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MAGNETISM IN RELATION TO STRUCTURE*

AFTER a brief introduction by Prof. Krishnan, the discussion was opened by Sir C. V. Raman, F.R.S., N.L., with the subject "Magnetic Susceptibility of Minerals". He outlined the work that had been carried out in his laboratory for some time. Starting with a tektite from the island of Billiton which proved to be an isotropic glass-like material, successively other minerals have been studied for their magnetic behaviour. An examination of a number of tourmalines showed considerable variations in both susceptibility and anisotropy and the interesting result that there was a close correlation between the two was obtained. Results of even greater theoretical and practical interest were obtained with the minerals iron pyrites and augite.

The iron pyrites used in the investigations were obtained from Nepal in the form of cubes with well-developed faces and of a tin-white colour, instead of the more common golden yellow. The crystals exhibited a brilliant metallic lustre. The susceptibility of the large number of specimens investigated varied from 0.2×10^{-6} to 190×10^{-6} , the greater part, however, being near the lower value. All the specimens showed a decrease in susceptibility with increase in field strength, the dependence on the field strength being larger, the larger the susceptibility of the specimen. Temperature had apparently no influence nor was there any sign of remanent magnetism.

The behaviour of augite also showed interesting points, the mineral being axially ferromagnetic, anisotropic at low fields and isotropic at high field strengths. While no generalisations could be attempted at this stage, the observations may be considered to open up a fresh field and, as in other cases the magnetic investigation of naturally occurring minerals may throw light where studies with pure substances have failed!

* Report of a discussion at the Joint Annual Meeting of the Indian Academy of Sciences and the National Academy of Sciences, held at Poona, on 28-31 December 1944, with Professor K. S. Krishnan, F.R.S., in the Chair.

Dr. Mata Prasad, of the Royal Institute of Science, Bombay, next presented a brief resumé of the work carried out by him in collaboration with Dr. S. S. Dharmatti and other students, on "Ionic Susceptibilities and Molecular Configuration". After dealing with the historical background, both in theory and in experiment, which showed clearly the anomalous state of affairs in the correlation of theory with experiment, Dr. Prasad dealt at some length with his work on the sulphur group and in the alkaline earth group. The use of susceptibility data in the assignment of structures was illustrated by taking as examples sulphur monochloride (disulphur dichloride), the selenium analogue and chromium dioxide. It may be mentioned in passing that these results are not quite in accord with structures indicated by the study of other properties, a point to which attention was drawn in the course of the discussion.

An interesting observation pointed out by Dr. Prasad in dealing with the alkaline earth group was the apparent variation in the cationic susceptibility with the nature of the anion when salts of organic acids were studied. There appeared to be a correlation between "the total number of electrons" or the "number of carbon atoms in the molecule" and the increase in cationic susceptibility. Here again, one cannot overlook the possibility that the real abnormality is with the organic ion.

Dr. S. V. Anantkrishnan, of Madras Christian College, Tambaram, followed next with "Diamagnetism and Chemical Bonding". While Pascal's additivity relationship has served a useful purpose in correlating diamagnetic susceptibility with the structure of carbon compounds, as in case of other physical properties, a different method of interpretation is possible correlating susceptibility with molecular structure in the light of present knowledge on the nature of valency. Following the method of Gray and Cruikshank, but using Slater's method for the evaluation of ionic susceptibilities, the paramagnetic contribution through bond formation can be evaluated as 'bond-depressions'. Using these values and the known values of bond moments, diamagnetic susceptibilities of a large number of compounds on calculation gave consistently close agreement with the experimentally determined values. It was also noticed an empirical curve could be drawn correlating bond-order with bond-depressions and, using this curve, the calculated and observed values in the case of resonance structures showed good correlation. By the same procedure the susceptibilities of the ammonium and the nitrate ions could be evaluated and the sum of these gave the molecular susceptibility of ammonium nitrate within the limits of experimental error. It may be remarked that the accuracy of susceptibility determination preclude any use of this as a means of determining structure, but there is no reason to consider that these data should be interpreted without reference to existing knowledge as to structure and valency.

In the brief discussion that followed, Dr. C. Mahadevan, Dr. Dharmatti, Principal S. Bhagavantam, Prof. T. R. Seshadri, the Chairman and others took part.