Correlation between Colour and Fluorescence of Lapis lazuli

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Colour and fluorescence of lapis lazuli depend on its mineral components. UV-VIS- and fluorescence-spectra of specimen rich in lazurite differ from those rich in haüyne.

Lapis lazuli is defined as a rock of varying composition. The following minerals have been identified in this rock by X-ray diffraction: lazurite, haüyne, sodalite, nosean, mica, diopside, wollastonite, calcite and pyrite. Among them the first two minerals, lazurite and haüyne, are responsible for the unique blue colour of massive lapis lazuli [1]. As it has been proved [2], the blue colour of lapis lazuli varies in hue and intensity according to the predominance of either lazurite or haüyne. The present note deals with the correlation between colour and fluorescence of different types of lapis lazuli.

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Thirty homogeneously coloured samples from Afghanistan and Chile were investigated by the following methods: UV-VIS-, Infrared- and Fluorescence-spectroscopy. The UV-VIS-spectra of the samples were measured by a spectrophotometer Lambda 3 (Perkin Elmer) from 300 to 700 nm. The samples can be divided into two groups according to their remission spectra. Spectra of the samples belonging to group A are typical for samples from Afghanistan, and those of group B are typical for samples from Chile. The samples of group A show two characteristic remission maxima at 375 and 460 nm, in contrast to the samples of group B, which show only the remission maximum at 460 nm (Fig. 1). Due to the similarity of the IR-spectra of the samples of group A to that of haüyne, it is concluded that their colour is due to haüyne. Similarly, it is concluded that lazurite causes the colour of the samples of group B.

The fluorescence spectra of the samples were measured by a double beam fluorescence spectrophotometer (Spex, Model F 212). As it is shown (Fig. 2), the spectra of group A differ considerably from those of group B. The emission peak at $\lambda = 460$ nm for the excitation wavelength $\lambda = 380$ nm is common to both groups. But in contrast to the spectra of the samples of group A those of group B show five more emission peaks at 580, 601, 643, 660 and 669 nm for the same excitation wavelength $\lambda = 380$ nm.

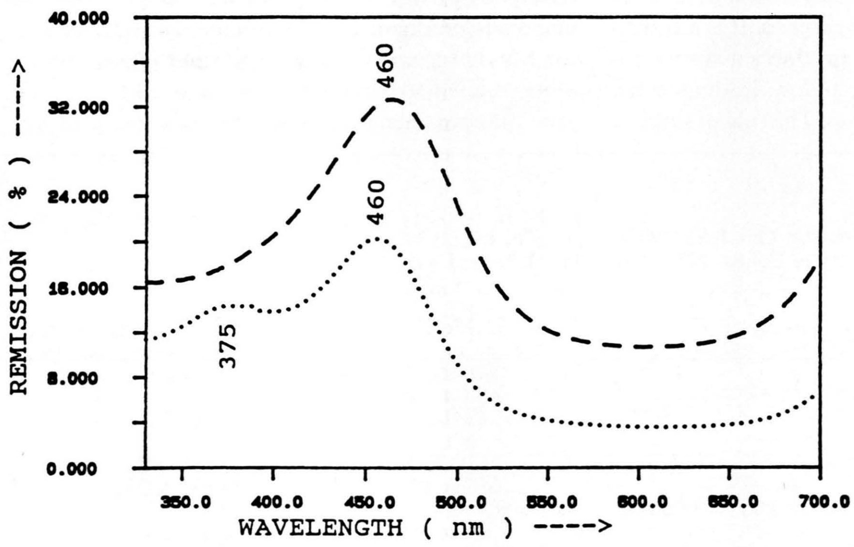

Fig. 1. UV-VIS spectra of lapis lazuli. (Below): lapis lazuli from Afghanistan (group A), (above): lapis lazuli from Chile (group B).

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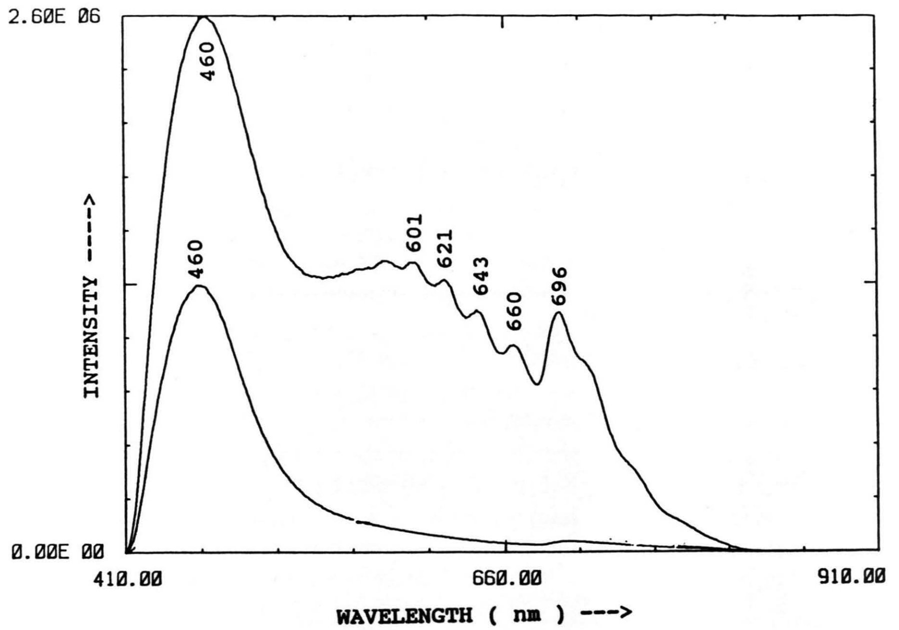

Fig. 2. Emission spectra of lapis lazuli for excitation wavelength $\lambda = 380$ nm. (Below): lapis lazuli from Afghanistan (group A), (above): lapis lazuli from Chile (group B).

As has been pointed out in [3], the colour of lapis lazuli can be explained as an anion-anion charge transfer. According to [4], the S_3^- ion is responsible for the colour of lapis lazuli. Sulphur has the configuration $3s^2\,3p^4$, so that the S_3^- ion has a total number of 19 outer electrons in molecular orbitals. It is a transition among these orbitals that produces a strong absorption band at 660 nm in the yellow, leading to the blue colour with purple overtones. The role of sulphur as cause of fluorescence of some minerals like sodalite was investigated in [5]. A comparison of the fluorescence spectra of lazurite and haüyne with those of both groups shows that the lazurite-rich samples (group B) posses all the emission peaks of lazurite under the emission wavelength $\lambda = 380$ nm, whereas the emission peak of the samples of group A coincide more or less with the emission peak of haüyne for the excitation wavelength $\lambda = 380$ nm mentioned above.

[1] K. Scarratt, J. Gem. **20,** 1 (1986).
[2] A. Banerjee and T. Häger, Ber. Dt. Min. Ges. **1,** 12 (1990).
[3] K. Nassau, Physics and Chemistry of Colour **149,** John Wiley, New York 1983.
[4] K. H. Schwarz and U. Hofman, Z. Anorg. Allg. Chem. **378,** 152 (1970).
[5] D. Dirk, J. Electrochem. Soc. **101,** 461 (1954).

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