Sorex, Searle), and western North American gophers (*Geomys* and *Thomomys*, Patton). Of these narrow zones, *Bombina*, *Caledia*, *Chorthippus*, *Heliconius*, *Mus*, and *Sorex* form broad contacts several hundred kilometers in length, and many have been studied at multiple transects. Irises and gophers form very limited, patchy hybrid zones, but Arnold and Bennett show the advantages of plant systems for laboratory and transplant experiments. Patton emphasizes that several aspects of gopher demography (exclusive-use territories and polygynous mating systems) make them ideal for studies of how mating systems influence patterns of hybridization and introgression.

Most of these studies concentrate on determining what selective forces are acting to maintain a given zone and, for zones in which there is strong selection against hybrids, whether or not reinforcement might be operating. In many cases, either reinforcement appears not to be operating even with very strong post-mating isolation (*Caledia*) or evidence for it is limited despite seemingly ideal conditions (*Chorthippus*).

Clines for most characters studied are coincident and appear to be maintained by extrinsic factors favoring different genotypes in different habitats (*Colaptes*) or by intrinsic factors coupled with a strong habitat component (most others). The *Heliconius* zones involve a series of Mullerian mimetic morphs of several species, and their structure is unusual in having the dynamics of a tension zone (frequency-dependent selection operates against intermediate phenotypes), but this is due to an ecological agent (avian predators). Some of the *Mus* and *Sorex* chromosomal clines described by Searle are unusual in that they are distinctly noncoincident with each other and form a "staggered" pattern.

The book could have provided a better-integrated exposition of the value of placing process-oriented studies into a phylogenetic context; the matter is mentioned in several chapters, but nowhere is it fully developed. Nevertheless, this book deserves a wide audience; organismal biologists not familiar with hybrid-zone research will be surprised at the number of interrelated topics that require attention. For example, a great deal remains to be learned about the ethological, ecological, and demographic aspects of most hybrid zones, about the genetic basis for ecologically important morphological traits, and about communication signals and mate choice. At the molecular level, the development of new markers will permit more robust estimates of gene flow and facilitate multiple-gene tree comparisons, and causal mechanisms responsible for the generation of new alleles and chromosomal rearrangements in hybrid zones remain only superficially understood. For those with a mathematical or statistical inclination, the extension of cline theory to describe noncoincident "staggered" clines and two-dimensional and small-sample cases, and a refinement of gene-flow estimators under a variety of different mating systems and selection regimes would repay further effort. This book should also stimulate investigators working on groups underrepresented in the hybrid-zone literature to undertake similar studies; only when enough examples are available will generalities emerge. The diversity of phenomena manifested in the examples in this book suggest that we have a long way to go.

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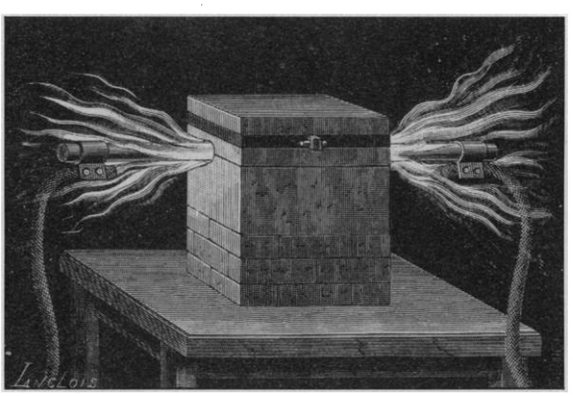
Diamond-Making

The New Alchemists. Breaking Through the Barriers of High Pressure. ROBERT M. HAZEN. Times Books, New York, 1993. xvi, 286 pp., illus. $25.

Synthesis of diamond from carbon is certainly the most spectacular achievement of high-pressure research. I believe no other material can challenge synthetic diamond's honored place, not even metallic hydrogen, if it is ever made. During my three decades at Bell Laboratories I was often asked by visitors, "What is the use of high-pressure research?" My ready reply was that high pressure has enabled us to accomplish feats that previously could be performed only by nature in the Earth's deepest interior. Then I would say, "Give me peanuts and I will turn them into diamonds with this apparatus in front of you," a massive, green-hued press that we had christened "the green elephant." The astonished visitor would retreat a few steps, look at me and the press and exclaim, "Is it really that simple?" It is indeed that simple now, but it was not prior to 1955.

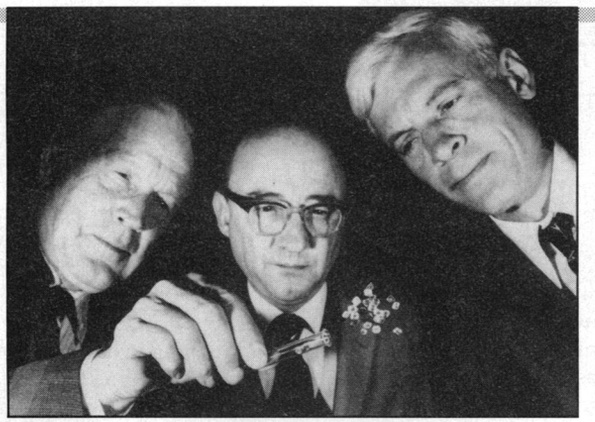
The successful synthesis of diamond has a long history behind it of failures, frustrations, rivalries, faked claims, and missed opportunities. Celebrated chemist and Nobel laureate Henri Moissan failed. The father of high-pressure research and Nobel Prize–winning physicist Percy Bridgman did not succeed either, despite many attempts. As a result of studies of natural diamonds by geologists it has long been known that diamond production requires both high pressures and high temperatures. What exactly these pressures and temperatures must be eluded the early diamond makers, and their hit-and-miss methods yielded no good results. Finally, thermodynamic calculations revealed diamond's pressure–temperature stability field. But the generation of sustained pressures and temperatures under which graphite would transform to diamond rapidly would have to await the advances of high-pressure technology of the 1950s. The expensive venture also needed the support of corporate players, for no individual scientist could afford the cost.

The feat was finally accomplished on 16 December 1954 by a team of scientists at the General Electric Research Laboratory with the so-called "Belt Apparatus," invented by one of its members. From 1950 to the day of success, the team plodded and sweated to build the right kind of apparatus, find the right recipe to cook, and prove the repeatability of the experiment so that the discovery could be patented. It was a great scientific achievement of immense practical value. (Diamond mines in Africa, Australia, and Russia together yield something like 20 tons annually, but the world annual production of synthetic diamond is estimated to be over 100 tons, almost all of which is marketed as abrasives and used in the machine-tool industry and in rock drilling. Synthetic gem-quality diamonds of a few carats in size have been produced, but the cost is at present prohibitive.)



"At full power, Henri Moissan's electric air furnace, pictured in this illustration from his 1904 monograph The Electric Furnace, produced a spectacular display of sparks and flame as it reached temperatures of 3,000°C. Moissan believed that he had synthesized diamonds in his apparatus." [From *The New Alchemists*]

The New Alchemists tells the exciting human story behind this important achievement, describing the players, the game they played and how they played, and consequent events. It is a brilliant exposition, very absorbing and gripping. I could not put the book down; the first part, called The Diamond Makers, reads like



"Flawless diamond crystals more than one carat in weight were grown by GE scientists in the late 1960s. Herbert Strong (left) and Robert Wentorf, Jr., (right) show a collection of synthetic gems to GE vice president of research and development Arthur M. Bueche in May 1970." [From *The New Alchemists*; courtesy of H. M. Strong]

a first-rate novel all the way through. The personalities involved and their motivations are blended into the story beautifully. I found the portrayal of Loring Coes especially moving; this humble scientist finished out his life in obscurity, despite his seminal contributions to high-pressure mineralogy and to the diamond-synthesis effort at the Norton Company. George Kennedy, another colorful figure in the high-pressure field, is featured prominently. Descriptions of his flamboyant personal style and his involvement in the patent controversy between GE and De Beers Consolidated Mines of South Africa, as well as his own attempts at diamond making, spice up the account. However, I felt that Hazen could have spared us the details of some of Kennedy's exploits.

Perhaps the most fascinating chapter in the book is "Risky business," which describes how the product development took shape at GE. It is a case history of the transformation of a scientific discovery into a billion-dollar industry. The transition from a few initial specifications to production of over 100 tons of the noble allotrope of carbon annually was not always smooth: as C. Guy Suits later wrote, "An ill-timed sneeze in the wrong place would have wiped out the entire world supply of Man-Made diamonds [GE's trademarked synthetic diamond abrasive]."

The second part of the book, The Diamond Breakers, deals with the evolution of the diamond-anvil cell (DAC), describing the wonder apparatus itself, the personalities involved in its development, and the attainment of megabar pressures with it. Ironically, diamond, itself a product of high pressures and temperatures, was found to be able to generate record-high static pressures in the laboratory, resulting in the engagement of hundreds of scientists in modern high-pressure research. As Hazen notes, "For the better part of a century scientists relied on the earth to learn how diamonds were made. Today, they rely on diamonds to learn how the earth was made" (p. 189). A chapter entitled "Journey to the center of the earth" briefly describes some important applications of DAC high-pressure research to the Earth sciences. The account ends with the quest for metallic hydrogen and related controversies. This is all covered in 90-odd pages—not nearly enough space to do justice to the topic, but enough to convey to the reader the flavor of modern high-pressure research.

An experiment that comes close to the spirit of this book's title is the spectacular "black-to-gold" valence transition in samarium sulfide. It is really like the alchemist's dream come true, and I was surprised that it was not mentioned in the book. Also, toward the end of the book Hazen writes, "Harry Drickamer and his students at the University of Illinois became the first to demonstrate that pressure can transform simple compounds like table salt to metal" (p. 251). I don't know of any such claim by this group. Other than these errors of omission and commission the text is free of factual mistakes.

The New Alchemists is the best rendering to date of the entire story of diamond synthesis. This carefully researched and well-written book will give hours of reading pleasure to anyone—laymen, students, and scientists alike—who wants to learn about an exciting scientific achievement worthy of a Nobel Prize, which was unfortunately lost for reasons I won't go into here.

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