

## Current Situation of Stone Mining for Construction Materials in an Giang Province

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**ABSTRACT :** An Giang is one of the provinces in the Mekong Delta. The Seven Mountains rise in the midst of vast land with an area of 43,000 ha. This is the source of abundant construction materials for the province, exploration reserves reached 80,810,587 m<sup>3</sup>. In the past few years, the exploitation and processing of stone for building materials has been strongly developed, the industry and construction has increased from 11.12% in 2010 to 12.61% in 2015. This is the advantage of the province and meets the increasing demand of building materials market. Currently, in the province, five enterprises are licensed to exploit rock in the areas of Mount Ba Doi, Mount Co To and Mount Giai with a total reserve of 76,494,087 m<sup>3</sup>, with the mining life from 10 to 30 years. However, the quarries are exploited by the open pit mining system by steep grade, cutting layer by blasting technology. The process of quarrying causes heavy pollution to the environment, disrupting the ecological balance, affecting the health and safety of workers, wasting resources...

**KEYWORDS:** Stone exploitation, Building materials, Environmental impact

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### I. INTRODUCTION

An Giang is one of the provinces in the Mekong Delta with advantages in mineral resources, especially minerals as building materials. Mining has been carried out since before 1975 in Sam mountain area, then flourished in mountainous areas of Tinh Bien, Tri Ton and Thoai Son districts. The province has the advantage of That Son mountain (Seven Mountains) range emerging from the vast land on an area of 43,000 hectares, this area is an abundant source of stone for construction materials for An Giang province. Currently, construction stone is quarried in 04 main areas: Giai Lon (andezite), Ta Pa (sandstone), South Co To (graniteoid) and Ba Doi (granite) (Fig.1).

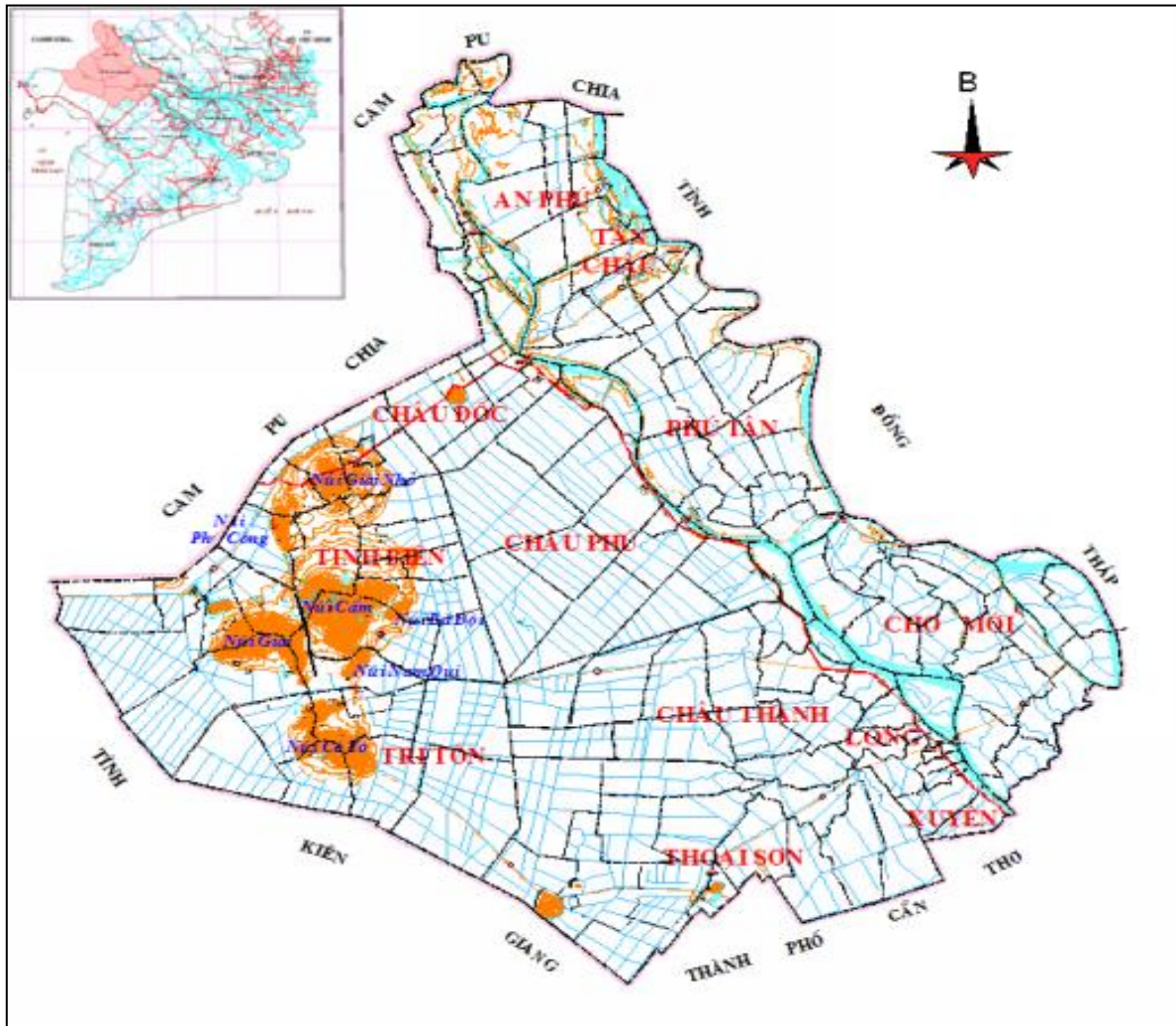


Fig.1. Site map of the study area

## II. RESEARCH METHOD

Collect geological exploration documents, mineral exploitation documents of mining units in the area.

Sampling work:

The petrographic sample: Samples were taken with a size of 3x6x9 cm, evenly distributed over the study area and by depth. Total number of samples: 20 samples; petrographic analysis of 10 samples, in which background photos of petrographic structures were taken: 10 samples.

Semi-quantitative spectral sample: Collected in the form of lumps at the exploration works, in order to evaluate the percentage by mass of trace elements to detect the possibility of containing rare elements. Total number of samples: 10 samples.

Silicate chemistry sample: Samples are taken in the form of lumps or spots, evenly distributed over the exploration area and rocks, usually taken at the same location as the mechanical sample. This type of sample is intended to determine the chemical composition of rocks, especially the possibility of containing harmful components such as  $SO_3$ . Total number of samples: 10 samples; requires analysis of 14 indicators:  $SiO_2$ ,  $TiO_2$ ,  $Al_2O_3$ ,  $Fe_2O_3$ ,  $FeO$ ,  $MnO$ ,  $MgO$ ,  $CaO$ ,  $Na_2O$ ,  $K_2O$ ,  $P_2O_5$ , LOI (Loss on ignition),  $SO_3$ ,  $H_2O$ .

Mechanical sample: Samples are taken from research works; Total number of samples: 10 samples. Requirements to analyze the following criteria: specific gravity, density, water absorption, natural compression resistance, saturated compression resistance, porosity, water absorption, softening coefficient, internal friction angle, cohesion force.

All samples were sent for processing and analysis at the Center for Analysis and Experimentation, South Vietnam Geological Mapping Division.

### III. RESEARCH RESULTS

#### 3.1. Geological features of construction stone in An Giang

Building stone has been discovered at 14 sites, including 3 types: granitoid intrusive rock (Deo Ca complex, Dinh Quan complex), andesite eruption rock (Xa Lon formation) and sedimentary rock (Ta Pa formation) (Duong Van Cau et al., 2016).

##### Granitoid construction stone:

Granite building stones were discovered at 7 points at Ba Doi mountain, Co To mountain, Ba The mountain, Sap mountain, Ro mountain, Sam mountain and Num Song mountain. A typical example for this type of granite is the Ba Doi mountain quarry.

Ba Doi mountain quarry is located in Tan Loi and An Hao communes, Tinh Bien district. The mine was explored in 1998 and put into operation until now. The mineral body is biotite hornblen granodiorite (phase 1) and biotite granite (phase 2) of the Deo Ca complex. Capping thickness is 0.0 - 12.5 m; average: 2.4 m. In the mineral body developed many cracks, divided into small sharp blocks, volume from 0.2 - 1.8 m<sup>3</sup>. The quality characteristics of Ba Doi mountain construction stone are as follows:

*Biotite hornblen granodiorite* has the main mineral composition of mediosilicic plagioclase (andesin), potassium feldspar (orthoclas), quartz, green amphibol (hornblen), biotite; Secondary minerals include sphe, apatite, magnetite ore (few small particles). Chemical composition (%): SiO<sub>2</sub> = 62 ÷ 65; Na<sub>2</sub>O = 4.44; K<sub>2</sub>O = 3.05; SO<sub>3</sub> = 0. The results of mechanical and physical analysis show that granodiorite has high mechanical strength: natural density: 2.7 ÷ 2.73 g/cm<sup>3</sup>; density: 2.73 ÷ 2.76 g/cm<sup>3</sup>, porosity: 0.18 ÷ 0.25%; water absorption: 0.17 ÷ 0.35%; dry compressive strength: 1090 ÷ 1920 kg/cm<sup>2</sup>; saturated compressive strength: 980 ÷ 1870 kg/cm<sup>2</sup>; flat coefficient: 12%.

*Biotite granite* has the main mineral compositions: potassium feldspar, plagioclase, quartz, and biotite. Chemical composition (%): SiO<sub>2</sub> = 72.34 ÷ 74.10; Na<sub>2</sub>O = 3.42 ÷ 4.06; K<sub>2</sub>O = 4.45 ÷ 4.73. The results of the physical and mechanical analysis of the samples showed that granite has high mechanical strength: natural density: 2.56 ÷ 2.71 g/cm<sup>3</sup>; density: 2.62 ÷ 2.81 g/cm<sup>3</sup>, porosity: 0.07 ÷ 7.5%; water absorption: 0.2 ÷ 0.4%; dry compressive strength: 1010 ÷ 2653 kg/cm<sup>2</sup>; dry compressive strength: 950 ÷ 2265 kg/cm<sup>2</sup>; flat coefficient: 7.1 - 10.0%.

The results of construction stone exploration have determined that the granite formations in Ba Doi mountain area have physical and chemical properties that meet the standards for building stone with the total reserves approved in 1998: Grade C1 + C2 (122 + 222) = 11,536,157 m<sup>3</sup>.

##### Construction stone andesite, felsite:

Andesite construction stone (Xa Lon Formation) has been discovered at 4 points at: Northeast of Gai Lon mountain, Dong An Loi, Southeast of Gai Lon mountain and Phu Cuong mountain. Typical for construction stone of this type is the Southeastern mine of Gai Lon mountain.

The andesite quarry in the Southeast of Gai Lon mountain is located in Chau Lang commune, Tri Ton district. Mine area is 70 ha. In 2005, An Giang Construction Materials Stone Mining and Processing Joint Venture Company (Antraco) conducted exploration to upgrade construction stone reserves in the deep part of the above-mentioned area. Mineral bodies are erupting rock formations of the Xa Lon Formation.

The petrographic composition of the erupting rock at the Southeast mine of Gai Lon mountain includes andezite, andezite porphyrite, tuf andezite, tuf sandstone..., in which tuf andezite and andezite dominate. The rock is blue-gray to dark gray, sometimes purple, reddish, strongly modified, usually chloritized, epidotized, zoizitized, carbonated. The rock is compressed, so it is very solid, with many calcite vessels through the cut. The rock has a micro-phanerocryst and granular architecture, mass and flow structure. Micro-phanerocrysts account for 12 to 16%, background accounts for 84 to 88%.

*Chemical composition:* average content of oxides, through the results of silicate analysis of andezite and tuf andezite rocks as shown in Table 1.

**Table 1. Chemical composition of andesite rock of Gai Lon mountain**

SiO <sub>2</sub>	TiO <sub>2</sub>	Al <sub>2</sub> O <sub>3</sub>	Fe <sub>2</sub> O <sub>3</sub>	FeO	MnO	MgO	CaO	Na <sub>2</sub> O	K <sub>2</sub> O
50,57	0.77	15,31	3.61	6.07	.12	3,84	6.72	2,85	6,95

In which SO<sub>3</sub> is not present, so it does not affect the quality of construction stone.

*Physical and mechanical properties of rock:* The results of analysis of 27 simple physical and mechanical samples show that andezite, tuf andezite have average indexes as shown in Table 2.

**Table 2. Physical and mechanical properties of andezite in Gai Lon mountain**

Dry density (g/cm <sup>3</sup> )	2.688
Saturation (g/cm <sup>3</sup> )	2.697
Specific gravity (g/cm <sup>3</sup> )	2.71
Empty coefficient, e	0.008
Porosity, n (%)	0.78
Water absorption, W (%)	0.33
Compressive strength (kg/cm <sup>2</sup> ), dried	1,306
Compressive strength (kg/cm <sup>2</sup> ), saturation	1,204
Softeners, K <sub>hm</sub>	0.921
Solid coefficient, f <sub>kc</sub>	10.9

Abrasion grinding wear: 11.4 - 11.5%. Asphalt adhesion reaches grade 4. The number of flat kernels is 17,8%. The intensity of natural radiation is low (13.1 to 13.7  $\mu$ R/h).

Exploration documents show that andezite, tuf andezite have very solid physical and mechanical properties, meeting the quality for construction stone.

*Construction stone reserves:* The 1995 exploration results calculated that the reserves of grade B + C1 (111 + 122) are 14,330,000 m<sup>3</sup> and of grade C2 (122) are 14,331,000 m<sup>3</sup>. The reserve of B + C1 + C2 (111 + 122) is 28,650,000 m<sup>3</sup>.

After 10 years of exploitation, on average, 300,000 m<sup>3</sup> can be exploited each year, the extracted volume is 300,000,000 m<sup>3</sup>. The remaining reserves of B + C1 (111 + 122) are 11,337,000 m<sup>3</sup>. After upgrading, the current reserves of grade B + C1 (111 + 122) are respectively: 11,337,000 m<sup>3</sup> + 5,513,000 m<sup>3</sup> = 16,850,000 m<sup>3</sup>.

#### **Sandstone construction stone:**

Sandstone building stone (Ta Pa Formation) has been discovered at 4 points in the North of Phu Cuong mountain, Ta Pa mountain, Nam Quy mountain, and Dat mountain. Typical for this type of construction stone is the Nam Quy mountain mine. The quarry for construction of Nam Quy mountain is located in Chau Lang commune, Tri Ton district. The construction rock mineral body is sandstone formations of the Ta Pa Formation. The petrographic composition of the rock is mainly sandstone, siltstone. The chemical composition of the sandstone of the Ta Pa Formation is shown in Table 3.

**Table 3. Chemical composition of sandstone of Nam Quy and Van Lanh mountains (%)**

Mine	SiO <sub>2</sub>	TiO <sub>2</sub>	Al <sub>2</sub> O <sub>3</sub>	Fe <sub>2</sub> O <sub>3</sub>	FeO	MgO	CaO	Na <sub>2</sub> O + K <sub>2</sub> O	SiO <sub>3</sub>
Van Lanh	61.3	0.77	17.95	0.48	4.43	-	-	8.54	0.51
Nam Quy	74.98	0.15	17.22	2.44	0.92	0.25	0.12	-	-

*Physical properties:* density: 2.69÷2.86 g/cm<sup>3</sup>; porosity: 1.43÷2.6%; water absorption: 0.17÷0.62%; resistance to dry compression: 817÷1,466 kg/cm<sup>2</sup>; compressive strength of saturation: 800÷1,447 kg/cm<sup>2</sup>; abrasion grinding wear: 11.4÷21.1%. This type of rock can be exploited to make crushed stone for unweathered rock. Semi-weathered rocks can be used for leveling and grading roads.

Forecasted resource of grade P1 (334a) at Ta Pa mine is: 6,210,000 m<sup>3</sup>.

### **3.2. Stone mining techniques and fields of use in An Giang**

All construction quarries in An Giang are exploited open-pit by selecting a mining system that follows steep layers, cutting small floors by blasting technology. Mining techniques currently in use include quarrying for raw materials and stone processing. The stages and operating procedures of the two activities mentioned above are as follows:

*Mining activities:* including the stages of coating removal - drilling - blasting - oversized rock breaking and loading and unloading - transporting raw stone to the processing area.

*Processing activities:* raw stone is put into the dam - crushing and screening complex, the product includes crushed stone with sizes 4×6, 3×4, 1×2 and flint.

The stone mining and processing technology used in An Giang is currently also a popular mining technology in the country. Mining and processing equipment and machinery are mostly imported products [5].

In general, mining technology is still less innovative; Mining, crushing and screening equipment has low productivity, so most of the mining capacity of enterprises does not reach the designed capacity. The quality of stone after processing is not high, so it is not used in the construction of solid works requiring high quality (bridges, high-rise buildings). Currently, construction stone products mainly meet the needs of the province, serving the construction of civil engineering foundations and roads [5].



### 3.3. Status of stone mining for construction materials in An Giang province

#### *Situation of stone exploitation as construction material*

Over the past time, the production of building materials has gradually developed in the right direction, stabilized production and has affirmed its position in the economic development balance of the province. Quarrying activities have basically met the construction needs in the province, and at the same time created jobs for workers in the province.

The reserve of construction stone is summarized through the exploration and upgrading reports of enterprises. Areas of exploration areas, construction stone reserves in each area [2] are shown in Table 4.

The volume of construction stone that has been explored is: 80,810,587 m<sup>3</sup>.

**Table 4. Area of exploration quarries of construction materials in An Giang**

Unit probe (exploited)	Name of the area (mine location)	Decision on exploration license	Proposed exploration (m <sup>3</sup> )	Licensed area (ha)
An Giang Stone Exploiting and Processing Company Limited	Mount Ba Doi, Tan Loi Commune, Tinh Bien District, An Giang Province	1913/QD-DKCS 27/10/1997	11,536,157	16.00
	Mount Co To, Co To Commune, Tri Ton, An Giang (zone I)	133/QD-DKCS 01/1998, 2012	22,913,478	39.50
	Mount Co To, Co To Commune, Tri Ton, An Giang (zone II)	133/QD-DKCS 20/01/1998	6,724,000	18.00
	Mount Co To, Co To Commune, Tri Ton, An Giang (zone III)	133/QD-DKCS 20/01/1998	6,880,448	13.00
Antraco Joint Venture Company Limited	Nui Giai, Chau Lang, Tri Ton, An Giang	772/GP-KHKT 27/10/1994; 12/2005	16,850,000	70.00
622 Stone Exploitation and Processing Enterprise	Co To mountain, Co To Commune, Tri Ton, An Giang	133/QD-DKCS 20/01/1998	6,209,800	13.00
622 - Quyet Thang Stone Exploitation Enterprise	Co To mountain, Co To Commune, Tri Ton, An Giang	133/QD-DKCS 20/01/1998	2,424,648	23.00
An Giang Transportation Company	In Soc Trang, Co To Mountain belongs to Co To Commune, Tri Ton, An Giang	133/QD-DKCS 20/01/1998	1,316,500	9.5
An Giang Construction Company Limited	Nui Ba Doi, Tan Loi Commune, Tinh Bien District, An Giang Province	577/QD-UBND 21/10/2016	2,955,556	20.00
	Ta Pa Mountain, Tri Ton District, An Giang Province	430/QD-TNMT 10/04/2003	3,000,000	18.07
<b>Total:</b>			<b>80,810,587</b>	<b>240.07</b>

### 3.4. The management situation of stone mining for construction materials in An Giang province

#### *Current status of management of quarrying activities*

The management and environmental protection in stone mining activities in the province have made positive changes. The stone mining enterprises have good coordination in environmental management and protection [1].

In order to protect non-renewable resources and protect the landscape and environment of Bay Nui area, An Giang Department of Natural Resources and Environment has set up a project to rearrange stone mining activities. The project proposes solutions such as:

Termination of exploitation in cases where the mining license expires or the mine runs out of reserves.

Policy to limit stone mining in the coming time, only exploiting enough to meet the needs of the province; to close quarries to ensure safety and clean environment, and to protect non-renewable natural resources.

#### *Difficult problems in the process of mining management*

Besides the positive contributions, the management in the quarrying industry has also revealed many limitations and negatives affecting the efficiency of mining activities and the regional environment such as:

The provisions of the law on environmental protection are still lacking and inconsistent. Some procedures related to licensing of resource exploitation and quality control of construction materials between departments and branches are still overlapping and take a long time.

The investment in human resources, means and equipment for environmental protection work is still lacking and weak, the sanctions related to environmental violations are not strong enough, leading to many individuals and units repeating violations...

Because the mining areas are not concentrated and small, often in remote areas, the management of mining activities still faces many difficulties.

The current level of environmental protection fee in mineral exploitation does not meet the requirements of renovating and overcoming environmental degradation and pollution caused by mining and consumption activities.

The investment capital of enterprises is limited, exploiting by manual, semi-mechanized methods, outdated technology and low sense of law observance, so establishment owners pay little attention to environmental protection, leaving many negative consequences on the environment.

#### IV. CONCLUDE

Favored by nature, An Giang province has an abundant source of stone as construction materials with exploration reserves reaching 80,810,587 m<sup>3</sup>. There are 5 enterprises licensed to exploit stone, concentrated in the areas of Ba Doi mountain, Co To mountain, Ta Pa mountain and Giai Lon mountain with a total mining reserve of 76,494,087 m<sup>3</sup>, mining term from 10 - 30 years.

The mining and processing stages need to be modernized by enterprises to create more products with high added value, less environmental pollution and saving raw materials, in order to improve the efficiency of quarrying activities. in An Giang.

#### REFERENCES

- [1]. An Giang Provincial People's Committee (2016). Decision No. 228/QĐ-UBND dated 29/01/2016 by An Giang Provincial People's Committee promulgating the plan for socio-economic development in 2016-2020 in An Giang province.
- [2]. An Giang Provincial People's Committee (2016). Summary report of the five-year socio-economic development plan (2016-2020) of An Giang province.
- [3]. An Giang Provincial People's Committee (2010). Decision No. 2077/QĐ-UBND dated 04/11/2010 by An Giang Provincial People's Committee on the approval of the plan for exploration, exploitation and utilization of minerals in An Giang province in the period of 2008 - 2020.
- [4]. Duong Van Cau et al., 2016. Report on the adjustment and supplementation of the plan for mineral exploration, exploitation and use in An Giang province up to 2020 with orientation to 2030.
- [5]. Vietnam Union of Science and Technology Associations, 2010. Research report on the status of management, exploitation and utilization of mineral resources in Vietnam. *Workshop on Mineral Resources and Sustainable Development in Vietnam*.14/5, Hanoi.

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