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DIAMOND SYNTHESIS: OBSERVATIONS ON THE MECHANISM OF FORMATION

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ABSTRACT

A brief history of diamond synthesis, as well as instrumentation capable of accomplishing the experiment, are given. The direct conversion of graphite to diamond by severe transient pressure and high adiabatic temperature is reviewed. Current tentative explanations of the mechanism are discussed. Studies performed at the U. S. Army Electronics Research and Development Laboratory on several metal-carbon, metal-carbon-silicate, and carbon-nonmetallic salt systems are described and data presented. A mechanism of formation is proposed for synthesis performed under relatively static high pressures and high temperatures; namely, crystallization from solution. Supporting evidence is given. The use of secondary chemical reactions in diamond formation processes also is described. A brief discussion is presented on correlation of laboratory data with the genesis of natural diamond.

INTRODUCTION

The first serious attempt by man to create diamond occurred approximately 80 years ago (Hannay, 1880). A second venture was reported 14 years later by Moissan (1894). The first substantiated synthesis was announced in February of 1955 by the General Electric Company Research Laboratory, Schenectady, N. Y. (Bundy *et al.*, 1955). Shortly thereafter, a second success was reported by the Swedish firm of Allmanna Svenska Elektriska Aktiebolaget (1955). Data on the third independent synthesis, by the U. S. Army Electronic Research and Development Laboratory, was published 5 years later (Giardini *et al.*, 1960). Within a few years, therefore, this significant mineral which withstood duplication for so long, became a routinely producible material.

Although the production of diamond has been reduced to practice, a clear understanding of the mechanisms of formation still is subject to discussion. Thus far two distinct thermodynamically permissible physical-chemical techniques have proven successful. The first, used by all references cited above, essentially involves a reaction of carbon with an intermediate material under relatively static high pressures and high temperatures. The second method, first announced by the Stanford Research Institute of Menlo Park, California (DeCarli and Jamieson, 1960), contemplates a direct transformation of graphite to diamond. The latter is accomplished by subjecting graphite to a very high instantaneous stress developed by explosive shock.

A third process has been recently reported by the Union Carbide Corporation of Kenmore, N. Y. (Eversole, 1962). Relatively high temperature solid-gas reactions are carried out at surprisingly low pressures.

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