

# Elements

An International Magazine of Mineralogy, Geochemistry, and Petrology

June 2005  
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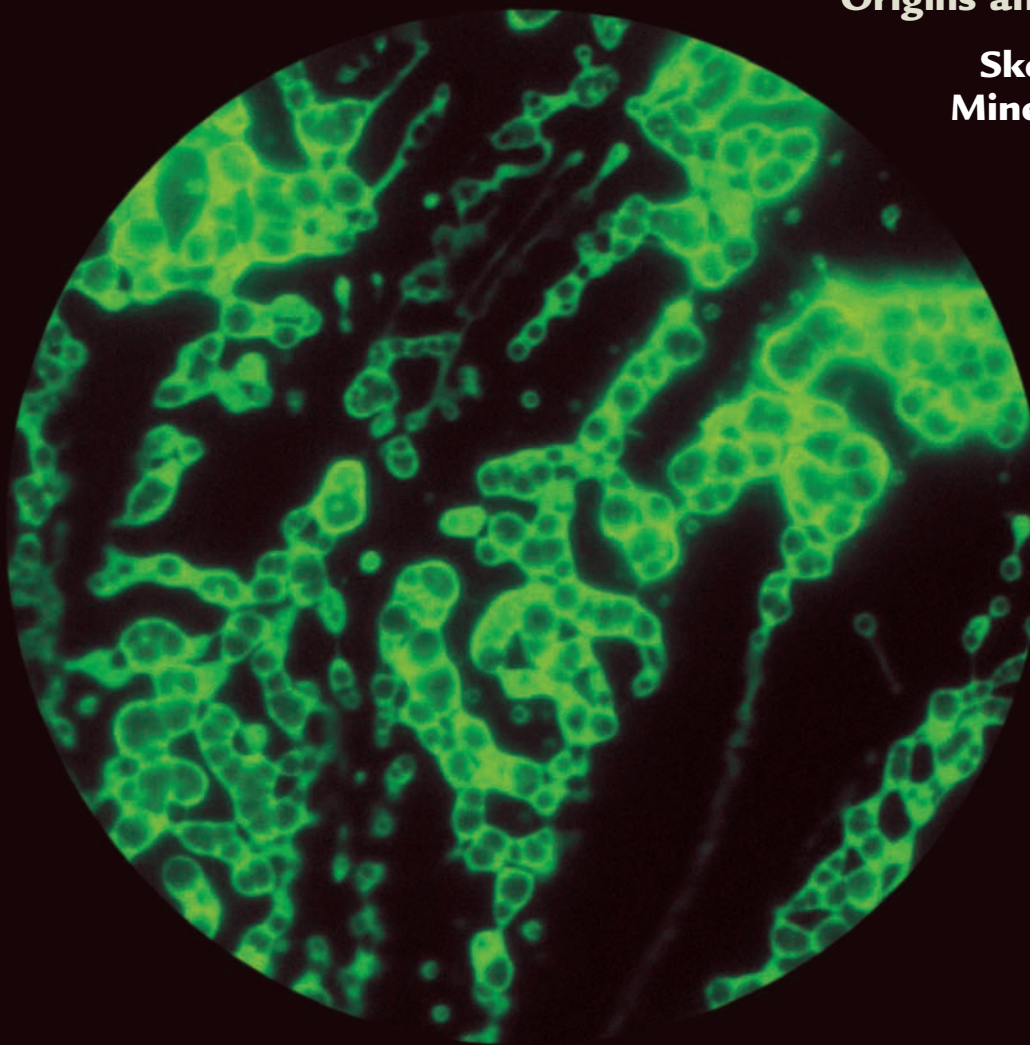
## **Genesis:** **Rocks, Minerals, and the Geochemical Origin of Life**

**Geochemical Connections to Primitive Metabolism**

**Mineral Catalysis and Prebiotic Synthesis**

**Geochemical Influences on Life's  
Origins and Evolution**

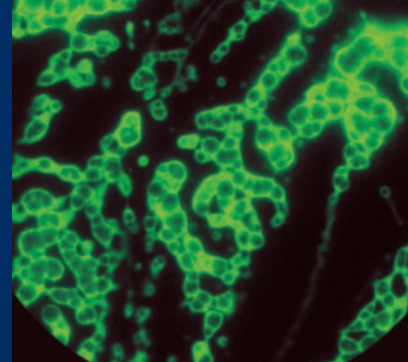
**Sketches for a  
Mineral Genetic  
Material**



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# Elements

An International Magazine of Mineralogy, Geochemistry, and Petrology



Volume 1, Number 3 • June 2005

*Elements* is published jointly by the Mineralogical Association of Canada, the Geochemical Society, The Clay Minerals Society, the European Association for Geochemistry, the International Association of GeoChemistry, the Mineralogical Society of America, and the Mineralogical Society of Great Britain and Ireland. It is provided as a benefit to members of these societies.

*Elements* will be published two more times in 2005. Individuals are encouraged to join any one of the participating societies to receive *Elements*. Institutional subscribers to any of the following journals—*American Mineralogist*, *The Canadian Mineralogist*, *Clays and Clay Minerals*—will also receive *Elements* as part of their subscription. Institutional subscriptions are available for US\$100 a year. Contact the managing editor for information.

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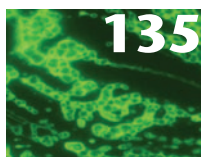
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## Genesis: Rocks, Minerals, and the Geochemical Origin of Life

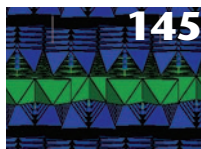
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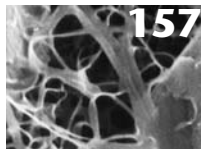
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ABOUT THE COVER:  
A key step in life's origin must have been the self-assembly of membrane-forming molecules into cell-shaped hollow spheres, called vesicles. These green-fluorescing vesicles, which range from 10 to 50 microns in diameter, form spontaneously in water. Recent studies show that fine-grained clay particles enhance the formation of these structures.

PHOTO COURTESY:  
DAVID DEAMER AND  
ROBERT HAZEN

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**The Geochemical Society** is an international non-profit organization for scientists involved in the practice, study, and teaching of geochemistry. Our principal roles are to provide our members with programs and services that will help them to be better geochemists; to enrich the professional development and careers of geochemists through information, education, relationships, and resources; and to advance the thought and application of geochemistry.

Membership includes a subscription to *Elements*, access to the online quarterly newsletter *Geochemical News*, as well as an optional subscription to *Geochimica et Cosmochimica Acta* (24 issues per year). Members receive discounts on publications (GS Special Publications, MSA, Elsevier and Wiley/Jossey-Bass), and on conference registrations including the V.M. Goldschmidt conference, the fall AGU meeting, and the annual GSA meeting. For more details on our programs or information on how to join, please visit our website at: <https://gs.wustl.edu>

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**The Mineralogical Society of America** is composed of individuals interested in mineralogy, crystallography, petrology, and geochemistry. Founded in 1919, the Society promotes, through education and research, the understanding and application of mineralogy by industry, universities, government, and the public. Membership benefits include special subscription rates for *American Mineralogist* as well as other journals; 25% discount for *Reviews in Mineralogy and Geochemistry* series and *Monographs*; *Elements*, reduced registration fees for MSA meetings and short courses; and participation in a society that supports the many facets of mineralogy. For additional information, contact the MSA Business Office.

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**The International Association of Geo-Chemistry (IAGC)** has been a pre-eminent international geochemical organization for over 40 years. Its principal objectives are to foster cooperation in, and advancement of, applied geochemistry, by sponsoring specialist scientific symposia, the activities organized by its working groups, and supporting its journal *Applied Geochemistry*. The administration and activities of IAGC are conducted by its Council, comprising an Executive and ten ordinary members. Day-to-day administration is performed through the IAGC Business Office.

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**The Mineralogical Society of Great Britain and Ireland** was founded in 1876 and has the general object of advancing

the science of mineralogy and its application to other subjects including crystallography, geochemistry, petrology, environmental science, and economic geology. The Society furthers its objectives through scientific meetings and the publication of scientific journals, books, and monographs. The Society publishes three journals, *Mineralogical Magazine* (print and online), *Clay Minerals* (print and online) and the e-journal *MINABS Online* (launched in January 2004). For full details on how to join the Society and its events and publications consult the Society's website at [www.minersoc.org](http://www.minersoc.org) or contact the General Office.

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**The Mineralogical Association of Canada** was incorporated in 1955 to promote and advance the knowledge of mineralogy

and the related disciplines of crystallography, petrology, geochemistry, and economic geology. Any person engaged or interested in the fields of mineralogy, crystallography, petrology, geochemistry, and economic geology may become a member of the Association. Membership benefits include a subscription to *Elements*, reduced cost for subscribing to *The Canadian Mineralogist*, a 20% discount on short-course volumes and special publications, and a discount on the registration fee at our annual meeting.

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*Clays and Clay Minerals* Go to the Ingenta web site, which hosts the electronic journal ([www.ingenta.com](http://www.ingenta.com)), or start at The Clay Minerals Society (CMS) website ([www.clays.org](http://www.clays.org)). You will find further instructions about registering and requesting access.

*Mineralogical Magazine* and *Clay Minerals*. Go to the Ingenta web site, which hosts the electronic journal ([www.ingenta.com](http://www.ingenta.com)). You will find further instructions about registering and requesting access.



## Jumping Across the Colorado

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When I was a teenager back in the early 1970s, I drove solo from Houston, Texas to San Diego, California across nearly 2,400 km of uninterrupted and enchanted desert in the American Southwest. For me, the highlight of the trip was to see the

Colorado River that far south, long after it had passed through the Grand Canyon and just before it disappeared into Mexico. But after I passed Yuma, Arizona, I was soon greeted by the “Welcome to California” sign, and I immediately realized to my amazement, and disgust, that I must have driven right over one of the world’s great rivers, in a desert no less, and not even noticed! Bewildered and too impatient to wait for the next exit to turn around, I made an illegal U-turn on the interstate highway and retraced my steps, determined to find out why I had been so blind. In fact, I had not been. There was the Colorado River all right, separating Arizona and California just as advertised, but lying humbly in no more than a glorified drainage ditch, so narrow that it seemed I could jump across without getting wet. The mighty and fabled Colorado had been reduced to this? At such a young age, I was shocked and, as I was soon to discover, terribly naïve.

Fast forward to December 26, 2004—the day of the unimaginable horror of the Sumatra earthquake and tsunami. The Earth is a dynamic place, and these things are geologically routine, but they are no less deeply painful. The world’s journalists were all over this event, of course, publishing story after story, week after week, with lots of commentary by writers who clearly don’t think about the Earth as much as we do. My wife, also an environmental scientist, started showing me statements in the nationally and internationally syndicated press like these: “Last Sunday’s tsunamis offered yet another humbling lesson that the power of Nature far exceeds the reach—indeed the imagination—of man.” And this: “...Mother Nature proves to be the worst of all terrorists in the horror of her sudden assault on innocents. We have never controlled the ways of Mother Nature...”

**“Even today, with... more Earth awareness and education than ever, the public still often gets sent the wrong message.”**

I have been reflecting on statements like these since, wondering why they bother me so much. What is the public supposed to take away from such grand statements? And suddenly I had answered my own question, at least to my satisfaction. These writers are just parroting what every casual observer of the planet has uttered since the dawn of humankind. Nature will have its way, and there is not much, if anything, we can do about it. After all, Nature is all powerful, right? And therein lies the rub. If we were still sitting in

caves, such contemplation would be perfectly acceptable, even beneficial to our survival. But in the modern age, despite what many in the popular press would have us believe, Nature in many ways now depends on us, not the other way around. Witness global atmospheric chemistry and temperature; witness the fact

that many population biologists say that we may be in the midst of the sixth mass extinction event since the Cambrian explosion; witness the estimation that humankind moves more Earth materials (rock and soil) on an annual basis than all geologic Earth movers (rivers, glaciers, even tectonics) combined. Oh, and what about the Colorado River? Actually, just before it enters Mexico, it has made a comeback since my teenage days. But it should be noted that it is not due to all-powerful Nature, but to us via water treaties with Mexico.

What can we learn from this? Even today, with a sophisticated press and more Earth awareness and education than ever, the public still often gets sent the wrong message. In this case, the message should have been that humankind is subject to aspects of Nature’s power that we will never control, but in other ways we are now a global force to be reckoned with, and we had better accept our role and pay attention to what is happening. Certainly, as residents of the third rock from the Sun, we have come a long way in paying attention. But in my opinion, garnered from my particular vantage point as a researcher and teacher, we still have a long, long way to go.

Michael F. Hochella Jr.  
 Hochella@vt.edu

NOTE FROM THE EDITORS: we are interested in hearing from you regarding Mike’s editorial and any of the other features.

I have just finished reading the second issue of *Elements* and I am greatly impressed, as I was with the first issue, by the quality of the scientific papers, the very informative discussions of the various contributing societies' activities, and the beautiful page layout, with lots of color. Congratulations to you and your co-editors for this great contribution to our sciences.

Malcolm Ross, Washington, USA

NOTE FROM THE EDITORS: We received several similar congratulatory letters. We are glad you enjoyed the diamond issue. We thank once again Guest Editor George Harlow for assembling such a fine line-up of papers and all the authors and contributors to that issue.

It was great to be able to download the full first issue. I am using some of the figures for teaching. I noticed that for the March 2005 diamonds issue, only the first 10 pages are available in the PDF version. Will there be a full PDF available?

Carl B. Agee, University of New Mexico, USA

I received the latest issue of *Elements* focusing on diamonds and was impressed. I would like to be able to use some of this material for teaching. In your future negotiations with the other participating societies, I urge you to try to make the articles available in html or some other format (perhaps with a password for society members) so that the pictures and figures can be downloaded. If this is already possible, please let me know; I didn't see any links to the articles on the *Elements* web page.

Robert Linnen, University of Waterloo, ON, Canada

Issue 2 of *Elements* is fantastic. So good in fact that I could use it in teaching my third year class in "Topics in Mineralogy" when we cover diamonds. Are there extra copies so that I could give each of the 13 students one? If not, I can photocopy what I need, but your colours are so good!

Ron C. Peterson, Queen's University, ON, Canada

NOTE FROM THE EDITORS: If *Elements* is used in the classroom, one of our key objectives has been met. Our main emphasis has been to get *Elements* up and running. However, we will now turn our attention to the electronic version of *Elements*. At our next editorial meeting on May 20, we will discuss the feasibility of putting *Elements* online and how best to make the electronic version available to members. In the meantime, we have decided to post a PDF file of each issue we will publish in 2005 shortly after most members receive their printed copy ([www.elementsmagazine.org](http://www.elementsmagazine.org)). We see this as a way to publicize *Elements* and to get people outside of our scientific communities to use it.

After getting several requests for additional copies, we have decided to offer additional copies at the following rates:

Number of copies	Price each (US\$)
1-4	\$20
5-10	\$15
10 or more	\$12

The pricing reflects the cost to process and ship an order.

I receive duplicate copies of *Elements*, with one sent to "Dr. J. William Miller Jr." and another to "J. William Miller Jr.", with virtually the same address. The journal is wonderful, but I cannot read two any faster than one.

J.W. Miller, University of North Carolina at Asheville, USA

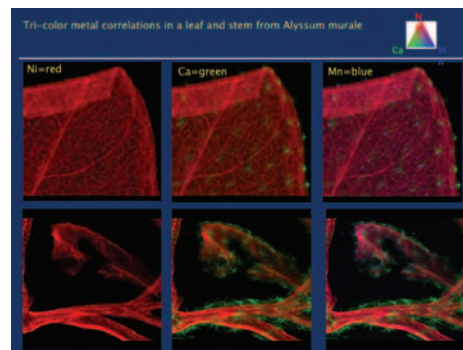
NOTE FROM THE EDITORS: We try to eliminate duplication as much as possible, and in fact the routine that Alex Speer and Gordon Nord use at MSA eliminates all but 1% of the duplicate addresses. If you do receive several copies, please let us know. We also encourage you to use your extra copy to promote *Elements*: give it to a deserving student or to a colleague who should belong to one of the participating societies, put it in the student lounge, send it to a funding agency or put it to any other good use.

We recently received the first two issues of *Elements*. Apparently they have come with our subscription to *Clays and Clay Minerals* and *The Canadian Mineralogist*. I note from the inside cover that we will receive free issues for 2005; however before I go ahead and have them catalogued, it would be useful to know what is to happen after that i.e., will we need to enter a subscription for 2006 or will we continue to receive complimentary issues as long as we maintain our other subscriptions?

Sue Watt, University of Auckland Library, New Zealand

NOTE FROM THE EDITORS: Institutional subscribers to *American Mineralogist*, *Clays and Clay Minerals*, and *The Canadian Mineralogist* receive complimentary copies of *Elements*. It is the intention of the societies publishing these journals to keep offering complimentary copies of *Elements* to their corporate subscribers, for 2006 and beyond.

Leaf and stem micro synchrotron x-ray fluorescence images taken at the advanced light source Lawrence Berkeley National Lab (ALS-LBNL), Berkeley, California



**IN THE NEXT ISSUE, READ ABOUT**

**Metals in the Environment**

Donald L. Sparks, Guest Editor

Metals are prevalent in the environment. They are derived from both natural and anthropogenic sources. Certain metals are essential for plant growth and for animal and human health. However, at excessive levels they are toxic. Metals undergo an array of processes, including sorption/desorption, precipitation/dissolution, and oxidation/reduction, with reactive natural surfaces such as clay minerals, metal oxides, humic substances, plant roots, and microbes. These biogeochemical processes control the solubility, mobility, bioavailability, and toxicity of the metals. This issue of *Elements* will explore research frontiers in the areas of metal mobility and reaction mechanisms on natural surfaces. These advances will be explored at multiple scales, using state-of-the-art analytical techniques.

**Earth's Nano-Compartment for Toxic Metals**

Michael F. Hochella Jr. and Andrew S. Madden (Virginia Tech, USA)

**Metal Retention and Transport on Particles in the Environment**

Ruben M. Kretzschmar (Swiss Federal Institute of Technology (ETH, Zurich) and Thorsten Schäfer (Forschungszentrum Karlsruhe, Germany)

**Shining Light on Metals in the Environment**

David H. McNear Jr., Ryan Tappero, and Donald L. Sparks (University of Delaware, USA)

**Synchrotron X-ray Investigations of Mineral-Metal-Microbe Interactions and their Effects on Metal Transformations**

Kenneth M. Kemner, Edward J.O. O'Loughlin, Shelly D. Kelly, and Maxim I. Boyanov (Argonne National Laboratory, USA)

**Trace-Metal Sorption on Biogenic Manganese Oxides**

Mario Villalobos (National Autonomous University of Mexico), John Bargar (Stanford Linear Accelerator Center, USA), and Garrison Sposito (University of California at Berkeley, USA)

# Voices from our Past

Peter J. Heaney<sup>1</sup>

**'m guessing that most of you never got to know Howard Evans. Now that Howard has passed away, you've missed the chance to hear him talk.**

**I blame myself for that.**



Howard was an X-ray crystallographer who determined the structures of over 100 minerals during his 42 years with the U.S. Geological Survey. Our lives intersected in 1990 when I was a postdoctoral researcher with Jeff Post at the Smithsonian. Jeff and I were working on a rare mineral called bannisterite, an Fe,Mn-sheet silicate with a so-called modulated structure. Whereas most micas contain negatively charged layers bonded by cations, the silicate sheets

in modulated layer structures are connected by inverted tetrahedral bridges.

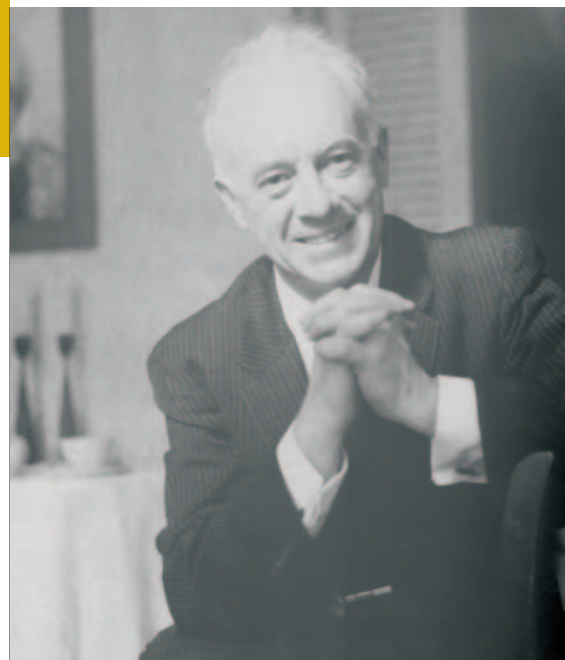
Bannisterite was the first modulated layer silicate for which a high-resolution structure was achieved, but Jeff and I were not the first to stake this claim. An Australian mineralogist named Ian Threadgold had solved the structure of the anhydrous variant. Threadgold published his results only as a brief abstract in a regional seminar volume, and he then switched careers to breed dogs in the Australian bush. Steve Guggenheim, an expert on modulated layer silicates, implored Threadgold to write up the structure properly, but to no avail. Steve had the full structure solution in his hands, but he could neither publish another person's data under his own byline nor pretend to solve a structure for which he already knew the solution.

After Threadgold's untimely death in 1990, Steve asked us to attack the problem. With Jeff's old Picker diffractometer and its PDP-11 computer, I began collecting 15,000 X-ray reflections from two bannisterite crystals from Broken Hill, Australia and Franklin, New Jersey. By the late spring we finally had the data in hand and started to process it. But after solving part of the structure, we hit a roadblock. Days of toying with new approaches turned into weeks, and it became clear that we needed the advice of a person with a lifetime of X-ray experience under his belt.

Jeff gave Howard a call, and the next day we were sitting in Howard's lab with the detritus of our failed attempts littering a lab bench in front of us. As Jeff took Howard through each of our unsuccessful tries, I could not help but remark how much Howard reminded me of Linus Pauling—partly from the wild spray of snow-white hair that sprouted around the sides of his head, but mostly it was the mannerisms of a man who is intensely in love with puzzles. Each description of a failed effort elicited a quiet but knowing chuckle.

When we completed our litany of woes, Howard told us that he had a few ideas to try over the weekend. Would we leave our data with him? I will admit to a serious skepticism that progress was imminent, but I gladly left all our real and virtual material behind for the prospect of a guilt-free interlude of thinking about anything other than crystallography.

As I walked into Jeff's office the next Monday morning, Jeff was returning the phone receiver to its cradle. He turned to me and said,



Howard Evans in 1966

"That was Howard. He's got the *R*-factor down to 10." I was stunned. For non-crystallographers, Jeff's words require translation: "Howard has cracked the problem, and he is leaving us the final bit of house-keeping." Straight away, we headed to Reston and listened with some

wistfulness as Howard happily described how he skirted the barriers that defeated us. His ploy was entirely counter-intuitive and should never have succeeded, but Howard's bag of tricks had grown enormously large over his career. I marveled at his ingenuity.

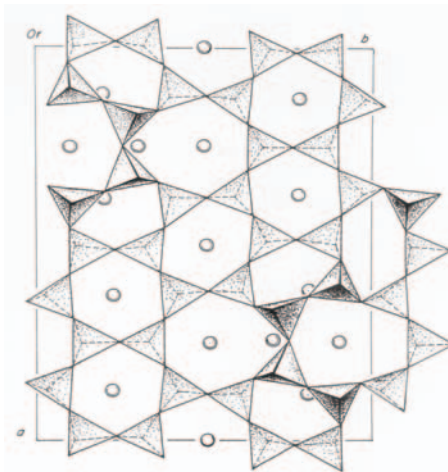
Over the next few months, as we tussled over the remainder of the refinement, I grew to admire Howard in another way. His extraordinary grasp of anecdotal detail made him the best storyteller I have ever encountered. Howard was integral to the effort that garnered Jerome Karle and Herbert Hauptman their Nobel Prize in 1985 for the invention of the symbolic addition procedure, which solved an age-old

problem in diffraction analysis. Howard's description of their race to validate the method before an impending conference provided an edge-of-the-seat thrill each time I heard it. I resolved that I would record it on tape for future generations.

Sadly, my interview with Howard never materialized.

I researched the proper approach for oral historiography and was overwhelmed by the number of thou-shalt-not pronouncements. I was distracted by the broad assortment of crises that attend every academic career. I assumed that each new year provided me with a

**"If you admire a scientist in the twilight of an illustrious career, grab a tape recorder and talk with her or him for an hour or two."**



Howard's hand drawing of the tetrahedral sheet in the bannisterite structure. Howard, who eschewed computer graphics, had a showing of his crystallographic renditions at a local art gallery.

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fresh opportunity to make good on my promise.

That last assumption was proved devastatingly wrong when Jeff called in January 2000 to tell me that Howard had died from a heart attack. My sense of personal loss was compounded with profound regret from my procrastination. An important part of our community's history disappeared with Howard—the human element that rarely is translated through the parched papers that announce our scientific discoveries.

Physicists seem to understand better than geoscientists the importance of preserving their best stories. *Physics Today* routinely contains eyewitness accounts of lives spent in the labs of the great sages of the last century, and the American Institute of Physics (AIP) sponsors the Center for History of Physics.

The CHP offers extensive support for oral historiography in the form of grants, transcription, and curation. Bob Hazen, president of MSA and also a distinguished historian, has suggested that members of the American Geophysical Union (a subsidiary of the AIP) may be able to take advantage of the CHP, and we are exploring this possibility.

In the meantime, we all need to be a little more active in the protection of our professional heritage. If you admire a scientist in the twilight of an illustrious career, grab a tape recorder and talk with her or him for an hour or two. At the CHP website ([www.aip.org/history/ctrbro.htm](http://www.aip.org/history/ctrbro.htm)), you will find some very simple tips to optimize the quality of your interview. And don't make my mistake of waiting for a better time. For Howard, it's too late. ■

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