

and covered by $\frac{7}{8}$ inch square cover glasses. It was, therefore, decided to limit the movement of the reference arm to 0.90 inch, (23 mm.). The distance that the thin section can move parallel to the reference arm is limited by the length of the thin section because the corners hit the mounting of the inner circle of the universal stage during manipulation. For universal stage work thin sections are cut to length between 1.6 and 1.8 inches, i.e. producing 25 mm. \times 45 mm. to 25 mm. \times 40 mm. thin sections. With the larger size the square area that can be brought beneath the crosswires is 14 \times 14 mm. and with the smaller 19 \times 19 mm. Allowing for the fact that it is not necessary to bring the grains beneath the crosswires the use of the smaller (25 mm. \times 40 mm.) glass slip will permit as much rock slice as can be mounted below a $\frac{7}{8}$ inch square (22 mm.) cover glass to be examined.

This device is designed to be fitted on the normal hemisphere mount of the Leitz U.T.4 or similar universal stage. The same principle of having the reference arm at right angles to the long axis of the hemisphere mount can be adopted in making up special hemisphere mounts as is indicated by the sketch in Fig. 3. In this design the hemisphere mount is cut away to enable the thin section to be moved more easily.

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ACTIVATION OF PHOTOLUMINESCENCE IN ARTIFICIAL CALCITE BY STANNOUS ION

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INTRODUCTION

Activation of calcite fluorescence has received a great deal of attention in the past, although the results and interpretations have been contradictory. Headen (1906) suggested the yttrium group as possible activators but presented little definite evidence. Nichols (1918) confirmed manganese activation and suggested that heat might be necessary for fluorescence. Tanaka (1924), analyzing calcite cathodoluminescence with a spectrophotometer, decided the "active agent" was manganese and suggested as other "active agents," dysprosium, yttrium, thallium, samarium, and strontium. Brown (1934), analyzing natural calcite, found that 3.4 mole per cent manganese gave the most intense luminescence.

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On the other hand Northup (1940), also using natural specimens, found no definite relation between manganese content and luminescent intensity, but found that the sample with the most intense luminescence had 0.2 per cent lead while the others had only a trace. Fonda (1940) artificially precipitated luminescent calcite using manganese as an activator. Schulman and others (1947), following Fonda's (1940) method of preparation, determined that manganese does not activate alone but requires an auxiliary activator such as lead, thallium, or samarium.

This study was intended to establish other possible activators of calcite photoluminescence by synthesis under carefully controlled chemical and physical conditions. The experiments were carried out in the Mineralogical Laboratory of the Department of Geology, Cornell University, Ithaca, New York.

PREPARATION OF PHOSPHORS

The method of preparation was patterned after Fonda (1940). A cold solution of 0.150 molar $(\text{NH}_4)_2\text{CO}_3$ was added to one containing 0.075 molar CaCl_2 and other cations, and the resulting precipitate was heated for 10 minutes to refine the crystals and to insure uniform solid solution. Letting the precipitate stand in cold solution for 10 hours gives equal luminescence. The precipitate was examined under a microscope to determine crystal form, then filtered, washed, and dried. The precipitates were pure white in color. Luminescent intensity and color were observed at room temperature using a cold quartz ultraviolet source.

EXPERIMENTAL RESULTS

Addition of stannous ion to calcite activates a bright white fluorescence. The limits of visible fluorescence are 0.02 and 19.0 mole per cent, with the most intense fluorescence at 0.6 mole per cent. A trace of bismuth alters the stannous-activated fluorescence to green, lanthanum and neodymium to pale yellow, manganese to deep orange, and magnesium to bluish green. Stannic ion fails to activate.

Co-activation of manganese with other ions was confirmed. Many other ions were tried in various combinations and concentrations, without inducing visible fluorescence.

CONCLUSIONS

Tin activation of calcite appears to be substitutional since only the stannous ion produces fluorescence and relatively large mole percentages are necessary for activation. The color shifts caused by the addition of other ions are probably examples of partially or completely sensitized

activation, as discussed by Schulman and others (1947) for the case of manganese-lead activation of calcite.

In general, natural luminescence results from an impurity ion having an absorption spectrum close to the wavelength of the source used for examination. This impurity ion either acts as a dominant activator and controls the emission spectrum, or acts as an auxiliary activator and sensitizes the fluorescence by transferring its absorbed energy to one or more dominant activators. Thus many of the additional impurity ions in a natural phosphor may modify the fluorescent spectrum, and make indiscriminate use of fluorescence for mineral identification or correlation of doubtful value.

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ON THE STABILITY AND HYDROTHERMAL
SYNTHESIS OF BENITOITE

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Although extremely rare, the mineral benitoite ($\text{BaTiSi}_3\text{O}_9$) is of considerable interest since it represents one main type of chain structure in silicates; it also has some value as a gem stone. Furthermore, its temperature and pressure range of stability could perhaps assist in understanding the formation of the rocks in which it occurs.

No previous work has been reported on the synthesis or stability of benitoite although numerous papers have appeared dealing with its physical and optical properties and crystalline structure. These aspects are thoroughly reviewed by Dana (1949) and Bragg (1937). The work reported here has been done in conjunction with a study of the equilibrium relations in the system barium titanate-silica. The experimental conditions and results obtained are presented in detail in another paper by the authors (1954).

The most prominent interplanar spacings for benitoite are presented in Table 1, since none are available in the literature. These data were

* Contribution No. 54-57.