



Updates on the Definition of Lapis Lazuli: What's Changing?

Stefania Coppola¹, Manuela Rossi²

¹ Department of Earth Sciences, Environment and Resources, University of Naples Federico II
Email address of the presenting author: stefania.coppola.1992@gmail.com

According to the definitions found in the literature until recently, lapis lazuli was described by most of the scientific community “as a metamorphic rock characterized by the presence of the mineral lazurite (which gives the rock its blue color), combined with other minerals whose presence and quantity vary among different localities of origin.” (Favaro et al., 2012; Re et al., 2013; Calligaro et al., 2014; Ali et al., 2014; Angelici et al., 2015; Gambardella et al., 2016; Lo Giudice, 2017; Ganio et al., 2017; Saleh et al., 2020). However, back in 2020, Belley and Groat, in defining lapis lazuli, highlighted that “it is a rock composed mainly of a feldspathoid: haüyne, commonly mistaken for lazurite,” while Gambardella et al. (2020) described lazurite as a phase “often considered a sulfur-rich form of haüyne.”

After 2021, the definition of lapis lazuli changed. It is now defined as “a polymineralic aggregate with a high percentage of lazurite and/or other sodalite-group minerals in various shades of blue. The gemological quality of the rock is determined by the color of these minerals, their proportion, their homogeneous distribution, and their granularity” (Sapozhnikov et al., 2022). Additionally, Sapozhnikov et al. (2022) specify: “Our investigations have shown that the vast majority (>90%) of the studied samples of lazurite-group minerals from deposits in the Lake Baikal area, the Pamirs, and Afghanistan, unlike the lazurite holotype, should be considered an S-rich variety of haüyne. It is also important to distinguish the use of the term ‘lazurite’ in a mineralogical sense from its use in a gemological context. In the latter case, the term ‘lapis lazuli’ refers to a specific ornamental rock or polymineralic aggregate in which a blue sodalite-group mineral is predominant.”

Currently, the International Mineralogical Association (IMA) defines lapis lazuli as follows: “The name lapis lazuli has been used both to describe the blue mineral previously known as lazurite (which in most cases is actually a sulfur-rich variety of haüyne) and to describe the rock composed predominantly of this mineral along with calcite, pyrite, and other minerals. In general, today the name lapis lazuli is used to describe the material used as an ornamental stone (i.e., the rock) rather than the mineral component. Many of the properties of lapis lazuli nonetheless refer to the blue mineral (an opaque sulfur-rich gem, haüyne) that is predominant in the rock. Worldwide, practically all occurrences of lapis lazuli contain haüyne, vladimirivanovite, afghanite, etc. The species lazurite is actually ultra-rare, and practically no sample to date is known to contain true lazurite. Therefore, the vast majority of lapis lazuli samples contain haüyne, the mineral responsible for the characteristic intense blue color that distinguishes this rock.”

Thus, the definition has shifted from focusing on one specific mineral—lazurite—to a description that includes a number of other minerals, such as sulfur-rich haüyne and blue sodalite-group minerals, and even afghanite. The change in the definition of lapis lazuli is closely tied to its



mineralogical composition, particularly the mineral responsible for its typical and distinctive blue coloration.

For defining lazurite, the IMA had been using an ideal formula with S in reduced form as the dominant anion rather than sulfate ($\text{Na}_6\text{Ca}_2(\text{Al}_6\text{Si}_6\text{O}_{24})\text{S}_2$), in line with the structural data presented by Hassan et al. (1985). However, this formula—introduced in the title of the cited article and subsequently included in the IMA’s mineral list—does not match the structural data of the two samples studied by Hassan et al. (1985). The molar content of the $(\text{SO}_4)^{2-}$ anionic group is significantly higher than that of S^{2-} ions, making lazurite essentially an S-rich variety of haüyne or simply a theoretical end-member of a series with haüyne. To address this issue, the IMA, based on the work of Sapozhnikov et al. (2021), made the presence of the $(\text{S}_3)^{-1}$ anion explicit in the crystal-chemical formula of lazurite—this ion is also responsible for the mineral’s blue color. In short, the previously cited general formula was $\text{Na}_6\text{Ca}_2(\text{Al}_6\text{Si}_6\text{O}_{24})(\text{SO}_4, \text{S}, \text{S}_2, \text{S}_3, \text{Cl}, \text{OH})_2$; it is now redefined as $\text{Na}_7\text{Ca}(\text{Al}_6\text{Si}_6\text{O}_{24})(\text{SO}_4)(\text{S}_3)^{-1} \cdot \text{H}_2\text{O}$. Meanwhile, the formula for haüyne remains unchanged: $\text{Na}_3\text{Ca}(\text{Si}_3\text{Al}_3)\text{O}_{12}(\text{SO}_4)$.

So what happens now? How should one describe lapis lazuli? Will the value of the gemstone change depending on which blue mineral it contains?

Furthermore, can sodalite be regarded as the mineral responsible for lapis lazuli’s typical color, since generally the blue color of lazurite, haüyne, and sodalite-group minerals is given by the presence of the trisulfide anion radical $(\text{S}_3)^{-}$? In the case of sodalite, the blue color is due to the presence of colloidal particles of metallic sodium (Gritsenko et al., 2023). Does this imply a devaluation of lapis lazuli containing sodalite?

From a scientific standpoint, it is crucial to stay constantly up to date by reading new publications, or else risk using incorrect or outdated definitions. This problem is evident in recent studies such as Soltani et al. (2023):

“The Persian name for lapis lazuli is lazward, meaning ‘blue’ as a color. The main ‘blue’ mineral is lazurite, an aluminosilicate ($\text{Na}_6\text{Ca}_2(\text{Al}_6\text{Si}_6\text{O}_{24})(\text{SO}_4, \text{S}_3, \text{S}_2, \text{Cl}, \text{OH})_2$) belonging to the sodalite group, associated with other minerals such as diopside, quartz, calcite, and pyrite, which form the lapis lazuli rock.” (Faryad et al., 2011; Calligaro et al., 2011; Rogić et al., 2011; Smith & Klinshaw, 2009)

Similarly, Oudbashi et al. (2024) refer to:

“XANES spectroscopy of lazurite from different lapis lazuli samples for provenance studies (Gambardella et al., 2016; Ganio et al., 2018; Fleet et al., 2005).” They also note that “Studies on the most famous lapis lazuli deposits in Sar-e-Sang, Badakhshan (Afghanistan), have revealed the presence of various feldspathoid-group minerals (scapolite and sodalite), including lazurite (as the main phase), sodalite, haüyne, and afghanite.” (Faryad, 2002; Nöller et al., 2019; Favaro et al., 2012; Wyart et al., 1981; Yurgenson & Sukharev, 1985).

This change in the definition of lapis lazuli underlines the dynamic nature of mineralogical classifications. The distinction between lazurite, haüyne, and other minerals of the sodalite group is crucial for both scientific and gemological applications. Researchers and gemologists should remain constantly updated and in communication to ensure not only correct identification and description of the gemstone but also an accurate and uniform assessment. A case study will be re-evaluating my thesis in light of the new definition of lapis lazuli.

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