GEOLOGY

Molecules Crack Rocks

Water molecules inside rocks exert sufficient pressure to cause cracking, according to research displacing the freeze-thaw theory of rock cracking

See Front Cover

➤ ROCKS are cracked and broken not by freezing and thawing but by more subtle and complex behavior of water molecules.

The new theory of why rocks break was discovered by Drs. James R. Dunn and Peter P. Hudec of the Rensselaer Polytechnic Institute. The results of their research may save millions of dollars for the nation's $600-million-a-year limestone and dolomite industries.

The principal reason for rock splitting in nature is that water molecules inside the pores and fissures of rock exert expansion and contraction forces similar to those displayed by ice. But the process is not freezing, for the water molecules adsorbed inside the rock pores are largely unfreezable even at temperatures as low as 40 degrees below zero F.

Until this research, man for centuries had thought that the weather-beaten rocks of mountains and cliffs were cracked and weakened by alternate freezing and thawing of water in the rock fissures.

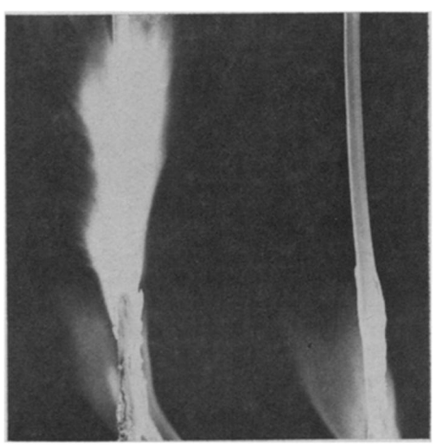
A molecule of water is made up of two atoms of hydrogen and one of oxygen. The two smaller positively charged hydrogen atoms are oriented toward one end of the larger negative oxygen atom. Thus the water molecule is a "polar liquid," having a positive and negative end.

When these polar molecules of water seep into a sedimentary rock, composed mainly of limestone, they come under the influence of a negatively charged field of clay particles that have moved around the boundaries of the rock crystals. The positive end of each molecule is attracted to the negative clay surface, and the molecules tend to stick out from the crystals like the quills on a porcupine, assuming a quasi-crystalline nature and exerting expansive force.

The degree to which the water dipoles order or line up inside rocks is strongly governed by temperature, vapor pressure and the distance the molecules are from the clay surface.

The dolomite samples shown on the cover illustrate typical breakdown of rocks.

(Cover photograph by Rensselaer Polytechnic Institute.)



GE

FIRE PREVENTION — Research scientists at General Electric Company, Waterford, N.Y., have developed a new kind of silicone rubber insulation (right) that will not support flame the way other types of insulation do (left). It is being used in color television and other appliances carrying very high voltage and may someday provide flameproof house wiring.

GEOPHYSICS

Primeval 'Soup' Poisonous

➤ THE POISONOUS chemical hydrogen cyanide was the principal ingredient of earth's primeval "soup" from which life-like substances were formed.

This planet's primitive atmosphere was not the methane-ammonia mixture suggested by many scientists, Dr. Philip H. Abelson reported in Washington, D. C. Dr. Abelson, director of Carnegie Institution of Washington's Geophysical Laboratory, thus challenges the prevailing view of how biologically active materials were formed early in earth's history.

Geologists favor the position that the genesis of air and oceans was in the gases seeping out from earth's crust or spewed forth when volcanoes erupted. Dr. Abelson charged that there is "no evidence" for a primitive methane-ammonia atmosphere and many factors against it.

He suggested that the volatile compounds in the gases issuing from earth's interior reacted with the chemicals in the crust to form an alkaline ocean and an atmosphere consisting of carbon monoxide, carbon dioxide, nitrogen and hydrogen.

Radiation interacting with such a mixture yields hydrogen cyanide as the main product. When solutions of hydrogen cyanide are irradiated with ultraviolet light, amino acids and "other important substances of biologic interest" result, Dr. Abelson has found.

He noted that during the past 15 years many scientists using a wide variety of energy sources have shown that life-like compounds can be made from simple starting materials. However, these experiments have had the "curious deficiency" of not taking into account what geologists have learned about earth's early environment.

The geologic record shows that volcanoes, with their associated release of gases, have been erupting for more than three billion years, Dr. Abelson said in the Proceedings of the National Academy of Sciences, 55:1365, 1966. The water vapor condensed, the carbon dioxide was dissolved in the water and converted to carbonate, and other acid gases were converted to nonvolatile salts.

Dr. Abelson, with Dr. T. C. Hoering, tested the reactions of various mixtures of nitrogen, carbon monoxide and hydrogen at room temperatures under varying pressures. They found that the major product by far was hydrogen cyanide.

GEOLOGY

600-Million-Year-Old Algae Found in Crater

➤ SEAWEED-LIKE ALGAE on earth either evolved faster or started earlier than many scientists believe, according to marks discovered in some Australian meteorite craters.

While mapping one crater, Daniel J. Milton of the U.S. Geological Survey, Menlo Park, Calif., came upon some curious marks in a layer of sandstone dating from the Upper Precambrian period more than 600 million years ago.

The marks were made by "semibuoyant, flexible objects at least 15 centimeters (about six inches) long, which presumably were algae."

Such life forms had already been known to exist from the Cambrian period to recent times. The new discovery, however, "extends the range (back) into the Precambrian and indicates that before the beginning of the Paleozoic era life had evolved beyond the microscopic forms . . . into organisms as large as much of the seaweed in modern seas."

The finding was reported in Science, 153:293, 1966.