sitivity for I^{129} have implications for many different kinds of tracer studies. When introduced into any system, I^{129} behaves essentially as a nonradioactive substance insofar as environmental effects and nuclear stability are concerned. Samples of the system or of any of its parts may be taken at any time following introduction of the tracer, and subjected at will to neutron-activation analysis. The net result of the sensitivity is that a single gram of I^{129} may be traced through processes which result in dilution factors up to 10^{13}. This is an equivalent dilution sensitivity to that attainable with about 350 curies of any radionuclide.

For full realization of the potentialities of the tracer applications described here for I^{129}, the base-level values (natural and artificial) described above should be established experimentally. Work is now in progress in our laboratories to obtain these values in pre-1945 and current biospheric, atmospheric, and hydrospheric iodine samples (*9*). Simple demonstration experiments of tracer applications of I^{129} in chemical systems (solubility of lead iodide), and in biological systems (with I^{125} as a parallel tracer) (*10*) have been performed successfully (*11, 12*).

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8. Since Br^{79} is "shielded" in fission by the 7×10^4 —yr Se^{79}, perturbations in the natural Br^{79}/Br^{81} ratios in upper atmospheric bromine might also be anticipated.
9. This work is supported in part by the U.S. Atomic Energy Commission.
10. R. L. Bogner, R. C. Koch, I. Gruverman, unpublished work.
11. Since preparing this manuscript, I have seen a prepublication copy of a paper from Argonne National Laboratory presenting a detailed analytical procedure for I^{129} (M. H. Studier, C. Postmus, Jr., J. Mech, R. R. Walters, and E. N. Sloth, *J. Inorg. Nucl. Chem.*, in press).
12. I acknowledge with pleasure stimulating discussions on this subject with R. A. Brightsen and other colleagues at NSEC, and with Professors Truman P. Kohman of Carnegie Tech. and Paul K. Kuroda of the University of Arkansas.

2 August 1962

Unit-Cell Dimensions of Natural and Synthetic Scapolites

Abstract. In natural scapolites the cell dimension *a* shows a regular increase from marialite to meionite composition, while *c* remains constant. Both *a* and *c* of synthetic meionite are larger than the corresponding dimensions of synthetic marialite. The cell volume of both natural and synthetic scapolites is a nearly linear function of composition. Variations in cell dimensions of scapolites may be caused by differences in structural state similar to those in plagioclase feldspars.

Scapolites are important constituents of certain marbles, skarns, volcanic rocks, and altered gneisses and igneous rocks. Most natural scapolites belong to a solid-solution series consisting primarily of the ideal end members marialite ($3NaAlSi_3O_8 \cdot NaCl$) and meionite ($3CaAl_2Si_2O_8 \cdot CaCO_3$). Scapolites are tetragonal, with the most probable space group $I4/m$ (*1, 2*). Synthesis of pure marialite was recently achieved (*3*). The meionite synthesis reported earlier by Eitel (*4*) has also been substantiated.

Published values for the cell dimensions *a* and *c* of a variety of natural scapolites show no systematic relationships when plotted against each other or against composition. Recently Shaw (*5*), in an extensive review of the geochemistry of scapolites, presented six new analyses. Burley, Freeman, and Shaw (*6*) found a reasonably good correlation between $[2\theta(400) - 2\theta(112)]$ and composition for these analyses. However, their determination of the space group appears to be in error, as it differs from that reported by Pauling (*1*) and Gibbs and Bloss (*2*) from single-crystal data.

Shaw kindly supplied us with samples of the analyzed scapolites. Values of 2θ of the (130), (301), (112), (321), (400), (141), and (312) reflections were carefully measured in duplicate with a Norelco x-ray spectrometer, with quartz ($a = 4.9131$ A, $c = 5.4046$ A at 18°C) as internal standard. Precise cell dimensions were then calculated on a digital computer, with a least-squares refinement procedure. The results are plotted in Fig. 1, with the compositions given as calculated from the analyses by Shaw (*5*). Also plotted are the cell dimensions, calculated in the same way, of six samples of synthetic marialite synthesized at 1 atm, in 80 to 450 hours, at temperatures between 770° and 850°C; and of five samples of synthetic meionite synthesized at CO_2 pressures between 1 and 4 bars, in 70 to 340 hours, at temperatures between 850° and 975°C (see also *3*). The cell dimensions of two scapolites published by Gibbs and Bloss are also included in Fig. 1.

No systematic relationships were noted between the conditions of synthesis of marialite and meionite and the cell dimensions. The mean values of the cell dimensions, together with standard errors of the cell dimensions estimated from the range of values obtained from different samples, are as follows: synthetic marialite, $a = 12.064$ A $\pm$ 0.008 A, $c = 7.514$ A $\pm$ 0.004 A, cell volume $= 1093.5$ A^3 $\pm$ 1.1 A^3; for synthetic meionite, $a = 12.174$ A $\pm$ 0.008A; $c =$ 7.652 A $\pm$ 0.015 A, cell volume $=$ 1134.1 A^3 $\pm$ 1.3 A^3.

Values of *a* of natural scapolites increase regularly with increasing meionite content (Fig. 1*a*), while the value of *c* is apparently independent of composition (Fig. 1*b*). In synthetic scapolite,

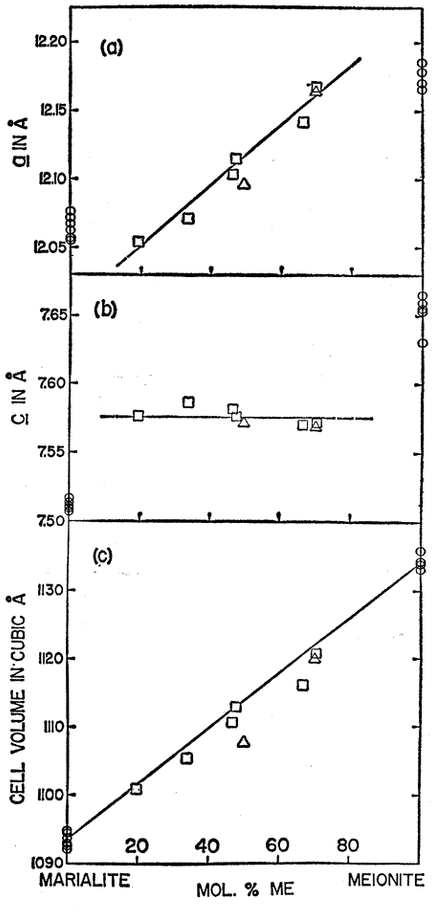

Fig. 1. Cell dimensions and cell volume of natural and synthetic scapolites, plotted as a function of mole percentage of meionite. Circles, synthetic scapolites; squares, natural scapolites of Shaw (*5*); triangles, natural scapolites of Gibbs and Bloss (*2*).

however, both a and c are larger in meionite than in marialite. If the curves of a and c versus composition for natural scapolites are extrapolated to the marialite and meionite compositions, a and c values are obtained which differ significantly from the values found for the synthetic end members. However, all of the cell dimensions obtained for the natural materials are within the range represented by synthetic marialite and meionite. When the cell volumes of scapolites are plotted as a function of increasing meionite content (Fig. 1c), it is seen that the volumes of the natural scapolites lie on or just below a line connecting the mean values for synthetic marialite and meionite. Apparently, the cell volume can be used to determine the composition of natural and synthetic scapolites. However, better calibration of the curve is desirable. Deviations of Shaw's natural scapolites from the straight line (Fig. 1c) do not appear to be related to departures in composition from the ideal marialite-meionite join as calculated by Shaw (*5*). Large deviations might be possible for scapolites containing more sulfate, bicarbonate, potassium, and other constituents.

The behavior of the cell dimensions may reflect (i) differences in structural state dependent on temperature, (ii) differences in structural state dependent on composition, or (iii) a combination of (i) and (ii). However, since no data are available for synthetic scapolites of intermediate composition, the possibility remains that the variations observed depend only on the composition. All of these explanations are consistent with the data presented here and with the structure proposed by Pauling (*1*). The similarities in composition between scapolite and plagioclase feldspar make it natural to suspect that differences in structural state, related to order-disorder phenomena, may also exist in scapolite. Syntheses of scapolites of intermediate composition as well as heating experiments are now under way to test this hypothesis (*7*).

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Additional Genetic Variation of Human Serum Transferrin

Abstract. A new molecular species of human transferrin, Tf $D_{Montreal}$, is described. Starch gel electrophoresis under high-voltage conditions permits the new variant to be clearly distinguished from previously described variants of closely similar mobilities. The presence of a faint iron-binding component which migrates slightly more rapidly than the principal transferrin with which it is associated is also described.

The technique of starch gel electrophoresis (*1*) has led to the discovery of an extensive genetically determined polymorphism of human and primate transferrins, the iron-binding globulins of the blood serum. Various authors have presented evidence for the inheritance of transferrin as an autosomal two-allele system without dominance. This evidence has been significantly increased by the recent report of Beckman (*2*) on the segregation of three transferrins in a single pedigree. At the present time, 13 different molecular species of human transferrin have been recognized (*3*); each of these transferrins is distinguishable by its characteristic mobility in starch gel electrophoresis. The most common molecular type is labeled transferrin C (Tf C) and is found in high frequency in all populations. Transferrins which are faster-moving electrophoretically than type C are labeled B, and slower-moving variants are named D. Subscripts are used to distinguish variants within the fast- and slow-moving categories. An interesting feature of the human transferrin polymorphism is the occurrence of particular transferrin variants in particular populations (*3*). Thus, transferrins B_{0-1} (Navajo) (*4*), B_2 (Caucasian) (*5*), D_{Chi} (Chinese) (*3*), and D_1 (Negro) (*6*) have each been observed in measurable gene frequency in their respective populations. The remaining variants have been found only in isolated individuals and their immediate families.

The purpose of the present report is to describe a new transferrin variant which has been observed in a Canadian individual of French and Irish descent. Examination of the serum by conventional vertical starch gel electrophoresis (*7*) revealed the individual to be heterozygous for transferrin C and a slower-moving transferrin variant. By means of a specially designed water-cooled apparatus, it has been possible to carry out the electrophoresis under conditions of relatively high voltage (*8*), thereby reducing the time required for a given separation of the protein components. By this method, the spread of the protein bands by diffusion is significantly reduced, and more precise comparisons of the relative mobilities of the proteins can be obtained. The increased sharpness of the bands also makes it possible to observe minor serum components whose presence is difficult to detect under conventional conditions. For example, under the high-voltage conditions, two components which migrate approximately in the ceruloplasmin position and four components unrelated to haptoglobin which migrate in the region of haptoglobin 1-1 can be clearly resolved in various sera. Differences among individual sera are also observed in the region between ceruloplasmin and albumin, where as many as five components can be identified; variations in these "post-albumins" have previously been described by Smithies (*7*), who has suggested that the improved resolution in this region may result in part from the variable potential gradient observed at the trailing edge of the albumin band (*8*).

In the present experiments vertical starch gel electrophoresis was carried out at 0°C in the borate buffer system of Smithies (*7*) for 5 hours at 20 volt/cm in a gel of 6 mm thickness; to facilitate heat transfer, the surface of the gel was covered with a thin cellophane film instead of petroleum jelly. Under these conditions transferrin C migrated approximately 5 inches from the origin. Iron-binding components were identified by autoradiography (*9*) and protein components were detected by the amido black stain.

Examination of the serum of the Canadian individual under these conditions revealed that the electrophoretic mobility of the slower-moving transferrin was slightly more rapid than