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ES-243-CC01 - Earth Science

MUSEUM REPORT

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We would like to express our sincere gratitude to MSc. Dong Uyen Thanh for her guidance and support during our study at the Ho Chi Minh City Geological Museum. Through her lectures and explanations, we gained not only theoretical knowledge but also practical insights into rocks, minerals, and the broader concepts of geology. The detailed stories and real-life examples she shared helped us better understand the subject and connect classroom knowledge with real-world applications.

The experience at the museum has provided us with valuable resources for future projects and strengthened our awareness of the Earth, encouraging us to care for and protect it. In this report, we have done our best to apply the lessons and knowledge received from Ms. Thanh, along with additional reference materials. Despite our efforts, some minor errors in grammar or understanding may remain.

Once again, we sincerely thank MSc. Dong Uyen Thanh for giving us the opportunity to learn through such a meaningful and practical experience.



1 INTRODUCTION

In the distant past, meteorites of enormous size flew through the Earth's atmosphere and crashed into our planet; these collisions vaporized mineral fragments from the ground and sent them into the sky. The molten minerals floated in the air like sparkling raindrops, each one traveling thousands of kilometers before falling back to the ground. Even further back, the collision of two hot celestial bodies caused the formation of the Earth and the Moon as we know them today, with the Earth carrying a multitude of minerals within it. After millions of years buried under layers of rock, these shiny mineral fragments occasionally rose to the surface to tell of the vastness of the Earth and the immensity of time.

Geology is the study and combination of knowledge about how rocks form over thousands of years, how fascinating gemstones can be created under pressure and temperature, how minerals are formed, and also about fossils and geological heritage. The Earth was formed about 4.6 billion years ago, so there must be beautiful formations of rare rocks, or even gemstones hidden somewhere within the Earth. Therefore, learning about the theory of rocks and minerals through books will only get us halfway through the actual knowledge of Earth geology. As President Ho Chi Minh taught us: "Learning must go hand in hand with practice. It is useless to study without practice; if you don't learn, you won't be fluent."

Therefore, we went on a trip to visit the Ho Chi Minh City Geological Museum as part of a learning activity, to practice observing and understanding the geological history of Vietnam, with the formation of rocks, ores, minerals, and even gemstones.



1.1 Museum Overview and Visit Objectives



Figure 1.1: Ho Chi Minh City Geological Museum

The visit to the Ho Chi Minh City Geological Museum provided us with a valuable chance to connect the theories we learned in class with real-world examples. While books and lectures give us the foundation of geological knowledge, nothing compares to directly observing the specimens that reflect millions, even billions, of years of Earth's history. At the museum, we could see how rocks, ores, minerals, and gemstones are preserved and displayed, each telling a story about the planet's formation and transformation over time.

This experience not only strengthened our understanding of the processes that shape the Earth but also gave us a clearer view of Vietnam's own geological heritage. By exploring these collections, we were able to develop a deeper appreciation of geology as both a science and a record of natural history. More importantly, the museum visit allowed us to practice critical observation, linking theory with practice, and to better prepare for future studies and projects related to Earth sciences.

1.2 Museum History and Significance

The Geological Museum has a long history closely tied to the development of geological research in Vietnam since the colonial period. In 1898, the French colonial government



established the Indochina Geological Service (Service Géologique de l'Indochine) and initiated the construction of a museum dedicated to geological research and education. By 1914, the museum's first building was completed in Hanoi. After the Geneva Agreement in 1954, part of the collection was moved to Saigon, where it was initially displayed in a temporary villa before being relocated to its current building in 1973. Following national reunification, the museum was managed by the Southern Geological Mapping Federation and continued to expand within the national geological system.

In 2001, it became one of the first museums in Vietnam to be recognized by the International Council of Museums (ICOM). In 2003, the Geological Museum system was restructured under the Department of Geology and Minerals, and in 2008, the Ho Chi Minh City branch was officially integrated as the southern division. Today, the Geological Museum stands as Vietnam's national geological museum, operating under the Department of Geology and Minerals of the Ministry of Natural Resources and Environment.

The museum currently holds about 13,000 precious geological specimens, of which about 3,000 are on permanent display. Including geological drill cores and archived samples, the total number of specimens here is more than 20,000. The highlight on the ground floor (General Geology) is the 1:500,000 scale geological map of Vietnam completed in 1988. This large map shows the geological structure of the entire territory of Vietnam clearly annotated, very useful for visitors to learn about the diversity of resources and stratigraphy.

This report will illustrate our visit to the Ho Chi Minh City Geological Museum, particularly focusing on Floor 1 and Floor 2. The first floor of the Museum will briefly introduce the geological evolution of Vietnam with the geological processes. On the second floor, we will demonstrate the fuel, metallic and non-metallic minerals, gemstones, mineral water and the concept of geological heritage. Throughout this report, we will organize the geological knowledge and our own experience to make this report more informative and easier to comprehend.

2 GENERAL GEOLOGY (1st floor)

2.1 Geological Evolution Through Time

The Earth has experienced a vast and dynamic history of about 4 billion years. This journey is divided into major geological eons and eras, each defined by important events such as the formation of the crust, shifts in the atmosphere, the rise of life, and tectonic movements. These processes become clearer when explored alongside physical specimens



and visual displays, such as those presented at the Ho Chi Minh City Geological Museum.

Precambrian Time (Hadean - Archean - Proterozoic; 4.6 billion - 541 million years ago)

The Archean Eon (4.0–2.6 billion years ago) represents one of the earliest chapters in Earth's history, when the crust stabilized, continents and oceans first formed, and simple life such as stromatolite-building cyanobacteria appeared, slowly altering the planet's atmosphere. In Vietnam, Archean rocks are found in the Kon Tum geoblock, mainly within the Kan Nack Group. These 3,000-meter-thick metamorphic rocks show complex changes, from granulite facies to amphibolite and greenschist facies, revealing the intense geological processes that shaped the ancient Earth.

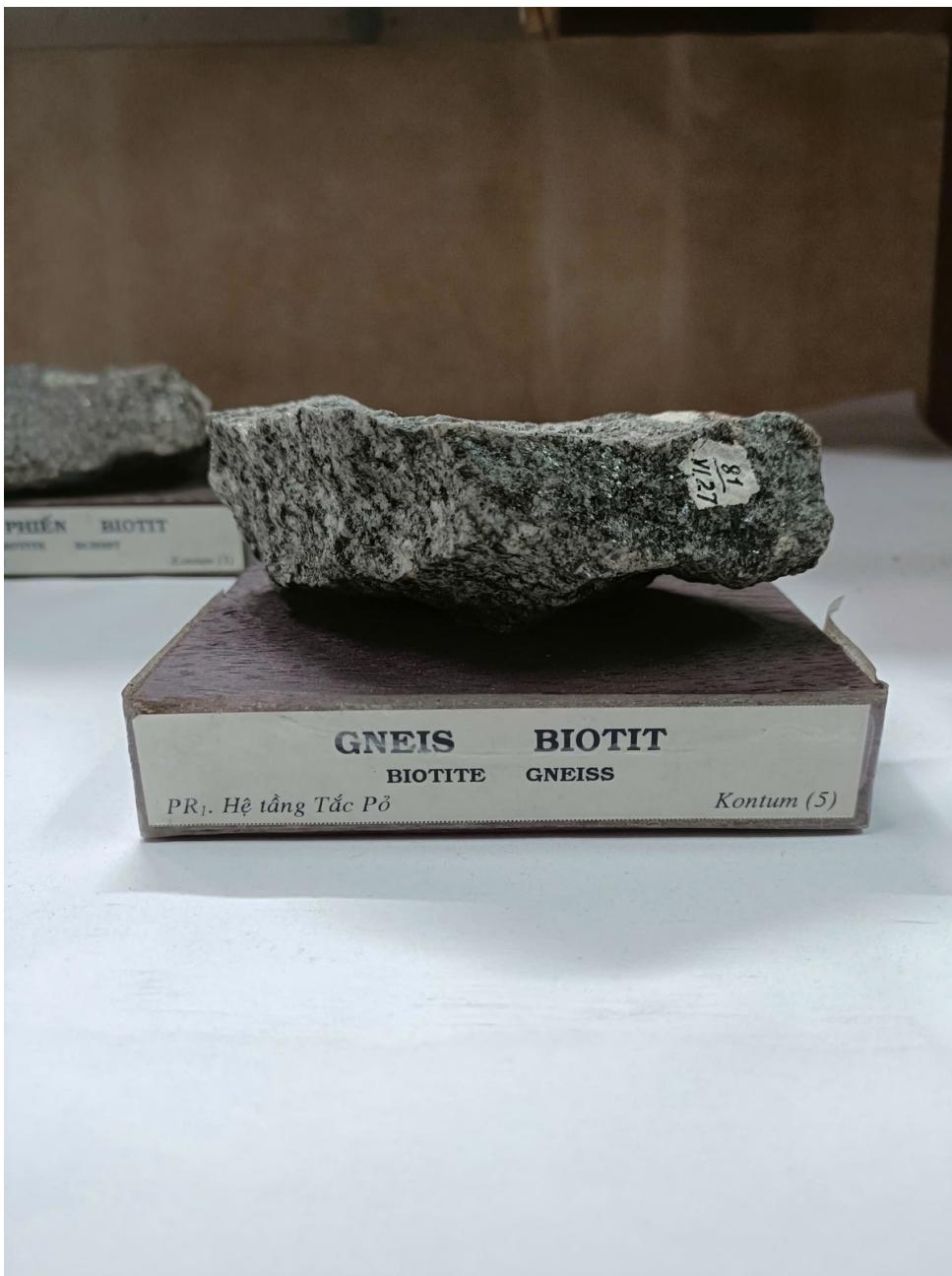


Figure 2.1: Sample of rock in Archean Eon

The Proterozoic Eon (2.6 billion to 541 million years ago) saw the Great Oxidation Event, global ice ages called "Snowball Earth," and the rise of the first multicellular life, including the Ediacaran biota. These changes prepared the planet for the Cambrian explosion of life. In Vietnam, rocks from the Proterozoic are found in areas like Red River, Fansipan, Chay River, Ma River, Phu Hoat, and Kon Tum. These include crystalline and metamorphic rocks as well as younger layers that lead into the Cambrian period. Some of

these rocks contain fossils of tiny early life forms.



Figure 2.2: Sample of rock in Proterozoic Eon

Paleozoic Era (541 – 252 million years ago)

This era began with the Cambrian Explosion, a massive diversification of marine life. It is divided into six periods: Cambrian, Ordovician, Silurian, Devonian, Carboniferous, and Permian. During this time, ocean life expanded rapidly with animals like trilobites, corals, crinoids, brachiopods, graptolites, and cephalopods. Later, plants and amphibians

colonized land. The era ended with the Permian-Triassic extinction, the largest known mass extinction, wiping out over 90% of marine species.

In Vietnam, marine sedimentary rocks with abundant fossils (e.g., corals, brachiopods, trilobites) are found in Northeast Vietnam, such as in Cao Bang and Ha Long Bay. The Truong Son (Annamite) Range began forming due to Caledonian and Hercynian orogenies. Many rocks from the Paleozoic Era can still be found today in regions like North Vietnam, Northwest Vietnam, Northeast Vietnam, and Central Vietnam, where the rocks are made of limestone and other sediments that contain fossils of trilobites, brachiopods, and corals.

At the museum, fossils of corals, mollusks, and petrified wood from areas like Truong Sa (Spratly Islands) and northern Vietnam are exhibited. Geological maps display Paleozoic strata across northern and central Vietnam.



Figure 2.3: Sample of rock in Paleozoic Era

Mesozoic Era (252 – 66 million years ago)

Known as the "Age of Dinosaurs," the Mesozoic saw the rise of reptiles, the breakup of Pangaea, and generally warm climates. It is divided into three periods: Triassic, Jurassic, and Cretaceous. This era is famous as the "Age of Reptiles," when dinosaurs, ammonites, and many other creatures lived, along with early plants and marine animals like bivalves and brachiopods. The era ended with the Cretaceous–Paleogene (K–Pg) extinction caused by the Chicxulub impact and Deccan volcanism.

In Vietnam, the Indosinian Orogeny uplifted the Truong Son Range and created sedimentary basins. Volcanic and sedimentary activity occurred in areas like Kon Tum, Son La, and Thanh Hoa. Fossil evidence of dinosaurs and ancient flora has been found in some localities. Mesozoic rocks are found in places such as An Chau, Da River, Hien River, and Southwest. Triassic rocks here contain fossils of ammonites, gastropods, plants, and bivalves. Later, during the Jurassic and Cretaceous, red continental rocks and coal-bearing formations appeared, especially in the North, while volcanic rocks developed in areas like Tam Lang and Tu Le. These layers preserve fossils that show how both land and sea environments changed during this era.

At the museum, basalt and volcanic sediment from this era are displayed in the "Magmatism" section. Fossils and stratigraphic profiles reflect the Mesozoic biosphere and tectonic events.

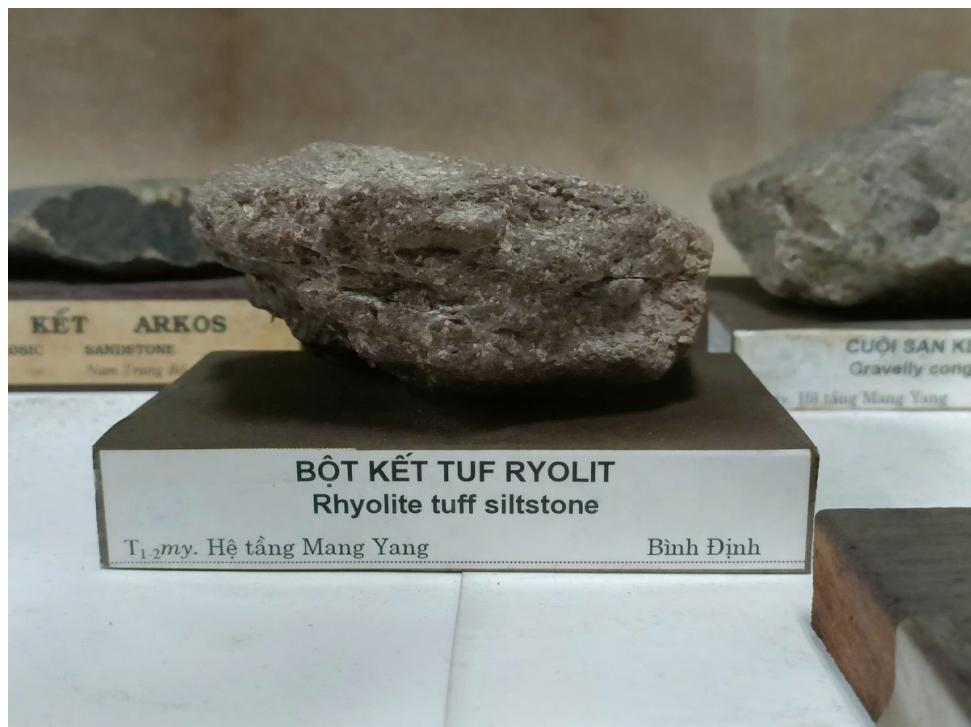


Figure 2.4: Sample of rock in Mesozoic Era

Cenozoic Era (66 million years ago to present)

This era features the evolution and dominance of mammals, birds, and eventually humans. Tectonic faulting, glaciations, and sedimentation shaped modern landforms and ecosystems. It is divided into three periods: Paleogene (66–23 million years ago), Neogene (23–2.6 million years ago), and the Quaternary (2.6 million years ago to today). This era is marked by great diversification of life, with many plants, mollusks, diatoms, ostracods,

foraminifers, and vertebrates flourishing.

In Vietnam, major faults like the Red River and Song Ca faults influenced the formation of the Cuu Long (Mekong) and Red River basins, rich in oil and gas. The Quaternary Period (2.58 Ma - present) witnessed alternating glaciations and interglacials, forming the Mekong and Red River deltas through alluvial deposition. Cenozoic rocks are found in regions such as Northwest (Pu Tra, Nam Bay), South Central Coast, and coastal basins. Paleogene rocks are rare, but Neogene sediments are widespread, often containing coal, kaolin, bentonite, and diatomite. These layers also include volcanic rocks, lagoon and delta deposits, and shallow marine formations, preserving fossils that show the rich environments of Vietnam during this era.

At the museum, core samples of crude oil from the Cuu Long basin (collected in the 1980s) are on display. Sediment cores and alluvial rock samples reflect recent geological processes, showcased in the "Fuel Group" and sedimentary sections.

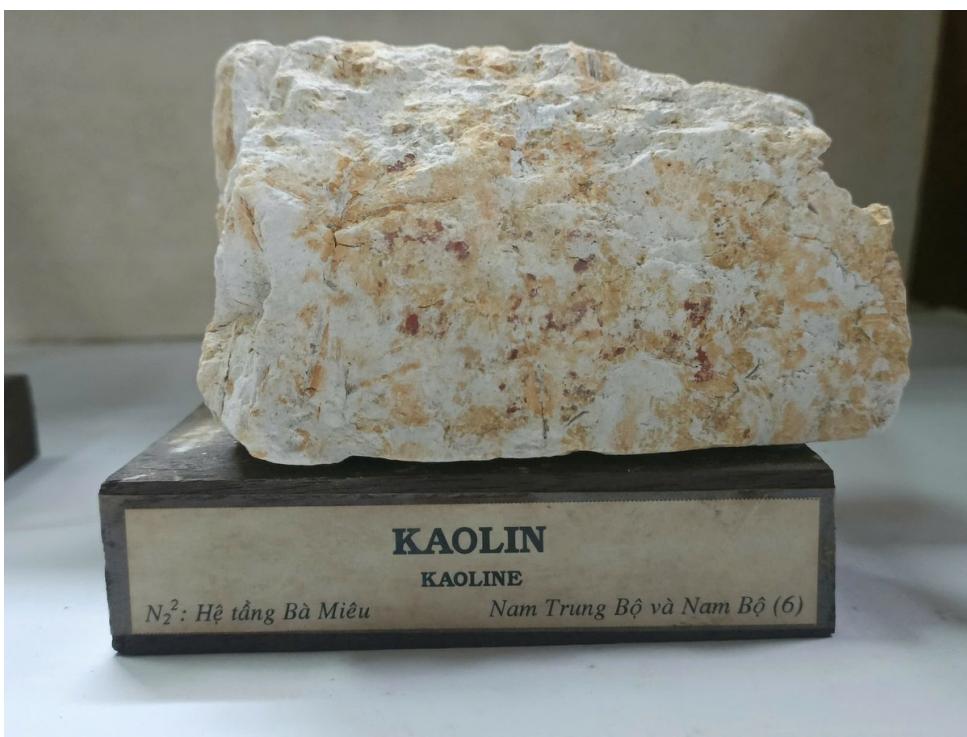


Figure 2.5: Sample of rock in Cenozoic Era

2.2 Geological Processes

Geological processes are natural forces that continuously shape and alter both the Earth's surface and its interior. At the Ho Chi Minh City Geological Museum, visitors were introduced to six key geological processes through rock samples, models, and diagrams.



These processes—ranging from extraterrestrial impacts to deep-earth activity and surface transformations—drive the creation, modification, and recycling of Earth's materials. The museum's exhibits illustrated how each process contributes to the formation of various rocks and landforms, highlighting the dynamic and interconnected system of the geological cycle.

Cosmic Process

Although no meteorite samples were displayed during the visit, the cosmic process remains essential in Earth's geological history. It refers to extraterrestrial impacts, especially meteorites, which helped shape the early Earth. These collisions formed craters, altered surface rocks, and delivered elements like iron, nickel, and platinum - key components of Earth's crust and core. Despite the lack of exhibits, this process highlights the planet's cosmic origins and is widely studied through global meteorite discoveries.

Tectonic Process

Tectonic processes involve the movement of the Earth's lithospheric plates. These dynamic movements are responsible for geological phenomena such as earthquakes, volcanic eruptions, mountain formation, and continental drift.

At the museum, this process was illustrated through global tectonic maps and a three-dimensional model of plate boundaries, showing the locations and interactions between major tectonic plates around the world. These materials effectively demonstrate how plates move and interact through different boundary types:

- Divergent boundaries, where plates move apart and new crust forms;
- Convergent boundaries, where plates collide, leading to subduction and mountain building;
- Transform boundaries, where plates slide past each other, often causing earthquakes.

The exhibit helps explain how these boundary interactions drive geological activity and continuously shape the Earth's surface.

Magmatic Process

Magmatic processes are responsible for the formation of igneous rocks through the cooling and solidification of magma. These rocks differ in texture and composition depending on where and how quickly the magma cools.

In the museum exhibit, igneous rocks were organized into two main groups. Extrusive rocks, such as basalt and andesite, are formed from lava that cools quickly at the surface. Because the cooling is rapid, crystals don't have time to grow large, resulting in a fine-grained texture. Intrusive rocks, like granite and diorite, form deep underground where



magma cools slowly over extended periods. This slow cooling allows large crystals to develop, giving the rocks a coarse, crystalline texture.

The museum displays showed how different cooling environments produce rocks with distinct characteristics, helping visitors understand the relationship between geological processes and rock formation.

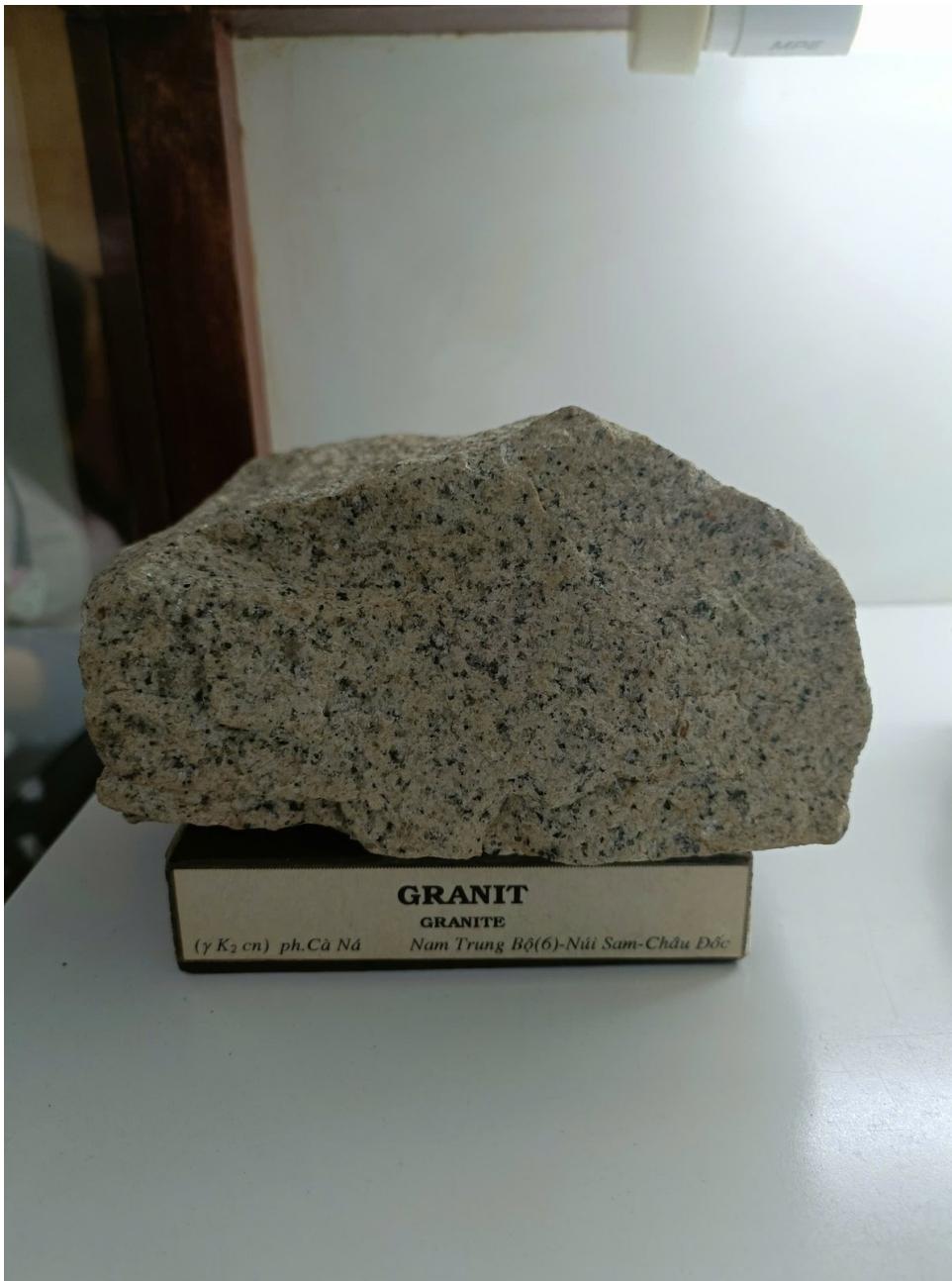


Figure 2.6: Sample of intrusive igneous rock

Metamorphic Process

Metamorphism happens when existing rocks undergo high heat, strong pressure, or interaction with reactive fluids, leading them to change into new rock types. At the museum, specimens like schist, gneiss, slate, quartzite, and marble were displayed, each representing different metamorphic environments.

One highlighted example was marble, which develops from limestone through contact metamorphism. The exhibit also included diagrams of metamorphic facies and processes, illustrating how different conditions drive these rock transformations.

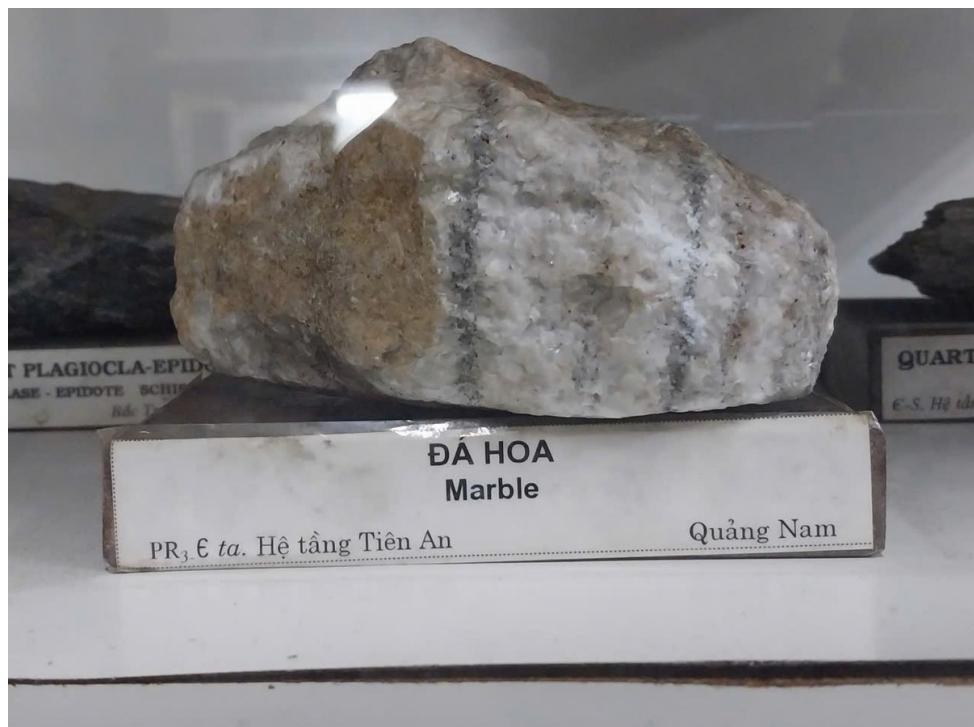


Figure 2.7: Sample of Marble

Sedimentary Process

Sedimentary processes occur when materials from older rocks or biological sources are gathered, compressed, and cemented together, resulting in sedimentary rocks that typically show layered structures.

- Mechanical sedimentation produces rocks such as sandstone and conglomerate, created from the physical breakdown and accumulation of rock fragments.
- Chemical sedimentation is seen in rocks like limestone, which forms when minerals precipitate from water-rich solutions.



Figure 2.8: Sample of Mechanical sedimentation rock

Weathering Process

Weathering is the natural process that breaks down rocks at Earth's surface through the effects of wind, rainfall, temperature changes, and chemical reactions. At the museum, this was demonstrated with diagrams and rock samples that showed how rocks are altered by different types of weathering.

Examples included mechanical weathering, such as rock fragmentation and exfoliation, and chemical weathering, like the oxidation of iron on rock surfaces. These displays highlighted weathering's important role in the rock cycle, as it produces loose sediments that can later compact and cement to form sedimentary rocks.



Figure 2.9: Sample of Bauxite

3 MINERAL RESOURCES (2nd floor)

The second floor of the Ho Chi Minh City Geological Museum showcases Vietnam's abundant mineral wealth and geological resources. This floor provides comprehensive displays of various mineral categories, from energy resources to precious gemstones, offering visitors insight into the country's geological diversity and economic potential. The exhibits demonstrate how these natural resources have been formed through millions of years of geological processes and their significance to Vietnam's development.

3.1 Energy and Fuel Resources

Energy resources represent naturally occurring materials that can be utilized to generate power and heat through combustion or other processes. The museum's collection highlights two fundamental categories of fossil fuels that have shaped Vietnam's energy landscape.

Petroleum constitutes a crucial liquid hydrocarbon resource formed from ancient marine organisms subjected to heat and pressure over geological time scales. This valuable resource undergoes refining processes to produce essential fuels including gasoline, diesel

fuel, and aviation kerosene. Vietnam's petroleum reserves, particularly in offshore basins, play a vital role in the nation's energy security and economic development.

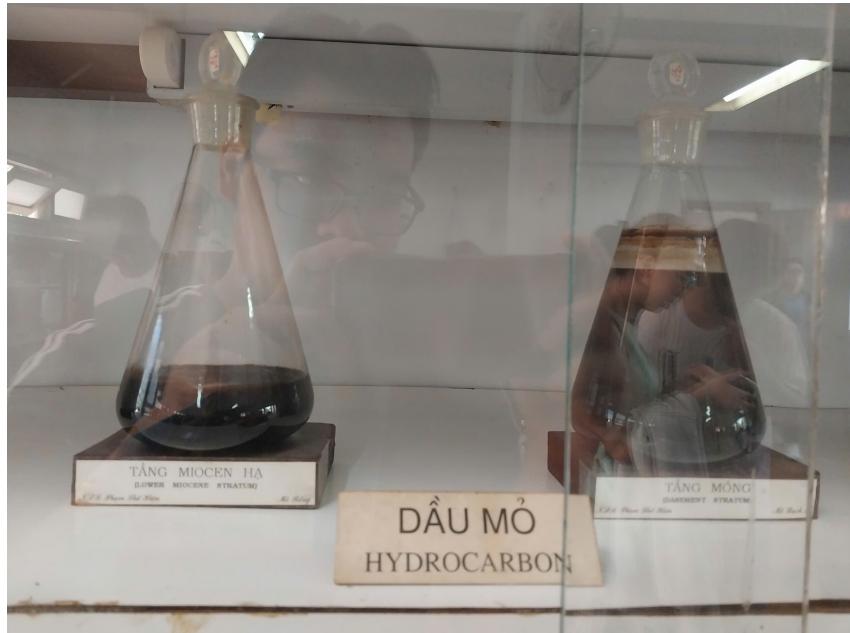


Figure 3.1: Petroleum sample display from Vietnamese offshore reserves

Coal represents a solid fossil fuel derived from ancient plant matter that underwent transformation through geological compression and heating over millions of years. The museum displays various coal types classified by their carbon content and energy density:

- Peat – representing the earliest stage of coal development
- Lignite – commonly referred to as brown coal with moderate energy content
- Bituminous coal – a widely utilized intermediate-grade coal
- Anthracite – the highest quality coal with maximum energy output

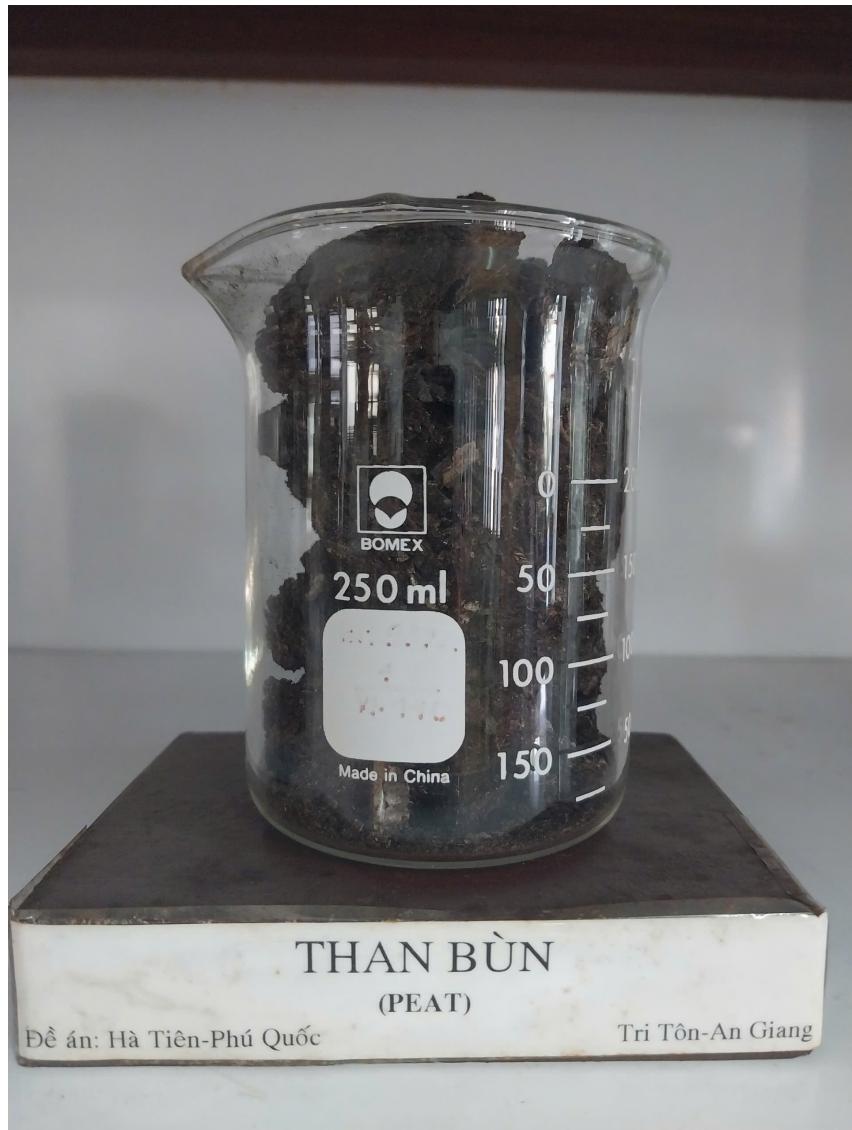


Figure 3.2: Different types of coal samples showing progression from peat to anthracite

These coal varieties serve primarily in electrical power generation and industrial applications, including steel production processes.



Figure 3.3: Additional coal specimens from Vietnamese geological formations

3.2 Metallic Mineral Resources

Vietnam possesses diverse metallic mineral resources distributed across different geological regions.

Strategic Metals Titanium: A lightweight, strong, and corrosion-resistant metal used in aerospace and medical applications. Vietnam has titanium deposits primarily in coastal sand formations.

Tin: Vietnam is one of the world's significant tin producers, with major deposits in the northern provinces. Tin is essential for electronics and soldering applications.

Chromium: Used in stainless steel production and chrome plating. Vietnam's chromium

deposits are found in ultramafic rock formations.

Rare Earth Elements: Critical for modern technology including electronics, renewable energy systems, and defense applications.



Figure 3.4: Strategic metal samples including titanium and rare earth elements

Industrial Metals Iron: The foundation of steel production, Vietnam has significant iron ore deposits in the northern regions, particularly in Thai Nguyen and Lao Cai provinces.

Aluminum: Derived from bauxite ore, Vietnam has substantial bauxite reserves in the Central Highlands region.

Copper: Essential for electrical applications and construction. Vietnam's copper deposits are found in various geological formations.

Zinc: Used in galvanizing and alloy production. Vietnam has zinc deposits associated with lead mineralization.

Lead: Important for batteries and radiation shielding applications.



Figure 3.5: Industrial metal samples including iron ore and copper

Precious Metals Gold: Vietnam has both placer and lode gold deposits. Gold mining has a long history in Vietnam, with significant deposits in Quang Nam and other provinces.

Silver: Often found associated with other metal ores, silver has both monetary and industrial applications.



Figure 3.6: Gold and silver samples from Vietnamese deposits

Specialty Metals Tungsten: Vietnam is a major tungsten producer globally. Tungsten is essential for high-temperature applications and cutting tools.

Molybdenum: Used in steel alloys and high-temperature applications.

Magnesium: Lightweight metal used in aerospace and automotive industries.

3.3 Non-Metallic Mineral Resources

Non-metallic minerals represent naturally occurring substances lacking metallic properties but possessing significant industrial and economic value. These materials serve essential functions in construction, agriculture, and manufacturing sectors.

Silica Sand High-purity silica sand is essential for glass manufacturing, foundry operations, and construction applications. Vietnam has significant silica sand deposits along its coastal regions, particularly suitable for high-quality glass production.

Pyrite Iron sulfide mineral (FeS) with applications in sulfuric acid production and as a source of sulfur for chemical industries. Pyrite is also known as "fool's gold" due to its metallic luster and golden color.



Figure 3.7: Pyrite specimen showing characteristic metallic luster

Apatite Phosphate mineral essential for fertilizer production and chemical industries. Vietnam has significant apatite deposits that support the country's agricultural sector through phosphate fertilizer production.



Talc A soft silicate mineral used in cosmetics, paper, paint, and ceramic industries due to its lubricating properties and chemical inertness.

Asbestos Fibrous silicate minerals with heat-resistant properties, though their use is now restricted due to health concerns.

Phosphorite Sedimentary rock containing phosphate minerals, primarily used for fertilizer production.

Kaolin A fine clay mineral used in ceramics, paper production, and as a filler in various industrial applications.

3.4 Construction Materials

Construction materials encompass naturally occurring substances utilized in building and infrastructure development. These materials form the foundation of human civilization's architectural achievements and continue to play crucial roles in modern construction practices.

Stone Materials Limestone: Sedimentary rock composed primarily of calcium carbonate, essential for cement production and construction. Vietnam has extensive limestone deposits throughout the country.

Marble: Metamorphosed limestone prized for decorative applications and high-end construction projects. Vietnamese marble is known for its quality and diverse colors.

Granite: Igneous rock valued for its durability and aesthetic appeal in construction and monuments. Vietnam has significant granite quarries producing various colors and textures.

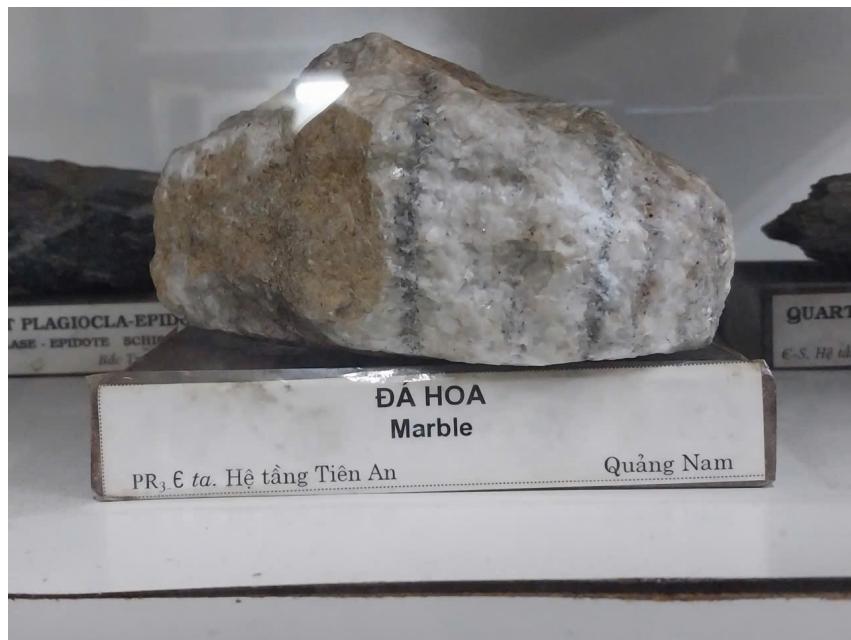


Figure 3.8: Marble sample

Clay and Ceramic Materials *Clay*: Fine-grained sedimentary material essential for brick, tile, and ceramic production. Vietnam has abundant clay deposits suitable for various ceramic applications.

Kaolin: High-quality white clay used in fine ceramics and porcelain production.

Aggregate Materials *Sand*: Essential component for concrete production and construction applications. Vietnam has both river sand and marine sand resources.

Gravel: Coarse aggregate material used in concrete and road construction.

Crushed Stone: Processed stone aggregate for various construction applications.

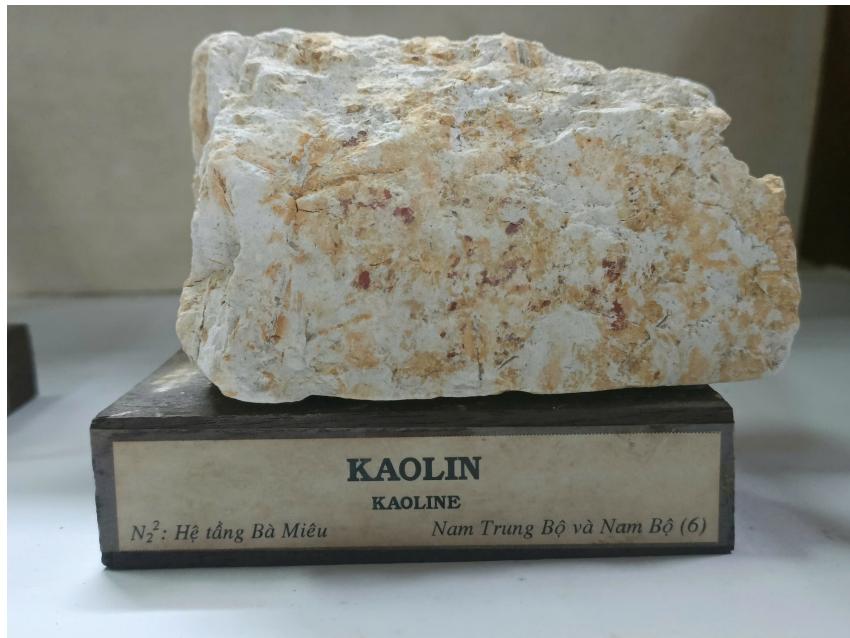


Figure 3.9: Kaolin clay sample showing characteristic white coloration and fine texture

3.5 Gemstones and Semi-Precious Stones

Vietnam possesses notable gemstone deposits with both aesthetic and economic value.

Quartz Varieties *Amethyst*: A purple variety of quartz that is highly prized for jewelry and decorative purposes. The purple color comes from trace amounts of iron and aluminum impurities. Amethyst is found in various locations throughout Vietnam and is considered one of the most valuable quartz varieties.



Figure 3.10: Amethyst sample showing characteristic purple coloration

Chalcedony: A cryptocrystalline form of silica composed of tiny quartz crystals. It typically has a waxy or glassy luster and comes in various colors including white, gray, blue, and brown. Chalcedony is commonly used in jewelry and decorative objects.



Figure 3.11: Chalcedony samples showing various colors and textures

Quartz Crystals: Clear crystalline quartz formations that are hexagonal in shape with pyramid-shaped termination points. These are used in both jewelry and industrial applications.

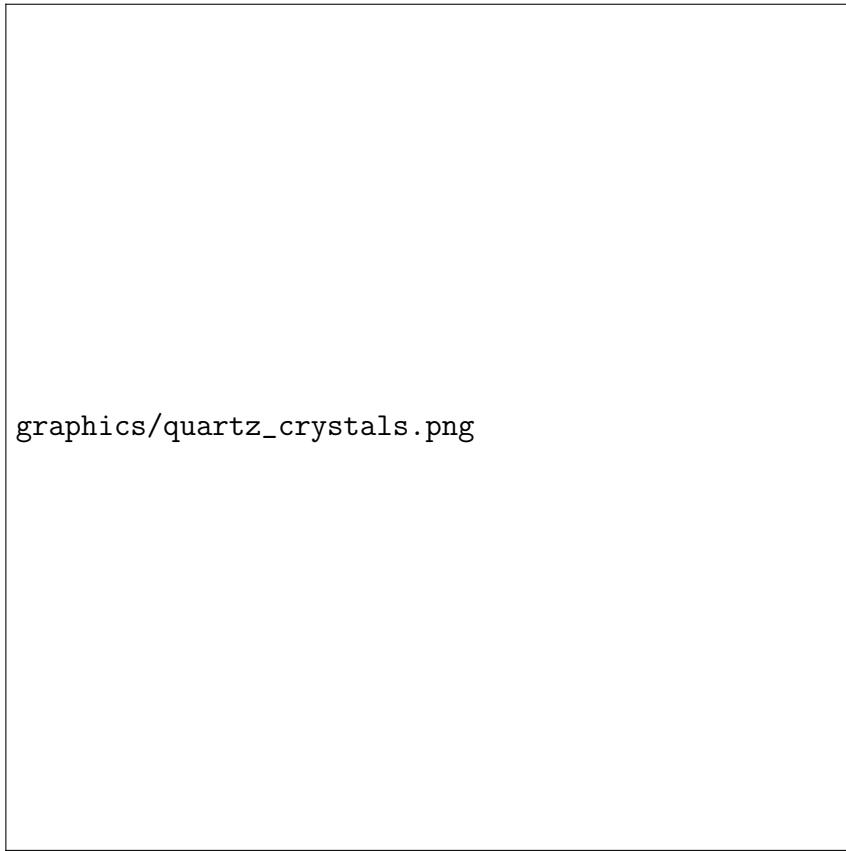


Figure 3.12: Clear quartz crystals displaying hexagonal structure

Precious Gemstones Ruby: A red variety of the mineral corundum, colored by trace amounts of chromium. Ruby is one of the most valuable gemstones and is highly prized for jewelry. Vietnamese rubies are found in marble formations and are known for their quality.

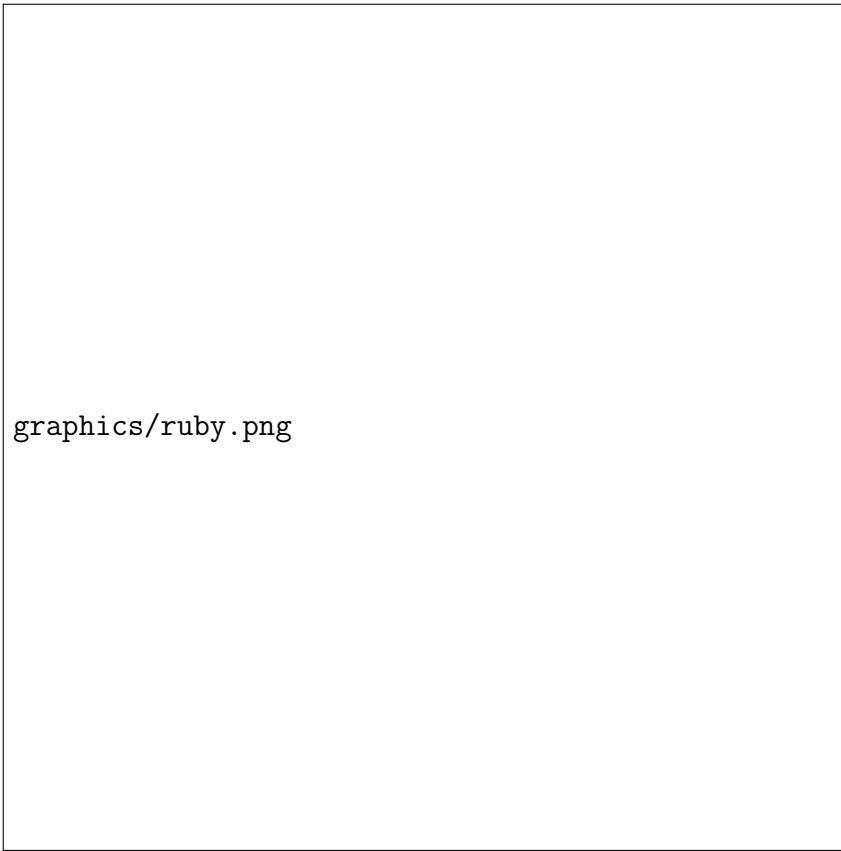


Figure 3.13: Ruby samples including ruby in marble matrix

Topaz: A rare silicate mineral with the chemical composition $\text{AlSiO}(\text{F},\text{OH})$. While pure topaz is colorless, trace elements can create various colors including blue, golden-brown, and yellow-orange. Topaz is valued for its hardness and brilliance in jewelry applications.



Figure 3.14: Topaz sample showing characteristic crystal structure

3.6 Mineral Water Resources

Vietnam possesses significant mineral water resources with therapeutic and commercial value.

Natural mineral water is derived from underground sources where water has gradually acquired minerals while flowing through layers of rock over extended periods. Vietnam has numerous mineral water sources with diverse chemical compositions and therapeutic properties.

Formation Process Groundwater penetrates deep underground, acquiring precious minerals and sometimes heating up in areas with tectonic activity, such as fault lines or historic volcanic zones. This process produces mineral-rich or hot springs that are geologically remarkable and recognized for their health benefits.

Vietnamese Sources Vietnam has mineral water sources in various regions including Binh Thuan and Ninh Thuan provinces. Notable sources include:

- *Vinh Hao*: Discovered by the French in 1928 in Vinh Hao, Tuy Phong, Binh Thuan



- *Van Lam*: Located in the northern regions
- *Ham Cuong*: Found in central Vietnam
- *Da Kai*: Another significant source

Chemical Composition Vinh Hao mineral water, due to the perfect geological conditions of the Southeast Truong Son region with numerous interwoven rock layers, has:

- High concentration of bicarbonate (HCO_3^-) - acts as an antacid to reduce stomach acidity
- Silicate dissolved in water - beneficial for digestion and nervous system
- Calcium - prevents osteoporosis
- Magnesium - strengthens immunity, improves heart function, and regulates blood pressure



Figure 3.15: Mineral water samples from various Vietnamese sources



3.7 Geological Heritage

Geological heritage represents a collection of geological resources with exceptional scientific, educational, artistic, and economic significance.

Definition and Components Geological heritage refers to specific locations or landscapes on Earth that preserve evidence of the planet's formation and evolution, as well as the evolutionary history of life. Components include:

- Geomorphological landscapes
- Paleontological sites and fossils
- Extinct or active volcanic craters
- Caves and river canyons
- Natural lakes and waterfalls
- Rock and ore exposures
- Geological formations recording special events
- Sites where geological processes can be observed

Importance and Conservation Geological heritage sites have significant scientific, aesthetic, and historical importance, as well as tourism potential. Like other types of heritage, geological heritage is a finite resource that must be maintained, developed, and used sustainably.

Vietnamese Context Vietnam's geological heritage includes diverse formations representing different geological periods and processes, from ancient Precambrian rocks to recent volcanic activity, providing valuable insights into Earth's history and geological evolution.

References

- [1] Thanh Niên. (2023). Bảo tàng ở TP.HCM: Bảo tàng Địa chất - Độc vị trái đất. <https://thanhnien.vn/bao-tang-o-tphcm-bao-tang-dia-chat-doc-vi-trai-dat-18525040712390276.htm>