are identical within the limits of error. The specific gravity of merrihueite, based on the cell and chemical analysis, is 2.87.

Five grains of merrihueite in a single chondrule were analyzed with an Applied Research Laboratories microprobe at the Smithsonian Institution of Washington (*4*), with the results presented in Table 3. The grains showed minor variations in K and Na, but are otherwise homogeneous. Partial analyses of merrihueite from several chondrules, made with a Philips-type microprobe at the Advanced Metals Research Corporation, Burlington, Mass., indicate that Fe varies widely from chondrule to chondrule and, in some instances, within chondrules.

The observed range is 10.5 to 24.8 percent Fe by weight, corresponding to a variation of $FeO/(FeO+MgO)$ (molecular ratio) from about 0.4 to unity. Spectral scans of two grains of merrihueite indicated no significant amounts of elements with atomic numbers greater than 8, other than those reported in Table 3.

The calculated oxide analysis in Table 3 is based on the assumption that all iron in merrihueite is divalent, an assumption which is consistent with the reduced nature of the chondrite as a whole and with the presence of metallic iron in the mineral assemblage. Failure of the analysis to total 100 percent may be due to underestimation of Na, to the presence of undetected water, or to other limitations of quantitative microprobe analysis. Refinement of the chemical analysis of merrihueite must await the location of a more abundant source for the mineral.

When the calculated oxide analysis is recast to moles and normalized to 12 SiO_2 (Table 3), it is evident that the ratio of alkali oxides to ferromagnesian oxides to silica is approximately 1 : 5 : 12. The formula of merrihueite thus appears to be essentially $(K,Na)_2(Fe,Mg)_5Si_{12}O_{30}$. The small amounts of Ca and Al present may proxy for the alkalies and silicon respectively.

Both the x-ray data and the chemical analysis of merrihueite indicate that it resembles the synthetic compounds $K_2Mg_5Si_{12}O_{30}$ (*3*) and $Na_2Mg_5Si_{12}O_{30}$ (*5*). It can be regarded as a solid solution of these components and their K-Fe and Na-Fe analogues. Merrihueite differs from all other osumilite-type minerals—osumilite (*2*), armenite (*6*), and milarite (*7*)—in lacking essential aluminum. It is of interest for this reason and because it is the only known meteoritic mineral which contains essential potassium.

Inasmuch as merrihueite contains variable amounts of Fe, Mg, Na, and K, it raises a problem of terminology. This problem is compounded by the facts that Al may substitute for Si in some environments to a theoretical upper limit of $Al : (Al + Si) = 0.4$ (atomic) in osumilite, and that Ca can proxy for K and Na (*2*). We propose that the name merrihueite be restricted to minerals with the osumilite structure in which (i) $K > (Na + Ca)$ (atomic), (ii) $(Fe + Mn) > Mg$, and (iii) $Al : (Al + Si) \leqq 0.2$.

Although our iron data include some grains in which $Mg > Fe$, the data for these grains are too meager to justify extending the name on this basis.

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8. The name and definition of merrihueite (mĕr′-ĭ-hū-īt) have been approved by the Committee on New Mineral Names, International Mineralogical Association.
9. Part of this work was done at the Department of Geological Sciences, Harvard University, under a program of meteorite research administered by Professor C. Frondel, NASA grant NsG 282-63. We are grateful to Professor Frondel and to Dr. Edwin W. Roedder (U.S. Geological Survey, Washington, D.C.) for valuable discussions during the preparation of this paper.

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12 July 1965

Saturn's Ring and the Satellites of Jupiter: Interpretations of Infrared Spectra

Abstract. *Infrared spectra of Saturn's ring correspond closely with the reflection spectrum of water ice. This result supports Kuiper's suggestion for the composition of the ring. The absence of the strong absorption at 8873 Å in spectra of Io, Ganymede, and Callisto leads to a new upper limit for the abundance of methane in possible atmospheres of these satellites.*

Low-dispersion infrared spectra of Saturn and the Galilean satellites of Jupiter have been published by Kuiper (*1*). The object of my investigation was to extend the study of the spectra of these bodies to longer wavelengths: 11,100 Å in the case of Saturn and 9700 Å for the Jovian satellites. Both projects were carried out at the Kitt Peak National Observatory with the Cassegrain spectrograph of the 36-inch (90-cm) reflector. Eastman I-M and I-Z spectrographic plates were used after hypersensitization with an ammonia solution. The observations were made in the autumns of 1963 and 1964.

The spectra of Saturn were compared with those of Jupiter obtained at the same dispersion (250 Å/mm) to determine whether any new features were present. The spectrum of Jupiter has been analyzed at higher resolution in this region (*2*) and thus serves as a reliable standard for line identifications. No new absorptions were found. The most interesting feature, first pointed out by Fredrick (*3*), in these spectra was the low reflectivity of Saturn's ring in the region 10,400 to 10,900 Å. In this wavelength region, the sensitivity of the I-Z emulsion rises to its maximum and then drops steeply toward longer wavelengths. This behavior is well illustrated by the spectra of Jupiter and the disk of Saturn, but the ring exhibits a nearly uniform brightness across the plate, indicating a definite drop in reflectivity in the region referred to.

Kuiper (*1*) has suggested that the particles making up the ring are covered by frost (if not composed of ice) on the basis of the low reflectivity of the ring near 1.5 μ. To test whether this deduction might also explain the present observation, spectra of sunlight, reflected by blocks of H_2O ice and CO_2 ice and by H_2O ice crystals, were obtained in the laboratory at a resolution comparable to that of the planetary spectra. The ice crystals were formed in a thin layer on a metal plate cooled by a piece of "dry ice." Both blocks had a milky appearance, that is, the ices were not transparent. Thus that fraction of the sunlight which penetrated the (roughly planar) front surfaces was scattered internally before emerging to be analyzed by the spectrograph. The dimensions of each block were sufficient to permit the acceptance of the full incident beam on the front (reflecting) surface, whereas no light was observed to pass through to the back surface. In each case a spectrum of sunlight reflected from a layer of MgO deposited on a sheet of metal was recorded on the same plate as the spectrum of sunlight reflected from the sample under investigation. The reflectivity of MgO is uniform in this region. An effort was made to keep the densities of each pair of spectra as equal as possible in the "neutral" region ($\lambda <$ 10,000 Å). Visual inspection of the plates obtained in this way indicated that the reflection spectrum from the ice block gave the best match to the absorption observed in Saturn's ring. A slight weakening was noticeable in the appropriate region of the spectrum from the ice crystals, while the CO_2 block gave an essentially neutral spectrum. Densitometer tracings verified these conclusions. The fact that the ice block produced a better fit to the ring spectrum than the ice crystals indicates that the light path in the latter was insufficient, that is, the layer of crystals was too thin.

Thus Kuiper's original suggestion is substantiated by the results described here. The observation of a second absorption at the correct wavelength makes it virtually certain that the absorbing substance associated with the ring particles is indeed water ice. The absorption observed by Kuiper at 1.5 μ is the solid-state equivalent of the ψ vapor band at 1.38 μ. The absorption described in this report corresponds to the ρ vapor band at 0.93 μ. It is therefore not surprising that Slipher (*4*) was unable to detect any absorption in spectra of the ring from 3500 to 7600 Å, since no strong water-vapor bands occur in this region. It is also apparent that what is observed in this case is a true solid-state absorption and not an evaporation effect, since in the latter case one would only expect to see the low-temperature rotational lines of the vapor band at 0.93 μ.

The explanation for the persistence of ice under conditions of high vacuum lies in its low vapor pressure at the predicted temperature of the ring, as Kuiper (*1*) has pointed out. The vapor pressure of ice at 90°K is given by Koller (*5*) as 1.5×10^{-19} μ-Hg. The use of this value in a formula for evaporation at low pressures, also given by Koller, indicates that the largest ice particle which could have evaporated since the origin of the solar system is only slightly larger than a water molecule. The same argument may be added to the spectral evidence to exclude ices of methane and ammonia (the most likely alternatives) since their vapor pressures are too high: 7×10^4 μ-Hg and 10^{-4} μ-Hg, respectively, at 90°K.

The observations of the Galilean satellites of Jupiter were made to test for the presence of gaseous atmospheres. The advantage of extending the wavelength range over which the satellites are observed lies in the fact that the strongest methane band in the photographically accessible region of the spectrum can be recorded. This band has its maximum at 8873 Å, a fact which was verified by overexposed spectra of Jupiter which clearly showed the structure of the band at the resolution of the satellite observations. Methane is present in the atmospheres of the major planets and Saturn's largest satellite, Titan. Its relatively high molecular weight, its high vapor pressure at low temperatures, and the high cosmic abundance of carbon and hydrogen make methane a likely constituent of cold, tenuous atmospheres in the outer regions of the solar system. Spectra of Io, Ganymede, and Callisto (three of the four largest satellites) were obtained and compared with laboratory spectra of methane taken at the same resolution. No trace of any nonsolar features was found. The laboratory spectra permitted the establishment of an upper limit of 100 cm atm (NTP) (*6*) for the methane abundance in possible atmospheres of these bodies. This negative result lowers Kuiper's (*1*) limit by a factor of two and is of particular interest in view of the recent observations reported by Binder and Cruikshank (*7*), which suggest the presence of an atmosphere about Io.

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† Operated by the Association of Universities for Research in Astronomy, Inc., under contract with NSF.

20 May 1965

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Antarcticite: A New Mineral, Calcium Chloride Hexahydrate, Discovered in Antarctica

Abstract. *A new mineral, calcium chloride hexahydrate, was discovered in the Don Juan Pond in Victoria Land, Antarctica. The optical properties, chemical analysis, and powder patterns obtained by x-ray diffraction agree with those of artificial calcium chloride hexahydrate. The name Antarcticite is proposed for the new mineral.*

Samples of a new mineral, calcium chloride hexahydrate, were collected by one of us (T.T.) at Don Juan Pond, Victoria Land, Antarctica, on 30 December 1963, and brought to the laboratory in Tokyo. Don Juan Pond is about 300 m long from east to west and 100 m wide (north to south); its depth is only 10 cm. It is situated at 77°34′S, 161°10′E. Don Juan Pond was mentioned by Meyer *et al.* (*1*). The pond is situated nearly at the cen-