

components does not take place, but that these common cases of differentiation do not seem to show it. The hypothesis of quartz migration allows in addition a ready explanation of the development of differences of quartz fabric in the two limb types of asymmetric folds where grains in the two limbs often are of a different shape<sup>7,8</sup>. Thus, difference in mineral shape accompanies mobility of constituents.

Fig. 2 shows a rock in which crenulations are almost symmetrical. Here there is no formation of fold limbs alternately rich in quartz and in mica, but instead of quartz-rich zones along the axial plane traces. Here it seems that, since all limbs lay equally obliquely across the principal stress and were equally strained, silica-seeking areas of minimum strain concentrated in the fold hinges.

Thus the petrographic evidence is in favour of silica migration and quartz recrystallization rather than mica recrystallization as this allows crenulation differentiation (a conclusion suggested by Dewey<sup>8</sup> for kink bands). The ready diffusion of silica in a schistose quartz-mica fabric during deformation thus seems to be a most important element in the metamorphic differentiation of such rocks, and post-kinematic mica recrystallization is relegated to a role in developing other mica arrangements not possessing the continuous and well-marked schistose arrangement common to those illustrated here.

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## CHEMISTRY

### Fluorescence Quantum Yield of 1-Dimethylaminonaphthalene-5-sulphonate

FLUORESCENCE quantum yields may be determined with spectrofluorimeters simply by comparing the corrected emission spectrum of an unknown substance with that of a compound of known fluorescence yield<sup>1</sup>, provided that the relative numbers of photons reaching the solutions are known. Recently, 1-dimethylaminonaphthalene-5-sulphonate (DNS) in water at 25° was used by Churchich<sup>2,3</sup> as a fluorescence standard which was assumed to have a quantum yield of 0.53 as reported by Weber and Teale<sup>4</sup>. The assumption that this quantum yield figure was correct was also made by Slayter and Hall<sup>5</sup> for the purpose of calculating the efficiency of energy transfer in protein-dye conjugates. The purpose of the present communication is to direct attention to the fact that while DNS may be a suitable fluorescence standard, the quantum yield figure of 0.53 is incorrect. In fact, Bowen and Seaman<sup>6</sup> have already published data indicating that the quantum yield of DNS in water at 20° C is only about 0.29. These authors found that the quantum yields were higher in solvents of lower dielectric constant and took pains to exclude oxygen quenching by purging the solutions with a stream of carbon dioxide. Measurements of DNS quantum yield have been performed recently in this laboratory.

An Aminco-Bowman spectrofluorometer (American Instrument Co., Silver Spring, Md.) was calibrated by modifications of standard techniques (see ref. 7); and the fluorescence quantum yields were measured by comparison with quinine—it is well established that the latter has a quantum efficiency of 0.55 at 25° C in 1 N sulphuric acid<sup>1,8</sup>. The apparatus and its associated instrumentation have been described previously<sup>9,10</sup>.

Table 1. QUANTUM YIELDS OF 1-DIMETHYLAMINONAPHTHALENE-5-SULPHONATE AT 23°

Solvent	Q
Water (purged with N <sub>2</sub> )	0.37 ± 0.01
0.1 M NaHCO <sub>3</sub>	0.36 ± 0.01
0.5 M NaHCO <sub>3</sub>	0.33 ± 0.01
1.0 M NaHCO <sub>3</sub>	0.31 ± 0.01
95 per cent ethanol (purged with N <sub>2</sub> )	0.72 ± 0.02

The results obtained are shown in Table 1. DNS was found to have a quantum yield of 0.37 in water, but the fluorescence was quenched in bicarbonate solutions. The value  $Q = 0.31$  in 1 M sodium bicarbonate is reasonably close to that reported by Bowen and Seaman<sup>6</sup>, so it can be assumed that their low figure was due to quenching as a result of the use of carbon dioxide to purge their solutions of oxygen. These authors also showed that the quantum yield of DNS in ethanol at 20° C, also purged with carbon dioxide, rose to about 0.75. This figure compares well with our measurements in ethanol purged with nitrogen. In ethanol, then, there is no appreciable quenching by carbon dioxide. Since the solubility at 25° C of carbon dioxide in ethanol is about four times that in water<sup>11</sup>, the quenching observed in aqueous solutions is probably due to the HCO<sub>3</sub><sup>-</sup> species.

DNS in 0.1 M sodium bicarbonate has now been used in this laboratory as a fluorescent standard ( $Q = 0.36$ ), and the results are the same as those obtained when quinine is used as the standard. DNS is easily crystallized, reasonably stable, and there is little overlap of the absorption and emission bands. Experience with our instrumentation leads us to agree with Parker and Rees<sup>1</sup> that determinations of quantum yield utilizing a comparison with a standard are probably more accurate than 'absolute' methods which attempt to measure  $Q$  directly.

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### Cadmium-109 in New Zealand Rainwater

CADMIUM-109 has been detected in rainwater collected at the Institute of Nuclear Sciences site, Lower Hutt, New Zealand. This isotope is presumed to have been produced during the high altitude nuclear detonation, 'Starfish Prime', carried out over Johnston Island on July 9, 1962. The cadmium-109 was introduced at an altitude of 400 km to investigate distribution and fallout for debris injected at the outer edge of the ionosphere<sup>1</sup>.

Cadmium-109, which has a half-life of 470 days, decays by electron capture to silver-109m ( $t_{1/2} = 40$  sec). In the experiments to be reported the specific activity of the cadmium-109 in the samples was determined by measurements on the 22–25-keV  $K$  X-rays which follow the electron capture process and which also arise from internal conversion of the 88-keV radiation in the decay of silver-109m.

Measurements have been made on monthly rainwater samples collected between April and October 1964. Initially samples were collected in a stainless steel vessel; this was later supplemented by a polythene-lined tray. Both vessels yielded similar activities in the October collection, but the September results are significantly