has the largest reserve—approximately4.8milliontonnes—butitsextraction is technically challenging due to complex geological and environmental conditions [6].

Beside titanium-bearing ores, beach sand tailings represent the most abundant source of titanium in Vietnam. Analytical results indicate that

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these beach sand tailings contain a total mineral content of approximately 0.791%, comprising mainly ilmenite (0.701%), followed by zircon (0.055%), rutile(0.007%), anatase(0.011%), leucoxene (0.016%), and monazite (0.001%) [7]. After mineral processing, ilmenite extracted from these sources typically contains 48–56% TiO_2, 16–23% Fe_2O_3, 13–21% FeO, along with minor quantities of other metal oxides [8]. This composition highlights a significant environmental concern associated with the recovery of ilmenite from beach sand tailings, due to the low mineral content and large volume of processed material required.

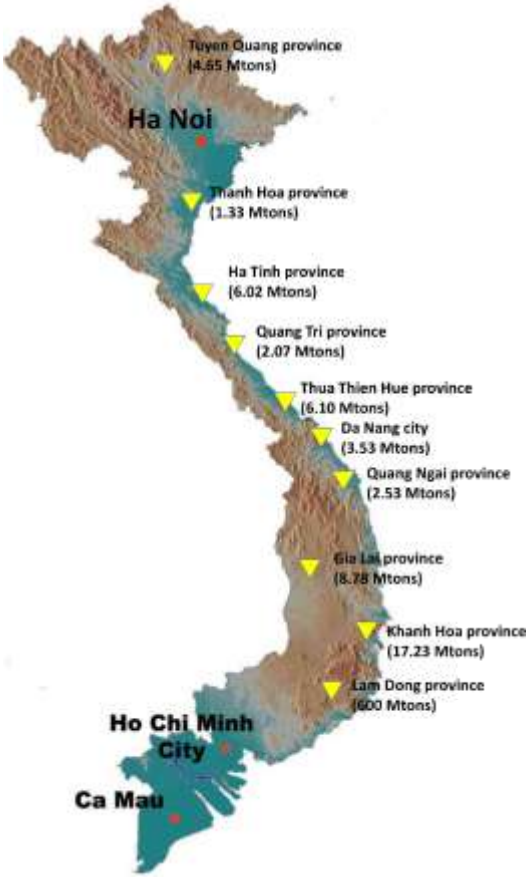

Figure1.Reserves of titanium ores in Vietnam (Topographic map from [9], data from [5])

In Vietnam, hydraulic separation technique is currently employed to recover ilmenite from beach sand tailings. This gravity-based separation method offers several advantages, including simple equipment, ease of operation, and economic feasibility [10]. As a result, it is widely used as a preliminary beneficiation step for various types of ores. However, this technique also presents several limitations, such as low efficiency in processing fine particles, generation of waste streams, and moderate separation performance [11]. Despite these drawbacks, the production of ilmenite concentrate from beach sand tailings remains a widely accepted option among companies in Vietnam due to its relatively low initial investment cost.

In the context of advanced titanium ore processing, impurities in ilmenite—primarily iron oxides—must be removed to obtain high-grade concentrates. Various methods are available to upgrade ilmenite, including acid leaching, selective chlorination, carbothermal reduction, alkaline leaching, the Leds process, and preliminary roasting followed by leaching [12]. Known that the ironoxide content in ilmenite typically ranges from 35–45%, ilmenite is often blended with primary iron ores as feedstock for iron smelting technologies; under such conditions, titanium dioxide separates and forms a slag known as titania slag in the blast furnace. The TiO_2 content in titania slag generally ranges from 75–80% [13]. Once titanium-bearing sources are upgraded to this level, they reach the input requirements for advanced titanium processing technologies, such as the production of $TiCl_4$ or titanium metal. Many ilmenite upgrading techniques fall under advanced

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technological categories that remain beyond Vietnam's current capabilities. Moreover, acid leaching generates a significant amount of waste. Consequently, the production of ilmenite concentrates in Vietnam is considerably lower than that of low-grade ilmenite.

III. THEIMPORT AND EXPORT STATUS OF TITANIUM PRODUCTS IN VIETNAM

The supply of domestically produced titanium products in Vietnam for internal demand is relatively low, leading to limited domestic utilization—accounting for only approximately 20% of total production, while the remaining 80% is exported. **Figure 2a** illustrates the total output of titanium products manufactured in Vietnam during the 2018–2023 period. Vietnamese titanium products are primarily exported in the form of ilmenite and ilmenite concentrates to industrialized countries (**Table 1**). As shown in **Figure 2b**, the export prices of Vietnamese titanium products experienced a significant decline between 2022 and 2023. This trend underscores the necessity of adopting improved production technologies to enhance product quality and market competitiveness.

Table 1. Vietnam's ilmenite ores and concentrates exports by year (tons) [16]

Country	Year			
	2020	2021	2022	2023
China	18.279	19.965	10.715	4.730
Turkey	1.915	2.858	2.314	462
India	-	26	69	10
Japan	-	0.6	18	5
Korea	630	1.986	-	-
Russian Federation	-	673	-	-

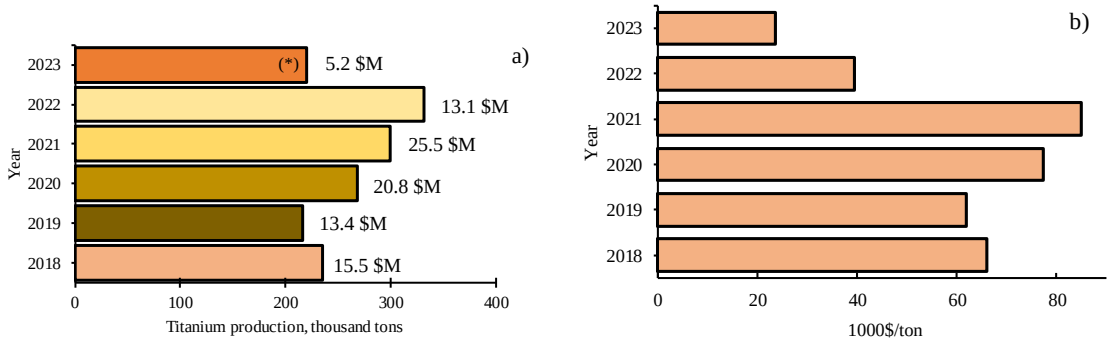

Figure 2. The status in Vietnam by year of a) the production of titanium commodities [14] (* data from [15]) and b) the mean price of titanium products [14]

Due to the lack of owning in advanced titanium ore processing technologies, the volume of titanium ores and concentrates imported into Vietnam remains negligible—approximately 2.8 thousand tonnes in 2023 [17]. However, Vietnam imports a significant quantity of titanium-based products, particularly TiO_2 pigment (with a growth annual rate, GAR, of 1.96%/year) and titanium metals and alloys (GAR = 10.4%/year) [18]. In2023, Vietnam imported approximately 193.1 million dollars worth of titanium metal and titanium-related products, primarily from China and the United States [19].

IV. TITANIUM MANAGEMENT IN VIETNAM

As a strategic mineral, titanium-bearing ores serve as an important source of raw materials for several nationally significant industries, including aerospace, defense, medicine, and automotive manufacturing [1]. Due to its strategic importance, industrialized countries rarely transfer advanced technologies for titanium processing, such as the production of $TiCl_4$, high-grade TiO_2 pigment, titanium metal, and titanium alloys. Instead, technology transfer is generally limited to mining and primary beneficiation stages. In Vietnam, advanced processing technologies for titanium have only been developed at the

laboratory or pilot scales. As a result, the development of a comprehensive titanium industry in Vietnam poses a significant challenge for both policymakers and the scientific community.

On September 3, 2013, the Prime Minister of Vietnam issued Decision No. 1546/QĐ-TTg [20], establishing a legal foundation for the development of the titanium industry. This decision reflects a strategic vision of owning titanium-related technologies across the entire value chain—including exploration, zoning, mining, and advanced processing—to meet both domestic demand and export goals. By 2030, Vietnam is expected to focus on advancing technologies for the production of TiO_2 pigments, titanium sponge, and titanium metal and alloys.

Subsequently, on July 18, 2023, the Prime Minister issued Decision No. 866/QĐ-TTg [21], approving the Master Plan for the exploration, mining, processing, and utilization of minerals for the period 2021–2030, with a vision to 2050. According to this decision, Vietnam's titanium reserves are sufficiently abundant to support the development of an integrated industrial complex for titanium extraction and processing, thereby reinforcing the country's potential to establish a robust titanium industry.

To implement this strategic vision, the Prime Minister issued Decision No. 333/QĐ-TTg [22] on April 23, 2024, which outlines the Implementation Plan for the aforementioned Master Plan. In this framework, the processing of titanium ores is expected to achieve the production of TiO_2 pigment during the 2021–2030 period, and to advance to the production of titanium sponge and titanium metal during the 2030–2050 period.

Recognized as the province with the largest titanium reserves in Vietnam, Binh Thuan (now part of Lam Dong Province) has been designated by the Prime Minister for the implementation of titanium mineral exploitation in conjunction with the construction of advanced processing facilities. This directive was formalized through Decision No. 1701/QĐ-TTg [23] dated December 27, 2023.

Although the development of advanced titanium processing technologies has been emphasized in various legal and policy documents in Vietnam, the current status indicates that titanium processing activities remain limited to ore seperation, preliminary treatment, and the production of titania slag [24], [25]. In 2019, there were six operational titanium mineral processing plants in the country; however, due to unfavorable operating conditions, only two facilities remained in operation by 2024 [26].

Vietnam recently enacted the Law on Geology and Mineral, No. 54/2024/QH15[27], on November 29, 2024, which will come into effect on July 1, 2025. The law comprises 12 chapters and 111 articles, governing geological investigation, mineral exploration, recovery, processing, protection of unexploited geological resources and minerals, general policies, and national strategies. To support the implementation of this law, Decree No. 193/2025/NĐ-CP [28]was issued on July 2, 2025, providing detailed guidance on several provisions and enforcement measures. Under this legal framework, titanium mineral are classified as Group I, which are subject to planned management and exploitation in accordance with the national mineral strategy.

CONCLUSION

Titanium resources in Vietnam are unevenly distributed, with the majority concentrated in Lam Dong Province in the form of beach sand tailings. Due to limitations in titanium processing technologies, Vietnam primarily exports ilmenite ores and concentrates; but, Vietnam imports a considerable volume of high-grade titanium products, such as TiO_2 pigments and titanium alloys. To address this imbalance, the Vietnamese government has issued several decisions aimed at improving extraction and processing technologies, with the goal of owing titanium-related technologies. Current policies and strategies future require evaluation and adjustment to better align with practical conditions and to resolve internal challenges and constraints within the titanium sector.

Declaration of generative AI in scientific writing

The manuscript was originally drafted by the authors themselves. All information and data presented in the article were obtained from referenced sources and were not generated by AI. However, ChatGPT was used to improve the fluency and readability of the text, and all content was subsequently verified by the authors. The authors bear full responsibility for the accuracy and reliability of the data presented; these are not attributed to AI tools.

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