

lower than before the recovery. However, at the very start of the experiment it did not make too much difference whether the specimens were fully annealed or in the heavily deformed condition. (That is, heavily deformed at room temperature.) The number of defects produced per unit strain was virtually the same for a specimen in either condition and was higher than the increase observed on a specimen deformed after a prior liquid nitrogen deformation and recovery treatment. Thus the temperature of deformation plays a major part in this behaviour.

During the recovery of cadmium previously deformed at 78° K preferred orientation in the specimen has been observed to occur. This suggests that the effect observed is due to orientation of the cadmium crystals with some crystallographic directions more amenable to defect production than others. Apparently liquid nitrogen deformation causes this phenomenon to arise more readily than elongation at room temperature.

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## GEOCHEMISTRY

### Informational Characteristic of Frequency Distributions in Geochemistry

MANY years after Clark's investigation, only average content of chemical elements was used for comparison in different geochemical investigations<sup>1</sup>. Recently it was understood that it is necessary to investigate not only average content of an element but also a whole frequency distribution<sup>2,3</sup>. But useful investigation of the frequency distribution is rather difficult since it is necessary to reveal the stochastic model of the geochemical process which causes this distribution<sup>4</sup>. It is impossible to do this in routine geochemical investigations, and thus it is necessary to choose some simple estimators of distribution which emphasize its specific features and, above all, the quantity of information included in this distribution about concentration of the element in a random sample.

My experience indicates that the best estimator for this purpose is the informational measures, and in particular entropy of distribution<sup>5</sup>:

$$H(x) = - \sum_{i=1}^n p_i \ln p_i$$

where  $H(x)$  is the entropy of the distribution of the element  $x$ ,  $n$  is the quantity of classes of frequency distribution, and  $p_i$  is a frequency or result of dividing the number of observations in the  $i$ th class by the general number of observations.

The entropy reflects the behaviour of frequencies in compliance with the geochemical process generating the distribution. Really the distribution which degenerates to one class ( $\delta$ -function) has the smallest entropy and the highest quantity of information about possible concentration of investigating element in the random sample. The uniform distribution has the highest entropy and the biggest uncertainty in estimating the concentration of element in the random sample. The U shape distribution carries the information about specific features of the geochemical process and it has rather a small entropy and rather a big quantity of information.

The entropy is a convenient measure for theoretical investigation; but in practice it is inconvenient in geochemistry because its value connected with the quantity of classes of distribution is dependent on the system of logarithms and the highest value is unlimited. This makes entropy inconvenient for comparison with the different distributions.

The coefficient of information can be offered as more convenient informational measure for geochemical practice than entropy. It can be determined as follows:

$$I_x = \frac{\ln n - H(x)}{\ln n}$$

$I_x$  is independent of the system of logarithms,  $0 \leq I_x \leq 1$ ,  $I_x = 1$  for  $\delta$ -function and is equal to 0 for uniform distribution; other distributions are characterized by  $I_x$  between 0 and 1.

Table 1 shows the real values of  $I_x$  for the distribution of  $TiO_2$  in granitic rocks of different regions of the world. The analyses were taken from the literature.

Table 1. FREQUENCY DISTRIBUTIONS OF  $TiO_2$  (IN GRANITIC ROCKS WITH  $SiO_2 \geq 60$  PER CENT) FROM DIFFERENT REGIONS

Classes	Finland (to the south of Rovaniemi)	Ukraine shield	Trans- and near Baikal	South Africa	French Guiana	Canada shield*	Australia
1	4	5	21	7	17	16	107
2	10	35	24	28	30	28	98
3	28	26	23	23	32	23	69
4	22	22	25	28	18	21	49
5	23	15	24	11	16	18	35
6	11	9	10	11	16	6	27
7	12	—	7	1	14	2	23
8	8	1	5	1	9	1	9
9	—	3	2	2	7	1	7
10	7	—	2	1	4	2	1
11	1	2	—	4	—	—	4
12	5	—	4	—	—	—	2
13	5	—	—	1	1	1	1
$I_{TiO_2}$	0.105	0.250	0.146	0.244	0.133	0.250	0.211

\* South-eastern part.

If we have a set of chemical analyses of some geochemical object it is convenient to characterize this set with small quantity of 'estimators'. The coefficient of information is an important estimator among others. If we wish to characterize the set of analyses with only two estimators, it is correct in such a case to use the average and the informational coefficient.

The coefficient of information can be used in lithology as the coefficient of sorting and in palaeontology for estimating distributions of taxonomic characteristics.

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## CRYSTALLOGRAPHY

### X-ray Diffraction Study of the Electron Density Distribution in Cyanuric Acid

FOR some time<sup>1</sup> X-ray crystallographers have been seeking information about the electron density distribution in chemical bonds. This communication reports some results recently obtained for cyanuric acid at 100° K. Experimental details are listed in Table 1; crystal axes and space-group are as in previous work<sup>2,3</sup>.

An anisotropic least-squares refinement, which included 941 reflexions, carried  $R$  down to 4 per cent<sup>4</sup>. The resulting bond-lengths and -angles are shown in Fig. 1. After

Table 1. EXPERIMENTAL DETAILS

Space group	$C2/c$
Cell constants at 100° K	$a = 7.749 \text{ \AA}$ $b = 6.736 \text{ \AA}$ $c = 9.032 \text{ \AA}$ $\beta = 90.11^\circ$
No. of reflexions measured	968 (all reflexions for which $(\sin \theta)/\lambda < 0.8$ )
Apparatus	Three-circle diffractometer, scintillation counter with pulse-height discriminator, Philips PW 1010 generator
Technique	Molybdenum radiation; balanced filters (zirconium and yttrium). Stationary counter-moving crystal
Corrections applied for	(1) Absorption by crystal and capillary (2) Long-term drift, etc., by comparing with a standard reflexion