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## RESEARCH ARTICLE

# Understanding Chemical and Mineralogical Composition of Nahartangi Nephrite from Goshta

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## ABSTRACT

The geochemical mineralogical characteristics of the Nahartangi nephrite deposit in the Goshta district of Nangarhar province are investigated in this research. Nephrite is a Cyclosilicate mineral with a high silicate content.  $\text{Ca}_2(\text{Mg}, \text{Fe})_5\text{Si}_8\text{O}_{22}(\text{OH})_2$  is its chemical formula, and it is monoclinic. It's been discovered in metamorphic rocks across the area. The nephrite zone of Nahartangi is linked to the Jalalabad structural band and the ophiolite complex. Jalalabad is a region in eastern Afghanistan, southeast of Nuristan. As a result, this belt is associated with the upper or late Cambrian. The age of the rocks in this quarter is related to the Archean-Mesoproterozoic AR-PR2. This manuscript offers the first systematic mineralogical and geochemical observation of the Nahartangi nephrite deposit electronic probe Microanalysis, X-ray fluorescence spectroscopy (XRF) and mineralogical analysis. The Nahartangi nephrite was investigated using an XRF and petrographic microscope. According to field research, dolomitic marble is involved in Nahartangi nephrite deposits close to the intrusive granitoids. According to petrographic investigations, nephrite is mostly made up of fine-grained actinolite, schist, and dolomite, all of which are metamorphic minerals. Through every phase, nephrite samples had low  $\text{Fe}/(\text{FeO}+\text{MgO})$  values (8.2524.17%) according to geochemical analysis, and  $\text{SiO}_2$  (81.30%),  $\text{Al}_2\text{O}_3$  (3.22), and  $\text{CaO}$  (17.41%) were also low and 1.21%  $\text{NiO}$  content, as well. Chemical records analysis and interpretation of  $\text{Mg}+\text{Fe}$  percentages indicate that actinolite is the type of nephrite. The formation of veins and hydrothermal lenses in contact with serpentinite and carbonates has produced nephrite deposits. Dolomitic marble rocks are the specific rocks found near the study area. The economy and value are immediately impacted by color and its transparency. The presence of  $\text{Mg}$  elements causes the nephrite from the Goshta district to appear green.

## KEYWORDS

Nahartangi, Serpentinite, Ophiolite, Nephrite, Goshta, Dolomitic marble

## ARTICLE INFORMATION

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## 1. Introduction

A calcium silicate mineral with Fe-Mg and a double chain form, nephrite  $\text{Ca}_2(\text{Fe}, \text{Mg})_5\text{Si}_8\text{O}_{22}(\text{OH})_2$  is a member of the amphibole group. The tremolite-ferroactinolite collection contains a wide range of intermediate components, many of which are characterized as mild or darkish green. However, they can also be white, yellowish, brown, or hardly ever have other colors. In rare cases, magnetite and other spinel-like minerals can be seen as excellent black inclusions within the good grained green aggregates. Its origins are primarily linked to metasomatic processes occurring inside ultrabasic (serpentinite) or carbonate (dolomite marble) materials. The main genetic variations of these deposits have a connection to gabbroid, acid igneous or metamorphic rocks in contact with ultramafic rocks or to dolomite marble. The mountain serpentinite convergent plate border is connected to some types of jade. Nephrite jade, which is abundant in Ca and Mg, contrasts with jadeite jade, which is abundant in Na and Al. Each variety of jade is a byproduct of a metasomatic reaction between blocks of serpentine and rock that are altered to occur at a convergent boundary. In terms of having unique metal, nonmetallic, and oil and gas resources, Afghanistan is, more specifically,

one of the richest nations in the world. According to studies and inquiries, Afghanistan shines in proudly possesses mineral reserves within the region. Having a few abandoned precious mines spread across vast areas. Due to its complicated geology and tectonic environment, which results in a variety of mineral deposits, Afghanistan is regarded as a unique country within the world. In this observation, the Goshta district's nephrite deposits' geological structure, chemical analysis, mineral commentary, and petrographic characteristics have been explored. The outcome of this investigation also generated interest in the nation's financial system.

## **2. Methodology**

**Library Method:** This method was considered an initial part of the research; relevant literature was reviewed using research and review articles, theses, textbooks and authoritative websites. This method intends to determine the weak and hidden points of previous studies on the Nahartangi nephrite deposit and to select the correct analytical method for the mineralogical and geochemical characterization of the nephrite. The method provides general information, including the geological and tectonic context of the study area

**Field observation method:** Field work and sampling are important in such research. Therefore, the fieldwork for this study consisted of Several geological transects to study and collect macroscopic properties. A sample of the selected points. Collection of samples for laboratory analysis. Two phases of fieldwork were carried out in the study area. These samples were taken at random and analyzed according to physical, morphological and structural changes in nephrite. Five samples and their associated coordinates were collected

**Laboratory method:** The purpose of this method is to carry out mineralogical, chemical and petrographic analyzes on the collected samples in order to show the properties of nephrite. Samples are sent to the Mineralogy Laboratory of the Ministry of Mine & petroleum in Kabul, Afghanistan, for reliable outcomes. The samples have been subjected to X-ray fluorescence and mineralogical analysis of chemical and mineral composition.

## **3. Objective of the research**

This research sought to understand the geological systems, geochemical analysis and determination of mineral composition, petrological characteristics, and physical characteristics of Nahartangi's nephrite.

### **3.1 Importance of research**

The studies were conducted through comprehensive fieldwork and sampling of major nephrite veins. The translation and outcomes of this examination can effectively serve as a mandated reference for the Afghanistan Geological Survey (AGS) and related research devices.

### **3.2 Research question**

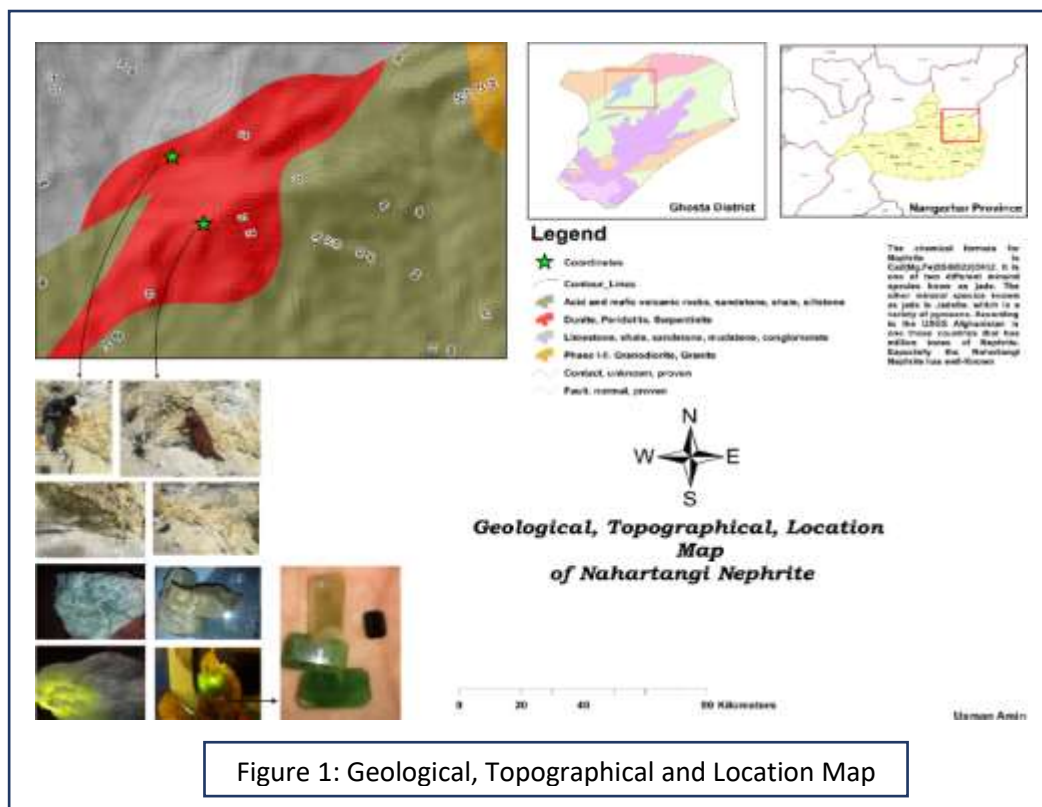
- I. What are the adjacent rocks Nahartangi mine field?
- II. What is the geochemistry of Nahartangi nephrite?
- III. What is the mineralogy of Nahartangi nephrite in the study area?
- IV. Does the Nahartangi Nephrite have economical value?
- V. What is the first origin of Nahartangi nephrite?

### **3.3 Research limitation**

Each study has its own set of limitations and dangers. In this regard, consider the safety concerns as well as the absence of prior mining activities and the loss of geological work in this area. A brief geological education from the government was insufficient to conduct an investigation, which enables you to identify and gather a thin segment of the sample in the Ministry of Mine & petroleum and other private businesses. A major obstacle to completion would be Kabul Poly Technic College's lack of adequate equipment and renowned labs, which were no longer available.

### **3.4. Study area**

The specimens for this study have been accumulated from the Nahartangi region positioned within the Ghostha district of Nangrhar province and have a not unusual border with the Khas Kunarr District of Kunarr province in Jalalabad city. The geographic coordinate of this area depicts that its latitude is 34°27'20.50"N, and its longitude is 70°45' 4.55" E. as it is shown in the map below.



This area is one of the areas which has several Nephrite veins and lenses. These veins and lenses have been identified due to the excavation of land by locals for construction purposes in the Nahartangi Nephrite field (R.G., 2017). The absolute elevation from the sea level in the aforementioned area varies from 421 to 890 meters, and the relative elevation of the area is about 250 meters. Nanghar Province is mountainous, and rugged terrain has been relatively flat-lands; the climate is almost Mediterranean, with warm summers and mild and slightly cold winters. The temperature is 47c° in summer and 3c° in winter. As stated before, the study area is located in the Jalalabad zone in eastern Afghanistan. This zone was separated in 1969 by Prof. Slavin to the Jalalabad tectonic zone for the first time. The basement metamorphic rock can be seen in the Spinghar Mountains, in the part of the aforementioned eastern zone in Jalalabad, the left side of Kabul River, as outcrops. (Karapetov, 1979-1981) .

In the central parts of this zone, the Neogene formation has deposited new tectonic troughs. In the tectonic map prepared in 1976 in this region, the sub-zone was separated into three sub-zones named Kunar subzone, Spinghar and depression of Jalalabad trough (Treloar, 1993).

During tremolite formation, three series of tremolites are formed, and the content of the third series determines the quality of the nephrite produced. (Hongsheng Xu, 29 January 2021).

According to its genetic setting, nephrite can be divided into (1) serpentinite-related deposits and (2) dolomite-related deposits (al F. B., December 2019)

This zone is related to the upper Cambrian or younger Cambrian. In this area, the age of rocks is related to Archean- Middle Proterozoic AR-PR2 (al S. S., 3 January 2022) .

White and green nephrites contain fewer mineral inclusions and have lower FeO and MnO contents. (al Y. L., Geochemistry and petrogenesis of placer nephrite from Hetian, Xinjiang, Northwest China, October 2011)

The high-quality green nephrite jade is predominately composed of tremolite and actinolite (al C. Z., January 2021).

Nephrite and dolomitic marble samples have the same REE patterns with negative Eu anomalies (al Y. L., Geochemistry and petrology of nephrite from Alamas, Xinjiang, NW China, 10 August 2011).

Pseudomorphic serpentinite, similar to abyssal serpentinites in terms of an isotopic composition ( $\delta^{18}\text{O} = +5.7\text{‰}$ ,  $\delta\text{D} = -64\text{‰}$ ,  $\delta^{37}\text{Cl} = +2.0\text{‰}$ ), recrystallized into non-pseudomorphic serpentinite ( $\delta^{18}\text{O} = +7.1\text{‰}$ ,  $\delta\text{D} = -48\text{‰}$ ,  $\delta^{37}\text{Cl} = -0.1\text{‰}$ ), (al G. G., July 2022)

Mostly in the form of microscopic crystalline and microscopic cryptocrystalline grains, while coarse crystalline grains are rare, so they appear slightly transparent and have a rather strong oily luster (al D. C., 06 January 2023)

#### **4. Geological Setting**

##### **4.1 Tectonic**

Jalalabad tectonic zone is located in the eastern part of Afghanistan and the SE part of Nuristan block. It was first identified in 1969 by Prof. Slavin as called the Tectonic Zone of Jalalabad, which is located and named Block of Nuristan. Correspondingly, the zone is related to the upper Cambrian or younger Cambrian. The basic metamorphic rocks are exposed in the Spinghar Mountains. They can also be observed in the eastern part of that zone, southeastern parts of Jalalabad city on the left bank of Kabul and Kunar River. In the central part of this zone, the Neogene sediments have been positioned in the new tectonic depression. In the tectonic map of 1976, in this area, sub-zones are isolated, which are called Kunar, Spinghar and Jalalabad depressions. (Peters, 2011)

The Nephrite of mineralization includes a group of actinolite and tremolite deposits that have formed as a result of the contact metasomatic impact of ultra-acidic mafic rocks with adjacent rock, such as phyllite and serpentinite metamorphic rock, upon Precambrian carbonate rocks in the Nurestan block. The nephrite occurrences are confined to a unit of calcite \_ dolomitic marble beds occurring in serpentinite and phyllite. A group of unique nephrite deposits is located in the Nuristan Block. Nephrite deposits and occurrences have been found in the areas that extend in veins and lens shapes for more than a few meters and 10 meters. And underlain by phyllite, calcite and dolomitic marbles and hornblende and biotite-garnet schists, garnet amphibolite and skarns. Nephrite is subdivided into Jade, which is a semi-precious gemstone that is further classified into two categories named Jadeite and Nephrite, divided into two groups of actinolite and tremolite deposits (Minerals in Afghanistan: Rare-Metal Deposits. British Geological Survey, Afghanistan project. Available from <https://www.bgs.ac.uk/afghanminerals/> last, 13 May 2019)

The stratigraphy of the Jalalabad zone is different in terms of age and composition; the oldest sediments are related to the Archean (Proterozoic) period, and the youngest to the Quaternary period, which means that there are sediments of all periods in this zone. Magmatic rocks are vastly developed in the Jalalabad zone, and they are outcropped along Kunar Valley and the Spinghar Mountain series. In the Jalalabad zone, the following magmatic complexes can be separated:

- I. Granites and gabbro amphibolite complex, Upper Proterozoic (PR3)
- II. Granite and granodiorites complex, Upper Paleogene (PZ) (Mohammad Aziz Amini, 2022)

##### **4.2 Mineral Deposit**

From the point of view of mines, the Jalalabad zone is not that much rich in mines. In this zone, the Achin and Ghunday magnesite and talc deposits occur within the east-west trending Spinghar Zone; the Spinghar Zone consists mainly of Early Proterozoic metamorphic rocks. The largest portion of this zone consists of middle Paleoproterozoic marble, biotite and garnet-staurolite-biotite gneiss and schist, quartzite, and amphibolites. Smaller portions of this zone consist of early Paleoproterozoic 2-mica, biotite, biotite-amphibole, garnet, garnet sillimanite biotite, pyroxene-amphibole, plagioclase, and cordierite gneisses, along with schist, quartzite, marble, and amphibolite. Other Proterozoic rocks consist of granite-gneiss, granite, and Plagiogranite and a minor amount of middle Proterozoic Meta volcanic lava[8,9]. Early Cretaceous rocks consist of gabbro, monzonite, diorite, and granodiorite intrusions. The rock unit codes noted above are those from. (chmyrinov a. a., 2008)

The northern part of the Ghunday-Achin magnesite and talc is covered mainly by Pliocene, and Quaternary conglomerate and sandstone Rocks of the Spinghar Zone may extend under the Pliocene and Quaternary cover. Detailed maps of the individual deposits are available (Figure. 3.1). In addition to surface geologic maps, audit maps, cross-sections, and long sections contain important information regarding the geology and geochemistry of these deposits. In the eastern parts of the Jalalabad tectonic zone, there are Nephrite veins and lens shape interlayered serpentinites and dolomite marble rock. (Mohammad Aziz Amini, 2022)

#### **5. Results**

##### **5.1 Petrographic analysis**

The petrographic examination indicates the origin of the rock, including whether it is volcanic, sedimentary, or metamorphic, as well as the mineral content. As part of an analysis, the rock's fabric, color, grain size, and other pertinent characteristics that can be seen in hand specimens or outcrops are typically described. However, the focus of analysis is primarily on the identification and description of microscopic characteristics of the studied material in thin sections, such as mineral composition, texture, grain size, and signs of alteration or deformation. (Mohammad Aziz Amini, 2022).

The neighboring rock to nephrite, dolomitic marble, has been examined with a petrographic microscope. They provide the following results, which are proved.

#1: the first sample based on Petrographic analyses is Marble with massive texture and granoblastic structure.

#2: the second sample based on Petrographic analyses is Amphibolite Schist with massive texture and granoblastic structure.

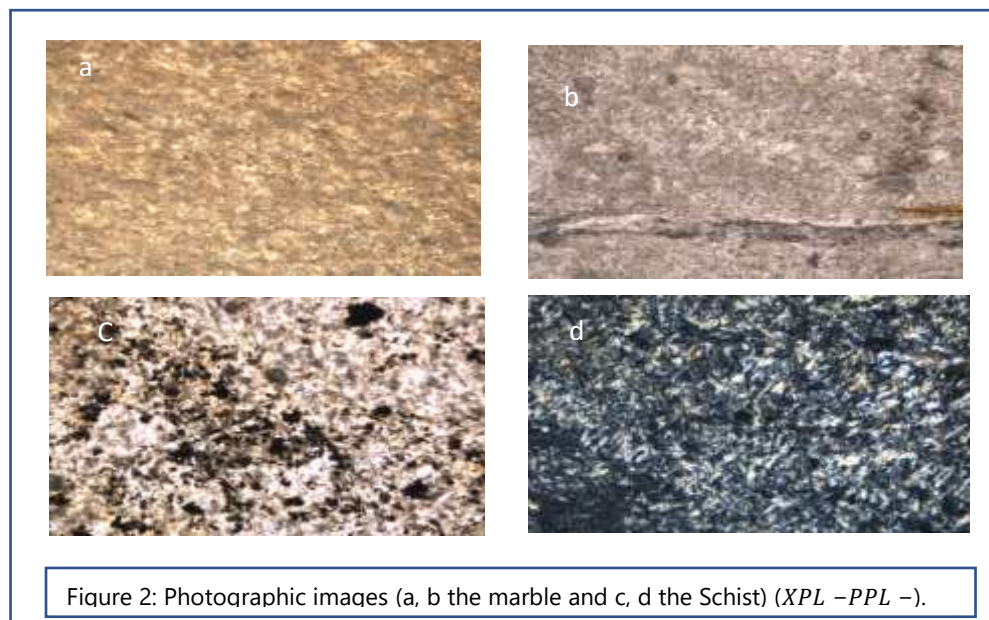


Figure 2: Photographic images (a, b the marble and c, d the Schist) (XPL -PPL -).

## 6. Chemical analysis

The chemical analysis shows the element percentage in Nephrite and its adjacent rocks; the result is shown in the following table.

Element	Bal	Si	Mg	Ca	Fe	Cl	Ba	Ti	Name of rock
Value of #1	89.23	14.24	1.01	6.17	1.21	1.28	1.01	1.00	Marble
Value of #2	44.22	38.86	22.00	11.24	4.16	2.36	1.23	1.02	Nephrite
Value of #3	55.02	28.81	211	5.16	9.27	1.01	2.33	1.20	Amphibolite Schist
Value of #4	41.80	17.48	17.18	3.10	2.35	1.36	1.11	0.00	Nephrite
Value of #5	22.50	18.32	23.61	11.18	7.29	1.22	1.22	1.02	Nephrite
Analysis Method	XRF								
Specimen Collected Date	16/04/2022								
Specimen Analysis Date	19/07/2023								

## 7. Results and Discussion

The goal of this study was to examine the geochemical and petrographic studies of the Nahartangi nephrite occurrences in the province of Nangrhar. Nephrite is typically found in metamorphic rocks (serpentines), with some contact metamorphic rocks also containing nephrite. Nephrite from the Goshta district contains many types of other minerals, including chromite, according to chemical analysis in particular. Because of these studies, the nephrite from Goshta district Nahartangi area is revolutionized and composed (serpentines), and the majority of the touch rock is composed of schist. Nephrite is one of the decorative rocks whose physical characteristics significantly affect its quality and cost, and it has a crucial role. Hardness, color, and clarity are the three primary physical properties of nephrite, and to avoid inclusion, the outstanding quality of nephrite is certain in accordance with these qualities. The financial system and its charges are immediately impacted by the color and its clarity because of the long lifetime of the chrome and iron elements; the nephrite from the Goshta district is found in a greenish tint.

## 8. Conclusion

In conclusion, this study concentrated on analyzing the geochemical and mineralogical properties of the Nahartangi nephrite deposit in the Nangarhar province's Goshta area. Nephrite, which has the chemical formula  $\text{Ca}_2(\text{Mg,Fe})_5\text{Si}_8\text{O}_{22}(\text{OH})_2$ , is a

cyclosilicate mineral having a high silicate concentration. Specifically, in the Nahartangi nephrite zone connected to the Jalalabad structural band and the ophiolite complex, it is mostly found in metamorphic rocks. It was discovered through fieldwork and petrographic analysis that the Nahartangi nephrite deposits are closely related to dolomitic marble and intrusive granitoids. Fine-grained metamorphic minerals like dolomite, schist, and actinolite constitute the majority of the nephrite's mineralogical composition. Geochemical analysis showed low  $\text{Fe}/(\text{FeO}+\text{MgO})$  values and low concentrations of  $\text{SiO}_2$ ,  $\text{Al}_2\text{O}_3$ ,  $\text{CaO}$ , and  $\text{NiO}$  in the nephrite samples. Furthermore, the presence of veins and hydrothermal lenses in contact with serpentinite and carbonates has contributed to the formation of nephrite deposits. The economic value of nephrite is influenced by its color and transparency, with the presence of magnesium elements giving the nephrite from the Goshta district its green appearance. The research aimed to provide a comprehensive understanding of the geological systems, geochemical analysis, mineral composition, petrological characteristics, and physical properties of Nahartangi's nephrite. The findings can serve as a valuable reference for the Afghanistan Geological Survey (AGS) and related research institutions. It is crucial to remember that this study had some limitations, such as safety issues, a lack of previous mining operations, and limited geological research in the region. The lack of reputable labs and suitable equipment made the research difficult. Overall, by throwing light on its geological and mineralogical characteristics and giving insights into its economic relevance, this research adds to our knowledge of and comprehension of the Nahartangi nephrite deposit.

## **9. Suggestion**

Based on a full detailed study we would like to give some suggestions which are as follows:

1. Further Exploration: Conduct additional field research and exploration activities in the Nahartangi nephrite deposit area to gain a more comprehensive understanding of its extent, distribution, and potential for commercial extraction.
2. Economic Assessment: Conduct a detailed economic assessment of the Nahartangi nephrite deposit, taking into account factors such as market demand, pricing, supply chain logistics, and potential profitability. This would help determine its economic viability and inform decision-making regarding future mining operations.
3. Environmental Impact Assessment: Conduct an environmental impact assessment to evaluate the potential environmental consequences of mining activities in the Nahartangi nephrite deposit area. This would help ensure that any future mining operations are conducted in an environmentally sustainable manner, minimizing negative impacts on the surrounding ecosystem.
4. Collaborative Research: Foster collaboration between the Afghanistan Geological Survey (AGS), relevant research institutions, and international experts to further study the Nahartangi nephrite deposit, which would facilitate knowledge sharing, technical expertise, and access to advanced laboratory facilities, overcoming the limitations mentioned in the study.
5. Safety Measures: Implement appropriate safety measures and protocols to address the safety concerns associated with mining activities in the area, which would ensure the well-being of workers and minimize the risk of accidents or hazards during exploration and extraction processes.
6. Community Engagement: Engage with local communities and stakeholders to raise awareness about the Nahartangi nephrite deposit, its potential economic benefits, and the importance of sustainable mining practices; it would help build positive relationships, address any concerns, and ensure that the local community benefits from the development of the deposit.

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