limit of ozone concentration (*2*) is about 10^{-4} volume percent and thus it is ignored. No account is taken either of the unknown effect of the so-called "blue haze" which may decrease the ultraviolet flux. According to Gold (*5*) radiation-induced coloration is responsible for the dark areas on our moon. There, however, the absence of an atmosphere and of drastic color changes makes the situation considerably different.

Two materials have been suggested (*6, 7*) as possible constituents of the martian surface: orange-rusty opaque limonite ($Fe_2O_3 \cdot 3H_2O$) and rhyolite (an igneous felsitic mixture of SiO_2 and various silicates). It is known that SiO_2 can be darkened by ionizing radiation and that these color centers are sensitive to impurity content. Experiments made in our laboratory have shown that no visibile color changes can be produced in the same way in limonite but that $NaAlSi_3O_8$, which is a known constituent of certain rhyolites, does indeed change from colorless to greenish under irradiation.

The seasonal color variation can be accounted for in various ways. One can assume, for instance, that besides color centers there are a large number of shallow electron traps which are easily thermally ionized during summer but are mostly occupied during winter. Another, more sophisticated, model is based on the assumption that there exists a set of recombination centers which produce supralinearity (*8*) of photocurrent in a narrow temperature range.

In this case it is necessary that the ultraviolet radiation is hard enough to produce holes in the valence band of the solid. Both models lead to a depletion of electrons from the color centers during winter and to an increased occupation of these centers by electrons during summer. This is just what is necessary to account qualitatively for the seasonal color changes. Whatever the model, it is essential that, in order to suppress the influence of daily variations of local temperature on coloration, the time constant for establishing equilibrium distribution of electrons in a given radiation flux be not less than several hours. Such long time constants occur in certain phenomena associated with color centers. The seasonal variations of the average daily temperature range from zero at the equator up to 120°C at increasing latitudes. The average blackbody temperature of Mars is 208° ± 10°K, depending upon the distance from the sun. It should be mentioned too that the seasonal increase of optical absorption of the surface material is in the right direction to account for the parallel increase of negative polarization of the reflected light (*6*). The theory of the latter effect is too uncertain at the present time to permit a more detailed comparison.

Goldstein and Gillmore (*9*) have observed that the dark areas of Mars have a much higher radar reflectivity that the rest of the planet. Usually such differences are interpreted in terms of surface roughness or other permanent properties. However, in this case it is tempting to associate this high reflectivity with the presumably high photoconductivity induced by the solar radiation. An unambiguous estimate of the magnitude of this effect would require a knowledge of the detailed mechanism and of the trap and carrier distribution. It appears, however, that under favorable conditions the skin depth can be much smaller than the wavelength of the incident radar, and the photoconductivity may play a significant role. It is hoped that the present opposition of Mars will provide a check of this conclusion.

The shapes of certain dark areas of Mars vary considerably from one year to another. On the proposed model these variations may be the result of solar flares (*10*) which produce exceedingly high fluxes of photons and corpuscular matter. A statistical correlation between these two phenomena would be very instructive.

It is not my intention to imply that there is no vegetation on Mars but rather to point out that some of the "organic" observations may have "inorganic" explanations.

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High-Pressure Single-Crystal Studies of Ice VI

Abstract. *By means of a precession camera incorporating a diamond-anvil high-pressure cell, x-ray diffraction data can be obtained from single crystals of ice VI produced and maintained under high pressures. The cell constants for ice VI at room temperature and approximately 9 kilobars are:* a = *8.38 Å*, b = *6.17 Å*, c = *8.90 Å. The unit cell is orthogonal and the space-group aspect is compatible with* P**a. *These data for single crystals agree with previously reported unindexed data obtained for polycrystalline ice VI, within the limits of experimental error. The single crystals of ice VI were grown in a diamond-anvil pressure cell, distilled water and a metal gasket being used.*

To obtain definitive data on the structures of high-pressure polymorphs, it is essential to obtain x-ray diffraction data on single crystals of the high-pressure phase. In a few instances, high-pressure phases may be quenched at low temperatures and single crystals recovered for study at 1 bar in a metastable condition. The number of such quenchable polymorphs appears to be limited, and it is desirable to have a method for producing and studying single crystals by x-ray diffraction while they are under high pressures. Such a method has been developed in our laboratory and has been found suitable for the study of high-pressure phases obtained by liquid-to-solid transformations as in ice VI, and by favorable solid-to-solid transitions —that is, transitions which exhibit relatively small volume changes, thereby retaining their single-crystal character. In this report we present preliminary data on ice VI obtained by this method. So far as we know, such data have not been obtained previously.

Single crystals of ice VI were ob-

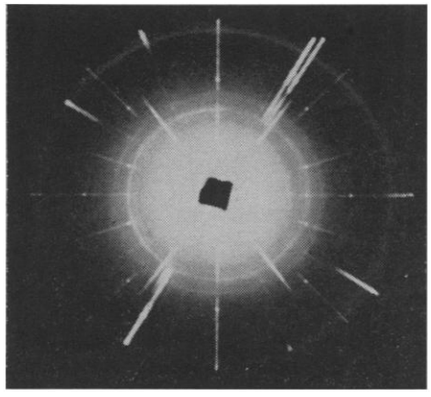

Fig. 1. Precession pattern ($\mu = 16°$, Pd-filtered Ag radiation) of the $hk0$ level of ice VI at room temperature. The heavy diagonal streaks are from the diamonds and the rings are from the metal gasket.

tained at room temperature and approximately 9 kb by means of a modified, opposed diamond-anvil pressure cell (*1*). Pressure was applied to distilled water confined between the diamond anvils by a metal gasket. On initial application of pressure, ice VI was formed in a polycrystalline mass. To eliminate the polycrystalline character, pressure was reduced until only one crystallite remained. This crystallite was grown by slowly reapplying pressure until it filled the entire pressure chamber (*2*). By means of a modified precession camera incorporating the pressure cell, single-crystal patterns of ice VI were obtained with Pd-filtered Ag radiation ($\lambda = 0.5609$ Å). Silver Kα radiation was employed to minimize absorption effects and to decrease the size of the reciprocal lattice, thus enabling us to obtain more data. A detailed description of the apparatus will be published elsewhere.

Table 1. Observed and calculated spacings.

Spacing, 10^{-8}cm		*hkl*
Obs.	Calc.	
4.3	4.3	111*
3.6	3.6	012
3.4	3.5	210
3.12	3.08	020
2.91	2.93	021*
2.75	2.75	121
2.63	2.67	301
2.51	2.51	022
2.43	2.42	203
2.21	2.22	004*
2.10	2.09	400
2.01	2.00	031*
1.97	1.97	204
1.85	1.85	230
1.75	1.76	124
1.64	1.64	205
1.56	1.57	502*
1.48	1.48	006
1.44	1.44	142*
1.41	1.42	513
1.37	1.37	424
1.34	1.34	035
1.30	1.30	612
1.26	1.26	107
1.21	1.21	151
1.14	1.14	712
1.104	1.104	108
1.084	1.081	615*
1.050	1.049	535*
1.010	1.009	642

* Multiple line, only one possible index is given.

Cone-axis photographs along c and precession patterns of $hk0$ and $hk1$ were obtained. Also, photographs of patterns containing b^* with $h0l$ ($h \neq 0$) were taken. Because of the preferential direction of growth of the crystal and the somewhat restricted movements of the pressure cell itself, no patterns containing c^* were observed. To date, information on the c-axis has been obtained only from cone-axis and mixed-index photographs. The cell constants derived from these data are $a = 8.38 \pm 0.05$ Å, $b = 6.17 \pm 0.05$ Å, and $c = 8.90 \pm 0.15$ Å (*3*). These values together with the density data reported by Bridgmen (*4*) yield $Z = 20$. The systematic absences are $hk0$, $h = 2n + 1$ and $0k0$, $k = 2n + 1$ and indicate the orthorhombic aspect $P^{**}a$.

Figure 1 shows a typical precession pattern of the $hk0$ level of ice VI. The μ angle was 16°. The heavy diagonal streaks arise from the diamonds and the diffraction rings from the metal gasket.

McFarlan (*5*) reported the first x-ray diffraction data on the high-pressure forms of ice. He conducted his x-ray diffraction studies at 1 bar and at low temperature—the low temperature being used to "freeze in" the structures formed at high pressure. No diffraction data were reported for ice VI—the dense form of ice in equilibrium with water at room temperature and approximately 9 kb—but he noted that the data were indicative of low symmetry and that the powder pattern could not be indexed readily. Recently, Bertie, Calvert, and Whalley (*6*) have reported diffraction data for all the known ice structures with measurements on the high-pressures phases being made at 1 bar and 90°K. They also have not indexed the diffraction data on polycrystalline ice VI.

The cell constants obtained here can be used to index the pattern of polycrystalline ice VI in the metastable state reported by Bertie, Calvert, and Whalley to within the probable errors arising from the differences in temperatures and pressures of the two experiments. The indexing is shown in Table 1.

As a result of work with ice VI, modifications of the pressure-cell are being considered to facilitate greater freedom of orientation of the crystals.

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Radioactivity: Detection of Gamma-Ray Emission in Sediments in situ

Abstract. *A probe for measuring emission of γ-rays in sediments* in situ *in water depths to about 35 meters was used to measure radioactivity in the Columbia River estuary and Oregon coastal areas. This technique offers some advantage over methods in which sediment samples are collected at sea and returned to the laboratory for radioanalysis.*

Because artificial radioactivity has been present in quantity only since 1944, man-made radionuclides are confined to the most recently deposited marine sediments. This thin surface layer of sediment, though of greatest interest, is most difficult to remove in its undisturbed state in quantities sufficient for radioanalysis. Coring devices cause the least disturbance in the sample, but the proportion of surface sediments recovered is small. Both dredged and grabbed samples contain relatively large proportions of surface sediments, but older, less radioactive sediments are often mixed into the desired sample and confound the analysis. Also some of the finer-grained sediments are likely to be washed out of such samples as they are brought to the surface. The greater