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# CMS News

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A Publication of The Clay Minerals Society

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Spring 1994

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## San Diego—sand, clay, and vitamin C

About 300 attended the 30th Annual Meeting of The Clay Minerals Society at the Red Lion Hotel in San Diego the last week of September, 1993. Both organization and weather were perfect, thanks to General Chair Dick Berry of host institution San Diego State University. A pre-meeting workshop on computer applications was convened by Bob Reynolds and Jeff Walker. For once, the final bound copy of the workshop notes, Volume 5, was ready for distribution at the workshop and for sale at the meeting.

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*Past, present, and future Presidents of the CMS, San Diego, September 1993: (back row) Jack Burst, Bob Reynolds, Dave Pevear, Marion Reed, Dennis Eberl, Ross Giese, Bill Moll, Haydn Murray, Joe Dixon; (front row) Bull Bailey, Brij Sawhney, Necip Güven, Tom Pinnavaia. Max Mortland, Ken Towe, Steve Guggenheim, Wayne Bundy, Marion Jackson.*

*High Iron Photos*

## 10th International Clay Conference in Adelaide

Clays Control the Environment" was the theme of the 10th International Clay Conference (ICC), held on the campus of the University of Adelaide the week of July 17 - 23, 1993. The "environment" in South Australia can be quite wet in July, winter in the Mediterranean climate of South Australia, but fortunately, the weather was cool and mostly free of rain during the conference. Although the rain was taking the week off, the conference participants were busy with a full schedule

of plenary sessions, oral and poster papers, and excursions.

The conference opened on Monday morning with a plenary session fea-

### Research Grant Deadline July 1

Because of the earlier annual meeting date this year, the deadline for sending research grant applications to the Society Office will be July 1. The date will be even earlier in 1995 as the annual meetings move closer to the Spring and early Summer. For grant applications, contact the Society Office.

turing opening addresses by Tony Eggleton, President of the Australian Clay Minerals Society, Inc. and General Chairman of the 10th ICC, Prof. J. M. Serratosa, President of the Association Internationale pour l'Etude

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The Clay Minerals Society

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## Letters

## Important drinking participants clarified

Editor:

In the *CMS News* of August 1992, page 16, I have seen a picture of our dear teacher Prof. Brindley, in Mexico City drinking wine. The others in the picture were Prof. Chukrov, Prof. Bailey, Prof. de Pablo (Univ. of Mexico), and myself. The caption says "Jordan and others" instead of

Pablo and myself because we are in the back. I remember very well that occasion at the International Clay Conference of Mexico, July 1975, because I was the winner of that competition to see who could drink wine continuously for the longest period of time.

Enclosed you will find another picture of the same competition, taken from the other point of view.

My congratulations for editing the *CMS News*. I like it very much.

With my best regards for the editors and contributors to this publication, I remain

Yours,

Prof. Dr. Emilio Galán  
Sevilla, Spain

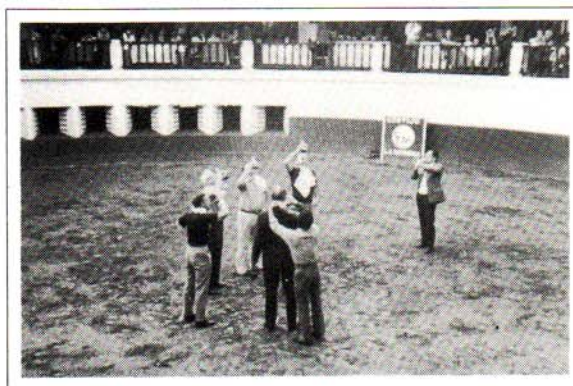
## Less geology indeed!

Editor:

Former President David R. Pevear gave a masterful review of the Society's current status in his presidential letter, "Turning Point" (*CMS News*, Summer 1993 issue). Probably CMS members will agree heartily with Dave's message. But a few, like me, may find his final statement just a little unsettling. Quote: "The nature of our science is changing: more chemistry—*less geology*, more environment—*less agriculture*." (emphasis mine). I suppose "our science" means clay science. It is not clear whether or not Dave approves of the changes he cites, but the inference is that he accepts those changes as a reality.

I will let the soils and agronomy folks address the question of "less agriculture." I'm writing here on the matter of "less geology." It will be a grievous  
*continued on next page*

*This newsletter printed on recycled paper.*



Clay mineralogists vie for wine-drinking championship, Mexico City, 1975, with E. Galán winning. *Courtesy E. Galán*

## Thanks...

To the following people who contributed to this issue:

Hank & Li-Hsia Abrons  
Bull Bailey  
Judith A. Davenport  
Joe Dixon  
Tom Dombrowski  
Victor Drits  
Dennis Eberl  
Emilio Galán  
Bob Hall  
Colin Harvey  
Richard Hay  
Warren Huff  
Junzhe Liu  
Dorothy Munro  
Inez Moselle  
M. J. Nash  
Paul Nadeau  
Gay Lynn Olsen  
Linus Pauling  
Linus Pauling, Jr.  
Dave Pevear  
Rich Pollastro  
Don Scafe  
Paul Schroeder  
Darrell Schulze  
Allan Treiman

**Letters, continued**

ous error if our Society de-emphasizes geology, given the present level of our understanding about the origins of clay minerals. There is still much to be learned about the genesis of clays in nature. Who among our members has an easy explanation for the occurrence of nacrite, dickite, and kaolinite in the same deposit in Mexico, as reported by Hanson, Zamora, and Keller in 1981? Who can explain the varied morphologies of halloysite? Professor Bailey may have part of the answer to that one, but the whole answer? Jim Post has told me of a remarkable assemblage of clay minerals in southwest Idaho, and confessed that he cannot explain the origin of this extraordinary occurrence.

Just a few examples. Less geology indeed!

*Robert B. Hall*

*Lakewood, Colorado*

P.S. *CMS News* just seems to get better with each new issue. I wonder how the Editor manages to do that?

**Bailey Australian family tree examined**

Dear Jo:

The enclosed photo may be of interest to you for your newsletter. It was taken in Adelaide at the 10th International Clay Conference, and shows my Australian connections.

John Jones was my student in the early 50's. He and I learned clay mineralogy together by reading George Brindley's 1951 monograph. John is now Prof. Emeritus at the University of Adelaide, and is probably best known for his pioneering work on opal. Tony Eggleton was John's student at Adelaide and then came to study with me at Wisconsin in the early 60's. He is now a Professor at Australian National University in Canberra. Steve Guggenheim studied with me in the 70's. But he has spent two sabbaticals with Tony in Can-

berra, where he met Tony's student Jill Banfield. Jill later studied with Dave Veblen at Johns Hopkins University and, upon completion of her Ph.D., came to Madison to succeed me. So it has come full circle, and it was great to all be together in Adelaide.

*Bull Bailey*

*Madison, Wisconsin*

**Australian Clay Conference offers a chance to see Grim's samples, student support**

Editor:

The 14th Australian Clay Conference of the Australian Clay Minerals Society will be held in Kalgoorlie from 21 to 23 September 1994. This will be the second time that this national society has held a conference outside of an Australian state capital city.

The aim of the conference is to promote discussion on all aspects of clay and other microminerals and their uses. As the conference is to be held in Kalgoorlie, Western Australia, it is hoped that papers highlighting the importance of clays in mineral exploration, mineral processing and mining will be presented. Papers on unusual clay and associated minerals related to mining are also welcomed.

Since the Gold Rush of the 1890's, Kalgoorlie has been a leading gold producer and is rich in mining history, tourist attractions, and colorful characters lured by the hope of striking it rich.

The technical sessions will be held on the campus of the Western Austra-



*Jill Banfield, Dave Veblen, Steve Guggenheim, Tony Eggleton, John Jones, Bull Bailey, Adelaide 1993.*  
*Courtesy S. W. Bailey*

lian School of Mines. Initially established at Coolgardie in 1902, it was moved to its present Kalgoorlie location in 1903. The original buildings still stand and contain, among other things, a geological museum.

Housed in the museum are many rock and mineral specimens from both past and present mining operations. Of particular interest is a set of clay samples donated to the museum by the late Professor R. E. Grim—the doyen of clay mineralogy—when he visited Kalgoorlie many years ago. We would be very appreciative if you could ask your members if anybody knows what year Professor Grim visited Kalgoorlie and the purpose of his visit.

The Australian Clay Society hopes to encourage student participation in the conference. The Society will assist the attendance of selected students who have demonstrated a significant level of achievement and who will make an active contribution.

Further information can be obtained from Dr. Ivor Roberts, Dept. of Mineral Exploration & Mining Geology, Western Australian School of Mines, Egan St, Kalgoorlie, Western Australia 6430. Telephone: (090) 805132; fax (090)805140.

*Ivor Roberts*

*Kalgoorlie, Western Australia*

## Interviews with the clay scientists

### Linus Pauling

*Linus Pauling, the two-time Nobel Prize winner, was the 1993 CMS Pioneer Lecturer. The following interview took place on September 28, 1993, and was conducted by Victor Drits (Russian Academy of Sciences) Dennis Eberl (U.S. Geological Survey), Jo Eberl (The Clay Minerals Society), and Paul Nadeau (Statoil, Norway), with Linus Pauling, Jr. (Linus Pauling Institute of Science & Medicine), in attendance, at the Red Lion Hotel, San Diego, California. Although the content of the interview has been transcribed, there is no way to effectively communicate the good humor and high spirits which marked the interview.*

*Drawing by M. J. Nash*



*The interview began with Pauling pointing out his bow tie, similar to his son's, which Pauling Jr. and other former Harvard Medical students wear.*

**PAULING:** Recently I've been thinking I have a lot of honorary doctorates but no honorary M.D. The best that I could think to do was to adopt the costume of the specialty of the Harvard Medical School M.D.'s.

**CMS:** Well, we've got you something else here which you might want to try. You've probably got a dozen of these, but you might take a look at it. *(Gives Pauling a garish necktie that displays a micrograph of vitamin C.)*

**PAULING:** Well, thank you. That's vitamin C.

**CMS:** There's a little tag here that mentions your name.

**PAULING:** Well! Pretty nice.

**CMS:** I'm sure you'd never want to wear it, but....

**PAULING:** I have an excuse now.

**CMS:** What do you feel has been your greatest contribution—scientific or humanitarian?

**PAULING:** Well, I suppose my greatest scientific contribution was my work on the nature of the chemical bond. On the 10th of October, 1963, which is the day that the Nobel Peace Prize was awarded to me, I had many calls from reporters; in fact, several of them flew in and interviewed me, and several of them asked about the two Nobel Prizes—which do you value the more? Well, absolutely, there's no question. I said, "Well, I would say the Nobel Peace Prize. Here I got the Nobel Prize in

Chemistry just from having a good time, working away on chemical things, trying to answer questions that I'd mulled about or worried about even when I was a student, really just enjoying myself. And here I got the Nobel Prize in Chemistry, just so much fun, you know." Well, I was pleased, all right. But then the Nobel Peace Prize I value especially because it indicates that working for world peace is respectable. You know, we'd all suffered considerably from the fact that my wife, in particular, and I were interested in world peace and human rights and questions of that sort.

**CMS:** I remember back in the fifties, the debates between you and Teller on television about atomic testing, and I wonder what you think of that, and also, how did you go about organizing scientists who attacked this issue? How did you do it, and what was your impact on it?

**PAULING:** In 1945, August, when the first atomic bombs were dropped on Hiroshima and Nagasaki, there was, of course, a lot of interest in the public about what was going on, and I hadn't been in the atomic bomb project. Oppenheimer had asked me to come to Los Alamos as head of the Chemistry Section, which I would not have done, so I didn't have top secret knowledge about nuclear weapons, and I was free, I thought, to say whatever I wanted to say.

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**Pauling**, *continued*

**CMS:** Why didn't you take Oppenheimer up on his request?

**PAULING:** Well, my biographer has said that I was directing 14 war projects at Cal Tech, and he thinks that that probably was a major factor. I would have had to give that up to go do atomic bomb work. Oppenheimer tried to tempt me by saying that there were lots of things I could do, that they had tritium by the gallon, but this didn't tempt me.

So I wasn't involved, and shortly thereafter, within a month, the Rotary Club in Hollywood asked me to give a talk at their next meeting about atomic bombs, and I did. It was purely a scientific talk, physics, what the nucleus of an atom is, the deuterium atom, the plutonium atom, what they're like, how small they are, and so on. The nuclei are ten thousand times smaller than the atoms, the electrons extend out very far, and how it's possible that you can pack energy into these particular nuclei to such a great extent that when they undergo fission, they liberate 20 million times as much energy as the same weight of TNT. I had taken a wooden ball about an inch and a quarter in diameter and sawed it in two, and said that in the nuclear weapon they have these two hemispheres of U235 and so on that are pushed together, and the biordinary explosive that is sort of shooting them together, using two guns. When they're compressed, they reach the critical mass, when the neutrons cause the autocatalytic reaction, so you get the bomb.

So the next morning, one day later, this second morning, here was an FBI man.

**CMS:** They thought you stole the secret?!

**PAULING:** He said, "Where did you get the information you used in your talk about how much uranium and plutonium?" So I said I figured it out in the usual way, at least for the time being.

Then I was asked a year or two later to be a member of the board of trustees, which was all that this organization consisted of, just the seven trustees, of the so-called Einstein Committee, which was really the Emergency Committee of Atomic Scientists. Einstein was the Chairman. He didn't come to the meetings. Harold Urey acted as vice chairman, presided, so I worked. I had that way of contributing. They collected half a million dollars during the five or six years that the committee existed. They made a film about the atomic bombs. Szilard and I made a lecture tour showing the film, talking about the need to control.

But in the meantime, back in 1945, I'd given three or four talks like the one at the Rotary Club, and my wife

said to me, "You know, I think you should stop giving those talks. You begin to talk about political matters or world affairs, and you quote the Secretary of State as having said this or somebody else as having said this, and you're not very convincing." She said, "When you give a scientific talk, everybody recognizes that you know what you're talking about, that you're the authority, and here you talk, and the people, well, it just isn't very good." So she said she thought I ought to stop doing it, and she said, "Either you have to learn enough about international relations and world affairs and so on to be able to speak with the same authority as you talk about scientific matters or you'd better just keep quiet."

Well, she sort of suggested that she thought it was worthwhile for me to sacrifice part of my scientific interests to do this. She wasn't saying I shouldn't give talks, but that I'd better do a better job. So for a good number of years, perhaps 20 years, I devoted half of my time, part of it to boning up to the extent that if the Secretary of State criticized me, I could answer back, and part of it to just going around giving talks on world affairs, nuclear weapons, and so on.

**CMS:** Obviously you feel that a scientist has a responsibility, then, to the rest of world, and I wonder how some of our younger scientists can find the courage to speak out when people are skeptical or hostile to their ideas.

**PAULING:** All along this period, how long has it been now, nearly 50 years, I have said that I think that scientists have essentially the same duties as other citizens, but

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*But then the Nobel Peace Prize I value especially because it indicates that working for world peace is respectable.*

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many matters that the public as a whole has to settle have a scientific content. There's almost no problem in the modern world that doesn't have a scientific content, and scientists may well have, and usually do have, somewhat more information about this scientific aspect of the problem than other people have, so it is the duty of the scientist to help educate his fellow citizens about this. I think if a scientist forms an opinion, it's his duty to say what his opinion is because that's also important. Not every scientist can effectively go around giving lectures about these matters, but every scientist should do what he feels he can do effectively.

**CMS:** Now there's a lot of hostility to science, and many people think the world might have been better off without

*continued on next page*

**Pauling, continued**

having science in the first place, when we look at the ozone hole, the destruction of the environment, and so on.

**PAULING:** Well, scientists have been involved in discovering these things, but it's not the scientists but the business community that's responsible. The scientists perhaps discovered the fluorocarbons, the freons, okay, but they didn't go ahead and manufacture millions of tons of the stuff and let it get out into the atmos-

phere, and of course, it was scientists that then recognized that these substances were damaging. So, I, and no other scientists, would have been smart enough to have been able to predict what would happen. Regarding the question of whether a scientist should suppress his discoveries or not, if the scientist can't say what's going to happen, he's not in a position to decide whether to suppress his discovery or not. But, of course, even if he were to decide to suppress his discovery, probably some other scientist would make the same discovery in a few years, so it's up to the people as a whole, I've always contended, to make the decisions. The scientists can help to the extent that they're able to, but I've said I don't think the world should be run by an oligarchy, even an oligarchy of scientists, de-



Victor Drits, Linus Pauling, Jr., Linus Pauling, Dennis Eberl, and Paul Nadeau, following the interview, San Diego, 1993.

Jo Eberl

for students who were given *cum laude* degrees or prizes. For the first time, I talked about the biological effects of the bomb tests, and made an estimate of how many unborn children would be born damaged to such an extent that they would have gross physical or mental defects that they would not have had, if the radioactive fall-out not occurred, and how many people would die early of cancer who would have lived longer if they had not been exposed to the high level of radiation. So there was a great response to this talk by the audience.

At the end of it, two of the professors, Ed Condon and a professor of biology who later was a candidate for the presidency of the United States, whose name I can't remember [Barry Commoner]. The physicists, I can remember! Well, they approached me and said they thought that we ought to get out an appeal, to be signed by American scientists, to stop the atmospheric bomb tests. So the next day we left, and each of us had written out wording of the appeal and we combined them into a 208-word statement that we immediately sent out to 25 scientists, and got answers within four or five days. Perhaps I was back in Pasadena, but by that time, we'd gotten 25 answers from people who agreed to be the initial signers, including the three of us. My friends and I and some people in the lab got together and mimeographed this and got a reference book, *Universities of the United States*. We mailed copies to people, in mainly chemistry and biology departments in American universities, and in three months, I think, we had 2000 signatures of American scientists.

**CMS:** This is when scientists were held in very high regard by the public.

**PAULING:** Yes. So these were all scientists. So that summer, I guess we sent this petition to the President of

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***There's almost no problem in the modern world that doesn't have a scientific content, and scientists may well have... somewhat more information about this scientific aspect of the problem than other people have, so it is the duty of the scientist to help educate his fellow citizens about this.***

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spite my high opinion of them. I believe in democracy, that things go wrong if you have a dictatorship or an oligarchy.

So then, several years later, 1953, I was asked to be the speaker at a special commencement ceremony in Washington University in St. Louis, where I first met Dick Berry, too. So, it was quite an affair, very formal, with the faculty and myself wearing academic gowns, and perhaps a lot of the students in academic costumes. The honors ceremony, it was not graduation, but a special ceremony

**Pauling, continued**

the United States, I'm not sure. That summer, my wife and I were in Europe, and we had already begun getting copies of this petition by American scientists with "American" crossed out and other countries' names put in, from Europe and elsewhere. When I got back in September, we got a world university atlas, and sent a copy of the petition to scientists—chemists and biologists—in every country listed as having a professor, and pretty soon we had 13,000 signatures of scientists. My wife and I went to New York and presented the petition. It had about 10,000 signatures, I think, when we presented it to Dag Hammarskjöld. So that was the way that got going, and I think it had a considerable effect. Raman, in India—he got the Nobel Prize for having discovered the Raman effect—said in his letter that every scientist in India would sign this petition, although he was sending only 200. I had a course from him, in 1924, I think, before he had discovered the Raman effect. He was a visiting professor for one term at Caltech, and I took a course from him on the scattering of light. The Raman effect was something that shows up in the scattering of light, quite an important discovery.

**CMS:** We don't have very much time left, and I think we'd better ask you some questions of a more scientific nature.

**PAULING:** Well, you know it's hard to stop me. Why am I here at the Clay Minerals Society? A few years ago, I received a letter from the President of the Clay Minerals Society, I think.

**CMS:** No, that letter was from me!

**PAULING:** Oh, from you! Saying that I had discovered the structures, the atomic structures, the molecular structures, the crystal structures of the clay minerals back in 1930, and would I write an article for publication in your newsletter about how it came about that I discovered this structure. So I wrote the article, sent it in to the newsletter, and it was published, and it's clear that I'm a pioneer in the field.

**CMS:** Absolutely! Yes!

**PAULING:** This paper discussed kaolinite and hydrargyllite and muscovite and micas and the group of micas. The second paper was on the structure of the chlorites, which are also in the category of clay minerals because mica is a hardened mineral with a basal cleavage; it splits into sheets. The clay minerals usually consist of minerals that will split into sheets but that are much softer, so that they split very easily. The chlorites are hard minerals,



Linus Pauling in San Diego, 1993.

Jo Ebert

too, but they're closely related to soft minerals, montmorillonite and other soft minerals which are also constituents of clay. And the clays are very important constituents of soils. The first one I studied was hydrargyllite, aluminum hydroxide, but then I immediately described it in the same paper as my mica work. In the mica paper, I also mentioned the structure of kaolinite and clay. Kaolinite is a characteristic clay mineral. So since The Clay Minerals Society published this article in the newsletter, since the Society has a lecture, Pioneers in Clay Science, it's clear that I'm a pioneer, perhaps *the* pioneer. There were clay mineralogists before that, of course, but they didn't know

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*I don't think the world should be run by an oligarchy, even an oligarchy of scientists, despite my high opinion of them. I believe in democracy, that things go wrong if you have a dictatorship or an oligarchy.*

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as much about the clay minerals as I did by the end of 1930. I had a better understanding, and I knew why mica splits and why chlorite splits into basal cleavage.

Mica I remember from a first-hand impression that I got when I was about five years old. I was looking out the window in Condon, Oregon, eastern Oregon, at the snow on the ground. My mother was trying to get me to get dressed, and I had stopped—perhaps I had taken off my pajamas—but I had started looking out the window. She said, "I've told you several times to get dressed. Put your clothes on now—go on, do it!" and I don't think that she

*continued on next page*

**Pauling**, *continued*

really swung at my behind, but I thought she was going to do it, so I ran, and ran into a hot stove which was in the room, a wood stove to give us heat, and got a burn on my tummy. Perhaps I hit the mica! Mica is a mineral that is used in place of glass. Very big crystals of mica, muscovite.

**CMS:** Speaking of Muscovites, we have one right here. Victor is from Moscow.

**PAULING:** Oh!

**CMS:** It would be interesting for me to know your opinion concerning the origin of life. For example, some people believe that clays play a certain important role in the origin of life, and other people suppose that life arrived from space, and so on. What do you think about it?

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*Eight hundred chemists met in Moscow and said that my ideas were incompatible with dialectical materialism, so patriotic Soviet scientists should not use them. Just at the same time, the United States State Department ... said my anti-communist statements hadn't been strong enough.*

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**PAULING:** Well, I don't think either of those statements is true. I think life arose in the thin hot soup that Oparin suggested. Oparin was a great leader among scientists in an effort to delve information about what happened, how did life originate. My first visit to the Soviet Union, in 1957, was at the invitation of Oparin. The International Congress of Biology was being held in Moscow in honor of Oparin, so that was when I met him for the first time, when my wife and I arrived in Moscow.

**CMS:** Do you suppose that his ideas are relevant?

**PAULING:** Yes, he was very influential. His ideas were very good. I can tell you to think about this problem, but I haven't. I'm not sure I've published anything significant about it. Perhaps a year later, I was elected a full member of the Soviet Academy of Sciences, and last year I was elected a full member of the Russian Academy of Sciences. The Soviet Academy of Sciences no longer exists.

**CMS:** Your book was translated into Russian several times, I think three editions. It is very popular and has

played a very important role in our scientific life because it seems to me that it is impossible to find crystallographers and crystal chemists anywhere who have not read this book. It strongly stimulated scientific developments in our country, so I think many, many scientists not only know your name, but use your knowledge for their scientific work.

**PAULING:** Around 1940-1950 I was in trouble with the State Department in the United States and also with the Soviet Union. In 1950, chemists in the Soviet Union held a mass meeting. Eight hundred chemists met in Moscow and said that my ideas were incompatible with dialectical materialism, so patriotic Soviet scientists should not use them. Just at the same time, the United States State Department had taken up my passport, and when I tried to find out why, they said my anti-communist statements hadn't been strong enough. They couldn't say I hadn't made anti-communist statements. But by 1957 when we arrived, the chemists had got over this bias and had reversed themselves and said it was all right to use my ideas.

**CMS:** I'm afraid we have to go to the reception, unless you have one more question.

**PAULING:** Since they're going to be there for an hour, I don't need to be exactly on time.

**CMS:** Well, I just had a question about crystal structures. As a clay scientist, we're very much interested in crystal structures and we're finding micro-crystalline minerals in many geologic environments. And one of the things I've noticed is that we seem to understand the crystal structures very well, but our understanding of the chemical processes that produce them is not as good. I wonder if you had any thoughts on why we don't understand the processes as well as we understand the crystal products or the structures.

**PAULING:** Well, the determination of the structure of a mineral is quite a straightforward job. It may involve a lot of work, but for the most part when the job is done, the result is going to be accepted. So if you are willing to do the work, and perhaps are able to do the work (sometimes there are some tricky points to it), then you know that you have been successful, and other scientists recognize that you have been successful, too. The geological processes that go on, or chemical processes in general, can be pretty complicated. The methods for investigating them, getting information as to just what's going on in the reacting mixture, are not nearly so precise and well-defined as the methods that we use in X-ray crystallography. The

*continued on next page*

Pauling, *continued*

Linus Pauling, 1993.

Jo Eberl

mechanisms for many chemical reactions are pretty well understood now, but there are also others for which we just don't have any understanding. This is true of geological phenomena as well. There is still much to be learned about the nature of the world.

There are still a lot of X-ray crystallographers determining the structures of such materials. After all, there have been about 20 million chemical compounds described in the scientific literature, about 10 million inorganic compounds, such as clay or muscovite, and 10 million organic compounds, such as hemoglobin and red cells, and the X-ray crystallographers have studied a great number of them. I happen to know approximately how many inter-metallic compounds have had their crystal structures determined, compounds such as steel, or cast-iron, say, which contains a compound  $\text{Fe}_3\text{C}$ , an iron carbide compound structure. Fifty thousand inter-metallic compounds have had their structures determined. And as I recall, something like 25,000 different structures. Some structures are found for only one alloy, but others are common to a couple of hundred alloy systems.

**CMS:** If these studies are so routine now, where do you think the future lies in crystallography and these types of studies? Certainly, it's not determining 50,000 more structures?

**PAULING:** Well, that no doubt will be done. There was a study made a year or two ago of publications by individual scientists, and how many papers have my name attached to them, for example. There is an organization that

checks this out, so I know I could find out. I have published perhaps 700 scientific papers. In the last 10 years I may have published 50, something like that. Not that many even, but several that have my name attached. The record is held by a Russian scientist, and in the last 10 years he has published 936 papers, one paper every 3.9 days, and he is an X-ray crystallographer.

**CMS:** He is a very famous Russian crystal chemist. I know him! He became very popular after that.

**PAULING:** There are a couple of Americans, one of whom calls himself my scientific grandson because he took his doctorate from a man who took his doctorate from me, and he worked in the fields that I was first in developing. These two fellows got the Nobel Prize for inventing, devising, the routine, automatic method of determining the crystal structure of a compound. You can automate the X-ray diffractometer to collect the data, and they have a method by which the computer can then determine the structure. And this whole job can be done in one day by the automatic diffractometer. This X-ray crystallographer in Russia managed to get support 15 years ago for building an apparatus of that sort in the Soviet Union. So he is the head of a group where he has 15 or 20 assistants who grow crystals or hunt for crystals and put them in this automatic diffractometer. And he thinks he ought to have his name on every one of these papers. Unfortu-

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*There is still much to be learned about the nature of the world.*

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nately, about half of the papers that are published have an error in them because the investigators don't think enough about whether the results are right or not. And if you want to publish a paper every 3.9 days, you don't have very long to determine whether the structure is right or not.

**CMS:** Victor is not going to be able to go back home now!

**PAULING:** Well, his 936 papers in 10 years is not a great record, and there lives an American who had 750, I think. And he was the same sort of fellow. He was the head of a large group that the National Institutes of Health kept supporting year after year doing research. His rule was that he would put his name on every paper that was published by this group.

**CMS:** How do you think the system should work?

*continued on next page*

## Pauling, *continued*

**PAULING:** I don't think that the head of a laboratory should have his name on a paper unless he has contributed significantly to it, other than just getting the money out of the National Institutes of Health. If he had an idea that the people working for him checked up on, then it is right that he should have his name on the paper. Perhaps even if several of the people working with him contributed in different ways and he combined these, then wrote a paper showing if you take these several results, and so on, it would be all right. But if all he did was to get the money, then I don't think he should have his name on the paper.

**CMS:** Do you use a computer in your work now?

**PAULING:** No. I don't. I use a hand-held calculator. I used to have a 20-inch slide rule to work with. But calculators are better than the slide rule. The slide rule gave only perhaps 4 significant figures when I worked at it. So the calculator is better, but I don't trust computers.

**CMS:** When you construct the quasi-crystals, for example, and want to reconstruct diffraction patterns, are you able to do it by hand, or do you ask somebody to modulate this diffraction pattern? How do you check the validity of your models for quasi-crystals? Without a computer, now it is difficult.

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*If you want to publish a paper every 3.9 days, you don't have very long to determine whether the structure is right or not.*

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**PAULING:** Well, most of the calculations I make myself, but I have also, even starting in 1927 or 1925, when I first had graduate students, had the students make the calculations.

**CMS:** You trust them more than the computers?

**PAULING:** Yes. Usually I check them myself.

**CMS:** Do you ever regret having left the phyllosilicate structure just when your career in clay mineralogy was



*Dennis Eberl, incoming CMS President and 1993 Brindley Lecturer, and Victor Driks, invited speaker, share a laugh with Linus Pauling during the interview, San Diego 1993.*

*Jo Eberl*

starting to take off?

**PAULING:** Well, I still would write papers on X-ray crystallography, but even starting in the 1920's, well 1930 perhaps is the first one I remember, I have published papers using somebody else's published data. My interpretation is better than these fellows' interpretation.

*The following conversation occurred after the interview when Dr. Pauling took his place at the reception for officers of the Society and organizers of the meeting. Present were Richard W. and JoAnne Berry, Roger L. Burtner, Dennis and Jo Eberl, Haydn and Juanita Murray, Linus Pauling, Jr., David R. Pevear, Thomas J. Pinnavaia, Marion L. and Betty Reed, R. C. Reynolds, Jr., Don and Georgie Scafe, José Serratosa, Don and Diane Short, and Kenneth M. Towe.*

**CMS:** Would you like something to drink?

**PAULING:** Sure.

**CMS:** Would you like some wine? Water? Soft drink?

**PAULING:** Martini! I'll have to limit myself because if I drink more than one, I'm apt to become too talkative.

**CMS:** Dr. Pauling, have you ever taken count of how many universities you've visited in your career? I imagine it would be a staggering number.

**PAULING:** Oh, I haven't. I can't even make an order of magnitude estimate. I remember going to Chulalongkorn University and giving a talk. This was in 1955. This is in Bangkok. I wondered, as I've become older and smarter, I've wondered how valuable was the lecture that I gave back in '55. It may have been so high-brow that nobody got anything out of it. It was in the Chemistry Department of Chulalongkorn University. Then my daughter gave me

*continued on next page*

**Pauling**, *continued*

a videotape, *The King and I*, which I played, and I noticed something that probably very few people noticed in this. Just at the end, the King is dying and his son, perhaps ten years old in the movie, is there beside him, and he makes a statement to his son about being a good King, Chulalongkorn. So this name, Chulalongkorn, appears in *The King and I*, but it wasn't said in a very loud way, but I noticed it because I had spoken at Chulalongkorn. So I looked in the encyclopedia and found that King Chulalongkorn was not this ten-year-old son. He had come along a decade or two later. So apparently the producer of *The King and I* liked the name Chulalongkorn as well as I did.

**CMS:** He didn't think anyone would look it up.

**PAULING:** No.

**CMS:** Sir, do you ever go to your office any more? At Caltech.

**PAULING:** I'm not sure what happened to my office at Caltech. The building may have been broken up in a somewhat different way.

**CMS:** You have your own institute now?

**PAULING:** Yes.

**CMS:** What are you working on?

**PAULING:** We formed the institute, the Linus Pauling Institute of Science and Medicine in 1973 because of my conviction that the medical profession and the belated investigators, nutritionists, were overlooking a good bit, namely that the optimum intake of vitamin C and also other vitamins may be much greater than the recommended dietary allowance. The RDA is the amount of vitamin C that keeps a person from dying of scurvy. The doctors and nutritionists apparently were satisfied that they had discovered how much vitamin C a person needs in order to keep from dying of scurvy. I knew that there was some evidence, but not very much, in the medical literature that much larger amounts would put people in better health. But there was very little published along this line. So I thought we ought to find out. You can take 10,000 times the RDA without being harmed. In fact, it improves you. But the RDA is 60 milligrams. Well, ten thousand times is a little large, but I've only heard of one man who took as much as 600 grams.

But I knew a man who took 100 grams of vitamin C a day or more for many years. He was a chemist working

for IBM, and he developed cancer, and after a few years, it had metastasized and the doctor told him that he had a few months to live, and he decided to see what he could do for himself. And one thing he had heard about was taking vitamin C. I think he took 10 grams, or he may have got up to somewhat more and decided that the bone pain that he had from the growing tumors was less. So he kept increasing his dose to 100 grams or as much as 130 grams, which suppressed the tumors for more than 10 years. He died 13 years after he had been told that he had a few months to live. So I thought our institute can try to find out what the optimum intake is, not just for people with cancer, but also to determine what amount cuts down the incidence of various diseases.

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*I don't think the head of a laboratory should have his name on a paper unless he has contributed significantly to it, other than just getting the money.*

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One of our associates, Jim Enstrom, in fact two of them, Mort Klein also, plus a third, a student from UCLA, published a paper two years ago, an analysis of 11,328 older people in the United States who were followed after information was obtained about them, interviews and so on, for 10 years. Their age-standardized death-rates were found. About a quarter of them were taking supplementary vitamin C. Another quarter or three-eighths were having a good diet but without vitamin C supplements, and there were three-eighths who didn't even have a good diet. Well, these data had never been analyzed to see whether the ones who took vitamin C supplements had lower death rates on average than those who just had a good diet. It turned out that the men had a 42% lower death rate from heart disease and strokes and a 25% lower death rate from cancer and a 15% lower death rate from diabetes and infectious diseases. The women didn't benefit quite so much. But there's no doubt that the amount they were taking—they estimate, in these vitamin supplements, this is just a guess—was 300 milligrams, on an average, only five times the RDA. Of course, I recommend taking 50 times the RDA for every adult. Three grams a day or more if you're not in the best of health for your age.

Two years ago, one of my associates and I published a paper saying let's carry out a quality test on this. Well, I'll tell you later what the paper says. It's an example of a thesis that I've been advocating for 25 years, I think—the need for theoretical medicine, theoretical people in the field of medicine. There are hundreds, perhaps thousands of theoretical physicists who don't do any experiments,

*continued on next page*

**Pauling**, *continued*

who just think. A good large number of theoretical chemists and, of course, crystallographers, well, they have to be sort of theoretical, otherwise if they don't do some thinking and rely on the computer, the computer will make mistakes. In medicine, there are some people who think, of course, but there ought to be more.

Goldstein got the Nobel Prize in Medicine a dozen years ago for having discovered the combining group for low-density lipoprotein, LDL. In a paper that they published eleven years ago, in *Scientific American*, the first sentence is, "The primary cause of atherosclerosis and cardiovascular disease in general, is a lesion in the wall of a blood vessel in a region of stress." So I thought, since this is my profession to think, I thought, "Why should there be a lesion in the wall of the blood vessel?" That's a simple question to ask. Because the wall of the blood vessel is not strong enough to prevent the break in the neighborhood of the heart or coronary artery, where it pulses from, and so on, and they went on to say, after the lesion, you have a whole cascade of efforts by the body to protect itself, to stop the leakage of blood from the circulation and so on, and this is cardiovascular disease. So I said, "Why are the blood vessels weak?" Because you don't get enough vitamin C. Blood vessels are strengthened by collagen, the fibrous protein collagen. You can't synthesize collagen without using up vitamin C. Animals, for the most part, make 200 times as much vitamin C as the RDA for humans on a weight basis. Animals don't develop cardiovascular disease of the sort that humans do, that is, lesions in the neighborhood of stress. If you feed an animal a diet very high in cholesterol, 20% or 40% cholesterol, the animal will develop a kind of cardiovascular disease, but not that is focused on the regions, close to the heart, say, where the stress is highest. It is really not analogous to human cardiovascular disease.

So, human beings get so little vitamin C that their arteries are weak, so you get a lesion in the artery and develop atherosclerosis. We went on to say, moreover, we know why you get plaques of lipoprotein in this neighborhood. One of the efforts the body makes to heal a lesion is to deposit fibrin or fibrinogen. The prosthetic group or the hapten on the fibrin that binds lipoprotein is lysine, a lysyl group, the amino acid lysine. So just from simple physical chemistry, you recognize that if you take lysine, the amino acid lysine, you'll get competition with the combining groups that will liberate or prevent the deposition of the lipoprotein. So to cut down the death rate from heart disease and strokes from 50% to a somewhat smaller figure, people ought to take vitamin C and also lysine.

**CMS:** How much vitamin C do you take daily?

**PAULING:** Eighteen grams a day.

**CMS:** Lysine is also involved in the cross-linking of collagen—hydroxylysine, the hydroxylation of lysine.

**PAULING:** Well, it's lysine that I was saying should be taken.

**CMS:** But you would also enhance the strength of your collagen with added lysine, wouldn't you, since isn't that a dietary amino acid, as well as with vitamin C?

**PAULING:** Well, perhaps so. Whether you produce extra collagen by taking extra vitamin C isn't known, so far as I'm aware. Hydroxylysine probably enhances the strength of the collagen, but the body doesn't build hydroxy-lysine directly into procollagen. You have to have vitamin C to hydroxylate the lysyl groups. Well, the paper that Dr. Matthias Rath and I published was pretty well received. There was only one commentator who jumped on it. That was Victor Herbert, who is completely unreliable.

But nothing much happened until two and a half years ago when I was in Washington, D.C., at an Academy meeting. A member of the Academy came up to me and introduced himself. I think I had met him previously perhaps; he was a biochemist. At any rate, he said "I have heart disease, and I've been taking five grams of vitamin C

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*In medicine, there are some people who think, of course, but there ought to be more.*

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for some time now, and I take a heart medicine and I've had three bypass operations. I like to walk, but I can't go for a walk because I've been getting chest pains, angina pectoris. Then I have to take a nitroglycerin tablet, and I can walk a little more, and then take another nitroglycerin tablet. Is there anything else I could do in addition to taking vitamin C?" The biochemist, who was retired several years before that for disability, came from a family where his brother and his father had both died of heart disease. So I said, "Well, perhaps you ought to take lysine." So far as I know he's the first heart patient to take lysine. So he said, "How much?" By the way, he received the National Medal of Science, one of the few biochemists ever to receive the National Medal of Science. He was 67 years old then. And I thought, nobody had ever taken lysine to control heart disease.

I thought, "Well, what do I remember about lysine?" W.C. Rose at the University of Illinois in the 1930's determined the amounts of various essential amino acids that

*continued on next page*

**Pauling, continued**

the male students in the university needed once he enlisted his study, and found that for lysine, which is an essential amino acid, 800 milligrams a day was needed for nitrogen balance. So obviously people can stand ingesting 800 milligrams a day if they need to do it. It is present in meat more than in other foods, and I thought, I don't remember just how much lysine is in the protein in meat, but it may well be that people are getting two or three grams if they are meat eaters and somewhat less if they aren't. So I said, "Five grams a day." And he thanked me. I didn't need to tell him what lysine was. He probably knew more about lysine than I did, as a biochemist.

**CMS:** I think it's about time for us to move on to the banquet if you're willing to come along with us now.

**PAULING:** No!

**CMS:** Let him finish the story!

**PAULING:** So a couple of months went by, and I got a letter. He apparently had started with one gram a day of

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*So to cut down the death rate from heart disease and strokes from 50% to a somewhat smaller figure, people ought to take vitamin C and also lysine.*

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lysine. He said, "Within a month after I had reached five grams of lysine a day, I could walk two miles without taking any nitroglycerin tablets. I have cut my heart medicine in half now." Then two or three more months went by, and he wrote, saying, "I am feeling so well that I started cutting down a tree in our yard and chopping it up for fuel, and I was also painting the house, and I got chest pains. So I went up to six grams a day of lysine, and now I'm feeling fine. It's almost miraculous." So I said, "You



*Jo Eberl and Linus Pauling after the interview, San Diego, 1993.*

*Dennis Eberl*

ought to write this up for publication." And he wrote it up, and I published it. He said he prefers anonymity. Well, he's a biochemist who has received the National Medal of Science and is 69 years old, and this is in the paper.

So I have now published three papers about three different people, all of them having angina pectoris who have taken lysine and find that between three grams and six grams a day is helpful. The third patient was also having some trouble because after he had been on lysine for a while, he was out for an hour shoveling snow, after a heavy snow storm in New York, and developed angina, and he realized he hadn't been taking his vitamin C and lysine very regularly. So he went rigorously onto six grams of each. All three of these patients, there is more to the stories about how I learned about these patients, but all three have said, "It's almost miraculous, this change."

So every older person ought to be taking a good slug of vitamin C every day and also lysine, and especially if you are at risk.

**CMS:** How old is "older?"

**PAULING:** I guess lots of young people aged 35 or 40 or 45 years old die of cardiovascular disease. They are probably people at risk. Perhaps everyone ought to be taking it. If there's a history of death from heart attacks in the family, if your lipoprotein a is over 20 milligrams per deciliter, you're at risk. That's the lipoprotein that's laid down in the plaques. If you have some heart trouble, you had better be taking lysine.

**CMS:** Well, I must tell you that I have a 94-year-old mother, and she is a firm believer in vitamin C. She aquacizes and bowls, and she keeps telling me that I should be taking vitamin C.

**PAULING:** I think this is the greatest contribution that we have made to health—this discovery about the lack of vitamin C as the primary cause of cardiovascular disease and the value of vitamin C and lysine for preventing it.

**Adelaide,** *continued from page 1*

des Argiles, Dr. R. S. Swift, Chief of the CSIRO Division of Soils, and R.S. Fardon, Director-General of the South Australian Department of Mines and Energy. The opening session continued with two keynote addresses, the first by Tom Pinnavaia entitled, "Pillared clay catalysts: Opportunities for their use in improving environmental quality," the second by Keith Norrish, entitled, "An unusual fibrous halloysite."

Following the refreshment break, the conference continued with a pattern generally followed for the remainder of the meeting. First, a plenary session with a 40-minute keynote address by a prominent clay sci-



Haydn Murray, new President of AIPEA, and Tony Eggleton, Secretary General of the meeting, Adelaide, 1993.

Dave Pevear

entist set the tone for the following three or four concurrent oral sessions comprised of four to six, 20-minute papers each. Plenary, oral, and poster sessions did not overlap, so it was possible to attend each session.

With over 350 oral and poster papers presented, we can highlight only a few, which obviously represent our biased appraisal of some of the scien-

tific highlights of the conference.

Theme sessions featured sediments, diagenesis, weathering and the always popular kaolins. Talks in the weathering sessions made it obvious that clay mineralogy is going to play a critical role in future paleoclimatic research. For example, Carolyn Olson and Allan Chivas each presented oral papers that combine stable isotope geochemistry and paleosol stratigraphy to create paleoclimatic records of past geological terrain. Keith Norrish described an unusual fibrous halloysite with unusually uniform tube diameters and a length to diameter ratio of 1200, perhaps a record for this mineral. David Veblen described interlayer precipitation of Cu metal in vermiculites, apparently the result of reduction of the Cu cations to Cu metal in the interlayer.

Weathering-related presentations also exemplified the now routine application of once non-traditional analytical methods including: the HRTEM work of Jillian Banfield, who has been examining weathered pyroxenoids; the near- and far-infrared spectroscopy of René Prost, to study both primary and secondary weathering of phyllosilicates; the XPS study of iron oxidation states in clays by Jessica Elzea; the  $^{27}\text{Al}$  and  $^{29}\text{Si}$  MAS NMR and X-ray absorption spectroscopy-based study of allophanes by Philippe Ildelfonse; and the EPR and Diffuse Reflectance analyses of kaolinite from different geological settings by Jean-Pierre Muller. Stephen Guggenheim predicted that synchrotron-based techniques would become increasingly important in the future, and a number of papers from France and



S. W. Bailey receives the first AIPEA Gold Medal from José Serratosa, President of AIPEA. R. C. Reynolds, Jr., was also awarded the Gold Medal by Serratosa, but at the CMS meeting in San Diego.

Dave Pevear

the U.S. illustrated examples of synchrotron-based X-ray absorption spectroscopy experiments.

Sessions on diagenesis were highlighted by talks from Dave Pevear who revealed petrographic evidence for the facilitation of vermiform kaolinite growth by nucleation on micas. Ray Ferrell discussed the application of back-scatter imagery in the analysis of clays in sandstones. Ray also facetiously introduced the term "chronovore," which eats neither meat nor plants, but time! A good chuckle was had by all.

This was the second international clay conference in which teaching



Jessica Elzea, Vlado Sucha, and M. Murtaugh on the AIPEA field trip.

Dave Pevear

**Adelaide,** *continued from previous page*

clay mineralogy was featured in a separate symposium. Udo Schwertmann presented the keynote lecture which was unique in that four common iron oxides were synthesized during the course of the presentation. David Low's presentation combined Maori folklore, embodied by Ruaimoko, the Maori god of earthquakes and volcanism, and science to show us a unique approach to teaching students about allophane. Joe Dixon described his experience with a field trip to introduce students to clay mineralogy in the field, while Darrell Schulze showed a number of approaches for using computers to teach students the details of clay mineral structures. The success of the session is illustrated by the AIPEA Council's

precipitated many discussions amongst presenters who often do not get a chance to view or discuss posters within their own sessions. Highlights of the poster session on clay structures included the microtopographic technique of Ryuji Kitagawa used in analysis of crystal growth mechanisms and the Raman spectral analysis of clays by Ray Frost. Gerard Besson and Paul Schroeder each demonstrated, respectively, how infrared and NMR spectroscopy can be used to further understand the sometimes heterogeneous structure of micaceous minerals.

The role of organisms in mediating the weathering or neoformation of clay-sized minerals was the topic of numerous oral and poster papers. Philippi Hingsinger showed how roots of oilseed rape can



Ray Ferrell, Randy Hughes, Dave Pevear, and Dewey Moore valiantly man the CMS booth in Adelaide. *Dave Pevear*

request to include a session on teaching at the next international conference.

Poster papers remained up for the duration of the conference. Each day, several posters were featured in "active" poster sessions, in which the author was allocated three minutes to give a verbal introduction of his or her paper. Morning and afternoon coffee and tea, as well as a basket lunch, were served in the poster area. This format was well received and

weather phlogopite to hydroxy-interlayered vermiculite within 16 days in agar culture, while Darrell Schulze presented data which suggest that a fungal pathogen of wheat precipitates Mn oxide minerals in the rhizosphere as part of the infection process. Kazue Tazaki presented a review of biomineralization in environmental geology, while Joe Stucki described work



Dave Pevear and Menard Thiery partake of spirits at Adelaide. *Courtesy D. Pevear*

aimed at determining the mechanism of microbial reduction of iron in smectites. Rob Fitzpatrick described the occurrence of schwertmannite, a poorly crystalline iron hydroxide. *continued on next page*



Jeanne Percival answers the phone in the fridge on an AIPEA field trip. *Dave Pevear*

**Adelaide**, *continued from page 15*

droxy-sulfate mineral in the sheaths around iron oxidizing bacteria, from some soils of South Australia.

There were seven field excursions associated with the conference. We report only on the three in which we participated. They were well organized and offered visits to the many varied geological terrains of Australia and New Zealand. The pre-meeting excursion on the North Island of New Zealand, led by David Lowe and Harry Percival, examined the occurrence and genesis of clay minerals, particularly allophane, halloysite, and ferrihydrite, associated with Quaternary volcanic deposits. The stops at a number of hydrothermal fields were particular treats. The excursion to SE

New South Wales led by Graham Taylor explored pisolitic bauxite derived from basalt, lateritic deep weathering profiles, diatomites and inter-flow bauxite profiles developed on Tertiary basalt. One trip to Australia will have you re-evaluate your view of weathering. Australia's tectonically stable craton has been integrating and recording weathering processes for many millions of years, aided particularly by the fact it has not seen glaciation since the Permian. The excursion to the area south of Perth in Western Australia, led by Bob Gilkes Peter Darragh, and Max Churchward, examined soils, deep lateritic weathering, land degradation, and miners producing gold, bauxite, heavy minerals, spodumine, and coal. The restoration of mined lands by Al-

coa, Westralian Sands, and Griffin Coal Mining Company were impressive examples of how companies can economically mine valuable minerals, while still addressing the long-term environmental concerns of society. A tour of a gold mine and processing plant where about 1ppm gold is extracted from lateritic ore made it clear how valuable the yellow metal really is.

The organizing committee is to be commended on a job well done. The conference was a success, and we are sure that many of the participants are looking forward to their next trip "down under."

*Darrell Schulze, West Lafayette, IN  
Paul Schroeder, Athens, Georgia  
Joe Dixon, College Station, Texas*

**Student grantees and awardees**

The CMS Council awarded research grants to the following students: **Steven Feldman**, Virginia Tech, student of **Lucian Zelazny**, for mineral transformations, elemental distribution, mass flux, and paleopedological reconstruction along a Piedmont soil climosequence, eastern USA; **Kendall Fountain**, Univ. of Florida, student of **Guerry McClellan**, for mineralogical and geochemical characterization of Plio-Pleistocene kaolinite deposits in north central Florida: genetic relationships among deposits in the southeastern United States; **George Grathoff**, Univ. of Illinois, student of **Richard Hay** and **Dewey Moore**, for nature and origin of illite in lower Paleozoic sediments of the Illinois basin; **José Lima**, Michigan State, student of **Sharon Anderson**, for kinetics and mechanisms of phosphate sorption related to amount and type of iron oxides in different aggregate size of soils; **Junzhe Liu**, Univ. of Illinois, student of **Richard Hay**, for age and origin of diagenetic illite/smectite in Precambrian rocks in west-central

Wisconsin and the St. Francis Mts., Missouri; **Siyan Shen**, Univ. of Illinois, student of **Joseph Stucki**, for effects of structural iron reduction on ammonium fixation of smectites; and **Jianqing Xu**, Texas A & M, student of **Albert Yeung**, for relations between microfabric and hydraulic conductivity of compacted clay.

Student paper and poster awards were awarded to the following: Best Paper to **Ruben Kretschmar**, with A. Amoozegar & W. P. Robarge, for "Filtration of submicron-size clay and iron oxide colloids during saturated flow through sapriolites;" Best Paper Runner-up to **Connie Kohut**, with M. J. Dudas, for "Characteristics of Clay Minerals in Salt-Affected Soils;" Best Poster to **Julia Sheets**, with R. Tettenhorst, for "Alteration of microcline perthites from Spruce Pine, North Carolina;" Best Paper Runner-up to **Kendall Fountain**, with Guerry McClellan, for "Origin of northcentral Florida kaolinite deposits in light of mineralogical and geochemical evidence;" and Best Paper Runner-up to **Monique A. M. Lawrence**, with

W. R. McWhinnie & J. Meer, for "Adsorption of aromatic and organometallic compounds by Quaternary ammonium exchanged smectites."

The Society wishes all of these talented young clay scientists a successful future.

**Proposals requested for source clays volume**

The Clay Minerals Society will entertain proposals for a source clays volume, similar to that written by H. van Olphen. The Society is looking for a compendium for researchers that will include characterization of source clays and analytical information. The format might involve a chapter on each clay, mineral data, where the clay is found, a computer data base, and so on. Please send proposals (before August) to The Clay Minerals Society, P.O. Box 4416, Boulder, CO 80306, USA.

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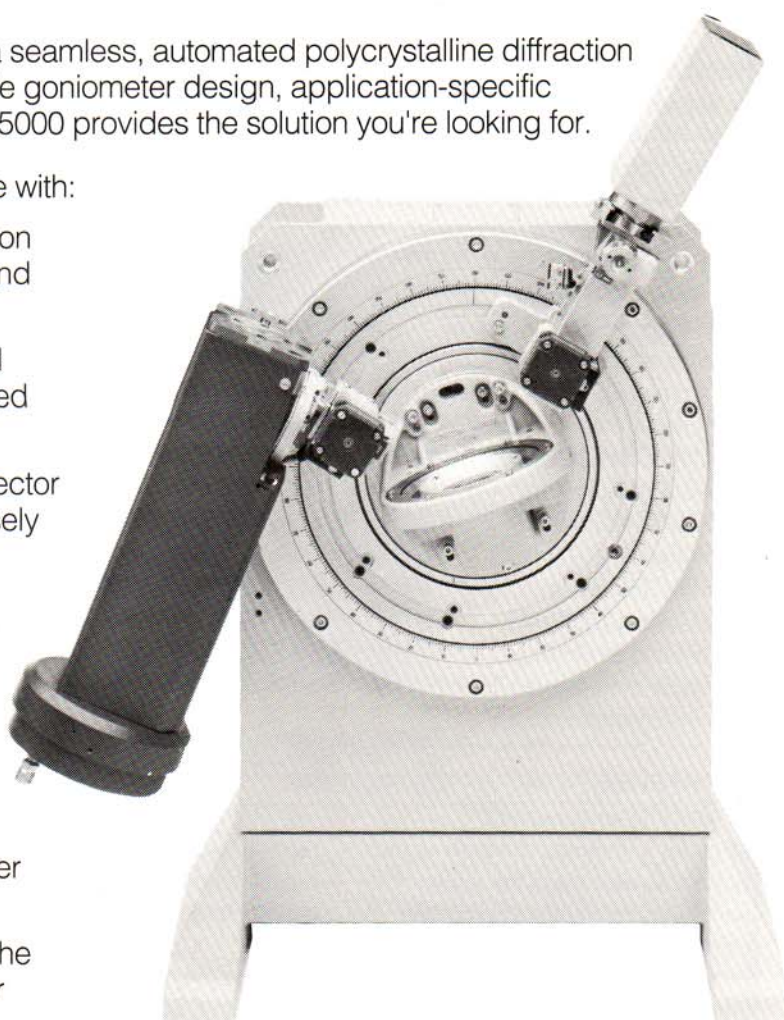
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## Student Profile

# Junzhe Liu

**Nationality:** Chinese

**Place of study:** Ph. D. (in progress): Geology Department, University of Illinois, Champaign, Illinois

**Previous degree:** Master's in Environmental Chemistry at the Research Center for Ecology-Environmental Sciences, Academia Sinica, Beijing.

**Thesis Advisor:** Richard L. Hay

**Thesis topic:** Potassic diagenesis of the uppermost Precambrian rocks in the North American Mid-continent. Potassic alteration occurs widely in lower Paleozoic and uppermost Precambrian rocks. Radiometric dates of illite and K-feldspar are of Paleozoic age. My research work includes petrography, X-ray diffraction study of clay and non-clay minerals, stable isotope (O,H) analysis, various dating methods for authigenic K-feldspar and illite (including mixed layer I/S), fluid inclusion, and modelling the reactions in the geochemical system I study.

**Interest in clay:** First, because clay minerals are the major authigenic minerals in the potassic alterations in my study. One cannot understand the diagenesis without studying the clay minerals. Second, I like layered minerals. Third, clay minerals are keys to understanding many geological processes. They also play an important role in the disposal of radioactive wastes. This is related to the environmental problems that I am concerned about very much.

### Other major interests:

Topics in geochemistry, especially low temperature geochemistry. I am also interested in environmental geology (geochemistry).

### Favorite literature:

*John Christopher* by French author Romain Roland, and *The Old Man and the Sea* by Ernest Hemingway. I like *John Christopher* because it reveals that real men are men of absolute truth. I like *The Old Man and*



Junzhe Liu in the lab, University of Illinois, 1994.

Courtesy J. Liu

ball, soccer, and bridge. My favorite sport is tennis.

**Other enjoyments:** I like to make friends and to help people. In my leisure time, I enjoy doing things with friends. I also like cooking. Cooking is an art to me. When people appreciate the flavor, color, and taste of the food you cook, it is a real pleasure.

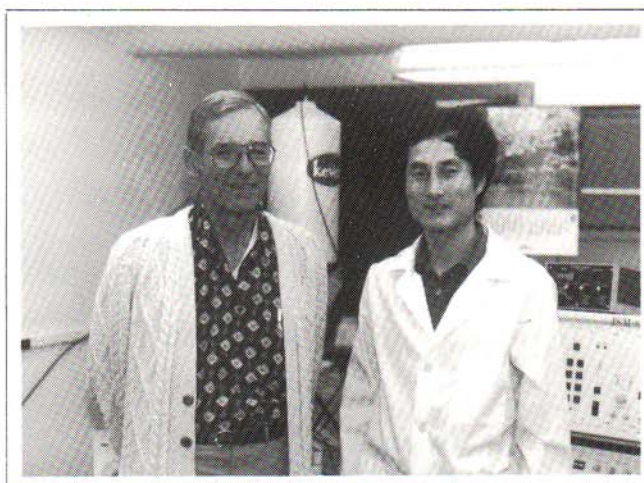
**Family:** I am married. My wife, Jianhui, and I have a little daughter, Melody, who is almost three months old. She already welcomes me home from school with a big smile every day.

### Recommended recipe:

**Lotus Shrimp:** slice 1/4 lb. unshelled shrimp, add a

little salt, wine, and starch, and stir fry in cooking oil until almost done. Fry 4 egg whites until half-done. Add shrimp and 1/8 cup green peas. Serve when egg is finished. This dish tastes delicious and looks good with alternating colors of white, green, and red.

**Favorite clay:** Mixed-layer illite/smectite.



Richard Hay, Ralph E. Grim Professor of Geology, and his student Junzhe Liu, a 1993 CMS research grant recipient, University of Illinois Geology Department, 1994.

Courtesy J. Liu

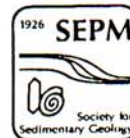
*the Sea* because it discloses that every success comes from hard work and unremitting efforts.

**Favorite art:** I love all the beautiful things, such as nice music, delicate painting, good movies, romantic poems, and so on.

**Favorite sports:** I am a big fan of sports, and I also play a lot of sports, such as volleyball, tennis, racquet

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Department of Earth, Atmospheric, and Planetary Sciences,  
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## New Members

We welcome the following people who have recently joined The Clay Minerals Society.

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**Archives donations**

Many thanks to Bull Bailey, Emilio Galán, Walter Keller, Dave Pevear, and Joe White for contributions to the Archives. Some of Keller's and White's contributions will be published in the next issue of the newsletter. Bailey's, Galán's, and Pevear's photos can be found in this issue.

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## Ask the Clay Doctor

(Not a real doctor)

**Dear Clay Doctor:** It seems to me much has been written about disorder in clay minerals. But I have yet to understand what actually causes it. Can you provide a brief explanation?

Wondering in Wapakoneta

**Dear Wondering:** Clay mineral disorder (or CMD, as the World Health Organization calls it) has probably been with us for millennia, or even thousands of years. But only in recent times has it been recognized for the serious and pervasive problem that it is. The earliest recorded diagnosis of CMD was made in the 1st century B.C. by a Roman getaway chariot driver named Buggy Octavius who, much to his dismay, discovered kaolinite-rich muds lodged in the axle of his vehicle following a major bank heist. He was thus prevented from reaching top speed, and was soon apprehended by the authorities and severely punished. Similar occurrences over the next century led to this being referred to as Buggy-axle (or B-axle) disorder, mistakenly translated by 12th century Egyptian scholars as b-axis disorder. This tendency to clog appears to stem from some sort of internal malfunction in clays supposedly related to unpleasant surroundings in their environments of formation. Research in the 1940's showed clays formed in cramped quarters and exposed to loud music were almost invariably disordered, and moreover, that the disorder was passed on to successive generations. So let that be a lesson.

**Dear Clay Doctor:** Many CMS members consider you to be omniscient, so I thought that perhaps you could help us locate a missing person. The one we seek used to attend CMS meetings years ago sporting a pony tail hairdo and showing every sign of being a defiant anti-establishment hippie. Later, it was rumored that he, being a fairly bright fellow, had somehow wangled a job in the research department of a giant oil company. However, during the past year or two, he has not been seen or heard from. I think his first name was Dan or Dale, something like that. Can you help? There might be a reward.

Worried in Waco

**Dear Worried:** I think I know the person about whom you write. He cut his pony tail, donated his bell-bottoms to Good Will, and left the Strawberry Fields to become an Exxon Texxon. Happily he did not become an Esso Asso.

However, Dale's transformation is nothing compared to that undergone recently by a clay scientist after the passage of NAFTA. One minute he was studying Precambrian illites in Montana. Then there was a giant sucking

sound, and the next minute he was studying kaolin minerals in Nayarit, Mexico!

**Dear Clay Doctor:** In your last column, a correspondent asked whether there were clays on other planets. The answer is, "Yes, Virginia, there are clays out there, at least on Mars!" As evidence, enclosed is an article by Allan Treiman, Ruth Barrett, and James Gooding purporting to be serious science and demonstrating that clays in a meteorite are pre-terrestrial. As the meteorite is almost certain to be from Mars, q.e.d. It was our conclusion that the clays were indigenous to Mars, but proponents of the Pan-Saponitia theory claim that these clays represent the lineal descendants of clays from an older and wiser planetary body.

Mutant Man, Houston

**Dear Mutant Man:** Thank you for your letter and illuminating journal article. Your research, together with episode #57 from Star Trek and information channeled from a reliable source on the planet Heutron, offer strong evidence for the existence of clay on other planets.

**Dear Clay Doctor:** As an afficiando of both clays and cats, I wonder what, if anything, the two have in common?

Torn Between in Topeka

**Dear Torn Between:** Aside from the letter c in both collective nouns, and the frequent use of one as litter for the other, there is yet a third, and little-known thread of commonality between clays and cats. A clue was provided by a famous British writer who reminded us that, in addition to their given names, cats also have secret names which they alone know. I can now tell you that the same is true for clays. You and I are accustomed to identifying clays by names such as dickite, nontronite, and chamosite, whose etymologies are well-known. But the true and proper names of these three species, for example, are Patty, Maxine, and Laverne. Beidellite is Yogi, and illite is Stanislaus, or Stan for short. I could go on, but I am afraid I would be betraying confidences.

**Dear Clay Doctor:** Why don't you discover a new clay, name it after my buddy, and call it Butt-headite? Heh. Heh.

Beavis, On Your Tube

**Dear Beavis:** Your suggestion is worthy. However, there is a precedent. The term "Buttheadite" has been proposed to resolve the nomenclatural problem between halloysite and endellite.

## Feats of Clay

The SSSA recently awarded **Philip Low** the Soil Science Distinguished Service Award, **Darrell Schulze** the Marion L. and Chrystie M. Jackson Soil Science Award, and **Scott Fendorf** the Emil Truog Award. **Joe Stucki** was named a Fellow of the SSSA.

**Sam Savin** has been appointed Associate Dean of Arts and Sciences at Case Western Reserve University.



Victor Drits in Boulder, 1993.

Jo Eberl

**Jack Burst** has been named president-elect of the Society for Mining, Metallurgy and Exploration, a 17,000-member society.

**Cliff Johnston** has taken a position as Associate Professor at Purdue, filling **Philip Low's** position.



New Dad Jeff Walker, co-editor, with R. C. Reynolds, Jr., of Volume 5 of the CMS Workshop Lectures, and co-convenor, with Michele Hluchy, of a recent symposium on clays. High Iron Photos

**Stephen Hillier** has

taken a position as Higher Scientific Officer at McCaulay Institute in Aberdeen, working with **Jeff Wilson**.

**George Guthrie** and his wife **Suzanne** are the happy new parents of **Nicholas**. **Jeff Walker** and his wife **Kathy** also welcomed a new little one, **Patrick**, into the fold this year.

**Sridhar Komarneni**, Professor of Clay Mineralogy at the Materials Research Laboratory and Department of Agronomy, The Pennsylvania State University, recently presented invited papers or lectures in Saarbrucken, Germany, Bratislava, Honolulu, Los Angeles, Melbourne, and Auckland.

**Michele Hluchy** and **Jeff Walker** convened a symposium at the Northeastern Sectional Meeting of the GSA in March on "What do clays tell us?"



Sam Savin and Jan Srodon in San Diego.

Jo Eberl



Jean Hemzacek, seated with Bill Moll at the Sustaining Contributors Breakfast in San Diego. Jo Eberl

**Jean Hemzacek** has gone back to school to get her doctorate with Haydn Murray.

**Victor Drits** and **Jan Srodon** spent several months working in Boulder with **Dennis Eberl**. Victor is now spending some time in Orléans with **Gerard Besson** and in Grenoble with **Alain Manceau**.



New Dad George Guthrie.

Jo Eberl

For information about Student Grant Recipients and Student Awardees, see page 16.

**Gray Thompson** has so far spent his sabbatical climbing in China, studying in Ecuador, and climbing all over the American West.

## San Diego, *continued from page 1*

During the opening plenary session, "illitist" Jan Srodon gave the Jackson Lecture (on illite, of course). The Brindley Lecture by Denny Eberl featured his reinterpretation of the original Hower data from Gulf Coast shales (Ostwald ripening, anyone?). Tom Pinnavaia gave the Distinguished Member lecture on environmental aspects of intercalated catalysts. At Tuesday's banquet, the Pioneer Lecture was given to a spellbound audience by two-time Nobel laureate Linus Pauling, then in his 93rd year.

The technical program was ably assembled by Chevron Clay Guys Roger Burtner, Eric Daniels, and Marion Reed, and the topics in the program suggest some of the trends in our science and in our membership. Symposia on environment (including a session on health ef-



R. C. Reynolds, Jr., receiving the AIPEA Gold Medal from former AIPEA President José Serratosa at the CMS Banquet, San Diego, 1993.

*High Iron Photos*

dicator. Three talks by Victor Drits, Douglas McCarty, and Bruno Lanson high-

smectite-to-illite reaction were aired: in addition to Eberl's (above), we heard Steve Altaner and Bob Ylagan on "interlayer-by-interlayer dissolution," a "nonlinear dynamics model" proposed by Huifang Xu, and a re-statement of Güven's "polar/nonpolar" idea by H. Vali and others. But we are not done yet! Gene Whitney proposed an "anion control" model, and Hugh Abercrombie and others of the Calgary Mafia presented fluid data showing that the whole thing is controlled by silica activity. Phil Rosenberg described illite-growing experiments at 100-250°C, including interesting TEM photos showing illite and I/S nucleating on muscovite, which seemed to support a solution-precipitation mechanism. Whew!

There were some interesting talks on mixed-layer chlorite/serpentine (C/Sp), a species hardly recognized a few years ago. Bull Bailey and Jill Banfield described a 1:1 regular interstratification, as well as an inexplicable polysomatic series exhibiting long range (up to 4:1) order. Peter Ryan and Bob



Marion Reed chatting with Monique Lawrence, Bill Dubbin, Sallie Greenberg, and David Finkelstein at the Student Reception, 1993.

*High Iron Photos*

facts), industrial applications (honoring Haydn Murray), and hydrothermal clays dominated the program. There were generally three concurrent sessions, so this reviewer was only able to attend a fraction of the talks, a few of which are highlighted below.

The genesis of kaolins was summarized by Randy Hughes and Dewey Moore in one of the better reviews I've heard on the subject. Well-crystallized kaolinite forms in reducing environments where Fe is incorporated into sulfides, whereas K/S forms under oxidizing conditions. They suggest that K/S is widespread and may be a useful environmental in-

lighted various aspects of the three-dimensional structure of illite and I/S and provide exciting hints that the cis and trans vacant IM varieties may be thermal or environmental indicators.

Several new models for the



Colin Harvey, Carolyn Olson, and Tom Dombrowski showing off the Haydn Murray ceremonial watch.

*Jo Eberl*

**San Diego**, *continued from previous page*

Reynolds showed all the "chlorite" in the subsurface Tuscaloosa Fm. to be C/Sp, with the %Sp decreasing from 16 to 3% with depth. Bob Klimentidis and others had a poster on genetically and compositionally complex C/Sp in a North Sea reservoir.

I found the several talks on expansive



*The imperious Jan Srodon, 1993 Jackson Lecturer, San Diego.*

*High Iron Photos*

soils more than just interesting, since I live in an area of smectite-rich soil. Damage to structures by soil shrinkage/expansion is one of our costliest environmental problems.

One wonders why a subdivision near Denver was built on bentonites, as described by J. Gill and others. A chemical remedy was outlined by D.



*Ken Towe, José Serratosa, Tom Pinnavaia, 1993 CMS Distinguished Member, Linus Pauling, Jr., and Linus Pauling chatting about crystallography in the hotel lobby.*

*Jo Eberl*



*Eric Daniels, Marion Reed, and Roger Burtner, Program Chairs of the Annual Meeting, San Diego, 1993.*

*High Iron Photos*

Marquant.

In keeping with the recent trend, there was a large and successful poster session, open all day, with afternoon refreshments. Posters included a symposium on Teaching Clay Science. I especially liked Sherry Fulk-Bringman and other's simple classroom demos and experiments designed to keep the learning curve going after students have passed the modelling clay stage. Michele Hluchy's ideas for teaching clay to undergrads are certainly timely. With the emphasis these days on environment, it would seem more important to know smectite than plagioclase. Many of the posters included computer applications, with actual demonstrations. It

appears that PC's will continue to be a regular part of our meetings, and must be planned for by future organizers. My favorite poster was

Steve Rice and Jessica Elzea's TEM and XRD study of stacking disorder in opals. Intergrowths of cristobalite and tridymite domains were clearly visible, and their size could be related to the XRD patterns. Nice job, guys.

The vendor demonstrations by both Biosym and Molecular Simulations on applications of computational chemistry to clay science were spectacular and filled with hints about future directions in our



*Dick Berry, General Chair of the highly successful 1993 Annual Meeting.*

*High Iron Photos*

science. Imagine being able to watch, at atomic scale, an organic molecule settle and orient itself on a mica surface. To be able to pre-

*continued on next page*

**San Diego**, *continued from previous page*

dict and visualize the preference of several molecules for a specific site (face, edge, etc.) on a clay surface!



1993 CMS President Dave Pevear, Daniel Webster, and Steve Guggenheim.

Jo Eberl

The portable IR spectrometer (PIMA) demonstrated by Spectral International, with its useful library of data and software options, appears to offer



Paul Nadeau and Simeon Tsipursky at the wine and cheese party.

Jo Eberl

new possibilities for clay fieldwork.

There were two mid-meeting field trips, one to the famous Pala gem pegmatites near the also famous Mt. Palomar observatory, the other to the well-known Otay "waxy" bentonites. Other than morning fog, the weather was expectedly beautiful. I did not go on the Pala trip, but it apparently went well, with ample opportunities for collecting. An unexpected extra was the supposed white beidelite clay that is apparently a late stage product filling the pegmatitic cavities. There were good opportunities for collecting the Otay bentonite on the other field trip, which I went on. The unexpected extra here was a visit to infamous Black's Beach, a well-known nudist spot. There were a few gems here, too; unfortunately, opportunities for collecting were

limited.

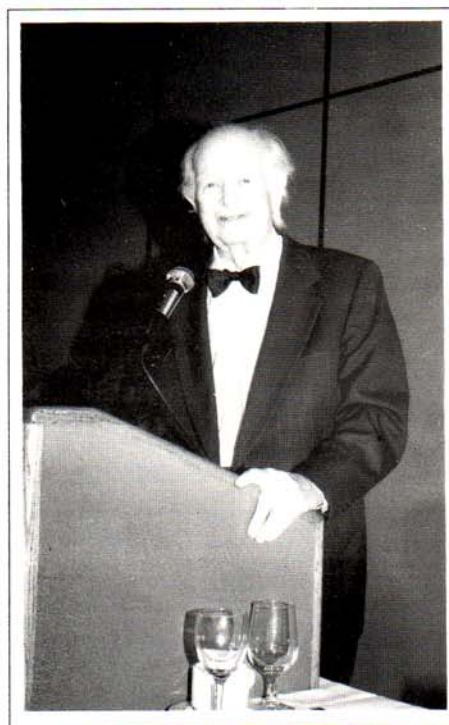
The Council approved the ballot elections of Ken Towe for Vice President Elect and Treasurer (for one year), Don Scafe for

Secretary, and George Austin, Jerry Bigham, S.Y. Lee, and Michael Velbel for Council Members. The Council election was so close that one of the spots had to be decided by the flip of a coin. The 1994 Brindley Lecturer will be Bob Reynolds, and the 1994 Jackson Lecturer will be Steve Guggenheim. There will be no 1994 Distinguished Member.

Nominees for the 1994 ballot will be as follows: Steve Guggenheim

for Vice-President Elect Nominee, Herman Roberson for Treasurer Nominee, and for Council: Janis Boettinger, Eric Eslinger, Jim Howard, Richard Lahann, Murray McBride, David Veblen, Jeff Walker, and Lucian Zelazny.

The 1994 CMS Annual Meeting will be held in Saskatoon

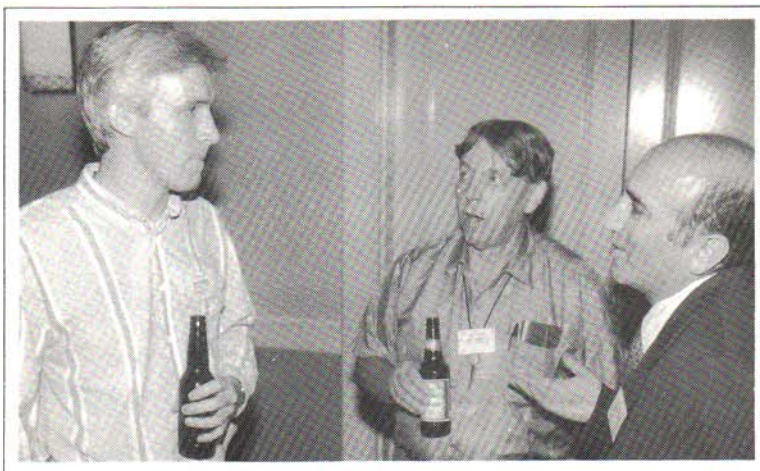


Linus Pauling giving the Pioneer Lecture.

High Iron Photos

from August 13-18. For more information, contact Meeting Chair Ahmet R. Mermut, Department of Soil Science, University of Saskatchewan, Saskatoon, SK S7N 0W0, Canada; telephone 306-966-6839; fax 306-966-6881. The 1995 meeting will be held in Baltimore from June 3-8. Contact Del Fanning, Dept. of Agronomy, U. of Maryland, College Park, MD 20742. Tel: 301-405-1344.

D. R. Pevear  
Houston, Texas



Bill Dubbin chatting with Del Fanning, organizer of the 1995 CMS Meeting, Baltimore, and Ahmet Mermut, organizer of the 1994 CMS Meeting in Saskatoon.

High Iron Photos

## *Mariana Paull Johns Fellowship established at University of Missouri*

The family of Mariana Paull Johns has endowed a scholarship in her name at the School of Social Work at the University of Missouri. Mariana was married to W. D. Johns, a long-time member and former President of the CMS. Mariana, who received her Masters in Social Work in 1988, had returned to school after having been a mother, a homemaker, and a "professional volunteer" for all of her adult life. She wanted to earn her degree in social work so she could expand on and continue what she had been doing as a volunteer. One of her professors, Joanne Mermelstein, says, "She

reached out to other students with her delight, and they really responded."

The family has asked that the scholarship be given to a non-traditional female student, "preferably someone who is making a life change and probably shares some of the fears and intimidation and feeling out of place that she probably felt when she took that risk and came back to school," said Mermelstein.

In a letter to the President and Manager of The Clay Minerals Society, Judith A. Davenport, Director of the School of Social Work, says of

Mariana, "From all that I hear, she was quite a remarkable woman. She was an excellent role model for non-traditional students. While she was in school, she helped and encouraged other students, many of whom were older, like herself, with special needs and problems... She was much loved and respected at the School."

All those in the Society who knew her can attest that she was indeed a lovely, bright, courageous, and unusual woman, who will be missed not only by her family, but by many others whose lives she touched.

## **CMS Council News**

Several actions of interest to members were achieved at the 30th Annual Meeting of the Society in San Diego, CA. Jeff Walker is the Editor of the Workshop Lecture Series publications for the next two years. The Society accepted the invitation to hold a joint meeting with AIPEA in Ottawa, Ontario, in the summer of 1997. Pat Costanzo is designated as our liaison. Because our members are so upwardly and geographically mobile, the membership list is quickly obsolete. A revised membership list will be published every year.

Several by-laws revisions approved by Council were subsequently ratified at the annual meeting. A search committee will be struck whenever the Editor-in-Chief resigns. Proposals for special publications and workshop lectures are to be submitted to the Chair of the Publications Committee and should contain a schedule for submission of manuscripts, an estimated budget and source of funding, and one or more nominations for special editor. These special editors will have the same responsibilities for these publications as the Editor-in-Chief has for *Clays and Clay Minerals*.

In order to minimize the risk and to diversify our portfolio, approximately fifty percent of the Endowment Fund now will be managed by the Vanguard Group, and the remainder by the Fidelity Group. Chairs of future CMS annual meetings will be encouraged to schedule them in the spring or summer, the two most favored times quoted in the recent survey of members. No student may receive more than one renewal of a Society grant to a previously funded project or more than two grants for separate projects in separate years. A request for a proposal to compile the Source Clays characterization data in book form is to be advertised.

*Don Scafe  
Edmonton, Alberta*

### ***The start of a new Society tradition?***

Judging by the many positive comments received, a new tradition may have been inaugurated at the San Diego CMS Conference. Host Dick Berry suggested to me at the previous meeting in Minneapolis that a short slide program showing Society members doing things that Society

members do might add something to the Icebreaker reception in San Diego.

Using slides from my own collection, some from Dick, and some supplied by Jo Eberl, I organized a ten- to twelve-minute review of events from past adventures by some Society members. We saw students who now are respected clay scientists, we saw misadventures from past conferences, and we remembered some of our colleagues who are no longer with us. Some people had more hair, less bulk, and fewer laugh lines when the photos were taken. The facts of a situation were not allowed to interfere with a good story!

Anyone interested in contributing to the next program can send original or duplicate slides to me. A few words about the when, who, and where of the slides would be helpful. The slides can be returned to you or contributed to the Society Archives after use.

*Don Scafe  
Edmonton, Alberta*

Question on a recent Indiana U. clay mineralogy exam: Who is Bull Bailey and what has he contributed? Answer: Father of Damon Bailey, guard of the IU basketball team. Colin Harvey comments, "Who says we're crazy about basketball?"

## The Clay Minerals Society Organization and Committee Personnel 1993-1994

**EXECUTIVE COMMITTEE**

Dennis D. Eberl, President  
 Rossman F. Giese, Vice President  
 Don Scafe, Secretary  
 Kenneth M. Towe, Treasurer  
 Ray E. Ferrell, Jr., Editor  
 David R. Pevear, Immediate Vice President  
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| C. G. Olson '94   | S. M. Savin '95  |
| D. G. Schulze '94 | G. S. Austin '96 |
| G. Whitney '94    | J. M. Bigham '96 |
| L. M. Coyne '95   | S. Y. Lee '96    |
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 R. L. Burtner '95  
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 H. H. Murray '96  
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 R. H. April '94  
 R. W. Lahann '95  
 G. Whitney '95  
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 D. W. Ming '96

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 S. M. Savin '94  
 C. C. Harvey '95  
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 \*J. M. Walker, Special Publications Ed.

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 T. Dombrowski '95  
 P. B. Malla '96  
 \*M. M. Hluchy, Chair Continuing Education  
 \*A. R. Mermut, Chair 1994 Meeting  
 \*D. S. Fanning, Chair 1995 Meeting

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**East European Liaison**

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 W. D. Huff  
 W. D. Johns  
 V. Sucha

**Source Clay Minerals**

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 W. D. Johns, Curator  
 M. C. Lee  
 W. F. Moll  
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**Regulatory Issues**

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 J. M. Bigham  
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 W. Hudnall  
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**Pevear's Committee**

D. R. Pevear

**Tellers Committee**

R. M. Pollastro, Chair  
 H. M. May

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 SSSA—D. G. Schulze  
 MSA—D. L. Bish  
 JCPDS—J. E. Post

**Advisor-Society Office**

R. M. Pollastro

\**Ex officio*

## Sustaining Member Profile

# Engelhard Corporation

**E**ngelhard Corporation produces and markets specialty chemical products and engineered materials. The company was started by Charles Engelhard, Sr., in 1902. After various acquisitions, mergers, and reorganizations, the company became known as Engelhard Corporation in 1981. Engelhard has expanded since 1981 through both growth and acquisition.

Engelhard is headquartered in Iselin, New Jersey, with affiliates and facilities in Australia, Canada, Finland, France, Germany, Italy, Japan, Mexico, the Netherlands, Russia, Singapore, Switzerland, South Korea, the United Kingdom, and the U.S.A. The company has approximately 6000 employees worldwide, and annual sales of more than 2.4 billion. Engelhard has seven operating groups within its three business segments. The Catalysts and Chemicals segment comprises the Petroleum Catalysts Group, the Chemical Catalysts Group, and the Environmental Catalysts Group. The Pigments and Additives segment consists of the Paper Pigments and Chemicals Group and the Specialty Minerals and Colors Group. The Engineered Materials and Precious Metals Management group comprise the third business segment.

CMS member Tom Dombrowski works with the Paper Pigments and Additives R & D Group. At Engelhard and previously at Georgia Kaolin, Tom has worked primarily on the processing and utilization of kaolinite for the paper industry. Tom received a master's and doctorate at Indiana University on the distribution of trace elements in kaolins from the Georgia-South Carolina kaolin district and their relationship to the kaolin source material. While at Indiana, he spent three months at Ernst-Mortiz-Armdt

University in Griefswald, Germany.

In response to questions posed by *CMS News*, Tom had the following comments to make.

I work primarily with the beneficiation and utilization of the mineral kaolinite, which is found in the Georgia-South Carolina kaolin deposits. This is a very interesting and challenging line of work because our primary customer, the paper industry, is demanding better performance characteristics from our kaolin. Therefore, as researchers, we are faced with the challenge of meeting the increasing needs of the paper industry with a finite resource that must be beneficiated and manipulated for specific purposes.

My job is a mixture of applied and fundamental research. To conduct applied research on clay, one must understand the fundamental nature of the material. Once we have a fundamental understanding of our problems, we are a lot better at finding solutions to them. In addition to solving specific business-related problems, we work on developing a fundamental understanding of our resources for the long term. In this part of my work, I am not so worried about solving a specific problem, *per se*, but about advancing our knowledge of our kaolins so that we can better serve our customers in the future.

The Engelhard Research Center has outstanding abilities to characterize fine materials by chemical, physical, and microscopic means, and these techniques are used to understand the nature of the problems with which we concern ourselves. In addition to the in-house facilities, we are encouraged



Tom Dombrowski and Inez Moselle, San Diego, 1993.

*High Iron Photos*

to collaborate with outside parties who can add to our fundamental knowledge base so that we can better serve our customers.

Inez Moselle is a patent agent who works for the patent department. She received a bachelor's degree in chemical engineering from Cornell University and supplemented this knowledge with graduate level chemistry classes. She performs a number of functions that are related to Engelhard's process development and research efforts. She keeps track of pertinent literature and disseminates that information to managers and researchers who may be able to find a use for that technology within Engelhard, or whom she feels needs to be informed about the new technology.

Inez has been with Engelhard since 1957 and has seen all the changes in kaolin and other clay minerals processing that are considered modern advancements. She has an experience level that is unsurpassed, and with that experience comes a practical knowledge of clays. Inez has a knowledge and understanding of clay minerals that comes from years of

*continued on next page*

**Engelhard, continued**

working, and it can truthfully be said that they "don't teach that in school."

It is also good to involve the patent department early in research and process development because Inez and her group have a wealth of ideas on how to make a patent stronger and more beneficial to Engelhard. Her technical background is a real strength because she can suggest additional work that can speed the patent application process and in many cases, make the patent stronger and more precise.

The research I do can be viewed as important on a variety of levels. From the applied research point of view, Engelhard is a profit-making company, and we have to satisfy our customers' needs. The historical evolution of the kaolin industry has been one of using poorer and poorer kaolins for more demanding uses. We are using kaolin today that would have been discarded a decade ago, and we are using the kaolins in applications that have the strictest limits ever. This has been true for every generation of kaolin worker this century. Therefore, clay mineral research has been needed to support the economy of the Georgia-South Carolina kaolin areas. On a more global level, I learned from my major professor, Haydn Murray, that the economic welfare of a society is a function of its industrial mineral wealth. Whereas kaolin is the most highly processed industrial mineral and most ubiquitously used clay mineral, kaolin researchers are providing some benefit to the standard of living of our society. And on the other hand, one must retain a certain humility about one's research on kaolinite because, to a certain extent, all we are doing is playing with mud.

I spend the majority of my time with kaolinite, but kaolins have minor amounts of illite and smectite. Small abundances of illite and smectite can have a dramatic effect on the utility

of the resource. Engelhard also has palygorskite deposits in south Georgia and bentonite deposits in Mississippi. Engelhard's fullers earth deposits in south Georgia are referred to as attapulgite rather than as palygorskite. I look at issues related to these deposits in my "spare time."

I see the future of clay research being driven by multidisciplinary research efforts and refinements in analytical methods. Today the world of clay mineral research is expanding by the inclusion of many different types of scientists—chemists with expertise in many facets of chemistry, soil scientists, physicists, environmental scientists, hydrogeologists, civil engineers, materials scientists, ceramic engineers, geologists, mineralogists—and each discipline has a unique manner of viewing clay minerals. The biggest "breakthrough" that I see in the future is that these people with diverse backgrounds are talking to each other and sharing their discoveries. Many new discoveries are made because people are analyzing clay with more sophisticated instruments and analytical techniques. The arbitrary limit of clay-sized material, 4 or 2 $\mu$ m, that once seemed so small now appears huge in light of discoveries and products made of 0.1  $\mu$ m to single nanometer size material. Often new information contradicts our paradigm of a clay mineral, and we must go back and check our premises. I see this happening with respect to kaolinite which is viewed as a "simple" clay mineral, so I am sure the learning process will go on long beyond my lifetime.

The technical issues facing the kaolin industry have not changed this century. Like every other mining industry, we have used the best material first and are now having to use more elaborate beneficiation schemes to meet our customers' needs. This situation makes research a necessity. The geopolitical issues facing the kaolin industry impose new challenges. Established producing areas

such as Cornwall and the southeastern U.S. are facing competition from emerging areas such as Brazil. In addition, new products such as precipitated calcium carbonate have made significant inroads in traditional kaolin markets. All these issues have to be faced with a better understanding of our resources.

Concerning Sustaining Membership, it is important to have a medium where representatives of varied industries, academic disciplines, and government research laboratories can exchange data, in print and in person, concerning clay minerals. The information is expanding so rapidly that no one individual or group can stay on top of all the breaking developments; therefore, there is a need for a "clearing house." Engelhard believes the CMS publications and meetings meet this need, and that is why Engelhard is proud to be a CMS Sustaining Patron.

I would like to publicly acknowledge my colleagues and professors that I have worked with in academia at the University of Georgia, Indiana University, and in the kaolin industry at Georgia Kaolin and Engelhard. I am very grateful for what I have learned from peers and co-workers. Some of the things I have learned in an office, laboratory, in a mine, or over a beer, and I would like to thank everybody for their contribution to my education. The CMS does not have the resources for me to thank everyone individually.

Finally, I would like to express my regards to The Clay Minerals Society for the organization they have developed. I believe the journal *Clays and Clay Minerals* is a first-class journal in all respects, and the annual meetings of the Society are without a doubt the best I have ever attended. The Society is one that promotes an openness among its members that I have not experienced at any other professional meeting.

*Tom Dombrowski  
Iselin, New Jersey*

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## The Clay Minerals Society 31st Annual Meeting

August 13-18, 1994  
Saskatoon, Saskatchewan

Sponsored by:  
Saskatchewan Institute of Pedology, Department of Soil Science, University of Saskatchewan

### Symposia Sessions

- \* Clays and the Environment
- \* Smectites
- \* Fundamental Properties of Clay Minerals
- \* Geotechnical Engineering of Clay Minerals
- \* Stable Isotope Geochemistry of Clays

Papers on other topics will be placed in general poster and oral sessions.

Kathryn Nagy and Alex Blum will organize a scanning probe microscopy of clays workshop on Saturday, August 13th. Dr. B. Schreiner (Saskatchewan Research Council) will lead the field trip to a potash mine shaft and Tertiary and Cretaceous clays of the Western Interior Basin in Southern Saskatchewan, August 18th. **Meeting Chair: Ahmet R. Mermut, Department of Soil Science, Saskatchewan Institute of Pedology, University of Saskatchewan, Saskatoon, SK S7N 0W0, Canada. Telephone: 306-966-6839. Fax: 306-966-6881. E-mail: mermut@sask.usak.ca**

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### *Books available from the CMS*

The Clay Minerals Society offers a number of publications at a discount to its members. Below is a list of available books and slide sets. To order, please send the required amount plus \$2.00 postage per book, in U.S. funds drawn on a U.S. bank, to The Clay Minerals Society, P. O. Box 4416, Boulder, CO 80306. Mastercard and Visa also accepted. Please include name as it appears on the card, card number, expiration date, and telephone number. Prices subject to change.

- Quantitative Mineral Analysis of Clays, CMS Workshop Lectures, Volume 1, Pevear & Mumpton, editors, \$14.00**
- Electron-Optical Methods in Clay Science, CMS Workshop Lectures, Volume 2, Mackinnon & Mumpton, editors, \$18.00**
- Thermal Analysis in Clay Science, CMS Workshop Lectures, Volume 3, Bish, Mumpton, & Stucki, editors, \$10.00**
- Package price, Volumes 1, 2, & 3, CMS Workshop Lectures, \$21.00**
- Clay-Water Interface and its Rheological Implications, CMS Workshop Lectures, Volume 4, Güven & Pollastro, editors, \$15.00**
- Computer Applications to X-ray Powder Diffraction Analysis of Clay Minerals, CMS Workshop Lectures, Volume 5, Reynolds & Walker, editors, \$15.00**
- Kaolin Genesis and Utilization, CMS Special Publication No. 1, Murray, Bundy, & Harvey, editors, \$20.00**
- Proceedings of the International Clay Conference 1985, Schulze, van Olphen, & Mumpton, eds., \$15.00 (previously \$64.00)**
- Crystallography Slide Set, Symmetry Drawings of the Seventeen Plane Groups, Prepared by Audrey C. Rule for the CMS, \$32.00**
- Mica Polytype Slide Set, Prepared by Audrey C. Rule for the CMS, \$15.00**
- Hydrous Phyllosilicates, MSA Review Series, Bailey, editor, \$21.00**
- Modern Powder Diffraction, MSA Review Series, Bish and Post, editors, \$20.00**
- Clay Minerals for Petroleum Geologists & Engineers, SEPM Short Course, Eslinger & Pevear, editors, \$28.00**
- X-Ray Diffraction and the Identification and Analysis of Clay Minerals, Moore & Reynolds, Jr., \$25.00**



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