THE WEATHERING OF STONES.

SPEAKING of the weathering of stones employed for building purposes, a correspondent of Indian Engineering says the subject is one which does not receive the attention it deserves. The older architects appear to have given it far more consideration, and it is quite common to see the older part of a building in good condition, so far as weathering is concerned, while the newest additions to it are in immediate want of repairs. Some stones are most liable to attack by chemical agency. Dolomites and limestones, for instance, both the marbles and the common varieties, are more susceptible to action by the gaseous constituents of the atmosphere than to the disintegrating effect of heat and cold. If anything, dolomites are more durable than limestones in this respect. Of course we have always present in the atmosphere carbon dioxide, tending to form acid carbonates with calcium and magnesium ; these compounds being soluble, are washed away with each shower of rain, leaving fresh surfaces for further attack. Where coal is burnt in any quantity sulphuric acid will make its appearance as sulphate of lime ; as, almost absolutely insoluble, this forms temporarily what should be a protective coat to the stone. Unfortunately, the coat formed, impervious though it is, is not in effect protective. Disintegrating changes are always found to be going on underneath, often very rapidly. Nitric acid is another active agent in the destruction of these stones. Oxygen and nitrogen, in the mechanical mixture which forms our atmosphere, appear to have no action at all ; but where combination is brought about—as it is for instance, during thunderstorms, forming oxides of nitrogen and oxygen—nitric acid immediately makes its appearance, and to its eroding properties many rapid disintegrations owe their origin. As the result of this action calcium nitrate is sometimes found crystallised on the walls of houses, often with phosphorescent effects like those of luminous paint.

All the chemical actions are likely to affect the cement substances of the stone first. Dolomites and limestones may be roughly viewed as consisting first of granites and crystals, secondly of materials making these granites or crystals to cohere. The latter material—which may not differ chemically from the former, but which often combines more iron and such like elements—we may call the cement substance of the stone. It is always the softest part, and, therefore, the most liable to attack. Thus the result of the chemical action is to leave the surface of the stone intersected with minute cracks, and so open the way for the destructive action of frost. A great deal may be learnt of the probable durability of a stone by examining a section under the microscope. The tiny cracks or rifts, precursors of more serious disintegration, can here be seen perfectly. Also the various constituents of the stone may be seen and their arrangement clearly made out. Pyrites, for instance, is a most objectionable ingredient, as it generally decomposes with ease, leaving an unsightly black spot to mark the place. If the grains of pyrites are imbedded in a porous light-colored matrix, this defect will be exaggerated accordingly. If, however, the grains of pyrites are confined to a hard, compact, non-absorbent part of the stone, the decomposition may take place and be carried out without leaving a trace ; and, moreover, pyrites in sharp, well-defined crystals often resist decomposition entirely. Thus in this respect alone a microscopic examination may prove of the greatest service. The chemical changes described, and particularly the decomposition of pyrites, is greatly aided, if not entirely due, to the actinic rays of the sun. The sun, indeed, is the great chemist of nature as it stands, and few natural chemical reactions can be brought about in the absence of sunlight, or, at least, daylight. Passing on to the consideration of granites, we find the causes of disintegration quite different. Whereas limestones and dolomites succumb chiefly to chemical action, the disintegration of granite is due almost entirely to mechanical strain. The surface of granite is so compact and non-absorbent that frost alone would be quite without effect, since its destructive action only obtains after the stone has absorbed a certain amount of water. The same may be said of diabases, porphyrys and basalts when magnetite or secondary calcite is not present in large quantities. These rocks, however, are all very bad conductors of heat ; consequently, where changes of temperature are frequent and considerable, only a thin outer layer of the stone would be concerned in the changes, and the various stresses brought about by these conditions initiate the fine rifts and cracks which are necessary for the effectual action of the frost as a disintegrating agent. Thus a granite, quite unattackable in a place where the changes of temperature are small and slow, may be disintegrated rapidly in places where the opposite conditions prevail. According to Dr. Hague, the granite obelisk in Central Park, New York City, is now suffering from the execrable climate of that city. Another reason why changes of temperature should have a particularly evil effect upon granite is the different co-efficients of expansion possessed by its various constituents. And not only has each constituent a different co-efficient of expansion from the remainder, but the co-efficient of each constituent varies according to the axis of crystallization parallel to which it is measured. How great the differences are may be demonstrated in one example: Hornblende gives .0000095, .00000084, .0000081 as the co-efficient of expansion parallel to its three axis respectfully. Quartz presents even greater variations. If we wish to compare the expansibility of one of these constituents with that of another, as a whole, we must, of course, consider their co-efficients of cubical expansion. Here again the differences which obtain amply explain the susceptibility of granite to disintegration in climates of great variability. How in the world granites got their reputation as fire-proof materials, a property they are still supposed to possess, it is difficult to understand. A greater delusion it would be hard to find, as the foregoing considerations testify. People certainly could not have taken experience as their guide. Every great fire demonstrates the superior virtues of sandstone, and even limestone, as a fire-resisting material. It is not to be understood that granite is absolutely impervious to chemical action ; the micas rust and the feldspars may be kaolinised, but the changes are so minute and slow as to be practically negligable. It is a pity the durability of stone excites so little interest.

PUBLICATIONS.

The Architects' Directory for 1895-6, containing a list of the architects in the United States and Canada, has reached our table. The names are classified by states and towns. Wm. T. Comstock, publisher, 23 Warren street, New York. Price, $1.00.
