

INTRODUCTION

An extensive deposit of oölitic limestone, lying on or near the surface, is found in Sanpete County, Utah. The chemical composition of this stone is substantially equivalent to that found in Bedford, Indiana. The "Bedford Stone" is extensively quarried for use in the construction of buildings in eastern United States including a number of the federal government office buildings in Washington, D.C. A similar stone is found in England and has been used extensively there for buildings, including some of the prominent government buildings.¹

The Sanpete oölitic limestone has been used for a number of prominent buildings in Utah including the following:

1. The Park Building, University of Utah, Salt Lake City
2. Maeser Building, Brigham Young University, Provo
3. The Manti Temple at Manti, Utah
4. Municipal buildings in several Sanpete County towns including Ephraim and Manti, Utah.

This stone was also used for the intricately carved facade of the "William Randolph Hearst Castle" at San Simeon, California. The stone is also quite extensively used for grave markers in the Sanpete County cemeteries.

The "Bedford Stone" is a very successful building material. The Sanpete limestone has not proven to be as permanent as desired. The purpose of this monograph is to examine the reasons for the poor quality

¹ "The Weathering of Natural Building Stones," P. J. Schaffer, 1932. (Published by His Majesty's Stationery Office, London.)

of the "Sanpete Stone" and discuss some proposed procedures to stabilize this stone.

Several quarries for the production of Sanpete oolithic limestone have been opened. The principle quarries are to be found a short distance north of the town of Ephraim and immediately to the east of Highway 89. These quarries were most recently worked in the 1930's during the great national depression as a "make work project" and supported by federal government funds. It was at this time that the stone was quarried to construct municipal buildings in some of the Sanpete County towns.

One of the earliest buildings to be constructed of the Sanpete limestone was the Manti Temple constructed in 1888. This edifice stands on an outcrop of this material and the stone for the building was quarried from an area contiguous to the site of the temple.

The use of the Sanpete limestone in this building, at least in the above ground courses of stone, was quite successful and undoubtedly was a factor in the later more extensive use of the stone. The reason for the partial success was undoubtedly the absence of acid pollutants in the atmosphere of this sparsely settled rural community. Nevertheless, there was deterioration of the stone in the building so that during the 1940's the whole building was resurfaced by chiseling away the surface to a depth sufficient to expose virgin stone.

The Nature of Oölitic Limestones

Oölitic limestone is formed by geological processes from beds of rounded concretionary particles of calcium carbonate. A petrographic description of the Bedford, Indiana, and Sanpete oölitic limestones is given by Professor Max Erickson of the Department of Mineralogy, University of Utah, as follows:

Indiana Oölitic Limestone (Bedford stone)

"In thin section the rock appears to be composed almost entirely of two generations of calcite. (See Figure 1.) The primary calcite is largely of organic origin and consists of the calcareous shells or skeletons of several forms of microscopic organisms. This primary calcite makes up 65 percent of the total volume of the rock as indicated by Delesse-Resiwal measurements with the integrating stage. The shells range in size from 0.3 mm. to 1.2 mm. in longest dimension. They are made of rather fine-grained calcite and are loosely packed together with no primary interstitial material between the shells. However, they are cemented together by rather large plates of secondary calcite which only partially fill the interstitial voids. Secondary calcite comprises 20 percent of the volume of the rock as indicated by integrating stage measurements. The grains are up to 1.0 mm. across. Open spaces not filled with secondary calcite account for 15 percent of the total volume. The void spaces probably are interconnected. The residue left after dissolving the calcium carbonate consists of quartz grains from 0.01 mm. to 0.1 mm. across. Most grains less than 0.05 mm. in size are anhedral doubly-terminated crystals. The residue also contains a small amount of light colored, finely divided, isotropic material which could not be identified."

Sanpete Oölitic Limestone

"Microscopic examination of this rock in thin section, Figure 2, reveals that it is composed of concentric bonded oölitites rather loosely cemented together. The oölitites are dense and very fine-grained with successive shells of varying color. They are predominantly calcite but with mixtures of a light yellowish mineral tentatively identified as a

clay mineral in some of the shells. A few of the calcites have detrital quartz grains as nuclei. The oölites range in diameter from 0.1 mm. to 1.0 mm. with the most common size about 0.5 mm. The interstitial material cementing the oölites together is a clear calcite with an average grain size of 0.01 mm. and an unidentified mineral occurring as clear, nearly square plates of smaller size.

"The cementing materials are very poorly consolidated, showing considerable void space. The porosity of the stone is about 23 percent. Considerable residue is left when the calcite is dissolved in dilute hydrochloric acid. This consists of the yellow clay mineral and the unidentified mineral occurring as noted above and as irregular microcrystalline aggregates. Also present are a few grains of quartz and an occasional diatom."

COMPARISON OF CERTAIN FEATURES OF INDIANA LIMESTONE
AND SANPETE LIMESTONE

a) NATURE OF PRIMARY MATERIAL

Indiana Limestone: strong, thin walled, microfossils; composed of fine grained, dense calcite.

Sanpete Limestone: concentric layered, calcareous oölites embedded in fine silt composed of clay particles and calcareous precipitate.

b) ORIGIN OF THE PRIMARY MATERIAL

Indiana Limestone: organic.

Sanpete Limestone: calcareous silt and oölites formed by precipitation of calcite from saturated solution. Clay particles are detrital.

c) ENVIRONMENT OF DEPOSITION

Indiana Limestone: unbroken shells, loose packing, and absence of detrital material indicate accumulation in quiet water.

Sanpete Limestone: oölites indicate rather rapid precipitation from agitated water. Detrital minerals also indicate the water was in motion.

d) PRIMARY BONDING

Indiana Limestone: very little primary bonding.

Sanpete Limestone: natural cohesion of the fine-grained matrix produced plastic to semi-solid state upon compaction.

e) SECONDARY BONDING

Indiana Limestone: cementation of shells by coarse crystalline calcite introduced by percolating waters.

Sanpete Limestone: hardening and loss of plasticity due to drying.

f) OPEN SPACES

Indiana Limestone: void spaces are relatively quite large, many are interconnected by a network of channels.

Sanpete Limestone: void spaces are relatively small but numerous. The secondary calcite is very poorly consolidated giving rise to a sponge-like structure. Such a structure is quite porous and is conducive to the capillary condensation of water vapor throughout the stone.

Photomicrographs of the Bedford limestone and Sanpete limestone are given in Figures 1 and 2, respectively. These figures support the petrographic description given above.



Figure 1. Bedford, Indiana oolitic limestone. X70.



Figure 2. Sanpete, Utah oolitic limestone. X70.

Chemical Analysis of Oölitic Limestone

	<u>Bedford Stone</u> ^(b)	<u>Sanpete Stone</u> ^(a)
	<u>%</u>	<u>%</u>
CaO	55.5	36.8 → 44.6
MgO ^(c)	0.42	8.0 → 13.2
R ₂ O ₃	0.16	0.71 → 1.20
SiO ₂	0.44	3.30 → 11.8
SO ₃	not measured	0.07 → .32
Ignition loss	43.4	38.2 → 43.8

- (a) Four samples were analyzed, taken from what was described by quarry owners as the best stone from the quarry. One sample was from the stone used in the L.D.S. Tabernacle in Spring City. Mr. Armstrong supplied one sample which he described as the best stone in the area and was taken from his quarry just north and east of the Ephraim cemetery.
- (b) One sample only, supplied by the Bedford Stone Company of Indiana as representative of their stone.
- (c) The Sanpete Stone has considerable MgCO₃ content whereas the Bedford Stone has very little MgCO₃. This is a significant difference between the two materials.

The Deterioration Processes of Oolitic Limestone

Deterioration of the Sanpete stone is due to three agencies: freeze-thaw cycles, ground water attack, and action of industrial gases.

The effect of freeze-thaw cycles is well illustrated in Figure 3 which was taken at one of the quarries near Ephraim, Utah. Some comparatively recently quarried stones are shown. These blocks originally had sharp corners since they were broken out of the bed in near rectangular blocks. The camera is looking from the southwest toward the northeast. The southwest oriented corners of these stones are all rounded. This is caused by a night and day freeze-thaw cycling during the wet wintertime. This cycling process has a heaving action which spalls-off the sharp corners and leaves the stone rounded. The corners of these blocks facing away from the sun are still sharp and show little of this sort of deterioration.



Figure 3. The effect of freeze-thaw cycling on Sanpete oolitic limestone. (Note the rounded corners on the sunny side of the quarried blocks.)

Deterioration by ground water attack is shown in Figure 4. Ground water always contains dissolved salts. Solutions of these diffuse into the porous stone, the water evaporates leaving the salts which act by various processes to weaken the bonding between the oölite grains, then the material crumbles away. This kind of attack is very noticeable where the Sanpete limestone is used for grave markers in cemeteries, and wherever the stone is used for ground level courses in buildings.

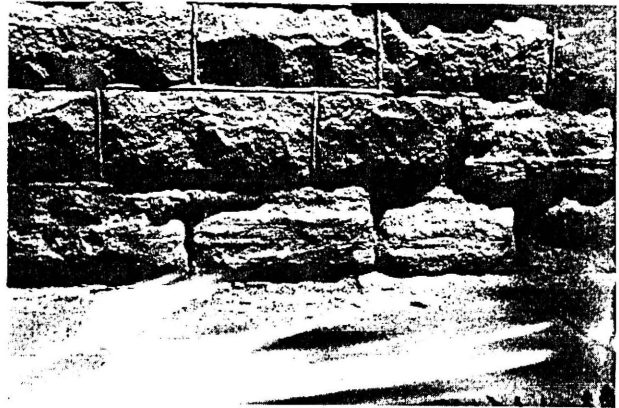


Figure 4. Lower courses of Sanpete stone, next to the ground, show severe deterioration while upper courses of stone are still well preserved.

The effect of industrial gases in the deterioration of the Sanpete limestone is dramatically shown in Figure 5. This unsightly type of deterioration is shown wherever the stone is used in an industrial or urban atmosphere. The intricately carved facade of the Hearst Castle at San Simeon, California, which is made from Sanpete limestone, shows none of this kind of deterioration. The castle is on a hilltop overlooking the ocean and far away from a large population center so that the air contains none of the acid-type contaminants associated with large centers of population. Furthermore, the castle is located in an area where freezing is a rare event so that in this location the stones are not subject to freeze-thaw deterioration.

Practically all industrial gases are acidic in nature. These

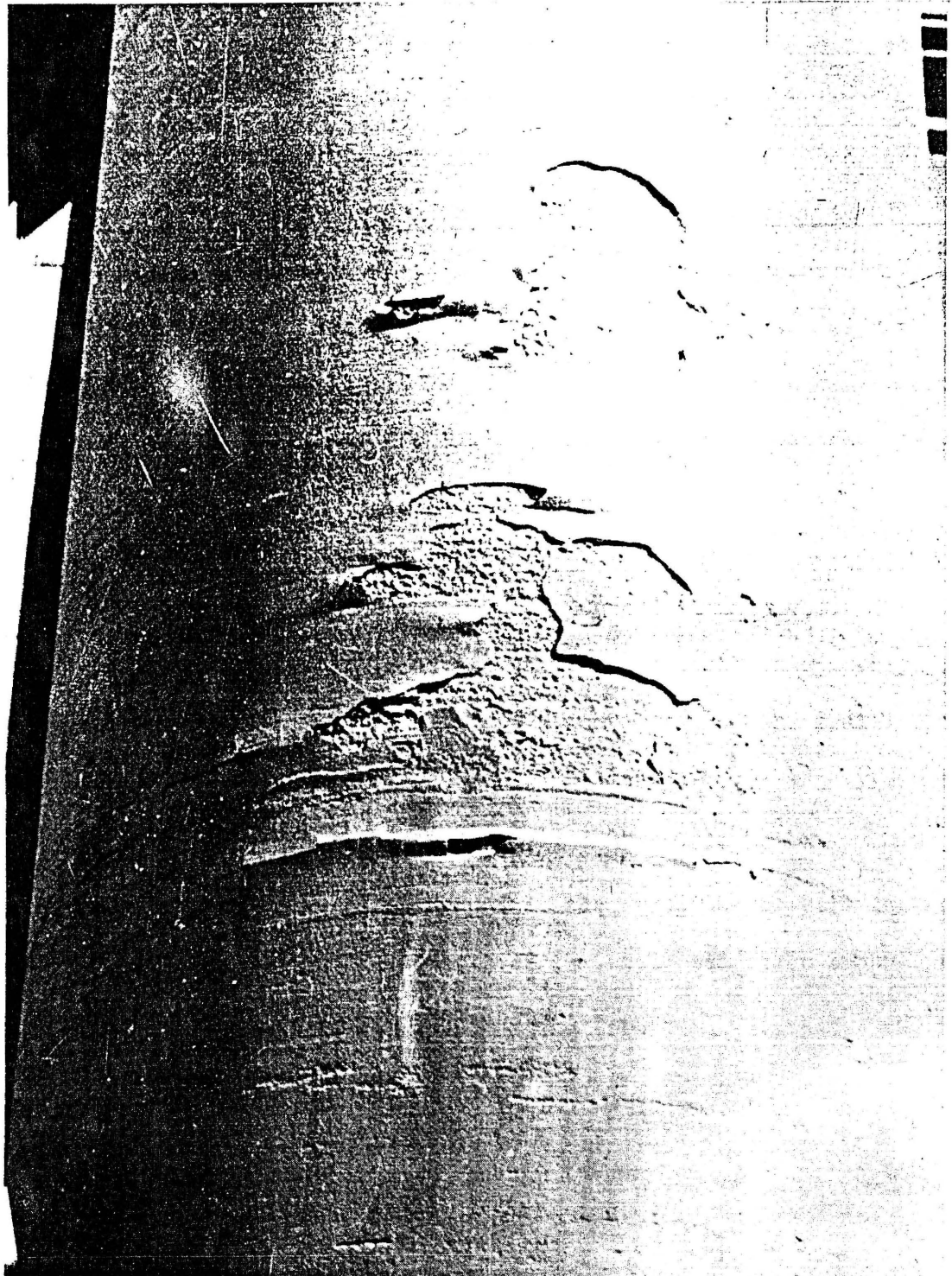


Figure 5. Large circular column of Sanpete oolitic limestone on west facade of the Park Building, University of Utah, showing the deterioration due to very small quantities of sulfur dioxide in the atmosphere.

arise from oxidation processes such as: (a) the combustion of gasoline; (b) the burning of solid, liquid and gaseous fuels, most of which contain at least a minimal amount of sulfur or sulfur compounds. The combustion of these materials leads to the production of small quantities of gaseous sulfur dioxide, SO_2 , which is a general atmospheric pollutant in all industrial areas and also in urban areas located in the colder climates where fuels are used for space heating. A long time analysis of the concentrations of SO_2 in the Salt Lake City atmosphere has been made by Dr. M. D. Thomas of the Department of Agricultural Research, American Smelting and Refining Company. According to a private communication from Dr. Thomas, these measurements show a continuous variation of 0.01 to 0.50 parts per million of SO_2 in the Salt Lake City area atmosphere. This may seem small; nevertheless, it is very significant in the effects which it produced on an alkaline rock such as the Sanpete stone. The spalling of the Sanpete limestone shown in Figure 5 is believed to be largely due to the trace amounts of SO_2 in the ambient atmosphere.

To determine the sulfate content of the stone in the Park Building, University of Utah, an exterior sample of the stone was taken and successive one millimeter layers from the outside were analyzed for SO_4^{--} content with the following results:

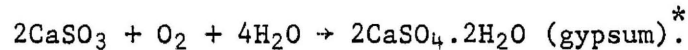
	<u>% SO_4^{--} Content</u>
1st layer	4.64
2nd "	3.29
3rd "	1.25
4th "	0.68
5th "	0.38
6th "	0.29
7th "	0.24

Nature of the Reaction Between Sanpete Limestone
and Sulfur Dioxide in the Atmosphere

Chemically speaking, limestone is basic and sulfur dioxide is acidic. As with all acid-base systems, sulfur dioxide and limestone are chemically quite reactive -- especially in the presence of water. The overall reaction would be expressed by the chemical equation



Calcium sulfite (CaSO_3) is unstable in the presence of atmospheric oxygen (especially in the presence of solid earthy materials which undoubtedly act as catalysts for the oxidation) and is oxidized to gypsum according to the equation



In the chemical change from CaCO_3 to $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$ the volume of the material is increased by approximately 200 percent. This expansion causes the exterior layer of the stone to be under compression as long as it is bonded to virgin stone on the interior. When the stress becomes too great the bond is broken and the observed spalling of the exterior layer takes place as is observed in Figure 5. Microscopic observation showed unmistakably the presence of gypsum in the location of the spall interface with the mother stone.

The conclusion to be reached is that the type of deterioration of Sanpete limestone illustrated in Figure 5 is due principally to the formation of gypsum from the limestone in interaction with atmospheric sulfur dioxide, oxygen, and water vapor.

* The exact chemical mechanism by which gypsum is formed from the interaction of limestone, sulfur dioxide, oxygen, and water vapor is presently unelucidated. That the reaction does take place is well known, however.

Comparison of Aging Properties of Sanpete and Bedford
Limestones With and Without Protective Substances

It is well demonstrated in actual use that the Bedford limestone is much more stable than the Sanpete limestone. This, of course, is the crucial test of the matter. However, in studies of this kind, due to time limitations, the chemist frequently resorts to accelerated aging tests. It is quite generally recognized by research workers that the development of a fully satisfactory accelerated aging test is a difficult task. The difficulty arises in part from the inability to obtain a one-to-one correlation between the results of the test and the normal aging, and in part because the degree of correlation cannot be determined until a sufficient period of time has elapsed to develop a normal aging. For building stone, this period of time would be of the order of a human lifetime. Hence, accelerated testing must be adopted for a quick answer. The results have usefulness even though the meaning of the test is frequently challenged by competent technologists. With this limitation in mind we offer herewith the following tests and propose they have considerable correlation with actual aging processes.

An Accelerated Test for the Action of Sulfur Dioxide Plus Water Vapor

Based on observation and some experimental evidence, it is believed that traces of sulfur dioxide in the atmosphere are a major agency causing the Sanpete oölitic limestones to disintegrate. Based on this hypothesis the following accelerated aging test was devised.

The stone was cut into cubes approximately 1-1/2 inches on a side. If the test of a possible stabilizing agent was to be made, each cube was treated with the reagent under study. The treated cubes, along with un-

treated samples, were placed on racks in large closed glass dessicator jars above water, Figure 6. Sulfur dioxide from a tank was bled into and out of the chamber at a very slow rate. The atmosphere surrounding the stone samples, therefore, consisted of sulfur dioxide and saturated water vapor at atmospheric pressure. In some cases oxygen was also introduced into the chamber so that oxidation of the SO_2 might take place. The samples were maintained at room temperature throughout the experiment. The course of disintegration of the samples with time could readily be observed through the glass walls of the jar.

In this test the product of reaction of the moist sulfur dioxide with the limestone is calcium sulfite dihydrate ($\text{CaSO}_3 \cdot 2\text{H}_2\text{O}$). The end product ($\text{CaSO}_3 \cdot 2\text{H}_2\text{O}$) in our accelerated tests differs from the gypsum ($\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$) observed in stone taken from buildings. However, we assume it to be roughly equivalent in its deleterious effect to that of $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$ forming in the stone under natural aging conditions. Calcium sulfite and calcium sulfite dihydrate are unstable substances and oxidize quite readily to the sulfate. A search of the literature has failed to reveal data on the density of calcium sulfite or calcium sulfite dihydrate, nor even data such as the crystal structure from which the density of these compounds could be calculated; but we are quite certain there is a progressive increase in the volume of the solid as calcium carbonate alters to calcium sulfite and then to calcium sulfite dihydrate. This being so, the reaction products formed in the interior of the stone will cause a stress in the stone which will disintegrate the stone as soon as the stress becomes great enough. The result will then be the same as though the alteration had proceeded to the gypsum (calcium sulfate dihydrate) product.

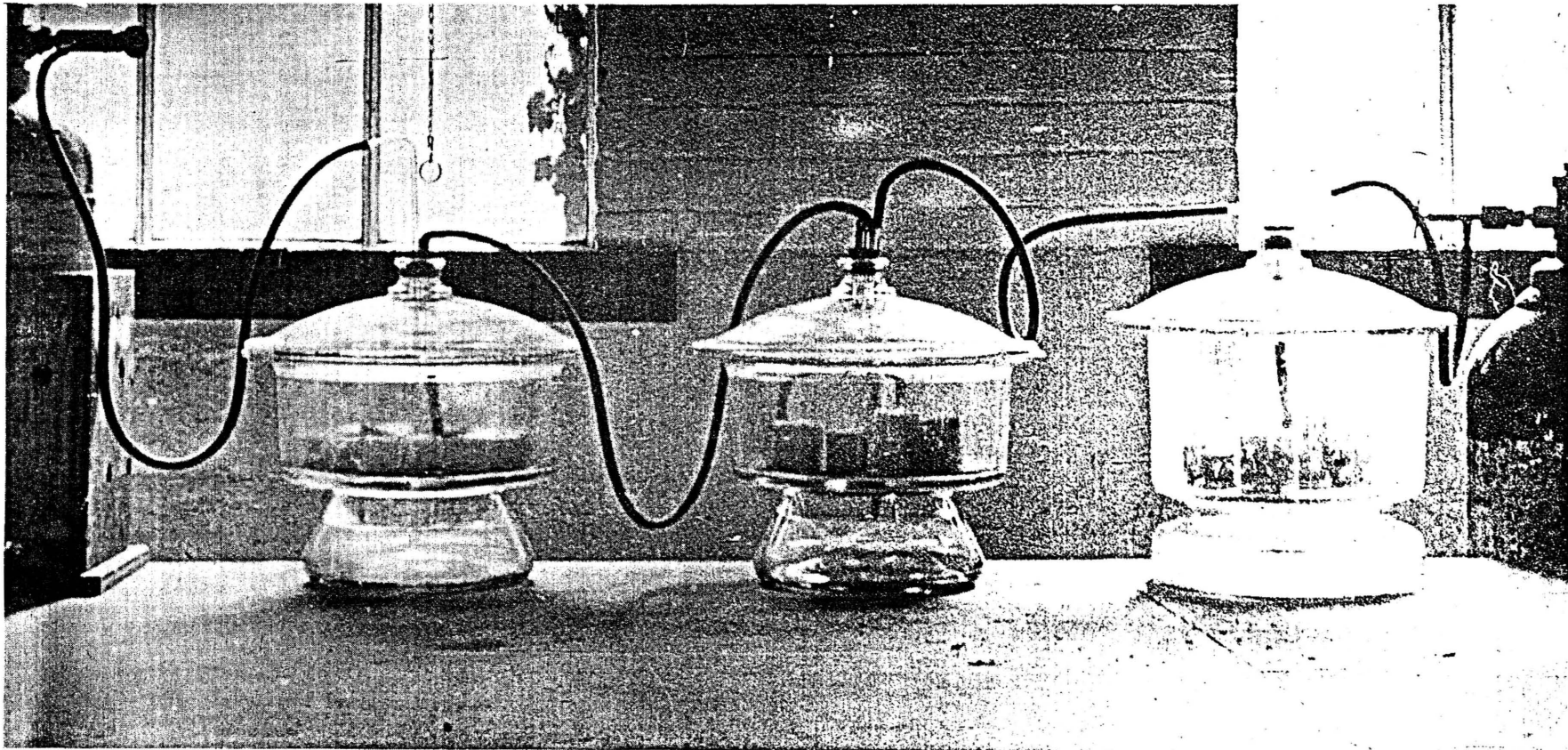


Figure 6. Limestone samples in closed dessicators being treated with SO_2 gas saturated with water vapor.

A parallel investigation of Sanpete limestone and Bedford limestone was made in this study. One can select the Sanpete stone out of the quarry for quality, the highest quality material being the most dense. Figure 7 shows a block of intermediate quality Sanpete stone after 21 days exposure to the moist SO₂ atmosphere. Figure 8 shows the best Sanpete stone after 36 days exposure to the same atmosphere. The exfoliation is much less in the higher quality stone than that of lesser quality, but in both cases the deterioration extends very deeply into the stone. In contrast is the deterioration of the Bedford stone, which is shown in Figures 9 and 10. Figure 9 shows the surface and corners of the block after 42 days exposure to the moist SO₂ atmosphere. No exfoliation is evident. Figure 10 shows a freshly sawed cross section through the same block pictured in Figure 9. The moist SO₂ atmosphere has attacked the surface of the stone, but the altered layer is still firmly adhered to the mother stone and the effect on the stone is only superficial; a sort of patina layer has been formed which is intact and the stone is still fully serviceable as a building material.

The relative porosities of the various stones was measured by the rate at which water vapor can diffuse through a prepared slab of the stone at a specific thickness and cross section. Slabs of various stones cut to a particular dimension were used as closures to a vessel holding water. The whole was put into an intensively dried atmosphere and the vessel weighed at intervals. The weight of the vessels decreased with time due to the diffusion of moisture through the stone slab covering the container. The Sanpete stone permitted a much more rapid diffusion of water vapor than did the Bedford stone, which fully corroborates the deduction made in the petrographic microscope examination.

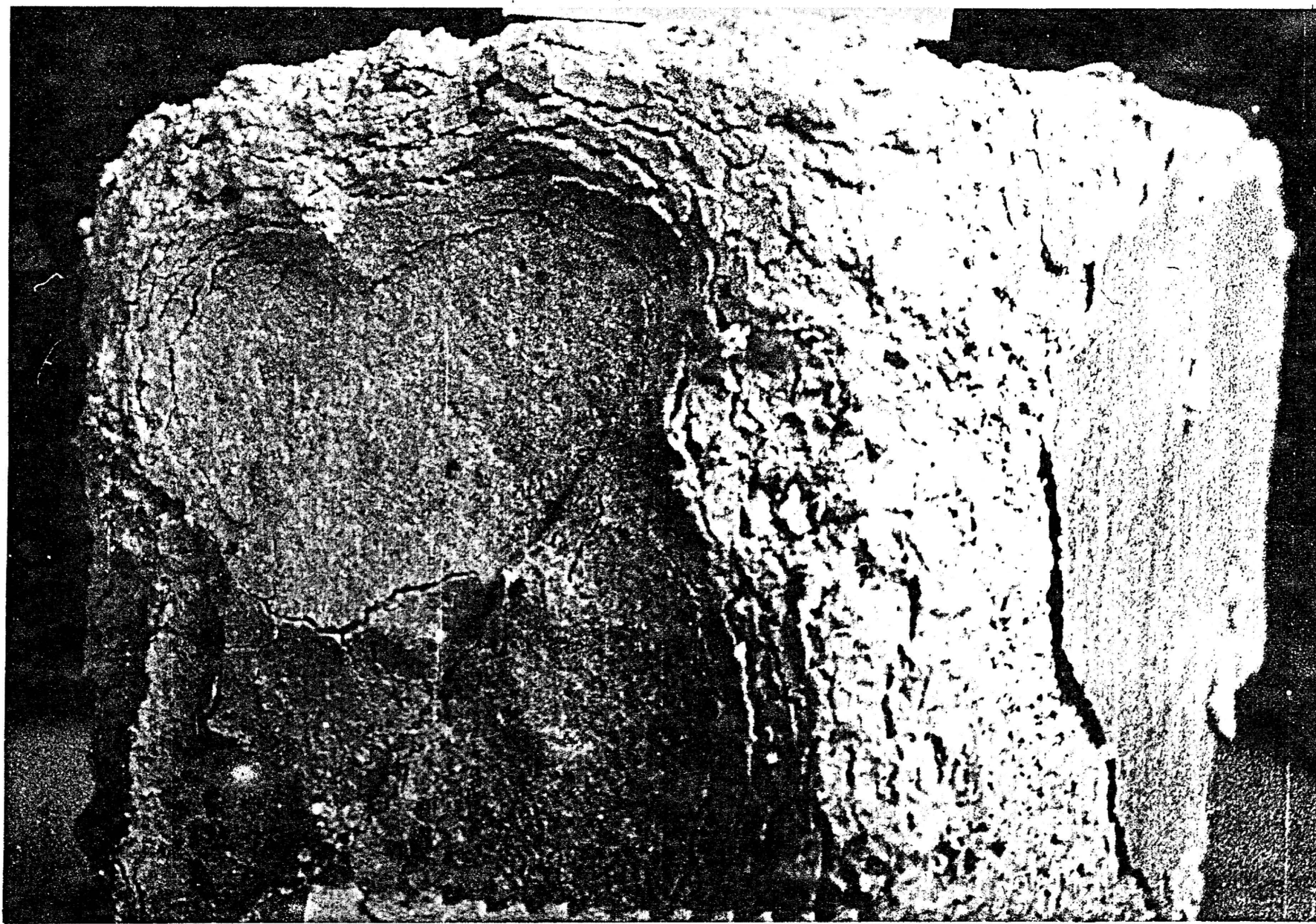


Figure 7. Untreated sample of intermediate quality Sanpete stone after 21 days in moist SO₂ atmosphere.



Figure 8. Untreated sample of best quality Sanpete stone after 36 days of treatment in the moist SO₂ atmosphere.

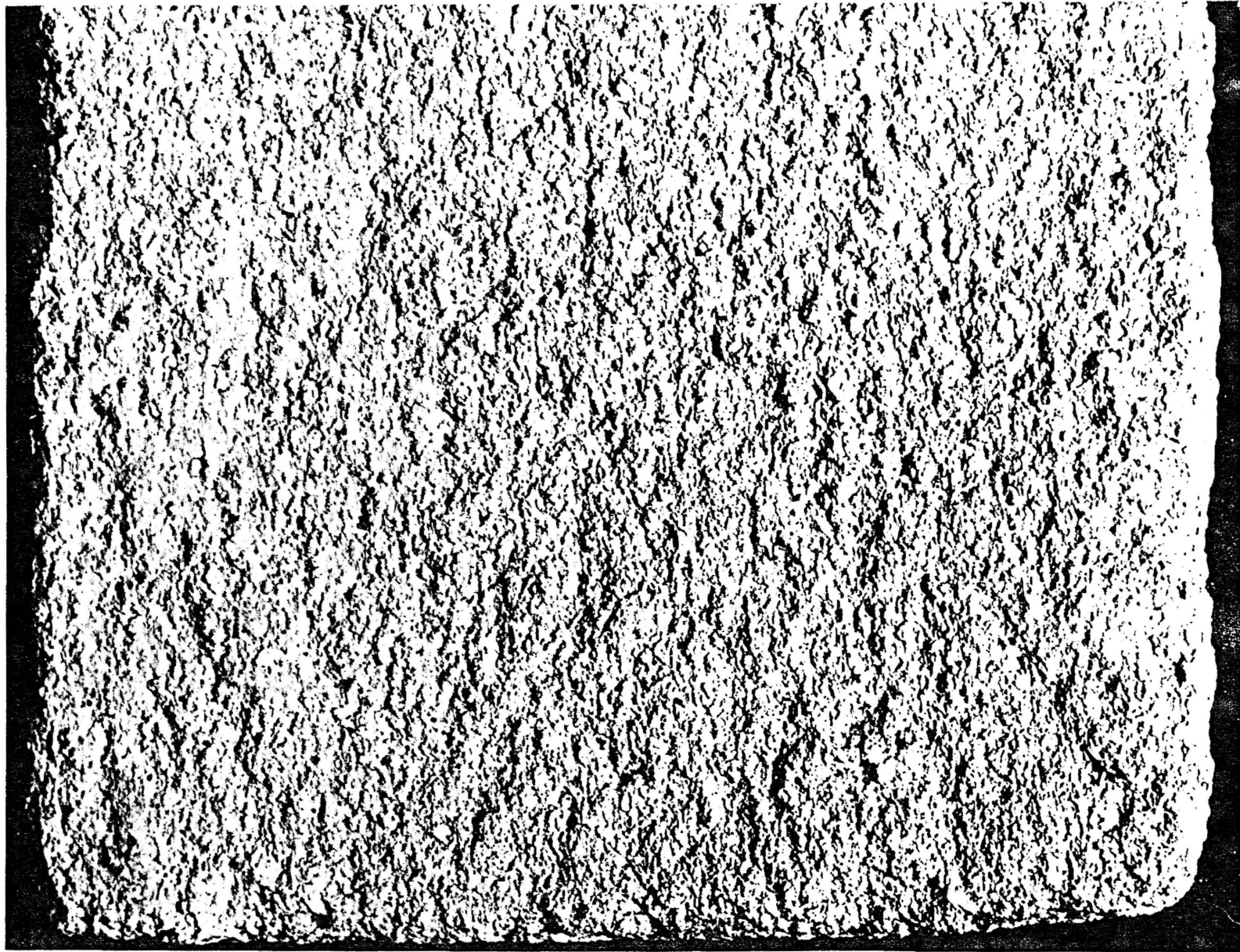


Figure 9. Indiana limestone after 42 days exposure to moist SO₂ atmosphere.

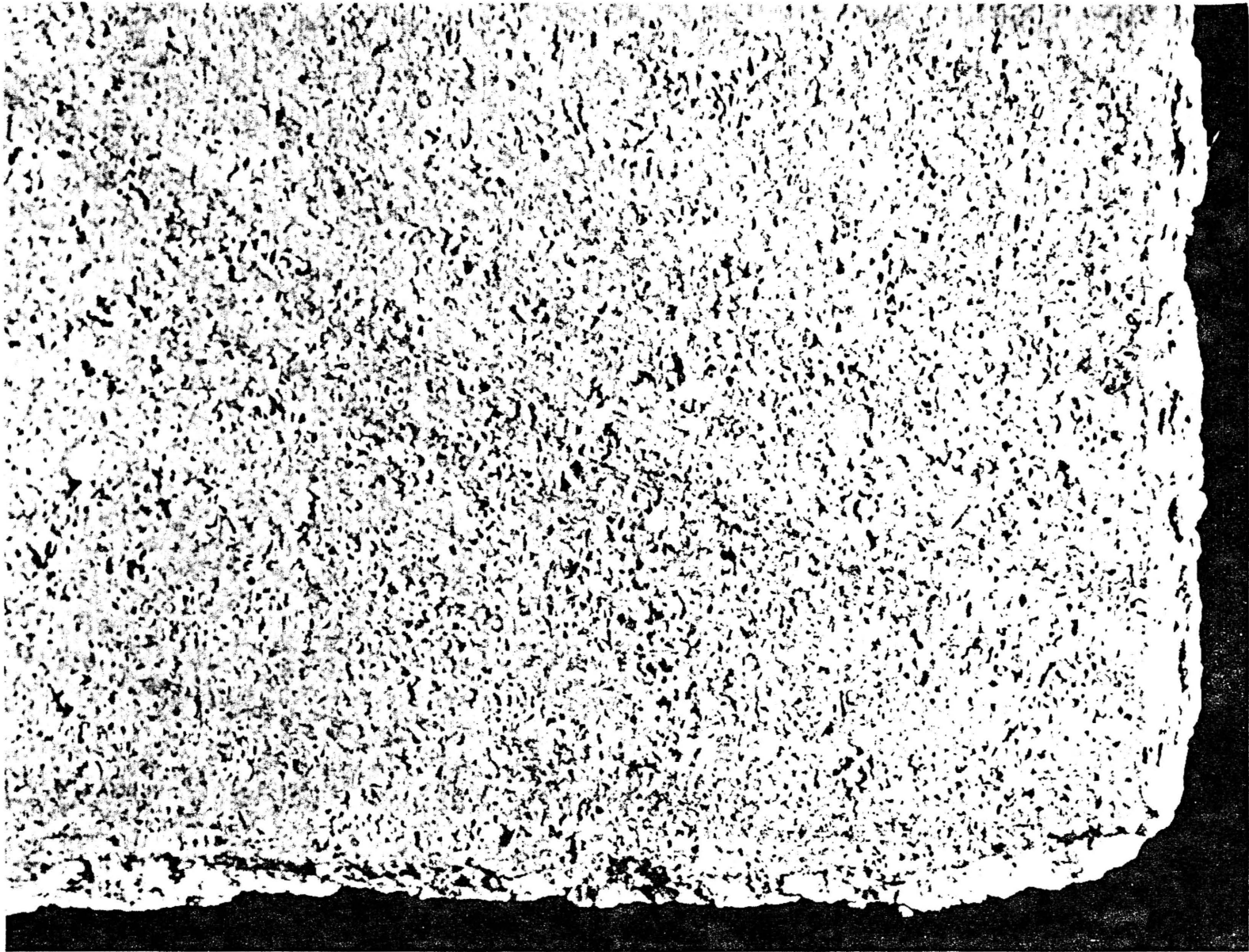


Figure 10. Same sample as Figure 9 showing a cross section cut which reveals the depth of reaction with SO_2 and water vapor.

The inevitable conclusion is that the Bedford stone has its superiority over the Sanpete stone largely in its greater density, (less porosity).

Also, the conclusion is that the Sanpete stone is not stable in an industrial atmosphere (urban atmosphere) and, therefore, should not be used where a long time service period is expected of the stone.

In explanation of the superiority of the Bedford stone, we observe that it is dense enough so that as the gypsum forms in its surface the pores are blocked to further passage of the SO₂ gas; thus the interior of the stone is naturally protected. The porosity of the Sanpete stone is so great that this blocking of the pores to the passage of SO₂ gas does not take place.

Stabilization Studies

Stone is now used as a construction material for the outside walls of buildings largely for aesthetic reasons. In general, it is considered that synthetic materials such as concrete, brick, cement block, stucco, etc., are less expensive than stone. The Sanpete stone has a very pleasing surface texture, and its near white surface gives buildings constructed from it a regal appearance. Furthermore, it can be readily -- and relatively inexpensively -- carved into delightfully decorative shapes as is so with the facade of the "Hearst Castle". Its non-stability, however, in the presence of traces of SO₂ gas in the atmosphere drastically limits its usefulness as a building material. If the stone could be stabilized by a suitable chemical process, its potential usefulness would be greatly enhanced. To be fully useful, however, any stabilizing treatment should not significantly alter the appearance of the stone, otherwise the cheaper synthetic materials would do as well. Several potentially stabilizing

treatments were tried and the product evaluated in the accelerated aging test described above. Following are the results:

A compound known as tetraethyloxysilane (tetraethyl silicate), $\text{Si}(\text{OC}_2\text{H}_5)_4$, can be readily hydrolyzed, especially in the presence of hydrogen ion as catalyst, to a hydrated form of silica ($\text{SiO}_2 \cdot \text{hydrate}$). On drying this converts to solid SiO_2 in a form usually described as silica gel which acts as a binder to cement solid earthy particles into a monolithic whole.

The use of hydrolyzed ethyl silicate as a stone preservative was discussed by Mr. George King in England in 1930.² Since that time the use of this material for the preservation of building and monumental stone has been actively promoted in England¹ and perhaps to a lesser extent in the United States. It is our purpose in the present study to evaluate the usefulness of this material in the preservation of Sanpete stone.

Since the properties of the film produced by hydrolyzed ethyl silicate differ with the method of hydrolysis, five different solutions were used. Four of these were formulated according to the table below:

	<u>Parts by Volume</u>			
Ethyl Silicate 40	20	53	--	--
Ethyl Silicate Condensed	--	--	40	5
Industrial Alcohol	80	42	60	--
HCl (aqueous) 1%	--	5	--	1
Water	--	--	2	9

The ethyl silicate 40 and the ethyl silicate condensed were obtained from the Carbide and Carbon Chemical Corporation, a subsidiary of Union Carbide.

² "Silicon Esters and Their Application to the Paint Industry," George King. Journal of Oil and Color Chemists Association, Vol. 13, pp. 28-55, (1930).

The fifth hydrated silica solution, known as AS-1001, was sent by Mr. H. D. Cogan under the date of March 5, 1948 from the Mellon Institute. Information concerning the composition and method of preparation of this solution was not made available to us.

All reagents were reacted by prolonged agitation and then allowed to age at least 24 hours before application to the stone.

Numerous samples of the Sanpete stone and the Indiana stone were treated in a multiplicity of ways with the five hydrolyzed ethyl silicate solutions described above. These treated samples were then placed in the humid sulfur dioxide atmospheres and their rate of disintegration observed.

The relative effectiveness of the various silica sol treatments of the Sanpete limestone is given in the table below. The results show no

Disintegration of Sanpete Limestone in Moist Sulfur Dioxide

<u>Solution Number</u>	<u>Coats</u>	<u>Hours for Visible Disintegration</u>
None	None	240
1	1	208
1	2	252
1	3	312
2	1	256
2	2	216
2	3	208
3	1	200
3	2	252
3	3	200
4	1	280
4	2	252
4	3	200
5	1	120
5	2	264
5	3	288

significant trends and indeed there is little or no evidence of any pre-

servative action due to this reagent. This is true regardless of the manner in which the solution was prepared, or the number of successive coats of the reagent applied to the surface of the stone.

The silica sol does not penetrate the stone deeply, but to the depth that it does penetrate the stone is protected, to a considerable degree, from reaction with the humid sulfur dioxide. The silica gel resulting from the treatment acts as a strong cementing bond on the calcitic oörites, but due to the shrinkage of the silica gel as the solvent evaporates the surface layer remains porous. The water vapor and sulfur dioxide diffuse through the outer modified skin and react with the limestone inside the modified layer.

Another stabilizing method tried was that of giving the Sanpete stone a coating of clear Dow-Corning silicone. Evaluation of the coated stone by means of our accelerated aging test gave no evidence of improvement due to the silicone treatment.

The results of these tests are pictorially summarized in Figures 11 (a, b, and c) which show one untreated sample and two hydrated silica treatment samples of Sanpete stone after 36 days in our accelerated aging test. It is evident the treated samples do not possess improved stability to our accelerated aging test, and presumably would not in actual use as a building material.

The hydrated silica and silicone treatment of the stone was especially interesting from the fact that the look-of-the-stone was only very slightly modified by this treatment.

An intriguing idea was to precipitate fresh calcium carbonate (CaCO_3) in the pores of the stone. This was done by repetitively

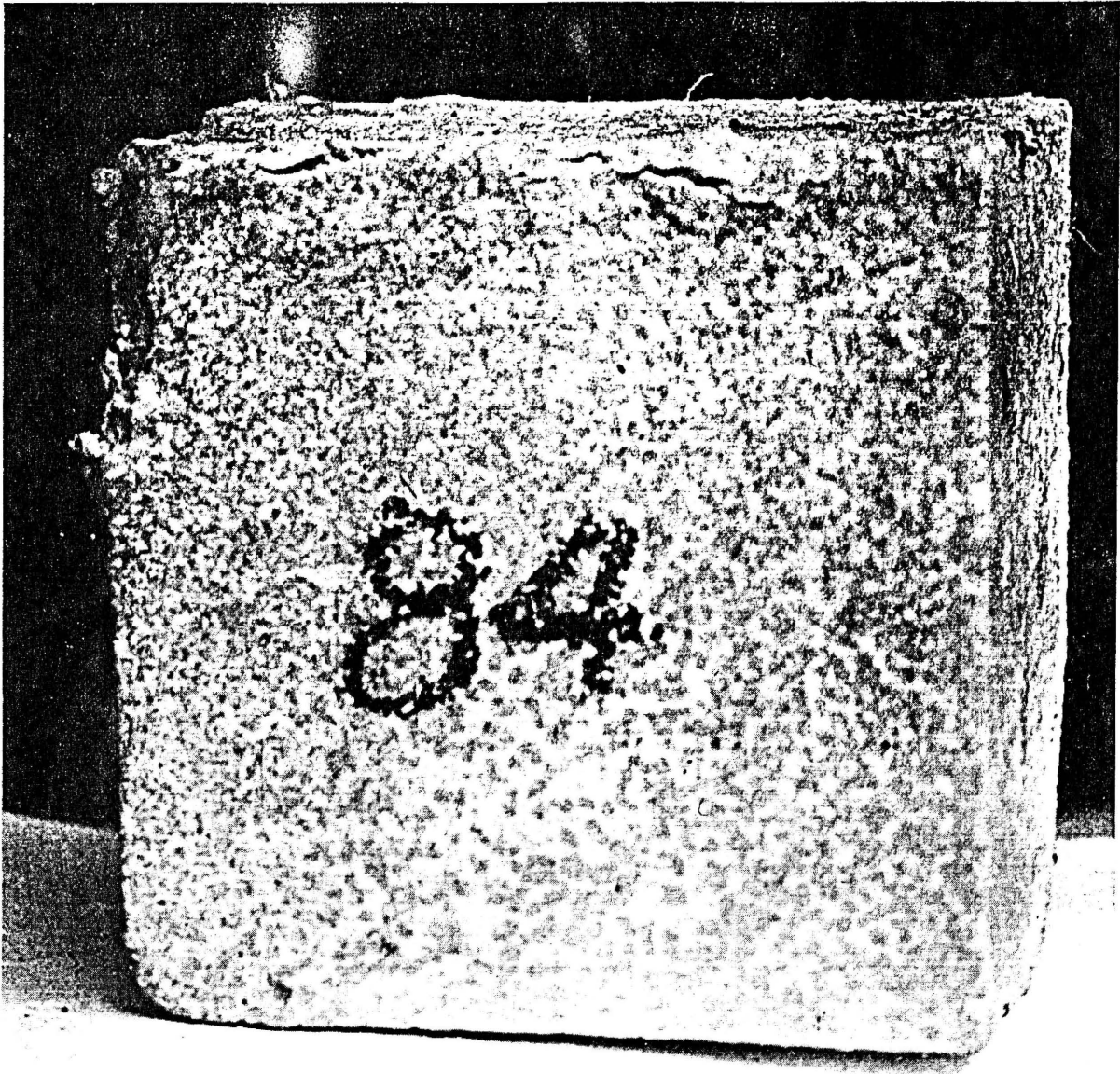


Figure 11(a). Sample #1, untreated Sanpete stone after 36 days in moist SO₂ atmosphere.

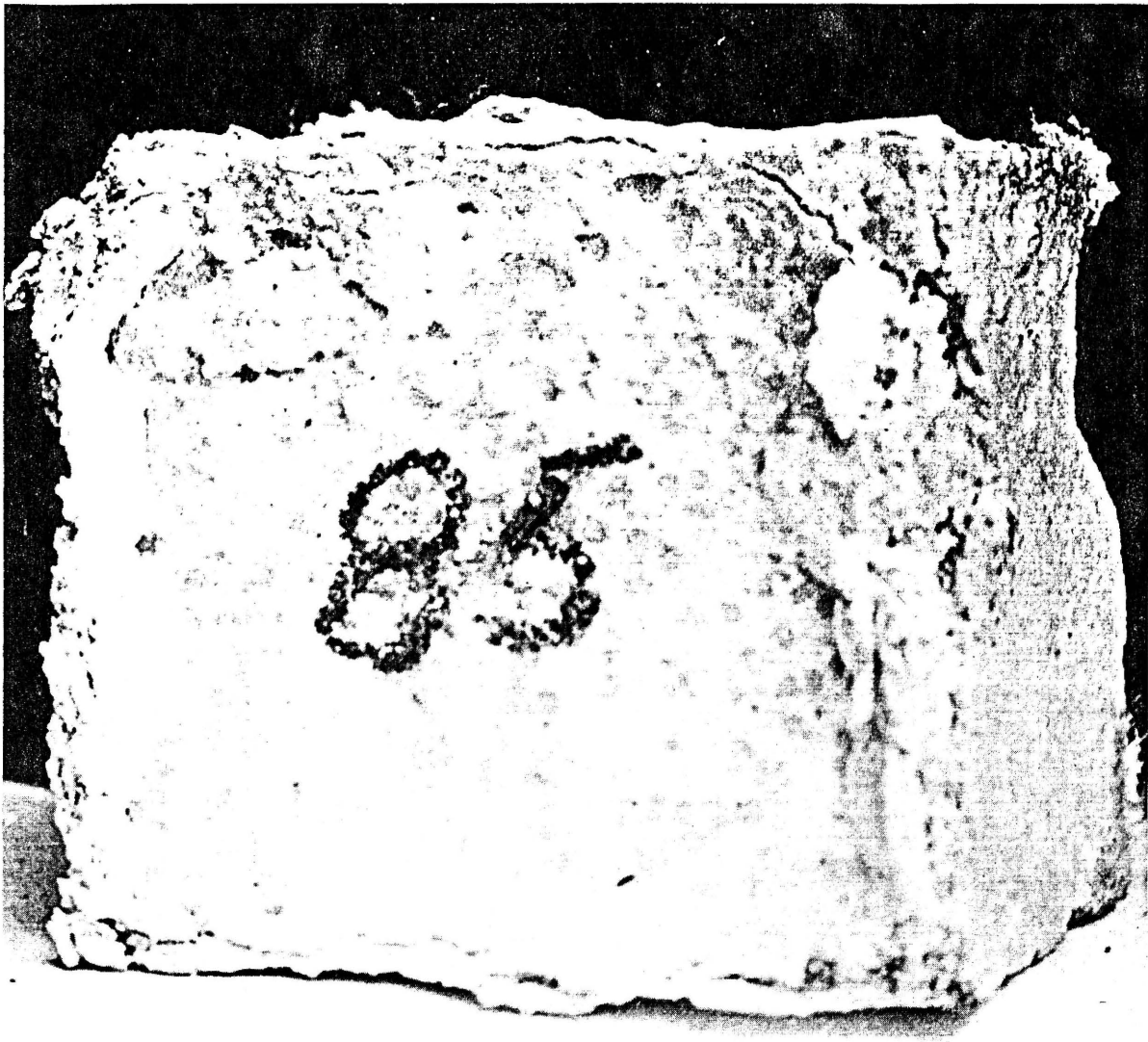


Figure 11(b). Sample #2, Sanpete stone treated with two coats of #1 hydrated silica solution after 36 days in moist SO₂ atmosphere.

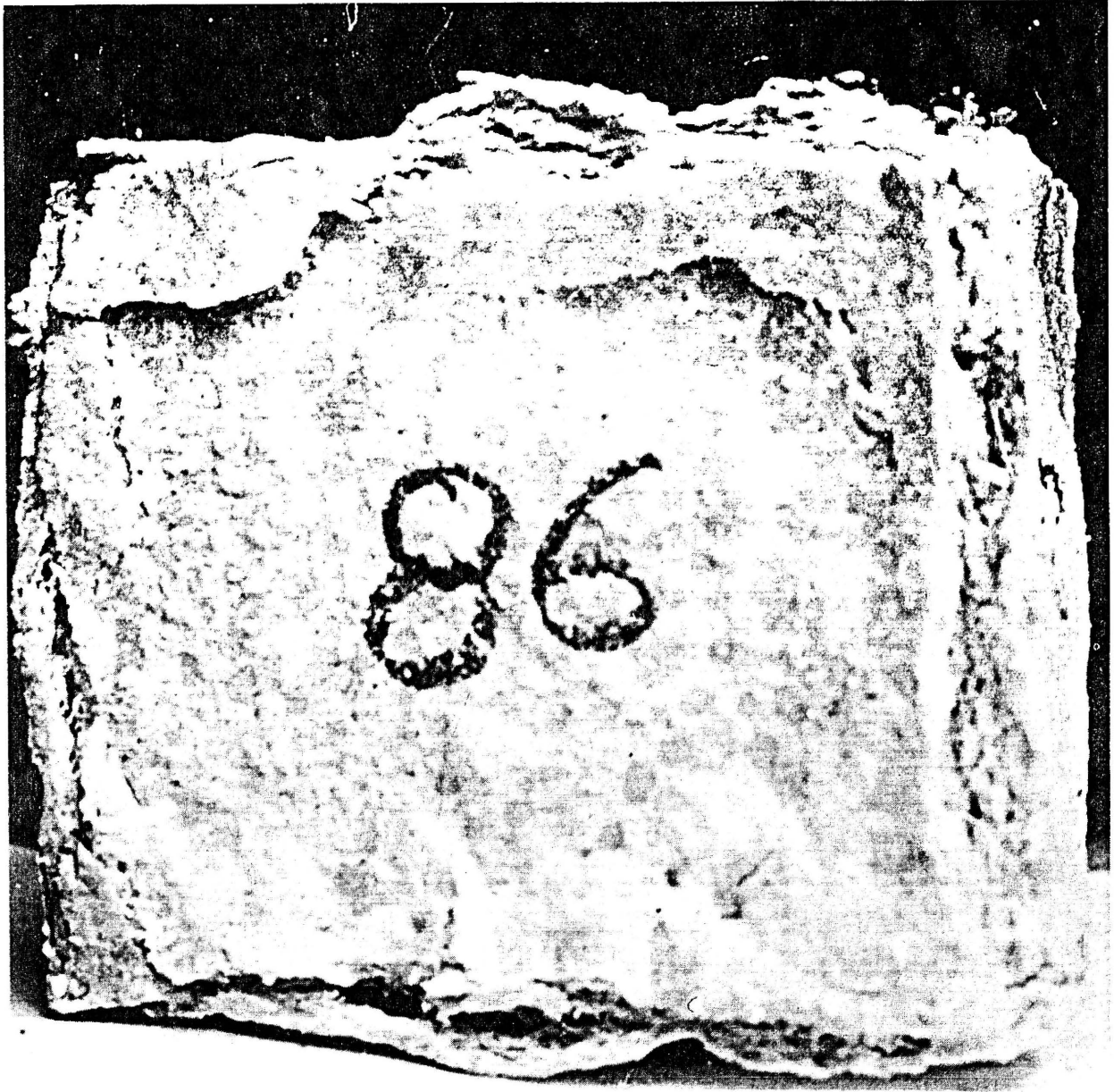
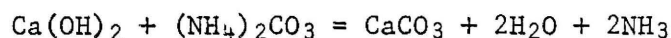


Figure 11(c). Sample #3, Sanpete stone treated with two coats of #2 hydrated silica solution after 36 days exposure in moist SO₂ atmosphere.

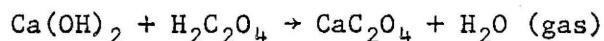
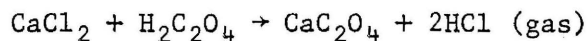
immersing the stone in a slurry of $\text{Ca}(\text{OH})_2$ (hydrated lime) until the pores were filled with the saturated solution and slurry of $\text{Ca}(\text{OH})_2$, then immersing the blocks in a saturated solution of ammonium carbonate, $(\text{NH}_4)_2\text{CO}_3$. The reaction would be



Thus the only residual product left in the stone would be CaCO_3 ; the water and NH_3 would leave as gases.

We were unable to find any beneficial effect due to this treatment. Due to the nature of the process the block would still be porous to gases.

A similar attempt to precipitate calcium oxalate in the pores of the stone via the two reactions



also failed to produce a desired effect.

We also used several commercial preparations of unknown composition on the stone with negative results. These included:

Carboline Water Repellent Reagent (Product #2109)

Carboline Company
32 Hanley Industrial Court
St. Louis 17, Mo.

Barrier Water Repellant Reagent

National Chemical Corp.
Newton, Mass.

Epoxy Sealer #K-5751

National Chemical Corp.
Newton, Mass.

Hornstone and Dehydratine

A. C. Horne Company

Treating the surface with an impervious layer of a paint-like substance such as acrylic or epoxy paints gave considerable protection, but at the expense of completely altering the surface appearance of the stone. For this reason treatments with these substances were considered to be unsatisfactory. If one is to have a "painted" surface, he could use much cheaper building materials as a closure wall of a building.

Conclusion

The Sanpete oölitic limestone is a much inferior stone to Bedford stone, a stone of similar chemical composition but very different physical properties. It is our conclusion that the Sanpete stone should not be used for exterior courses of a building constructed with the intent that it should last 100 years or more. Buildings constructed of this stone should have plane surfaces so that "resurfacing" of the stone can be carried out at reasonable intervals of time -- perhaps 25 years. Intricately carved designs on exterior surfaces will be destroyed in a few years time.

No good stabilizing treatment of the stone which leaves the surface with the original raw stone appearance has been found. Surface films which are impervious to moisture and SO₂ gas do give protection to the stone, but if such a treatment is necessary, cheaper surfacing materials such as cement blocks can be used for buildings.

The Sanpete stone can be used successfully on interiors of buildings where the stone is not subject to periodic wetting due to storms.