THE POTENTIALITIES OF HIGH-TEMPERATURE SUPERPRESSURE RESEARCH

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You have just heard the story of diamonds made through high-temperature superpressure processes in the General Electric Company. This marks our first big step in high-temperature superpressure research. We look to discoveries of importance to science from studies of many other substances and processes which occur under these extreme conditions.

Thus our work during the past four years in this field of high-temperature superpressure, in which we made diamonds, is part of a program aimed at increasing our understanding of the structure of matter and the mechanisms involved in the changes that occur. The making of real diamonds in the Laboratory was deliberately aimed at gaging the requirements for effective research in the broad field of high-temperature superpressure. It was fully realized that new or improved tools and techniques had to be added to the existing technology. We believe there are excellent prospects for fruitful research in this high-temperature superpressure field.

In carbon, which exists as either diamond or graphite, we have a striking illustration of what may be done in changing the structure and properties of matter simply through superpressure processes. These two forms of the element carbon have greater differences in physical and chemical properties than exist between many substances — compounds as well as elements — of even different chemical content.

Other known products of superpressure techniques, specifically certain compounds, also exhibit physical properties that are markedly different from those of the primary substance. Coesite (high-density silica) is an example of one of these. Coesite is a high-pressure phase and, like diamond and graphite, its high- and low-pressure phases are identical in chemical content.

We look to the superpressure techniques to yield new forms of matter with properties of scientific value. The structural changes, the phase changes, and the chemical reactions that occur only at superpressures represent a wide field for scientific attention. It should be mentioned that studies in which molecules are grown to large sizes, i.e., polymerization, are also included in the objectives in this field. The importance of polymerization in chemical technology is well known. Silicones and polyethylene are examples of high polymers.

The great depths of the earth constitute a vast superpressure cell. Temperature data from mines and holes go down to a depth of less than four miles. From these we estimate a temperature rise of about 105°F per mile. The pressure is estimated as increasing at a rate of 6000 lbs./sq.in./mile. Thus, at 160 miles below the surface of the earth it is estimated that the pressure is 1,000,000 lbs./sq.in., and the temperature is estimated (very uncertainly) at several thousand degrees F.

The high-density silica (Coesite), formed at pressures above 500,000 lbs./sq.in., is returned to the low-pressure silica by heating at lower pressures at 1300°F. Since the temperatures found in the hot cores of volcanos are close to 2000°F, we can understand why naturally-formed high-density silica is not found on the earth's surface. It undoubtedly is altered to a lower pressure phase on its way to the surface of the earth.

In the Laboratory superpressure cell, the temperature may be lowered while the pressure is maintained. Thus we expect to obtain high-pressure forms not found in nature. This applies particularly to those that are less stable than the diamond.

We look on the field of high-temperature superpressure as a vast and interesting field. By controlling the chemical charge in the superpressure cell and controlling pressure and temperature at will, we look towards new discoveries. The Laboratory formation of the diamond from carbonaceous material is a great encouraging step in this direction.