

## Correlation between Colour and Fluorescence of Lapis lazuli

A. Banerjee

Institut für Geowissenschaften der Universität Mainz,  
D-55099 Mainz

Z. Naturforsch. **48 a**, 1267–1268 (1993);  
received September 29, 1993

Colour and fluorescence of lapis lazuli depend on its mineral components. UV-VIS- and fluorescence-spectra of specimens 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.

Reprint requests to Dr. A. Banerjee, Institut für Geowissenschaften – Edelsteinforschung –, Universität Mainz, Saarstraße, D-55099 Mainz.

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.

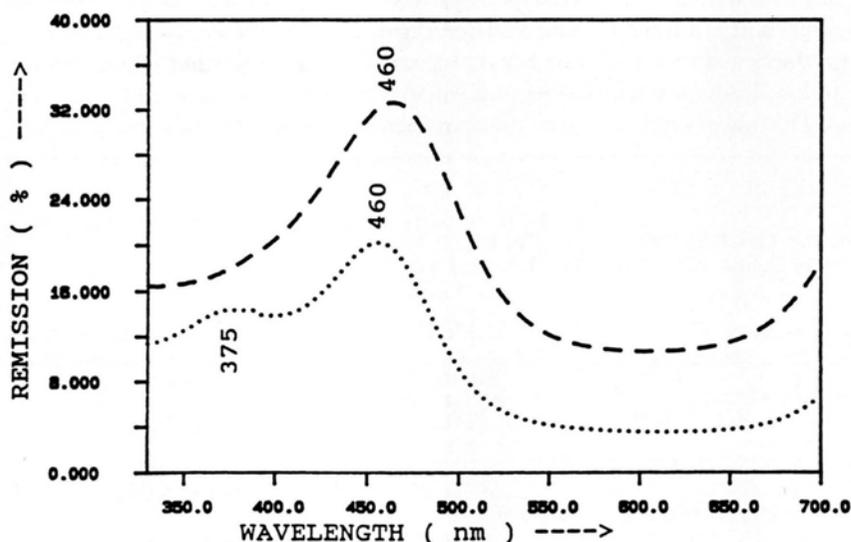


Fig. 1. UV-VIS spectra of lapis lazuli. (Below): lapis lazuli from Afghanistan (group A), (above): lapis lazuli from Chile (group B).

0932-0784 / 93 / 1200-1267\$ 01.30/0. – Please order a reprint rather than making your own copy.



Dieses Werk wurde im Jahr 2013 vom Verlag Zeitschrift für Naturforschung in Zusammenarbeit mit der Max-Planck-Gesellschaft zur Förderung der Wissenschaften e.V. digitalisiert und unter folgender Lizenz veröffentlicht: Creative Commons Namensnennung-Keine Bearbeitung 3.0 Deutschland Lizenz.

Zum 01.01.2015 ist eine Anpassung der Lizenzbedingungen (Entfall der Creative Commons Lizenzbedingung „Keine Bearbeitung“) beabsichtigt, um eine Nachnutzung auch im Rahmen zukünftiger wissenschaftlicher Nutzungsformen zu ermöglichen.

This work has been digitalized and published in 2013 by Verlag Zeitschrift für Naturforschung in cooperation with the Max Planck Society for the Advancement of Science under a Creative Commons Attribution-NoDerivs 3.0 Germany License.

On 01.01.2015 it is planned to change the License Conditions (the removal of the Creative Commons License condition "no derivative works"). This is to allow reuse in the area of future scientific usage.

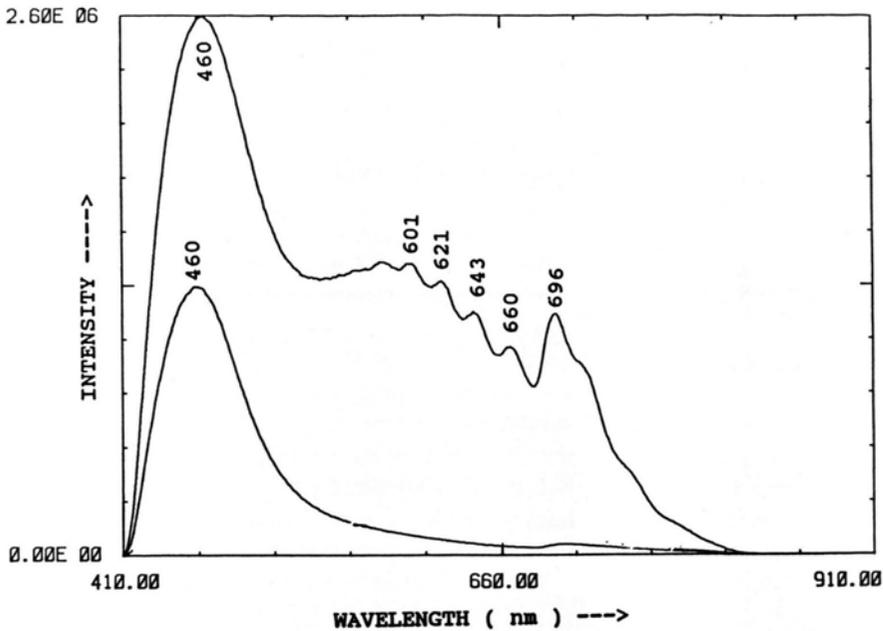


Fig. 2. Emission spectra of lapis lazuli for excitation wavelength  $\lambda = 380$  nm. (Below): lapis lazuli from Afghanistan (group A), (above): lapis lazuli from Chile (group B).

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) possess all the emission peaks of lazurite under the emission wavelength  $\lambda = 380$  nm, whereas the emission peak of the samples of group A coincides 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).